Cyprus

Seventh National Communication
& Third Biennial Report
- under the United Nations Framework Convention on Climate Change

Department of Environment

Ministry of Agriculture,
Rural Development and Environment

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Title of report	**2018 7th National Communication and 3rd Biennial report under the UNFCCC of Cyprus**
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CYPRUS' SEVENTH NATIONAL COMMUNICATION

1. Introduction

This document represents the Cyprus' seventh National Communication (7NC) required under the United Nations Framework Convention on Climate Change (UNFCCC), as reaffirmed by UNFCCC decision 9/CP.16 and UNFCCC decision 2/CP.17. It provides a comprehensive overview of climate change-related activity in Cyprus.

As defined in the UNFCCC reporting guidelines for National Communications[1], the information is structured into:

- National circumstances relevant to greenhouse gas emissions and removals (Chapter 2);
- Greenhouse gas inventory information (Chapter 3);
- Policies and measures (Chapter 4);
- Projections and the total effects of policies and measures (Chapter 5);
- Vulnerability assessment, climate change impacts and adaptation measures (Chapter 6);
- Financial resources and transfer of technology (Chapter 7);
- Research and systemic observation (Chapter 8) and
- Education, training and public awareness (Chapter 9).

UNFCCC decision 2/CP.17 also requires the Cyprus to submit its third Biennial Report (BR) by 1st January 2018. The UNFCCC reporting guidelines for National Communications content-wise overlap with the UNFCCC biennial reporting guidelines for developed country Parties (Annex I of decision 2/CP.17).

As endorsed in UNFCCC decision 2/CP.17, Cyprus has opted to submit its third Biennial Report as Annex 1 to this 7th National Communication. The tables as defined in the common tabular format (CTF) for the UNFCCC biennial reporting guidelines for developed country Parties (UNFCCC decision 19/CP.18) are enclosed as Appendix to Annex I. For the CTF submission to the UNFCCC, the electronic reporting facility provided by the UNFCCC secretariat has been used as required by UNFCCC decision 19/CP.18.

To avoid unnecessary duplication of information, overlapping contents were concentrated in the seventh National Communication: Those sections of the third Biennial report's main body which content-wise would be identical to sections of the seventh National Communication, do thus solely contain a reference to the corresponding section of seventh National Communication.

This communication focuses to the years up to which data is available; i.e. until 2016.

[1] FCCC/CP/1999/7 part II, in combination with UNFCCC decision 15/CMP.1

2. National circumstances

2.1. Introduction

This chapter reports the national circumstances of the Republic of Cyprus. It illustrates a number of key characteristics that relate directly or indirectly to the greenhouse gas emissions and include energy, transport, land use, climatic conditions and trade patterns. The chapter analyses how these various factors have influenced greenhouse gas emissions to-date and how the historic trends observed might influence emissions going forward.

The Ministry of Agriculture, Rural Development and Environment is the governmental body with the overall responsibility for the preparation, approval and submission of national communications (Contact persons: Dr Theodoulos Mesimeris and Dr Nicoletta Kythreotou, UNFCCC National Focal Points). Experts from governmental and non-governmental institutions participated in the preparation of the present national communication as information providers.

2.2. Geographic profile

Cyprus is an island country, located in the eastern end of the Mediterranean Sea, and the third largest island in the Mediterranean Sea, after the Italian islands of Sicily and Sardinia (both in terms of area and population). The total area of the island is 9,251 km^2. It measures 240 km long and 100 km wide at its widest point. It lies between latitudes 34° and 36° N, and longitudes 32° and 35° E.

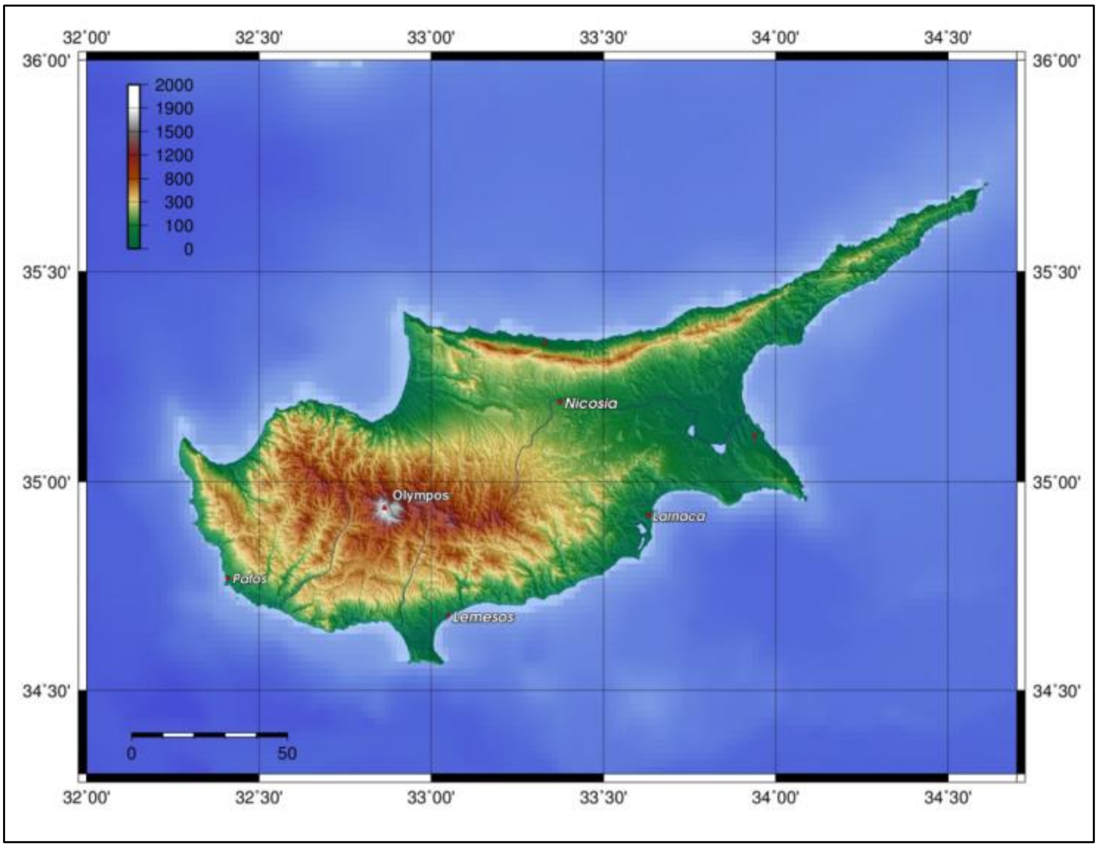

Figure 2.1. Topographic map of Cyprus

The physical relief of the island is dominated by two mountain ranges, the Troodos Mountains and the smaller Kyrenia Range, and the central plain they encompass, the Mesaoria. The Mesaoria plain is drained by the Pedieos River, the longest on the island. The Troodos Mountains cover most of the southern and western portions of the island and account for roughly half its area. The highest point on Cyprus is Mount Olympus at 1,952 m, located in the centre of the Troodos range. The narrow Kyrenia Range, extending along the northern coastline, occupies substantially less area, and elevations are lower, reaching a maximum of 1,024 m.

2.3. Government Structure

Cyprus is an independent sovereign Republic with a presidential system of government. The constitution provides for separate executive, legislative and judicial branches of government with independent powers. The President is both Head of State and Government.

Presidency

According to the 1960 Constitution, the President is to be Greek Cypriot elected directly by the Greek Cypriot community and the Vice-President is to be Turkish Cypriot elected directly by the Turkish Cypriot community, for a five-year term of office. The Constitution provides that executive power is exercised jointly by the President and the Vice-President, through a Council of Ministers appointed by them (seven and three ministers respectively).

Both the President and the Vice-President have the right of final veto on decisions of the Council of Ministers and laws or decisions of the House of Representatives concerning foreign affairs, defence and security. In 1964, however, the Turkish Cypriot Vice-President and the three Turkish Cypriot ministers withdrew from the government and since then the government has been functioning by necessity only with Greek Cypriots in all ministries, which have been subsequently increased to eleven. The post of Vice-President remains vacant.

The ministries are the following: Ministry of Defence, Ministry of Agriculture, Rural Development and Environment, Ministry of Justice and Public Order, Ministry of Energy, Commerce, Industry and Tourism, Ministry of Foreign Affairs, Ministry of Labour, Welfare and Social Insurance, Ministry of the Interior, Ministry of Finance, Ministry of Education and Culture, Ministry of Transport, Communications and Works, Ministry of Health.

Council of Ministers

The Council of Ministers exercises executive power in all matters. Each Minister is the head of his or her Ministry and exercises executive power on all matters within that Ministry's domain. The Government Spokesman and the Deputy Minister to the President are also present at the meetings of the Council of Ministers. The Ministers are appointed by the President. The ministries mainly prepare and implement national laws.

Local Authorities

Cyprus is separated into 6 districts: Nicosia (Lefkosia), Limassol (Lemesos), Pafos, Larnaca, Ammochostos and Keryneia (Figure 2.2). Each district has a District Officer, who reports to the Minister for the Interior. Keryneia are not under the effective control of the Republic of Cyprus, whereas Ammochostos is partially under the effective control of the Republic of Cyprus.

There are two types of local authorities: Municipalities and Communities, which are governed by separate laws. In principle, Municipalities constitute the form of local government in urban and tourist centres, while Communities constitute the local structure in rural areas. Mayors and Community Presidents are elected directly by the residents for a five-year term.

Any Community may become a Municipality by local referendum subject to the approval of the Council of Ministers, provided it has either a population of more than 5,000, or has the economic resources to function as a Municipality. The main responsibilities of Municipalities are the construction, maintenance and lighting of streets, the collection, disposal and treatment of waste and environmental protection and improvement. The functions of Communities are generally similar to those of Municipalities, although structurally different. The government provides to most Communities essential administrative and technical assistance through its District Offices.

Currently, there are 39 municipalities and 485 communities, of which 9 and 132 respectively are not under the effective control of the Republic of Cyprus.

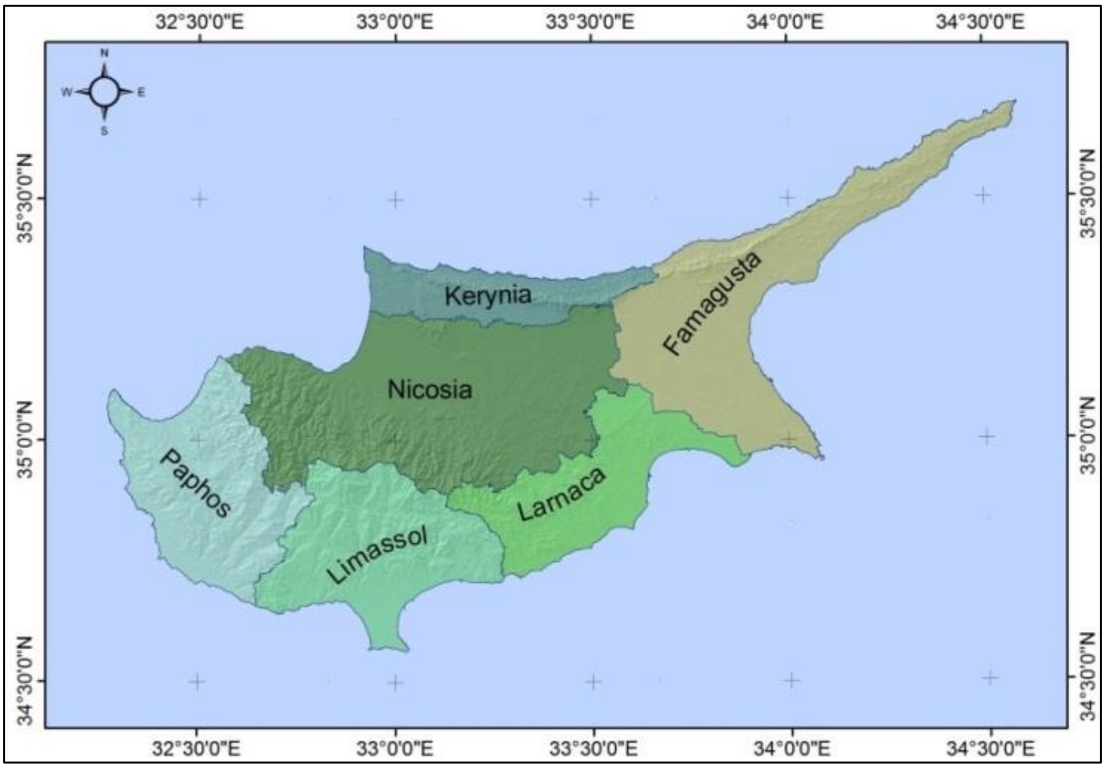

Figure 2.2. The six administrative districts of Cyprus

Legislature

House of Representatives

Legislative authority is exercised by a unicameral House of Representatives. Its members are elected for a five-year term. At the time of its establishment the House consisted of 50 members, 35 of whom were to be Greek Cypriots and 15 Turkish Cypriots. In 1985 the number of seats was increased to 80, 56 allocated to Greek Cypriot members and 24 reserved for Turkish Cypriot deputies. Following the withdrawal of the Turkish Cypriot members in 1964, the House has been functioning only with the Greek Cypriot members.

The Maronite, Armenian and Latin religious groups, which vote as part of the Greek Cypriot community, elect one additional representative each from their ranks. These non-voting representatives attend meetings, but do not participate in the House deliberations. They are consulted on issues of particular interest to their respective group.

Given the vacancy in the Vice- President's office, the House President serves as Acting President of the Republic in the case of temporary absence or temporary incapacity of the President of the Republic.

Judiciary

The administration of justice is exercised by the Republic's separate and independent judiciary. Under the 1960 Constitution and other legislation in force, the following judicial institutions have been established: The Supreme Court, The Assize Courts and District Courts.

Independent Officers and Bodies

There are also independent officers and bodies which do not come under any ministry, including the: Attorney-General and Auditor-General who head the Law Office and Audit Office respectively;

Governor of the Central Bank; Ombudsman (Commissioner for Administration); Public Service Commission; Education Service Commission; Planning Bureau; Treasury; Commission for the Protection of Competition; Commissioner of Electronic Communications and Postal Regulation; Commissioner for Personal Data Protection; Commissioner for the Protection of Children's Rights; Law Commissioner; Commissioner for the Environment; Commissioner for the Reform of the Civil Service; Commissioner for Humanitarian Affairs; Commissioner for Volunteering and Nongovernmental Organisations; Tenders Review Authority; Internal Audit Service; Cyprus Radio Television Authority; Cyprus Securities and Exchange Commission.

Member of the European Union

On 1 May 2004 the Republic of Cyprus became a full member of the EU. Accession to the EU was a natural choice for Cyprus, dictated by its culture, civilisation, history, its European outlook and adherence to the ideals of democracy, freedom and justice.

The application of the EU laws and regulations (the acquis communautaire) is suspended in the area under military occupation by Turkey, pending a solution to the occupation and forcible division of the country. Meanwhile, the government, in cooperation with the EU Commission, has been promoting arrangements to facilitate increased economic transactions between the two communities and improve the standard of living of Turkish Cypriots, who are also victims of Turkey's military aggression against Cyprus.

While Cyprus has a lot to benefit from EU membership, it also has a lot to offer as a member state. Strategically situated at the crossroads of Europe, the Middle East, North Africa and Asia, Cyprus is becoming an even more important regional business centre, as well as an international communications and transport hub. It is also a prospective energy (natural gas) provider for Europe.

Given its modern infrastructure, sound legal system, tax incentives, low crime rate and well educated labour force, Cyprus is a favourite regional operations platform for European and other international companies.

Since its accession to the EU, Cyprus has undergone significant structural reforms that have transformed its economic landscape. Trade and interest rates have been liberalised, while price controls and investment restrictions have been lifted. Private financing has been introduced for the construction and operation of major infrastructure projects and monopolies have been abolished.

Cyprus held the Presidency of the Council of the European Union for the first time from July – December 2012.

2.4. Population[2]

In general, aggregate increases in population are drivers for increasing consumption, energy use and greenhouse gas emissions. The population of Cyprus is estimated at 947.000 at the end of 2016 compared with 940.100 the previous year, recording an increase of 0.7%. Total population figures do not include illegal settlers from Turkey. Out of a total of 947.000 inhabitants, the estimated composition of the population by community at the end of 2016 was:

- Greek Cypriot community 706.800 or 74,6%
- Turkish Cypriot community 92.200 or 9,8%
- Foreign residents 148.000 or 15,6%

The population of the Government controlled area is estimated at 854.800 at the end of 2016, compared to 848.300 at the end of 2015, recording an increase of 0,8%.

[2] Information on population was obtained from the publication: Demographic Report 2016 (Statistical Service, 2017)

2.5. Climate[3]

Cyprus has an intense Mediterranean climate with the typical seasonal rhythm strongly marked in respect of temperature, rainfall and weather generally. Hot and dry summers from mid-May to mid-October and mild, rainy, rather changeable, winters from November to mid-March are separated by short autumn and spring seasons of rapid change in weather conditions.

The central Troodos massif, rising to 1951 metres and, to a less extent, the long narrow Kyrenia mountain range, with peaks of about 1,000 metres, play an important part in the climate of Cyprus. The predominantly clear skies and high sunshine amounts give large seasonal and daily differences between temperatures of the sea and the interior of the island which also cause considerable local effects especially near the coasts.

During the summer, the island is mainly under the influence of a trough of low pressure extending from the great continental thermal low centred over southwest Asia. It is a season of high temperatures with almost cloudless skies. Rainfall is almost negligible, but isolated thunderstorms sometimes occur which give rainfall amounting to less than 5% of the total in the average year.

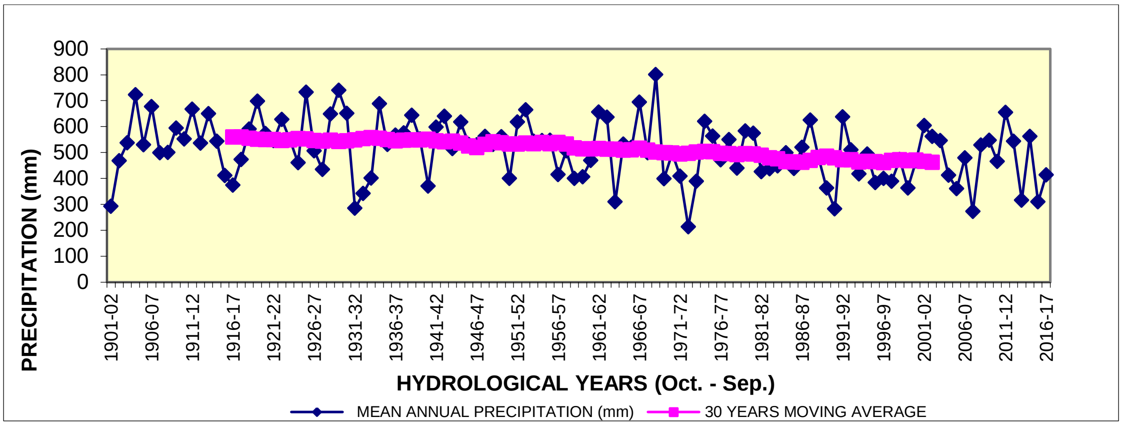

Figure 2.3. Mean annual precipitation in Cyprus 1901-02 – 2016-17 (normal 1961-90: 503 mm)

In winter Cyprus is near the track of fairly frequent depressions which mainly cross the Mediterranean Sea from west to east. These depressions give periods of unsaddle weather conditions usually lasting from two to five days and produce most of the annual precipitation. Snow occurs rarely in the lowlands and on the Kyrenia range, but falls frequently every winter on ground above 1,000 metres usually occurring by the first week in December and ending by the middle of April.

Precipitation

The mean annual precipitation varies from year to year and from place to place. The lowest mean annual precipitation for Cyprus was 213mm in 1972-73 and the highest was 800mm in 1968-69. The mean annual precipitation for the period 1961-90 is 503mm. The wettest months are normally December, January and February and the driest are July, August and September.

Statistical analysis of rainfall in Cyprus reveals a decreasing trend of rainfall amounts in the last 116 years. Annual precipitation in Cyprus has on average decreased by about 100mm in the last 85 years (see Figure 2.4).

During the recent years, it has been observed that even though the total annual amount of rainfall does not change significantly, the annual distribution of rainfall has changed considerably, showing extreme rainfall years large amounts of rain alternating with periods of drought (Michaelides et al. 2009).

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Temperature

Cyprus has a hot summer and mild winter, but this generalization must be modified by consideration of altitude, which lowers temperatures by about 5°C per 1,000 metres and of marine influences which give cooler summers and warmer winters near most of the coastline and especially on the west coast.

The annual mean temperature for Cyprus varies from year to year, from 16.1°C to 19.7°C, with an average of 17.5°C. The year 2010 was the warmest ever recorded in Cyprus. The years 1961, 1965 and 1967 were the coldest in the last 62 years.

The seasonal difference between mid-summer and mid-winter temperatures is quite large at 18°C inland and about 14°C on the coasts. Differences between day maximum and night minimum temperatures are also quite large especially inland in summer. These differences are in winter 8 to 10°C on the lowlands and 5 to 6°C on the mountains increasing in summer to 16°C on the central plain and 9 to 12°C elsewhere.

The average annual temperature in Cyprus, both in urban and in rural areas, presents an increasing trend. The greater increase in temperature in the towns is due to the urbanization effect, however, the fact that an increase is also observed in rural areas, it is indicative of the general increase in temperature in our area as well as globally. In Nicosia the average annual temperature increased from 18.9°C in the first 30-year period of the century to 20.3°C in the last 30-year period, an increase of 1.4°C (see figure below).

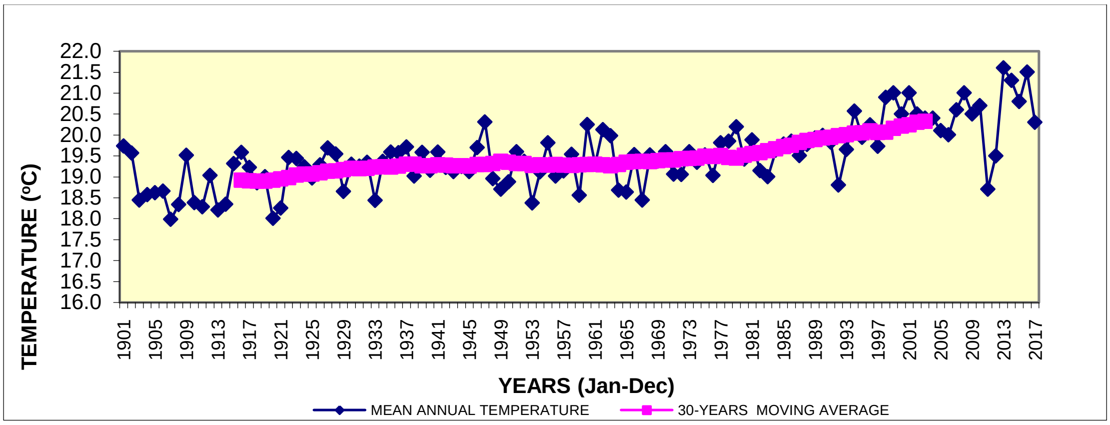

Figure 2.4. Mean annual temperature for Nicosia 1901-2017 (normal 1961-90: 19.5 °C)

Wind

Over the eastern Mediterranean generally surface winds are mostly westerly or south-westerly in winter and north-westerly or northerly in summer. Usually of light or moderate strength, they rarely reach gale force.

Over the island of Cyprus however winds are quite variable in direction with orography and local heating effects playing a large part in determination of local wind direction and strength. Temperature differences between sea and land which are built up daily in predominant periods of clear skies (mainly in summer), cause considerable sea and land breezes. Whilst these are most marked near the coasts they regularly penetrate far inland.

Gales are infrequent over Cyprus but may occur especially on exposed coasts with winter depressions. Small whirlwinds are common in summer appearing mostly near midday as "dust devils" on the hot dry central plain. Very rarely vortices, approaching a diameter of 100 metres or so and with the characteristics of water spouts at sea and of small tornadoes on land occur in a thundery type of weather. Localized damage caused by these has been reported on a few occasions but in general Cyprus suffers relatively little wind damage.

Sunshine

All parts of Cyprus enjoy a very sunny climate compared with most European countries. In the central plain and eastern lowlands the average number of hours of bright sunshine for the whole year is 75% of the time that the sun is above the horizon. Over the whole summer six months there is an average of 11.5 hours of bright sunshine per day whilst in winter this is reduced only to 5.5 hours in the cloudiest months, December and January.

Even on the high mountains the cloudiest winter months have an average of nearly 4 hours bright sunshine per day which goes up to 11 hours during June and July.

2.6. Economy[4]

The economic profile of a country has a strong link to greenhouse gas emissions, with the overall level and types of economic activity, strongly correlated to energy use. However, this is also dependent on factors such as energy efficiency and the structure of the economy.

The economy of Cyprus can generally be characterised as small, open and dynamic, with services constituting its engine power. Since the accession of the country to the European Union on 1 May 2004 the subsequent participation to the ERMII in 29 April 2005 and finally membership to the EURO area as of January 1st 2008, its economy has undergone significant economic and structural reforms that have transformed the economic landscape. Interest rates have been liberalised exchange rates and monetary policy was undertaken by the ECB, while other wide-ranging structural reforms have been promoted, covering the areas of competition, the financial sector and the business sector.

The tertiary sector (services) is the biggest contributor to GVA, accounting for about for about 86.5% in 2016. This development reflects the gradual restructuring of the Cypriot economy from an exporter of minerals and agricultural products in the period 1961-73 and an exporter of manufactured goods in the latter part of the 1970s and the early part of the 80s, to an international tourist, business and services centre during the 1980s, 1990s and the 2000s. The secondary sector (manufacturing) accounted for around 11.4% of GVA in 2016. The primary sector (agriculture and fishing) is continuously shrinking and only reached 2.1% of GVA in 2016.

Table 2.1. Main economic indicators

	2013	2014	2015	2016
GDP (in € mln)	18,140	17,606	17,742	18,123
Real GDP growth rate	-5.9%	-1.4%	2.0%	3.0%
Per capita GDP in PPS, (EU-28 = 100)	84	81	81	81
Rate of Inflation HICP	0.4%	-0.3%	-1.5%	-1.2%
Unemployment Rate	15.9%	16.1%	14.9%	12.9%
Employment Growth	-5.9%	-1.8%	1.5%	3.2%

The private sector, which is dominated by small and medium-sized enterprises, has a leading role in the production process. On the other hand, the government’s role is mainly to support the private sector and regulate the markets in order to maintain conditions of macroeconomic stability and a favourable business climate, via the creation of the necessary legal and institutional framework and secure conditions of fair competition.

Before the emergence of the global economic crisis Cyprus had enjoyed a track record of satisfactory economic growth, low unemployment and relatively stable macroeconomic conditions. Over the years 2003 to 2008, real GDP rose at an annual average rate of 4 per cent propelled by buoyant investment and growth of private consumption and exports. Consumption was supported by annual employment growth averaging nearly 3.5 per cent over this period, attributable mainly to large inflows of migrant labour, particularly from other EU countries. During this period, per capita income in Cyprus converged rapidly with the EU-27, with GDP in euro per capita terms reaching €21,812 in 2008, or 100 per cent of the EU average in purchasing power parity terms.

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The average annual growth in the five years (2008–2012) was 0.1 per cent, while inflation stood at 2.7 per cent and unemployment (as a percentage of the economically active population) at 7 per cent over that period. During that period the international economic crisis affected Cyprus indirectly mainly through lower external demand in tourism, whilst investment was also affected by lower external demand for housing by foreigners.

However, the crisis highlighted large existing imbalances in the economy stemming from the banking sector's large exposure in the Greek economy, domestic overexpansion in the property market and its overall size relative to the economy. At the same time persistent "twin deficits" in the fiscal and current account elevated the economy's vulnerability. Following the loss of market access in May 2011, the government of Cyprus requested financial assistance from its Eurozone partners and the IMF in June 2012. After a period of negotiations, a decision was taken by the Eurogroup and the Executive Board of the IMF in March and April 2013 for a 3-year Macroeconomic Adjustment Programme (the "MAP") to March 2016 of €10 billion financing via the European Stability Mechanism and the IMF.

The MAP agreed with Programme Partners addressed short- and medium-term challenges in the financial, fiscal and structural areas. The programme aimed at bringing back macroeconomic stability through the restoration of market confidence in the financial system, continuing with the ongoing fiscal consolidation process and implementing structural reforms to support competitiveness and sustainable and balanced growth, allowing for the unwinding of macroeconomic imbalances. The MAP was ambitious and addressed fundamental challenges of the Cyprus economy by promoting major reforms in the banking and fiscal areas as well in structural matters. The key programme objectives were:

- to restore the soundness of the Cypriot banking sector and rebuild depositors' and market confidence by thoroughly restructuring and downsizing financial institutions and strengthening supervision;
- to continue the on-going process of fiscal consolidation in order to correct the excessive general government deficit by 2016, in particular through measures to reduce current primary expenditure, and maintain fiscal consolidation in the medium-term, in particular through measures to increase the efficiency of public spending within a medium-term budgetary framework, enhance revenue collection and improve the functioning of the public sector; and
- to implement structural reforms to support competitiveness and sustainable and balanced growth, allowing for the unwinding of macroeconomic imbalances, in particular by reforming the wage indexation system and removing obstacles to the smooth functioning of services markets.

Cyprus authorities successfully completed the three year macro-economic adjustment program leading to an overall transformation of the production sectors of the economy

The agreement reached on a Memorandum of Understanding in March 2013 safeguarding a financial assistance programme for a three-year period contributed to the gradual stabilisation of the Cyprus economy and its gradual transformation leading to a steady recovery in confidence levels.

The resilience of the Cyprus economy has been shown by the fact that economic activity contracted by 5.9% in 2013 compared to a forecast contraction of 8.7%, while in 2014, the recession was contained to approximately 1.4% compared with a projected contraction of 3.9%.The resilience of the business sector, as well as, the better than anticipated performance in the tourist sector, contributed to the containment of the severity of the contraction of the economy.

In 2015, positive growth was achieved for the first time since 2011 to about 2% and further accelerated in 2016 (growth of 3%). Growth has been broad-based, driven by very strong performance in the tourism sector, improved labour market conditions and gradual recovery in investment.

Unemployment also fared better than expected as it peeked to around 16.1% in 2014, despite projections of more than 20% of the labour force. A concerning issue however is the high rate of youth unemployment, as well as the long-term unemployment. Youth unemployment has been on a declining path since 2014. In 2016, unemployment fell to 12.9% and is expected to continue on a downward trend.

As regards public finances, targets have been met with considerable margins. In 2015, the budget deficit fell below the reference value of 3% of GDP at around 1%, one year ahead of the deadline set by the ECOFIN Council, allowing for the abrogation of the Excessive Deficit Procedure to commence. The nominal budget balance turned in surplus reaching 0.5% of GDP in 2016. This robust fiscal performance has supported debt sustainability, with public debt expected to drop below 100% of GDP by 2017.

In the context of the MOU, the Cypriot Banking Sector has been recapitalised and also went through significant restructuring. The supervisory framework has also been strengthened and enhanced while specific measures have been adopted in order to tackle the main challenge in this sector, that is the high level of Non-Performing Loans. These measures include, the new Foreclosure and Insolvency Laws, which introduce the right incentives for all stakeholders, including creditors and debtors, to negotiate a settlement of liabilities. They also create a safety net for vulnerable groups directly affected by the crisis.

Overall, the better than expected performance of the Cyprus economy is also reflected in the upgrades by credit rating agencies, which emphasise the successful transformation of the economy and the rapid correction of macroeconomic imbalances, as well as the impressive performance and resilience of the Cyprus economy.

In the longer term, the recent explorations for hydrocarbon reserves that have taken place in the Exclusive Economic Zone of Cyprus have revealed positive prospects for the development of the industry, which will have significant implications for the Cyprus economy. The Government has submitted a holistic legal framework regarding economic policy surrounding the exploration, discovery and exploitation of natural gas in Cyprus to the House of Representatives for their considerations and approval.

2.6.1. Trade patterns[5]

Due to the island's small domestic market and the open nature of its economy, trade and access to international markets is of utmost importance for Cyprus' well-being. The country's trade balance is traditionally in deficit because the island has to import extensively in order to satisfy domestic demand, while the island also depends on imports for its energy supplies. In 2016 Cyprus exported €2.71B and imported €7.12B, resulting in a negative trade balance of €4.40B.

During the last five years the total exports of Cyprus have increased by 94%, from €1.40B in 2010 to €2.71B in 2016. 'Vehicles, aircraft, vessels and associated transport equipment' lead the list with €1.02B followed by 'Mineral products' (including Refined Petroleum and Cement) with €0.50B, 'Products of the chemical or allied industries' (including Packed Medicaments) with €0.34B, 'Machinery, electrical equipment, sound recorders, etc.' (including Broadcasting Equipment) with €0.24B, 'Live animals, animal products' (including Halloumi) with €0.18B, 'Prepared foodstuffs, beverages, spirits and vinegar, tobacco and manufactured tobacco substitutes' with €0.13B, 'Vegetable products' (including Potatoes) with €0.08B and 'Base metal and articles' with €0.06B.

Dispatches to the European Union accounted for €1.20B (44%) in 2016 of the total exports. The top export destinations are the United Kingdom (€0.32B – 12%) and Greece (€0.27B – 10%). Exports to Near and Middle Eastern countries occupied the second place in importance with €0.27B in 2016. Exports to other Asian countries in 2016 amounted to €0.22B.

[5] Trade Policy and Bilateral Relations, Trade Service, Ministry of Energy, Commerce, Industry and Tourism, 6 Andrea Araouzou Street, Nicosia; Tel.: +357 22 867123 ;Fax: +357 22 375120; email: ts@mcit.gov.cy

During the last five years the imports of Cyprus have increased by 13%, from €6.31B in 2011 to €7.12B in 2016. The most recent imports are led by ‘Vehicles, aircraft, vessels and associated transport equipment’ with €2.36B followed by ‘Mineral products’ (including Refined Petroleum) with €1.07B, ‘Prepared foodstuffs, beverages, spirits and vinegar, tobacco and manufactured tobacco substitutes’ with €0.65B, ‘Machinery, electrical equipment and parts’ with €0.63B, and ‘Products of the chemical or allied industries’ with €0.57B.

The European Union continued to be the main source of supply of goods to Cyprus in 2016, with a share of €4.68B of total imports. Major suppliers within the Union were Greece with €1.28B, Germany with €1.18B, and Italy with €0.40B.

Imports from the rest of the world in 2016 amounted to €2.18B with China being the top import origin outside the EU (€0.55B).

2.7. Energy[6]

The energy sector in Cyprus[7]

A key challenge for Cyprus is its high dependency on fossil fuels for energy – the biggest share within the EU in fact, which makes it crucial for the country to develop both its hydrocarbon and renewable energy sources. Cyprus is reliant on fossil fuel imports for its electricity needs, and spends over 8% of its GDP to cover the costs.

The island also saw the biggest increase in energy demand among the EU28, growing 41% since 1990 from 1.6 million tonnes of oil equivalent (Mtoe) to 2.3 Mtoe in 2015. These figures may be low when compared with its larger EU partners, but a more accurate comparison would be Malta where consumption was only 0.8 Mtoe in 2015. However, Cyprus is determined to find a cleaner solution until it can exploit its own reserves.

The 13% Renewable Energy Sources (RES) goal for 2020 is set to be generated by wind farms, photovoltaic (PV) systems, solar thermal plants and biomass and biogas utilisation plants. Latest data show that RES accounted for 8.4% of electricity production in 2016. RES power production rose 6% in 2016, compared to 2015, mainly on increased output generated by private photovoltaic systems. Wind farms generated almost 55% of electricity from RES in 2016, while the private-owned photovoltaic systems generation rose by approximately 15% from 2015 to 2016.

In Cyprus, electricity from renewable sources is no more promoted through subsidy since 2013 where a net metering scheme and self-consumption has been put in place. In addition a new scheme was recently announced for RES that will participate in the competitive market.

Access of electricity from renewable energy sources to the grid shall be granted according to the principle of non-discrimination. With regard to the use of the grid renewable energy shall be given priority. Grid development is a matter of central planning (Transmission Grid Development Plan 2007-2016 by the Cypriot TSO). In addition, renewable heating and cooling (RES H&C) is promoted by support schemes offering subsidies to households.

However, the country’s national grid system has certain intrinsic and technical limitations affecting RES penetration and reliability of the energy system – such as the lack of interconnections to the trans-European electricity networks, a limitation to the amount of intermittent renewable energy that can be connected to the electricity system, and a lack of centralised storage capability.

To tackle these problems the country is exploring ways to introduce smart grids in the national network and is on the look-out for projects that could facilitate energy storage, and ventures that

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[7] Cyprus Profile, 2017, Energy and Environment, available at http://www.cyprusprofile.com/en/sectors/energy-and-environment (accessed 20/12/2017)

have production on a 24-hour basis. Also the EuroAsia Interconnector could bring more solutions in its wake.

The island is already one of the highest users per capita in the world of solar water heaters in households, with over 90% of households equipped with solar water heaters and over 50% of hotels using large systems of this kind. With almost year-round sunshine, Cyprus certainly has plenty of energy to harness, but competitive energy storing capabilities are crucial in order to fully tap into its solar potential and facilitate better RES penetration.

There continues to be much ground to cover in terms of renewable energy production, but international interest in developing the sector in Cyprus has been on the rise. In this respect, the production of renewable energy is expected to experience considerable growth in coming years, and significant investment is required in order for Cyprus to achieve its targets – opening the field for companies with expertise in renewables.

The Cyprus Energy Regulatory Authority (CERA) has worked towards the full opening up of the energy market and granting consumers the right to choose their own supplier – with expectations of a full liberalisation by May 2019. CERA's proposition is a 'net pool' model, where the operations of the state power company, EAC, are unbundled and the production and supply operations separated. EAC production would then enter into bilateral agreements with suppliers for the sale of energy at regulated prices. However, these plans have experienced some resistance from unions, as they are seen as moves which could put pressure to privatise the state power company.

«In respect to the supply of natural gas to Cyprus, the Council of Ministers, at its meeting in June 2016, decided to approve the import of Liquefied Natural Gas (LNG) to Cyprus in a manner leading to the commencement of natural gas supply preferably by the year 2020. For the purpose of implementing the Decision, the Cyprus Natural Gas Company (DEFA) was mandated to carry out a study which concluded that the preferred LNG supply option project is through the use of a floating infrastructure with the development of the necessary mooring facilities and pipeline connection to the natural gas receiving point at Vassilikos. On the basis of the results of the study the Council of Ministers, at its meeting on May 18th 2017, decided to mandate DEFA to issue, as soon as possible, an invitation for tenders regarding the long-term supply of LNG to Cyprus to satisfy electricity requirements and an invitation for tenders for the construction and operation of the necessary infrastructure. In parallel with the above DEFA was mandated to proceed with the FEED study for the internal pipeline network. The anticipated time plan for the implementation of the tenders is expected to take place in the first half of 2018.

The electrical interconnection with Israel and Greece will be the next major challenge in the country energy sector. Cyprus is promoting the «EuroAsia Interconnector» project as aiming at commissioning in 2019-2022. The project will effectively contribute to the security of energy supply and reduction in CO2 emissions by allowing the countries in the region renewable energy sources for electricity generation.

Energy use is the largest source of GHG emissions. The following sections provide a high-level overview of the most relevant factors. Climate policy drivers have had some impact on changes in the national energy system to-date (for-example leading to improvements in energy efficiency or increases in the share of renewables), although to a large extent these have been driven by other factors. Historic trends in GHG emissions from energy-related activities are shown in later sections. However, the impacts of future climate policy in the energy sector are likely to be far more significant, particularly as a result of the new EU Climate and Energy package. These will lead to more sizeable shifts in energy use towards renewables as well as an overall impact on primary and final energy consumption due to improvements in energy efficiency; these effects should become more noticeable within these indicators in coming years.

Total primary energy consumption in Cyprus rose over the period from 1990 despite continued efforts to improve energy efficiency. Trends in the consumption of different energy types within the total have changed significantly since 1990. Since 1990 there has been a decrease of nearly 38% in the consumption of carbon intensive coal used in cement industry.

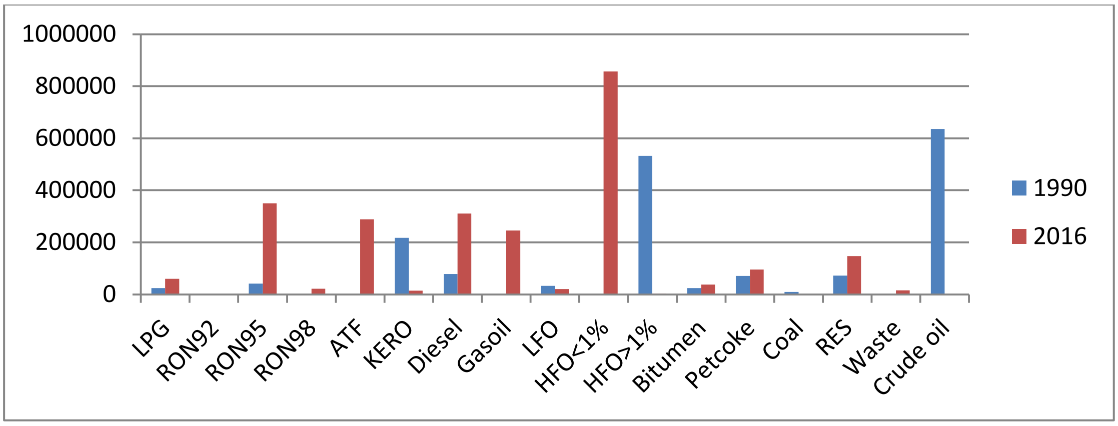

Figure 2.5. Primary energy consumption by fuel for Cyprus, 1990 and 2016

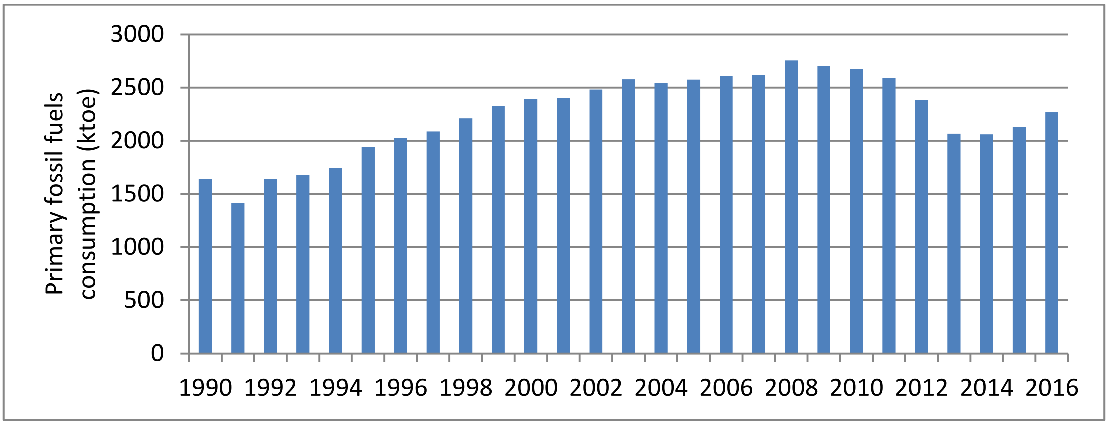

Figure 2.6. Primary consumption of fossil fuels in ktoe, 1990-2016

Renewables have the most marked increase with consumption increasing by 213% from 1990 levels.

Fossil fuels continue to dominate total energy consumption and the share of renewable energy sources remains small despite the increase in use. The overall increase in total primary energy consumption has also acted to counteract some of the environmental benefits from fuel switching.

The final energy needs of the economy of Cyprus for 2015 represent 73% of the country's primary energy consumption. There are very significant energy losses linked to the transformation and distribution of useful energy (e.g. as electricity) to the end users. Energy losses broadly depend on the average efficiency of conventional thermal power stations and CHP plants and the penetration of non-thermal renewables.

2.7.1. Energy Supply

All the oil consumed is from imports and the trend, although cyclical since 1990, has been upwards of 35% in 2015 since 1990. In the case of solid fuels, overall consumption has increased by 85% between 1990 and 2004, due to the thrive of the constructing industry. From 2004 until 2008 the consumption of solid fuel was stable, while after 2008, it decreases substantially to reach 1990s levels.

Although the absolute amount of electricity production from renewables has increased by more than 310 times since 2006 (Figure 2.7), renewable electricity still makes only a 8% contribution to total generation. Overall, the generation mix of electricity in Cyprus has become less carbon intensive since 2008, when the first combined cycle unit for the production of electricity entered in operation and the contribution of renewable sources started to be significant. The increase in total electricity production was 225% from 1990 to 2015.

The share of primary energy met by renewables has increased steadily over time to around 6.07% of total primary energy consumption in 2016. The bulk of renewable energy consumed, about 68 %, comes from solar thermal and biomass. Wind is the next biggest contributor, providing 13% of total renewable energy). Biofuels has seen the biggest increase - from zero 0 in 1990 to contributing around 6% of total renewable energy in 2016.

Based on 2016 figures Cyprus, as all EU countries, has a significant challenge ahead to reach the new Renewable Energy Sources (RES) targets for 2020. The RES targets include all sources of electricity, heat and transport fuel. Cyprus' target is 13% of the final energy consumption to be from renewable sources by 2020.

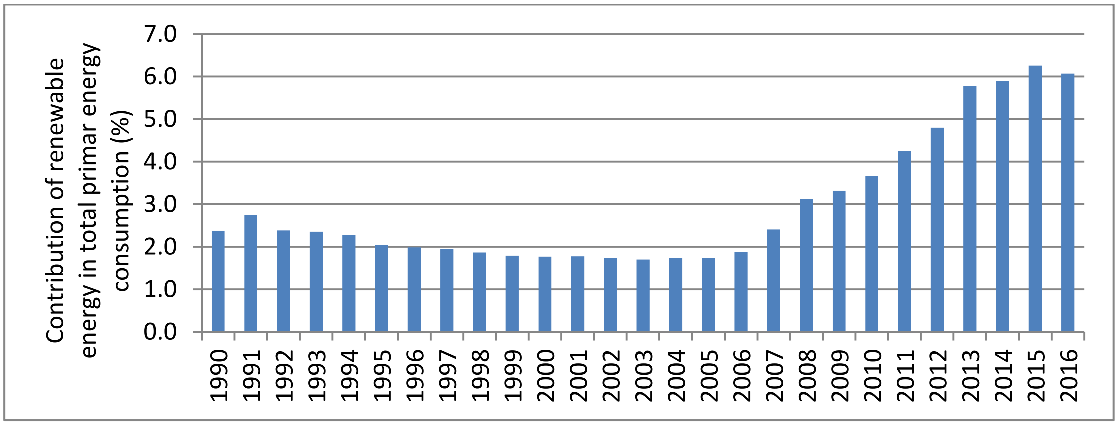

Figure 2.7. Share of renewable energy in total primary energy consumption in per cent, 1990-2016

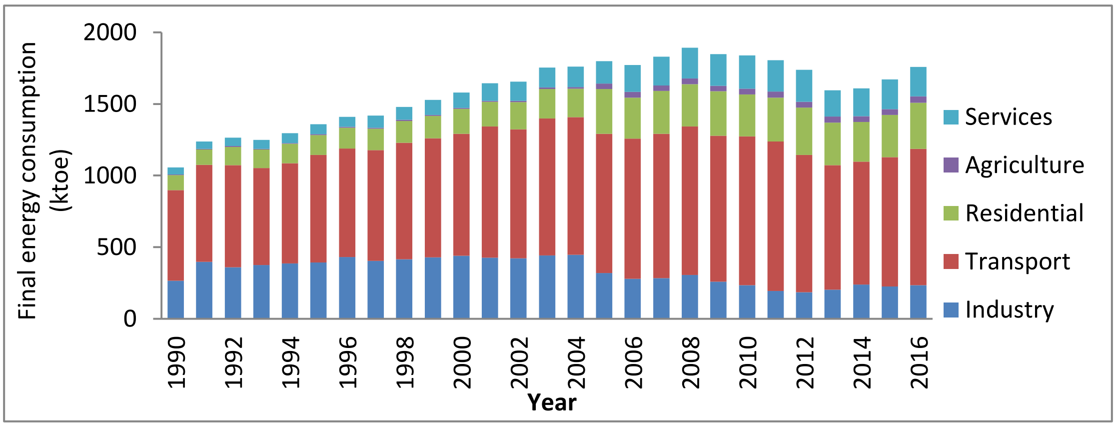

Figure 2.8. Final energy consumption by sector in ktoe, 1990-2016

2.7.2. Energy consumption in different sectors

Final energy consumption in Cyprus increased by about 38% between 1990 and 2015. The electricity t sector has seen the biggest increase in overall energy consumption, increasing its consumption by over 174% since 1990. The final consumption of electricity produced from conventional fuels increased by 152% between 1990 and 2016. This is having a significant impact on GHG emissions. The Services sector has also increased its energy consumption markedly, by 358% since 1990, which correlates with an increasing share of GVA coming from this sector. Households are also one of the largest consumers of final energy in the EU. Space heating and cooling are the most significant components of household energy demand, and can vary substantially from year to year depending on climatic conditions. In very recent years, household energy consumption has declined partly as a result of higher fuel prices. Final energy consumption in industry has fallen since 1990, largely as a result of a shift towards less energy-intensive manufacturing industries, as well as the continuing transition to a more service oriented economy.

2.7.3. Liberalisation of energy markets

As far as the electricity domestic market is concerned the new regulatory regime has been established since 2004 by liberalising 35% of the market. The proportion of the liberalised market increased from 35% to 65% from 1/1/2009, so eligible customers (those who can choose their supplier) are all non-domestic customers. From 1/1/2014, the electricity market in Cyprus was fully liberalized and eligible customers are all the customers. The main objective of the liberalization process is to provide competitive prices and improved services to all electricity customers. With respect to the further structuring of energy markets, one major change is the EU's Third Energy Package. Cyprus has achieved compliance on transposition of the 3rd Energy Package.

2.7.4. Energy prices

The graph below shows how the average end-user prices of electricity have varied since 1990 for industry, households and agriculture in Cyprus. In addition, it illustrates how disposable income has varied over this period, as this provides a very broad indication of how expenditure on energy varies as a share of income.

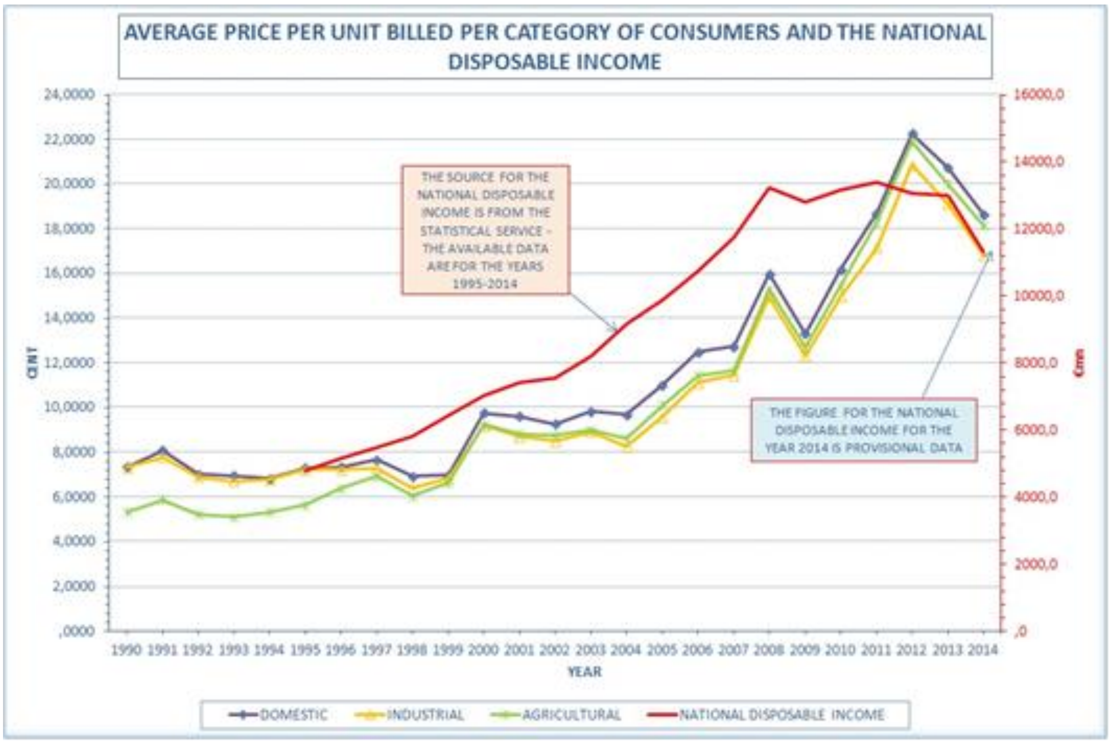

Figure 2.9. Change in average end-user energy prices in Cyprus compared to the gross disposable income for households, industry and agriculture, 1990-2014

2.8. Transport

Both freight and passenger transport, have continued to grow strongly since 1990 with continued growth in GHG emissions. According to the available information, there is no clear relation between freight or passenger transport with GDP. The transport sector is now the largest consumer of energy in Cyprus after electricity production and the issue of growing greenhouse gas emissions from this sector needs to be addressed.

2.8.1. Freight transport

Since 2002 (the year for which the first data is available) the demand for freight transport in Cyprus has decreased mainly to the changes in the economy of the country after 2008. All the freight transport in Cyprus takes place via road.

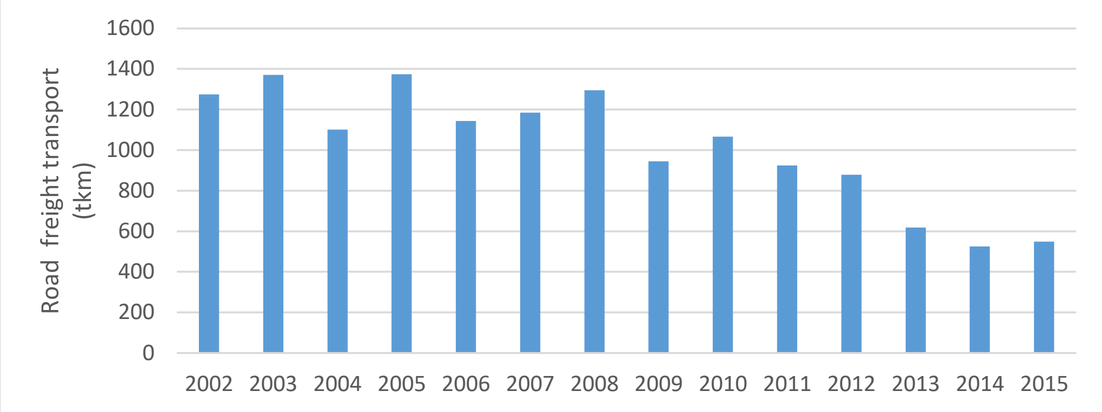

Figure 2.10. Growth in road freight transport 2002- 2015

2.8.2. Passenger transport

Since 1990 the demand for passenger transport in Cyprus has been increasing. It appears that the desired outcome, of a gradual decoupling in passenger transport from GDP, has not yet been observed. Given the continuing upward trend in demand, a reduction in absolute carbon emissions in this sector will need to come primarily via improved vehicle efficiency, modal shift to less energy intensive transport modes, and the shift to less carbon intensive transport fuels (e.g. sustainably produced biofuels or low carbon electricity).

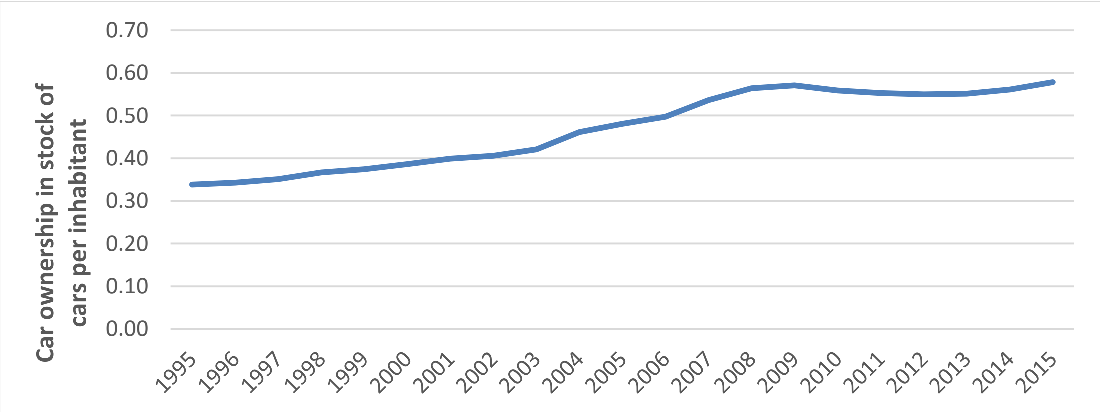

Figure 2.11. Level of car ownership in stock of cars per inhabitant, 1995 -2015

2.8.3. Prices of transport fuels[8]

Overall, the prices for both road transport fuels have increased between 1990 and 2016 due to substantial increases in oil prices and taxes. The tax on petrol increased by 274% (in 1990 €128/1000 litres and 2014 €479/1000 litres) and the tax on diesel increased from zero to €450/1000 litres over the same period. Furthermore, the VAT tax was zero in 1990 and was 19% since 2014. Also, comparison of the oil prices of transport fuels occurred between 1990 and 2016 is not possible due the different quality of the fuels, ex. in 1990 the petrol was Leaded with high sulphur content and today the petrol is unleaded and sulphur free (10 ppm). Rising prices will also help stimulate demand for more efficient vehicles. Road fuels have declined sharply from their peak in 2008 as the price of oil has declined, with (nominal) prices again similar to those in the early 2000s.

[8] Energy Service, Ministry of Energy, Commerce, Industry and Tourism; 1421 Nicosia; Tel.+357 22 409303; email: energyservice@mcit.gov.cy

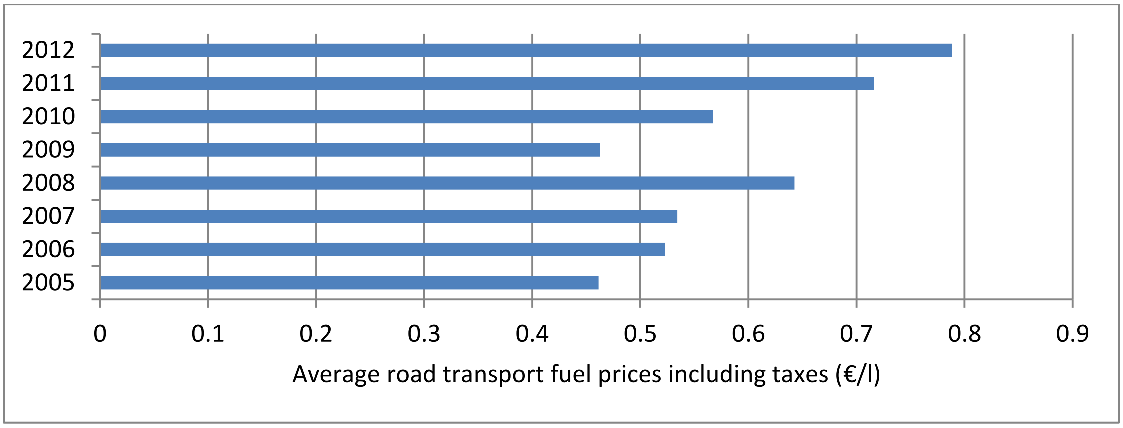

Figure 2.12. Average road transport fuel prices including taxes in €/litre, 2005-2012

2.9. Industry

Cyprus, after its independence in 1960, demonstrated a successful economic performance in terms of full employment and economic stability, apart from some isolated events. The underdeveloped rural economy inherited from colonialism was transformed into a modern economy with dynamic services, light industry, a very good agricultural sector and advanced physical and social infrastructure. From being traditionally agricultural, Cyprus embraced industrial development in the 1960s and today specializes in the manufacture of medium and high-technology products and semi-customized small-batch products. Industry grew in a sheltered environment with tariffs and quotas which have been introduced to protect local production.

Major events, that have affected the growth and structure of the economy and specifically of the industrial sector were, the Turkish invasion in 1974, accession to the World Trade Organization (WTO), the Customs Union Agreement with the EU in 1988 and eventual membership to the EU in 2004.

The Protocol for the Customs Union and Accession to the EU provided for the elimination of all restrictions to trade and increased competition in the local market. This had a major impact on the industrial sector which had to face fierce competition both from EU markets and third countries.

1990-2002

In 2002, distribution of Value Added in Manufacturing by Industry, showed Food, beverages and tobacco, as the largest group contributing 38,8% to the manufacturing value added, registered a 1,0% increase in volume of production. This was mainly due to the increase of domestic demand. Following were the subsectors of: Basic Metals and Metal Products, Machinery and Electrical and Optical Equipment and Manufacture of Transport Equipment, Other Non – Metallic Mineral Products, Refined Petroleum Products, Chemicals and Chemical Products and Rubber and Plastic Products, Manufacturing n.e.c, Pulp Paper and Paper Products; Publishing and Printing, Wood and Wood Products, Textiles and Textile Products and Manufacture of Leather and Leather Products. Large increases were recorded in the exports of pharmaceutical products, plastic products, dairy products and perfumes and toilet preparations. Decreases were recorded in the exports of cigarettes, wearing apparel, footwear, electricity distribution and control apparatus, kitchen furniture and jewellery and related articles.

2004-2009

On May 1st 2004, Cyprus, together with nine other countries, formally takes its place alongside the 15 member-states of the European Union. During 2004, the Cyprus economy exhibited an accelerated rate of growth, in contrast to the conditions of subdued growth observed during the previous two years. The gradual improvement of the overall confidence climate, following the accession of Cyprus to the EU, and the improved external environment of Cyprus, which positively affected the external demand for goods and services, constituted the main contributing factors towards this development.

The significant increase of the oil price in international markets constituted a restraining factor towards further growth of the Cyprus economy. In summary, the Cyprus economy exhibited conditions of acceleration of economic activity in 2004, mainly due to the strengthening of domestic demand and in particular private consumption demand and investment demand in machinery and transport equipment as well as construction works.

2009-2014

In 2009, the Cypriot economy began to shrink as the economic crisis in Europe and elsewhere began to bite. The industrial sector has been hit the hardest. Local investment was negatively affected by the financial crisis in 2013 where industry found it difficult to secure funding from the local banks.

Cyprus has no heavy industry and the expansion of its light industry is limited by the lack of raw materials and the size of the domestic market. Cyprus is radically restructuring its manufacturing base and actively seeking to attract new high-tech and knowledge-based industries. Main growth industries have been in ICT sector manufacturing parts, instruments and electronics, as well as consumer products such as food and cosmetics. Cyprus' key industrial products are pharmaceuticals, food, beverages, chemicals, mineral products, machinery and equipment. Of these, only pharmaceuticals and non-metallic minerals have experienced growth in recent years. Today, manufacturing contributes approximately 5% of GDP and accounts for 9% of people in employment.

The majority of manufacturers are small and medium-sized enterprises (SMEs), which employ less than 10 workers. This makes the sector flexible and open to innovation. The government is seeking to improve SMEs' access to finance and overseas markets, and to maximize the commercial potential of local research and development in order to open up untapped areas of productivity.

2.10. Waste

<u>Municipal and Solid Waste Management</u>

The national municipal waste Management Plant of 2015-2021 (MWMP) contains quantitative and qualitative targets and enumerates specific measures and actions to be taken in order for the EU targets to be reached. One of the quantitative target is that no more than 95,000 tonnes of biodegradable waste to be disposed in landfills (represents the 35% target of the 1999/31/EC directive). Also the Legal Measures will be focused on the:

- Development of local waste prevention and management schemes
- Mandatory obligation for establishing separate collection systems by local authorities,
- Establishment of extended producer responsibility (EPR) in streams other than packaging waste,
- Establishment of a landfill tax/levy,
- Banning the disposal of certain waste streams from entering into landfills (e.g. green waste, high calorific value waste, etc)

The adaptations of the strategy that are envisaged:

a) One Sanitary Landfill and one Residual Sanitary Landfill (supplementing MBT unit at Koshi) were constructed and operated (both meet the requirements of directive 99/31/EC). The MBT unit was constructed and operated from 01/04/2010 servicing Larnaca - Ammochostos districts. The Plant was designed in a way that a high separation of recycled and biodegradable material is achieved. Another I.W.M.P (Integrated Waste Management Plant) servicing Limassol district is expected to be operated by the year 2018.
b) The construction of the Green Point Network (22 collection points for the depositing of various waste streams out of households – bulky waste, green, textile, furniture, weee, etc.) is competed. The 4 Green Points, servicing Paphos district are operated and the rest expected to be operated by 2018.
c) Separate collection at source was promoted at households, from the existing collective system for the packing waste servicing also and all types of paper, created under the packaging directive

while the competent authority promotes the separate collection from other household streams such as other organic waste eg. food and green waste.

d) The construction works for the rehabilitation/restoration of the old non approved landfills, which are closed at Paphos and Larnaca - Ammochostos districts, were completed. The preparation of studies/documents regarding the rehabilitation/restoration of the 20 non sanitary landfills of Nicosia district and the 44 sanitary landfills of Limassol district, will be completed within 2018 and after that the construction works will begin.

A comprehensive study was undertaken in 2005 for the elaboration of a Strategic Plan, an Environmental study and a Feasibility study for the restoration and management of landfills. The purpose of the study was to record all landfills, assess their status and level of risk, create a restoration priority list based on pollution risk assessments, undertake the appropriate environmental studies as well as feasibility studies for the restoration of the prioterized landfills. These studies were a necessary step for the restoration of all landfills recorded.

Two (2) landfills are still active in Cyprus but arrangements are made in order to be closed and restored. According to recent data, these two landfills are feeded with approximately 155.000 ton and 200.000 ton of municipality waste each year respectively (reference year 2012).

Sixty-two (62) non sanitary landfills are planned to be restored appropriately within the following years. According to the preliminary study contacted in 2005, these landfills contain approximately 597.269 m3 of solid waste excluding 2 major landfills that have not been closed yet.

Fifty-three (53) landfills have been restored the last five years and are being monitored. During their restoration a total of 4.902.000 m3 of solid waste were reallocated and properly buried using composite liners and leakage collection systems.

The EU landfill directive is fully harmonized in the national legislation but not fully implemented. Cyprus didn’t manage to seize of the operation of non-compliant landfills by 2009. Also Cyprus has rehabilitated only 46% of its closed landfills.

2.11. Building stock and urban structure

Energy consumption for space heating or cooling within buildings forms a significant component of the country’s energy consumption. The level of energy consumption within buildings is primarily affected by: the thermal properties of the building (in terms of insulation, building type – e.g. flat/house); the efficiency of the heating or cooling system; and the stock/efficiency of the appliances used. In general, newer dwellings are likely to be more energy efficient than older buildings. The building sector has one of the highest potentials for improved energy efficiency and measures to reduce the space heating/cooling demand in buildings represent a significant part of this potential. Many of these measures (such as improved insulation) are highly cost-effective, but a number of other barriers to their implementation exist. These are being addressed by a number of the policies related to end-use energy efficiency.

2.11.1. Building Permissions

The construction industry is demonstrating negative growth rates in recent years due to the country's economic downturn. This is evident from the number of building permissions issued during the period 2011-2016, as recorded by the Cyprus Statistical Service.

From the data for the period 1980-2016 (as shown in Figure 1), it is noticeable that the maximum number of building permissions issued was in 2006 (9.794) and the minimum in 2014 (4.933). A steep upward trend is recorded during the period 2000-2006, from then on the number of building permissions issued started to decrease, reaching the minimum number recorded in 2014. From 2015, the number of building permissions issued increased slightly.

Looking at the latest data concerning the period January-June 2017, 2.870 building permissions were issued, representing a decrease of 9.9% over the corresponding period of the previous year (January -

June 2016), where the number of building permissions issued was 2.611. Regarding the 2.780 building permissions issued, 2.012 (70.1%) concerned residential buildings, 537 (18.7%) non-residential buildings, 99 (3.45%) Civil Engineering projects, 170 (5.95%) concerned the division of plots and 52 building permissions (1.8%) were issued for road construction projects.

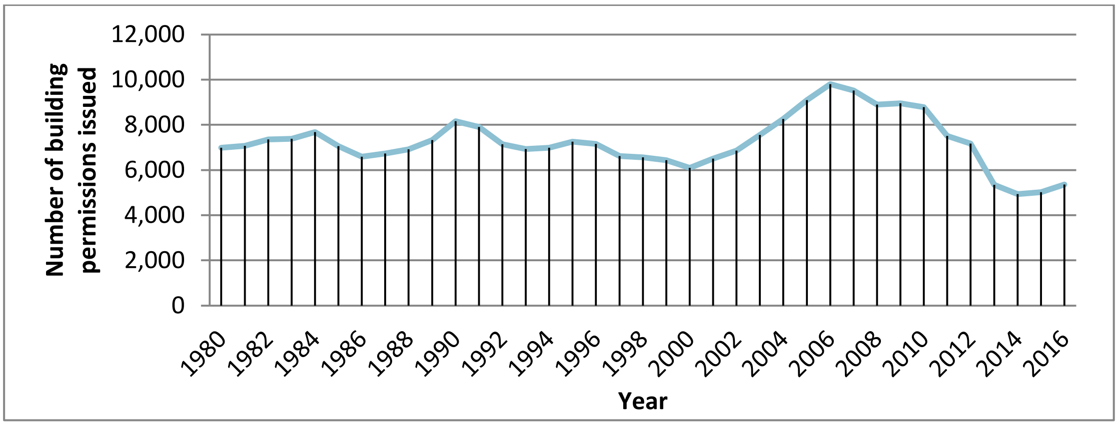

Figure 2.13. Building Permissions Authorised, 1980-2016 (Source: Construction and Housing Statistics 2017, Cyprus Statistical Service)

2.11.2. Dwelling Stock

According to the Cyprus Statistical Service (Source: Construction and Housing Statistics 2015), the dwelling stock at the end of 2015 increased by 0,5% and reached 446.183 units as against 443.829 in 2014. Of these dwellings, 61,9% were in the urban areas. The occupied living quarters in 2015 numbered 309.799 units. The following Figure presents the total dwelling stock during the period 1980-2015.

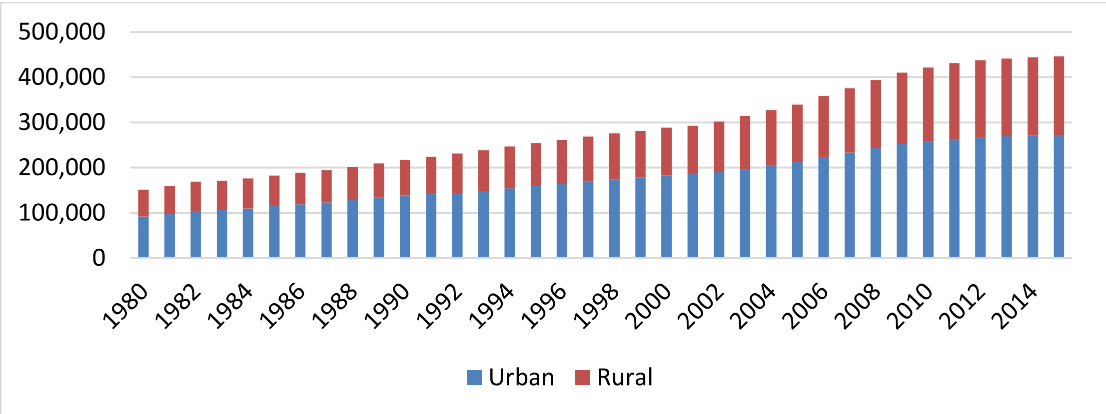

Figure 2.14. Total dwelling stock and occupied living quarters, 1980-2015 (Source: Construction and Housing Statistics 2015, Cyprus Statistical Service)

2.12. Agriculture[9]

Until 1974, the agricultural sector was considered to be one of the most important sectors of Cyprus' economy. Over the period 1960-1974 the agricultural sector had the largest contribution to Gross Domestic Product, ranging from 16% to 21%, and provided employment to more than 30% of the economically active population. Agricultural production almost doubled in the period 1960-1974 and the added value of the agricultural sector showed an average annual growth rate of about 8%.

[9] Mr. George Theophanous, Agriculture Officer, Department of Agriculture, Ministry of Agriculture, Rural Development and Environment; Loukis Akritas Avenue, 1412 Nicosia; Tel: +357 22464028; Fax: +357 22305494; email: gtheophanous@da.moa.gov.cy

Following the Turkish invasion (1974), the agricultural sector suffered severely since the Turkish occupying forces occupied an area that accounted for 46% of total agricultural production and 47% of livestock production. At the same time, the population that was concentrated in the less productive areas of Cyprus was displaced from the occupied areas.

Cyprus' economy, mainly from 2000 until today, is characterised by the growth of the tertiary sector (services) and the shrinking of the other two sectors of the economy (primary and secondary). Indicatively, agriculture accounts for 1.7% of GDP and employs 3.8% of the labor force.

Agricultural income, although it showed increasing trends in the period 2000-2002, with the accession of Cyprus to the EU in 2004 and the implementation of the Common Agricultural Policy (CFP) is decreasing, with the decrease being particularly pronounced in recent years, especially in small which highlights the need to redesign Cyprus' agriculture with emphasis on improving its competitiveness and exploiting its comparative advantages (high quality, early products, etc.).

The competitiveness of the agricultural sector and productivity depend to a large extent on their structural characteristics. The total utilized agricultural land decreased by 24% between 2003 and 2010. In addition, 81% had a size of less than 3 hectares and cultivated 22% of the agricultural land used, while the remaining 19% had a size of more than 3 hectares and cultivated 78% of the agricultural land used. This structural development is mainly the result of a change in the operating environment of the agricultural sector after EU accession, in particular the reduction of protectionism, the abolition of price support, the decoupling of production aid, the simultaneous reduction of prices and subsidies, rising input costs, opening markets and the functioning of the agricultural sector in a highly competitive environment. However, the impact of climate change, and more specifically drought, should not be overlooked.

The agriculture sector has shrunk considerably over the past decades and its contribution to the GDP, combined with the fisheries and forestry sectors, was only 2.2% in 2010. Nevertheless, the importance of agriculture socially and environmentally is great, as can be seen from the amounts allocated annually by the state to support this sector. Indicatively, in 2011, the Agricultural Payments Agency made payments of € 145,736,930 (€ 78,665,076 from Community funds and € 67,071,854 from national funds) whereas all payments made by the Agency to farmers since 2004 amounted to almost € 1 billion.

In addition to the above, the agricultural sector in Cyprus is already experiencing the impact of climate change, which has caused, among other things, the degradation of agricultural land, the reduction of agricultural production, the increase in damage caused by extreme weather events (prolonged droughts, the lack and degradation of water resources).

2.13. Forest

Wild vegetation in Cyprus is classified in two major categories: a) forest and b) Other Wooded Land (OWL, which includes maquis and garique), which are either of state or private ownership. These two categories account for 41.7 % (386,190 hectares) of the total land area. The change of forest cover is almost invariable the last 16 years. Analytical data are shown on Table 2.2. (Data taken from FRA 2015- Cyprus Country Report).

Table 2.2. Wild vegetation in Cyprus

Category of Vegetation	Forests	Other Wooded Land (OWL)	Total
1999			
Area (ha)	171610	213860	385470
%	18.5	23.1	41.7
2005			
Area (ha)	172851	213865	386716
%	18.5	23.1	41.8
2010			
Area (ha)	172841	213285	386126

%	18.7	23.1	41.7
2012			
Area (ha)	172778	213389	386167
%	18.7	23.1	41.7
2015			
Area (ha)	172700	213490	386190
%	18.7	23.1	41.7

3. Greenhouse gas inventory information

3.1. Introduction

This chapter provides the key points about the Cyprus' GHG inventory.

Under the Kyoto Protocol, for its second commitment period, the EU, its Member States and Iceland have agreed to fulfil their quantified emission limitation and reduction commitments jointly. The Union, its Member States and Iceland agreed to a quantified emission reduction commitment that limits their average annual emissions of greenhouse gases during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment[10].

The GHG data presented in this chapter are consistent with the 2017 submission of Cyprus to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), under the Convention and the Kyoto Protocol[11].

The legal basis for the compilation of the Cyprus' inventory is the Council of Ministers' Decision adopted 15/11/2017 entitled "Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities".

Summary tables of GHG emissions for Cyprus in the common reporting format are presented in Annex II for the whole of the reporting period of the NIR2017 (1990-2015) as this was submitted to the UNFCCC secretariat after the TERT review[12].

Information related to the geographical scope

On July 20 1974, the Turkish armed forces staged a full scale invasion against Cyprus. Turkey proceeded to occupy the northern part of the island and empty it from its Greek inhabitants. By the end of the following year, the majority of the Turkish Cypriots living in the areas left under the control of the Republic of Cyprus had also made their way to the part of Cyprus occupied by the Turkish army.

On November 15 1983 the Turkish Cypriot leadership unilaterally declared that area an independent state, by the name of "Turkish Republic of Northern Cyprus". Despite the fact that this act has been condemned by the UN and that no country other than Turkey has recognised this illegal secessionist entity, the situation continues.

For further information please refer to the website of the Ministry of Foreign Affairs of the Republic of Cyprus[13].

That area is not under the effective control of the Republic of Cyprus. Therefore, no data from official sources are available for the activities taking place in the particular areas, thus no emissions can be estimated for any activities.

<u>This inventory estimates emissions only for areas under the effective control of the Republic of Cyprus.</u>

[10] See https://ec.europa.eu/clima/policies/strategies/progress/kyoto_2_en
[11] Available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php
[12] NIR 08 May 2017, CRF 07 Nov 2017, available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php
[13] http://www.mfa.gov.cy/mfa/mfa2016.nsf/mfa08_en/mfa08_en?OpenDocument

3.2. Descriptive Summary of GHG Emissions Trends

This section only has a brief description of the trends in GHG emissions. For a full description of the trends, please see relevant sections in Cyprus' National Inventory Report (NIR).

3.2.1. Overall Greenhouse Gas Emissions Trends

In 2015 total GHG emissions in Cyprus, without LULUCF, were 50.6 % (2 845 Gg CO2 equivalents) above 1990, (see Figure 3.1). Between 2014 and 2015 emissions increased by 0.4 % (35 Gg CO2 equivalents).

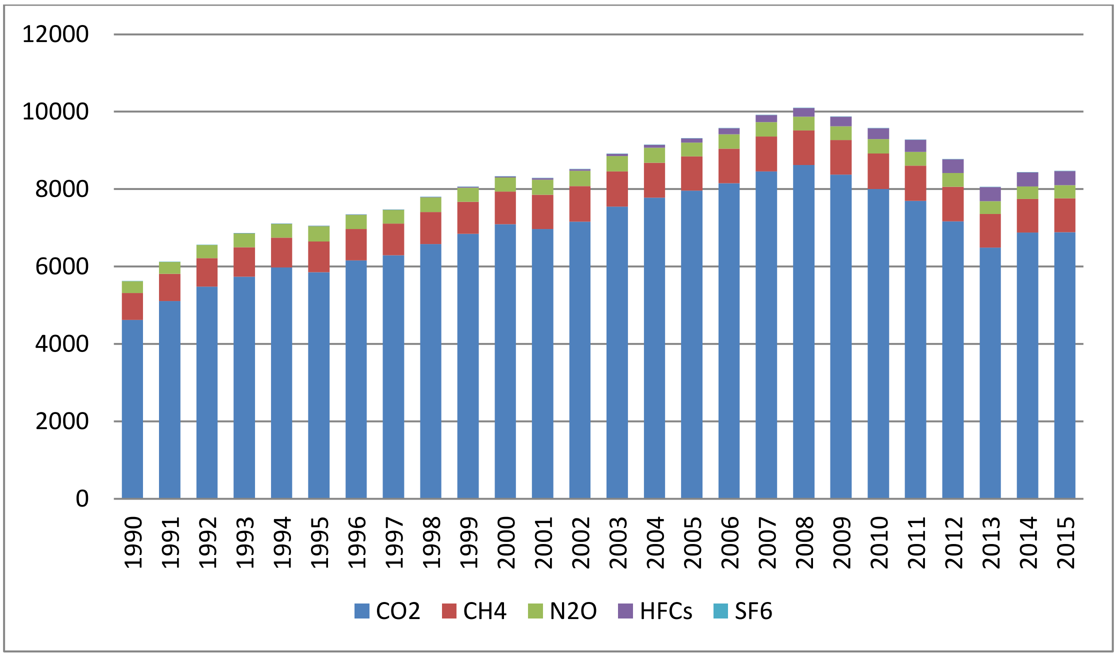

Figure 3.1. Cyprus' GHG emissions 1990 to 2015, excluding LULUCF.

3.2.2. Emission trends by gas

Table 3.1 provides an overview on the main trends in Cyprus GHG emissions and removals for 1990–2015. The most important GHG is CO2, accounting for 81.3 % of total emissions in 2015. In 2015, CO2 emissions without LULUCF were 6 887 Gg, which was 49 % above 1990 levels. CH4 and N2O emissions account for 10.4 % and 4 % of total GHG emissions respectively in 2015; both gases show increasing trends. As a group of gases, fluorinated gases (HFCs and SF6) are increasing and account for the remaining 4.3 % of total GHG emissions.

Table 3.1. Cyprus' GHG emissions 1990 to 2015, excluding LULUCF.

	CO2	CH4	N2O	HFCs	SF6	Total
1990	4620.99	691.71	308.92	NO	0.03	5621.64
1991	5107.07	702.45	308.89	NO	0.03	6118.43
1992	5482.96	731.61	341.48	NO	0.03	6556.09
1993	5733.67	759.54	362.00	0.01	0.04	6855.26
1994	5977.25	771.05	350.72	0.28	0.05	7099.35
1995	5848.04	794.92	397.41	1.64	0.06	7042.07
1996	6156.12	815.41	363.43	2.70	0.07	7337.71
1997	6287.01	822.65	352.06	5.21	0.07	7467.01
1998	6580.28	825.96	378.33	10.62	0.07	7795.25
1999	6847.63	826.57	364.93	16.97	0.07	8056.16
2000	7095.92	842.54	361.82	25.20	0.08	8325.55
2001	6969.45	882.07	393.33	36.55	0.08	8281.49
2002	7160.37	914.83	394.89	47.77	0.08	8517.95
2003	7550.07	909.51	392.97	59.40	0.09	8912.04

2004	7776.89	904.43	384.25	77.60	0.10	9143.28
2005	7961.97	883.32	357.8	103.28	0.12	9306.49
2006	8152.48	887.44	374.89	156.10	0.12	9571.04
2007	8458.66	899.69	367.87	182.93	0.14	9909.29
2008	8620.39	897.28	357.09	216.65	0.15	10091.56
2009	8372.39	895.15	355.26	249.22	0.16	9872.18
2010	8004.90	914.44	374.24	280.66	0.15	9574.4
2011	7696.66	906.54	358.67	313.24	0.15	9275.27
2012	7164.09	895.93	351.32	356.67	0.16	8768.17
2013	6487.25	873.33	324.04	363.98	0.15	8048.74
2014	6878.37	868.01	317.69	367.56	0.15	8431.78
2015	6886.71	876.86	334.98	367.97	0.15	8466.67

3.2.3. Trends in emissions by main source and sink categories

Table 3.2 provides an overview of Cyprus' GHG emissions in the main source categories for 1990 to 2015. Emissions from international aviation and shipping are excluded from national totals and are presented in the table as memo items.

The energy sector contributed 73.1 % to total GHG emissions in 2015. This sector is the largest source of emissions in Cyprus. Total GHG emissions from this sector increased by 54% from 3 941 in 1990 to 6 067 million tonnes in 2015. The main reasons for the increasing emissions since 1990 are increase of electricity demand due to improvement of living conditions and increase of number of privately owned vehicles.

The industrial processes and product use sector is the second largest source of emissions, and contributed 16 % to total GHG emissions in 2015. Total GHG emissions from this sector increased by 73.2 % from 765 Gg CO2 equivalent in 1990 to 1 325 Gg tonnes CO2 equivalent in 2015, primarily due to the mainly due to the increase of product uses as ODS substitutes

The agriculture sector is the third largest source of emissions in Cyprus, and contributed 6.7% to total GHG emissions in 2015. Total GHG emissions from this sector increased by 5.3% from 531 Gg tonnes CO2 equivalent in 1990 to 559 Gg tonnes CO2 equivalent in 2015, reflecting increasing animal population, reduction in fertilisers' use and improvement in waste management practices.

The remaining emissions arise from the waste sector, contributing 6.2 % to total national GHG emissions in 2015. Total GHG emissions from this sector increased by 33.7 % from 385 Gg CO2 equivalent in 1990 to 515 Gg CO2 equivalent in 2015. Key factors causing this increase is increasing solid waste production per capita which is partly counterbalanced by the improvement of solid waste domestic wastewater management.

In addition, net removals from land use, land use change and forestry (LULUCF) increased in the EU over the same 25-year period. Based on the 2017 EU GHG inventory, net removals increased by 67.6 % between 1990 and 2015 and the net sink has increased from 1.8 % of total net GHG emissions in 1990 to 2.0 % in 2015. In 2015, net removals from the LULUCF sector in Cyprus amounted to 168 Gg CO2 equivalent compared to 100 Gg CO2 equivalent. The key driver for the increase in net removals is the prohibition of logging. Environmental policies have also resulted in less intensive agricultural practices and an increase in forest and woodland conservation areas for the purpose of preserving biodiversity and landscapes.

Table 3.2. Cyprus' GHG emissions 1990 to 2015 by source.

	Energy	IPPU	Agriculture	LULUCF	Waste	Total
1990	3940.66	764.91	531.02	-100.32	385.06	5521.32
1991	4470.94	724.51	533.3	-119.15	389.69	5999.29
1992	4798.13	776.50	582.38	-126.39	399.08	6429.7
1993	4977.59	849.67	620.22	-110.43	407.78	6744.82
1994	5187.04	887.03	606.30	-113.71	418.97	6985.64

1995	5093.38	855.64	666.42	-126.08	426.63	6915.99
1996	5345.97	915.46	645.37	-126.43	430.91	7211.28
1997	5511.69	885.21	631.46	-130.60	438.65	7336.41
1998	5854.76	844.49	651.08	-109.65	444.92	7685.60
1999	6117.80	857.68	628.66	-147.67	452.02	7908.49
2000	6344.87	888.38	632.31	-73.66	460.00	8251.89
2001	6236.74	885.24	690.97	-134.88	468.54	8146.61
2002	6395.36	930.39	717.35	-167.84	474.84	8350.11
2003	6785.63	946.44	703.55	-171.37	476.42	8740.66
2004	6949.96	1032.37	681.98	-171.60	478.97	8971.67
2005	7128.69	1067.86	624.16	-179.22	485.78	9127.27
2006	7311.54	1132.00	647.41	-179.59	480.09	9391.46
2007	7632.93	1150.41	643.89	-111.72	482.06	9797.57
2008	7799.59	1185.31	616.78	-160.53	489.88	9931.03
2009	7724.74	1047.01	611.74	-177.73	488.68	9694.45
2010	7494.87	942.06	637.48	-166.03	499.98	9408.37
2011	7201.96	958.54	619.21	-168.87	495.55	9106.40
2012	6709.07	957.16	593.81	-162.92	508.13	8605.24
2013	5788.58	1199.3	550.18	-172.17	510.68	7876.57
2014	5959.03	1422.37	537.75	-173.22	512.62	8258.55
2015	6067.25	1325.19	559.30	-168.11	514.94	8298.56

3.2.4. Changes since the 6th National Communication

Since the publication of the 6NC, various updates and revisions to methodologies have been implemented in Cyprus' GHG inventory, which have impacted on the time-series of emissions. The 2013 GHG inventory was used in the 6NC. This means changes to the GHG inventory used in this Communication are a result of four GHG inventory updates.

Cross cutting changes that affect the GHG inventories since 6NC include:

- Implementation of the IPCC 2006 guidelines (moving from the 1996 GLs, the 2000 Good Practice Guidelines and the 2003 LULUCF Good Practice Guidance);
- Changes to the Global Warming Potentials that are used;

Because of these cross cutting changes, direct comparisons of the changes in the magnitude of emissions between the 6NC and 7NC are not valid.

3.3. National system

3.3.1. Institutional arrangements

The Ministry of Agriculture, Rural Development and Environment (MARDE) is the governmental body responsible for the development and implementation of the majority of the environmental policy in Cyprus. The MARDE is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organisation, in relation to the implementation of the provisions of the European legislation associated with climate change.

In this context, the MARDE has the overall responsibility for the national GHG inventory, and the official preparation and approval of the inventory prior to its submission. The Figure below provides an overview of the organisational structure of the National Inventory System. The entities participating are:

- The MARDE, designated as the national entity responsible for the national inventory, which keeps the overall responsibility, plays an active role in the inventory planning, preparation and management, and also compiles the annual inventory.

- Governmental ministries and agencies, and non-governmental organisations through their appointed focal persons, ensure the data provision.

At the time the 2017 GHG inventory report was prepared there was no legal framework available defining the roles-responsibilities and the co-operation between the MARDE and contact points of the involved ministries and agencies.

The legal framework defining the roles-responsibilities and the co-operation between the Inventory team at the Department of Environment and the designated contact points of the competent Ministries was formalized by Council of Ministers' Decision adopted 15/11/2017 entitled "Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities". The above-mentioned Decision includes a description of each entity's responsibilities, concerning the inventory preparation, data providing or other relative information. This formal framework has improved the collaboration between the entities involved, assuring the timely collection and quality of the activity data required and solving data access restriction problems raised due to confidentiality issues.

3.3.2. Quality Assurance/Quality Control (QA/QC) Procedures

A QA/QC system is being implemented since the May 2007. The Ministry of Agriculture, Rural Development and Environment is responsible for the implementation of the QA/QC system. The system has the following objectives:

- Compliance with the IPCC guidelines and the UNFCCC reporting guidelines while estimating and reporting emissions/removals.
- Continuous improvement of GHG emissions/ removals estimates.
- Timely submission of necessary information in compliance with relevant requirements defined in international conventions, protocols and agreements

The accomplishment of the above-mentioned objectives can only be ensured by the implementation, from all the members of the Inventory Team, of the QA/QC procedures included in the plan for the following:

- Data collection and processing.
- Applying methods consistent with IPCC Good Practice Guidance and LULUCF Good Practice Guidance for calculating / recalculating emissions or removals.
- Making quantitative estimates of inventory uncertainty.
- Archiving information and record keeping.
- Compiling national inventory reports.

The QA/QC system developed covers the following processes:

- QA/QC system management: comprises of all activities that are necessary for the management and control of the inventory agency in order to ensure the accomplishment of the abovementioned quality objectives.
- Quality control: directly related to the estimation of emissions. The process includes activities related to (a) data inquiry, collection and documentation, (b) methodological choice in accordance with IPCC Good Practice Guidance, (c) quality control checks for data from secondary sources and (d) record keeping.
- Archiving inventory information: comprises of activities related to central archiving of inventory information and the compilation of the national inventory report.
- Quality assurance: comprises of activities related to the different levels of review processes including the review of input data from experts, if necessary, and comments from the public
- Estimation of uncertainties: defines procedures for estimating and documenting uncertainty estimates per source / sink category and for the whole inventory.
- Inventory improvement: related to the preparation and the justification of any recalculations made.

This QA/QC system was revised in 2017 after the adoption of the Council of Ministers' Decision (15/11/2017). Details on the QA/QC system implemented for the preparation of the 2017 GHG inventory submission are available in the 2017 inventory report, while information on the current QA/QC system is available in the 2018 submission to the European Commission for compliance with the EU MMR Regulation[14].

Further details on the QA/QC plan are available in the 2017 submission of the NIR.

3.3.3. The Inventory Methodology and Data

3.3.3.1. Emission factors

The estimation of GHG emissions / removals per source / sink category is predominately based on the methods described in the revised 2006 IPCC Guidelines. The emission factors used were derived from the 2006 IPCC Guidelines and special attention was paid in selecting the emission factors that are most representative of practices and conditions in Cyprus. Furthermore, emission factors were obtained from plant specific information contained in EU ETS reports. Due to data unavailability, for the estimation of the emissions of the sectors Refrigeration and Air Conditioning (2F1), Foam Blowing Agents (2F2), Fire Protection (2F3) and Metered Dose Inhalers (2F4a) the implied emission factors per capita from the average of Greece, Italy, Malta and Spain (NIR2015) have been used. For Use of Electrical Equipment (2G1) and N2O from Product Uses (2G3), the implied emission factor per capita from Greece was used. Details on the methods applied for the calculation of emissions / removals are given the chapters that follow.

The key categories analysis constitutes the basic tool for methodological choice and for the prioritisation of the necessary improvements. In addition, the results of the various review processes (at national and EU level) represent key input information for the identification of possible improvements. It should be mentioned however, that data availability as well as availability of resources (both human and financial) also have to be considered.

- Data availability could become a significant restrictive parameter when selecting an estimation methodology. The accuracy and the consistency of the emissions estimated depend on the availability of the data needed for the correct application of the selected methodology.
- Availability of resources needs also to be considered as the searching for and the collection of the necessary data in order to apply a detailed methodology for a source category should not affect the completeness and the on-time preparation of an inventory submission.

3.3.3.2. Global warming potential

Emissions from anthropogenic activities affect the concentration and distribution of greenhouse gases in the atmosphere. These changes can potentially produce a radiative forcing of the Earth's surface and lower atmosphere, by changing either the reflection or absorption of solar radiation or the emissions and absorption of long-wave radiation. A simple measure of the relative radiative effects of the emissions of various greenhouse gases is the Global Warming Potential (GWP) index. This index is defined as the cumulative radiative forcing between the present and some chosen time-horizon caused by a unit mass of gas emitted now, expressed relative to that for some reference gas. The values for GWP for the greenhouse gases that are used in this inventory are according to Decision 24/CP.19[15] (Annex II).

Corresponding values of GWP for other gases (NOx, CO, NMVOC) are not given by the IPCC (nor by other sources for this purpose), since at present it is impossible to calculate the indirect results of these gases, as the scientific knowledge on their chemical reactions taking place in the atmosphere is not sufficient.

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[14] Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting GHG emissions and for reporting other information at national and EU level relevant to climate change and repealing Decision No 280/2004/EC; available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&from=EN

[15] Decision 24/CP.19 Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention

Table 3.3. Direct Global Warming Potentials (mass basis) relative to carbon dioxide for the 100-year horizon

Gas	Chemical Compound	100-year Global Warming Potential
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298
HFC-32	CH_2F_2	675
HFC-125	CHF_2CF_2	3500
HFC-134a	CH_2FCF_3	1430
HFC-143a	CF_3CH_3	4470
HFC-227ea	CF_3CHFCF_3	3220
HFC-245fa	$CH_2FCF_2CHF_2$	1030
HCF-365mfc	$CH_3CF_2CH_2CH_2CF_3$	794
Sulphur hexafluoride	SF_6	22800
Nitrogen trifluoride	NF_3	17200

3.3.3.3. Key categories assessment

The determination of the key categories for the Cyprus' inventory system is based on the application of the Tier 1 methodology (see Annex I for presentation of calculations) described in the IPCC Good Practice Guidance, adopting the categorization of sources that is presented in Table 7.1 of the IPCC Good Practice Guidance.

Tier 1 methodology for the identification of key categories assesses the impacts of various source categories on the level and the trend of the national emissions inventory. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of total emissions (level assessment) or the trend of the inventory in absolute terms.

In line with the specifications and options set out in the Kyoto Protocol and it´s follow up procedures, Cyprus identifies 1990 as its base year for carbon dioxide, methane and nitrous oxide and 1995 as its base year for hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride.

Key category analysis for 1990 and 2015 without LULUCF is summarised in Table 3.4.

Table 3.4. Key category analysis for 1990 and 2015 without LULUCF

		level 1990	level 2015	trend 2015
1A1a. Public electricity and heat production	CO2	⍰	⍰	⍰
1A1b. Petroleum refining	CO2	⍰		
1A2e. Food processing, beverages and tobacco	CO2	⍰	⍰	⍰
1A2f. Non-metallic minerals	CO2	⍰	⍰	⍰
1A2g. Other (please specify)	CO2	⍰		⍰
1A3a. Domestic aviation	CO2			⍰
1A3b. Road transportation	CO2	⍰	⍰	⍰
1A3b. Road transportation	N2O			⍰
1A4a. Commercial/institutional	CO2	⍰	⍰	⍰
1A4b. Residential	CO2	⍰	⍰	⍰
1A4c. Agriculture/forestry/fishing	CO2	⍰	⍰	
2A1. Cement production	CO2	⍰	⍰	⍰
2A4. Other process uses of carbonates	CO2	⍰		⍰
2F1. Refrigeration and air conditioning	HFCs(1)		⍰	⍰
2F4. Aerosols	HFCs(1)			⍰
2G3. N2O from product uses	N2O	⍰	⍰	
3A1. Cattle	CH4	⍰	⍰	⍰
3A2. Sheep	CH4	⍰	⍰	⍰

3A4. Other livestock	CH4			?
3B3. Swine	CH4	?	?	?
3B4. Other livestock	N2O			?
3B5. Indirect N2O emissions	N2O			?
3D. Agricultural soils	N2O	?	?	?
5A1. Managed waste disposal sites	CH4		?	?
5A2. Unmanaged waste disposal sites	CH4	?	?	?
5D1. Domestic wastewater	CH4	?		?
5D2. Industrial wastewater	CH4			?

3.4. National registry

This section of the National Communication summarises the national registry of Cyprus. Further details can be found in Chapter 14 of the NIR.

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and Decision 24/CP.8.

Cyprus is only connected to the EU registry and still not connected to the ITL.

4. Policies and measures

4.1. National Policies

4.1.1. Introduction

The majority of scholars today agree on the growing influence of the economy and society on the earth's climate through activities such as fossil fuel burning, rainforest deforestation and livestock farming. Recognizing the impact of human activities on the climate, the international community agreed at the Rio Summit in Rio de Janeiro in 1992 with the United Nations Framework Convention on Climate Change. Cyprus ratified the Convention in 1997. The objective of the Convention is to stabilize concentrations of greenhouse gases in the atmosphere at levels that prevent dangerous impacts on the climate from human activities.

In 1997 the Kyoto Protocol was adopted, which set legally binding greenhouse gas emission limit values for the period 2008-2012. Cyprus has ratified the Kyoto Protocol as a state without obligations to reduce or limit emissions. In 2012, at the Climate Change Summit held in Doha, Qatar, the second binding period of the Protocol (2013-2020) was agreed. As part of the EU's commitments (20% reduction in greenhouse gas emissions by 2020 compared to 1990), the Republic of Cyprus also assumed the national targets for a 21% reduction in greenhouse gas emissions by 2020 relative to 2020 with 2005 from electricity, cement and ceramics, and 5% in other sectors such as agriculture, transport, waste, etc., compared to 2005 levels.

Wanting to prepare for the post-2020 international negotiations, EU leaders agreed in October 2014 to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990. This target for Cyprus corresponds to a reduction of greenhouse gas emissions by 42% by 2030 compared to 2005 by electricity, cement and ceramics industries (ETS sectors), and 24% in other sectors such as agriculture, transport, waste, etc. (non-ETS sectors), compared to 2005 levels.

The culmination of the collective efforts that took place in recent years to reduce greenhouse gas emissions and hence to tackle climate change effectively by the global community is the historic agreement reached in Paris in December 2015 at the 21st Session of the Parties to the United Nations Framework Convention on Climate Change. The Paris Agreement entered into force on 4 November 2016. Cyprus completed the ratification process of the Paris Agreement on 4 January 2017.

The effects of climate change are becoming increasingly felt both in Europe and globally. These are expected to be particularly serious for Cyprus, as climate change is already evident; over the last 100 years there has been an increase in average temperature and a decrease in average annual rainfall. The effects of climate change will not only continue but will also increase over the next decades.

In view of the above, Cyprus is faced with the challenge of developing its economy in a way that reduces greenhouse gas emissions, while taking appropriate measures and actions to adapt to climate change.

Climate change is a horizontal issue requiring the involvement and activation of almost all Ministries of Cyprus, including the Ministry of Agriculture, Rural Development and Environment, the Ministry of Energy, Trade, Industry and Tourism, the Ministry of Foreign Affairs, the Ministry of Transport, Communications and Works, the Ministry of Labour, Welfare and Social Insurance, the Energy Regulatory Authority and the Local Authorities. As a result, the role of the Environment Department of the Ministry of Agriculture, Rural Development and Environment as a national coordinator is upgraded and strengthened. Additionally, an important factor in the effort is the continuous improvement of the institutional framework.

Climate change mitigation is one of the main targets identified in the Cypriot strategy for sustainable development launched by MARDE in 2007[16]. The objective of the strategy is the development of a set of principles for the formulation of an action plan in line with international challenges, and in accordance with EU policy directions and adjusted to the specific national circumstances.

Strategic planning

In February 2014, the House of Parliament voted the Law on Fiscal Responsibility and Budget Systems (FRBSL) no. 20(I)/2014, which covers a wide range of issues related to Management of Public Finance. The goal was to introduce new principles for budgeting that strengthen the flexibility of economic operators and the transparency of the use of state resources, achieving measurable results. In this context, ministries have been asked to implement new procedures for the preparation of a medium-term strategy plan and budgeting on the basis of those activities to achieve their objectives.

The importance of climate change mitigation (and adaptation) for Cyprus is highlighted through its inclusion as the first target of the strategic plan of the Department of Environment and as one of the strategic goals of the Ministry of Agriculture, Rural Development and Environment[17].

National Policies and measures

Given that Cyprus was a non-Annex I party to the UNFCCC until 2013, national policies and measures for the reduction of greenhouse gas emissions have been developed for the first time in 2007 for the implementation of EU Decision 280/2004[18]. Ever since, policies and measures are reviewed, revised and updated every 2 years. The involved ministries are presented in Table 4.1. The sections that follow present the policies and measures by sector.

Table 4.1. Involved ministries to climate change mitigation policies and measures

Ministry	Issues
Ministry of Agriculture, Rural Development and Environment	Agriculture Forestry Land use
Ministry of Energy, Trade, Industry and Tourism	Energy
Ministry of Transport, Communications and Works	Transport
Ministry of Finance	National budgets
Ministry of Interior	Land use

4.1.2. Sectoral policies and measures: Energy

The emissions of the energy sector except transport increased from 2,727 Gg CO_2 eq. in 1990 to 4,178 Gg CO_2 eq. in 2015, corresponding to 53% increase. In 2015, emissions increased by 1% compared to 2014. Energy is the sector which has to contribute the most in the reduction of greenhouse gases of Cyprus. The import of natural gas, and its initial use for electricity production, is expected to contribute considerable reductions of emissions.

Cyprus is the southernmost region of the European Union at the crossroads of three continents, with a dominant position in the Mediterranean and South East. In general Cyprus presents the common energy problems of most islands:

(a) Isolated energy system.
(b) High rates of economic and social development involving high rates of growth in energy demand.
(c) High cost of energy supply.

[16] http://www.un.org/esa/agenda21/natlinfo/countr/cyprus/nsds_2007en.pdf
[17] http://www.moa.gov.cy/moa/agriculture.nsf/Stratigikos%20Sxediasmos%202016-2018%20EL%20-%20YpOik%20150901.pdf
[18] Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol

(d) High dependence on petroleum products - small supply security.
(e) Seasonal variations in energy demand.
(f) Maximum operation of the system of production and distribution of electricity in peak load demand.
(g) Strict limitations of protection and promotion of the island environment that act as a disincentive to develop initiatives in energy investments.

Since its independence in 1960, Cyprus has relied on oil for all of its energy related needs; electricity generation, transport, and heating and cooling. In the absence of any domestic oil production, there has been high vulnerability to fluctuating oil prices. Despite the widespread use of solar water heaters for several decades throughout the island, it was only in recent years that additions of renewable energy technologies have been made for electricity generation. By the end of 2015 renewable energy corresponded to roughly 8.5% of total generation (Ministry of Energy, Commerce, Industry and Tourism based on information released by TSO-Cy, 2016).

The past system of electricity generation has dominated for the past 40 years and has been based on monopolised ownership of a few, large, centralised and inflexible generation plants. Even though it has served well for most of the past, recent years have increasingly exposed its vulnerability, be it from the risk of consequences of generation incidents, be it from the emergence of rather high swing load during the day and year due to the lack of base consumption and the high tertiary activity during the day in summer months, or be it simply to volatility to global oil price fluctuations.

A key challenge for Cyprus is therefore its high dependency on fossil fuels for energy – the biggest share within the EU in fact, which makes it crucial for the country to develop both its hydrocarbon and renewable energy sources. Cyprus is reliant on fossil fuel imports for its electricity needs, and spends over 8% of its GDP to cover the costs.

The island also saw the biggest increase in energy demand among the EU28, growing 41% since 1990 from 1.6 million tonnes of oil equivalent (Mtoe) to 2.3 Mtoe in 2015. These figures may be low when compared with its larger EU partners, but a more accurate comparison would be Malta where consumption was only 0.8 Mtoe in 2015. However, Cyprus is determined to find a cleaner solution until it can exploit its own reserves.

Several stricter restrictions regarding emissions of greenhouse gases and air pollutants will effectively be introduced in 2020. These will affect electricity generation, transportation, and heating and cooling sectors. Frequently, energy planning decisions are made in a disaggregated manner. The electricity supply may be assessed individually and be seen as disconnected from demands for heating and cooling. At the same time, the transport sector is often treated as a separate entity. However, it is obvious to argue that in case of an increased electric vehicle fleet, for instance, this is no longer the case. Similarly, once domestic gas reserves become operational, demand for natural gas may not be confined to conventional power generation. Compressed natural gas may become a viable alternative in the transport sector. Also, even though outside the scope of this study, use of natural gas in industry, residential heating purposes or gasification of the transport sector are potential alternatives.

Such shifts in the national energy profile can bring about challenges, but can also provide opportunities.

The 13% Renewable Energy Sources (RES) goal for 2020[19] is set to be generated by wind farms, photovoltaic (PV) systems, solar thermal plants and biomass and biogas utilisation plants. Latest data show that RES accounted for 8.4% of electricity production in 2016. RES power production rose 6% in 2016, compared to 2015, mainly on increased output generated by private photovoltaic systems. Wind farms generated almost 55% of electricity from RES in 2016, while the private-owned photovoltaic systems generation rose by approximately 15% from 2015 to 2016.

[19] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), OJ L 140, 5.6.2009, p. 16–62

In Cyprus, electricity from renewable sources is no more promoted through subsidy since 2013 where a net metering scheme and self-consumption has been put in place. In addition a new scheme was recently announced for RES that will participate in the competitive market.

Access of electricity from renewable energy sources to the grid shall be granted according to the principle of non-discrimination. With regard to the use of the grid renewable energy shall be given priority. Grid development is a matter of central planning (Transmission Grid Development Plan 2007-2016 by the Cypriot TSO). In addition, renewable heating and cooling (RES H&C) is promoted by support schemes offering subsidies to households.

However, the country's national grid system has certain intrinsic and technical limitations affecting RES penetration and reliability of the energy system – such as the lack of interconnections to the trans-European electricity networks, a limitation to the amount of intermittent renewable energy that can be connected to the electricity system, and a lack of centralised storage capability.

To tackle these problems the country is exploring ways to introduce smart grids in the national network and is on the look-out for projects that could facilitate energy storage, and ventures that have production on a 24-hour basis. Also the EuroAsia Interconnector could bring more solutions in its wake.

The island is already one of the highest users per capita in the world of solar water heaters in households, with over 90% of households equipped with solar water heaters and over 50% of hotels using large systems of this kind. With almost year-round sunshine, Cyprus certainly has plenty of energy to harness, but competitive energy storing capabilities are crucial in order to fully tap into its solar potential and facilitate better RES penetration.

There continues to be much ground to cover in terms of renewable energy production, but international interest in developing the sector in Cyprus has been on the rise. In this respect, the production of renewable energy is expected to experience considerable growth in coming years, and significant investment is required in order for Cyprus to achieve its targets – opening the field for companies with expertise in renewables.

The Cyprus Energy Regulatory Authority (CERA) has worked towards the full opening up of the energy market and granting consumers the right to choose their own supplier – with expectations of a full liberalisation by May 2019. CERA's proposition is a 'net pool' model, where the operations of the state power company, EAC, are unbundled and the production and supply operations separated. EAC production would then enter into bilateral agreements with suppliers for the sale of energy at regulated prices. However, these plans have experienced some resistance from unions, as they are seen as moves which could put pressure to privatise the state power company.

In respect to the supply of natural gas to Cyprus, the Council of Ministers, at its meeting in June 2016, decided to approve the import of Liquefied Natural Gas (LNG) to Cyprus in a manner leading to the commencement of natural gas supply preferably by the year 2020. For the purpose of implementing the Decision, the Cyprus Natural Gas Company (DEFA) was mandated to carry out a study which concluded that the preferred LNG supply option project is through the use of a floating infrastructure with the development of the necessary mooring facilities and pipeline connection to the natural gas receiving point at Vassilikos. On the basis of the results of the study the Council of Ministers, at its meeting on May 18th 2017, decided to mandate DEFA to issue, as soon as possible, an invitation for tenders regarding the long-term supply of LNG to Cyprus to satisfy electricity requirements and an invitation for tenders for the construction and operation of the necessary infrastructure. In parallel with the above DEFA was mandated to proceed with the FEED study for the internal pipeline network. The anticipated time plan for the implementation of the tenders is expected to take place in the first half of 2018.

The electrical interconnection with Israel and Greece will be the next major challenge in the country energy sector. Cyprus is promoting the «EuroAsia Interconnector» project as aiming at commissioning in 2019-2022. The project will effectively contribute to the security of energy supply and reduction in

CO2 emissions by allowing the countries in the region renewable energy sources for electricity generation.

The competent authority in relation to energy policies is the Energy Service of the Ministry of Energy, Commerce, Industry and Tourism. The main energy consumers in Cyprus (2016) are presented in Figure 4.1.

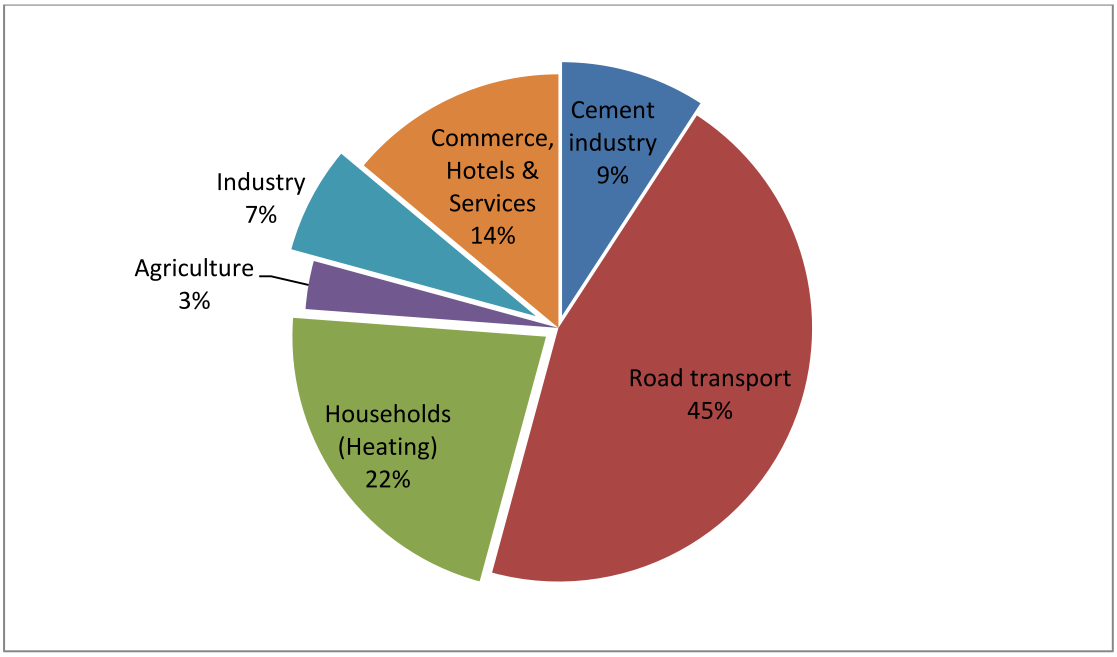


Figure 4.1. Main energy consumers in Cyprus (2016)[20]

4.1.2.1. Introduction and use of Natural gas in the internal market for electricity production (E1)

The Government of Cyprus, recognizing the positive contribution that the introduction and use of natural gas will have on the economy and the environment of Cyprus, is considering the introduction of natural gas initially for use for electricity generation. It is however expected that after its arrival, natural gas will also be used in other sectors of the economy (commercial, industrial and transport).

In the view of the fact that the interim solution tender process was terminated by DEFA without conclusion with a gas supply agreement, the Ministry of Energy, Commerce, Industry and Tourism, in collaboration with the Cyprus Energy Regulatory Authority (CERA), are examining all available options for the introduction of LNG in Cyprus as soon as possible and complementary to the supply of natural gas from indigenous reserves.

By importing natural gas, apart from the reduction of emissions from the actual use of the natural gas, there would also be a positive contribution to emission reductions through the increased efficiency of the newer technologies used.

The development of natural gas market in Cyprus will be based on the provisions of the relevant EU Directives including the making use of relevant derogations provided in the Directive 2009/73/EC concerning isolated and emergent markets.

Box 4.1. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism

Other involved authorities
- Cyprus Energy Regulatory Authority

[20] Energy Service; Energy balance 2016 (in toe)

- Public Natural Gas Company (DEFA)
- Electricity Authority of Cyprus
- Department of Environment

Type
Political, legislative

National legislation
- Κ.Δ.Π. 115/2006
- N. 183(I)/2004 as amended

Measures towards attainment
- Introduction and use of natural gas for electricity production
- Installation of combined cycle electricity production units using natural gas as fuel
- Decommissioning or conversion of existing electricity production units

4.1.2.2. Promotion of Renewable energy sources

[21]The energy policy of Cyprus is harmonized with the European Union goal of promoting the use of energy from renewable sources, as a major step towards the reduction of global warming and climate change phenomena.

The EU RES Directive[22] sets out specific national targets to be achieved by each individual Member State, regarding the share of RES generated in each Member State by the year 2020. For Cyprus, the national target states that the share of energy produced from RES must be at least 13% out of the gross national final consumption of energy in 2020.

The main types of RES technologies promoted under these measures for integration in the Cyprus power system are solar energy, wind energy and biomass. Cyprus ranks first in the world in solar energy use for water heating in households, and has achieved significant progress in the production of energy from Renewable Energy Sources (RES).

Cyprus has already exceeded its intermediate 2020 targets, with RES comprising of about 8.7% of its total electricity generation, compared to the 7.45% threshold for 2015- 2016. In addition, Cyprus holds the EU-28 record according to the "European Solar Thermal Industry Federation" for use of solar water heating systems per capita. Currently, more than 93% of households and 52% of hotels in Cyprus heat water through solar power heating systems.

Cyprus is on track in achieving its Renewable Energy Sources (RES) target, i.e. to supply 13% of the island's energy by 2020 (Table 4.2). Details on how Cyprus will achieve the targets are available in the National Renewable Energy Action Plans that has been prepared according to Article 4 of the renewable energy Directive (2009/28/EC) and submitted in July 2010[23]. Currently there is no policy related to RES for the period after 2020.

Table 4.2. Summary of the targets trajectory for Renewable energy sources in Cyprus (according to the National Renewable Energy Action Plan) excluding transport

	2010	2015	2020
Renewable energy sources to reach 13% in 2020 in the gross final energy consumption			
Heating and cooling	16.2%	20%	23.5%
Electricity production	4.3%	8.4%	16%
Transport	2.2%	3.1%	4.9%
Total share of RES	6.5%	9.0%	13%

[21] http://www.investcyprus.org.cy/en/growth-sectors/cyprus-investment-sectors/energy-sector
[22] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), OJ L 140, 5.6.2009, p. 16–62
[23] https://ec.europa.eu/energy/sites/ener/files/documents/dir_2009_0028_action_plan_cyprus.zip

The most important projects relating to power generation from RES concern wind parks and photovoltaic (PV) parks, concentrated solar thermal plants and biomass and biogas utilisation plants. 6 wind parks are currently in operation, while as regards solar energy, 4 PV parks have been connected to the national grid so far, generating 1,000 MWh. Table 4.3 shows the distribution of the renewable energy sources according to the type of renewable technology and consumer.

Table 4.3. Renewable energy sources in the energy balance of Cyprus in toe, 2016[24]

	Solar Thermal	Geothermal	Biomass	Electricity from Biomass	Heating from CHP (Biomass)	Electricity from wind	Electricity from PV Systems	Biofuels
Cement industry			11529					
Road transport								8889
Households (Heating)	58621	1551	8027				1828	
Agriculture				1325	4441			
Industry			1718					
Commerce, Hotels & Services	10345		5748			36.8	5.5	
Electricity from RES fed to the Grid				3148		19459	10864	

Measures are separated into two key categories: Renewable energy sources in electricity production and renewable energy sources for heating and cooling.

4.1.2.2.1. Renewable energy sources in electricity production

Electricity production contributed 50% to the emissions of the energy sector in 2015, which corresponds to 36% to the total emissions of the country (excluding LULUCF) (Department of Environment, 2017). This corresponds to 3,033 Gg CO_2 eq., whereas the total emissions of the country without LULUCF were 8,467 Gg CO_2 eq. All units producing electricity in Cyprus for public use running on conventional fuels are operated by the Electricity Authority of Cyprus. The main fuel used for the production of electricity is HFO while there also some consumption of gas oil (approximately 10% in 2015). Electricity production is regulated by the Emissions Trading System.

Box 4.2. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
Other involved authorities
- Cyprus Energy Regulatory Authority
- Transmission System Operator
- Ministry of Finance
- Department of Town Planning and Housing, Ministry of Interior
- Department of Environment, Ministry of Agriculture, Natural Resources and Environment

Type
Legislative, voluntary
National legislation
- Law No. 112(I)/2013 on the promotion and encouragement of the use of renewable energy sources which has repealed the old one (N.33(I)/2013)

[24] Energy Service; Energy balance 2016 (in toe)

- Law 110(I)/2011 establishing a European emissions trading system and other relevant issues

Relevant EU legislation

- Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market (Directive 2001/77/EC is repealed by Directive 2009/28/EC from 1 January 2012. Moreover, from 1 April 2010, Article 2, paragraph 2 of Article 3 and Articles 4 to 8 will be deleted)
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community

Measures towards attainment

- RES support schemes
- Informational campaigns
- Implementation of relevant legislation

4.1.2.2.2. Renewable energy sources for heating and cooling

Heating and cooling for industrial, housing and tertiary sectors, contributed 18% to the emissions of the energy sector in 2015, and 13% to the total emissions of the country (excluding LULUCF) (Department of Environment, 2017).

The main technologies being traditionally used in Cyprus for heating and cooling are Oil-burning central heating and air-conditioning split units. The low operating cost based on cheap oil prices in the past, and clean and effective heating, provided practical advantages, far outweighing the implementation cost in the long-run. While there are not major changes during the recent years in cooling, for heating, gas-burning central heaters, fireplaces and wood-burning stoves have been gaining popularity in recent years.

The measures promoted are predominately associated with the promotion of solar thermal, biomass and geothermal energy.

Box 4.3. Key information

Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

Other involved authorities

- Department of Town Planning and Housing, Ministry of Interior
- Department of Environment, Ministry of Agriculture, Natural Resources and Environment
- Department of Labour Inspection, Ministry of Labour and Social Insurance

Type

Legislative, voluntary

National legislation

- Law No. 112(I)/2013 on the promotion and encouragement of the use of renewable energy sources, which has repealed the old one (N.33(I)/2013)
- Law No. 142(I)/2006 regulating energy efficiency in buildings
- Law No. 30(I)/2009 amending Law No. 142(I)/2006 regulating energy efficiency in buildings
- Law No. 56(I)/2003 on Integrated Pollution Prevention Control (with amending laws no. 15(I)/2006, 12(I)/2008)

Relevant EU legislation

- Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market (Directive 2001/77/EC is repealed by Directive 2009/28/EC from 1 January 2012. Moreover, from 1 April 2010, Article 2, paragraph 2 of Article 3 and Articles 4 to 8 will be deleted)

- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community
- Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control and related amendments

Measures towards attainment

- RES support schemes
- Informational campaigns
- Implementation of relevant legislation

4.1.2.3. Promotion of energy efficiency (E3-E9)

Because of its national peculiarities, which make it a small and isolated system (an island country) without any interconnections to European or other energy networks (electricity, petroleum, natural gas) at present, Cyprus attaches great importance to energy efficiency aiming, inter alia, to improve energy supply security, increase competitiveness and ensure sustainable development/environmental protection.

There is significant potential for end use energy efficiency, especially in buildings and in the transport sector. Cyprus has met the interim end use energy savings EU target for 2010. The measures taken so far, combined with the measures expected to be taken in implementation of the Energy Efficiency Directive (Directive 2012/27/EU) and the Energy Performance of Buildings Directive (Directive 2010/31/EU), will allow Cyprus to largely exceed the end use target set for 2016, while laying the ground for achieving the 2020 primary Energy Saving target. Raising consumer awareness in combination with the measures promoted by Cyprus under the EU Directives for improving energy efficiency have contributed decisively to the reduction in the growth rate of energy consumed and have brought positive results for the economy and employment sector.

In application of the provisions of the Directive 2012/27/EU on energy efficiency, as an alternative to the adoption of an energy efficiency obligation scheme, Cyprus has prepared a National Energy Efficiency Programme (NEEP) for the purpose of achieving the cumulative end use energy savings target. Some of the measures selected for inclusion in the NEEP relate to proposals submitted for project co-financing by EU Structural and Investment Funds. Grant Schemes have been put in place for the implementation of these measures. In particular, these measures are:

- An annual renovation of 3% of the surface of air conditioned and heated public buildings owned by the State and used by the central government.
- Conducting energy inspections in industries and implementing investments in energy savings.
- Energy upgrading of existing residences so that they may comply with the minimum energy efficiency requirements.
- Installation of roof thermal insulation on dwellings.
- Energy upgrading of existing buildings so that they may comply with the minimum energy efficiency requirements for buildings.
- Infrastructure for supporting and promoting electric vehicles in Cyprus.
- Installing an integrated AMI system with 500 000 smart metres.

Further details on the energy efficiency policy and measures are available in the 3rd National Energy Efficiency Action Plan (NEEAP) of Cyprus[25].

[25] https://ec.europa.eu/energy/sites/ener/files/documents/CuprusArt42014.pdf

4.1.2.3.1. Energy efficiency in industry (existing companies) – E3

A Grant Scheme for encouraging the use of Renewable Energy Sources and Energy Saving for Natural and Legal Persons as well as for Public Sector Bodies engaged in an economic activity, was in place up until the end of 2013. The investments covered by the Grant Scheme fall into two subcategories. NA - Energy Saving (SA) and NB - Renewable Energy Sources (RES).

According to the provisions of the 2013 NEEAP, energy-savings investment means an investment in systems, equipment and materials whose installation achieves at least 10% energy savings in a specific application. Eligible expenses also included the design costs, where necessary, under the restrictions set out in the relevant application documents for the different categories and subcategories of the Scheme.

Category NA1 of the grant scheme applied only to existing undertakings operating in Cyprus for at least four (4) years. Financial aid was granted to energy investments in existing holdings of the undertakings in question, under the condition that the building licence was issued by 28 December 2008. There were five (5) subcategories of investments as follows:

1. Purchase/installation of new equipment for the recovery of waste energy, either directly or indirectly by recovery/recycling of discarded materials, product or employed medium.
2. Purchase/integration of new materials and equipment to reduce idle energy consumption and energy losses.
3. Purchase of new equipment for the production, transmission, distribution and use of energy.
4. Purchase/installation of a new energy management IT system and/or integration of automated direct energy regulation/switch-off devices.
5. Replacement of existing materials and/or equipment connected with the subcategories 1 to 4.

Training seminars on energy management are held on an annual basis, in cooperation with the Human Resources Development Authority of Cyprus (HRDA), the Productivity Centre and the Energy Institute. Four (4) seminars were held in 2013 in Nicosia, Limassol, Larnaca and Paphos, with a duration of 60 hours each. The seminars were addressed to unemployed engineers of all specialties and focused, inter alia, on issues related to energy saving and energy efficiency improvement technologies/systems, ways of operation, selection of an appropriate system and applications in Cyprus (industry, hotels, services, etc.). In addition, examples for drawing up a technical-financial study for the installation of energy-saving systems and other examples of studies under ES Grant Schemes were presented.

Furthermore, information days were held in Nicosia, Limassol and Paphos addressed mainly to engineers who are members of the Cyprus Scientific and Technical Chamber (ETEK), the Cyprus Employers and Industrialists Federation (OEB), the Cyprus Chamber of Commerce and Industry (KEBE), hotel owners, entrepreneurs, credit institutions, municipalities and communities, contractors and the general public. Information days focused on energy audits, the energy efficiency of buildings, energy labelling, energy-saving and RES technologies used for heating and cooling purposes.

In recent years, the Cyprus Employers and Industrialists Federation (OEB) holds an annual fair on energy saving, in cooperation with the EAC and the Energy Department. Printed information material on the different energy-saving technologies is distributed at the fairs. In addition, information is provided to the general public with regard to the provisions of the grant schemes. The most efficient energy-saving investments made by natural or legal persons under the grant scheme of the Special Fund ES are rewarded at the 'Save Energy' fair.

Within 2013, the Energy Service has approved training institutes to carry out training programmes for candidate Category A and B energy auditors. Category A relates to all buildings regardless of their surface and air conditioning system and includes, inter alia, ports, airports and street lighting. Category B relates to industrial facilities, as well as agricultural activities and installations. The first category B energy auditors have been entered in the relevant registry within 2014. The first energy auditors have been included in the registry of Category A energy auditors in 2013.

In addition, Cyprus' NEEP establishes, as a measure to achieve the target under Article 7, co-financing for conducting energy audits in industries and for the implementation of the energy-saving investments proposed by the energy audit. The measure will concern approximately 10 industries per year.

These measures are expected to be renewed within the following years in view of the new EU obligations for 2030.

Box 4.4. Important information

<u>Competent authority</u>
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
<u>Other involved authorities</u>
Department of Environment
<u>Type</u>
Legislative, compulsory
<u>National legislation</u>
Law No. 31/2009 on energy end-use efficiency and energy services
<u>Relevant EU legislation</u>
- Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.
- Decision 406/209/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

<u>Measures towards attainment</u>
Grant scheme for energy conservation

4.1.2.3.2. Residential buildings – E4-E5-E6

According to Article 4 of Directive 2012/27/EU on energy efficiency, Member States shall establish a long-term strategy for mobilising investments in the renovation of their national stock of buildings.

In Cyprus, it is estimated that houses account for 19% of final energy consumption, whereas another 13% corresponds to commerce, hotels and services, i.e., mainly office buildings[26]. The different political, economic and social conditions over the years did not allow for the implementation of energy-saving measures during the construction of buildings. The first organised attempt to implement energy-saving measures in buildings was made in 2004 through the grant schemes of the Special Fund for RES and ES, whereas the implementation of compulsory measures in new buildings and large buildings undergoing major renovation started in 2007 with the adoption of the 2007 Decree on the 'Regulation of the Energy Efficiency of Buildings (Minimum Energy Efficiency Requirements)'. Therefore, there is currently an energy-intensive building stock, which has negative consequences for the economy and the environment. In addition, the lack of sufficient thermal insulation measures and the excessive exposure to sunlight observed in many buildings are harmful to the health of citizens, reduce the productivity of workers and diminish the quality of life. Major building renovations offer an opportunity to resolve many of these issues.

Dwellings are the majority of Cyprus' building stock, as 431 059 dwellings have been recorded (2014). However, 78 088 houses are used as weekend or tourist residences, which means that they are used less and, therefore, they consume less energy. In addition, 54 651 homes are empty.

Most dwellings of Cyprus' current building stock have been constructed in the period 2001-2008, followed by the 1980's and the 1990's, which reflect the periods of increased construction activity. In the case of 91% of dwellings, there was no obligation to apply thermal insulation or any other energy-saving measures at the time they were built. Therefore, the energy status of most buildings may be

[26] Energy Service, 2014, Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency; Annex F of 3rd National Energy Efficiency Action Plan (NEEAP) of Cyprus available at https://ec.europa.eu/energy/sites/ener/files/documents /CuprusArt42014.pdf

characterised from poor to average, given that, as a rule, building owners did not take any measures during the building's construction, whereas some home owners have taken energy-saving measures at a subsequent stage, mainly under grant schemes of the Special Fund for RES and ES. According to the available statistics, 49% of dwellings have not taken any energy efficiency measures, whereas only 12% have applied some sort of thermal insulation at the building's envelope. The situation is better in the case of window frames, where over 38% have double-glazing.

The main energy product used in the residential sector is electricity coming from the grid, as it is responsible for almost half the final energy consumption, followed by fuel oil and LPG, which are the most important energy products after electricity. Solar energy has penetrated the market with a rate exceeding 16%, whereas other renewable energy sources, such as PV systems, geothermal heat pumps and biomass have a smaller contribution. The highest primary energy consumption rates are due to air conditioning and heating. Solar thermal systems for domestic hot water production have an increased penetration in the residential sector as they are installed in 91% of dwellings.

The measures implemented in the residential sector taken into consideration are the following:

- Residential new buildings
- Residential buildings energy upgrade
- Residential solar panels replacement

The policies and measures that will stimulate investments in the renovation of existing buildings may be divided into: legislative measures and policies, incentives, training measures and awareness raising measures. Details on the measures implemented are available in Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency (2014)[27].

Box 4.5. Key information

<u>Competent authority</u>
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
<u>Other involved authorities</u>
- Ministry of Interior
- Municipalities
- Department of Environment

<u>Type</u>
Legislative, compulsory
<u>National legislation</u>
Law No. 142 (I)/2006 regulating energy efficiency of buildings and amending Laws N. 30(I)2009, N. 210 (I)2012, N. 15 (I)2017
<u>Relevant EU legislation</u>
Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010
on the energy performance of buildings
Decision 406/209/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020
<u>Measures towards attainment</u>
- Implementation of national action plan on energy efficiency
- Implementation of national legislation

4.1.2.3.3. Non-residential buildings – E7-E8

Non-residential buildings include various types of buildings, the most important of which are offices, retail shops, restaurants, hotels and hospitals. There are no statistics on this building category.

[27] Energy Service, 2014, Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency; Annex F of 3rd National Energy Efficiency Action Plan (NEEAP) of Cyprus available at https://ec.europa.eu/energy/sites/ener/files/documents /CuprusArt42014.pdf

However, in 2012 the Electricity Authority of Cyprus (EAC) had 85,198 commercial customers, i.e., buildings and building units owned by enterprises and organisations. Table 4.4 provides an analysis of EAC's commercial customers per category of use, which reflects to a great extent the relevant number of buildings and building units per type.

Table 4.4. Electricity consumers per category

Type of consumer	Number of consumers
Wholesale and retail sale, repair of vehicles	24,788
Accommodation premises and establishments serving food	10,097
Public administration and defense	1,671
Education	2,454
Human health and social work activities	2,143
Culture, entertainment and recreation	2,907
Other services	41,138

The vast majority of customers under category 'other services' represent buildings and building units used as offices, which rank first in terms of number followed by retail shops. Despite the fact that there are no statistics on the age of these buildings, it may be assumed that they have a distribution over time which is similar to the one of dwellings, as commercial and other buildings had the same peak period as dwellings. Both in the case of dwellings and other buildings, there was no obligation to apply thermal insulation or any other energy-saving measures at the time they were built. Approaches to envelope construction were the same for all building categories.

The sector of non-residential buildings uses two-thirds of total final consumption of electricity from the grid. The use of RES is reduced as compared to households, with solar energy showing the highest penetration. In some building types, such as hotels, where 50% uses solar energy for hot water production, there is an increased penetration of RES, as compared to the average penetration in buildings of the tertiary sector. One- to five-star hotels in Cyprus number 224, of which 20 are located in mountainous regions.

The measures implemented in the non-residential (tertiary) sector taken into consideration are the following:

- Tertiary new buildings
- Tertiary buildings energy upgrade

The policies and measures that will stimulate investments in the renovation of existing buildings may be divided into: legislative measures and policies, incentives, training measures and awareness raising measures. Details on the measures implemented are available in Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency (2014)[28].

Box 4.6. Key information

<u>Competent authority</u>
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
<u>Other involved authorities</u>
- Ministry of Interior
- Municipalities
- Department of Environment

<u>Type</u>
Legislative, compulsory
<u>National legislation</u>

[28] Energy Service, 2014, Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency; Annex F of 3rd National Energy Efficiency Action Plan (NEEAP) of Cyprus available at https://ec.europa.eu/energy/sites/ener/files/documents /CuprusArt42014.pdf

Law No. 142 (I)/2006 regulating energy efficiency of buildings and amending Laws N. 30(I)2009, N. 210 (I)2012, N. 15 (I)2017
Relevant EU legislation
Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010
on the energy performance of buildings
Decision 406/209/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020
Measures towards attainment
- Implementation of national action plan on energy efficiency
- Implementation of national legislation

4.1.2.3.4. Public buildings – E9

The term "public buildings", means buildings used by:

- Central government authorities such as Ministries, the Police and the General Prosecutor's Office;
- Local Administration, such as Municipalities and Communities
- Public schools, public universities and other public educational institutions;
- The military.

Central governmental authorities means all administrative services whose competence extends to the whole territory of the Republic of Cyprus, which are laid down in Annex IV to the 2006 Coordination of the Public Procurement, Works and Services Contracting Procedures and Relevant Matters Act. These authorities use 1,066 buildings and building units of which only 572 are property of the public sector. As a rule, they use only electricity to cover their energy needs.

In the areas under the effective control of the Republic of Cyprus, Local Administration consists of 30 Municipalities and 350 Communities. Most Municipalities and large communities have only one building, used for administrative purposes and events. However, large Municipalities own more buildings which are being used to serve the public, as well as other building types, such as libraries and sports centres.

In Cyprus there are 833 public schools of primary and secondary education. The Technical Department of the Ministry of Education and Culture is responsible for the implementation of projects related to the construction of new school units and the maintenance and extension of already existing ones. Regarding public universities, the University of Cyprus, which is the largest public university, owns most of the buildings that have been constructed in recent years within the Campus. The Technological University of Cyprus uses mainly historical buildings and leased buildings in the historical center of Limassol, whereas the Open University of Cyprus uses a building in Nicosia. Public universities have technical departments which are responsible for the maintenance and the smooth operation of their building infrastructures.

Box 4.6. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
Other involved authorities
-
Type
Legislative, Compulsory
National legislation
Law No. 142 (I)/2006 regulating energy efficiency of buildings and amending Laws N. 30(I)2009, N. 210 (I)2012, N. 15 (I)2017
Relevant EU legislation
Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010
on the energy performance of buildings
Measures towards attainment

-

4.1.2.4. Promotion of biomass and alternative fuels in industry

Cement is considered one of the most important building materials around the world. Cement production is an energy-intensive process consuming considerable amounts of thermal energy. Globally, historically, the primary fuel used in cement industry is coal[29]. A wide range of other fuels such as gas, oil, liquid waste materials, solid waste materials and petroleum coke have all been successfully used as sources of energy for firing cement-making kilns, either on their own or in various combinations. In Cyprus the predominant fuel used in cement production is pet-coke, while biomass and the non-biomass fraction of waste are also used.

The new cement producing installation in Cyprus installed in 2011 has the capability of using considerable amounts of alternative fuels and biomass. This advantage should be exploited by encouraging the installation to use non-conventional fuels.

4.1.3. Sectoral policies and measures: Transport

In 2015, road transport emissions contributed 22% of the total national emissions excluding LULUCF (Department of Environment, 2017). The emissions of road transport increased by 56% compared to 1990. According to information from the International Road Federation, Cyprus has the highest car ownership rate in the world with 742 cars per 1,000 people. Other means of transport are very low compared to other countries: 3% public transport and bicycle less than 2% (Ministry of Communications and Public Works, 2010).

In addition to the importance for emissions, transport has been an issue of particularly great interest to the society of Cyprus, due to the very large growth of the number of privately owned cars and the associated problems in traffic that are experienced, especially in the capital, Nicosia. Even though many studies have been completed since the 1990s on how to deal with traffic in the urban areas of Cyprus and especially Nicosia, only recently (end of 2009) action has been taken and measures are implemented.

The energy intensity in the transport sector is among the highest in the EU, mainly due to the large percentage of road transport operations. However, there has been a remarkable improvement in this sector in recent years. The increase in the energy efficiency of private vehicles and the import of smaller and more efficient cars have led to better results although public transport in Cyprus are not adequately developed. The transport sector, along with the electricity generation and building sectors, is one of those sectors that offer a significant potential for energy efficiency improvement.

According to the 2013 (Amending) Law on Motor Vehicles and Road Traffic, which entered into force on 1 January 2014, the annual circulation tax for each category M1 motor vehicle and the annual circulation tax for each category N1 motor vehicle, resulting from a category M1 motor vehicle and classified under the category of light lorry (VAN type), is calculated on the basis of the carbon dioxide emissions of the vehicle's engine. In addition, as from 1 January 2014, category N2 and N3 vehicles (lorries) and M2 and M3 vehicles (buses) are registered in so far as they have been proven to comply with the 'EURO VI' requirements on the emission of pollutants.

The launch of the 4th Old Vehicle Scrapping and Replacement Scheme was announced on 11 October 2010, whereas the scheme was implemented in 2011. Applications were admitted for a period of 2 months with final date on 13 December 2010. The 4th Scheme related to the payment of a grant equal to EUR 1 800 and covered the scrapping of M1 category motor vehicles, older than 15 years old, under the condition that a new car with CO2 mass emissions lower or equal to 165gr/km would be purchased.

[29] Chinyama, 2011, Alternative Fuels in Cement Manufacturing, available at https://www.intechopen.com/books/alternative-fuel/alternative-fuels-in-cement-manufacturing

The new public transportation system was put in force in the second half of 2010. The new public transportation bodies replaced part of their vehicles with new ones that have low fuel consumption and pollutant emissions, as compared to the old vehicles that were replaced. Provincial urban companies have re-organised their routes, aiming to optimise their efficiency in this sector. Their websites contain a detailed map of the routes and the timetable of buses in order to facilitate passengers.

Before the end of 2011, the widening of the motorway linking the Alambra and the GSP intersections (entry to Nicosia) from four to six circulation lanes was completed. Works started on 11 January 2010 against the amount of EUR 32.4 million + VAT and were co-financed by the Trans-European Transport Networks Fund.

In the context of the implementation of EU Regulation (EC) No 1222/2009 on the labelling of tyres with respect to fuel efficiency and other essential parameters, delegated inspectors of the Energy Department perform market surveillance checks in order to identify cases of noncompliance with these provisions. In addition, presentations on energy savings in the transport sector and on eco-driving are made in the context of the seminars addressed to unemployed engineers of all specialisations organised by the Energy Department and the Productivity Centre, with the support of the Human Resources Development Authority of Cyprus.

The municipalities of Nicosia have founded the Inter-municipal Bicycle Company of Nicosia (DEPL), aiming to change the way things work on Cypriot roads via an automated 3rd generation bike rental system. The installation of this innovative system will be combined with the design of new bicycle lanes, which will be used by a large part of the population and by tourists to commute from and to the city centre. In particular, the Nicosia Municipality has installed 100 bicycles in 5 stations, the Aglantzia Municipality, 50 bicycles in 4 stations, the Strovolos Municipality, 80 bicycles in 8 stations, the Dali Municipality, 20 bicycles in 3 stations, the Aghios Dometios Municipality, 20 bicycles in 2 stations, the Latsia Municipality, 15 bicycles in 2 stations and the Engomi Municipality, 30 bicycles in 3 stations. There is one single system for all municipalities that participate in the programme, whereas each user can take a bicycle from the station of one municipality and return it to the station of another municipality. The programme aims to promote the use of bicycles among citizens as an alternative means of transport in the city.

Furthermore, a Grant Scheme for energy saving in the transport sector (purchase of hybrid vehicles, electric vehicles and low-pollutant vehicles), was in force in the period 2004-2009.

The European Directive 2014/94 / EU on the Development of Rural Renewables Infrastructures establishes a common framework for measures to develop the market for alternative fuels in the transport sector and the implementation of relevant infrastructure within the Union in order to minimize dependence on liquid minerals to reduce the environmental impact in the transport sector. Within the framework of the directive, which sets practical goals, the development of the market and related infrastructure for the use of electricity, liquefied natural gas (LNG), compressed natural gas (CNG) and hydrogen in transport is specifically promoted. Directive 2014/94 / EC is a tool to meet the mandatory 2020 target for road transport, i.e. (a) 10% energy from RES in transport (Directive 2009/28 / EC) and b) 6 % reduction in greenhouse gas emission intensity in the life cycle of road transport fuels (Directive 2009/30/EC) the competent authority is the Ministry of Energy, Trade, Industry and Tourism. A National Policy Framework describing national targets and targets, guidelines, support actions and policies for the development of alternative fuels and developing the necessary infrastructures was prepared by the Ministry of Transport, Communications and Works in cooperation with the Ministry of Energy, Commerce, Industry and Tourism.

Charging points and infrastructures for electric vehicles have been installed in public buildings and in public roads, whereas installation costs in private buildings, single-family houses and undertakings will be subsidised under specific criteria and specifications. There are currently 20 charging stations in Cyprus: 7 charging stations in Nicosia, 6 in Limassol, 2 in Larnaca, 2 in Ammochostos and 3 in Paphos. Although the numbers are still very small, the expectation is that the registration of electric cars will increase considerably over the next five years. New electric car sales are expected to comprise 25%-50% of total vehicles on the road by 2040.

The installation of LPG systems in vehicles has also started in 2017 and will reduce the emission of pollutants and fuel consumption in old vehicles.

For the reduction of emissions from road transport the competent authorities are considering the implementation in the immediate future of further measures in the fields of Traffic demand management, Improvement of road traffic flow, Reduction in transport demand, Switch in transport modes and Alternative fuels and technologies.

The continuation and further development of measures such as the above and additional measures such as improvement of infrastructure for further encouragement of use of public transport, cycling and walking and financial incentives to encourage new vehicles with low to zero emissions and discourage vehicles with high emissions, can reduce the emissions of one of the most important sectors in Cyprus with respect to mitigation.

Biofuels

Biofuels are liquid or gaseous transport fuels such as biodiesel and bioethanol which are made from biomass. They serve as a renewable alternative to fossil fuels in the EU's transport sector, helping to reduce greenhouse gas emissions and improve the EU's security of supply. By 2020, the EU aims to have 10% of the transport fuel of every EU country come from renewable sources such as biofuels. Fuel suppliers are also required to reduce the greenhouse gas intensity of the EU fuel mix by 6% by 2020 in comparison to 2010.

Box 4.7. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
Other involved authorities
-
Type
Legislative, Compulsory

National legislation
Law N. 112 (I)/2013 – 2015(transposition of EU Directive 2009/28/EC)
Relevant EU legislation
Directive 2009/28/EC of the European Parliament and the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
Measures towards attainment
-

4.1.4. Sectoral policies and measures: Industry

The New EU F-gas Regulation adopted in 2014 and applies from 1 January 2015, aims among others in preventing emissions of F-gases from existing equipment by requiring leakage checks, proper serving and recovery of the gases at the end of the equipment's life. For the full implementation of this regulation in Cyprus a proper recovery system needs to be setup and used in Cyprus. Given the high GWP of the F-gases, and their increasing contribution to the national emissions, it is considered crucial for proper recovery to be implemented within the following years.

Under provisions of Art. 9 of Regulation 517/2014/EC, on fluorinated greenhouse gases, without prejudice to existing Union legislation, Member States shall encourage the development of producer responsibility schemes for the recovery of fluorinated greenhouse gases and their recycling, reclamation or destruction. Cyprus has recently adopted and harmonized the above Regulation into Cypriot Law 62(I)/2016 and 46(I)/2017. The next step is to forward a national Law regarding a producer's responsibility scheme. The main provision of this Law will follow the "polluter pays" principle and each producer will have to participate in an appropriate scheme for management of f-gases that have been recovered for any reason.

At the same time, under the provisions of the same scheme, certified technicians will be encouraged to return to the scheme any fluorinated gases the have recovered, for a pre-decided profit.

Box 4.8. Key information

Competent authority
Department of Environment, Ministry of Agriculture, Rural Development and Environment
Other involved authorities
-
Type
Legislative, compulsory
National legislation
Fluorinated greenhouse gases Law (No. 62(I)/2016 and 46(I)/2017)
Relevant EU legislation
Regulation on fluorinated greenhouse gases 517/2014
Measures towards attainment
- Implementation of “polluter pays” principle; each producer will have to participate in an appropriate scheme for management of f-gases that have been recovered

4.1.5. Sectoral policies and measures: Agriculture

Anaerobic digestion technology may help to address two congressional concerns that have some measure of interdependence: development of clean energy sources and reduction of greenhouse gas emissions. Anaerobic digestion, as a way of converting biomass to energy, has been practiced for hundreds of years. It is a technology that helps to reduce waste, generate energy and cut down on carbon emissions. The general performance of anaerobic digesters and the diversity of wastes which they can treat have been increasing steadily as a result of new reactor design, operating conditions, or the use of specialised microbial consortia, during the last decades. In Cyprus there are currently operating more than 10 anaerobic digesters, of which the majority is at large animal farms. All available studies show that there is a great potential in Cyprus to further promote anaerobic digestion for the treatment of waste with high organic content.

Even though anaerobic digestion is not clearly stated in the European or national legislation, the technology is preferred by large animal farms to comply with the terms stated on the wastewater and air emissions permits. The technology is strongly promoted by the Department of Environment, especially for the large installations that fall under the Industrial Emissions directive. Relevant national legislation that encourages the promotion of anaerobic digestion is (a) the Control of Water Pollution (Waste Water Disposal) Regulations 2003, Κ.Δ.Π. 772/2003; (b) the Control of Water Pollution (Sensitive Areas for urban waste water discharges) Κ.Δ.Π. 111/2004. It is a voluntary measure which is expected to increase. Therefore it is considered important to further promote the use of anaerobic digestion for the treatment of animal waste.

4.1.6. Sectoral policies and measures: Waste

With the EU Landfill Directive being the main guiding force, in combination to the improvement of the infrastructure of the country, Cyprus has developed and implementing during the recent years the revised strategy for municipal solid waste management. The implementation of the strategy is the responsibility of the Department of Environment.

The National Municipal Waste Management Plan of 2015-2021 (MWMP) contains quantitative and qualitative targets and enumerates specific measures and actions to be taken in order for the EU targets to be reached. One of the quantitative target is that no more than 95,000 tonnes of biodegradable waste to be disposed in landfills (represents the 35% target of the 1999/31/EC directive). Also the Legal Measures will be focused on the:

- Development of local waste prevention and management schemes
- Mandatory obligation for establishing separate collection systems by local authorities,
- Establishment of extended producer responsibility (EPR) in streams other than packaging waste,

- Establishment of a landfill tax/levy,
- Banning the disposal of certain waste streams from entering into landfills (e.g. green waste, high calorific value waste, etc.)

The adaptations of the strategy that are envisaged:

a) One Sanitary Landfill and one Residual Sanitary Landfill (supplementing MBT unit at Koshi) were constructed and operated (both meet the requirements of directive 99/31/EC). The MBT unit was constructed and operated from 01/04/2010 serving Larnaca - Ammochostos districts. The Plant was designed in a way that a high separation of recycled and biodegradable material is achieved. Another I.W.M.P (Integrated Waste Management Plant) serving Limassol district is expected to be operated by the year 2018.
b) The construction of the Green Point Network (22 collection points for the depositing of various waste streams out of households – bulky waste, green, textile, furniture, WEEE, etc.) is competed. The 4 Green Points, serving Paphos district are operated and the rest expected to be operated by 2018.
c) Separate collection at source was promoted at households, from the existing collective system for the packing waste serving also and all types of paper, created under the packaging directive while the competent authority promotes the separate collection from other household streams such as other organic waste e.g. food and green waste.
d) The construction works for the rehabilitation/restoration of the old non approved landfills, which are closed at Paphos and Larnaca - Ammochostos districts, were completed. The preparation of studies/documents regarding the rehabilitation/ restoration of the 20 non sanitary landfills of Nicosia district and the 44 sanitary landfills of Limassol district will be completed within 2018 and after that the construction works will begin.

A comprehensive study was undertaken in 2005 for the elaboration of a Strategic Plan, an Environmental study and a Feasibility study for the restoration and management of landfills. The purpose of the study was to record all landfills, assess their status and level of risk, create a restoration priority list based on pollution risk assessments, and undertake the appropriate environmental studies as well as feasibility studies for the restoration of the prioritised landfills. These studies were a necessary step for the restoration of all landfills recorded.

Two (2) landfills are still active in Cyprus but arrangements are made in order to be closed and restored. According to recent data, these two landfills are fed with approximately 155,000 ton and 200,000 ton of municipality waste each year respectively (reference year 2012).

Sixty two (62) non sanitary landfills are planned to be restored appropriately within the following years. According to the preliminary study contacted in 2005, these landfills contain approximately 597,269 m3 of solid waste excluding 2 major landfills that have not been closed yet.

Fifty three (53) landfills have been restored the last five years and are being monitored. During their restoration a total of 4,902,000 m3 of solid waste were reallocated and properly buried using composite liners and leakage collection systems.

The key features of the strategy that have been included in the GHG reduction Policies and Measures are the following:

- Reduction of waste to solid waste disposal sites from sorting at production level
- Reduction of organics to landfills
- Increase of amount of organic wastes treated by composting
- Promotion of anaerobic digestion for the treatment of the organic fraction of the municipal solid waste

An additional measure considered and not included in the solid waste management strategy is biogas recovery from old landfills, during their restoration.

4.2. EU policy on climate change

This section describes some of the key over-arching strategies and programmes that guide the EU policy-making process on climate change. Further details on these are available in the National Communication of the European Union[30].

4.2.1. European Climate Change Programme

The Second European Climate Change Programme (ECCP II) was launched in October 2005 to provide the framework for EU implementation of the Kyoto Protocol. Further information was included in the EU 4th National Communication.

4.2.2. 2020 Climate and Energy Package

The 2020 Climate and Energy Package was formally adopted in 2009 and for the first time provided an integrated and ambitious package of policies and measures to tackle climate change. It includes the 20-20-20 targets, which set the following key objectives:

- To reduce greenhouse gas emissions by at least 20 % compared to 1990 by 2020, with a firm commitment to increase this target to 30 % in the event of a satisfactory international agreement being reached;
- To achieve 20 % of energy from renewable sources by 2020 (as a share of total EU gross final energy consumption), supplemented by a target to achieve a minimum of 10 % renewable transport fuel;
- To save 20 % of total primary energy consumption by 2020 compared to a business as usual baseline.

These are also headline targets of the Europe 2020 strategy for smart, sustainable and inclusive growth[31]. In order to meet these key objectives, the Climate and Energy Package comprises four pieces of complementary legislation:

- A Directive revising the EU Emissions Trading System;
- An Effort-Sharing Decision setting binding national targets for emissions from sectors not covered by the EU ETS;
- A Directive setting binding national targets for increasing the share of renewable energy sources in the energy mix;
- A Directive creating a legal framework for the safe and environmentally sound use of carbon capture and storage technologies.

The package was complemented by two further legislative acts that were agreed at the same time: A regulation requiring a reduction in CO2 emissions from new cars and a revision of the Fuel Quality Directive. The Energy Efficiency Directive was adopted in 2012 to help achieve the energy efficiency target.

4.2.3. 2030 Climate and Energy Framework[32]

This framework[33] was agreed by EU leaders in October 2014 and builds on the 2020 climate and energy package mentioned above. It sets three key targets for the year 2030:

- At least 40 % reduction in greenhouse gas emissions (from 1990 levels). To achieve this, EU ETS sectors would have to cut emissions by 43 % (compared to 2005), and the ETS will be reformed

[30] C(2017)8511 REPORT FROM THE COMMISSION Seventh national communication and third biennial report from the European Union under the UN Framework Convention on Climate Change (UNFCCC) (required under the UNFCCC and the Kyoto Protocol); available at http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/459381_european_union-nc7-br3-1-nc7_br3_combined_version.pdf

[31] http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A52010DC2020

[32] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2030-energy-strategy

[33] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0015&from=EN

and strengthened to achieve this. Non-ETS sectors would need to cut emissions by 30 % (compared to 2005), and this will need to be translated into individual binding targets for Member States;
- At least 27 % share of EU energy consumption for renewable energy;
- At least 27 % improvement in energy efficiency.

The European Council asked the Commission to review the energy efficiency target by 2020 having in mind an EU level of 30 %. With the Clean Energy for All Europeans package from November 2016, the Commission has already proposed to set a binding EU-wide target of 30 % for energy efficiency by 2030.

The framework is in line with the longer-term perspective set out in the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050 and the Transport White Paper.

The framework will be underpinned by a new and transparent governance process that will the targets outlined above to be met in an effective and coherent manner. This governance process will be based on national plans for competitive, secure, and sustainable energy but will follow a common EU approach.

The European Commission has proposed a number of actions to help deliver the framework and the 2030 targets, including a reformed EU ETS (with a proposal for legislation being presented in parallel to the Communication on the 2030 framework), a new Effort Sharing Regulation, a proposal to integrate greenhouse gas emissions and removals from land use, land use-change and forestry (LULUCF) into the 2030 climate and energy framework a proposal for amending the Energy Efficiency Directive and the Energy Performance of Buildings Directive and a new set of indicators for the competitiveness and security of the energy system, such as price differences with major trading partners, diversification of supply, and interconnection capacity between EU countries.

An impact assessment for the framework was published in January 2014 and considers the costs and benefits of the proposed framework for 2030. It found that average annual additional investments are projected to be in the order of € 38 billion for the EU as a whole over the period 2011-2030, with more than half of the investments needed in the residential and tertiary sectors. However it should also be noted that fuel savings will to a large extent compensate for these investments. Crucially, costs do not differ substantially from the costs of renewing an ageing energy system, which would be necessary in any case.

The European Commission adopted "A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy" in February 2015. This strategy is made up of five closely related and mutually reinforcing dimensions – ‘security, solidarity and trust’, ‘a fully-integrated internal energy market’, ‘energy efficiency’, ‘climate action –decarbonising the economy’ and ‘research, innovation and competitiveness’. Every year a State of the Energy Union review is conducted to assess progress and consider areas for further strengthening. The second State of the Energy Union report was published in February 2017, noting that 2016 had been a year of delivery, translating the overall vision into “concrete legislative and non-legislative initiatives”. It also looked forward to the low emission mobility strategy due to be published in late 2017.

4.2.4. The 2020 Energy Strategy[34]

The communication ‘Energy 2020 – A strategy for competitive, sustainable and secure energy’ was published in November 2010. In March 2017, data was published which showed that the share of energy from renewable sources in gross final consumption of energy in the EU reached 16.7 %, nearly double the figure for 2004 (8.5 %), the first year for which the data are available[35]. Alongside this,

[34] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2020-energy-strategy
[35] http://ec.europa.eu/eurostat/documents/2995521/7905983/8-14032017-BP-EN.pdf/af8b4671-fb2a-477b-b7cf-d9a28cb8beea

information on the performance of each Member State was published, which showed that 11 Member States had already reached their individual renewable energy 2020 targets by 2015[36].

4.2.5. European Bioeconomy Strategy

The Bioeconomy Strategy (launched in February 2012) addresses the production of renewable biological resources and their conversion into vital products and bio-energy. It is structured around three pillars:

- Investments in research, innovation and skills;
- Reinforced policy interaction and stakeholder engagement;
- Enhancement of markets and competitiveness.

There is a currently planned review and update of the Strategy which will consider the need for new political impetus and orientation.

4.2.6. Roadmaps 2050

In 2011, the European Commission launched three roadmaps to promote the discussion on the long-term framework of climate and energy policies in Europe: a) the “Roadmap for Moving to a Competitive Low Carbon Economy in 2050” b) the “Roadmap to a Single European Transport Area - Towards a Competitive and Resource Efficient Transport System” and c) the “Energy Roadmap 2050”.

4.2.7. 7th Environmental Action Programme

The 7th Environmental Action Programme (EAP) - proposed by the European Commission in 2012 - provides an overarching framework for environmental policy up to 2020. It does not include specific objectives for climate policy as this is now a separate policy area.

4.3. Information on EU-level policies and measures

4.3.1. Reference list of cross-sectoral and sectoral policies and measures

This section lists for ease of reference the various cross-sectoral and sectoral policies and measures at the EU-level. Further details on these are available in the National Communication of the European Union[37].

4.3.1.1. Cross Cutting Polices and Measures

- The EU Emissions Trading System (2003/87/EC amended by 2009/29/EC);
- The Effort Sharing Decision (Decision No 406/2009/EC);
- Carbon Capture and Storage Directive (2009/31/EC);
- Monitoring Mechanism Regulation (Regulation No 525/2013);
- Energy Taxation Directive (2003/96/EC);
- Horizon 2020;
- European Structural and Investment Funds (ESIF)[38];
- National Emissions Ceilings Directive (2016/2284/EU) ;
- Covenant of Mayors for climate and energy;

[36] Bulgaria, the Czech Republic, Denmark, Estonia, Croatia, Italy, Lithuania, Hungary, Romania, Finland and Sweden.

[37] C(2017)8511 REPORT FROM THE COMMISSION Seventh national communication and third biennial report from the European Union under the UN Framework Convention on Climate Change (UNFCCC) (required under the UNFCCC and the Kyoto Protocol); available at http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/459381_european_union-nc7-br3-1-nc7_br3_combined_version.pdf

[38] The five ESI Funds are the European Regional Development Fund, the Cohesion Fund, the European Social Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund

- Proposal for a revision to Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments (COM (2015) 337 final);
- Proposed Regulation on binding annual greenhouse gas emission reductions by
- Member States from 2021 to 2030 for a resilient Energy Union (COM(2016) 482 final).

4.3.1.2. Sectoral policies and measures: Energy

- Directive 2009/28/EC on the promotion of the use of energy from renewable sources;
- Directive 2010/31/EU on the Energy Performance of Buildings;
- Directive 2012/27/EU on Energy Efficiency;
- Directive 2009/125/EC establishing a framework for the setting of eco-design requirements for energy- related products;
- Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy- related products;
- Proposal for a Regulation setting a framework for energy efficiency labelling and repealing Directive 2010/30/EU;
- Green Public Procurement;
- Energy Star Programme;
- EU Project Development Assistance (PDA) Facilities;
- European Energy Efficiency Fund (EEEF);
- Motor Challenge Programme;
- Strategic Energy Technology Plan (COM(2007) 723);
- Energy Union Strategy (COM(2015) 80 final);
- Biomass Action Plan;
- Communication on Accelerating Clean Energy Innovation (COM(2016) 763 final);
- Communication on Ecodesign Working Plan (COM(2016) 773 final);
- Proposals for revised Energy Efficiency Directive (COM/2016/0761 final);
- Proposal for revised Energy Performance of Buildings Directive (COM/2016/0765 final);
- Proposal for revised Renewable Energy Directive (COM(2016) 767 final/2);
- Commission Implementing Decision on energy labelling, in support of and as regards: Commission Delegated Regulation (EU) 2015/1186, Commission Regulation (EU) 2015/1188, Commission Regulation (EU) 2015/1185;
- Commission Regulation (EU) 2016/2281 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air heating products, cooling products and high temperature process chillers
- Commission Regulation (EU) 2015/1189 of 28 April 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to eco-design requirements for solid fuel boilers
- Commission Regulation (EU) 2015/1188 of 28 April 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to eco-design requirements for local space heaters
- CO2 and Cars Regulation (EC 443/2009)
- CO2 and Vans Regulation (EC 510/2011)
- Strategy for reducing Heavy-Duty Vehicles’ fuel consumption and CO2 emissions
- Car and tyre labelling Directives (1999/94/EC and EC 1222/2009 respectively)
- Regulation of Safe motor vehicles and trailers (EC 661/2009)
- Renewable Energy Directive (2009/28/EC)
- Fuel Quality Directive (2009/30/EC)
- Infrastructure charging for heavy goods vehicles (1999/62//EC, amended by 2006/38/EC and 2011/76/EU)
- Directive 2014/94/EU on Deployment of Alternative Fuels Infrastructure
- Clean Vehicles Directive (2009/33/EC)
- Integrating maritime transport emissions in the EU’s greenhouse gas reduction policies (COM(2013) 479 final and Regulation (EU) 2015/757)
- White Paper: Roadmap to a Single European Transport Area COM(2011) 144 final
- A European Strategy for Low-Emission Mobility (COM(2016) 501 final)
- European strategy on Cooperative Intelligent Transport Systems (COM(2016)766 final)

- Europe on the move: An agenda for a socially fair transition towards clean, competitive and connected mobility for all (COM(2017)283 final)
- Action Plan on Alternative Fuels Infrastructure
- Fuel Cells and Hydrogen Joint Undertaking (JU)
- Proposal for revised Eurovignette Directive (COM(2017)275 final)
- Proposal for revised European Electronic Tolling Services Directive (COM(2017)280 final)
- Proposal for monitoring and reporting systems for heavy duty vehicles (COM(2017)279 final)
- Proposal for revision of the Clean Vehicles Directive
- Proposal for revised Combined Transport Directive
- Proposal for revised market access rules for coach and bus services
- Proposal for revision of cars and vans CO2 performance standards Sectoral policies and measures: Industry / industrial processes
- Mobile Air Conditioning Systems (MAC) Directive (Directive 2006/40/EC);
- Fluorinated greenhouse gases regulation (Regulation (EU) No 517/2014);
- Industrial Emissions Directive 2010/75/EU (IED).

4.3.1.5. Sectoral policies and measures: Agriculture

- Agricultural Market and Income support (1st pillar of Common Agricultural Policy / CAP);
- Rural Development Policy (2nd pillar of CAP);
- Soil Thematic Strategy (COM(2006) 231);
- Nitrates Directive (91/676/EEC).

4.3.1.6. Sectoral policies and measures: Forestry / LULUCF

- LULUCF accounting (Decision 529/2013/EU);
- Proposal to integrated greenhouse gas emissions and removals from land use, land use-change and forestry (LULUCF) into the 2030 climate and energy framework (COM/2016/0479).

4.3.1.7. Sectoral policies and measures: Waste

- Directive on Waste (2008/98/EC);
- Landfill Directive (1999/31/EC);
- Management of biodegradable waste (COM/2008/0811 final);
- Urban Waste Water Directive (91/271/EEC);
- Directives on end-of-life vehicles (2000/53/EC);
- EU action plan for the Circular Economy (COM(2015) 614 final);
- Motor Vehicles Directive (2005/64/EC);
- Directive on batteries and accumulators and waste batteries and accumulators (2006/66/EC);
- Directive on waste electrical and electronic equipment (2012/19/EU);
- Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (Directive 2011/65/EU);
- Packaging and Packaging Waste Directive ((EU) 2015/720 regarding 94/62/EC);
- A legislative proposal on online sales of goods (December 2015);
- A legislative proposal on fertilisers (March 2016);
- Launch of the Innovation Deals for a circular economy (May 2016);
- Ecodesign Working Plan 2016-2019 (COM(2016) 773 final);
- Establishment of the EU Platform on Food Losses and Food Waste (August 2016);
- A Communication on waste-to-energy processes and their role in the circular economy (January 2017).

4.3.2. Policies and measures no longer in place

There are no policies and measures that are no longer in place, although various regulatory proposals have been made to amend Directives.

5. Projections and the total effects of policies and measures

5.1. Introduction

This Chapter describes a “without measures” or “business as usual” (BaU) scenario, a “with measures” or “with existing measures” (WEM) scenario and a “with additional measures” (WAM) scenario concerning the national projections of greenhouse gas emissions by sources and their removals by sinks for the years 2020, 2030 and 2040. The “without measures” scenario assumes that no emission reduction policies are implemented. The “with measures” scenario assumes that no additional emission reduction policies and measures are adopted than the existing ones (implemented and adopted). The “with additional measures” scenarios assume the implementation of additional policies (planned). The three scenarios are presented in the following sections.

5.2. Projections

This section describes a “without measures” or “business as usual” (BaU) scenario, a “with measures” scenario, and a “with additional measures” (WAM) scenario concerning the national projections of greenhouse gas emissions by sources and their removals by sinks for the year 2040.

The “without measures” scenario assumes that no additional emission reduction policies and measures are implemented than the existing ones. The “with measures” scenario assumes that no additional emission reduction policies and measures are adopted than the existing ones. The “with additional measures” scenario assumes the implementation of additional policies (planned). The three scenarios are presented in the following sections.

The policies and measures included in each scenario are presented in Table 5.2 and the resulting impact is presented in Figure 5.1 and Table 5.1.

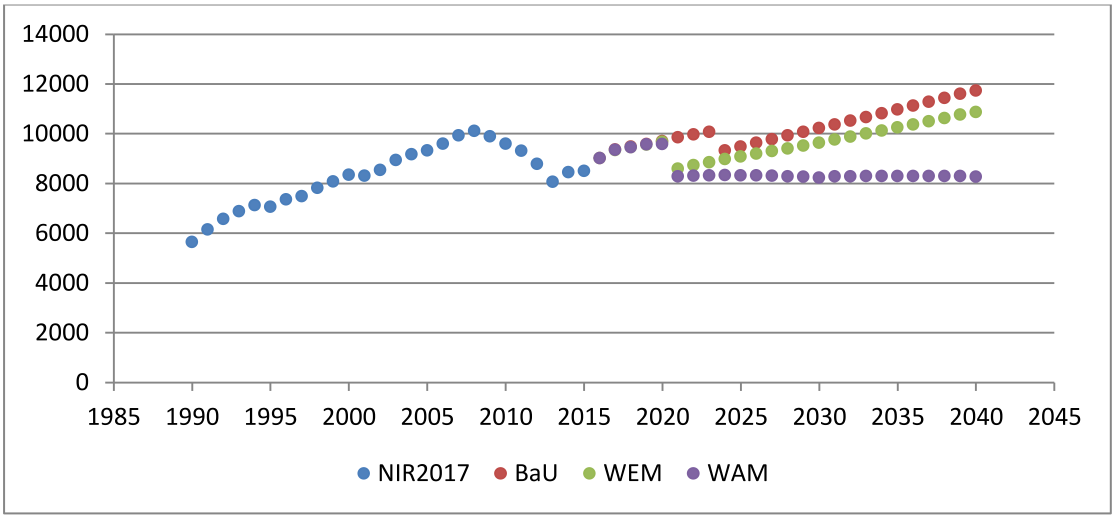


Figure 5.1. BaU, WEM and WAM Projections of total national GHG emissions (excluding LULUCF)

Three important things that should be noted for these projections are the following:

(a) The change noticed during the recent years in the types of HFCs used is not taken into consideration due to the high uncertainty associated to any prediction of such changes.
(b) The emissions from the possible exploitation of natural gas in the Exclusive Economic Zone are not taken into account due to the high uncertainty associated to any prediction of such changes.
(c) The organic fraction of solid waste not going to the landfill is treated by composting, anaerobic digestion and incinerated for energy. The additional organics for incineration at the cement installation have not been accounted for.

Table 5.1. Projections of national GHG emissions disaggregated by sector (excluding LULUCF)

	1990	2000	2010	2015	2020	2030	2040
BaU							
Energy	2740	4552	5181	4181	4599	4308	4980
Transport	1200	1792	2313	1887	2247	2788	3398
IPPU	765	888	942	1325	1548	1575	1592
Agriculture	543	647	651	589	691	726	694
Waste	385	460	499	515	608	824	1056
TOTAL	5634	8339	9586	8496	9692	10221	11720
WEM							
Energy	2740	4552	5181	4181	4331	3811	4272
Transport	1200	1792	2313	1887	2247	2788	3398
IPPU	765	888	942	1325	1546	1555	1551
Agriculture	543	647	651	580	682	717	692
Waste	385	460	499	515	620	533	620
TOTAL	5634	8339	9586	8487	9425	9404	10533
WAM							
Energy	2740	4552	5181	4181	4358	3473	3797
Transport	1200	1792	2313	1887	2175	1757	1553
IPPU	765	888	942	1325	1529	1535	1530
Agriculture	543	647	651	580	681	713	685
Waste	385	460	499	515	608	428	256
TOTAL	5634	8339	9586	8487	9351	7906	7820

Table 5.2. Summary of policies and measures included in each scenario

		BaU			WM			WAM		
	Short	**2020**	**2030**	**2040**	**2020**	**2030**	**2040**	**2020**	**2030**	**2040**
Energy										
E1	Natural Gas	2024			2021			2021		
E2	RES[39] in electricity	10%	13%	20%	13%	20%	27%	16%	27%	35%
E3	EE[40] in industry (existing companies)				97	8	8	97	97	97
E4	Residential new buildings				4073	1983	1983	4073	4073	4073
E5	Residential buildings energy upgrade				120	120	120	120	120	120
E6	Residential solar panels replacement				4	4	4	4	4	4
E7	Tertiary new buildings				467	298	298	467	467	467
E8	Tertiary buildings energy upgrade				198	198	198	198	198	198
E9	Public buildings				6	6	6	6	6	6
E10	Promotion of biomass and alternative fuels in industry				10%+10%	10%+12%	10%+14%	10%+10%	10%+15%	10%+20%
E11	RES in residential (heating & cooling)	32%	35%	37%	35%	38%	42%	35%	40%	45%
E12	RES in commercial (heating & cooling)	25%	27%	28%	25%	28%	32%	25%	30%	35%
Transport										
T1	Biofuels	6%	6%	6%	6%	6%	6%	6%	10%	10%
T2	Infrastructure							start from 2030; 5% reduction of emissions 2040		
T3	New technologies and other measures							25% reduction of emissions 2030; 40% reduction of emissions 2040		
T4	Renewable energy sources in sources								10%	10%
IPPU										
I1	F-gases Recovery of F-gases from old equipment				start from 2020; 5% reduction of emissions 2030; 10% by 2040			5% reduction of emissions 2020; 10% reduction of emissions 2030; 15% by 2040		
Agriculture										
A1	Promotion of anaerobic digestion for treatment of animal waste	cattle +0.25% annually; swine 70% 2040; sheep & goats 5% in 2040 from 2020; poultry 70% 2040			cattle +0.5% annually; swine 75% 2040; sheep & goats 10% in 2040 from 2020; poultry 75% 2040			cattle +0.75% annually; swine 80% 2040; sheep & goats 20% in 2040 from 2020; poultry 80% 2040		
Waste										
W1	Sorting				2021 40%; constant->2040			2021 40%; 2025 55%; 2030 60%; 2035 65%		

[39] RES: Renewable energy source (% contribution to total energy)
[40] EE: Energy Efficiency (TJ savings)

W2	Landfilling				from 2020 15% to landfill constant	from 2020 15% to landfill ->10% 2035
W3	Composting	Constant % as 2016			From 2021 5% constant	from 5% 2021 -> 10% 2035
W4	Anaerobic digestion				from 2021 10% constant	from 10% 2021 -> 40% 2035
W5	Biogas recovery				20% reduction of emissions from deep unmanaged	30% reduction of emissions from deep unmanaged

5.3. Assessment of aggregate effect of policies and measures

The effect of currently implemented and adopted policies and measures (that is incorporated in the WEM projections scenario) is presented in Table 5.3 in terms of GHG emissions avoided on a CO_2 equivalent basis, while the effect of planned policies and measures is illustrated in Table 5.4. The aggregate impact is not equal to the sum of the reductions from each measure, as when combined they produce different results.

Table 5.3. Aggregate effect of currently implemented and adopted policies and measures (Gg CO2 eq.)

Gg CO2 eq.	2020	2030	2040
E1 - natural gas	0.00	0.00	0.00
E2 - RES in electricity	1.16	215.33	262.55
E3 - EE in industry	8.44	0.68	0.68
E4 - EE residential new buildings	185.44	112.27	135.52
E5 - EE residential energy upgrade	7.44	32.52	58.55
E6 - EE residential solar panels replacement	2.24	27.58	53.78
E7 - EE tertiary new buildings	20.47	12.61	12.39
E8 - EE tertiary energy upgrade	8.67	8.38	8.23
E9 - EE in public buildings	0.24	0.24	0.23
E10 - industry (alternative fuels)	12.43	33.24	62.25
E11 - RES in residential	22.09	52.26	104.11
E12 - RES in commercial	0.00	1.91	9.31
T1 - biofuels	0.00	0.00	0.00
I1 - F-gases	1.73	20.06	41.56
A1 - Anaerobic digestion	0.26	1.62	2.93
W1 - sorting	0.00	57.01	100.44
W2 - organics to landfill	0.00	145.67	277.60
W3 - composting	0.00	-0.88	-0.60
W4 - anaerobic digestion	0.00	1.49	1.62
W5 - biogas recovery	0.00	89.24	58.65
Aggregate impact	266.86	816.91	1186.94

Table 5.4. Aggregate effect of planned policies and measures (Gg CO2 eq.)

Gg CO2 eq.	2020	2030	2040
E1 - natural gas	0.00	0.00	0.00
E2 - RES in electricity	2.41	430.16	561.80
E3 - EE in industry	8.44	8.44	8.44
E4 - EE residential new buildings	185.44	201.69	221.82
E5 - EE residential energy upgrade	7.44	32.52	58.55
E6 - EE residential solar panels replacement	2.24	27.58	53.78
E7 - EE tertiary new buildings	0.24	0.24	0.23
E8 - EE tertiary energy upgrade	8.67	8.38	8.23
E9 - EE in public buildings	0.24	0.24	0.23
E10 - industry (alternative fuels)	12.43	59.98	127.43
E11 - RES in residential	22.09	68.84	134.42
E12 - RES in commercial	81.41	93.97	105.00
T1 - biofuels	0.00	49.84	60.76
T2 - Infrastructure	0.00	12.67	169.91
T3 - New technologies and other	51.07	696.94	1359.31
T4 - RES in transport	21.03	287.02	349.87
I1 - F-gases	18.98	40.12	62.34
A1 - Anaerobic digestion	0.51	3.81	7.02
W1 - sorting	0.00	105.56	466.73

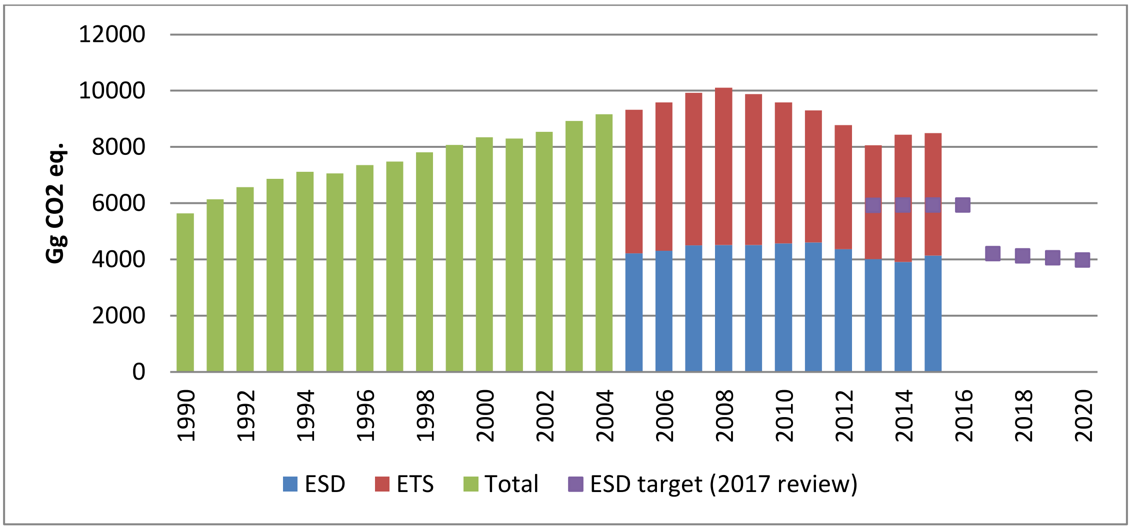
W2 - organics to landfill	0.00	161.59	255.13
W3 - composting	0.00	-4.98	-7.56
W4 - anaerobic digestion	0.00	4.36	6.50
W5 - biogas recovery	0.00	133.85	86.23
Aggregate impact	341.62	2314.76	3900.10

5.3.1. Progress in achievement of the quantified economy-wide emission reduction targets

Cyprus is committed to reducing its emissions in sectors covered under the Effort Sharing Decision (ESD, non-ETS) by 5% compared to 2005 emissions. The quantified annual reduction targets set by EU Decisions[41] for Cyprus are 5.92 million AEA in 2013, reducing to 3.97 million in 2020 (according to AR4 GWPs). The cumulative amount of AEAs for the period 2013-2020 is set at 40.0 Mt CO_2 eq. The annual allocation is presented in Table 5.5 and Figure 5.2.

Table 5.5. Cyprus' ESD annual emission allocations (t CO_2 eq.) for the period 2013–2020, using GWPs calculated applying GWP from the AR4, according to Commission Decision 2017/1471

Year	Annual Emission Allocations (t CO_2 eq.)
2013	5 919 071
2014	5 922 555
2015	5 926 039
2016	5 929 524
2017	4 196 633
2018	4 122 837
2019	4 049 042
2020	3 975 247
TOTAL	**40 040 948**



[41] Commission Decision of 26 March 2013 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council (2013/162/EU) available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013D0162;
Commission Decision (EU) 2017/1471 of 10 August 2017 amending Decision 2013/162/EU to revise Member States' annual emission allocations for the period from 2017 to 2020 available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2017.209.01.0053.01.ENG

Figure 5.2. Cyprus' total greenhouse gas emissions for the period 1990-2015, including a breakdown of the emissions 2008-2015 in emissions under ETS and emissions under ESD (non-ETS) and the ESD target for 2013-2020 (Gg CO_2 eq).

5.4. Supplementarity relating to mechanisms under Article 6, 12 and 17, of the Kyoto Protocol

Within EU, supplementarity obligations under the Kyoto Protocol require that any international credit purchases by Member States must be in addition to emission abatement action taken domestically. The use of flexible mechanisms within the EU takes place by operators in the EU ETS and by governments in their achievement of Kyoto targets.

Cyprus did not have a Kyoto Protocol target for the 1st commitment period.

In general, in the EU the use of flexible mechanisms can take place on the one hand by operators in the EU ETS, on the other hand by governments for the achievement of ESD targets.

The amended EU ETS Directive 2009/29/EC (Article 11a(8)) sets the upper limit for credit use for the period from 2008 to 2020 at a maximum of 50 % of the reduction effort below 2005 levels. This is further specified into installation-level limits in the Commission Regulation on international credit entitlements (RICE) (EU No 1123/2013). Since some entitlements are expressed as a percentage of verified emissions over the entire period, the overall maximum amount will only be known at the end of the third trading period.

Since 2013 it is no longer possible to track the use of flexible mechanisms in the EU ETS directly via information on the EUTL public website because CERs and ERUs are no longer surrendered directly but are exchanged into EUAs. These exchanges will become public on an installation level after three years219[42]; however aggregated data at EU-level is available earlier.

The ESD allows Member States to make use of flexibility provisions for meeting their annual targets, with certain limitations. In the ESD sectors, the annual use of carbon credits is limited to up to 3 % of each Member State's ESD emissions in 2005. Member States that do not use their 3 % limit for the use of international credits in any specific year can transfer the unused part of their limit to another Member State or bank it for their own use until 2020. Member States fulfilling additional criteria (Austria, Belgium, Cyprus, Denmark, Finland, Ireland, Italy, Luxembourg, Portugal, Slovenia, Spain and Sweden) may use credits from projects in Least Developed Countries (LDCs) and Small Island Developing States (SIDS) up to an additional 1 % of their verified emissions in 2005. These credits are not bankable and transferable. Approximately 750 Mt of international credits can be used during the period from 2013 to 2020 in the ESD.

Cyprus will not use credits from flexible mechanisms for its ESD target. EU-ETS operators could use international credits subject to quantitative and qualitative limits.

According to the latest official GHG emission projections of Cyprus, Cyprus is expected to meet its annual ESD target without the use of international carbon credits, on the basis of the domestic policies and measures.

5.5. Methodology used for the presented GHG emission projections

5.5.1. Without measures (BaU)

The BaU emissions by sector are presented in Table 5.6 and Figure 5.3. Emissions for LULUCF have not been estimated. The latest inventory year used as reference is 2015. Emissions data was also available for 2016 since during the preparation of the report 2018 submission had already been made to the

[42] Annex XIV of European Commission. Commission Regulation (EU) No 389/2013. 2013. http://eurlex.europa.eu/legal-content/EN/TXT/?uri=celex:32013R0389

European Commission. BaU emissions are projected to increase by 108% in 2040 compared to 1990 and by 26% compared to 2005.

Table 5.6. Total BaU GHG emissions aggregated by source category (Gg CO2 eq.) 1990-2040

	1990	**2005**	**2015**	**2020**	**2030**	**2040**
ENERGY	**3940.5**	**7128.7**	**6067.3**	**6846.2**	**7095.7**	**8377.8**
1A1 Energy Industries	1767.0	3483.3	3032.9	3310.0	2712.4	3036.9
1A2 Manufacturing Industries & Construction	514.8	912.0	575.6	675.1	837.6	1021.0
1A3a ii Domestic Aviation	11.1	12.6	0.9	0.6	0.8	1.0
1A3b Road Transport	1200.4	2089.4	1886.8	2247.0	2787.8	3398.3
1A3d ii Domestic water-borne navigation	2.2	2.4	1.6	2.6	3.3	4.0
1A4a Commercial / Institutional	75.8	99.5	107.5	90.6	108.5	130.0
1A4b Residential	302.3	420.7	356.7	405.6	503.2	613.4
1A4c Agriculture / Forestry / Fishing / Fish farms	55.8	89.5	83.0	89.9	111.6	136.0
1A5 Non-Specified	11.1	19.2	22.4	24.6	30.5	37.2
INDUSTRY	**764.9**	**1067.8**	**1324.7**	**1547.7**	**1575.2**	**1592.1**
2A1 Cement production	667.7	821.8	877.1	1071.7	1071.7	1071.7
2A2 Lime Production	5.5	12.4	2.4	3.6	6.0	6.0
2A4a Ceramics	43.8	60.0	7.0	19.9	19.9	19.9
2A4b Other Uses of Soda Ash	0.3	0.3	0.1	0.2	0.3	0.5
2D1: Lubricant Use	0.0	5.9	4.7	4.7	4.7	4.7
2D2: Paraffin Wax Use	0.1	0.0	0.1	0.2	0.2	0.2
2D3 Solvent Use	5.2	10.0	4.8	4.8	4.8	4.8
Urea-based catalysts	1.0	1.6	1.1	1.3	1.3	1.3
2F1: Refrigeration and Air Conditioning	0.0	98.4	353.7	365.3	386.0	399.9
2F2: Foam Blowing Agents	0.0	0.9	1.6	1.7	1.8	1.8
2F3: Fire Protection	0.0	1.2	3.7	3.8	4.0	4.2
2F4a: Metered Dose Inhalers	0.0	2.8	8.4	8.7	9.2	9.5
2G1: Electrical Equipment	0.0	0.1	0.2	0.2	0.2	0.2
2G3a: Medical Applications	3.9	4.9	5.6	5.8	6.1	6.3
2G3b: Propellant for Pressure & Aerosol Products	37.4	47.4	54.1	55.9	59.0	61.2
AGRICULTURE	**543.3**	**638.3**	**589.5**	**690.7**	**725.6**	**693.8**
3A1 Enteric Fermentation	196.9	228.4	224.4	296.4	320.8	320.8
3B2 Manure Management	152.7	215.5	175.3	185.5	189.0	188.3
3B2.5 Indirect N2O emissions	30.1	36.7	26.4	30.8	32.5	32.5
3C3 Urea application	1.8	1.0	0.4	0.4	0.4	0.4
3C4 Direct N2O emissions - managed soils	62.5	43.6	39.4	40.3	40.3	40.3
3C5 Indirect N2O emissions - managed soils	19.9	13.8	34.0	36.5	36.6	5.4
3C6 Indirect N2O emissions - manure management	12.3	14.2	31.9	36.4	38.4	38.3
3D1.2. Organic Fertilisers	66.6	84.8	57.3	63.9	67.1	67.2
3F Field burning of agricultural residues	0.5	0.2	0.4	0.5	0.5	0.5
WASTE	**385.1**	**485.8**	**514.8**	**607.7**	**824.2**	**1056.0**
4A Solid Waste Disposal	258.3	359.9	458.2	507.5	625.6	747.5
4B Biological Treatment of Solid Waste	0.0	0.0	7.5	8.1	9.4	10.7
4D1 Domestic Wastewater Treatment & Discharge	102.2	99.7	22.5	59.7	140.2	225.1
4D2 Industrial Wastewater Treatment & Discharge	24.5	26.1	26.6	32.4	49.0	72.8
BaU TOTAL (excl. LULUCF)	**5634**	**9321**	**8496**	**9694**	**10227**	**11730**
Change compared to 1990		**65%**	**51%**	**72%**	**82%**	**108%**
Change compared to 2005			**-9%**	**4%**	**10%**	**26%**
Change compared to 2015				**14%**	**20%**	**38%**

Gg CO2 eq.	1990	2005	2015	2020	2030	2040
CO2	4621	7962	6887	7860	8101	9361
CH4	692	883	877	1046	1283	1513
N2O	321	372	356	398	427	430
HFCs	0.03	103	368	380	401	416
TOTAL	5634	9321	8487	9684	10213	11719

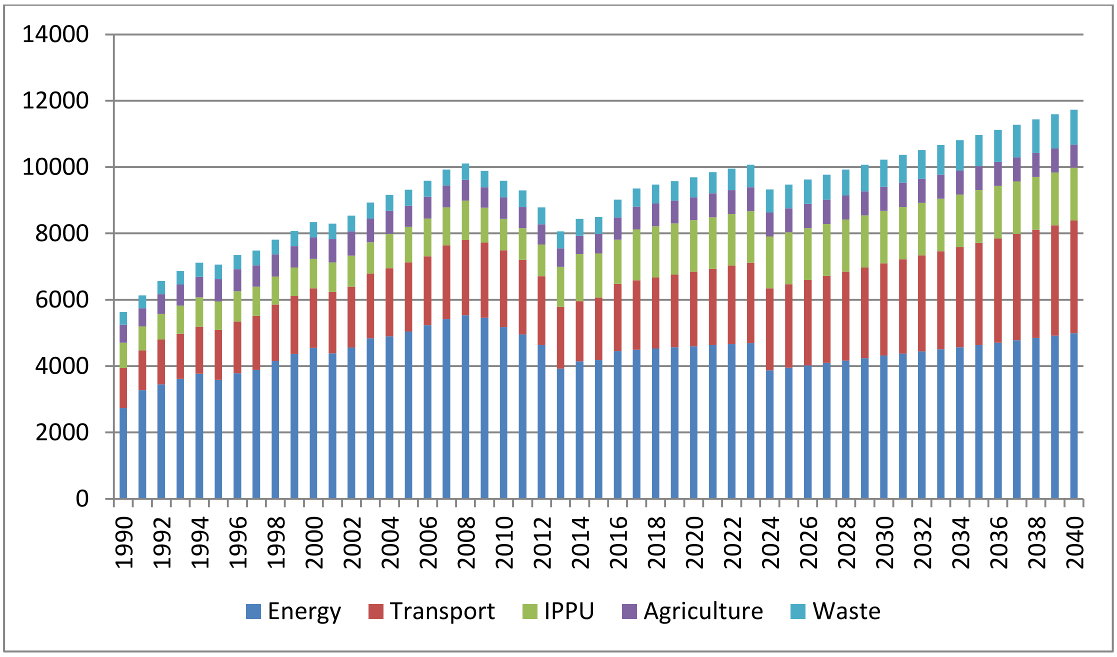


Figure 5.3. Total BaU GHG emissions by sector (Gg CO2 eq.) 1990-2040

The methodologies applied are the same as those used for the preparation of the 2017 submission of National Greenhouse Gas emissions inventory of Cyprus to the UNFCCC [43] and projected activity data (Annex III).

For electricity demand projections five different projections were compared to determine the most appropriate for GHG projections (Figure 5.4). It was considered the most suitable to use the EAC real demand until 2016 projected with the real GDP forecast[44] (Annex III). Other key assumptions for electricity is the introduction of natural gas in 2024 and 10% RES in 2020, 13% RES in 2030 and 20% RES in 2040. It should also be noted that all RES is assumed to be for electricity production.

43

http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/cyp-2017-nir-08may17.zip

44 GDP forecast as prepared by the Ministry of Finance in October 2017; Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance, 1439 Nicosia – Cyprus, Tel. no.: +35722601231, Email: mmatsi@mof.gov.cy

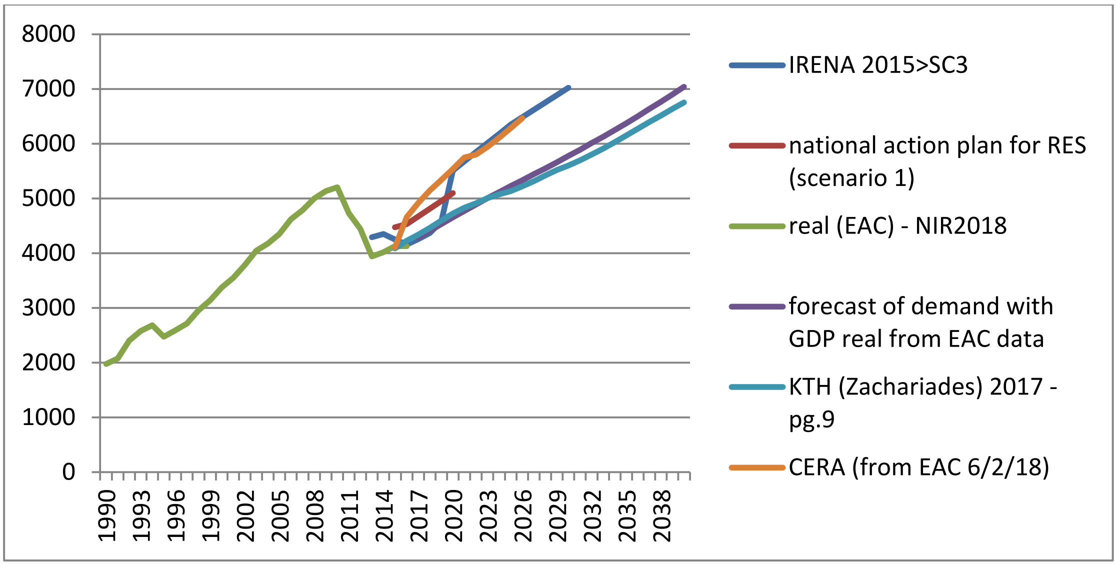


Figure 5.4. Options examined for the determination of electricity demand

5.5.2. With existing measures (WEM)

A description of the measures included in the WEM scenario are listed in Table 5.7. The activity data used for the calculations is presented in Annex IV. Reduction in the emissions caused by each measure is presented in Table 5.8.

The methodologies applied are the same as those used for the preparation of the 2017 submission of National Greenhouse Gas emissions inventory of Cyprus to the UNFCCC[45]. The impact in the emissions is presented in Table 5.9 and Figure 5.5.

The difference in the total emissions between the BaU and the WEM scenario are presented in Figure 5.6. Emissions based on the WEM scenario are projected to increase by 87% in 2040 compared to 1990 and by 13% compared to 2005. In 2040 the difference between WEM and BaU is -10%.

Table 5.7. Measures included in the WEM scenario

	Name	Description	2020	2030	2040
Energy					
E1	Natural Gas	According to the relevant political decisions and legislation the import of natural gas in Cyprus is anticipated in 2020. However, due to the delays noticed during the recent years in the realization of this project, it was decided to use 2021 as the start of natural gas utilization in Cyprus if measures are taken in comparison to 2024 that was used in BaU. Once natural gas is available, the majority of electricity production will be produced with natural gas.			
E2	RES in electricity	Even though the national target for RES in electricity is 16% by 2020, it was considered that this will not be achieved and additional measures are necessary for its achievement. For 2030 and 2040 there are currently no plans or policies from the competent authorities. However, in view of the 2030 EU national target	13%	20%	27%

45 http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/cyp-2017-nir-08may17.zip

	Name	Description	2020	2030	2040
		for reduction of GHG by 24%, further promotion of RES has been allowed towards that end.			
E3	EE in industry (existing companies)	As with RES, there are currently no measures planned to be implemented after 2020. However, in view of the 2030 EU national target for reduction of GHG by 24%, promotion of EE has been allowed to maintain some energy savings.	Savings 97 TJ	Savings 8 TJ	Savings 8 TJ
E4	Residential new buildings		Savings 4073 TJ	Savings 1983 TJ	Savings 1983 TJ
E5	Residential buildings energy upgrade		Savings 120 TJ	Savings 120 TJ	Savings 120 TJ
E6	Residential solar panels replacement		Savings 4 TJ	Savings 4 TJ	Savings 4 TJ
E7	Tertiary new buildings		Savings 467 TJ	Savings 298 TJ	Savings 298 TJ
E8	Tertiary buildings energy upgrade		Savings 198 TJ	Savings 198 TJ	Savings 198 TJ
E9	Public buildings		Savings 6 TJ	Savings 6 TJ	Savings 6 TJ
E10	Promotion of biomass and alternative fuels in industry	The larger consumer of biomass and the only consumed of alternative fuels in industry is the cement installation. It is recognized that the large capacity of the installation should be further exploited and the necessary policies should be developed towards that end. Emphasis should be given in biomass.	10%+10 %	10%+12 %	10%+14 %
E11	RES in residential (heating & cooling)	The national energy target for RES in heating and cooling for 2020 is 23.4%. However, this is overachieved according the energy balance of 2016, especially in the residential sector. Recognizing the additional potential, it was decided to further increase the contribution of RES in residential and commercial sectors.	35%	38%	42%
E12	RES in commercial (heating & cooling)		25%	28%	32%
Transport					
T1	Biofuels	This is the national target according to the relevant EU and national legislation. No additional measures have been considered other continuation of the current practice.	6%	6%	6%
IPPU					
I1	F-gases Recovery of F-gases from old equipment	This is an obligation according to EU and national legislation. It is however still not properly implemented. WEM considers that the necessary implementing measures will be taken so that in 2020 proper recovery of F-gases in old equipment is performed.	start from 2020; 5% reduction of emissions 2030; 10% by 2040		
Agriculture					
A1	Promotion of anaerobic digestion for treatment of animal waste	Promotion of anaerobic digestion in existing biogas plants; New biogas plants to exploit organic waste from livestock breeding	cattle +0.5% annually; swine 75% 2040; sheep & goats 10% in 2040 from 2020; poultry 75% 2040		
Waste					
W1	Sorting	This will be achieved by reorganization of the	2021 40%; constant->2040		

	Name	Description	2020	2030	2040
		currently implemented Municipal Waste Collection Scheme; waste will be separately collected with the goal to reduce the amounts of waste going to landfills.			
W2	Landfilling	According to the waste management hierarchy, landfilling is the least preferable option and should be limited to the necessary minimum and this is encouraged by the relevant national and EU legislation. This is an obligation and measures should be taken for its implementation.	from 2020 15% to landfill constant		
W3	Composting*	Composting and anaerobic digestion will be further exploited to treat the organic waste that will be diverted from the landfill	From 2021 5% constant		
W4	Anaerobic digestion		from 2021 10% constant		
W5	Biogas recovery	Part of the contracts for the recovery of old and currently operating landfills is biogas recovery. However, it is not possible to collect biogas from all landfills; the conservative collection rate of 20% has been chosen from deep unmanaged.	20% reduction of emissions from deep unmanaged		

* composting is anticipated and has been estimated to produce non-CO2 emissions from its implementation; however, these emissions are saved from not landfilling the organics

Table 5.8. Reduction in the emissions caused by each measure of WEM scenario (a) 2017-2028

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
E1 - natural gas	0.00	0.00	0.00	0.00	995.25	945.80	899.97	0.00	0.00	0.00	0.00	0.00
E2 - RES in electricity	0.28	0.57	0.86	1.16	1.33	1.51	1.69	125.33	139.10	153.40	168.08	183.28
E3 - EE in industry	8.75	8.65	8.54	8.44	7.66	6.89	6.11	5.33	4.56	3.78	3.01	2.23
E4 - EE residential new buildings	184.56	184.83	185.12	185.44	177.28	169.30	161.52	153.93	146.51	139.28	132.24	125.38
E5 - EE residential energy upgrade	5.88	6.37	6.89	7.44	9.51	11.70	13.97	16.35	18.80	21.36	23.99	26.73
E6 - EE residential solar panels replacement	0.66	1.16	1.68	2.24	4.34	6.55	8.85	11.25	13.73	16.31	18.97	21.74
E7 - EE tertiary new buildings	20.83	20.71	20.59	20.47	19.67	18.86	18.06	17.27	16.48	15.70	14.92	14.15
E8 - EE tertiary energy upgrade	8.82	8.77	8.72	8.67	8.64	8.61	8.58	8.55	8.52	8.49	8.46	8.43
E9 - EE in public buildings	0.55	0.44	0.34	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
E10 - industry (alternative fuels)	3.18	6.56	10.11	12.43	14.21	16.08	17.99	19.98	22.02	24.13	26.29	28.53
E11 - RES in residential	1.88	8.27	15.00	22.09	24.69	27.42	30.20	33.10	36.04	39.10	42.22	45.45
E12 - RES in commercial	0.00	0.00	0.00	0.00	0.16	0.32	0.50	0.68	0.86	1.06	1.26	1.47
T1 - biofuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I1 - F-gases	0.00	0.00	0.00	1.73	3.47	5.24	7.03	8.84	10.67	12.52	14.38	16.26
A1 - Anaerobic digestion	0.05	0.09	0.14	0.26	0.43	0.56	0.69	0.83	0.96	1.09	1.22	1.35
W1 - sorting	0.00	0.00	0.00	0.00	0.00	7.13	14.03	20.71	27.20	33.48	39.60	45.54
W2 - organics to landfill	0.00	0.00	0.00	0.00	0.00	2.81	22.77	42.05	60.69	78.72	96.19	113.14
W3 - composting	0.00	0.00	0.00	0.00	-1.21	-1.17	-1.13	-1.09	-1.05	-1.01	-0.98	-0.95
W4 - anaerobic digestion	0.00	0.00	0.00	0.00	1.36	1.37	1.38	1.39	1.41	1.42	1.43	1.45
W5 - biogas recovery	0.00	0.00	0.00	0.00	134.43	128.39	122.63	117.15	111.92	106.94	102.19	97.67
Aggregate impact	243.71	254.76	266.34	266.86	1492.96	1461.43	1451.59	588.15	624.83	662.08	699.71	738.00

Table 5.8. Reduction in the emissions caused by each measure of WEM scenario (b) 2029-2040

	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
E1 - natural gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E2 - RES in electricity	199.02	215.33	219.64	224.04	228.53	233.11	237.78	242.54	247.39	252.35	257.40	262.55
E3 - EE in industry	1.46	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
E4 - EE residential new buildings	118.73	112.27	114.21	116.23	118.33	120.52	122.79	125.15	127.60	130.14	132.78	135.52
E5 - EE residential energy upgrade	29.57	32.52	34.74	37.04	39.42	41.89	44.43	47.07	49.80	52.62	55.53	58.55
E6 - EE residential solar panels replacement	24.61	27.58	29.82	32.13	34.53	37.01	39.58	42.23	44.98	47.81	50.75	53.78
E7 - EE tertiary new buildings	13.38	12.61	12.61	12.61	12.61	12.61	12.61	12.61	12.61	12.61	12.61	12.39
E8 - EE tertiary energy upgrade	8.41	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.23

E9 - EE in public buildings	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.23
E10 - industry (alternative fuels)	30.84	33.24	35.73	38.29	40.95	43.70	46.54	49.48	52.52	55.66	58.90	62.25
E11 - RES in residential	48.80	52.26	56.69	61.27	66.01	70.92	76.00	81.25	86.69	92.30	98.11	104.11
E12 - RES in commercial	1.69	1.91	1.95	1.99	2.03	2.07	2.11	2.15	2.19	2.24	2.28	9.31
T1 - biofuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I1 - F-gases	18.15	20.06	22.16	24.27	26.39	28.52	30.67	32.82	34.99	37.17	39.36	41.56
A1 - Anaerobic digestion	1.49	1.62	1.75	1.88	2.01	2.14	2.28	2.41	2.54	2.67	2.80	2.93
W1 - sorting	51.34	57.01	52.02	57.90	63.64	69.24	74.72	80.08	85.33	90.47	95.50	100.44
W2 - organics to landfill	129.62	145.67	150.81	166.41	181.58	196.35	210.74	224.76	238.45	251.80	264.85	277.60
W3 - composting	-0.91	-0.88	-0.85	-0.82	-0.79	-0.76	-0.73	-0.70	-0.68	-0.65	-0.62	-0.60
W4 - anaerobic digestion	1.47	1.49	1.49	1.51	1.52	1.54	1.55	1.57	1.58	1.59	1.61	1.62
W5 - biogas recovery	93.35	89.24	87.13	83.31	79.67	76.20	72.90	69.77	66.78	63.93	61.23	58.65
Aggregate impact	777.04	816.91	834.82	872.89	911.17	949.70	988.51	1027.64	1067.12	1106.99	1147.27	1186.94

Table 5.9. Total WEM GHG emissions aggregated by source category (Gg CO2 eq.) 1990-2040

	1990	2005	2015	2020	2030	2040
ENERGY	**3940.5**	**7128.7**	**6067.3**	**6577.5**	**6598.7**	**7670.2**
1A1 Energy Industries	1767.0	3483.3	3032.9	3308.9	2497.1	2774.3
1A2 Manufacturing Industries & Construction	514.8	912.0	575.6	654.3	803.7	958.1
1A3a ii Domestic Aviation	11.1	12.6	0.9	0.6	0.8	1.0
1A3b Road Transport	1200.4	2089.4	1886.8	2247.0	2787.8	3398.3
1A3d ii Domestic water-borne navigation	2.2	2.4	1.6	2.6	3.3	4.0
1A4a Commercial / Institutional	75.8	99.5	107.5	61.2	85.4	99.8
1A4b Residential	302.3	420.7	356.7	188.4	278.6	261.5
1A4c Agriculture / Forestry / Fishing / Fish farms	55.8	89.5	83.0	89.9	111.6	136.0
1A5 Non-Specified	11.1	19.2	22.4	24.6	30.5	37.2
INDUSTRY	**764.9**	**1067.8**	**1324.7**	**1546.0**	**1555.2**	**1550.6**
2A1 Cement production	667.7	821.8	877.1	1071.7	1071.7	1071.7
2A2 Lime Production	5.5	12.4	2.4	3.6	6.0	6.0
2A4a Ceramics	43.8	60.0	7.0	19.9	19.9	19.9
2A4b Other Uses of Soda Ash	0.3	0.3	0.1	0.2	0.3	0.5
2D1: Lubricant Use	0.0	5.9	4.7	4.7	4.7	4.7
2D2: Paraffin Wax Use	0.1	0.0	0.1	0.2	0.2	0.2
2D3 Solvent Use	5.2	10.0	4.8	4.8	4.8	4.8
Urea-based catalysts	1.0	1.6	1.1	1.3	1.3	1.3
2F1: Refrigeration and Air Conditioning	0.0	98.4	353.7	363.7	366.7	359.9
2F2: Foam Blowing Agents	0.0	0.9	1.6	1.7	1.7	1.6
2F3: Fire Protection	0.0	1.2	3.7	3.8	3.8	3.7
2F4a: Metered Dose Inhalers	0.0	2.8	8.4	8.7	8.8	8.6
2G1: Electrical Equipment	0.0	0.1	0.2	0.2	0.2	0.2
2G3a: Medical Applications	3.9	4.9	5.6	5.8	6.1	6.3
2G3b: Propellant for Pressure & Aerosol Products	37.4	47.4	54.1	55.9	59.0	61.2
AGRICULTURE	**543.3**	**638.3**	**589.5**	**681.9**	**716.8**	**692.1**
3A1 Enteric Fermentation	196.9	228.4	224.4	296.4	320.8	320.8
3B2 Manure Management	152.7	215.5	175.3	185.5	189.0	188.3
3B2.5 Indirect N2O emissions	30.1	36.7	26.4	30.8	32.5	32.5
3C3 Urea application	1.8	1.0	0.4	0.4	0.4	0.4
3C4 Direct N2O emissions - managed soils	62.5	43.6	39.4	40.3	40.3	40.3
3C5 Indirect N2O emissions - managed soils	19.9	13.8	34.0	32.0	32.3	8.8
3C6 Indirect N2O emissions - manure management	12.3	14.2	31.9	15.6	16.4	15.9
3D1.2. Organic Fertilisers	66.6	84.8	57.3	80.5	84.6	84.6
3F Field burning of agricultural residues	0.5	0.2	0.4	0.5	0.5	0.5
WASTE	**385.1**	**485.8**	**514.8**	**620.0**	**533.2**	**619.9**
4A Solid Waste Disposal	258.3	359.9	458.2	519.8	333.7	310.8
4B Biological Treatment of Solid Waste	0.0	0.0	7.5	8.1	10.3	11.2
4D1 Domestic Wastewater Treatment & Discharge	102.2	99.7	22.5	59.7	140.2	225.1
4D2 Industrial Wastewater Treatment & Discharge	24.5	26.1	26.6	32.4	49.0	72.8
WEM TOTAL (excl. LULUCF)	**5634.0**	**9321.0**	**8496.0**	**9425.5**	**9403.9**	**10532.8**
Change compared to 1990		**65%**	**51%**	**67%**	**67%**	**87%**
Change compared to 2005			**-9%**	**1%**	**1%**	**13%**
Change compared to 2015				**11%**	**11%**	**24%**
Compared to BaU				**-3%**	**-8%**	**-10%**

Gg CO2 eq.	1990	2005	2015	2020	2030	2040
CO2	4621	7962	6887	7594	7606	8655
CH4	692	883	877	1056	990	1073
N2O	321	372	356	397	426	428
HFCs	0.03	103	368	378	381	374
TOTAL	5634	9321	8487	9425	9402	10530

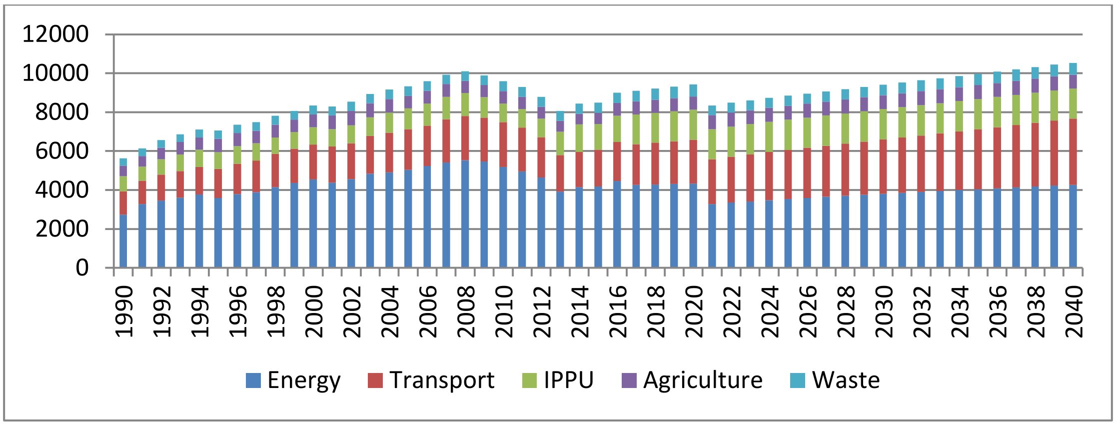


Figure 5.5. Total WEM GHG emissions by sector (Gg CO2 eq.) 1990-2040

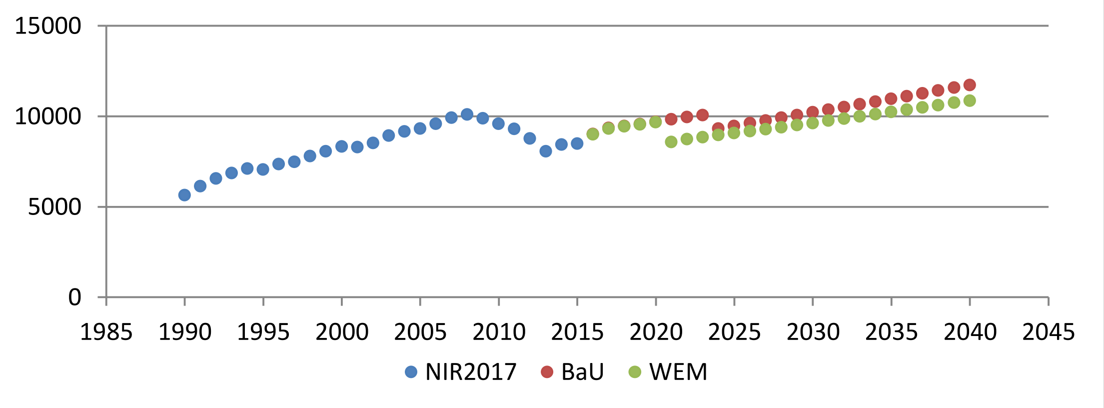


Figure 5.6. Total WEM GHG emissions compared to BaU (Gg CO2 eq.) 1990-2040

5.5.2.1. WEM sensitivity analysis

Sensitivity analysis was carried out using the change in the total at 1% change of each measure. The results of the calculations for the WEM scenario are presented in Table 5.10 and Figure 5.7. the impact of introduction of natural gas appears zero for all years in the table as for those years there is no difference from the BaU.

Table 5.10. Change in total of WEM scenario at 1% change of each measure

	2020	2030	2040
E1 - natural gas	0.00%	0.00%	0.00%
E2 - RES in electricity	0.00%	0.27%	0.22%
E3 - EE in industry	0.03%	0.00%	0.00%
E4 - EE residential new buildings	0.69%	0.14%	0.11%
E5 - EE residential energy upgrade	0.03%	0.04%	0.05%
E6 - EE residential solar panels replacement	0.01%	0.03%	0.05%
E7 - EE tertiary new buildings	0.08%	0.02%	0.01%
E8 - EE tertiary energy upgrade	0.03%	0.01%	0.01%
E9 - EE in public buildings	0.00%	0.00%	0.00%
E10 - industry (alternative fuels)	0.05%	0.04%	0.05%

E11 - RES in residential	0.08%	0.06%	0.09%
E12 - RES in commercial	0.00%	0.00%	0.01%
T1 - biofuels	0.00%	0.00%	0.00%
I1 - F-gases	0.01%	0.02%	0.03%
A1 - Anaerobic digestion	0.00%	0.00%	0.00%
W1 - sorting	0.00%	0.07%	0.08%
W2 - organics to landfill	0.00%	0.18%	0.23%
W3 - composting	0.00%	0.00%	0.00%
W4 - anaerobic digestion	0.00%	0.00%	0.00%
W5 - biogas recovery	0.00%	0.11%	0.05%

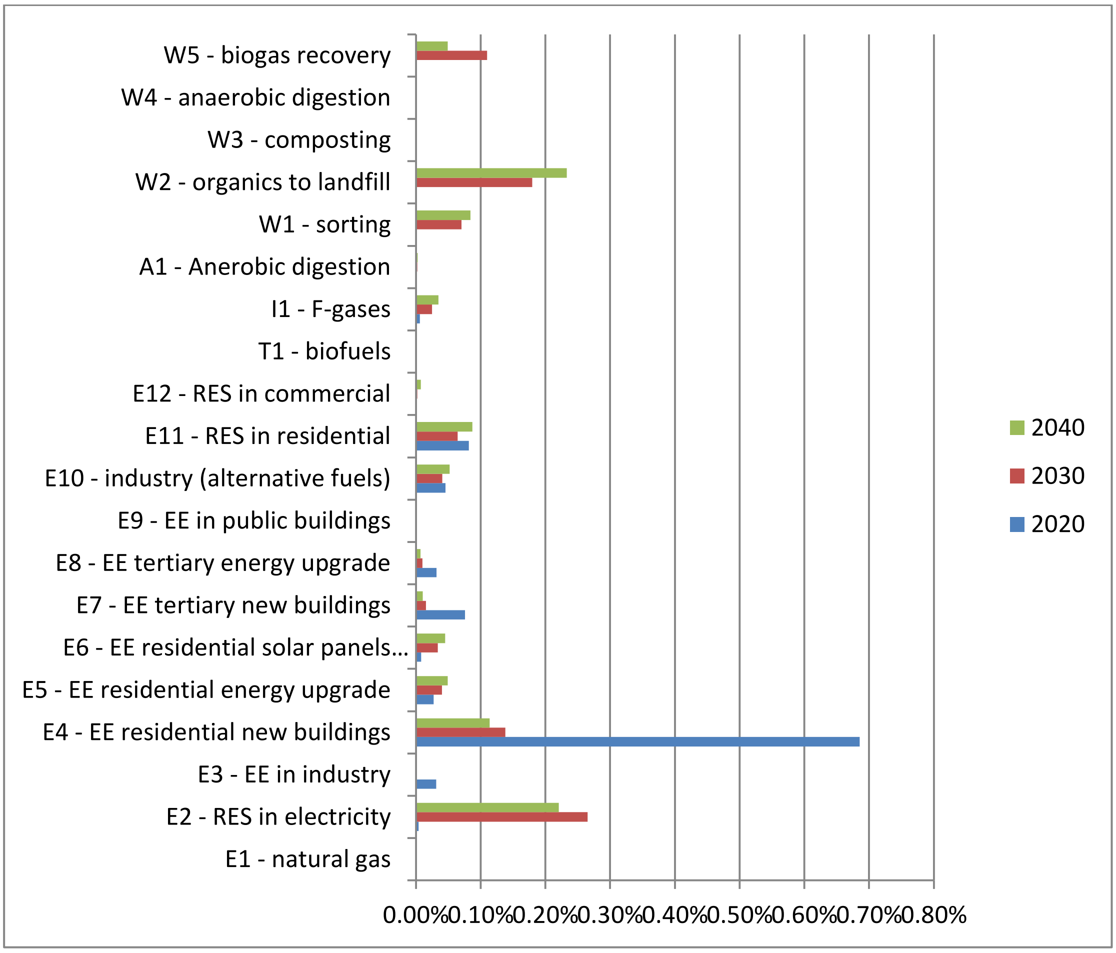


Figure 5.7. Change in total of WEM scenario at 1% change of each measure

5.5.3. With additional measures (WAM)

A description of the measures included in the WAM scenario are listed in Table 5.11. The activity data used for the calculations is presented in Annex V. Reduction in the emissions caused by each measure is presented in Table 5.12.

The methodologies applied are the same as those used for the preparation of the 2017 submission of National Greenhouse Gas emissions inventory of Cyprus to the UNFCCC[46]. The impact in the emissions is presented in Table 5.13 and Figure 5.8.

46 http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/cyp-2017-nir-08may17.zip

The difference in the total emissions between the BaU and the WAM scenario are presented in Figure 5.9. Emissions based on the WAM scenario are projected to increase by 39% in 2040 compared to 1990 and decrease by 16% compared to 2005. In 2040 the difference between WAM and BaU is -33%, while the difference between WAM and WEM is -26%.

Table 5.11. Measures included in the WAM scenario

	Name	Description	2020	2030	2040
Energy					
E1	Natural Gas	According to the relevant political decisions and legislation the import of natural gas in Cyprus is anticipated in 2020. However, due to the delays noticed during the recent years in the realization of this project, it was decided to use 2021 as the start of natural gas utilization in Cyprus if measures are taken in comparison to 2024 that was used in BaU. Once natural gas is available, the majority of electricity production will be produced with natural gas.			
E2	RES in electricity	16% is the national target for RES in electricity according to relevant EU directive; it was considered that the necessary additional measures for its achievement will be implemented. For 2030 and 2040 there are currently no plans or policies from the competent authorities. However, in view of the 2030 EU national target for reduction of GHG by 24%, further promotion of RES has been allowed towards that end.	16%	27%	35%
E3	EE in industry (existing companies)	As with RES, there are currently no measures planned to be implemented after 2020. However, in view of the 2030 EU national target for reduction of GHG by 24%, promotion of EE has been allowed to maintain some energy savings.	Savings 97 TJ	Savings 97 TJ	Savings 97 TJ
E4	Residential new buildings		Savings 4073 TJ	Savings 4073 TJ	Savings 4073 TJ
E5	Residential buildings energy upgrade		Savings 120 TJ	Savings 120 TJ	Savings 120 TJ
E6	Residential solar panels replacement		Savings 4 TJ	Savings 4 TJ	Savings 4 TJ
E7	Tertiary new buildings		Savings 467 TJ	Savings 467 TJ	Savings 467 TJ
E8	Tertiary buildings energy upgrade		Savings 198 TJ	Savings 198 TJ	Savings 198 TJ
E9	Public buildings		Savings 6 TJ	Savings 6 TJ	Savings 6 TJ
E10	Promotion of biomass and alternative fuels in industry	The larger consumer of biomass and the only consumed of alternative fuels in industry is the cement installation. It is recognized that the large capacity of the installation should be further exploited and the necessary policies should be developed towards that end. Emphasis should be given in biomass.	10%+10 %	10%+15 %	10%+20 %
E11	RES in residential (heating &	The national energy target for RES in heating and cooling for 2020 is 23.4%. However, this is overachieved according the energy balance of	35%	40%	45%

	Name	Description	2020	2030	2040
	cooling)	2016, especially in the residential sector.			
E12	RES in commercial (heating & cooling)	Recognizing the additional potential, it was decided to further increase the contribution of RES in residential and commercial sectors.	25%	30%	35%
Transport					
T1	Biofuels	6% is the national target according to the relevant EU and national legislation for 2020. There are currently no measures planned to be implemented after 2020. However, in view of the 2030 EU national target for reduction of GHG by 24%, promotion of EE has been allowed to maintain some energy savings.	6%	10%	10%
T2	Infrastructure	Promotion of public transport, cycling, walking	start from 2030; 5% reduction of emissions 2040		
T3	New technologies and other measures	Promotion of vehicles of new technology with low to zero emissions; Revision of taxation for all vehicles, measures for fleets with high emissions and high mileage	25% reduction of emissions 2030; 40% reduction of emissions 2040		
T4	Renewable energy sources in sources	Renewable energy sources in transport to reach 10% in 2020 (according to the National Renewable Energy Action Plan)		10%	10%
IPPU					
I1	F-gases Recovery of F-gases from old equipment	This is an obligation according to EU and national legislation. It is however still not properly implemented. WEM considers that the necessary implementing measures will be taken so that in 2020 proper recovery of F-gases in old equipment is performed.	5% reduction of emissions 2020; 10% reduction of emissions 2030; 15% by 2040		
Agriculture					
A1	Promotion of anaerobic digestion for treatment of animal waste	Further promotion of anaerobic digestion in existing biogas plants; New biogas plants to exploit organic waste from livestock breeding	cattle +0.75% annually; swine 80% 2040; sheep & goats 20% in 2040 from 2020; poultry 80% 2040		
Waste					
W1	Sorting	This will be achieved by reorganization of the currently implemented Municipal Waste Collection Scheme; waste will be separately collected with the goal to reduce the amounts of waste going to landfills.	2021 40%; 2025 55%; 2030 60%; 2035 65%		
W2	Landfilling	According to the waste management hierarchy, landfilling is the least preferable option and should be limited to the necessary minimum and this is encouraged by the relevant national and EU legislation. This is an obligation and measures should be taken for its implementation.	from 2020 15% to landfill ->10% 2035		
W3	Composting*	Composting and anaerobic digestion will be further exploited to treat the organic waste that will be diverted from the landfill	from 5% 2021 -> 10% 2035		
W4	Anaerobic digestion		from 10% 2021 -> 40% 2035		
W5	Biogas recovery	Part of the contracts for the recovery of old and currently operating landfills is biogas recovery. However, it is not possible to collect biogas from all landfills; the conservative collection rate of	30% reduction of emissions from deep unmanaged		

	Name	Description	2020	2030	2040
		20% has been chosen from deep unmanaged.			

* composting is anticipated and has been estimated to produce non-CO_2 emissions from its implementation; however, these emissions are saved from not landfilling the organics

Table 5.12a. Reduction in the emissions caused by each measure of WAM scenario 2017-2028

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
E1 - natural gas	0.00	0.00	0.00	0.00	995.25	945.80	899.97	0.00	0.00	0.00	0.00	0.00
E2 - RES in electricity	0.57	1.16	1.77	2.41	2.78	3.16	3.55	250.47	277.98	306.54	335.84	366.19
E3 - EE in industry	8.75	8.65	8.54	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44
E4 - EE residential new buildings	184.56	184.83	185.12	185.44	186.64	187.94	189.33	190.82	192.39	194.06	195.81	197.67
E5 - EE residential energy upgrade	5.88	6.37	6.89	7.44	9.51	11.70	13.97	16.35	18.80	21.36	23.99	26.73
E6 - EE residential solar panels replacement	0.66	1.16	1.68	2.24	4.34	6.55	8.85	11.25	13.73	16.31	18.97	21.74
E7 - EE tertiary new buildings	0.55	0.44	0.34	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
E8 - EE tertiary energy upgrade	8.82	8.77	8.72	8.67	8.64	8.61	8.58	8.55	8.52	8.49	8.46	8.43
E9 - EE in public buildings	0.55	0.44	0.34	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
E10 - industry (alternative fuels)	3.18	6.56	10.11	12.43	16.42	20.60	24.94	29.46	34.11	38.94	43.92	49.08
E11 - RES in residential	1.88	8.27	15.00	22.09	26.06	30.22	34.51	38.97	43.54	48.28	53.15	58.20
E12 - RES in commercial	74.80	77.13	79.26	81.41	82.92	84.44	85.80	87.17	88.35	89.55	90.65	91.75
T1 - biofuels	0.00	0.00	0.00	0.00	4.12	8.44	12.95	17.67	22.55	27.63	32.88	38.32
T2 - Infrastructure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T3 - New technologies and other	0.00	0.00	0.00	51.07	104.69	160.96	219.55	280.75	343.98	409.73	477.63	548.08
T4 - RES in transport	0.00	0.00	0.00	21.03	43.11	66.29	90.42	115.62	141.66	168.74	196.70	225.71
I1 - F-gases	0.00	0.00	0.00	18.98	21.02	23.07	25.15	27.24	29.35	31.48	33.62	35.78
A1 - Anaerobic digestion	0.07	0.15	0.22	0.51	0.92	1.24	1.56	1.88	2.20	2.53	2.85	3.17
W1 - sorting	0.00	0.00	0.00	0.00	0.00	7.13	15.82	26.05	37.81	51.08	64.47	78.00
W2 - organics to landfill	0.00	0.00	0.00	0.00	0.00	20.65	40.53	59.67	78.12	95.93	113.14	129.78
W3 - composting	0.00	0.00	0.00	0.00	-1.21	-1.59	-1.98	-2.37	-2.77	-3.19	-3.62	-4.06
W4 - anaerobic digestion	0.00	0.00	0.00	0.00	1.36	1.66	1.97	2.29	2.61	2.94	3.28	3.63
W5 - biogas recovery	0.00	0.00	0.00	0.00	201.64	192.58	183.95	175.73	167.89	160.41	153.29	146.50
Aggregate impact	215.03	226.58	238.68	341.62	1802.77	1897.12	2000.83	1257.08	1418.38	1586.17	1758.04	1935.07

Table 5.12b. Reduction in the emissions caused by each measure of WAM scenario 2029-2040

	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
E1 - natural gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E2 - RES in electricity	397.62	430.16	441.90	453.94	466.28	478.93	491.90	505.20	518.83	532.80	547.12	561.80
E3 - EE in industry	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44	8.44
E4 - EE residential new buildings	199.63	201.69	203.32	205.03	206.82	208.70	210.66	212.70	214.84	217.07	219.40	221.82
E5 - EE residential energy upgrade	29.57	32.52	34.74	37.04	39.42	41.89	44.43	47.07	49.80	52.62	55.53	58.55

E6 - EE residential solar panels replacement	24.61	27.58	29.82	32.13	34.53	37.01	39.58	42.23	44.98	47.81	50.75	53.78
E7 - EE tertiary new buildings	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.23
E8 - EE tertiary energy upgrade	8.41	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.23
E9 - EE in public buildings	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.23
E10 - industry (alternative fuels)	54.43	59.98	65.72	71.67	77.83	84.21	90.82	97.65	104.72	112.04	119.60	127.43
E11 - RES in residential	63.42	68.84	74.44	80.24	86.24	92.45	98.87	105.52	112.39	119.49	126.83	134.42
E12 - RES in commercial	92.86	93.97	96.03	98.13	100.27	102.45	104.67	106.95	109.26	111.62	114.03	105.00
T1 - biofuels	43.98	49.84	50.84	51.85	52.89	53.95	55.03	56.13	57.25	58.40	59.56	60.76
T2 - Infrastructure	0.00	12.67	25.85	39.55	53.79	68.58	83.94	99.89	116.45	133.62	151.44	169.91
T3 - New technologies and other	621.16	696.94	753.53	812.11	872.73	935.45	1000.32	1067.42	1136.81	1208.54	1282.68	1359.31
T4 - RES in transport	255.81	287.02	292.76	298.61	304.58	310.67	316.89	323.23	329.69	336.28	343.01	349.87
I1 - F-gases	37.94	40.12	42.30	44.49	46.69	48.90	51.11	53.34	55.57	57.82	60.07	62.34
A1 - Anaerobic digestion	3.49	3.81	4.13	4.45	4.77	5.09	5.41	5.74	6.06	6.38	6.70	7.02
W1 - sorting	91.69	105.56	131.63	168.78	206.09	243.57	281.23	319.07	356.53	393.61	430.34	466.73
W2 - organics to landfill	145.92	161.59	140.54	154.87	168.74	182.18	195.22	207.86	220.15	232.12	243.77	255.13
W3 - composting	-4.51	-4.98	-5.42	-5.89	-6.38	-6.87	-7.38	-7.41	-7.45	-7.49	-7.52	-7.56
W4 - anaerobic digestion	3.99	4.36	4.69	5.06	5.43	5.81	6.20	6.26	6.32	6.38	6.44	6.50
W5 - biogas recovery	140.03	133.85	127.97	122.36	117.03	111.95	107.12	102.52	98.14	93.97	90.01	86.23
Aggregate impact	2117.46	2314.76	2416.95	2568.85	2723.81	2881.90	3043.23	3208.35	3376.35	3547.32	3721.38	3900.10

Table 5.13. Total WAM GHG emissions aggregated by source category (Gg CO2 eq.) 1990-2040

	1990	2005	2015	2020	2030	2040
ENERGY	**3940.5**	**7128.7**	**6067.3**	**6532.9**	**5229.7**	**5349.2**
1A1 Energy Industries	1767.0	3483.3	3032.9	3307.6	2282.3	2475.1
1A2 Manufacturing Industries & Construction	514.8	912.0	575.6	662.7	777.6	893.6
1A3a ii Domestic Aviation	11.1	12.6	0.9	0.6	0.8	1.0
1A3b Road Transport	1200.4	2089.4	1886.8	2174.9	1757.1	1552.5
1A3d ii Domestic water-borne navigation	2.2	2.4	1.6	2.6	3.3	4.0
1A4a Commercial / Institutional	75.8	99.5	107.5	81.4	94.0	105.0
1A4b Residential	302.3	420.7	356.7	188.4	172.6	144.8
1A4c Agriculture / Forestry / Fishing / Fish farms	55.8	89.5	83.0	89.9	111.6	136.0
1A5 Non-Specified	11.1	19.2	22.4	24.6	30.5	37.2
INDUSTRY	**764.9**	**1067.8**	**1324.7**	**1528.8**	**1535.1**	**1529.8**
2A1 Cement production	667.7	821.8	877.1	1071.7	1071.7	1071.7
2A2 Lime Production	5.5	12.4	2.4	3.6	6.0	6.0
2A4a Ceramics	43.8	60.0	7.0	19.9	19.9	19.9
2A4b Other Uses of Soda Ash	0.3	0.3	0.1	0.2	0.3	0.5
2D1: Lubricant Use	0.0	5.9	4.7	4.7	4.7	4.7
2D2: Paraffin Wax Use	0.1	0.0	0.1	0.2	0.2	0.2
2D3 Solvent Use	5.2	10.0	4.8	4.8	4.8	4.8
Urea-based catalysts	1.0	1.6	1.1	1.3	1.3	1.3
2F1: Refrigeration and Air Conditioning	0.0	98.4	353.7	347.1	347.4	339.9
2F2: Foam Blowing Agents	0.0	0.9	1.6	1.6	1.6	1.6
2F3: Fire Protection	0.0	1.2	3.7	3.6	3.6	3.5
2F4a: Metered Dose Inhalers	0.0	2.8	8.4	8.3	8.3	8.1
2G1: Electrical Equipment	0.0	0.1	0.2	0.1	0.1	0.1
2G3a: Medical Applications	3.9	4.9	5.6	5.8	6.1	6.3
2G3b: Propellant for Pressure & Aerosol Products	37.4	47.4	54.1	55.9	59.0	61.2
AGRICULTURE	**543.3**	**638.3**	**579.8**	**681.4**	**713.0**	**685.1**
3A1 Enteric Fermentation	196.9	228.4	224.4	296.4	320.8	320.8
3B2 Manure Management	152.7	215.5	175.3	185.2	186.7	183.9
3B2.5 Indirect N2O emissions	30.1	36.7	26.4	30.8	32.2	31.9
3C3 Urea application	1.8	1.0	0.4	0.4	0.4	0.4
3C4 Direct N2O emissions - managed soils	62.5	43.6	39.4	40.3	40.3	40.3
3C5 Indirect N2O emissions - managed soils	19.9	13.8	29.6	32.0	32.3	8.8
3C6 Indirect N2O emissions - manure management	12.3	14.2	12.4	15.4	15.3	13.9
3D1.2. Organic Fertilisers	66.6	84.8	71.5	80.5	84.6	84.6
3F Field burning of agricultural residues	0.5	0.2	0.4	0.5	0.5	0.5
WASTE	**385.1**	**485.8**	**514.9**	**607.7**	**428.2**	**255.5**
4A Solid Waste Disposal	258.3	359.9	458.3	507.5	224.6	-60.6
4B Biological Treatment of Solid Waste	0.0	0.0	7.5	8.1	14.4	18.2
4D1 Domestic Wastewater Treatment & Discharge	102.2	99.7	22.5	59.7	140.2	225.1
4D2 Industrial Wastewater Treatment & Discharge	24.5	26.1	26.6	32.4	49.0	72.8
WAM TOTAL (excl. LULUCF)	**5633.7**	**9320.6**	**8486.8**	**9350.7**	**7906.1**	**7819.6**
Change compared to 1990						
Change compared to 2005		**65%**	**51%**	**66%**	**40%**	**39%**
Change compared to 2015			**-9%**	**0.3%**	**-15%**	**-16%**
Compared to BaU				**10%**	**-7%**	**-8%**

Gg CO2 eq.	1990	2005	2015	2020	2030	2040
CO2	4621	7962	6887	7551	6269	6393
CH4	692	883	877	1044	877	694
N2O	321	372	356	395	399	380
HFCs	0.03	103	368	361	361	353
TOTAL	5634	9321	8487	9351	7906	7820

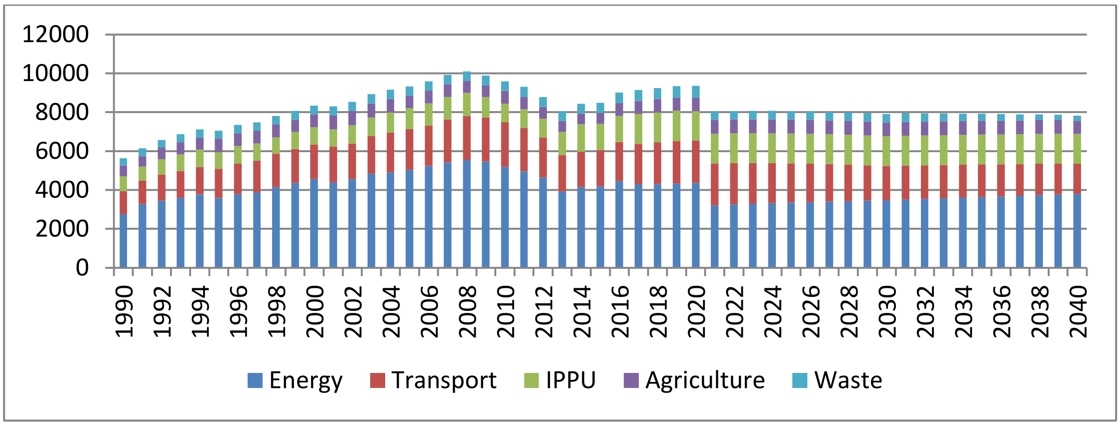


Figure 5.8. Total WAM GHG emissions by sector (Gg CO2 eq.) 1990-2040

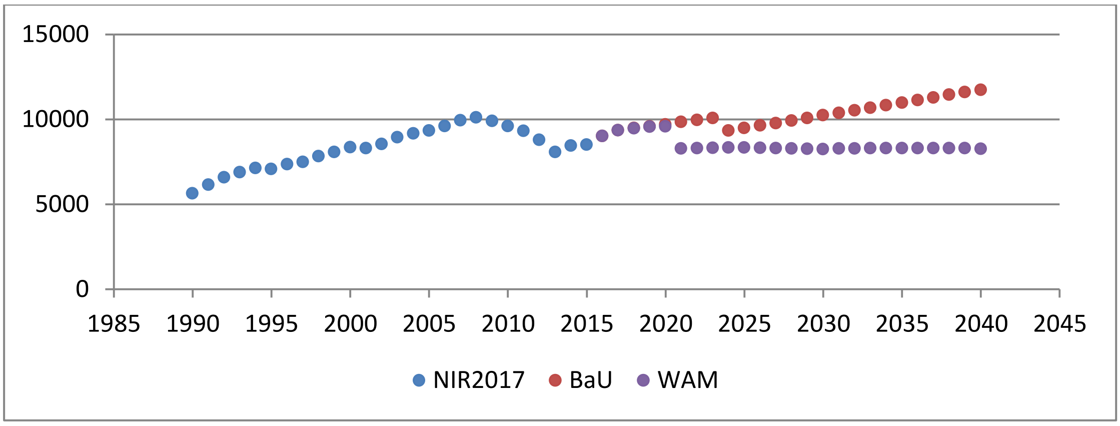


Figure 5.9. Total WAM GHG emissions compared to BaU (Gg CO2 eq.) 1990-2040

5.5.3.1. WEM sensitivity analysis

Sensitivity analysis was carried out using the change in the total at 1% change of each measure. The results of the calculations for the WAM scenario are presented in Table 5.14 and Figure 5.10.

Table 5.14. Change in total of WAM scenario at 1% change of each measure

	2020	2030	2040
E1 - natural gas	0.00%	0.00%	0.00%
E2 - RES in electricity	0.01%	0.18%	0.14%
E3 - EE in industry	0.02%	0.00%	0.00%
E4 - EE residential new buildings	0.44%	0.08%	0.05%
E5 - EE residential energy upgrade	0.02%	0.01%	0.01%
E6 - EE residential solar panels replacement	0.01%	0.01%	0.01%
E7 - EE tertiary new buildings	0.00%	0.00%	0.00%
E8 - EE tertiary energy upgrade	0.02%	0.00%	0.00%
E9 - EE in public buildings	0.00%	0.00%	0.00%
E10 - industry (alternative fuels)	0.03%	0.02%	0.03%
E11 - RES in residential	0.05%	0.03%	0.03%

E12 - RES in commercial	0.19%	0.04%	0.03%
T1 - biofuels	0.00%	0.02%	0.01%
T2 - Infastructure	0.00%	0.01%	0.04%
T3 - New technologies and other	0.12%	0.29%	0.33%
T4 - RES in transport	0.05%	0.12%	0.09%
I1 - F-gases	0.04%	0.02%	0.02%
A1 - Anerobic digestion	0.00%	0.00%	0.00%
W1 - sorting	0.00%	0.04%	0.11%
W2 - organics to landfill	0.00%	0.07%	0.06%
W3 - composting	0.00%	0.00%	0.00%
W4 - anaerobic digestion	0.00%	0.00%	0.00%
W5 - biogas recovery	0.00%	0.06%	0.02%

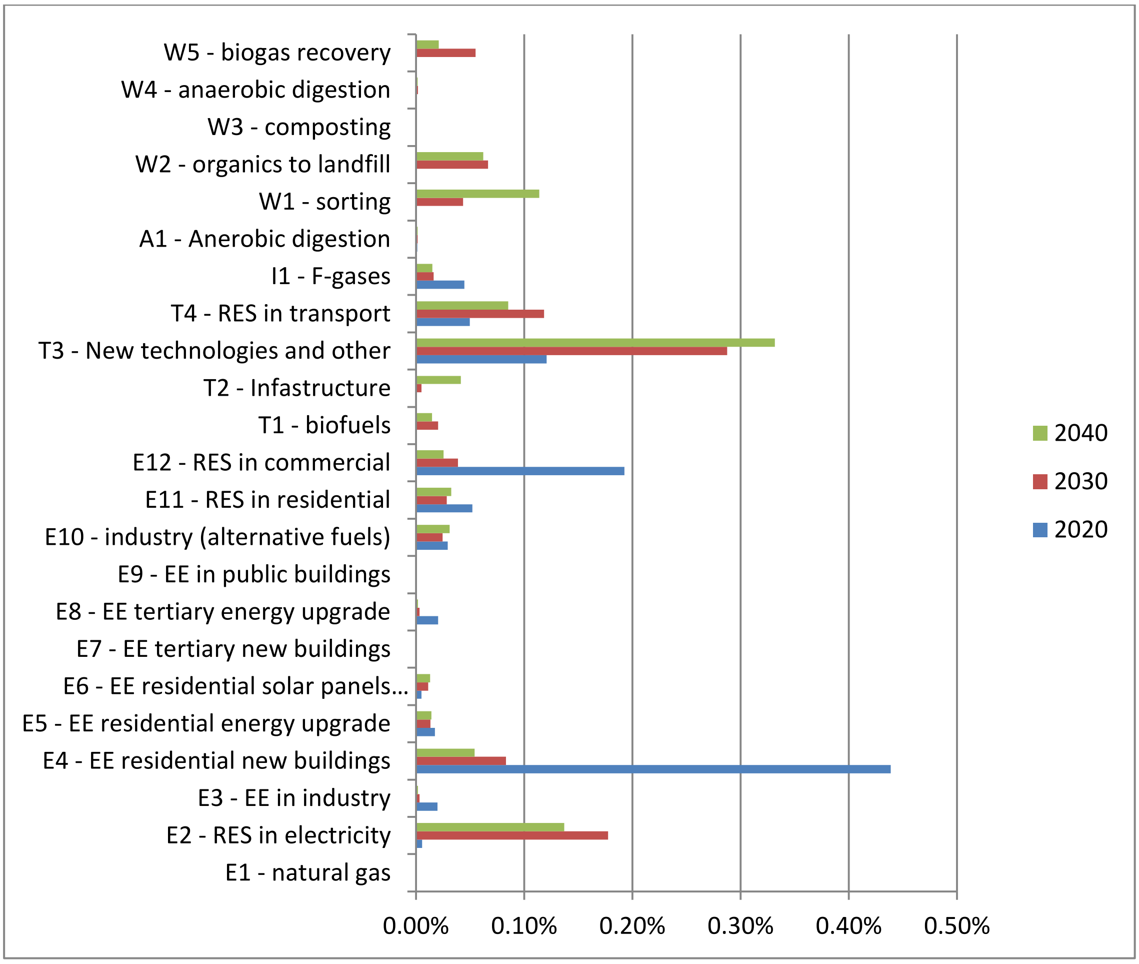


Figure 5.10. Change in total of WAM scenario at 1% change of each measure

6. Vulnerability assessment, climate change impacts and adaptation measures [47]

6.1. Introduction

The information presented in this Chapter has been initially collected through the project "Development of a national strategy for adaptation to climate change adverse impacts in Cyprus" or CYPADAPT and has been further enhanced with new research work published after the end of the project. CYPADAPT is co-financed (50:50) by the government of Cyprus and the European Union through the programme LIFE+ (LIFE10ENV/CY/000723). The CYPADAPT main aim is to strengthen and increase Cyprus adaptive capacity to climate change impacts through the development of a National Adaptation Strategy. Further information is available at the website of the project http://uest.ntua.gr/cypadapt/.

6.2. Observed patterns of climate change across and projections for the future

Cyprus lies at the south-eastern end of the Mediterranean Sea and Europe, which is one of the most sensitive hot-spots and most vulnerable regions in the world regarding climate change (Alcamo et al., 2007, Giannakopoulos et al., 2009, Kostopoulou et al., 2014 [48]).

Climate in Cyprus is generally characterized by mild rainy winters, occasional droughts, and long, hot and dry summers. In winder, the average daytime temperature ranges from 12–15oC while the wet season extends from November to March, with most (approx. 60%) of the rain falling between December and February (Pashiardis, 2002). Precipitation is generally associated with the movement of moist maritime flows to the North, occurring particularly over areas of high elevation (Kostopoulou and Jones, 2007a). Winter precipitation is closely related to cyclogenesis in the region (Maheras et al., 2001). In summer, the average maximum temperature in coastal regions is 32oC and often reaches 40oC in lowland continental areas. This is attributed to the extension of the summer Asian Thermal Low which is evident throughout the eastern Mediterranean in all seasonal circulation patterns (Kostopoulou and Jones, 2007a,b) and associated high temperatures and abundant sunshine. The characteristic summer aridity of the region has significant implications in several socio-economic sectors (Giannakopoulos et al., 2010).

Recent studies on present and future climate have shown that this semi-arid island has been affected and is expected to be relatively strongly affected by the projected warming and related changes (Christensen et al. 2007, Michaelides et al., 2009). The already observed shift of the mean synoptic weather patterns in Europe (Michaelides et al., 2010) and in the close area (Tyrlis et al., 2015) has been connected with increase in appearance of heavy rainfall events (Hatzaki et al., 2008; Tymvios et al., 2010), rainfall (Lingis and Michaelides, 2009), heat events (Tymvios et al., 2013) and severe dust events (Michaelides et al., 2013). Therefore, Cyprus, where diverse and extreme climate conditions are already common, is likely to face increases in the frequency and intensity of droughts and hot weather conditions in the near future, with probably disproportional impacts.

The future climate changes were projected by using PRECIS as the main Regional Climate Model and the A1B scenario of the Special Report on Emissions Scenarios (SRES) of the Intergovernmental Panel on Climate Change (Nakićenović and Swart 2000) which provides a good mid-line scenario for carbon dioxide emissions and economic grow.

[47] Dr. Filippos Tymvios, Department of Meteorology, Ministry of Agriculture, Rural Development and the Environment, 1418 Nicosia, tel. +357 22802934, ftymvios@dom.moa.gov.cy

[48] Kostopoulou, E., C. Giannakopoulos, M. Hatzaki, A. Karali, P. Hadjinicolaou, J. Lelieveld and M.A. Lange (2014) Spatial and temporal patterns of recent and future climat extremes in the Eastern Mediterranean and Middle East region. Nat. Hazards Earth Syst. Sci. 14, 1565-1577

The predictions of future climate change were examined in two future periods i.e. the near future period 2021-2050 and the distant future period 2071-2100. The derived values of various climatic parameters in Cyprus for both future stages were compared to the reference values during the period 1960-1990 (control period). The projected climate changes for the 2021- 2050 period were made by using six additional simulation models of the ENSEMBLES prediction system[49] beside PRECIS, whereas for the 2071-2100 period the emissions scenarios A2 and B2 were use in addition to the A1B.

The future period 2021-2050 has been chosen specifically and examined in detail for the needs of stakeholders and policy makers, in order to assist their planning in relation to adaptation measures, impacts and vulnerability assessment.

In general, regional climate models consistently predict an overall warming and drying of Cyprus with significant impacts in human health, energy use, water resources and other socio-economic sectors Pronounced warming and precipitation reductions are also detected from time series of temperature and precipitation parameters, regarding representative locations of Cyprus during the period 1951-2100.

6.2.1. Observed and projected change in temperature

6.2.1.1. Observed changes

Temperature records and long term changes in diurnal temperature range have been studied by Collins Price (Price et al., 1999) and more recently, for the period 1892 – 2010 from the Department of Meteorology (Pashiardis, 2011) and the Cyprus Institute (Hadjinicolaou et al. 2011). These studies show an increase in the annual mean air temperature of the atmosphere of the order of 1.4°C in Nicosia (Figure 6.1) and 2.3°C in Lemesos (Figure 6.2). This increase is higher than the rise in the global mean surface temperature, which was ranging between 0.74°C ± 0.18°C over the last 100 years (1906 – 2005), according to the Intergovernmental Panel on Climate Change (IPCC, 2007).

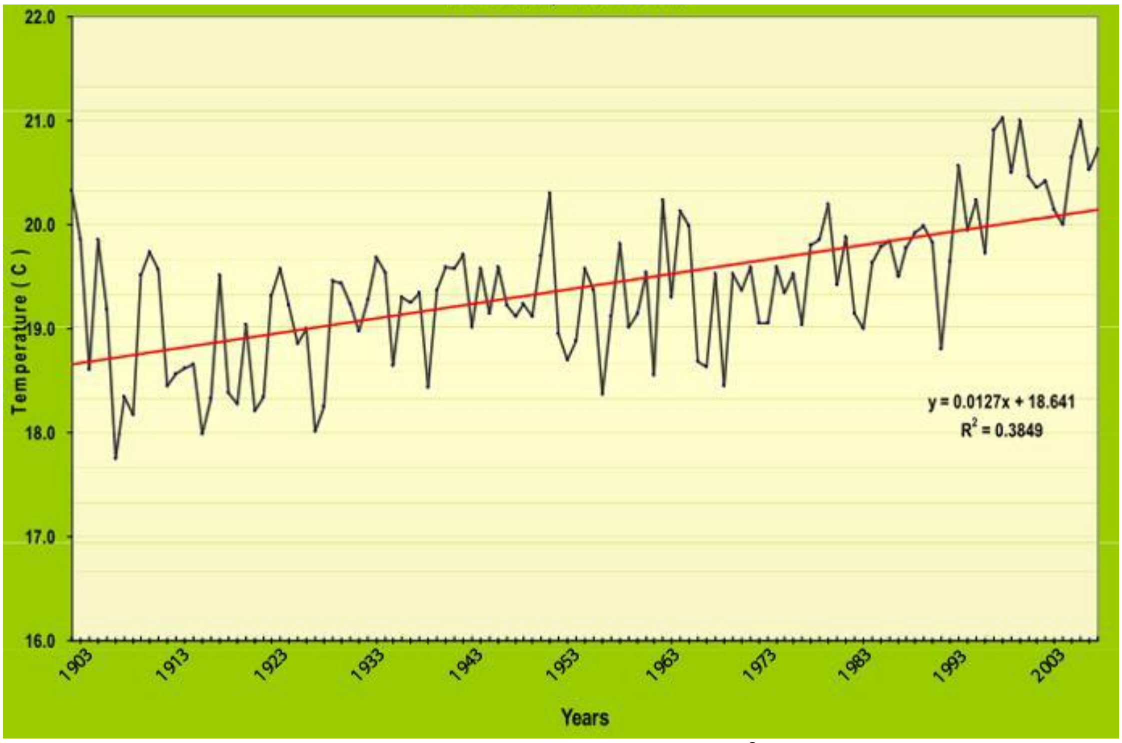


Figure 6.1. Observed changes in the annual mean air temperature (°C) from 1892 till 2010 in Nicosia

[49] ESNEMBLES prediction system: analysed by the National Observatory of Athens and accessed from http://ensemblesrt3.dmi.dk

Moreover, as regards the annual mean air maximum and minimum temperature, the former varies depending on the location, while the later show an increase for the whole area have found a less rapid warming In Tmin over the mountains compared to inland and coastal areas.

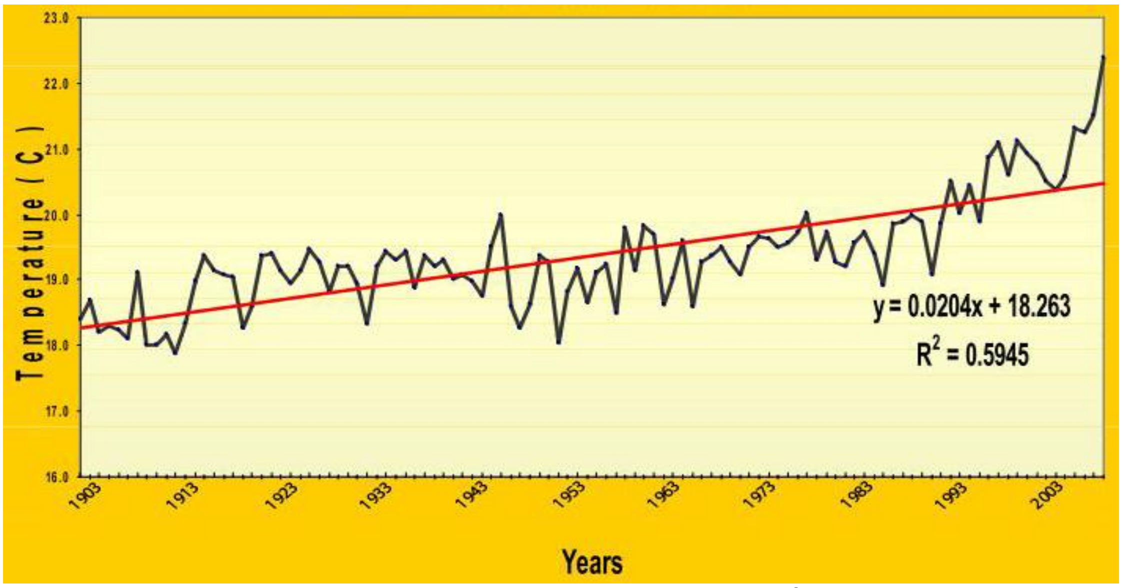


Figure 6.2. Observed changes in the annual mean air temperature (°C) from 1903 till 2010 in Lemesos

The 1961-1990 reference temperature patterns generally illustrate the different climatic zones within Cyprus, from the cool higher elevation regions to the hot and dry lowlands and the warm and humid coasts. Regarding this reference period, the average maximum temperature range is 10-16°C in winter and 25-35°C in summer. The summertime maximum TX in coastal regions is about 33°C, while further inland it often exceeds 40°C.

The average minimum temperature (TN) during winter (DJF) ranges between 2-14°C and in summer ranges between 15-25°C, showing the contrast between the coastal and the continental areas. Winter average TN does not fall below 2°C, even in continental parts of the country, whereas minimum temperatures above 7°C are typical of the Cyprus milder coastal climate.

6.2.1.2. Projected changes

In the period 2021-2050, the projected changes in temperature are remarkable and in agreement with previous work that shows that heat stress is expected to intensify. In particular a continual, gradual and relatively strong warming, as is shown from the projected changes of the average annual maximum temperature (TX) range from 1.0°C to 2.0°C with spatial variations in comparison to the 1961-1990 reference period. Similarly, the average annual minimum temperature (TN) changes are ranged from 1.0°C at the eastern and northern coasts to 2.0°C in higher elevation areas.

Maximum and minimum seasonal temperatures appear to increase most in the continental part of Cyprus. Hot summer conditions that rarely occurred in the reference period may become the norm by the middle of the 21st century. In summer the increase of maximum temperature will exceed 2.5°C. During winter, the average maximum temperature change ranges from 0.5°C to 1.4°C.

Seasonal variations in temperature changes exist between the coastal, mountainous and the continental areas.

In the period 2071-2100, (Figure 6.5) the projected changes based on A1B scenario in temperature are remarkable. In particular, a very strong warming of about 2.5 to 4.5°C may occur between the 1961-1990 reference period and the future period 2071-2100, as shown by the annual maximum and minimum TX patterns.

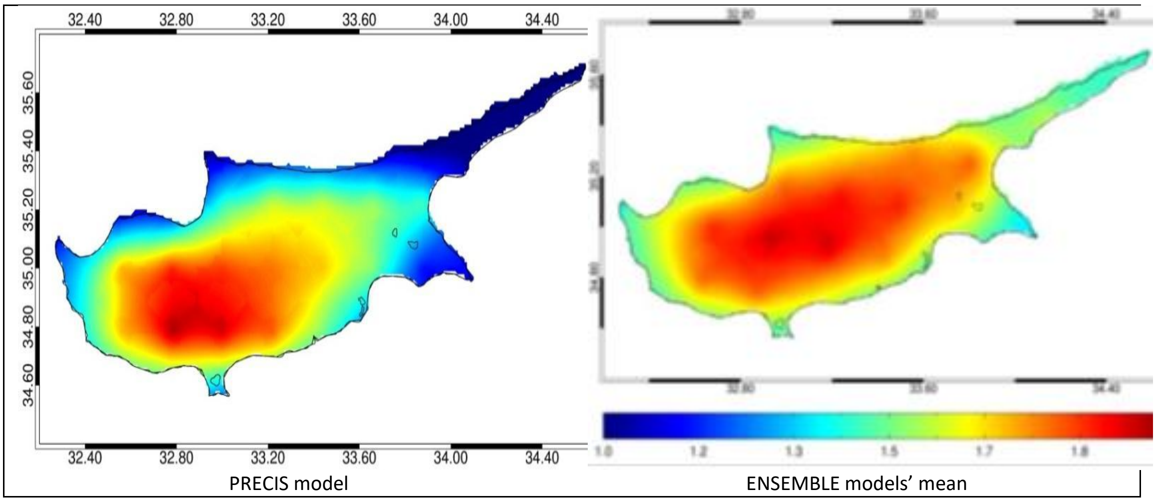


Figure 6.3. Changes in average annual maximum temperature between the future (2021-2050) and the control period (1961-1990)

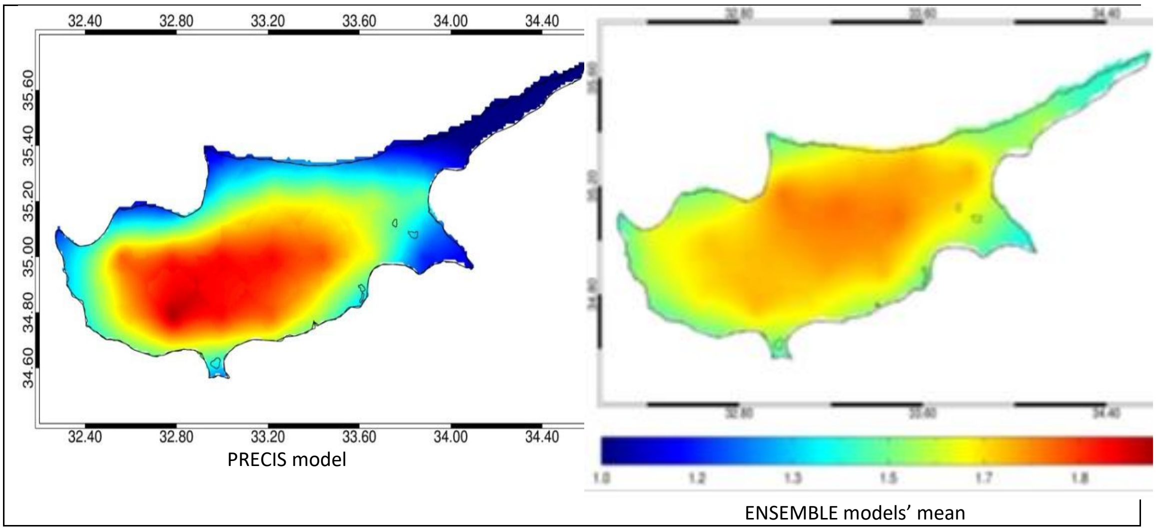


Figure 6.4. Changes in average annual minimum temperature between the future (2021-2050) and the control period (1961-1990)

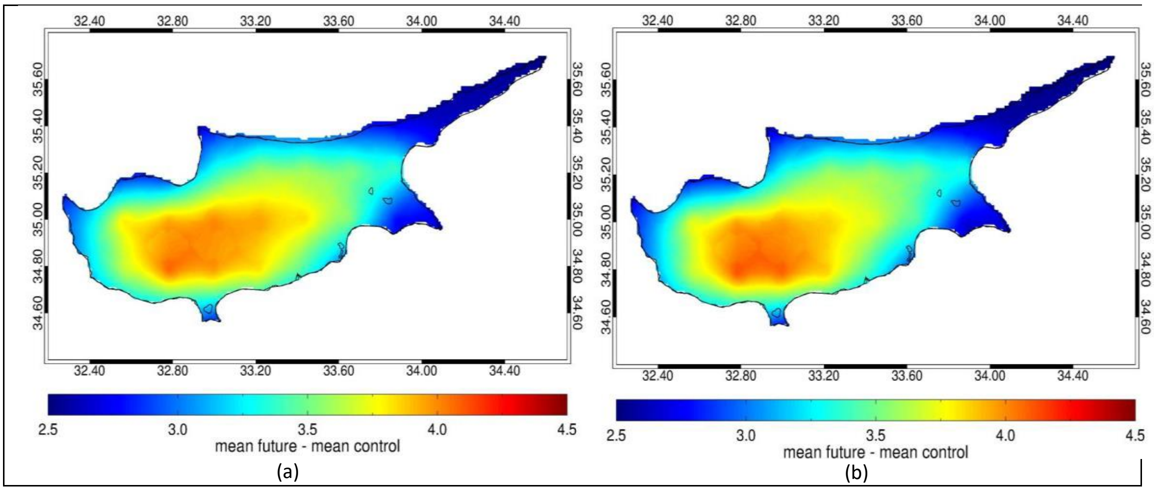


Figure 6.5. Changes in (a) average annual minimum temperature (TN), (b) average annual maximum temperature between the reference period (1961-1990) and the future period (2071-2100).

6.2.2. Observed and projected change in precipitation

6.2.2.1. Observed changes

Data from the Department of Meteorology (Pashiardis, 2011) indicate that the amount of rain which falls in the region has been declining year by year (Figure 6.6). The annual average precipitation has reduced from 559 mm (1901 – 1930) to 463 mm (1971 to 2000), a decrease of 17%. The blue line in the diagram shows the declining trend in precipitation. According to Lange and Manfred (2009) the reduction in rainfall for the period 1905 to 2005 was around 170mm whereas, in 2008 the rainfall reduction which was by 45% lower than the average of the period 2000 – 2007 leading to a severe drought. The problem of the rainfall reduction in Cyprus is also depicted in Figure 6.7 which shows the water stress index in other words the availability of water. Cyprus ranks first among the European countries in terms of water stress index (Wintgens and Hochstrat, 2006).

The total annual precipitation is presented in Figure 6.8. The large east–west contrast is evident in both annual and seasonal precipitation patterns. The maximum annual total precipitation occurs at the western coasts and most precipitation occurs in winter and autumn, in similar patterns. The winter total precipitation ranges from about 75mm in the lowlands of central Cyprus to 270mm in the western higher elevation areas, woodlands and wetlands.

The frequency distribution of the annual precipitation per climatic period (30 years) was investigated by Michaelides et al. (2009). The analysis revealed that although the mean precipitation value of each climatic period had minor variation, the statistical distribution characteristics of the annual precipitation between climatological periods diversified significantly with an increase of years with high and low precipitation at the expense of years with average precipitation during consequent climatological periods. These findings are in agreement with the findings of Alpert Pinhas (Pinhas et al., 2002) who studied the paradoxical increase of Mediterranean extreme daily rainfall in spite of decrease in total annual values.

Another important parameter for Cyprus is the increase in evapotranspiration. As shown in Figure 6.9, evapotranspiration has increased by 60-80 mm in the period 1976 - 2006. This, combined with temperature rise and rainfall decrease, intensifies the drying of soils and leads gradually to their desertification.

The 1961-1990 precipitation patterns in Cyprus do not depend only upon the synoptic weather conditions but also on the pronounced topography. The dominance of local topography is also evident from the seasonal total precipitations. For example, winter total precipitation ranges from about 75mm in the lowlands of central Cyprus to 270mm in the western higher elevation areas, woodlands and wetlands.

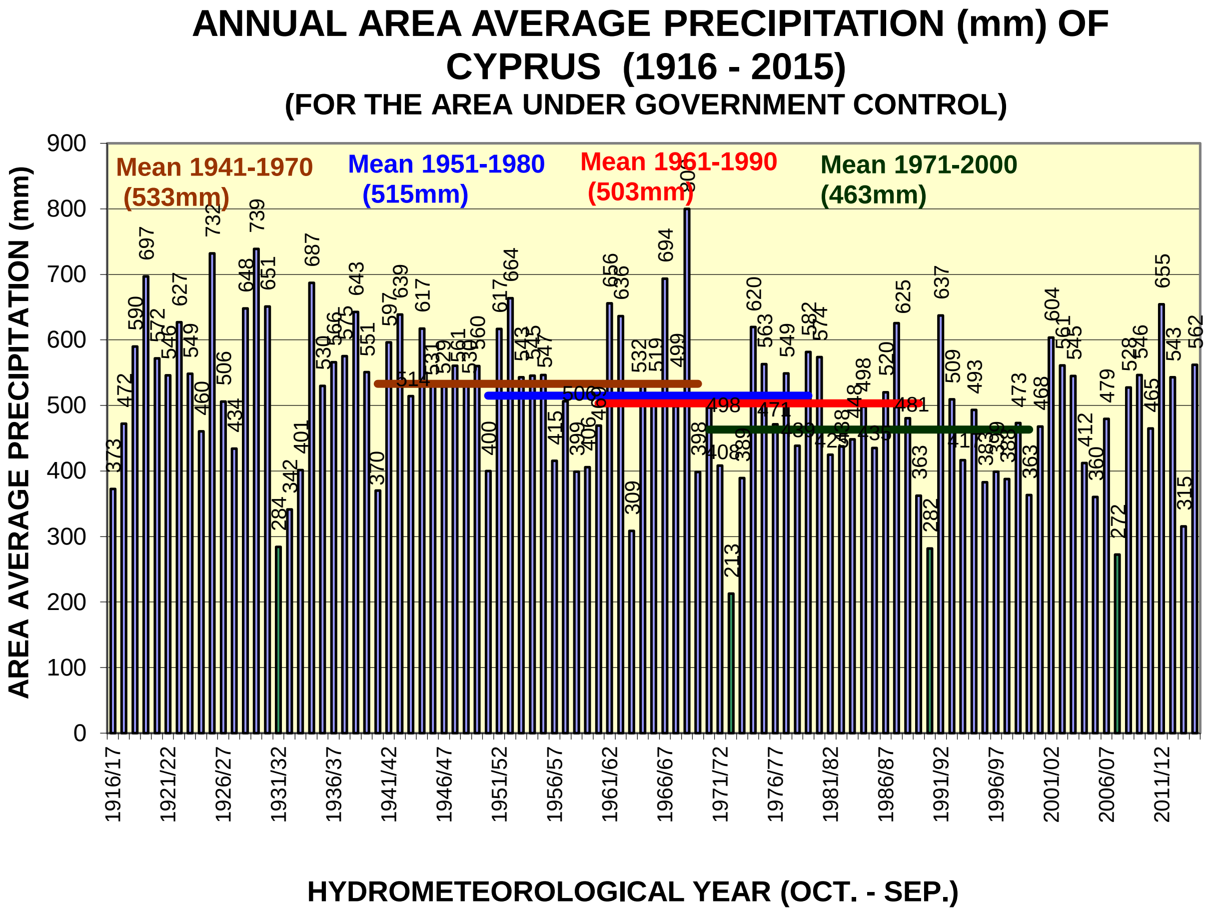


Figure 6.6. Annual average precipitation (mm) in Cyprus from hydrological year 1901-02 till 2014-15 Mean 1901-1930 559mm, mean 1971-2000 559 mm, mean 1971-2000 463mm, decrease 559-463 = 96mm (17%)

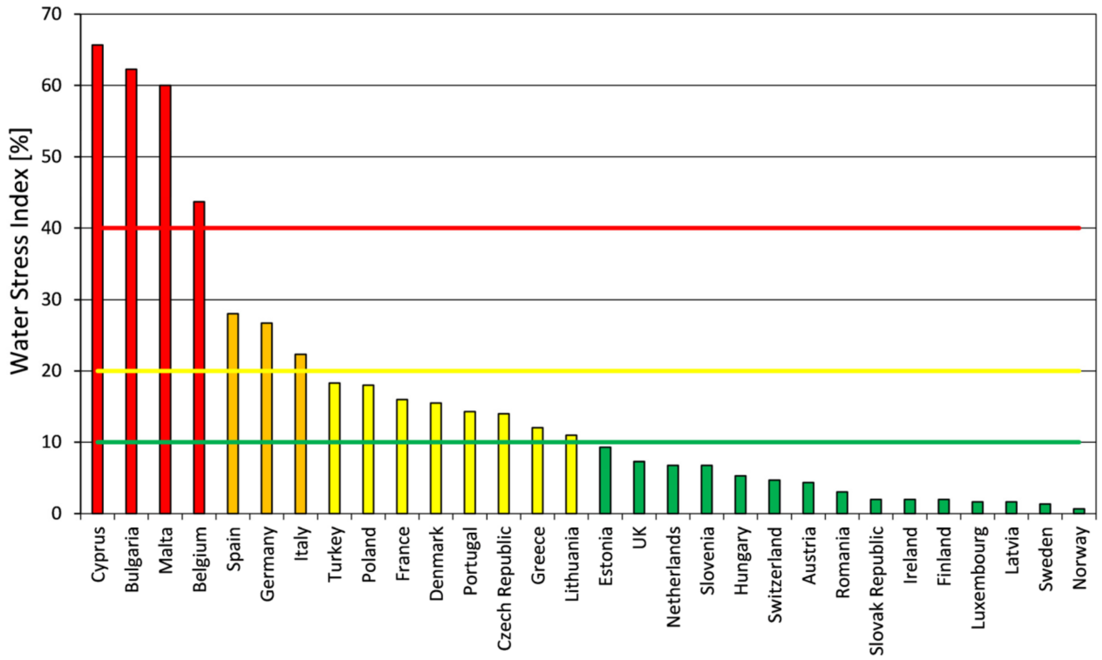


Figure 6.7. Water Stress Index among European countries. Cyprus ranks first (Sofroniou and Bishop, 2014)

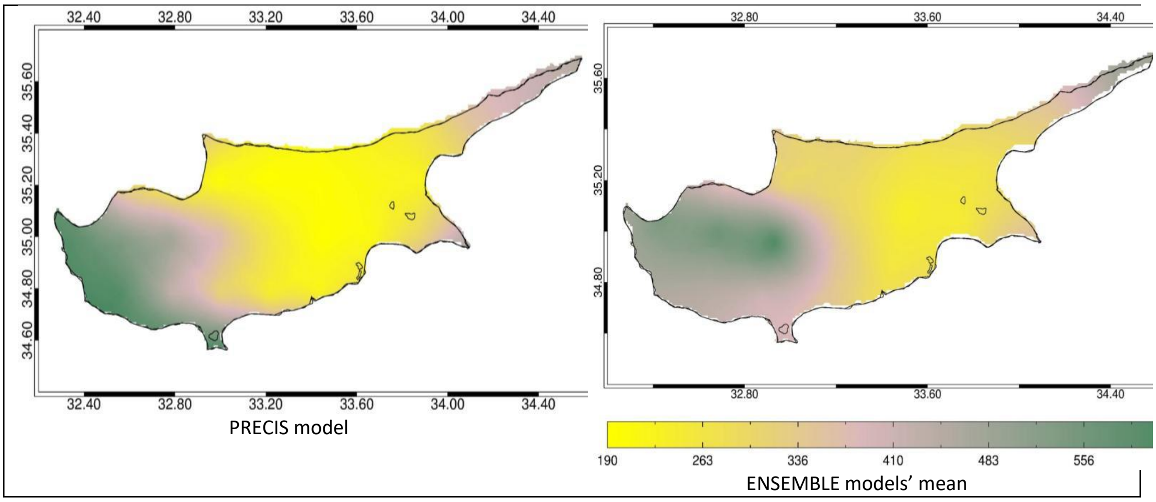


Figure 6.8. Annual total precipitation for the years 1961-1990 (control period)

6.2.2.2. Projected changes

Cyprus projected precipitation changes are quite variable among models. Therefore, Cyprus precipitation patterns must be interpreted with caution, owing to the large temporal variability of rainfall and the inherent limitations of climate models to simulate accurately the hydrological cycle and the large variations of future projected changes among models. Changes in annual precipitation provide important information about occurrences of droughts and subsequent water shortages in Cyprus, expected in the near future (2021-2050).

In the period 2021-2050, Cyprus projected precipitation will be decreased (though at different values among models) with seasonal and regional variations (Figure 6.10). The northern coasts, especially Karpasia peninsula, are expected to receive less annual total precipitation. In all other parts of Cyprus, the annual total precipitation appears to have minor decreases or no changes at all. In addition, models show that the relative humidity will decrease in the near future, except from the coastal areas of Cyprus where increases of relative humidity are expected (with an associated increase of heat stress).

The spatial distributions of seasonal precipitation changes over Cyprus exhibit a large spatial and temporal variability. Since most precipitation occurs in winter and autumn, the precipitation changes during these two seasons are very important for the study of droughts and associated water shortages.

The winter total precipitation changes, derived from PRECIS output, are negative or zero all over Cyprus, whereas the ENSEMBLE models' mean presents an almost reverse image from PRECIS. Similar to winter, the autumn total precipitation changes, derived from PRECIS output, are negative or zero all over Cyprus, whereas the ENSEMBLE models' mean gives a wetter projection of the near future. All Cyprus appears to receive more autumn total precipitation in the future than in the recent past (1961-1990), with the largest increases (up to 20 mm) in the western part of the country.

Changes in annual precipitation provide important information about the occurrences of droughts and subsequent water shortages in Cyprus, expected in the distant future (2071-2100).

As far as precipitation projections are concerned, all northern coasts are expected to receive less annual total precipitation in the distant future. In lowland and continental areas in the central part of the country, the annual total precipitation appears to have small decreases (up to 50mm). A significant increase of up to 30 days/year in the number of dry days is expected in the northern coastal areas (Ayia Irini Forest, Karpasia peninsula) by the end of the century.

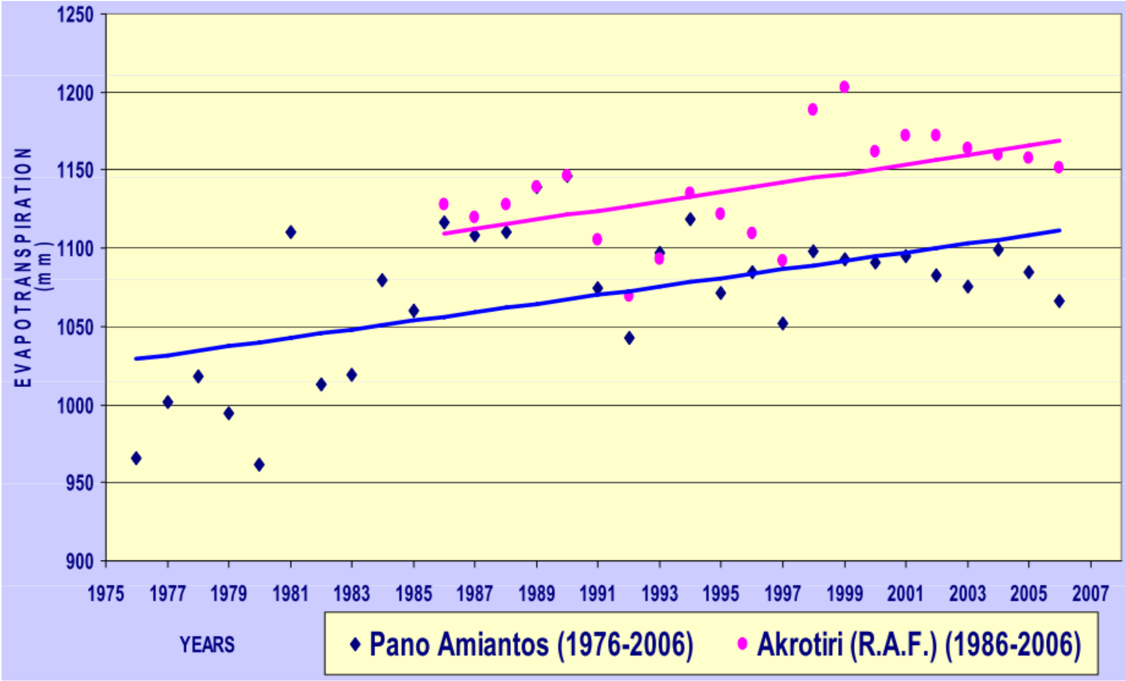


Figure 6.9. Increasing trend in annual evapotranspiration as it testified by records at Pano Amiantos station (1976 – 2006) and Akrotiri station (1986 – 2006) of the Penman-Monteith evapotranspiration

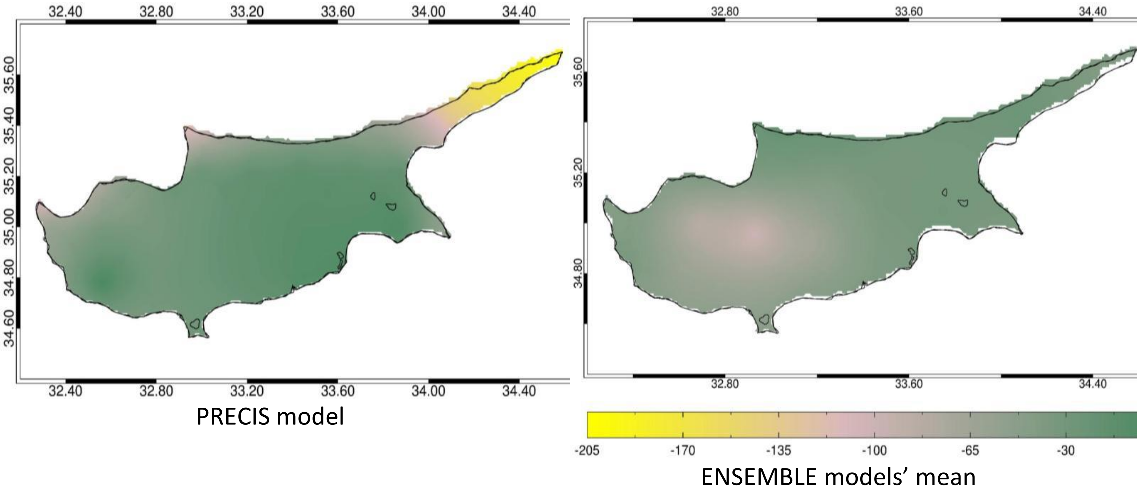


Figure 6.10. Changes in annual total precipitation between the future (2021-2050) and the control period (1961-1990)

6.2.3. Observed and projected change in Extreme weather events: heat wave, drought, flood, dust

6.2.3.1. Observed changes

Since 1950 an increasing number of heat wave events have been observed in many regions around the world. An increase in the number of hot nights has also been recorded (IPCC, 2007, IPCC 2013). In addition, larger parts of the world have been affected by droughts as a combined effect of rainfall decline and evapotranspiration increase. Still, heavy rainfall events which lead to flooding have been intensified but this does not characterize a global trend. Finally, the number of tropical storms affecting the Eastern Mediterranean (although varying from year to year) has generally increased in terms of their intensity and duration since the 70s (IPCC 2007, IPCC 2013). However, studies for the Eastern Mediterranean and the Middle East have presented mixed results (Kostopoulou et al., 2005; Tanarhte et al., 2015).

The connection of specific atmospheric circulation patterns with heat events (Tymvios et al., 2013) and the differentiation of the frequency of occurrences of the patterns in the recent climatological periods (Michaelides et al., 2010) confirm the shift of the general climate mean of the area towards drier and warmer conditions with prolonged summertime periods with increasingly frequent occurrence of extreme and lengthier heat events.

In Cyprus, during the last decades the number of hot days and warm nights has increased, whereas the number of days with temperatures less than or equal to $0^{o}C$ has greatly declined. There has been reported an increasing trend in the minimum temperatures in the island, as indicated form the increase in the number of days with temperature $40^{o}C$ or higher (Figure 6.11) and the great reduction the number of days with temperatures less than or equal to $0^{o}C$ (Figure 6.12).

In most patterns of projected changes in indices of climate extremes, there is a rather good agreement between PRECIS and the ENSEMBLE models' mean. The increase in the number of days with TN>25°C (tropical nights) is expected to be approximately 1 month, which is of great concern, in combination with the given remarkable increases of all indices of maximum temperature.

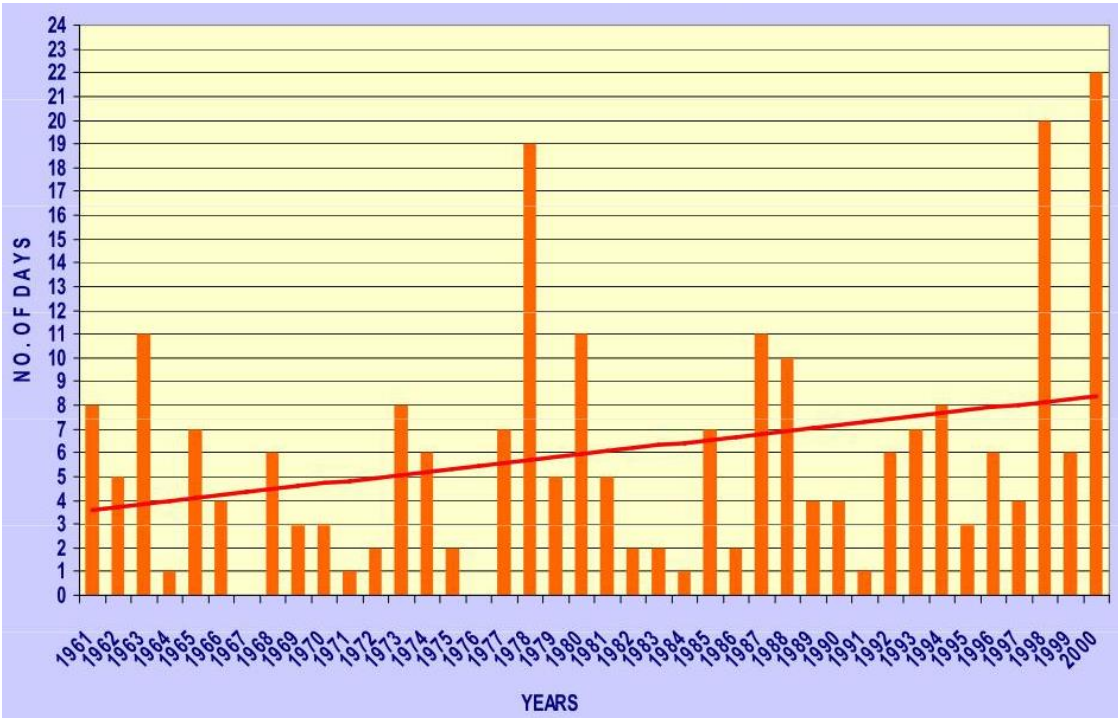


Figure 6.11. Number of days with temperature $40^{o}C$ or higher from Nicosia station for the period 1961 - 2010

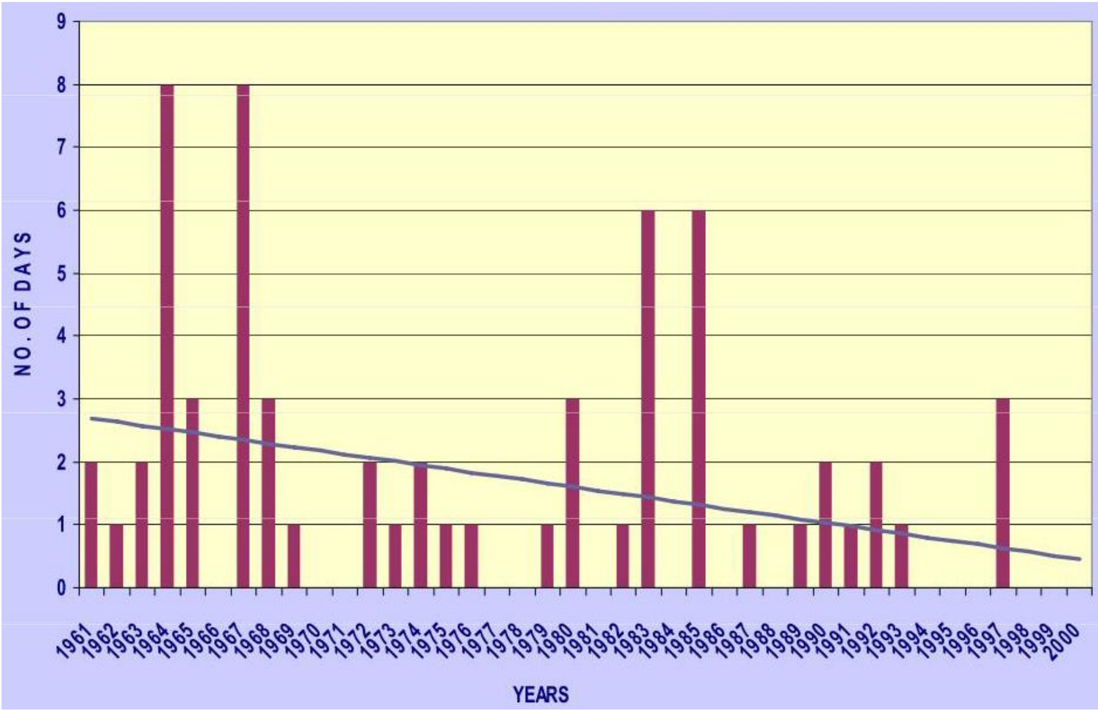
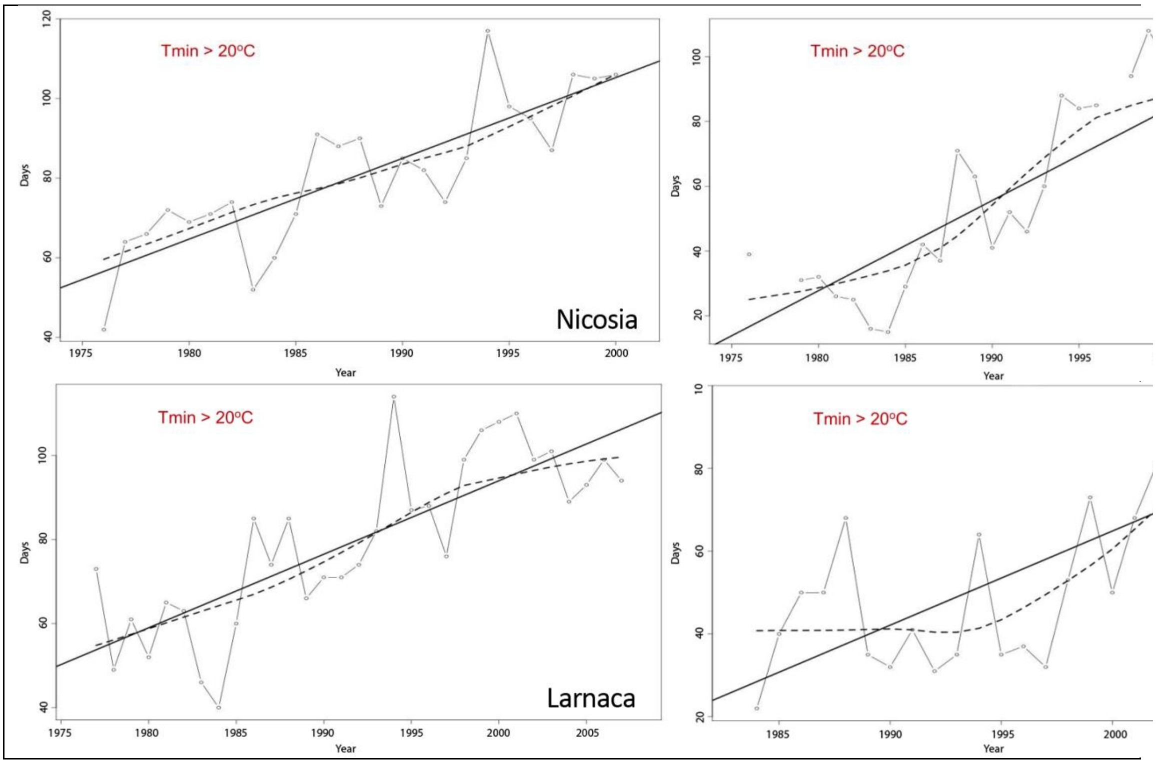


Figure 6.12. Number of days with temperatures less than or equal to 0oC from Nicosia station for the period 1961 - 2010

Furthermore, very important is the increase in the number of warm nights in almost all of Cyprus as evidenced in Figure 6.13 (Hadjinicolaou et al., 2011) and the annual mean temperature distributions present the temperature changes between the periods 1981-1990 and 2001-2008 (Figure 6.14). Over the last decade the greatest part of Cyprus has suffered from high temperatures and the largest part of the population residing in the three major cities, suffered high discomfort and serious socioeconomic problems such as increase in energy for cooling, water consumption and forest fire risk.



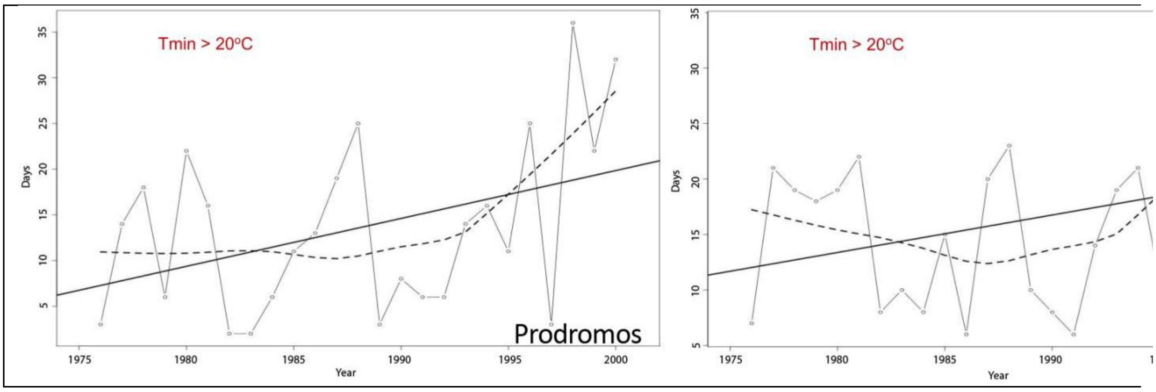


Figure 6.13. Increase in the number of warm nights in Cyprus as it testified by stations' records at Nicosia (1976 – 2000), Lemesos (1976 – 2006), Larnaca (1977 – 2007), Pafos (1983 – 2007), Prodromos (1976 –2000) and Saittas (1976 – 2000)

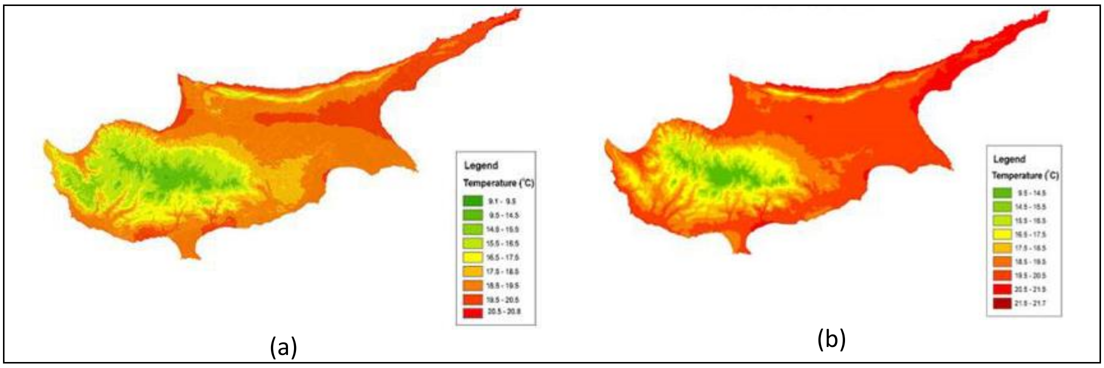


Figure 6.14. Spatial mean annual temperature distribution for period 1981 – 1990 (a) in contrast with the respective for period 2001 – 2008 (b)

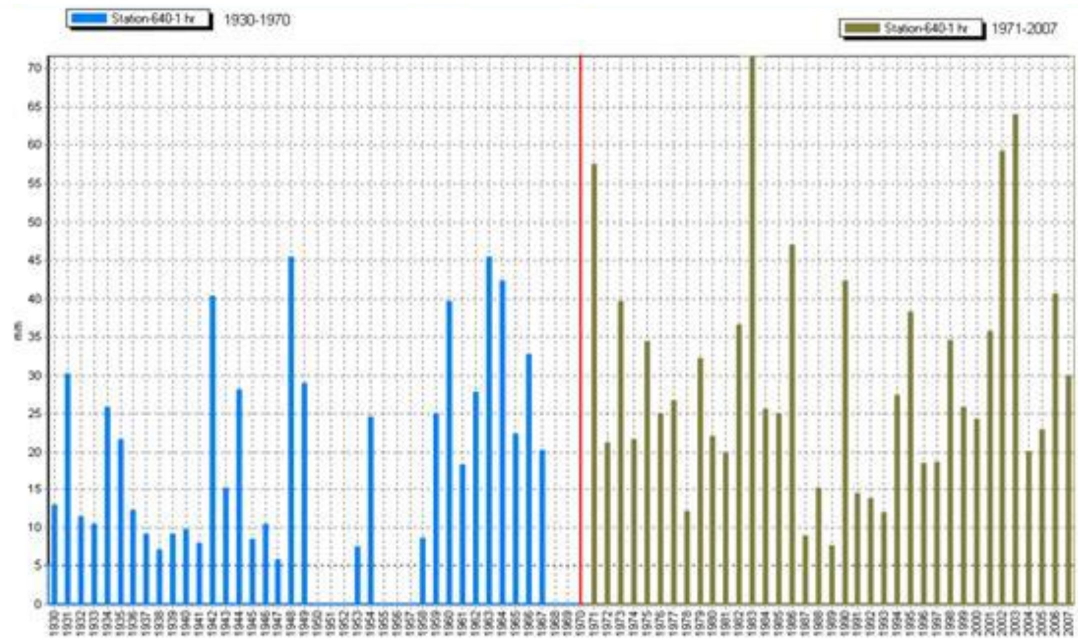


Figure 6.15. Increase in the highest amounts of rainfall in 1 hour for the period 1971 – 2007 in contrast with the respective for the period 1930 – 1970

As mentioned above, Cyprus experienced periodically severe droughts due to the declining precipitation, the worst of which was in 2008. During that event the water reservoirs were filled in only 3% of their capacity, prompting the Cyprus government to spend millions of Euros for water import from Greece (Davenport, 2008). Figure 6.15 shows the observed increase in heavy rainfall which falls in 1 hour for the period 1930-2007 despite the decrease in the mean precipitation. These extreme rainfall events may potentially cause localized flooding phenomena with devastating impacts. Nevertheless, it is not uncommon for isolated summer thunderstorms to occur, which however contribute to less than 5% to the total annual precipitation amount (Pashiardis, 2002).

6.2.3.2. Projected changes

As regards to extreme events in future, the combination of projected higher temperatures and reduced mean summer precipitation, as well as the increase intensity of precipitation, would enhance more the occurrence of heat waves and droughts, and the annual number of heavy rainfall events (Zittis et al., 2015). Furthermore, the photochemical air pollution, associated with peak ozone levels in excess of 100 ppbv and high concentrations of particulates by desert dust and anthropogenic aerosols, is expected to considerably reduce air quality during heat wave conditions. Considering the multiple environmental stresses in metropolitan areas, including confounding factors such as the urban heat island effect and growing air pollution, the cities in the Eastern Mediterranean and the Middle East will become true hot spots of climate change (Lelieveld et al., 2014).

Projections of future changes reveal increases in annual maximum temperature which may reach 2.4-2.6°C in continental and mountain areas and 2.0°C in coastal areas. Also, one additional month with maximum temperature higher than 35°C is expected in inland and mountain regions. Similar increases are also anticipated for tropical nights to the whole study domain.

Concerning precipitation extremes, an increase of about 8-10 days is expected in dry days as well as in the length of dry spell.

In distant future (2071-2100), the extreme temperature and precipitation conditions in Cyprus will be worse

- The expected increase of the number of summer days (TX>25°C) during the period 2071-2100, varies between 30-45days per year (Figure 6.16a) to about 60 days in the northern coastal and continental lowlands areas, and the west southern areas of Cyprus respectively.
- The number of hot days (TX>30^{o}C) per year will be increased by 25-45 days throughout Cyprus as seen in figure (Figure 6.16b) and the number of heat wave days (TX>35^{o}C) will be also increased by 20-60 days in between coastal and continental regions (Figure 6.16c).
- The number tropical night index (TN>20°C) for the distant future is expected to increase by 35-50 days in most of the coastal areas and continental lowlands (Figure 6.16d), whereas higher elevation areas, are characterized by a maximum increase of 65-75 days per year.
- The annual max total rainfall over 3 days is expected to have a slight decrease of up to 10mm per year and the annual maximum total precipitation over 3 days in the lowland central regions is expected to have an increase of up to 15mm/year (Figure 6.16e)
- Furthermore, the annual number of dry days (with less than 0.5mm precipitation) for the 2071-2100 period is not expected to change much over the southern coastal part of the domain. A significant increase of up to 30 days/year is noted though in Ayia Irini Forest, Karpasia peninsula, as well as in some other highlands (Figure 6.16f).

In distant future 2071-2100 the number of tropical nights is expected to increase by up to 75 additional days per year in the western and south-western part of the country. Furthermore, the number of heat wave days may increase in the entire domain. The more pessimistic scenario A2 further enhances the number of heat wave days compared to the A1B projections, in Nicosia. The more optimistic scenario B2 slightly reduces their number, though they are still strongly enhanced compared to the reference period.

The aforementioned increase in climate extremes is to be accompanied by secondary effects conserning public health. Lubczynska et al., using data from Cyprus have proven a relationship between high temperatures and cardiovascular mortality for cerebrovascular diseases, ischemic and other heart diseases, with the highest risk associated with ischemic heart diseases (Lubczynska et al., 2015) while Proestos et al. connected the future distribution of the population of the Asian Tiger mosquito (Aedes Albopictus) with the potential threat to public health owing to its environmental adjustability and its capability to transmit the pathogens that cause dengue fever, chikungunya infection, West Nile fever and other diseases (Proestos et al., 2015).

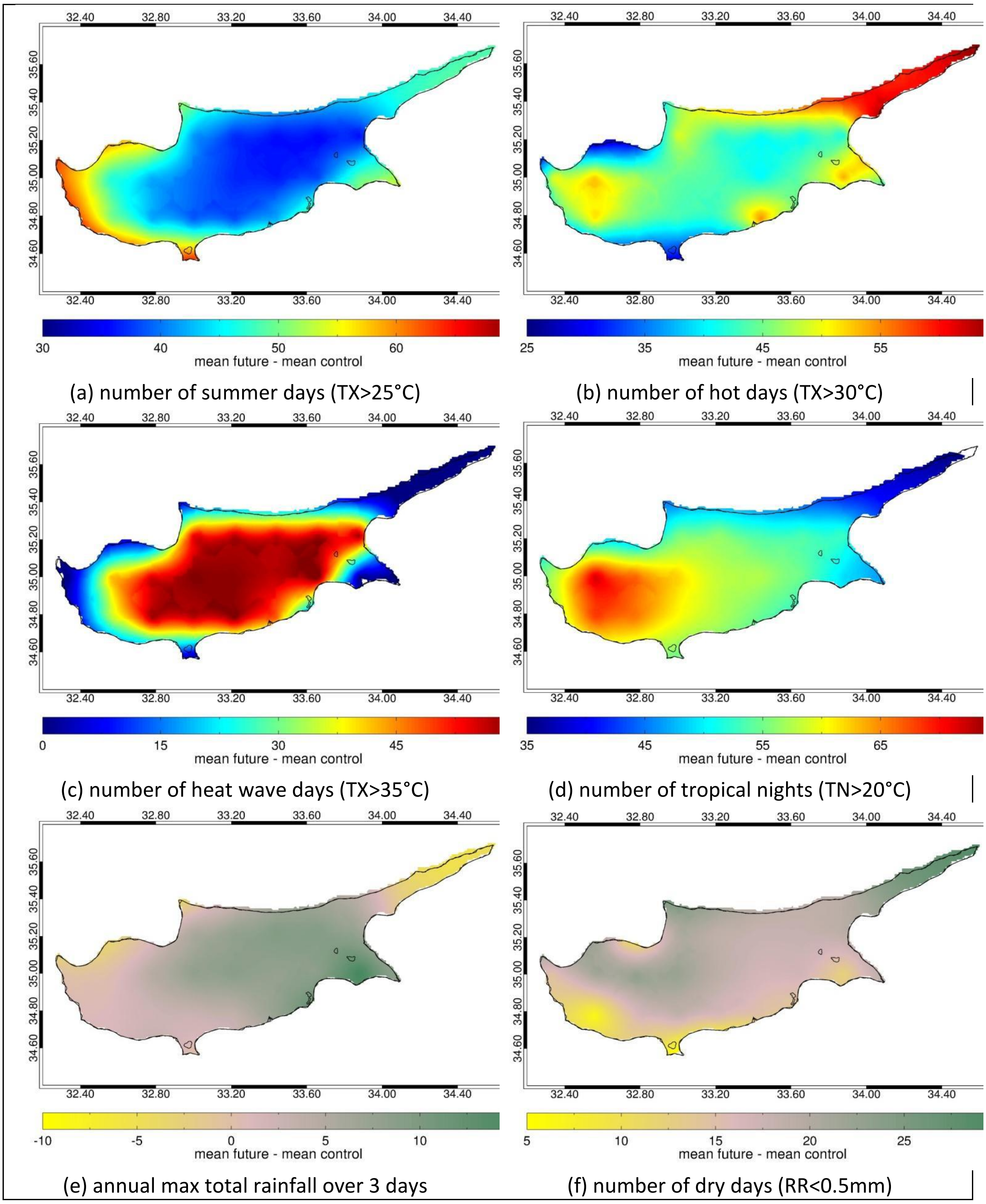


Figure 6.16. Changes between the reference period (1961-1990) and the future period (2071-2100)

6.3. Expected impacts and vulnerabilities of climate change in Cyprus

The following sections present the expected impacts and vulnerabilities of climate change in Cyprus for biodiversity, infrastructure, energy, health, forestry, agriculture and water.

6.3.1. Biodiversity

Climate change is likely to become one of the most significant drivers of biodiversity loss by the end of the century, as already evidenced from the very rapid increase over the last century, especially in dry lands, mountains and Polar Regions (Millennium Ecosystem Assessment- MA, 2005)

Projected changes in climate, combined with land use change and the spread of exotic or alien species are likely to limit the capability of some species to migrate and therefore will accelerate species loss (CBD, 2007).

Cyprus due to its geographical position in the eastern part of the Mediterranean Sea bears all the characteristics of a semi-arid climate and some of the deficits of the global climate change. The rich biodiversity of Cyprus is the result of the combination of the geographical structure, landscape isolation due to its insular character, surrounding sea, topographic relief, geological structure and of course climatic conditions. The flora and fauna of the island are adapted to the various natural biotopes and climatic conditions, resulting in a large number of endemic and rare species (DoE, 2000).

Direct impacts of climate change on Cyprus biodiversity arise mainly from decreased rainfall and increased temperature, droughts, fluctuations in intensified precipitation, sea level rise and increased atmospheric CO_2. These impacts are expected to worsen in future period (2021–2050) as already projected PRECIS and ENSEMBLES prediction system.

Biodiversity is affected by numerous factors concerning the climate, ecology, society, culture, economy and technology (United Nations University, 2005). In terms of climate, the main factors affecting the biodiversity of Cyprus are among others the following: Variability (uneven geographic distribution and temporality of precipitation) - Reduction of frequency of precipitation -Increase of frequency of rainfall's intensity -Increase of temperature (and certain variables of temperature) -Heat-wave -Reduction of snow cover in Troodos -Increase of evapotranspiration (contributes to the intensification of soil drying).

The above mentioned pressures in combination with other factors such as the island's landscape fragmentations, the intrusion of harmful invasive alien species and the deteriorated freshwater quality, are expected to threaten further and in more complicated way, mainly the terrestrial, marine and freshwater biodiversity of Cyprus.

6.3.1.1. Future Impact assessment

The climatic factors that may have an impact on the biodiversity of Cyprus include the decreased rainfall and increased temperature, droughts, fluctuations in intense precipitation events, sea level rise, increased atmospheric CO_2 and changes in fire regimes. According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2^{o}C, precipitation to decrease in seasonal level and in minor degree in annual level, the maximum length of dry spells (precipitation<0.5mm) is expected to increase 10 to 12 days on average, heat wave days (temperature >35^{o}C) will be increased averagely about 10-30 days on annual basis, depending on the region. Concerning future changes of annual max total rainfall over 1 day, PRECIS projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected. For the purpose of this report, the future impacts of climate change are grouped in categories and assessed in the sections that follow.

- Terrestrial ecosystems
  - Distribution of plant species in terrestrial ecosystems
  - Plant phenology of terrestrial ecosystems
  - Distribution of animal species in terrestrial ecosystems
  - Animal phenology of terrestrial ecosystems
- Aquatic ecosystems
  - Marine biodiversity
  - Freshwater biodiversity
  - Phenology of aquatic ecosystems

Impacts on terrestrial ecosystems

The distribution of plant species in terrestrial ecosystems, in terms of number of species, services of plants and plant communities, is expected to be affected even more with the projected milder winters in future. So far northward and uphill movements of plants and extinctions of species have been observed, emerging the concern about the resilience of wild plants to the rate of climate change. Another impact that is expected to be exacerbated is the invasion of alien species, having caused ecological changes throughout the world in the past few hundred years (Clout and Lowie, 1997; Unit of Environmental Studies), such as diseases of local species and alterations of keystone species. The invasive alien species alter or even extinct populations and native species in the natural ecosystems. In Cyprus the already low plants species richness will be worsening in the future period (2021-2050) were droughts are anticipated to be increased.

Changes in phenological responses of plants have been noticed in several places of Europe, including Cyprus, as mentioned in the survey “Growing Season Temperatures in Europe and Climate Forcing over the Past 1400 Years”.

In the future period (2021-2050) the expected temperature increases of about 1-2°C on average, as well as the milder winters, can affect biodiversity negatively, especially in Akamas area, Troodos mountain and Akrotiri peninsula, were the threatened plants located in a significant level. Both the winter minimum and summer maximum temperature is anticipated to have an increase of 0.8 - 1°C and 1-2°C, respectively, mainly in southern, inland and, western and mountain regions. Since there is no data available for on plant phenology, the extent of future climate impacts cannot be estimated at present.

The population and distribution of animal species in terrestrial ecosystems will be also changed with the temperature rise in the future; as a result of the decreased food availability and the expansion of invasive species and their associated diseases. The most typical example is the establishment of new pest species -such as migratory moths, butterflies, ticks and mosquitoes- due to warmer winters.

Furthermore, projections about the mammals of the Mediterranean regions- especially the threatened in terrestrial environments- suggest up to 9% risk of extinction (assuming no migration) during the 21st century (Andreou et al.).

As regard as the animal phenology of terrestrial ecosystems in Cyprus, there is no information available in relation with the increasing temperature, apart from the noticed increased populations of insects in the forests of Cyprus (DoF). However, the projected increase in temperature can affect animal phenology, due to the induced changes in the metabolic limits of animals, in the reduction of the thermoregulation capacity of warm blooded animal species, in the length of breeding seasons and the higher reproduction of temperature-sensitive insects and others.

Impacts on aquatic ecosystems

The marine flora and fauna of Cyprus with the great diversity and low biomass are more vulnerable to climate change. Furthermore the surrounding environment, the Levantine basin (Eastern Mediterranean Sea) is characterized by high temperature and salinity, as well as low nutrient levels, making it a challenging biological niche which constantly tests species’ tolerance limits to physical components (Parari, 2009).

The temperature in Cyprus is expected to increase about 1.0 – 2.0°C in winter and about 2.0 – 2.7°C in summer, (according to PRECIS projections, for the future period 2021-2050), resulting in lower nutrient levels (phytobenthos and phytoplankton), higher salinity and acidification and, displacement of the endemic species by the invasive species, that entering the Mediterranean Sea through the Gibraltar straits and the Suez Canal.

For example, marine habitats of neuralgic importance -such as *Posidonia oceanica* meadows- are very sensitive to salinity, temperature and sedimentation alterations. The meadows produced by this marine plant function as nursery grounds for juvenile fish, reproductive fields and fisheries stock replenishment areas are exceptionally important. A potential loss of these meadows would bring catastrophic consequences for the marine biodiversity of Cyprus and its commercial fisheries (Parari, 2009). Since there is no data available further research is required to assess the future impact on marine biodiversity due to changes in nutrient levels.

The inland aquatic biodiversity will be affected by future climate change, as they can cause enhanced phytoplankton bloom, favouring and stabilizing the dominance of harmful cyanobacteria in phytoplankton communities, resulting in increased threats to the ecological status of lakes and enhanced health risks, particularly in water bodies used for public water supply and bathing (EEA et al., 2008). The plants, fish and aquatic organisms of rivers and water storage reservoirs (dams) of Cyprus are threatened by the eutrophication, which can be deteriorated by temperature rise. One of the most important effects in aquatic phenology is the change in the size and growth of phytoplankton and the consequent influence on the light levels, surface temperature and magnitude of nutrient recycling. However information about phytoplankton growth and bloom response to temperature rise is not available and further research is required.

6.3.1.2. Future vulnerability assessment

The future vulnerability of biodiversity to climate change impacts in terms of their sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050 is assessed for the impact categories as follows:
1. Distribution of plant species in terrestrial ecosystems
2. Distribution of animal species in terrestrial ecosystems
3. Marine biodiversity
4. Freshwater biodiversity

Terrestrial ecosystems

It is noted that, the future vulnerability of “Plant phenology of terrestrial ecosystems”, “Animal phenology of terrestrial ecosystems” and “Phenology of marine ecosystems” was not assessed due to lack of relevant research findings.

The future vulnerability of biodiversity varies substantially as it is related to the different rate and magnitude of climate change in different parts of Cyprus due to the variability of the air pollution levels, altitude, temperature and rainfall variations, meteorological conditions (e.g. wind, moisture), local geomorphology and soil characteristics.

The general characteristics of the plant distribution in Cyprus which indicate a sensitive environment to climate change plant species are the following: (i) low species richness, (ii) sensitive endemic plant species and (iii) several invasive plant species. The number of plant species in Cyprus is generally considered low in comparison with the levels in Europe, perhaps due to the semi-arid climate of the island and the more frequent presence of consecutive years of droughts according to Biosoil project (Hiederer and Durrant, 2010). Nevertheless studies undertaken in Cyprus indicate that the percentage of endemism is 7.39% which is one of the highest in Europe (Hadjichambis and Della, 2007).

The more sensitive plant species are considered those that belong to relic populations and those that are less capable to adapt in the new environmental conditions. More specifically, according to the Red Book of Flora of Cyprus (Tsintides et al., 2007), 7% of the plant taxa in Cyprus is Regionally Extinct (RE), 14% of endemic plants of Cyprus is characterized as Critically Endangered (CR), 19.5% as Endangered (EN), 39% as Vulnerable (VU), 4,6% as Close Threatened (NT) and 2.2% as Low Danger (LC).

According to the studies of Hadjikyriakou and Hadjisterkotis (2002), 152 adventive species have been recorded. More specifically *Acacia saligna (Labill.) (H.Wendl.)* is described as the most dangerous invasive species in Cyprus, threatening many natural habitats, invading maquis, garigue, phrygana, marshy areas and agricultural land. It has been recorded as a serious threat to the habitat of the salt lake of Larnaca and it was considered necessary to remove a number of its population from the area (Atlantis Consulting Cyprus Ltd). Likewise, the *Robinia pseudoacacia* L. has spread in forests, maquis, garigue and phrygana vegetation. In addition, the observed for the first time *Ailantus altissimma* (Mill.) *Swingle andCasuarina cunninghamiana Miq*. is also spreading, threatening natural habitats such as forests and maquis.

Considering the above, the sensitivity of the distribution of plant species (including Invasive Alien plant Species) in Cyprus for the future period (2021-2050) can be characterized high**.**

Table 6.1. List with the Critically Endangered (CR) plants of Cyprus

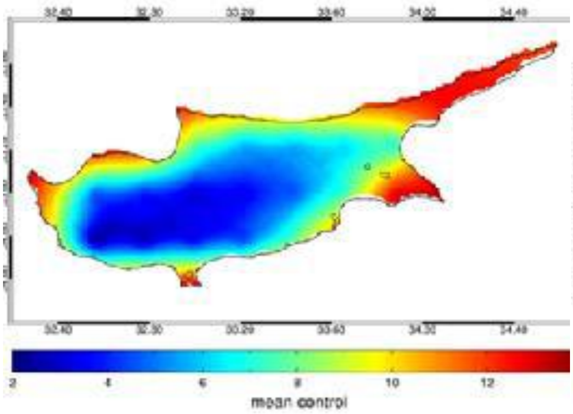
Species	*Description*
Arabis kennedyae	Troodos, Triptilos (in altitude 9001350m)
Astragalus macrocarpus subsp. lefkarensis	Only in Cyprus in Leykara, Asgata, Alaminos and Kelokedara
Centaurea akamantis	Only in Akamas of Cyprus
Delphinium caseyi	Only in Cyprus, in Pentadaktylos (tops of Saint Ilarionas and Kyparrissovouno
Scilla morrisii	Exclusively at southwest of Cyprus (Monastiri, Agia Moni, Saint Neofytos)
Salvia veneris	West of Kithreas villages
Erysimum kykkoticum	One the rarest endemic species. It is located in the valley of Xeros (Argakin of Pissokremmou

The distribution of the critically endangered plant species (Table 6.1), seems to be in many and scattered areas on the island. Though is no scientific data available concerning phenological responses of plants, these will be affected. In general the area that the majority of threatened plants are situated will face temperature increase of about 1-2 °C in future (2021-2050), increase in maximum length of dry spell and variations in precipitation and so will threaten even more these species. Combination of density, width and dry spell increase in these areas will determine the degree of its final exposure. Taking into consideration the above findings the distribution of plant terrestrial ecosystems for the future period (2021-2050) is preliminary assessed as high.

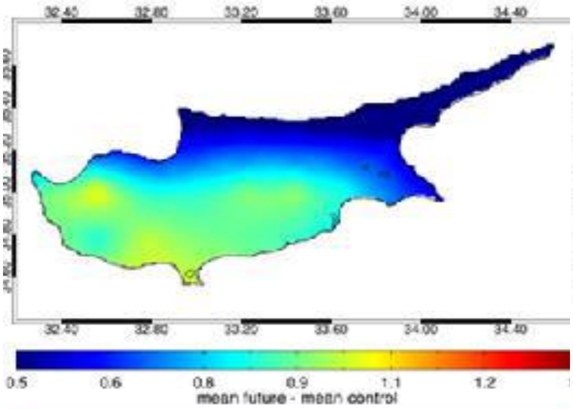
The resilience of plants towards climate change refers to their ability to genetically adjust to changing environmental conditions as well as to their ability for uphill migration. However, more research in this field is necessary to be done.

The existing national legislative framework among which the Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (with the Law 153(I)/2003), the ratification of the Bern Convention on the conservation of European wildlife and natural habitats (with the Law 24/1988), the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the CITES (with the Law 20/1974) and the Convention on Biological Diversity (with the Law 4(III)/1996), aim mainly to reduce human pressures posed on biodiversity, while little can be done to reduce the effects from adverse climate conditions. As for example the Action Plan for the planting control and eradication of the Invasive Alien Species of *Acasia* in NATURA 2000 areas[50], was completed with great success, regarding the spreading of harmful invasive species.

[50] An ecological network of protected areas in the territory of the European Union, regulated by Directive 92/43/EEC and Directive 2009/147/EC



(a)



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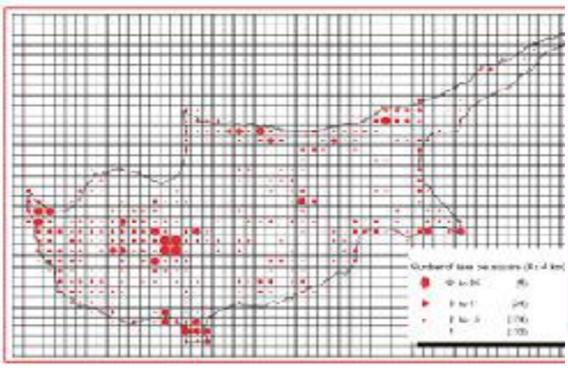
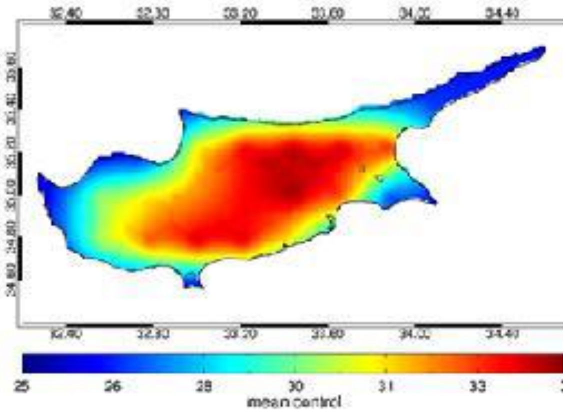
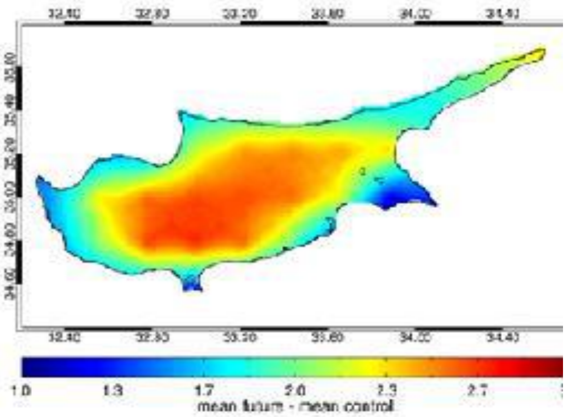


(c)

Figure 6.17. Average winter minimum temperature for control period (a) and in the near future using PRECIS RCM model (b) and, Geographic distribution of the threatened plants of Cyprus (c)



(a)



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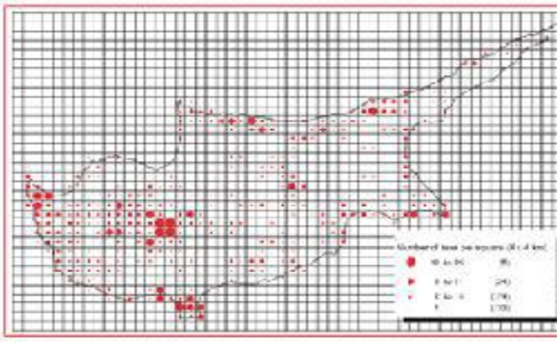


(c)

Figure 6.18. Average summer maximum temperatures for control period (a) and in the near future using PRECIS RCM model (b) and, Geographic distribution of the threatened plants in Cyprus (c)

Consequently the exposure for the future period (2021-2050) can be considered as high.

The resilience of animals towards climate changes refers to their ability to genetically adjust to changing environmental conditions as well as to their ability for uphill migration. There are no data available for the animal population movements in Cyprus. In addition, the extensive existing national legislative framework is protective for many animal species as shown in Table 6.2.

Nevertheless, the genetic adjustment of animals and the measures taken are not enough for combating the increasing risk of terrestrial animals towards climate change and additional adaptation measures are needed.

Aquatic ecosystems

The high Sea Surface Salinity (SSS) and Sea Surface Temperature (SST) of Cyprus, in comparison with the rest of the Mediterranean region, results in a relatively high species diversity and very low biomass. Temperature rise is the main reason for the northward movement of marine species, changing the composition of local and regional marine ecosystems. Thus both distribution of fish and the socioeconomic situation of local fishermen are affected heavily.

The increasing intrusion of exotic fish in the Mediterranean Sea has not yet been determined whether it constitutes a serious threat for the extinction of the endemic species. The number of invasive species introduced in the coastal and offshore waters of Cyprus has grown over the last 50 years (Katsanevakis et al., 2009. Studies have shown that the rate of new biological invasions in the Mediterranean Sea is as high as 1 new species every 9 days (Zenetos et al., 2008). Considering the above, the sensitivity for the future period (2021-2050) can be characterized moderate.

The number of alien biota in the Mediterranean Sea appears to be underestimated, especially the coasts of the Levantine basin, which is one of the hot spot areas for possible species introductions (Zenetos et al., 2005).

Cyprus is located near the manmade nautical channel of Suez which favours the migration and relocation of the Lessepsian species. However there is no data available for the anticipated effect of temperature increase on the displacement of marine biodiversity. Further research is required.

Anticipated changes in temperature, as already presented, may cause fluctuations in sea water temperatures which are responsible for changes in physiology and sex ratios of fished species, alteration in timing of spawning, migrations, and/or peak abundance and also, for the increasing of invasive species, diseases and algal blooms. These impacts are leading to reduced production of target species in marine systems. Considering the above, the exposure of marine species, for the future period (2021-2050) can be characterized high to very high.

Table 6.2. Protection status of the endangered animal species of the terrestrial ecosystems in Cyprus

Protected fauna species	***Measures***
Reptiles	
Mauremys caspica	Protected under Annex IV of Directive 92/43/EEC, Annex II of Bern Convention
Coluber cypriensis - EN	Protected under Annex II and IV of Directive 92/43/EEC, Annex II of Bern Convention
Emys orbicularis	Annex II of Bern Convention
10 other species	Protected under Annex II of Directive 92/43/EEC
Birds	
Numenius tenuirostris	Protected under Annex II of SPA[51] protocol, Annex II of Bern Convention
Pelecanus crispus - VU	Protected under Annex II of SPA protocol
Oxyura leucocephala - EN	Protected under Annex II of Bern Convention
Branta ruficollis - VU	Protected under Annex II of Bern Convention
Crex crex - LR	Protected under Annex II of Bern Convention
Emberiza aureola	Protected under Annex II of Bern Convention
Gallinago media	Protected under Annex II of Bern Convention
Larus audouinii - LR	Protected under Annex II of Bern Convention
Emberiza cineracea	Protected under Annex II of Bern Convention

[51] Specially Protected Areas

Mammals	
Ovis orientalis ophion (Cyprus muflon) – VU	Protected under Annex II and IV of Directive 92/43/EEC
Rhinolophus Euryale - VU	Protected under Annex II and IV of Directive 92/43/EEC
Capra aegagrus (Cyprus goat) - VU	Protected under Annex II and IV of Directive 92/43/EEC, Annex II of Bern Convention
Rousettus aegyptiacus	Protected under Annex II and IV of Directive 92/43/EEC

Scientific recording of the populations of marine species reveals some of the extent of the threat for the marine host species. The genetic adjustments of the host organisms to new conditions need many reproductive cycles, and as a result the most common way of survival is the migration to other latitudes.

In addition, there are numerous institutional measures for the protection of marine ecosystems in Cyprus, including the coastal protected area of Lara-Toxeftra, which encompasses the most important breeding biotope for the sea turtles (*Chelonia mydas* and *Caretta caretta*) (Fisheries Law and related regulations, NATURA 2000 network (DoE, 2010).

The protection of aquatic species of inland and marine waters, is implemented through the provisions of national law since 1971 and its related regulations, as well as through the Law 153(I)/2003 which harmonizes Directive 92/43/EEC on the Conservation of Natural Habitats and Wild Fauna and Flora. In addition, Cyprus has ratified the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution and in particular the SPA Protocol concerning Specially Protected Areas and Biodiversity in the Mediterranean. Complementary to these are the Convention on Conservation of European Wildlife and Natural Habitats (Bern Convention), the Convention on the International Trade in Wild Fauna and Flora (CITES) and the Convention on Biological Diversity (CBD). In particular, protected marine species and habitats are those listed in the aforementioned Directives and Conventions, as well as those in the Fisheries Law and Regulations, including all species of sea turtles, dolphins, seals and a species of sand crab (DoE, 2010).

Though the important habitats along the coastal waters of Cyprus are well-preserved, could be threaten by the increased number of successful intrusions of marine species in the area (Ben Rais Lasram and Mouillot, 2009) due to climate change. Considering the above, the adaptive capacity in the future period (2021-2050) can be characterised as moderate.

The indigenous fish species richness in Cyprus is exceptionally poor and susceptible to numerous threats such as the landscape fragmentations, the environmental alterations (caused with the introduction of freshwater fish and crayfish in the artificial dams for recreation purposes) and the pollution caused by human activities. Additional stress on water quality and aquatic populations is expected as a result of further oxygen depletion and eutrophication, induced by the projected temperature increase. Based on the above facts the sensitivity for the future period (2021-2050) can be considered as moderate.

In Cyprus, the plants, fish and aquatic organisms of rivers and lake dams of Cyprus are generally in good condition, whereas the organisms of groundwater are more strained. Climatic changes will have an impact mainly on the quality of the surface waters in Cyprus and consequently on the biodiversity. The nitrogen pollution from untreated sewage effluent and agricultural run-off carrying fertilisers is responsible for the phenomenon of eutrophication, which can possibly be deteriorated by climate change.

There is no data available to correlate the effect of water quality with the change of biodiversity in freshwater bodies. Nevertheless significant reduction in precipitation which is anticipated for the autumn period, may affect ecosystems of perennial rivers due to delayed flow and the intense reduction in recharge rates. Another factor influencing the water quality and thus the biodiversity in freshwater bodies is the number of heavy rain events due to drifting of fertilizers, sediments and other pollutants. Considering the above, the exposure of freshwater biodiversity and quality in Cyprus is considered as moderate

The resilience of the organisms of these habitats to climate change refers to their ability to genetically adjust to changing environmental conditions. Nevertheless, most of the times, due to landscape deterioration of this kind of habitats, the phenomena of extinction are inevitable.

Further to the needed adaptation measures, a limitation of the extinction phenomena is also achieved my means of several measures implemented for the protecting water resources and inland aquatic species, such as the Laws:13(I)/2004 on the protection and management of water, 34/2002 on the nitrogen pollution of waters (based on the European Directive 91/676/EEC), 42/2004 on the control of nitrogen polluted waters, 41/2004 on the control of water pollution, 517/2002 on the control of water pollution, 56(I)/2003 on waste management,1/1971 on sewerage systems, 108(I)/2004 about sewerage systems,772/2003 about urban wastewater, 254/2003 about the nitrogen pollution of water bodies, 106(I)/2002 about the control of the water and soil pollution,45/1996 about the control of the water and soil pollution.

Consequently, the adaptive capacity of Cyprus' freshwater biodiversity and quality to climate changes is considered to be moderate.

Assessment of overall future vulnerability

The overall future vulnerability of biodiversity against a climatic change impact, in terms of sensitivity, exposure, adaptive capacity on the based on the available data for the above mentioned indicators are quantified as shown in Table 6.3.

The main indicator for assessing the vulnerability of the terrestrial biodiversity towards climate changes appears to be the landscape fragmentations of the island, as species cannot move neither northern nor higher after a certain point. Instead, the main advantage of the marine biodiversity is the ability of migration, which can also be counted as a disadvantage due to the intrusion of harmful invasive alien species. On the other hand, freshwater biodiversity is not threatened. Considering the above, it is assumed that the first vulnerability priority of the biodiversity in Cyprus to climate changes is the distribution of species in terrestrial ecosystems while the second priority is the biodiversity of aquatic ecosystems.

Table 6.3. Overall vulnerability assessment of biodiversity in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Distribution of plant species in terrestrial ecosystems	High (5)	High (5)	Limited to Moderate (2)	Moderate (3)
Distribution of animal species in terrestrial ecosystems	High (5)	High (5)	Limited to Moderate (2	Moderate (3)
Marine biodiversity	Moderate (3)	High to Very high (6)	Moderate (3)	Limited to Moderate (1.2)
Freshwater biodiversity	Moderate (3)	Moderate (3)	Moderate (3)	None (0)

6.3.2. Infrastructure

he island of Cyprus is situated in the south-eastern part of the Mediterranean Sea. Administratively, Cyprus is divided into the following six districts: (a) Lefkosia (capital), (b) Limassol, (c) Larnaca, (d) Paphos, (e) Famagusta and (f) Kyrenia. It has a total of 772 km of shoreline, of which: (a) 404 km in the occupied zone after the Turkish invasion in 1974; (b) 72 km within the British Military Bases; and (c) 296 km under Government control. The critical infrastructure of Cyprus has been developed near the coastal area, except for Lefkosia which is located near the centre of the island.

In general, the infrastructures in Cyprus are not considered very vulnerable to climate changes, which arise mainly from decreased rainfall and increased temperature, droughts, fluctuations in intense precipitation events, sea level rise, increased atmospheric CO_2 and changes in fire regimes.

The future impact, vulnerability and adaptation measures for the infrastructure sector in Cyprus regarding climatic changes were also assessed as part of the Life+ CYPADAPT project, by using PRECIS and six other regional of the ENSEMBLES prediction system and, the future period (2021–2050) against the control period (1961–1990).

The main vulnerability priority of the sector to climate changes observed until now has been related to the damages caused by urban floods and sea floods. It has to be noted that specific measures have been undertaken the last decades to reduce the severity of this impact (drainage works, town plans, SUDS etc.) and that Cyprus has not experienced any severe floods from the sea in the past. The point of this consideration is the great number of tourist units and other infrastructures, important to Cyprus economy are located in the coastal areas.

According to the Intergovernmental Panel on Climate Change (IPCC), the infrastructure is defined as 'the basic equipment, utilities, productive enterprises, installations and services essential for the development, operation and growth of a city or nation'. Thus:

- Utility services; (Water supply; Energy supply (power plant and electricity networks); Wastewater and waste collection, treatment and disposal)
- Transport;
- Information and Communications Technology (ICT) infrastructure;
- Industry; and
- Buildings (residential and tourist accommodation units).

The main climate change impacts on the infrastructure sector include: (i) material damages to infrastructure, possibly linked with extreme events and flooding, (ii) disturbances in normal community function such as interruption and obstruction of passenger or freight transport, (iii) human safety.

6.3.2.1. Future Impact assessment

The climatic factors that are likely to induce impact on Cyprus infrastructure system in the future are the extreme events, mainly the heavy rain, sea level rise, flooding and wind speed. Heavy rain may affect all types of infrastructure due to the risk of flooding, land sliding and collapsing. The relationship between potential climate changes and impacts on infrastructure is shown in Table 6.4.

Heavy rain is anticipated to have an impact on infrastructure. PRECIS predictions show that future changes of annual max total rainfall over 1 day, have a minor increase of about 2-4 mm in western and higher level regions. The heavy rain events have been monitored since 1917 by the Department of Meteorology and as shown in Figure 6.19 they follow a rising trend. There is evidence that this rising trend is related with climate change.

Flooding which is associated with heavy rain also follows the same pattern, thus an increase, both in terms of frequency and magnitude, especially in the last seven years (2000-2007).

As mentioned above, the infrastructure system is expected to be affected mainly by the following two main categories of impacts: material damages; and disruptive operation.

For the case of Cyprus, the above mentioned impacts are related with flooding events induced by heavy rain (flash floods). However, there is no evidence that these events are directly connected with climate change and as a result the impacts due to climate change on the infrastructure sector are limited to uncertain. The available data were not conclusive and could not be used as a basis for measuring the future impact of climate change on infrastructure. It is worth saying, however, that there is an increasing trend in the appearance of flooding events, the intensity of which, both in terms of frequency and severity, is likely to exacerbate due to climate change. In general, it must be noticed that sensitivity of the sector is increasing in flood and landslide prone areas (MoE, 2011).

Table 6.4. Relationship between potential climate changes and impacts on the infrastructure sector

Potential climate change in Cyprus	Type of Infrastructure	Future impacts on infrastructure	Selected Indicators
Heavy rain	All types	- Flood - Landslides	Severity of material damages to infrastructure
	Water infrastructure (water treatment, wastewater collection and treatment)	- Risk for flooding of Sewerage Treatment Plants - Risk for sewer flooding	
	Transport infrastructure	- Increased demand for car use - Flooding of underground networks - Flood damage - Bridge collapse and associated implications	
	Communications	- Reliability of the signal - Disturbances to overhead networks	- Disruption frequency - Duration of disruption
Storm surge	(located at coast)	- Flood - Periodic flooding of coastal infrastructure	- Percentage of critical infrastructure located in or near coastal areas - Disruption frequency in daily operations (social activity and trade) - Duration of disruption
Sea Level Rise	All types (located at coast)	Permanent asset loss at coastal sites	Percentage of critical infrastructure located in or near coastal areas
	Transport infrastructure (ports)	- Limited access to ports - Threat to port operation	Coastal infrastructure asset losses due to Sea Level Rise
High winds	Transport	- Transport disruption (caused by blown down trees etc.) - Impede aircraft operation	- Disruption frequency in daily operations (social activity and trade) - Duration of disruption
Temperature increase	Transport	- Deformation of road and airport asphalt surfaces - Passenger discomfort	
	Communications	Decreased wireless transmission signal	
Extreme events	All types	Risks for human safety	- Number of accidents related to extreme weather events - Population living in disaster prone areas (areas prone to flooding and landslides) - Changes in the proportion of built-over land in disaster prone areas
	Transport infrastructure	- Asset failure due to long, hot, dry periods followed by	

Potential climate change in Cyprus	Type of Infrastructure	Future impacts on infrastructure	Selected Indicators
		intense rain causing flash floods. - Stability of foundations of transmission masts and towers, mostly attributable to increased risk of subsidence (more susceptible during drier summers and wetter winters) - Damage to underground cables(more susceptible during drier summers and wetter winters)	

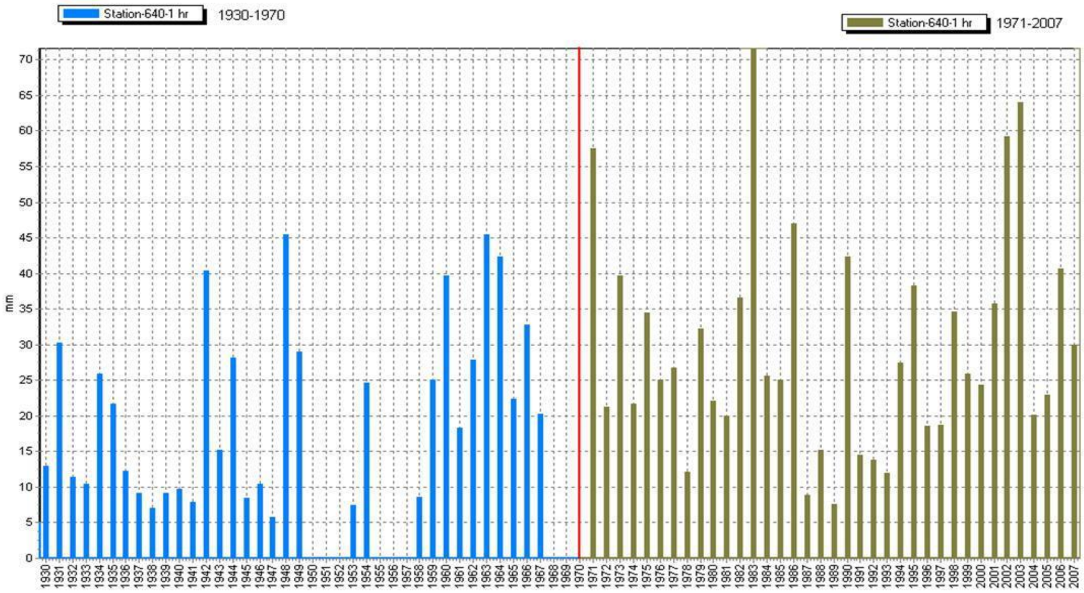


Figure 6.19. Highest amounts of rainfall in 1 hour, in Cyprus (Pashiardis, 2011)

6.3.2.2. Future vulnerability assessment

The future vulnerability of the infrastructure sector is assessed in terms of its sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021-2050, presented in the CYPADAPT project.

It must be noted that, there are no sufficient scientific evidence and data to evaluate or correlate all impacts and indicators to future climate changes. Consequently, further research is required in order to provide concrete information for a more detailed and descriptive assessment of the future vulnerability of the sector. Nevertheless, an attempt was made to provide a preliminary assessment of the vulnerability for the following impacts: Infrastructure damage due to floods (urban and sea floods); and Infrastructure damage due to landslides.

Damages of infrastructure due to floods

The vulnerability of the Cypriot infrastructure was assessed regarding the sea floods and urban floods. The former type is caused by storm surge or sea-level and affects mainly the highly developed coastal infrastructure of the island. However, no significant sea flood events have been recorded while for future projections further research is required. The urban floods are directly connected with heavy rain and the consequent damages. According to the records of the flood events observed in Cyprus between 1859 and 2011, over 200 floods caused implications in multiple levels such as damages to road infrastructure, disruption of economic, social and cultural activities and in turn financial losses (WDD, 2011). To sum up, taking into account the current situation as well as the relative future climate changes the sensitivity of infrastructure due to floods was ranked as moderate to high.

The exposure to future sea floods depends on the importance of infrastructure which is located on or near the coastline. In Cyprus this infrastructure includes:

- Electricity supply (three power stations and the Energy centre)
- Water supply (Water treatment plants, Wastewater treatment plants, Desalination plants)
- The international airports of Larnaca and Pafos.
- Seaports;
- Marinas and fishing shelters;
- Industries (two cement plants)
- Buildings (hotels, tourist and residential accommodation units)

Sea-level rise, generally, may affect infrastructure located in or near coastal areas. For the case of Cyprus, however, sea level rise is expected to be moderate (EC, 2009). Furthermore it must be added that, based on archaeological data, Cyprus appears to be experiencing long-term uplift of between 0 and 1 mm per year. This uplift is expected to counteract sea-level rise and given a global rise in sea level of 0.5m by 2100, relative sea-level rise in Cyprus will be in the range 0.4-0.5m (Nicholls and Hoozemans, 1996)

The general assessment of the effects of storminess changes on storm surge is not possible due to the limited geographical coverage of studies and the associated uncertainties (IPCC, 2012). However, according to the projections of the PRECIS climate model, the mean wind speed greater than 5 m/s in Cyprus during the future period 2021-2050 is not expected to present substantial changes, on the contrary, it presents minor decreases in general of the order of about 5-12 days for the number of days with mean wind speed greater than 5 m/s.

The urban centres of Larnaca, Limassol and Lefkosia are sensitive to flood risks mainly due to their dense structuring and the restriction of green space, the elimination of natural waterways for the construction of roads, the deficient or even absent storm-water drainage system and, the covering of waterways and drain entrances with garbage. On the other hand, mountain areas are less sensitive to floods, given that the inclination of terrain together with the infiltration capacity of forested areas do not allow for flooding events to take place.

The climate projection model used for the case of Cyprus does not provide estimates for the frequency and intensity of floods in the future. Nevertheless, there is an indicator referring to the annual maximum total precipitation over one day indicating heavy rainfall, which could also be associated with flood risk.

In compliance with the Floods Directive 2007/60/EC, the Water Development Department of MANRE through its report “Preliminary Flood Risk Assessment” identified 19 areas around the island as “Areas with Potential Significant Flood Risk” which are monitored.

In relation to the exposure of the infrastructure to flood events, future changes in land use and their implications should be considered. Land use changes can induce significant flood risk through changes in the runoff coefficient, (influenced by the percentage of precipitation, the ground cover of an area, ground slope).

To sum up, the exposure of the infrastructure sector to urban floods as the relative future climate changes the future exposure is ranked as high.

In order to reduce the impact of floods, the Cyprus Government has undertaken a series of flood protective measures including but not limited to the following:
(a) Hard coastal defence works (for sea flood protection),
(b) Fishing shelters and artificial reefs (for sea flood protection),
(c) Dams (for urban flood protection)
(d) Sustainable Urban Drainage systems (for urban flood protection).

Due to lack of sufficient data on the future impacts of climate change on the infrastructures of Cyprus, the analysis on the effectiveness of the already applied measures as well on the necessity for additional measures for the protection of infrastructure could not be conducted. Further research is suggested to take place on the subject. Taking everything into account, the adaptive capacity for urban floods was considered to be moderate.

Damages of infrastructure due to landslide damage

Cyprus is well-known for its interesting and often complex geology, particularly in the south-west part of the island. The reason for the increased susceptibility of this area to landslides is the remains of former sea-floor deposits and massive submarine slides, which tend to be heavily deformed and are rich in the types of clay minerals that are prone to land sliding. This tendency is exacerbated by the steep terrain and the long history of powerful earthquakes in the region (British Geological Survey). In addition, climate change increases the likelihood for land displacements. More specifically changes in temperature and precipitation could be relevant for more landslides. In this regard the sensitivity was ranked as limited. However further research is required in order to provide concrete information for the future.

Variations in precipitation, temperature, heavy rain and heat wave days changes, can have an impact on landslide occurrence (Crozier, 2009) and therefore pose risk of infrastructure. However, due to the lack of data landslides in Cyprus and the issue should be investigated further.

A research project entitled 'Study of landslides in areas of Pafos District', has being undertaken aiming to minimize the landslide risk and, to promote a more efficient and secure urban development. It must be emphasized that it is appropriate such studies to be elaborated in order to allow the adaptive capacity to increase.

As few landslide protection measures have been undertaken such as road protection measures, retention walls and terraces and further research is suggested to take place on the subject. Considering the above, both the exposure and adaptive capacity of infrastructure to landslide damages for the future period (2021-2050) can be characterized as limited.

6.3.2.3. Assessment of overall vulnerability

The overall future vulnerability of the infrastructure system against climatic change impacts, in terms of sensitivity, exposure, adaptive capacity, based on the available data is presented in Table 6.5.

In general, the infrastructures in Cyprus are not considered very vulnerable to future climate changes. In specific, the first vulnerability priority of the sector to climate changes is related to the damages caused by urban floods. However, it must be noticed that specific measures have been undertaken in order to reduce the severity of this impact (drainage works, SUDS etc.). The second vulnerability priority is related to the damages to infrastructure caused by sea floods. Considering that a great number of infrastructures important for Cyprus is located in the coastal areas of the island and that Cyprus has not experienced any severe floods from the sea in the past, the vulnerability towards this impact is considered limited. The vulnerability of infrastructure systems to landslide cannot be evaluated due to limited availability of data.

Table 6.5. Overall vulnerability assessment of the infrastructure sector in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Damage from urban floods	Moderate to High (4)	High (5)	Moderate (3)	Limited to Moderate (1.5)
Damage from sea floods	Limited (1)	Very High (7)	Limited to Moderate (2)	Limited (0.6)
Damage from landslides	Limited (1)	Limited (1)	Limited (1)	None (0)

6.3.3. Energy

Cyprus as an island situated in the south-eastern part of the Mediterranean Sea, constitutes an isolated energy system. The energy requirements are covered mostly by oil imports, making Cyprus a highly energy dependent island (Koroneos et al., 2005; Zachariadis 2010). Until recently, renewable energy was considered to be as the sole indigenous form of energy, before the discovery of significant amount of fossil fuel resources in its Exclusive Economic Zone (EEZ). This is expected to change the energy mix profile and consequently to improve the energy sufficiency of the island.

On a worldwide basis, it is expected that the energy sector will experience different impacts due to climate change, including change of the heating/cooling degree days over year, reduction of the overall efficiency of the power stations associated with the increase in temperature of the cooling medium used in the energy production process, reduction in hydropower production etc.

According to EEA the Mediterranean basin has already been subjected to decrease precipitation something that is going to exacerbate as the climate change continues to persist and intensify. The decreased precipitation and stream flows will lead apart from low water availability, to decreased energy yield (regarding hydroelectricity). However, hydropower is not used in Cyprus and is not projected to be introduced to the energy mix of the island in the coming years, due to limited water resources and intermittent river flows.

The main vulnerability priorities identified for the sector are related to the energy demand for cooling and heating, which is directly affected by climate changes and, to the efficiency of thermal power plants, which is not expected to be significantly affected by climate changes. With regard to the impact of climate changes on the various types of RES generation -except hydropower which is not exploited in Cyprus - this is minor.

The impacts of future climate change on the energy sector based on the climate projections output produced by the PRECIS and six other ENSEMBLES regional climate models, as well as on other socioeconomic projections for the period 2021-2050. The future period 2021-2050 has been chosen, instead of the end of the twenty-first century as frequently used in other climate impact studies, in order to assist investors and policy makers to develop near future plans.

The main pressure on the sector is the energy production cost. Cyprus shows particular vulnerability on the energy sector stemming from oil prices as the total amount of oil used is imported. Additional pressures -especially during the summer- are the energy demand for drinking water production from seawater desalination plants (to reduce the dependence of drinking water on rainfall) and for irrigation (for longer periods through pressurized irrigation systems and long conveyance pipe works) due to decreasing precipitation.

Climate change will affect both the supply and demand of energy profile in different ways.

Table 6.6. Relationship between climate changes and impacts on the energy sector

Potential climate changes	Impacts
Increase in temperature and relative humidity	- Increased cooling demand and decreased heating demand
	- Decreased thermal efficiency in thermal power plants
Precipitation	Change in Bio-power generation
Wind speed	Change in Wind power generation
Cloud cover	Change in Solar power generation

6.3.3.1. Future impact assessment

The climate change impacts on the energy sector as these have been identified and assessed in light of the climate projections for the future (2021-2050) are mainly connected to the change in the heading and the cooling loads.

The climatic factors that are likely to induce impacts on the energy sector as shown in Table 6.6 are the following: (a) temperature and relative humidity; (b) precipitation; (c) wind and cloud cover; (d) extreme events.

The future impacts of climate change on the energy sector are summarized below.

1. Renewable energy yield

The renewable energy sources that are likely to be affected by climate change are the (a) wind power; (b) solar power and (c) bio-power (Kirkinen et al., 2005).

The future climate change impact on the aforementioned sources is rather insignificant; since their contribution to the total electricity production is rather small. Thus:

a) Wind power, which is affected by the wind speed and the change in wind variability, was introduced to the Cypriot energy system in 2010. There are no available data for estimating the impact of climate change on wind power production in Cyprus. As concern the future potential in wind power yield in Cyprus, this follows the decreasing trend of the projected annual mean wind speed during the period 2021- 2050.

b) Solar energy is influenced by the cloudiness and atmospheric aerosol composition, but the magnitude of the potential impact is unknown, due complex relationship between these climate factors (Kirkinen, 2005). The energy production efficiency of photovoltaics or solar panels varies with the temperature and level of sunlight. Cyprus is one of the most favourable areas worldwide in terms of solar potential. The 92% of households and 53% of tourist accommodation units satisfy their hot water needs with the use of active solar systems while 1,039 PV units were installed by the end of 2012 all over Cyprus. According to projections for the period 2021-2050, the solar energy potential of Cyprus will increase due to the increase in annual sunshine duration (additional 60-160 hours), but will hindered to some extent by the potential increase number of hot days per year (additional 17 to 24 days per year).

c) The use of biomass energy is limited for electricity production, heat generation and transportation fuel.

2. Efficiency of thermal power plants

Regarding future changes in the efficiency of thermal power plants, future changes in temperature may be used as an indicator. According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2^{o}C with respect to the control period 1960-1990. However, it is not known whether a change in temperature of this magnitude will have an impact on the efficiency of thermal power plants.

3. Energy demand

Energy consumption is particularly sensitive to weather (mainly air temperature).

In the Mediterranean basin, the expected change in energy demand is expected to change by 2050 as follows 2 to 3 fewer weeks per year will require heating; and additional 2 to 5 weeks will require cooling (Alcamo, 2007). According to PRECIS a further increase in the maximum and minimum temperature (by 1.3-1.9^{o}C and 1.3- 1.8^{o}C respectively) is expected in Cyprus during the period 2021-2050. Consequently, an increase in cooling demand and a decrease in heating demand are expected.

6.3.3.2. Future Impact assessment

The future vulnerability of the energy sector to climate change impacts is assessed in terms of its sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050, presented in the CYPADAPT project.

Due to the lack of sufficient scientific evidence and data, a preliminary assessment of the vulnerability of the following impacts on the energy sector, is attempted: 1. Renewable energy yield; 2. Efficiency of thermal power plants; 3. Energy demand.

1. Renewable energy yield

Renewable power production is considered sensitive to climate changes due to the reduction in renewable energy potential such as wind, solar and biomass. Given that the wind power is considered particularly sensitive to changes in wind speed and that solar energy potential is sensitive to changes in sunshine duration and higher temperatures and, that the use of biomass is limited, the sensitivity of RES energy production to climate changes can be characterised as limited to moderate.

The future exposure of RES energy potential and production to projected climate changes, rely mainly on the variations of wind and solar power potential. The annual mean wind speed changes will be slightly decreased of about 0.20 m/s in western, south-eastern and inland regions were the majority of wind parks are installed. Therefore the wind production is also expected to decrease in the near future. The solar energy yields are expected to be slightly increased in the future due to the projected increase in annual total sunshine duration (ranging between 60-75 hours for most of the domains and between 100-140 hours for the mountain areas).

The high temperatures, which are considered to be associated with reduced solar power potential in photovoltaics, or solar panels, will increase throughout Cyprus. According to PRECIS projections the hot day index (number of days with maximum temperature >30°C) seems to increase by 5–12 days over the northwestern and south-western coasts,by 20–24 days in continental lowlands, and by 26-28 days over Troodos mountains. Considering that the renewable energy potential in Cyprus is not significant, the future exposure of RES yield is ranked as limited.

The main policy action related to renewable energy deployment in Cyprus is the Directive 2009/28/EC on the promotion of the use of energy from renewable sources. The variety of measures taken for fostering renewable power penetration to the energy production sector, make the adaptive capacity to be considered as moderate.

2. Efficiency of thermal power plants

Though the required condensing power is sensitive to temperature increase (air and water) and is expected to reduce the thermal efficiency of power plants, no such evidence is found (Electricity Authority of Cyprus).

Considering that the energy produced and delivered to balance the energy demand would slightly be affected, the sensitivity was ranked as limited, while the exposure of power plants to future increases in temperature is moderate. On the other hand, the modernization and replacement of old equipment and the implementation of the necessary maintenance activities are expected to increase or stabilize thermal efficiency of the plants and ranked its adaptive capacity as limited to moderate.

3. Energy demand

The energy consumption is sensitive to climatic conditions and it is expected to decrease in warmer winter, and to increase in summer. Moreover, peak energy demand will be considerably greater than net consumption due higher temperatures in summer, imposing the installation of additional generating capacity over and above that needed to cater for underlying economic growth.

Energy consumption shows a clearer upward trend compared to air temperature. The energy load variations are seasonal and yearly, as it reflects both the economic growth and the greater usage of air conditioners in residential and commercial situations. The former is mainly influenced by the prevailing weather conditions and the latter by economic, social and demographic factors. Conclusively, the sensitivity of power demand towards temperature changes is considered very high.

The exposure of energy demand to future climate changes, as indicated by the overall energy consumption variation, as well as the changes in the heating and cooling demand, due to temperature changes, is ranked as very high.

According to a study combining econometric models of electricity demand with climate projections of the regionally focused PRECIS model (Zachariadis and Hadjinicolaou, 2012), by the mid-21st century annual electricity demand is projected to rise by 5.6% due to climate change, causing annual welfare losses in Cyprus of more than 100 million Euros (at constant prices of year 2010). Although additional power requirements are not very remarkable on an annual basis, climate change is expected to exacerbate the already existing imbalance between winter and summer electricity demand in the country. This outlook indicates that a reasonable and cost-effective future energy path in regions with Mediterranean climate would involve substantial deployment of solar-powered electricity generation, a zero-carbon energy source that can meet peak load requirements without increasing the country's dependency on imported fossil fuels. Moreover, this forecast highlights the need for adaptation to climate change through substantial investments in the improvement of the energy performance of the Mediterranean building stock.

The adaptive capacity of the sector to changing demand for electricity and heat is built up by means of the following:

- Installation of new power plants to satisfy future energy demand: The EAC's plan includes the installation of new power plants and the replacement of the old ones.
- Energy efficiency measures undertaken or underway: The established National Energy Efficiency Action Plan involves the implementation of measures for improving energy efficiency until 2020.
- Use of solar energy for heating and cooling. In Cyprus, solar thermal systems are widely used for the needs for hot water, while photovoltaic systems are increasingly used at household level reducing therefore the pressure on the energy supply sector; and
- Introduction of natural gas in the energy supply portfolio. The upcoming introduction of natural gas is a policy measure aiming to diversify the energy supply mix.

Based on the measures taken so far and those under way, the adaptive capacity of the cooling/heating energy demand was ranked as high.

6.3.3.3. Future vulnerability assessment

The overall vulnerability of the energy sector to climate changes, in terms of sensitivity, exposure and adaptive capacity is presented in Table 6.7.

As indicated, the energy sector of Cyprus is not considered very vulnerable to climate changes. In particular, the main vulnerability priority identified for the sector is related to the energy demand for cooling and heating, since it is directly affected by climate changes. However, given that there is potential for increasing energy supply in Cyprus to meet the increasing energy demand, the vulnerability towards this impact is characterized as limited to moderate. The impact of climate changes on the efficiency of thermal power plants is not expected to be significant, while no vulnerability was identified on RES generation. The reason for this is that hydropower, which is the only type of RES being be significantly affected by climate changes, is not exploited in Cyprus due to the already limited water resources, while the impact of climate changes on the other types of RES is minor.

Table 6.7. Overall vulnerability assessment of the energy sector in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Renewable energy yield	Limited to Moderate (2)	Limited (1)	Moderate (3)	None (-1.6)
Efficiency of thermal power plants	Limited (1)	Moderate (3)	Limited to Moderate (2)	None (-0.3)
Energy demand	Very High (7)	Very High (7)	High (5)	Limited to Moderate (2)

6.3.4. Health

6.3.4.1. Climate change and public health

In case of a continuous increase of current emissions, the next generations will face more diseases, deaths related to heat waves and natural disasters, higher rates of climate-related infections and morbidity /mortality associated with allergic and air pollution diseases. There is high possibility according to the IPCC (80% confidence) that in the future the increase in cardio-respiratory morbidity and mortality will be attributed to ground-level ozone. There is significant evidence that the Mediterranean Basin is already experiencing some of the impacts of climate change including those on public health. The main climate change related phenomena that have been recorded in Cyprus are temperature increase (especially during the summer months), an enhance in the frequency and intensity of heat waves, a reduction in the total precipitation amounts in parallel with increasing rainfall intensity and enhanced drought.

The impact, vulnerability and adaptation assessment of public health sector regarding the observed climate changes in recent years showed that public health in Cyprus has good adaptive capacity. The main vulnerability that was identified is related to the deaths and health problems, due to the frequent heat waves and high temperatures, especially during summer. In addition, human discomfort, in particular for elderly people is getting worse when the humidity levels are high and when air is polluted with the particles of dust from Sahara desert.

Research on the climate change effects upon public health in Cyprus is performed by institutions and government departments in Cyprus concerning the study of climatological data and their possible health effects (CDC, 2009). Cyprus also participates in MedCLIVAR, which is an international network, aiming to study the climate change impacts and challenges pose to public health, as well as the occurrence of extreme events -closely related to climate variability in the Mediterranean and other regions around the world.

6.3.4.2. Future impact assessment

Human beings are exposed to climate change both directly through changing weather patterns and indirectly through changes in the ecological and social systems (Confalonieri et al., 2007)

Changes in the frequency and severity of extreme events, particularly heatwaves, floods, droughts and intense rainfall, result in local air pollution and more aeroallergens affecting health directly. Other indirect health impacts may result from the effects of climate change on ecological and social systems, such as changes in the occurrence of infectious diseases, local food production and under-nutrition, and various health consequences of population displacement and economic disruption.

A summary of the potential impacts of climate change on human health in Cyprus per climate change factor is presented in Table 6.8.

Table 6.8. Relationship between climate changes and impacts on the public health sector

Potential climate changes	**Direct Impacts**	**Indirect Impacts**
High temperatures and heat waves	- Heat related stresses - Deaths due to heat strokes - Cardiovascular diseases - Respiratory and metabolic disorders	- Water-borne diseases due to increased algal blooms - Food-borne diseases due to food contamination - Vector-borne diseases due to the higher risk of transmission, geographical and seasonal distribution
Increase in the intensity and frequency of extreme events (floods, storms)	- Deaths and injuries from floods, storms, landslides and fires - Psychological morbidity (mental disorders) from floods, storms, landslides and fires	- Water-borne diseases caused by water contamination and poor sanitation - Vector-borne diseases (malaria, Leishmaniasis, Mosquitos) due to stagnant waters - Diarrhoea diseases (including cholera) - Reduced nutritional status
Droughts	- Deaths and injuries from fires caused by high temperatures combined by strong winds and drought	- Vector-borne diseases due to contamination of small rivers and drainage canals - Water-borne diseases - Respiratory diseases due to increased air-borne particulate matter - Child malnutrition and under-nutrition, due to loss of agricultural production
Air pollution		- Eye irritation - Respiratory tract irritation - Exacerbation of respiratory diseases - Exacerbation of asthma and irritation of bronchi - Exacerbation of allergic rhinitis, asthma and other atopic diseases

There is increasing evidence of the importance of mental disorders as an impact of disasters (Ahern et al., 2005). A systematic review of post-traumatic stress disorder in high income countries found a small but significant effect following disasters, such as medium to long-term impactson behavioural disorders in young children (Durkin et al., 1993; Becht et al., 1998; Bokszczanin, 2000).

However, the effects of climate change on existing environmental and public health problems are difficult to discern. The challenge is to identify their 'additional' effect, i.e., the increase in health problems that can be attributed to climate change as an additional risk factor.

The climate change impacts on the public health sector in Cyprus were assessed on the base of PRESIS projections for the future (2021-2050) within the CYPADAPT project, under the following categories:
I. Direct impacts
1. Deaths and health problems related to heat waves and high temperatures,
2. Deaths /injuries from floods,
3. Deaths /injuries from landslides,
4. Deaths /injuries from fires.

II. Indirect impacts
1. Vector-borne and rodent-borne diseases
2. Water- borne and food-borne diseases,
3. Climate-related effects upon nutrition,
4. Air pollution related diseases.

I. Direct impacts

Deaths and health problems related to heat waves and high temperatures are of primary concern in Cyprus, although these issues are also influenced by socio-economic changes such as population growth, the increased average age and migration. General predictions and observations in Mediterranean cities have shown that heat waves can have very strong effects on mortality, reporting an increase of 1-4% for each 1°C rise (IPCC 2007). In addition, mortality is associated to the timing of heat waves as indicated by the higher mortality found early in the summer than the mortality in late season.

Exposure to extreme and prolonged heat is associated with heat cramps, heat syncope, heat exhaustion and heat stroke (Faunt et al., 1995) and occupational health implications.

According to PRECIS projections, the annual number of hot days (Tmax exceeds 30°C) and the annual number of tropical nights (TNmax exceeds 20°C)are expected to increase all over Cyprus in the future, by 17 -24 days and by 20-45 days per year, respectively. While the number of heat wave days per year (days with Tmax t over 35°C), is expected to present a wider range of changes from 2 to 34 days. In addition, humidity during summer in the coastal cities of Cyprus could reaches high levels which in conjunction with high temperatures, cause great discomfort to people. However, there are no sufficient data for estimating heat related deaths and health problems which could be associated with climate changes in Cyprus.

Flood-related deaths and injuries are expected to increase with the anticipated increase in the frequency and intensity of extreme weather events such as heavy rainfall, storms and floods. Generally, the exposure to high-frequency flooding events can result in long-term problems such as increased rates of anxiety and depression stemming from the experience itself, troubles brought about by geographic displacement, damage to the home or loss of family possessions. Moreover, the persistence of flood-related health effects is directly related to flood intensity. The number floods with recorded victims in Cyprus between 1970-2011 shows an increasing trend (WDD, 2011), but the data were not sufficient to assess the deaths and injuries from floods.

Landslide-related deaths and injuries are expected to increase with increasing extreme rainfall events (Confaloniery et al., 2007) and may also result in the displacement of communities and migration. However, there is no official record in Cyprus of victims affected.

The impacts of future climate changes on both the frequency and intensity of floods and the occurrence of landslides in Cyprus, could not be assed as the only related indicator provided by

PRECIS was the annual maximum total precipitation over one day, which is expected to have minor changes in the future period (2021-2050) ranging from 2 to 5 mm.

Fire- related deaths and injuries are expected to increase with increasing the risk of forest and rural fires due to climate change. Forest and bush fires may cause deaths of people trapped in them, burns and other injuries. Large fires are also accompanied by an increased number of patients seeking emergency services. In particular, forest fires in Cyprus are considered a major and permanent threat, causing enormous damage to forest ecosystems and in some cases threaten residential regions (Alker, 2009), taking into account, the high temperatures, prolonged and severe drought periods, strong winds and the configuration of the ground and extremely flammable vegetation.

The future risk of fires in Cyprus, as assessed by means of the Fire Weather Index (FWI) and, the PRECIS climate model is high. In specific, there will be an increase in the number of days with high fire risk of 5-15 days/year, as well as an increase in the number of days with extreme fire risk of 1-10 days/year in the future period (2021-2050) compared to control period (1960-1990).

However, there are no sufficient data for estimating whether there is an increasing trend on the incidents of fire-related deaths and injuries which could be associated with the trend in fires in Cyprus.

II. Indirect impacts

Vector-borne and rodent-borne diseases are among the well-studied diseases associated with climate change, due to their widespread occurrence and sensitivity to climatic factors. The former are transmitted by infected mosquitoes and other arthropod species, mainly during droughts, whereas the other are transmitted directly to humans by contact with rodent urine or other body fluids, mainly during floods or high rainfall events, droughts and introduction of exotic plant species

According to PRECIS climate projections in Cyprus for the period 2021-2050, the length of drought periods which is associated with the occurrence of both vector- and rodent- borne diseases is projected to increase up to 13 days/year on average. As for the heavy rainfall events, the most relative indicator provided by PRECIS refers to the annual maximum total precipitation over one day, which is expected to have minor increase.

In general, water-borne diseases are likely to increase with climate changes such as reduced rainfall, increased temperature, increase in the frequency of extreme weather events (droughts, heavy rainfall, floods), due to the possible risk of water deterioration and lack of good hygiene. Higher water temperatures and flooding may also lead to contamination of water with harmful algal blooms or runoff pollutants. Contamination of food may be induced by higher temperatures (surface and ocean) due to enhance the survival and proliferation of viruses, bacteria and pathogens in foodstuffs.

However, in Cyprus there many measures in place such as effective water and food legislation, high quality of health services, sanitation standards and drainage systems, to safeguard public health.

The future climate changes projected for Cyprus include minor changes in the annual average precipitation while the length of drought periods is projected to present an increase up to 13 days/year on average. It must be noted that although Cyprus is considered a dry region, the water availability is very satisfactory, with the substantial contribution of desalinated water to drinking water supply and the extensive waste water drainage system.

The causal chains through which climate variability and extreme weather influence human nutrition are complex and involve different pathways such as water scarcity, salinisation of agricultural lands, destruction of crops through flood events, wind storms, frosts and hail, disruption of food logistics through disasters, and increased burden of plant infectious diseases or pests (Confalonieri et al., 2007). Reduced food production may lead in diminished dietary diversity, reduction in overall food consumption and in malnutrition, especially in low-income countries.

In Cyprus the greatest climatic threats for the agricultural production (especially seasonal) and food availability, are droughts (through cuts in irrigation water) and frosts. Other extreme weather events such, heat waves, wind storms, hail and floods are, also related to damaged crop yields and have impacts upon nutrition.

According to PRECIS climate projections in Cyprus for the period 2021-2050, the length of drought periods (precipitation<0,5mm) is projected to increase up to 13 days per year on average. However, as drinking water supply will be satisfied by desalinated water in a great extent (except for the areas not connected to government water works), the irrigation water availability will increase compared to the control period. Furthermore, the mean number of heat wave days per year (temperature >35^{o}C) is expected to increase from +2 to +34 days per year and the number of heavy rainfall events, as indicated by the annual maximum total precipitation over one day, is expected to have minor changes, ranging from 2 to 5 mm on average. Finally the frequency of damages to crops due to frosts and wind storms will decrease while as regards the damages due to heat waves it is expected that they will increase. Concerning the frequency of damages by droughts and floods, it is not clear whether the effect will be negative, positive or none.

The diseases related to air pollution include exacerbation of respiratory diseases, tract irritation, exacerbation of asthma, irritation of bronchi, atopic diseases, exacerbation of allergic rhinitis, eye irritation. The air pollution health risks related to climate change are caused primarily from the increased concentrations in the atmosphere of particulate matter and ozone, related to forest fires, heat-waves, Sahara dust events, re-suspension from soils and other surfaces, as well as from traffic and other anthropogenic activities.

The future climate changes in Cyprus that are considered to be associated with the impact of air pollution-related diseases are according to PRECIS climate projections in Cyprus for the period 2021-2050: the mean number of heat wave days per year (temperature >35^{o}C) which is associated with increases of tropospheric ozone and particulates, is expected to increase from +2 to +34 days per year. In addition, it is expected that the already dry climate in Cyprus which contributes to the suspension of PM10 will be further intensified with the prolongation of drought periods (precipitation <0,5mm) up to 13 days/year on average. However, wind speed which also associated with this effect is expected to decrease. As for the changes in the mean annual maximum temperature in Cyprus which is related to increased pathogen prevalence in air, this is expected to increase by 1 - 2^{o}C with respect to the control period. 1960-1990. In general, it can be said that climate changes will have a negative impact on the air pollution related diseases in Cyprus.

6.3.4.3. Future vulnerability assessment

The future vulnerability of public health to climate change impacts is assessed in terms of its sensitivity, exposure and adaptive capacity, based on selected indicators and on the available quantitative and qualitative data for Cyprus as well as on the climate projections for the period 2021-2050 and presented in the CYPADAPT project.

The vulnerability of public health is assessed for each of the following impacts:
- Deaths and health problems related to heat waves and high temperatures
- Deaths and injuries from floods/storms
- Landslide-related deaths and injuries
- Fire- related deaths and injuries
- Vector-borne and Rodent-borne diseases
- Water-borne and food-borne diseases
- Climate-related effects upon nutrition
- Air pollution-related diseases

It must be noted that, there are no sufficient scientific evidence and data to evaluate or correlate all impacts and indicators to future climate changes. Consequently, further research is required in order to provide concrete information for a more detailed and descriptive assessment of the future vulnerability of the sector.

1. Deaths and health problems related to heat waves and high temperatures

Excessive heat is a well-known cause of heat stress, exacerbated illness and mortality. Heat waves have readily discernible health outcomes because they result in a large number of deaths and affect relatively large, heterogeneous areas simultaneously. However, not all heat waves have a similar impact on mortality. In addition to the intensity of a heat wave, the duration and the timing of the event are particularly important. Illnesses recognisable as the direct results of exposure to prolonged periods of high environmental temperature are heatstroke, heat exhaustion, and heat cramps.

Empirical-statistical models for heat stress are constructed for Cyprus during summer (June-August) for the period 2004-2011, in order to investigate the relationship between hot weather conditions and mortality for Cyprus since excessive heat is a well-known cause of heat stress, exacerbated illness and mortality. The calculated summer excess deaths (or the heat related mortality) per day for each maximum air temperature interval, as well as the frequency of occurrence of the temperature intervals during this period are presented in Figure 6.20.

A fairly linear increase of mortality with increasing temperature and thus high sensitivity is observed - with hotter days associated with greater morality risk. Heat-related deaths start to be discernible when the maximum temperature is 38^{o}C or above.

In addition, local factors, apart from climate, such as topography, heat-island magnitude, income, and the proportion of elderly people, are also important in determining the underlying temperature–mortality relationship in a population (Curriero et al., 2002). The population groups that are most vulnerable to heat waves are the elderly, persons with pre-existing chronic diseases, people confined to bed, children, population groups with low socio-economic status, workers in outdoor environments. Moreover, heat waves have a much bigger health impact in cities than in surrounding suburban and rural areas.

Generally, the risk period for heat waves in Cyprus is identified during the whole summer, that is, from June to August (three months). According to the WHO (2010), the 98.8% of Cyprus population is exposed to moderate heat wave hazard (32- 41^{o}C). The heat-related mortality, as projected to the future climate of 2021-2050 using temperature output from the PRECIS and ENSEMBLES climate model simulations under the A1B emissions scenario, is expected to increase up to 10 excess deaths per day under very hot weather conditions (Figure 6.21).

To investigate the potential negative impacts of climate warming on human life, the humidity index or “Humidex” (Masterton and Richardson, 1979) was employed to express the temperature perceived by people (Figure 6.22).

The public health response of Cyprus in heat waves is based at forecasting heat waves, issuing warnings and providing advices for self-protection from heat waves, through the mass media (television, radio, newspapers, and public websites). Furthermore, to the sufficient ability of the health care system of Cyprus to respond to heat related incidents, there are working regulations prohibiting outdoor labour work when temperature exceeds 40^{o}C and, though the majority of houses and buildings are fully air-conditioned, communal centres have been established to accommodate people with no access to an air-conditioned environment. Considering the above mentioned indicators, the adaptive capacity of Cyprus’ public health to heat waves is characterized as limited to moderate.

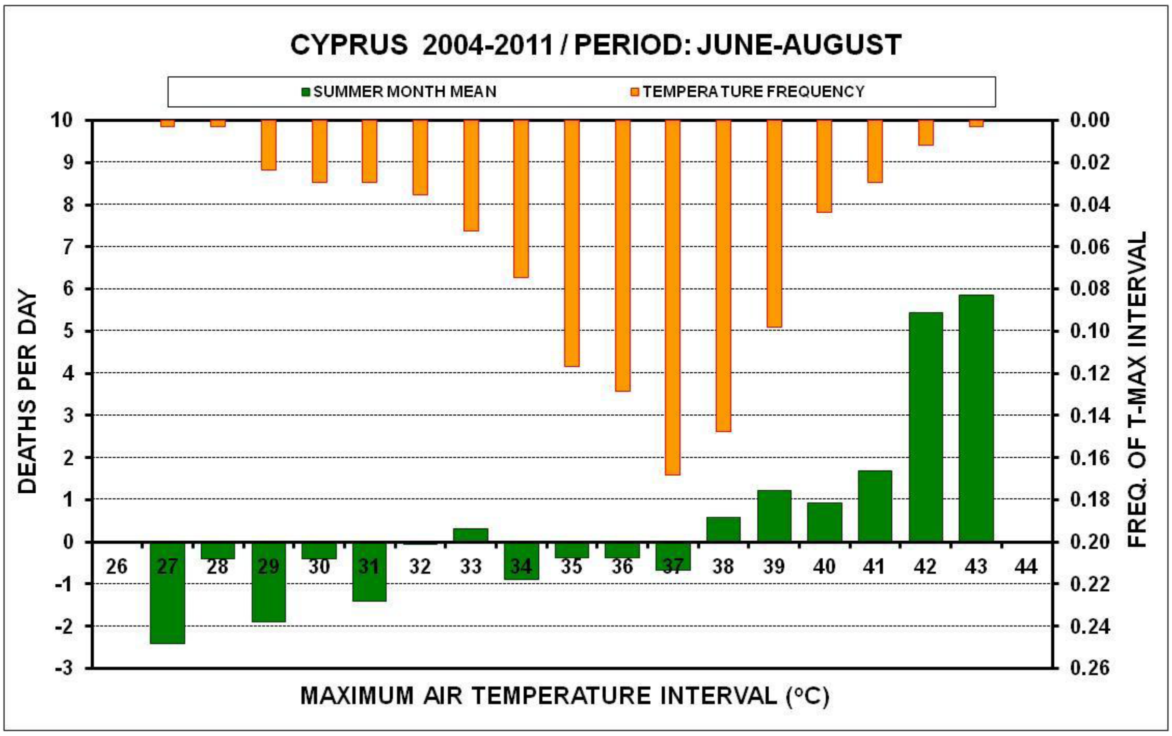


Figure 6.20. Daily excess summer deaths (green bars, left-hand axis) in Cyprus by maximum air temperature interval for the years 2004-2011. The frequency of occurrence of each temperature interval (right-hand axis) is shown using orange bars

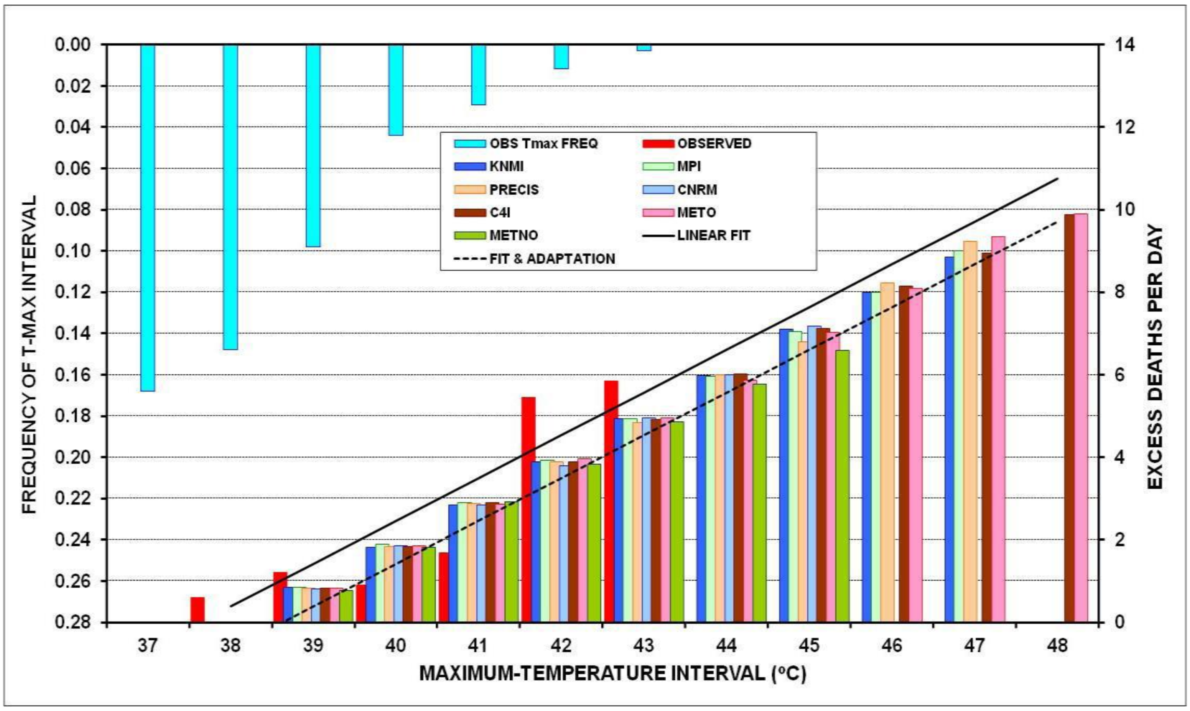


Figure 6.21. Excess deaths (right axis; model and observation bars for present and future climate with adaptation) and daily temperature frequencies (left axis; light blue bars) in Cyprus for the future period 2021-2050

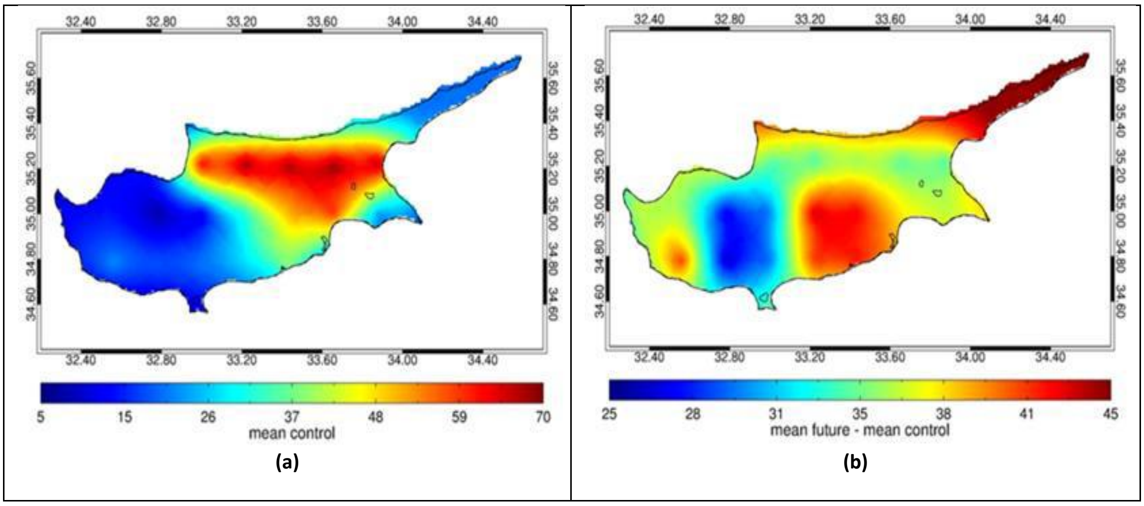


Figure 6.22. Maximum length of Humidex > 38°C (a) for the control period (1960-1990) and (b) the near future (Future – Control period), PRECIS RCM model

2. Deaths and injuries from floods/storms

The main population groups that are considered sensitive to deaths and injuries from floods and storms are (i) the elderly over 65 (13.3%) which cannot move easily and fast in case of a flooding event and (ii) infants and young children (16.1%) especially if they are not under the protection of an adult. The following figures illustrate the level of severity for public health of recorded flooding events in Cyprus during the period 1859-2011.

The flood hazard distribution map of Cyprus (Figure 6.24) indicates that the risk ranges from very high levels (Lefkosia) to very low (Troodos) depending on the regions.

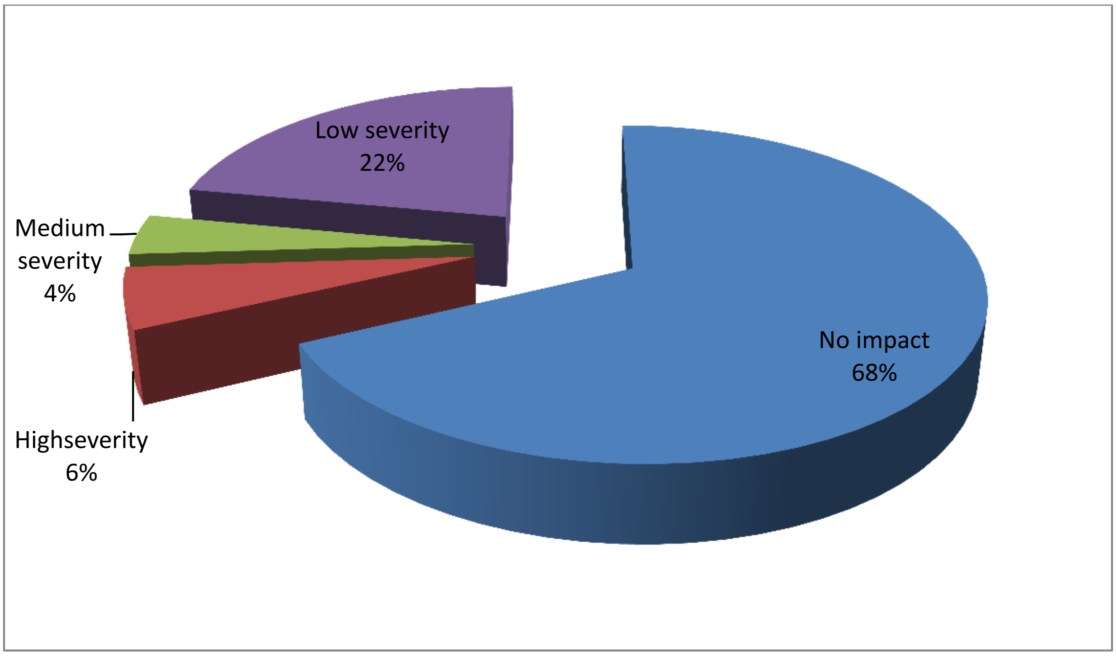


Figure 6.23. Impact of flooding events on public health (1859-2011) (WDD, 2011)

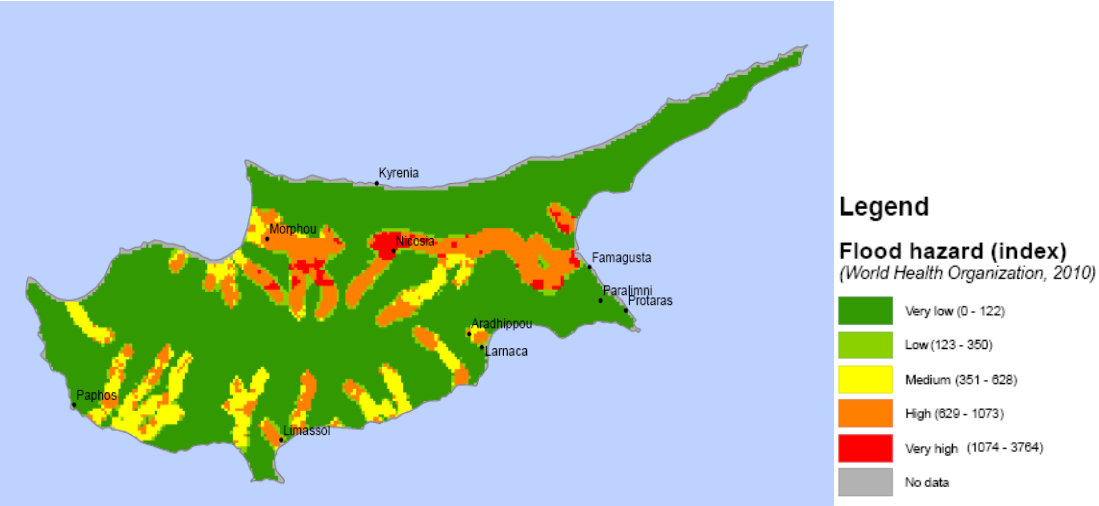


Figure 6.24. Flood hazard distribution map of Cyprus (WHO, 2010)

For the protection of people during a severe flooding event, the civil preparedness and defence service of Cyprus is in place and the health care system of Cyprus cherishes injured people. To prevent the occurrence of flooding events in Cyprus, a separate drainage system is being developed and expanded the last two decades in order to collect stormwater. Furthermore, it is expected that through the implementation of the Flood Risk Management Plans by the end of 2015 and the associated flood protection works, public health will be substantially safeguarded by the adverse effects of floods.

Taking into account the above, the sensitivity, exposure and the adaptive capacity of public health in Cyprus to floods and storms is considered limited to moderate, for the former and moderate for the rest aspects.

3. Landslide-related deaths and injuries

The main population groups that are considered sensitive to deaths and injuries from landslides are the elderly people and the young children, same as mentioned above. According to the landslide hazard map produced by the World Health Organization (2010) (Figure 6.25), Cyprus population is not at risk from landslides. Similarly, is the risk regarding future climate changes as the related the related indicator, the annual maximum total precipitation over one day, show a slight increase.

Figure 6.25. Landslide hazard distribution map of Cyprus (WHO, 2010)

Taking into account that above, the sensitivity and the exposure of public health in Cyprus to landslides is considered limited to moderate and, limited respectively.

Further to the preparedness of all responsible governmental departments for the protection of citizens living in landslide prone areas from future landslides, entire settlements have been relocated to safer places and technical structures were built. A research has been also undertaken to promote a more secure urban development

Considering the magnitude of the impact of landslides on public health which is estimated as limited to moderate, the developed adaptive capacity to cope with the impact, is characterized as moderate.

4. Fire-related deaths and injuries

Given that there are no data on the number of people killed or injured during fire events in Cyprus, the vulnerability of public health to fires is based on the fire risk areas in conjunction with the population density in these areas

According to PRECIS near future (2021-2050) the Fire Weather Index (FWI) projections rich the highest values during summer and is higher at the elevated forested areas, mainly at Troodos mountain which are not densely populated (Figures 6.28 and 6.29).

Considering that the total share of population, which is sensitive to fires is 29% (the elderly over 65 and infants and young children), the geographic distribution of high fire risk and the low population density of these areas, the sensitivity and exposure of the population in Cyprus to fire-related deaths and injuries, are characterized as moderate and, as limited to moderate, respectively.

Several measures for fires, even though no specific adaptive measures to public health, are taken by the Forestry Department of Cyprus aiming to eliminate forest fires including prevention, pre-suppression, detection and suppression measures. Among the measures concerning public health are the information campaigns on fire prevention and protection, fire danger mapping, installation of fire protection systems in areas where large numbers of people may concentrate. In addition, relative legislation and action plans have are applied by the Fire Brigade, the Civil Defence Service and the Health Care System to protect the population from fires.

Therefore, the adaptive capacity of Cyprus public health to fire-related deaths and injuries can be characterized as moderate.

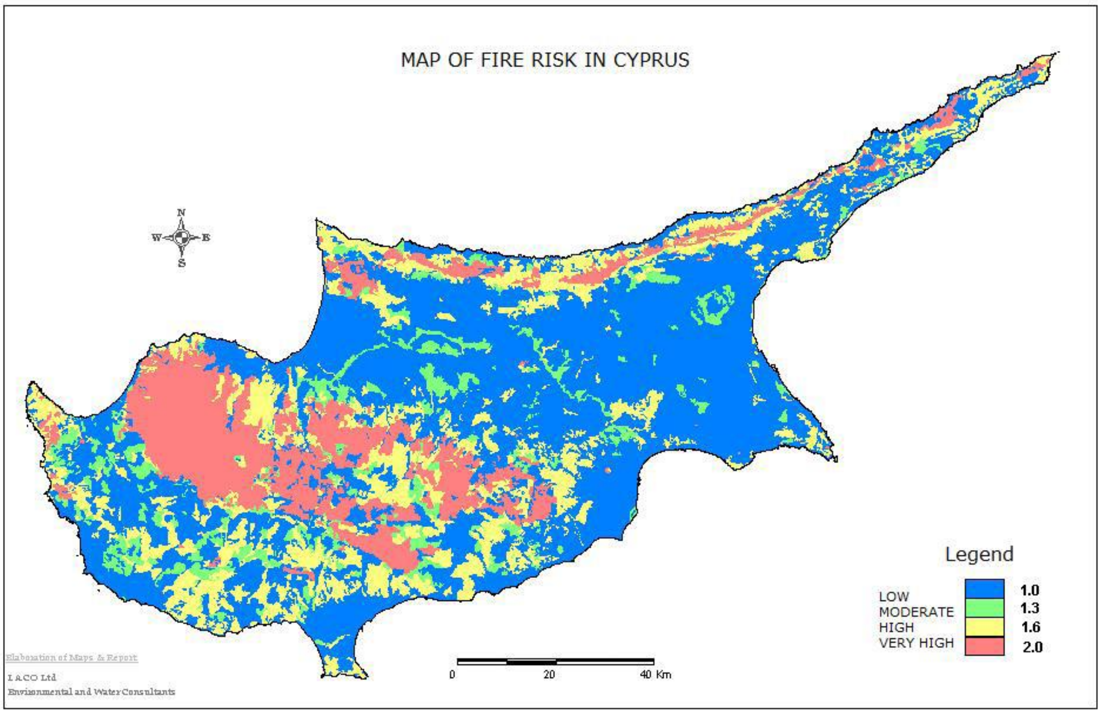


Figure 6.26. Map of fire risk in Cyprus (Department of Environment), 2007

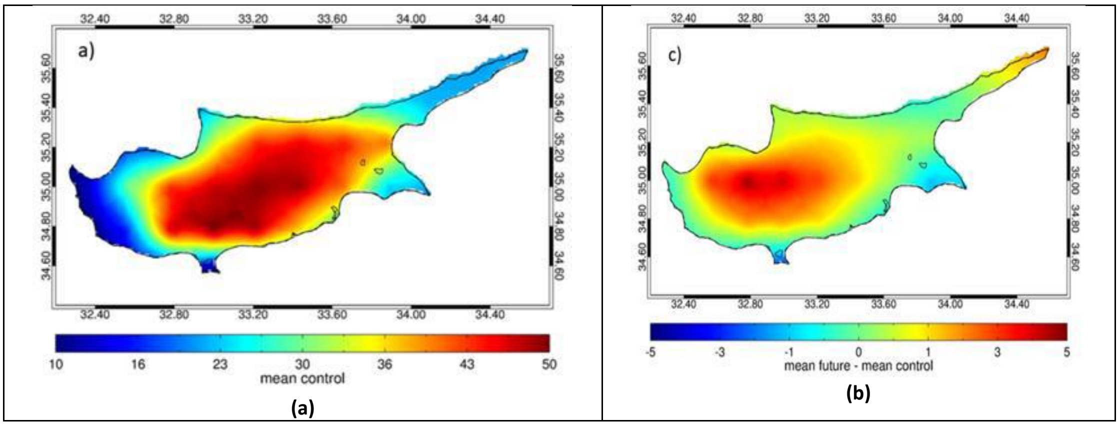


Figure 6.27. July average FWI in (a) the control period (1960-1990) and (b) the near future (Future – Control period)

5. Vector-borne and Rodent-borne diseases

All citizens in Cyprus, living either in urban or rural areas, have direct access to clean and safe water and are served with an efficient sanitation system(public wastewater network, septic tanks, waste disposal system) (Figure 6.28). According to data provided by the United Nations Environment Programme (UNEP), Cyprus presents the lowest rate for vector-borne diseases among other countries (Cosmatos, 2009).

The exposure of public health to vector-borne and rodent-borne diseases is more possible during periods of increased temperatures, prolonged droughts or after floods. Projections for the period 2021-2050 according to the PRECIS model, indicate that the average annual maximum temperature (TX) will increase by 1.0 to 2.0 °C, while the increase of the maximum length of dry spell will be about 15 to 20 days/year and, the annual maximum total precipitation over one day will be slightly increased by about 2-5 mm. (Figure 6.29).

Taking into consideration the above, both the sensitivity and the exposure of public health in Cyprus to vector-borne and rodent-borne diseases is characterized as limited and as limited to moderate, respectively.

The measures currently available to control vector-and rodent-borne diseases are disease specific include diagnosis and treatment, vaccination, vector control, reservoir host control (spaying stagnant waters especially during summer), information and health education as well as disease surveillance and monitoring. Considering the above, the adaptive capacity of Cyprus public health to vector-borne and rodent-borne diseases can be characterized as moderate.

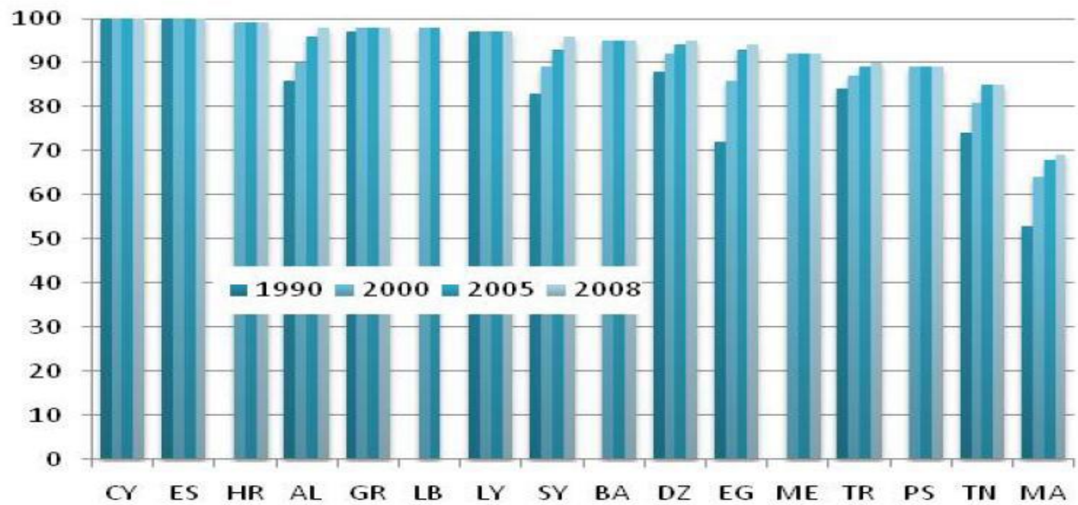


Figure 6.28. Share of population with access to an improved sanitation system, 1990 – 2008 (%)

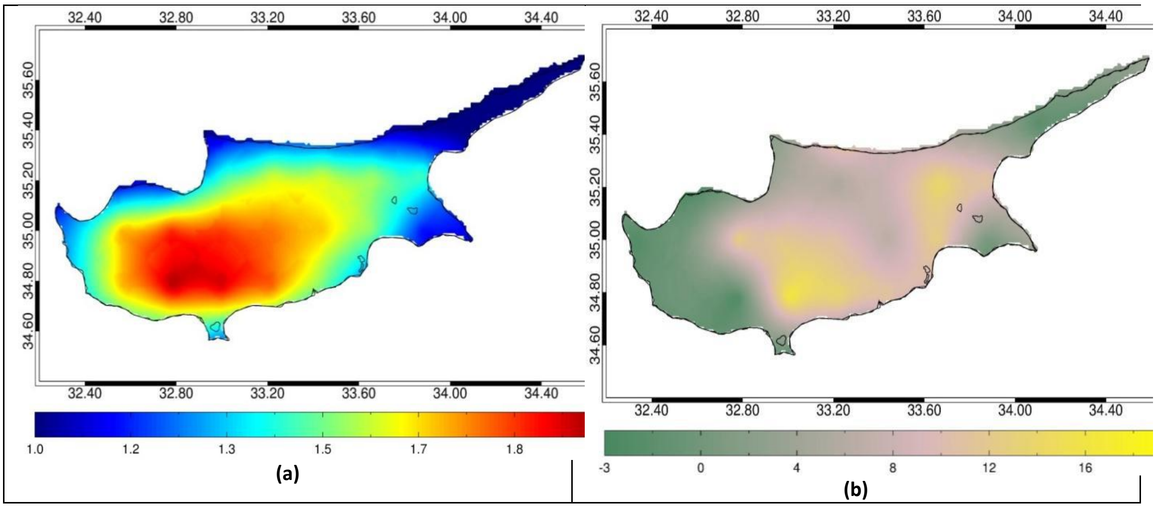


Figure 6.29. Changes in (a) average annual maximum temperature and (b) maximum length of dry spell (RR<0.5mm) between the future (2021-2050) and the control period (1961-1990)

6. Water-borne and food-borne diseases

Provided that many waterborne diseases are associated either directly or indirectly, to the quantity and quality of the water supply, it is noted that all people leaving in Cyprus have direct access to clean and safe water and to adequate sanitation facilities.

The following facts are indicative of the exposure status of public health in Cyprus to water-borne and food-borne diseases:

- The estimated number of "healthy" life years lost (DALYs) attributable to water, sanitation and hygiene for 16 Member States of the EU27, shows that Cyprus is in the first place (reference year 2002)
- The recorded incidents of salmonellosis in Cyprus for the period 1984-2007 present a general increasing trend, although they remain quite below the average respective values in the EU
- The incidents of Hepatitis A in Cyprus are quite low (less than 1 incident/100,000 capita per year) for the period 1980-2007 while the respective value for the EU was significantly higher until recently when it declined the current exposure level of population to water and food-borne diseases can be characterized as limited to moderate.

The expected changes of the climate factors influencing the exposure of public health in water-borne and food –borne diseases through drinking water contamination, according to the PRESIS model for the future period 2021-2050 are: the decreased rainfall, the increased temperature, the increase in the frequency and intensity of droughts.

Thus, the future sensitivity and exposure of population to water and food-borne diseases e can be characterized as limited and, as limited to moderate respectively.

The Ministry of Health, the Ministry of Agriculture, Natural Resources and Environment and the Ministry of Labour and Social Insurance jointly are responsible for environmental health. They apply and manage continuous control and monitoring programmes i) the food chains and drinking water supplies for ensuring quality and safety ii)the environmental pollution level of the water bodies, the wastewater solid waste systems.

There are also National Councils for Food and Water, for the effective implementation of the food-borne surveillance system, the food and drinking water safety and quality, in addition to the national legislation, which is in full compliance with all relevant international and European regulations, therefore the adaptive capacity of Cyprus to water-borne and food-borne diseases is considered as moderate to high.

7. Climate-related effects upon nutrition

Incidents of malnutrition are more likely to be detected in population groups with lower socio-economic status as well as to infants and young children. The population groups characterized by high risk of poverty in Cyprus amounted to 16% of the total population in the period 2005-2008 and the percentage of infants and young children amounts to 16.2% of the total population.

The agricultural sector is the first to suffer from the consequences of extreme climatic phenomena and their impact in farmers' seasonal yields as well as the availability of food. In Cyprus, nutrition is based on both agriculture and livestock national production but also on a great extent on imports.

Consequently, the sensitivity and exposure of public health in Cyprus to climate-related effects upon nutrition are considered as limited to moderate and, limited respectively.

The measures to protect public health from under-nutrition are associated with the measures to secure water availability for irrigation in periods of droughts (e.g. use of recycled water, increase water storage capacity, satisfaction of drinking water supply by desalination plants etc.) and the measures for the protection of crops from extreme climatic events (e.g. installation of hedgerows, green houses etc.). Last but not least, the economic ability of Cyprus to secure food availability even when national productivity is reduced through imports of agricultural, meat and dairy products substantially enhances the adaptive capacity of Cyprus. It must also be noted that, the National Committee for Nutrition, is responsible inter alia for safeguarding the production and distribution of food prod

Consequently, the adaptive capacity of Cyprus public health to the climate-related effects upon nutrition can be characterized as high.

8. Air pollution-related diseases

Certain groups are potentially more vulnerable than others to air pollution, such as the children, pregnant women, people over 65 years of age, and persons suffering from cardiovascular and respiratory diseases (e.g. asthma). The data available on these groups in Cyprus show that comprise the 30% of the total population. Therefore, the sensitivity of Cyprus public health to air pollution is considered moderate.

The ground-level ozone in Cyprus constitutes an overall transboundary problem, being lower in the cities than high elevated background areas, because of the depletion by the primary emitted pollutants there. (Figure 6.30) Considering the fact that population density in those areas is low, the exposure of population to ozone is limited.

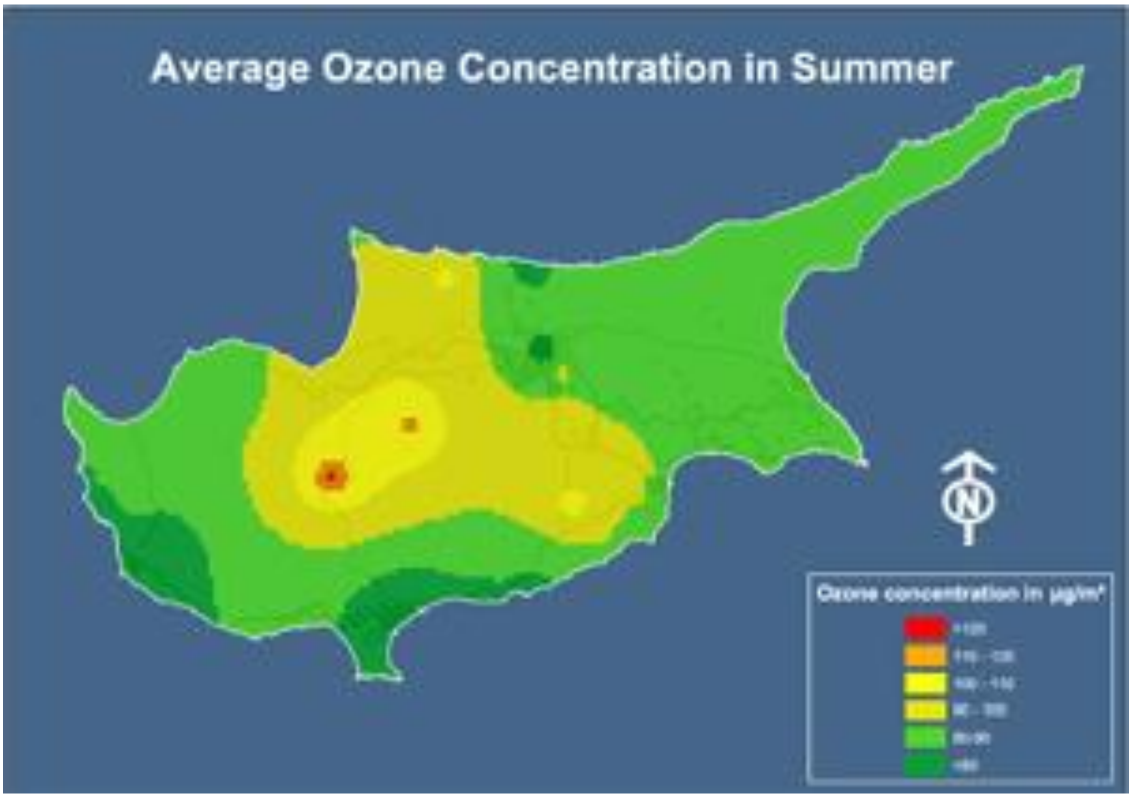


Figure 6.30. Average Ozone Concentration in Cyprus (Department of Labour Inspection, Cyprus)

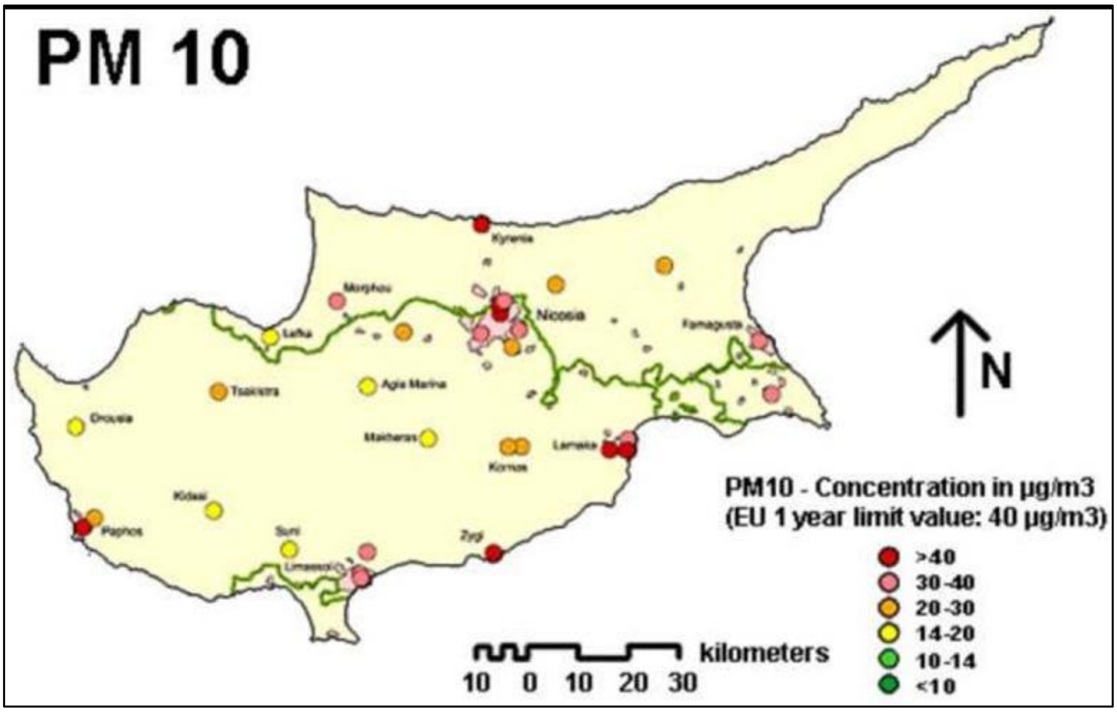


Figure 6.31. Annual PM10 concentrations in Cyprus including Sahara dust events (Department of Labour Inspection, 2007)

In addition, the results of the “Preliminary Assessment of Ambient Air Quality and Drawing up of Zones of Pollution in Cyprus" indicate that the particulate matter (PM10) in Cyprus primarily originate from Sahara dust events and anthropogenic activities such as traffic and secondarily industrial activities.

As it can be seen from Figure 6.31, the higher values of PM10 have been recorded in the main urban centres (reaching the EU limit values), where approximately 70% of the population leaves.

The future changes (2021-2050) in climate, according to the PRECIS model, which are associated with air-pollution related diseases are: the number of heat wave days (Tmax>35^{o}C) will increase up to 20-35 days, the maximum length of dry spell will increase about 15-20 days/year and the average annual maximum temperature (TX) will increase by 1.0- 2.0°C. Considering the above, the exposure of the public health of Cyprus to atmospheric pollution is characterized as moderate.

The measures for controlling air-pollution related diseases are measures for the prevention of such diseases, with for the mitigation of air pollution and the provision of medical services by the health care system of Cyprus.

The measures for air pollution mitigation applied in Cyprus by the Ministry of Labour and Social Insurance include among others the enforcement of air quality EU directive, the implementation of national and regional plans for air quality and improvement of the Action Plan for the support of public transportation in Cyprus. Consequently, the adaptive capacity of Cyprus to deal with air pollution can be characterized as moderate.

6.3.4.4. Assessment of overall vulnerability

The overall future vulnerability of public health to future climate changes, in terms of sensitivity, exposure, adaptive capacity based on the available data is as presented in Table 6.9. As it can be seen from the table, the public health of Cyprus is not considered vulnerable to climate changes mainly due to the fact that it is characterized by a good adaptive capacity. The only vulnerability that was identified through the CYPADAPT project is related to the deaths and health problems from heat waves and high temperatures. Thus, the adaptive capacity should be enhanced with urgent and satisfactory measures for the effective protection of the population from heat waves.

Table 6.9. Overall vulnerability assessment of public health in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Deaths and health problems related to heat waves and high temperatures	High (5)	Moderate to High (4)	Limited to moderate (2)	Moderate (2.5)
Flood-related deaths and injuries	Limited to moderate (2)	Moderate(3)	Moderate(3)	None (- 0.6)
Landslide-related deaths and injuries	Limited to moderate (2)	Limited (1)	Moderate(3)	None (-1.6)
Fire-related deaths and injuries	Moderate(3)	Limited to moderate (2)	Moderate(3)	None (-0.6)
Vector-borne and rodent-borne diseases	Limited (1)	Limited to moderate (2)	Moderate(3)	None (-1.6)
Water-borne and food-borne diseases	Limited (1)	Limited to moderate (2)	Moderate to High (4)	None (-2.6)
Climate-related effects upon nutrition	Limited to moderate (2)	Limited (1)	High (5)	None (-3.6)
Air pollution-related diseases	Moderate(3)	Moderate(3)	Moderate(3)	None (0)

6.3.5. Forestry

The total forest area in Cyprus, covering 390,944 ha, which is the 42.3% of the island, consists of forests (44.2%) and other wooded land (55.8%). The Cypriot forests are natural with the main forest species of pine (*Pinus brutia*, *Pinus nigra*), many endemic species such as the Golden oak (*Quercus alnifolia*) and Cyprus cedar (*Cedrus brevifolia*) species (DoF, 2011a).

The forest sector is highly dependent on climate. Direct impacts of climate change on Cyprus forests arise mainly from decreased rainfall and increased temperature, droughts, fluctuations in intensified precipitation and changes in fire regimes. Indirect impacts come from the interactions between changes in climatic variables and several abiotic and biotic factors (Lindner et al., 2008). Non climate related pressures are mainly associated with (i) unsustainable timber harvesting, (ii) overgrazing which causes degradation not only on the vegetation but also on the soil and water regime of the island and (iii) land development especially for tourism development and construction of holiday dwellings.

The future impact, vulnerability and adaptation measures for the forestry sector in Cyprus regarding climatic changes were also assessed as part of the Life+ CYPADAPT project, by using PRECIS and six other regional of the ENSEMBLES models and, the future period (2021–2050) against the control period (1961–1990).

The main vulnerability priorities for the forests of Cyprus as observed in the recent past, has been related to the damages caused by fires as well as insect attacks and diseases on the dieback of tree species. These impacts are expected to worsen in future.

Cyprus has formulated a forest policy and a National Forest Programme, while starting a process of updating its forest legislation, laying the stress on environmental services and recreation rather than wood production.

6.3.5.1. Future impact assessment

The magnitude of the direct impacts on Cyprus' forests is expected to increase, as the relevant climate change factors are expected to intensify.

According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2^{o}C with respect to the control period 1960-1990, while precipitation is expected to decrease in seasonal level and in minor degree in annual level. In addition, the maximum length of dry spells (precipitation<0.5mm) is expected to increase by 10 to 13 days on average, while heat wave days (temperature >35^{o}C) will be increased averagely about 10-30 days on annual basis. Concerning future changes of annual max total rainfall over 1 day, projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected.

In the context of the future impact assessment the indicators presented in Table 6.10 summarize the potential impacts of climate change on Cyprus' forests. The main direct and indirect impacts presented in the table were grouped in the following impact categories: 1. Dieback of tree species, insect attacks and diseases leading to desertification, 2. Fires, 3. Floods, wind throws and storm damages, and 4. Forest growth.

Table 6.10. Relationship between potential climate changes and impacts on the forest sector

Potential climate change in Cyprus	**Potential Forest impacts**	
	Direct Impacts	**Indirect Impacts**
Drought	Insect attacks Dieback of trees Pressure on fauna species Biodiversity loss Desertification	Reduction of forestry regeneration and growth Degradation of forest, impacts on forests' health and vitality Increase in number and severity of forest fires Soil erosion Increase of dust in the atmosphere Negative effect on reforestations and natural stands
Higher mean annual temperatures – Hot spells	Insect attacks Dieback of trees Pressure on fauna species	Increase in number and severity of forest fires Photosynthesis decrease Decrease of biomass growth and yield Decrease of forests' productivity

	Biodiversity loss Desertification	Decrease of wood production Effect on carbon sequestration rates and net carbon balance
Decreased rainfall	Change in competition among - plant species Nutrient availability in soils Deficiency in water for fauna	
Increase of extreme events (floods, wind throws and storm damages)	Injuries Inhibition of seed germination Changes in plant anatomy Promotion of early senescence and mortality Nutrient availability in soils	
Atmospheric CO_2 increase	Increase in photosynthesis rates (varying with plant nitrogen status and species) Effects on forest growth, tree physiology Insect attacks	

1. Dieback of tree species, insect attacks and diseases leading to desertification

Climate change has an effect on insect development and diseases, which are the main harmful forest organisms in Cyprus forests. Faster development of insects due to rising temperature and low levels of soil moisture due to drought can lead to further necrosis of trees. The typical Mediterranean climate with mild winters and hot, dry summers favours the breeding of harmful forest organisms in large populations (DoF).

The anticipated increase in temperature in the island and decrease in rainfall, as well as their related changes in heat wave days and maximum length of dry spell, will have a negative impact on forest organisms in Cyprus forests. This climatic change except from dieback of the tree species due to thermal stress has secondary results such as increase in the severity of future insect attacks.

The warm and dry climate conditions make pine stands in the forests of Cyprus vulnerable to pests such as the pine processionary caterpillar and bark beetle.

Projections of PRECIS regional climate model make evident that all forested areas of Cyprus will experience, in the near future, a warming of about 0.8 – 1.1°C. In specific, winter minimum temperature is expected to reach 6°C in mountains and, 7-9°C in forested area in coastal regions. Furthermore forested regions of Troodos Mountain will experience a significant warming of about 2.0 – 2.7°C reaching summer maximum temperatures of about 32 – 35.7°C in comparison with the control period.

As a conclusion rising temperature may enable some insect species to develop faster and endanger thus the forest growth. In this frame the predicted increase in winter minimum and summer maximum temperature in the future period can worsen current situation of dieback of tree species.

Increases in maximum length of dry spell can affect negatively forest species sensitive to soil moisture content causing the drying of trees, further stress on forest ecosystems, particularly those found in lowland and hilly areas, and possible necrosis of trees due to enhanced the activity of insects. In Cyprus, the necrosis of a significant number of pines and cypress in Stavrovouni forest during the dry period 2005 – 2008 was attributed to the impact of insects (DoF, 2011b; Cyprus Institute, 2011).

Number of heatwaves days is also a very important factor since in combination with the length of dry period can cause "thermal stress" to trees leading to extended necrosis mainly during the long hot summer period.

An increase of about 20-30 days (temperature over 35°C) is expected for mountain regions and conversely 10 days for other areas. Concerning annual rainfall no increase is anticipated in the future period (2021-2050), but seasonal precipitation will decrease, inducing thermal stress on trees and increase in the severity of future insect attacks. Changes in the hydrological regime may also have serious implications for the forests' sustainability.

2. Fires

Forests of Cyprus are vulnerable to fire, primarily due to the long, hot and dry summers, mild winters, strong winds, intense relief and flammable xerophytic vegetation. These natural factors are further exacerbated by changing climatic conditions, which favour prolonged periods of drought and extreme weather events. Also, the accumulation of biomass due to the abandonment of rural areas and the increasing tourism and exodus of city residents to forested areas, are also important factors which contribute to an increased fire risk, especially during summer months.

In addition, as already mentioned above, forest fires are highly sensitive to climate change because fire behaviour responds immediately to fuel moisture, which is affected by precipitation, relative humidity, air temperature and wind speed. Thus, the projected increase in temperature will increase fuel dryness and reduce relative humidity and this effect will worsen in those regions where rainfall decreases. Accordingly, increases in climate extreme events are expected to have a great impact on forest fire vulnerability.

Mediterranean Europe, in general, has been identified as likely to suffer potentially increased fire risk. Among the climatic parameters with implication on fire risk, is the maximum length of dry spell (amount of rainfall less than 0.5 mm) because it is a parameter which not only increases fire risk but also highly influence forest species due to their sensitivity to soil moisture content. As mentioned this parameter is expected to increase by 8 to 12 days, in comparison to the control period.

The Canadian Fire Weather Index system (FWI) is one of the most widely used indices of fire risk. Regarding PRECIS results, FWI reaches extremely high values in forested areas of about 50 (extreme high risk) in the control period, especially in summer, while a slight increase is projected for the future.

3. Floods, wind throws and storm damages

Forest damage by wind and snow are a continuing cause of economic loss in forestry throughout Europe and Cyprus (Lindner et al., 2008) because of reduction in the yield of recoverable timber, increased costs of unscheduled thinning and clear-cutting, and resulting problems in forestry planning. Despite the great severity of the particular climate change impact on forests, there are no available data for future estimation of wind throws and storm damages in Cyprus.

Flooding is harmful especially if it occurs during the growing season (Lindner et al., 2008). Extreme flooding events are expected to occur more frequently as a consequence of climate change. While the number of rain days is projected to decrease the number of days with heavy rain events is projected to increase (annual max total rainfall over 1 day show a slight increase of about 5mm is anticipated for forested areas and 2-4 mm is anticipated in western and inland regions).

4. Forest growth

Forest growth and productivity may be affected by projected climate change aspects such as increases in temperature, changes in precipitation and increases in air pollution. More specifically all forested areas of Cyprus will experience, in the near future, a warming of about 0.8 – 1.1°C and minor decreases in the annual total precipitation. Higher mean annual temperatures, decreases photosynthesis affecting thus the biomass growth and yield (Linder et al., 2010). Future changes in precipitation, in terms of frequency and availability, will have a significant effect on plant and forests' growth, as well on forestry species.

It is recognized that, rising concentrations of CO_2 in the atmosphere is believed to act as a fertilizer and increase photosynthesis rate, while higher ozone and nitrogen deposition affect tree physiology, carbon allocation and plant interactions, resulting in complex interactions with other climatic impact factors such as drought (Lindner et al., 2008).

In general, Cyprus, a region with already warm and dry conditions especially during summer, is likely to experience decrease in forest growth while the projected climate conditions will magnify the already intense water stress circumstances provoking forest growth failure.

6.3.5.2. Future vulnerability assessment

The future vulnerability of forestry sector to climate change impacts in terms of their sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050 is assessed for the impact categories as follows: (1) Dieback of tree species, insect attacks and diseases, (2) Fires, (3) Floods, wind throws and storm damages, and (4) Forest growth.

1. Dieback of tree species, insect attacks and diseases

Increase in temperature is significant for the health of the forest ecosystem, enabling some insect species to develop faster and endanger thus the forest growth. Studies showed that the increased incidents of dieback of forest species in Cyprus are attributed to the adverse environmental conditions that prevailed and particularly the decrease in rainfall and increase in air temperature (Christou et al., 2001).A large number of tree species are affected by indigenous insects.

The summer maximum temperature is anticipated to increase about 2-2.7 °C in forested regions reaching 30-32 °C which may also lead to extinction of certain species in their current geographical range. Furthermore PRECIS predicts duplication of heat wave days in forested areas for the future period reaching 40-60 days. Increases in maximum length of dry spell can affect negatively forest species sensitive to soil moisture content.

The number of heatwaves days is a very important factor since in combination with the length of dry period can cause “thermal stress” to trees leading to extended necrosis mainly during the long hot summer period. As PRECIS predictions show, an increase of about 20-30 days is expected for Troodos mountain regions and conversely 10 days for western areas, in comparison to the control period.

Precipitation is being geographically and seasonally, unevenly distributed, with maximum precipitation falling on the island’s two mountainous masses during November and March. The overall decrease in precipitation for the future period is not significant, but it is most evident for winter and autumn seasons. The projected decrease of about 20mm in winter precipitation in combination with higher predicted temperatures in all forested areas may enhance the dieback of forest species.

Thus both the sensitivity and exposure of Cyprus’ forests to increased diebacks and insect outbreaks is expected to be very high.

The Department of Forests in Cyprus has taken action considering the implications of droughts and high temperatures and prepared a "Short-term Action Plan for the Confrontation of the Implications of Drought in Cyprus state forests (2009-2010)". The measures and actions of the Plan address the dieback of tree species, insect attacks, biodiversity loss as well as fires (DoF, 2009b). Despite the numerous measures that are implemented in Cyprus for combating dieback of forests and insect attacks as well as for the protection of biodiversity, the effect can only be alleviated but not eliminated. Additional adaptation measures are needed to further enhance adaptive capacity towards this impact.

Thus the adaptive capacity of Cyprus’ forests to increased diebacks is characterized as moderate.

2. Fires

Forests in Cyprus are sensitive to fires because of their composition which is dominated by flammable vegetation and the topography of the forested areas, which is mostly mountainous (DoF).

In Cyprus for the future period it is expected to have increase in temperature, decrease in total rainfall and increase in dry spell days. Nevertheless the overall Fire Weather Index is expected to have a small increase.

The Fire Weather Index for the control period has an extremely high value (about 50: extreme high risk), especially during July and August and will be higher in future of about 2-3 in all the forestry areas of Cyprus. The overall findings of the analysis (FWI) suggest that number of days with fire risk (FWI>15) will be increased from 5 to 15 days and number of days with extreme fire risk (FWI>30) will have an increase of 1 to 5day for the future period. It was also found, that future exposure of almost all forested areas in Cyprus to fire risk is expected to be medium to high in spring period, whereas in autumn period is expected to be high.

Wind speed in summer, which is also a dominant factor of fire behaviour, is expected have a slight decrease of about 0.018-0.23 m/sec in the future period (2021-2050).

Considering the above, both the sensitivity and exposure of Cyprus' forests to fires are characterized as very high.

As far as concern the adaptive capacity of Cyprus forests to fires can be characterized as moderate, due to the several measures which are taken by the Forestry Department of Cyprus aiming to eliminate forest fires. Particularly, these are (a) prevention, (b) pre-suppression, (c) detection and suppression measures.

In addition, under the framework of the Rural Development Programme 2007-2013 of Cyprus, various economic incentives were provided to individuals to apply measures in order to improve the existing protection system of forests from fire as well as the restoration of burned areas. Despite the great efforts and the good results of recent years, the problem of fires still exists and will always constitute a permanent threat for the forests of Cyprus. However further measures can increase the adaptive capacity.

3. Floods, wind throws and storm damages

The factors affecting the sensitivity of forests to floods are the slope of the area, the age of the plant species, their anatomy, the type of soils and others. In Cyprus slopes in excess of 18% and 12% cover 10% and 22% of the island (Geological Survey Department; I.A.CO Ltd, 2007). Maquis and garique vegetation, which consist 56% of the total forest and OWL area in Cyprus, are more generally sensitive to floods due to their lower height. However, are located in areas with inclination, thus they are not considered sensitive to flooding.

The Water Development Department of MANRE through its report "Preliminary Flood Risk Assessment" identified 19 areas around the island as "Areas with Potential Significant Flood Risk", which are mainly the urban centres. In the future period (2021-2050), annual max total rainfall over 1 day is anticipated to have a slight increase of about 2-4 mm in western, inland and mountain regions and the risk of floods will not be increased significantly Consequently, both the sensitivity and exposure of Cyprus' forests to floods are considered to be limited.

The fact that there are limited flooding events in Cyprus forests without any human intervention for their protection, indicates that the forests themselves due to their topography (mountain areas) have the capacity to be self-protected from floods (autonomous adaptive capacity), as water run-off finds its way to the plains.

Therefore, the adaptive capacity of Cyprus can be characterized as high.

4. Forest growth

Forest growth and productivity may be affected by projected climate change aspects such as increases in temperature, decrease in precipitation and increases in air pollution.

According to PRECIS forested regions of Troodos Mountain (Troodos and Paphos forest) will experience a significant warming of about 2.0 – 2.7°C in comparison with the current situation (control period). Future increase in winter temperature will affect the biggest part of Cyprus and forested areas. However the impact on forest growth and productivity cannot be evaluated. Considering the fact that summer temperatures are already high, a further increase may result in increasing the risk of halting of forest growth in forested areas in the future. The most significant increase in number of heat wave days, of about 20-30 days, appears in the central part of Cyprus affecting significantly Troodos forest and increasing the risk of forest growth.

Decrease in precipitation for the future period are not significant however they are most evident for winter and autumn seasons. PRECIS results indicate that all forested areas in Cyprus will experience a decrease in rainfall during autumn season. The decrease in autumn rainfall may have an effect on forest growth since it follows a prolonged dry summer period which may put forested areas under stress.

6.3.5.3. Assessment of overall vulnerability

The overall future vulnerability of forests to climate changes, in terms of sensitivity, exposure, adaptive capacity on the based on the available data for the above mentioned indicators are quantified as shown in Table 6.11. As it can be seen from the table, the main future vulnerability priorities for the forests of Cyprus are the impact of climate changes on the dieback of tree species, insect attacks and diseases as a significant part of Cyprus' forests has already been affected and the effect of increased frequency and intensity of forest fires as the latter cause severe and extended damages on forests.

Table 6.11. Overall vulnerability assessment of forests in Cyprus to climate changes Impact

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Dieback of tree species, insect attacks and diseases	Very high (7)	Very high (7)	Moderate (3)	Moderate to high (4)
Fires	Very high (7)	Very high (7)	Moderate (3)	Moderate to high (4)
Floods	Limited (1)	Limited (1)	High (5)	None (-5)
Forest growth	Not evaluated	Very high (7)	Moderate (3)	Not evaluated

6.3.6. Agriculture

riculture has always been an economic activity of great importance in the Mediterranean basin and a major source of employment and income for the countries of the region, including Cyprus. Agriculture serves for the direct supply of safe, nutritious and affordable food to society and plays an important role in landscape preservation and prevention of desertification (Demetriou, 2005).

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007), climatic condition patterns have brought and will bring about numerous changes concerning agricultural activities on a global scale and consequently will influence the world's food supply.

The agricultural sector is highly dependent on climate since temperature, sunlight and water sources are the key factors for plant growth. Although certain impacts of climate change may be beneficial, as for instance prolonged growing seasons and rise of temperatures, there will be also severe consequences that can put agricultural activities at significant risk, as well. Shifting weather conditions can cause variations in the sowing and harvest time of various crops. Moreover, extreme weather phenomena, such as heatwaves, droughts or hail can damage arable cultivations and reduce crop yields (Iglesias et al., 2007; IPCC, 2007).

At present, agriculture is still considered to be one of the major economic sectors of Cyprus due to the island's favourable climate and location near by its leading market, Europe. Additionally, it contributes to the social cohesion, the employment, the protection of the environment, as well as the general welfare of the society (Bruggeman et al., 2011a).

The main components of the agricultural sector, is agriculture and livestock. The most important crops in terms of production value are wheat, potatoes, grapes, citrus, vegetables and olives (Figure 6.32). The subsectors of the animal husbandry industry are mainly cattle, sheep and goats, pigs and poultry, while ostrich farming has been also recently established for commercial uses (Figure 6.33).

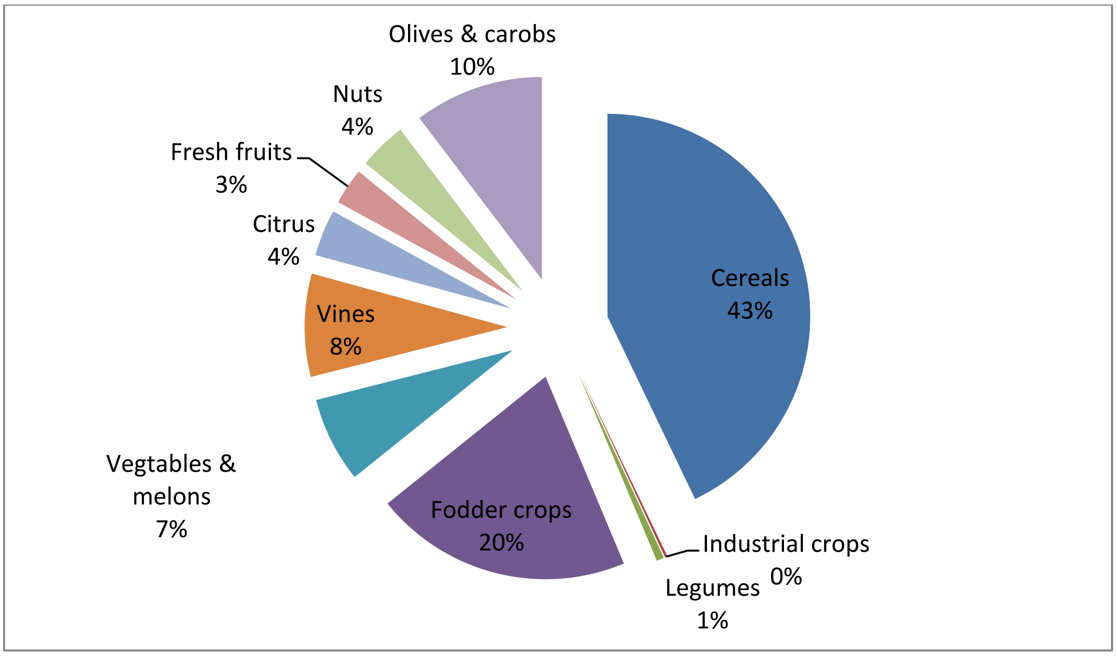


Figure 6.32. Area covered by type of crop as a per cent of total crop area, 2002-2008 (CYSTAT, 2010)

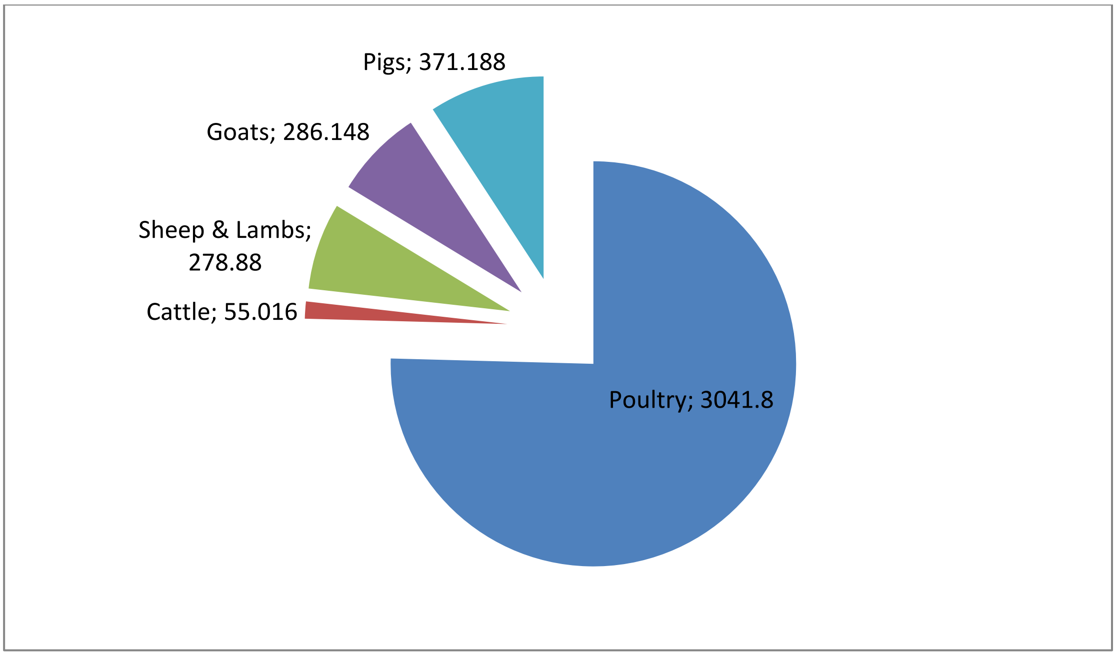


Figure 6.33. Animal population in husbandry (in thousands), average 1984-2008 (CYSTAT, 2010)

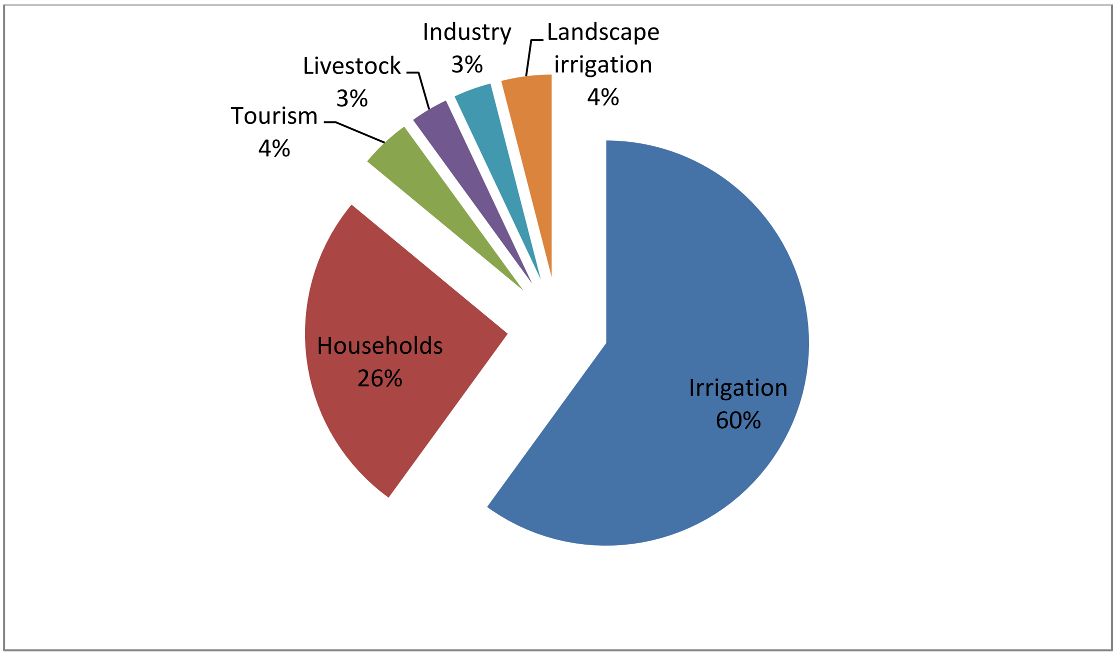


Figure 6.34. Allocation of total water consumption per sector for 2011 (WDD, 2011a)

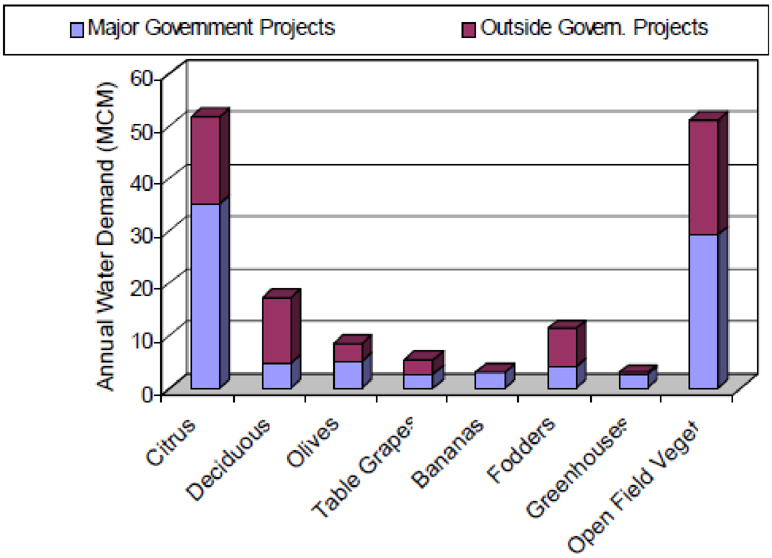


Figure 6.35. Annual water demand data for various crops (WDD – FAO, 2001)

The water consumption in agriculture and livestock represents the 60% and 3% of the total water demand in Cyprus respectively (Figure 6.34). As it can be seen in Figure 6.35 the most water-intensive crops are citrus and open-field vegetables.

In general, 24% of the total crop area is irrigated (mainly for vegetables, citrus, potatoes, melons, table grapes, deciduous fruit, bananas), while the remaining76% is non-irrigated (rain fed for cereals, fodders, olives, carobs, wine grapes, almonds) (CYSTAT, 2010). The irrigation water supply is provided by 73% of the demand, from non-Governmental Water Works (GWW), mainly private boreholes, and the remaining 27% from GWW, mainly surface water (WDD, 2009).

The water demand for livestock varies significantly among animal species (e.g. animal's size and growth) and is being influenced by environmental and other factors, such as air temperature, relative humidity and the level of animal exertion or production, the water content of the animal's feed or dietary needs etc. (OMAFRA, 2007).

The main vulnerability priorities for the agricultural sector of Cyprus as observed in the recent past, that have been related to impact of climate changes are the reduced crop yield/ productivity due to the limited water resources, the damages caused to crops due to extreme weather events, and the declining soil fertility.

The future impact, vulnerability and adaptation measures for the agricultural sector in Cyprus regarding climatic changes were also assessed as part of the Life+ CYPADAPT project, by using PRECIS and six other regional of the ENSEMBLES models and, the future period (2021–2050) against the control period (1961–1990).

6.3.6.1. Future impact assessment

The magnitude of the impacts on Cyprus' agricultural sector is expected to increase, as the relevant climate change factors are expected to intensify.

According to PRECIS projections for the future period 2021-2050, with respect to the control period 1960-1990: the average annual temperature in Cyprus is expected to increase by 1-2^{o}C, while precipitation is expected to decrease in seasonal level and in minor degree in annual level. In addition, the maximum length of dry spells (precipitation<0.5mm) is expected to increase by 10 to 13 days on average, while heat wave days (temperature >35^{o}C) will be increased averagely about 10-30 days on annual basis. Concerning future changes of annual max total rainfall over 1 day, projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected.

Even though the effects of climate change on the primary sector are generally difficult to be distinguished from non-climatic impacts associated with the management of natural resources, there are some basic impacts identified which are related to global change (IPCC, 2007).

According to FAO (2007), the principal climate change impacts on agriculture can be roughly divided into two categories, namely the biophysical impacts and the socio-economic impacts, as shown in Table 6.12. The potential changes in climate and their respective impacts on the agricultural sector for the case of Cyprus are presented in Table 6.13.

Table 6.12. Climate change impacts on the agricultural sector

Biophysical impacts	Socio-economic impacts
Physiological effects on crops, pasture, forests and livestock (quantity, quality)	Decline in yields and production
Changes in land, soil, water resources (quantity, quality)	Reduced marginal GDP from agriculture
Increased weed and pest challenges	Fluctuations in world market prices
Shifts in spatial and temporal distribution of impacts	Changes in geographical distribution of trade regimes
Sea level rise, changes to ocean salinity	Increased number of people at risk of hunger and food insecurity; Migration and civil unrest

Table 6.13. Potential changes in climate and their respective impacts on the agricultural sector in Cyprus

Potential climate changes	Impacts
Increased Temperature	- Reduction of crop suitability and productivity - Changes in crop quality - Increased challenges of weeds, crop pests and diseases - Increased water requirements for irrigation - Water scarcity intensification - Water quality deterioration - Intensification of desertification

Decreased Precipitation	- Decreased crop productivity - Intensification of desertification - Decreased soil fertility
Increase of atmospheric CO_2	- Increased biomass production and increased potential efficiency of physiological water use in crops and weeds - Modified hydrologic balance of soils due to C/N ratio modification - Changed weed ecology with potential for increased weed competitive crops - Increased water use efficiency of some plants and as a result altered competitive interactions of species - Changes in the distribution of animal species
Increase of atmospheric O_3	- Crop yield decrease
Sea level rise	- Loss of arable land in coastal agricultural areas - Soil salinization in coastal agricultural areas - Salinization of groundwater aquifers resulting in low water quality for irrigation
Increased frequency of extreme weather events (heat waves, droughts, hail, floods)	- Crop failure - Damages to crops - Decrease in crop yield - Competition for water between different sectors (irrigation, tourism, domestic etc.) due to extended drought periods - Damage to grain formation - Increase in pests - Heat stress for animals

The extent of climate change impacts varies upon different ecosystems, regions and countries. In warmer regions like the Mediterranean basin, the majority of impacts are likely to have a negative influence, resulting in economic losses, especially significant in areas which are already under pressure due to socio-economic and other environmental problems, for instance water scarcity (EEA, 2008b).

The main direct and indirect impacts presented in the table above were grouped in the following impact categories and analysed in brief below: 1. Crop yield alterations, 2. Soil fertility alteration, 3. Increase in pests and diseases, 4. Damages to crops from extreme weather events, 5. Alterations in livestock productivity, 6. Increase in costs for livestock catering.

1. Crop yield alterations

The increases in ambient CO_2 seem to have positive impacts on plant growth and lengthening of the growing season, trough the enhancement of photosynthesis and plant respiration (EAA, 2008a). However, these potential positive impacts, in southern and warmer latitudes are less significant than the potential negative impacts, which include reduced crop yields due to high temperatures, increased water demand for irrigation and reduced water availability due to periods of prolonged droughts, water scarcity, rainfall decrease and increased competition for water between sectors, which will in turn be much more intense (Behrens et al., 2010).

In Cyprus, the anticipated increase in temperature and evapotranspiration, and the decrease in rainfall, as well as their related changes in heat wave days and maximum length of dry spell, will decrease the crop yield.

Furthermore, the projected climate conditions will magnify the already intense water stress circumstances (drought, water shortage problems) on the agricultural sector, provoking crop failure (Bruggeman et al, 2011c). The combination of decreased rainfall and increased drought periods are expected to decrease water availability for irrigation and to increase crop moisture stress and thus further decrease crop yields. In particular, the traditional irrigated farming is the first to receive water cuts during drought years, leading to a significant decrease of the lands covered with annual crops such as vegetables and potatoes.

2. Soil fertility alteration

The principal soil aspects that affect soil fertility and are susceptible to climate change are soil biodiversity, organic carbon content, available soil moisture, erosion, salinization and desertification.

Soil fertility in Cyprus experiences a declining trend in recent years, mainly due to the erosion which has affected specifically the arable land and the land used for permanent crops (MANRE, 2007).

The expected higher temperature and lower precipitation may intensify the loss in soil organic carbon and soil moisture, the reduced water availability and the increase and variations in fires and desertification. It has been shown that the occurred desertification and loss of productive land in Cyprus are being exacerbated in recent past, because of the deterioration of soil quality with the expansion of droughts (IACO Ltd, 2007).

Regarding the fire risk in Cyprus, it is expected to be higher in forested areas, increasing so the risk for extended land erosion and the loss of cultivated areas (Behrens et al., 2010).

A further reduction in surface water availability may lead to the overexploitation and depletion of aquifers, which will result in sea intrusion to coastal aquifers, extended soil salinization and erosion, reducing so the fertility of agricultural land in particular the irrigated farms.

3. Increase in pests and diseases

Additional risk for crop production, as secondary effects induced by higher temperatures and prolonged growing season, will be posed by pest outbreaks, emergence of new pests and pathogens, weeds cycle acceleration and an increase in the frequency of diseases. There are no sufficient data to asset this issue and further research is needed.

4. Damages to crops from extreme weather events

The increasing trend in the occurrence of extreme weather phenomena will be more frequent and intense in the future, causing more damages to crops yields. In addition, the magnitude of damage caused to crops depends highly on the timing of the cycle of crops when the extreme weather events take place. More frequent, occurrence of dry spells, heat waves, and frost and hail incidents will potentially damage agriculture more than changes in the annual average temperature (Behrens et al., 2010).

Considering the above, damages to crops due to extreme weather events in Cyprus are expected to be further intensified in the future, mainly due to the increase in the number of heat wave days and to a lesser extent due to the increase in drought periods, while the damages to crops due to frosts, are expected to be reduced.

As mentioned earlier, the PRECIS climate projections in Cyprus for the period 2021-2050, indicate increases in the mean number of heat wave days per year (temperature>35^{o}C) up to 34 days, and up to 12 days per year on average in the length of drought periods (precipitation<0,5mm). On the other hand, the mean number of frost nights per year (temperature<0^{o}C) is expected to decrease up to 8 days on average, while the heavy rainfall and flooding events, will slightly decrease as the annual maximum total precipitation over one day shows minor changes in the future.

5. Alterations in livestock productivity

The projected increase in temperatures and heat waves are expected to reduce livestock productivity due to diseases outbreaks and heat stress suffered by animals, causing among others reduction in the feed intake, conception, growth and productivity rates.

In addition, warmer and drier climate conditions may reduce forage production resulting in shortage of animal feed which could modify animal diets and reduce growth and reproduction rates.

Changes in precipitation patterns and in particular the increase in flooding events may also cause the spreading of animal diseases, thus putting additional constraints to livestock productivity (IFAD, 2009).

The most important constraints of the livestock sector in Cyprus encompass the insufficient production of animal feed, as the reduced rainfall and increased drought periods in Cyprus will have also a negative effect on livestock feed productivity.

6. Increase in costs for livestock catering

The livestock sector in Cyprus depends mainly on imports due to the insufficient production of animal feed.

Rising temperatures and decreasing rainfall, resulting in reduced yields of forage crops and increased costs for farmers for providing other sources of feeding.

Increased risk for heat stress and unproductive grazing land during the summer months, as well as, the increase in extreme weather events may lead to increased housing requirements. Increased mechanical ventilation of both housing and transportation for livestock in order to reduce the risk of thermal discomfort in animals and, the risk of spreading of diseases is also expected to increase the cost for livestock catering. Additional research is needed to gather information and data regarding the climate change impact in the sector.

6.3.6.2. Future vulnerability assessment

e future vulnerability of the agricultural sector to climate change impacts is assessed in terms of its sensitivity, exposure and adaptive capacity, based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050, as follows: 1. Crop yield alterations, 2. Soil fertility alteration, 3. Increase in pests and diseases, 4. Damages to crops from extreme weather events, 5. Alterations in livestock productivity, 6. Increase in costs for livestock catering

1. Crop yield

In general, crop yield is favoured by the positive effect of increased CO_2 concentrations for the majority plants. However, this is counterbalanced by the negative effects, such as the decreased photosynthetic and water use efficiency, induced by the hot and dry conditions as in Cyprus. Crop production, both rainfed and irrigated, is highly sensitive to precipitation as crops, as shown in Figure 6.36.

During the studied period 1988-208, the lack of water caused an extensive reduction of crop production, with rainfed crops such as cereals, straw and green fodder being mostly affected, with a reduction of 90%, 85% and 87.6% respectively (CYSTAT, 2010).

Considering the percentage of rainfed crops in the total crop production, the exposure of crop yields regarding this indicator, is characterized as moderate.

In addition, the sensitivity of crop production to water availability especially for irrigated crops depends on the water allocation policy of Cyprus under drought conditions (water rationing) and the prioritization of water uses, as their water requirements are the last to be satisfied (WDD, 2011b). In addition, which the loss in irrigated production is mainly due to the reduction in irrigation water supply, whereas the loss in rainfed production is both due to climate change and an overall decrease in agricultural land use (Bruggeman et al, 2011c).

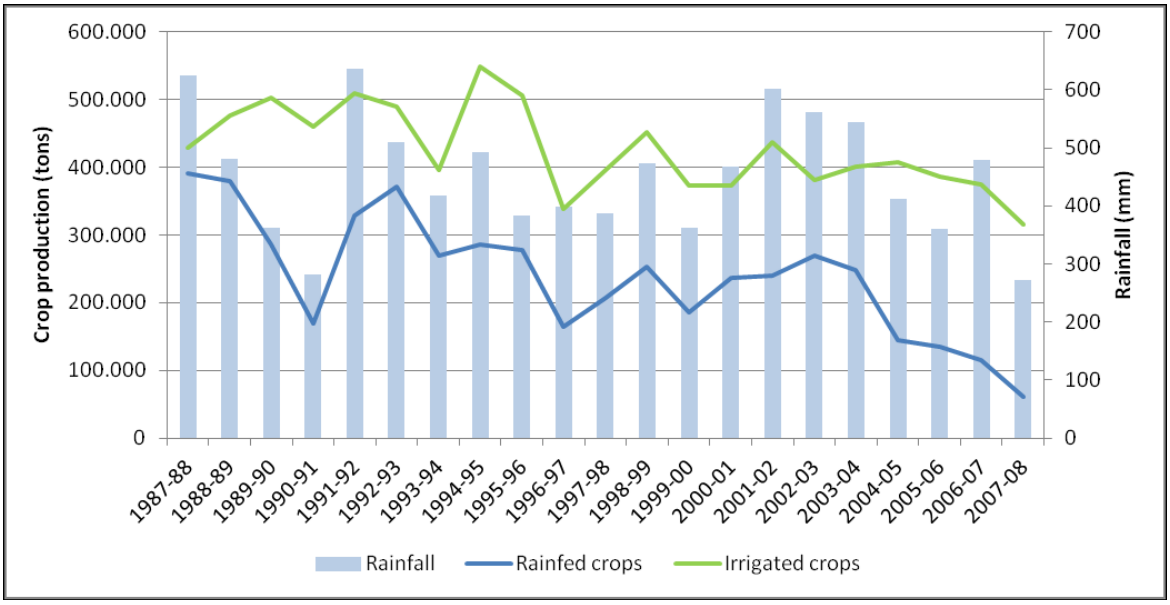


Figure 6.36. Rainfed and irrigated crop production and precipitation during the period 1987/88-2007/8 (CYSTAT, 2010; MSC, 2012)

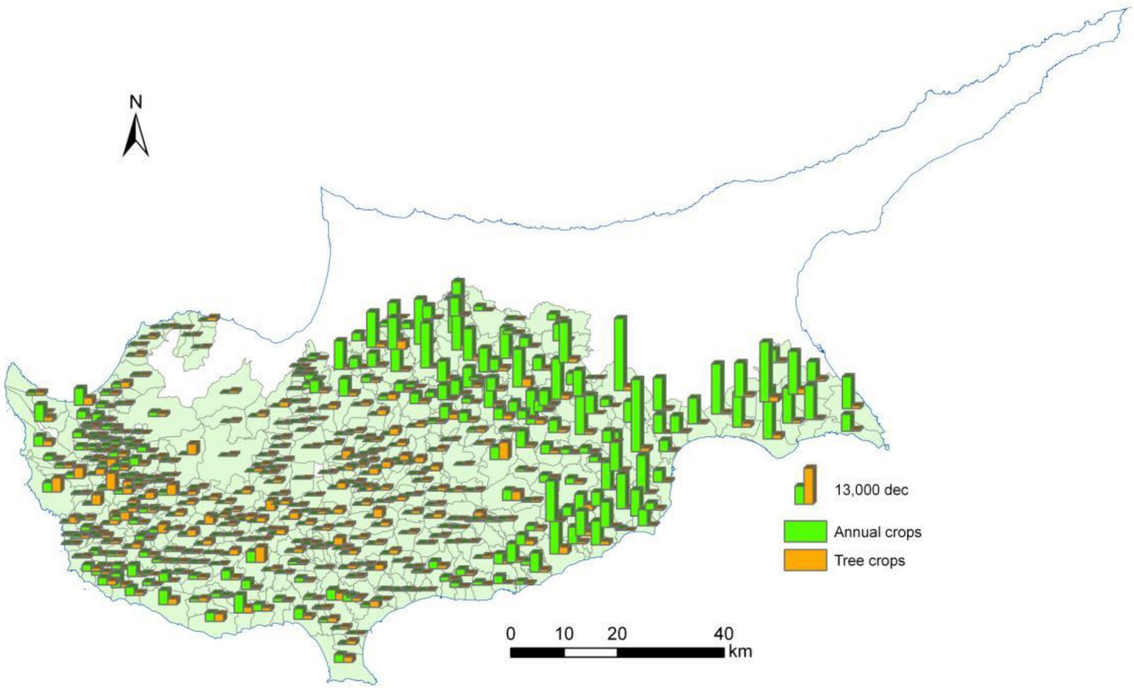


Figure 6.37. Distribution of the annual and tree crops (Bruggeman et al., 2011d)

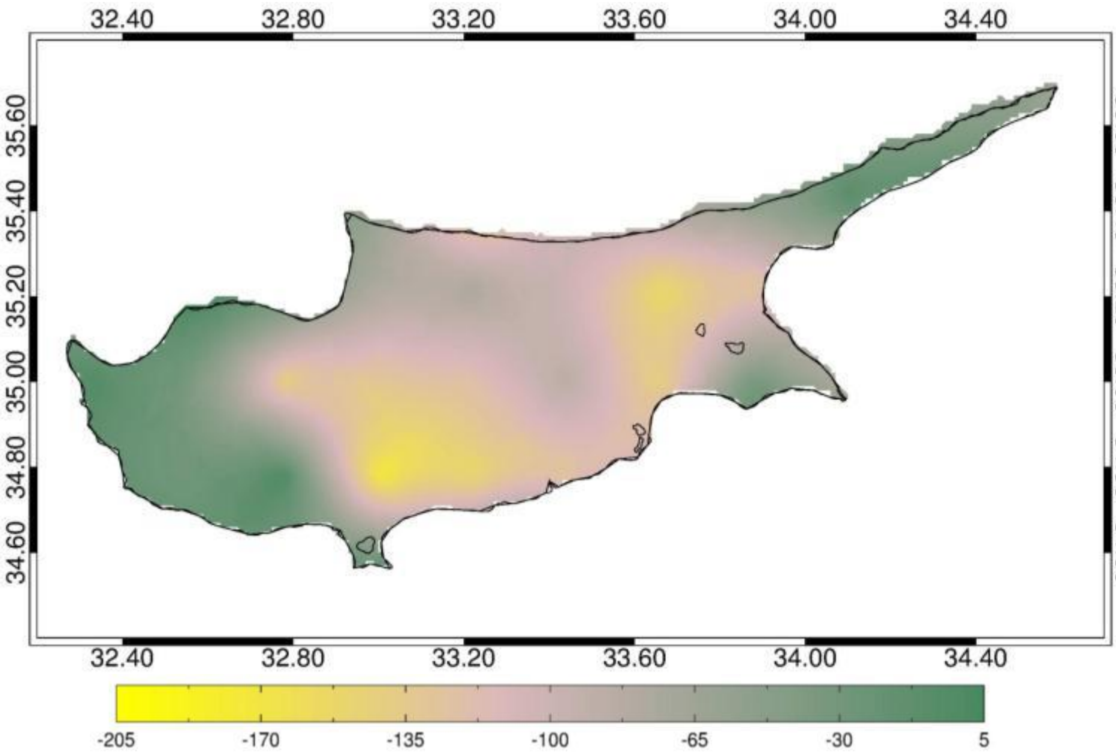


Figure 6.38. Changes in maximum length of dry spell (RR<0.5mm) between the future (2021-2050) and the control period (1961-1990)

Consequently, irrigated temporary crops are more exposed to the reduced water availability under drought conditions, and considering their percentage in the total crop production, the exposure of crops to reduced water availability, is characterized as high to very high.
The geographical distribution of crops is also linked with reduced water availability and crop yields under climate changes (Figure 6.37).

The crops located in the mountain areas, although at limited extent, are irrigated only from groundwater resources. Thus apart from the risk of their overexploitation, they depend on climate parameters such as precipitation and evapotranspiration, as well as on climate-related parameters such as soil moisture and run-off. Therefore the crops located in the mountain areas very sensitive to climate changes, especially during prolonged drought periods (>1year).

On the other hand, although flat plain areas and coastal regions have less precipitation than mountainous regions, they are irrigated mainly by the Government Water Works, which are also connected to desalination plants. It must be noted that some coastal areas are irrigated with low quality (saline) water from private boreholes.

With climate changes, the aforementioned effects on the crops located at the mountain and coastal areas are expected to be exacerbated, thus making them highly sensitive to climate changes.

Another factor associated with crop yields is the water availability. Although a minor reduction in precipitation of 5% is estimated based on the PRECIS model, the future total dam inflow will be decreased by 23% while the available groundwater resources are estimated to be reduced by approximately 29%.

As far as the length of drought periods in the future (2021-2050) is concerned, the central part of Cyprus will face an increase in the maximum length of dry spell, between 15 -20 days/year in the continental agricultural areas in the eastern part of Troodos mountain, respectively (Figure 6.38).

The length of the growing season will be influenced mainly by the increase in temperatures in autumn and spring (Ainsworth and Long, 2005) and the decrease in the number of frost days. According to the PRECIS projections in the future period 2021-2050 (Figure 6.39), the expected increase in the average autumn maximum temperature(TX) ranges between 1.0-2.0°C in the northern coasts and south-eastern area, and the in the area around southern Troodos, respectively. A similar pattern is also projected for the spring season, where TX increase is between 1.0-1.8°C. Furthermore, the number of frost nights (temperature<0^{o}C), is expected to decrease up to the maximum 6-9 days in the greater area around central and southern Troodos.

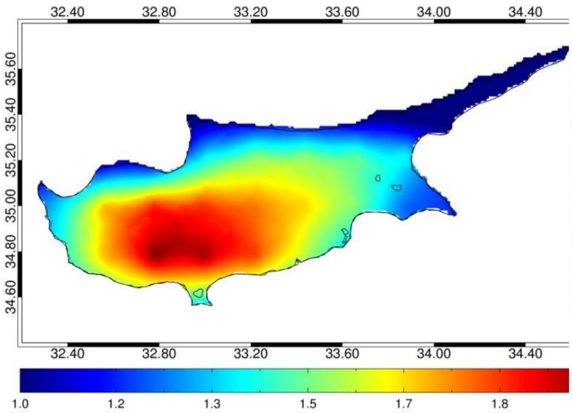


Figure 6.39. Changes in average autumn maximum temperature between the future (2021-2050) and the control period (1961-1990)

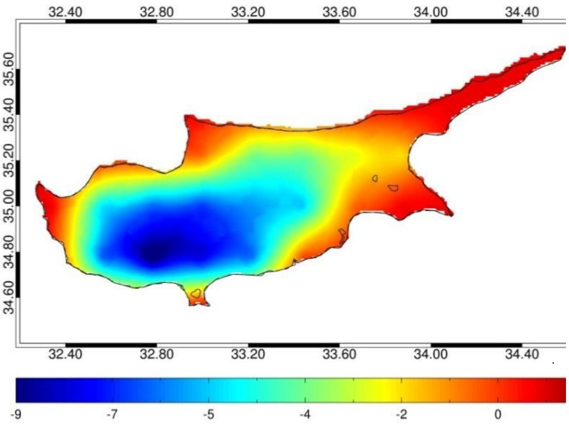


Figure 6.40. Changes in the annual number of frost nights (TN<0oC) between the future (2021-2050) and the control period (1961-1990)

Considering the above, it is highly likely that the length of the growing season will be extended and crops yield on mountains is expected to increase. Therefore, the sensitivity of crop yields to climate change is characterized as very high and the exposure as high.

<u>Assessment of adaptive capacity</u>

The practices applied in Cyprus in order to reduce the impact of reduced crop yields are:

(a) increasing water availability for irrigation. This is achieved by increasing water availability from Government Water Works, and by applying on-farm practices.
(b) reducing water demand for irrigation This is achieved through (i) increasing water use efficiency in irrigation (Redistribution of irrigated land, Use of advanced irrigation system, Irrigation scheduling, (ii) reducing run-off (Minimum soil cover, Minimum land management reflecting site-specific conditions, Terracing)and (iii) using less water intensive crops
(c) increasing crop productivity, The increase in crop productivity is achieved through (i) the application of crop rotation, (ii) fertilization and (iii) using crops more resistant to hot and dry climates.

2. Soil fertility

Soil fertility is sensitive to increasing temperatures as they intensify the loss of soil organic carbon and soil moisture and increase wildfires and desertification. According to the PRECIS model, the change in the average annual maximum temperature (TX) for the period 2021-2050 will increase by 1.0 –2.0°C at the eastern and western coastal agricultural area, and in higher elevation areas, respectively.

To sum up, all agricultural areas are expected to be exposed to increased temperatures and especially the mountain areas, followed by the continental lowland agricultural areas and the coastal agricultural areas.

Soils are sensitive to long dry periods along with regular strong seasonal winds as they causes wind erosion. In addition, soil erosion by rain is caused by intense precipitation and river flooding. However, the agricultural land in Cyprus and especially arable land and land used for permanent crops which constitutes approximately 70% of the total agricultural land, is sensitive to erosion mainly due to the intensive cultivation and overexploitation of land resources, which overburden the soil and reduce its productivity.

As for the future changes in droughts and strong winds, affecting the exposure of soils to wind erosion it is mentioned that the maximum increase in the length of dry spell, will be between 15 -20 days/year in the central part of Cyprus (Figure 6.40), while the number of days with mean wind speed greater than 5 m/s will decrease up to 12 days/year. In general, all agricultural areas are characterized by decreases in strong winds and the exposure to soil erosion by wind in the future due to climate changes will not further intensify.

As regards the future exposure of agricultural land to erosion by rain, since the future changes in the maximum amount of rainwater that falls in a short period of time (1 day in this case) within the year is insignificant, it is expected that the exposure to soil erosion by rain in the future due to climate changes will not be further intensified. The agricultural land located at the coasts, which represents the higher percentage of cultivated land, is mainly irrigated with good water quality from Government Water Works and in lesser degree from private boreholes, becoming so more sensitive to soil salinization due to overexploitation and sea intrusion.

The future changes in precipitation and in the periods of drought, which are associated with the salinization of coastal agricultural land, are expected to be minor and thus the future exposure of crops to the risk of soil salinization is moderate.

Desertification is a result of erosion by wind and rain, reduced soil moisture and chemical degradation of land (e.g. salinization) (IACO, 2007).The combined evaluation of Figure 6.41 and Figure 6.37, showed that the majority of crops cultivated in Cyprus are located in areas which

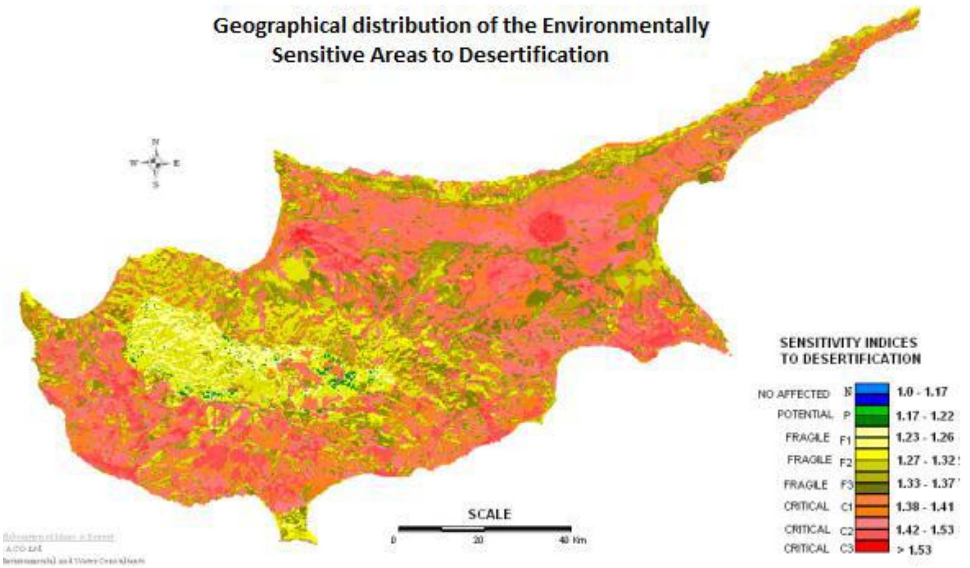


Figure 6.41. Geographical distribution of the Environmentally Sensitive Areas to Desertification (IACO, 2007)

are considered as fragile or critical to desertification, and therefore their current exposure to desertification is characterized as high.

Considering the abovementioned climate change impact indicators on soil fertility, it is concluded that the agricultural sector of Cyprus has moderate sensitivity and high exposure to climate changes.

<u>Assessment of adaptive capacity</u>

Measures to minimize the degradation of arable land are provided, including economic incentives under the Rural Development Programme of Cyprus (2007-2013) such as for the use (i) mechanical instead of chemical destruction of weeds, (ii) integrated production management and (iii) organic production.

Additionally, guidance and technical support is provided to farmers regarding salinity and infiltration problems, irrigation management methods for overcoming them, as well as a plethora of measures and different approaches which could be employed by farmers for mitigating risk of reduced soil fertility. Thus, the current adaptive capacity of Cyprus' agriculture towards this impact is considered as limited to moderate.

3. Pests and diseases

The assessment of the sensitivity and exposure of the agriculture in Cyprus to pests and diseases due to climate changes is not yet possible, because of the lack of data. Further research is needed regarding the number of pest outbreaks, the areas covered by weeds, the recorded incidents of plant diseases as well as the exposure of crops to climate changes and other aspects.

<u>Assessment of adaptive capacity</u>

The measures that have been undertaken in Cyprus to support farmers in order to reduce the proliferation of new pests and diseases are categorized into four groups: (a) promotion of indigenous and locally adapted plants and animals, (b) development of an Integrated Pest Management Strategy, (c) application of crop rotation and (d) resistance enhancement of existing plants and animals against pests and diseases.

However, in absence of data on the magnitude of the impact of climate changes on pests and diseases on crops, the adaptive capacity towards this impact cannot be evaluated.

4. Damages to crops from extreme weather events

The sensitivity of crops to extreme weather events is evaluated based on the extent of the damage caused in the recent past, in terms of crop species and type of extreme event, while the exposure is assessed based on the current and future frequency of the extreme climatic events causing damages to crops in Cyprus. The major losses to crops, because of these damages, for the period 1978-2009 is possessed by cereal and dry fodder crops, followed by potato crops deciduous crops, vines with 9.2% and citrus as illustrated in Figure 6.42. The common damaging extreme climatic event is hail, since when it occurs almost all crops are affected with extensive damages (Ioannou, 2010).

Therefore, it is estimated that the sensitivity of crops cultivated in Cyprus to extreme climatic events is high.

With regard to exposure it was observed that compensations for damages by hail events were paid every year from the establishment of the Agriculture Insurance Organisation in 1978 until 2007 with a frequency of occurrence 100%, followed by compensations for frosts with a frequency of occurrence 83%, droughts with 70%, heatwaves and windstorms with 53% each and floods with 47%.

Considering the above and their related future climate changes was mentioned earlier, the exposure of the agricultural sector of Cyprus to extreme climatic events is characterized as moderate to high.

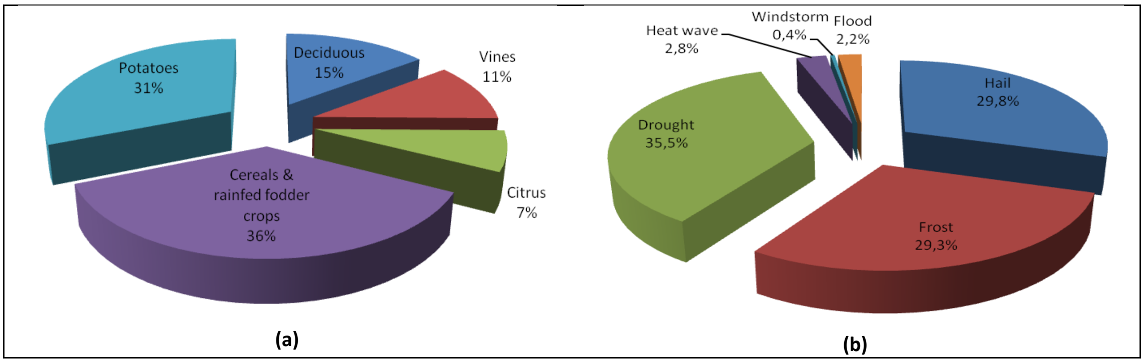


Figure 6.42. Contribution of the compensations (a) paid to main crops affected and (b) paid for the main extreme weather events to the total compensations provided in Cyprus during the period 1987-2007 (AIO, 2008a)

Assessment of adaptive capacity

For the protection of crops against droughts, a plethora of measures have been undertaken or promoted, in order to increase water availability for irrigation and reduce run-off. However, in spite of the measures, water demand for irrigation during drought events is not fully met in most cases, and thus the adaptive capacity of crops to droughts is considered limited to moderate.

In general, the abovementioned measures for the protection of crops from extreme events are applied on farm level and hence their implementation depends on the private initiative of farmers. Considering the above the adaptive capacity to this impact is characterized as limited to moderate.

5. Livestock productivity

There are no available data for the determination of the sensitivity and exposure of livestock productivity in Cyprus to climate changes. Further research is needed concerning for example, the animal species which are more resilience to increased temperatures and heat waves, production of animal feed, the reduction of incidents of diseases outbreaks etc.

Assessment of adaptive capacity

Catering for animal welfare under adverse weather conditions can be enhanced by increasing the amount of shade and shelter or by keeping livestock indoors, such as shelterbelts, planting tall, fast-growing, trees on the southern edge of pastures. The implementation of this measure is promoted through the Rural Development Programme with the provision of economic incentives for the plantation of hedgerows of forest trees.

Another measure adopted, which also contributes to the increase of the sector's adaptive capacity, is the establishment of a gene bank for animal species in order to protect genetic diversity. Guidance and advice is also provided by the Ministry of Agriculture, Natural Resources and Environment of Cyprus to farmers, in increasing of animal productivity by promoting improved breeding and management methods, improving veterinary services for animal disease control and treatment, local production of animal feed, and upgrading of farm units through mechanization and enhancing their management skills.

However, in absence of data on the magnitude of the impact of climate changes on livestock productivity, the adaptive capacity towards this impact cannot be evaluated.

6. Costs for livestock catering

There are no available data for the determination of the sensitivity and exposure of costs for livestock catering in Cyprus to climate change. Further research is needed concerning the increase in costs for livestock catering during extended warm periods in Cyprus, the deficit in local animal feed production and the excess costs for importing animal feed, for providing housing, ventilation, etc.

Assessment of adaptive capacity

The measures for enhancing adaptive capacity to increased costs for livestock catering are related mainly to the financial support provided by the Rural Development Programme of Cyprus for improving outdoor and indoor conditions for livestock.

In absence of data on the magnitude of the impact of climate changes on the costs for livestock catering, the adaptive capacity towards this impact cannot be evaluated.

6.3.6.3. Assessment of overall vulnerability

The overall future vulnerability of the agricultural sector of Cyprus to future to climate changes, in terms of sensitivity, exposure, adaptive capacity on the based on the available data for the above mentioned indicators are quantified as shown in Table 6.14. The first vulnerability priority of the sector is the impact of climate changes on crop yield, which is expected to be significantly reduced.

The second priority of the sector regarding its vulnerability to climate changes is related to the damages caused to crops due to extreme weather events, taking into account the magnitude, frequency and intensity of these effects on crops, especially of droughts and heat waves. The last priority refers to the impact of climate changes on soil fertility, is expected to magnify the existing deterioration. For the rest of the identified impacts, no evaluation took place due to lack of sufficient data.

Table 6.14. Overall vulnerability assessment of the agricultural sector in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Crop yield alterations	Very high (7)	High (5)	Limited to Moderate (2)	Moderate to high (3.9)
Soil fertility alterations	Moderate (3)	High (5)	Limited to Moderate (2)	Limited to Moderate (1.9)
Increase in pests and diseases	Not evaluated	Not evaluated	Not evaluated	---
Damages to crops from extreme weather events	High (5)	Moderate to high (4)	Limited to Moderate (2)	Moderate (2.5)
Alterations in livestock productivity	Not evaluated	Not evaluated	Not evaluated	---
Increase in costs for livestock catering	Not evaluated	Not evaluated	Not evaluated	---

6.3.7. Water resources

Freshwater resources, their systems and management are strongly depended on climate changes such as increases in temperature, sea level and precipitation variability (Kundzewicz et al., 2007), with a potential of high vulnerability not only for water resources but also to human societies and ecosystems as a consequence (Bates et al., 2008).

Water resources are closely interrelated with climate as the physical processes, through which the water cycle takes place, strongly depends on climate factors. Thus, the processes of evaporation, condensation, precipitation, infiltration, runoff, and subsurface flow strongly dependant on climatic factors such as temperature, radiation, sea level rise, vapour pressure and wind. In addition, climate affects the soil moisture and consequently the infiltration of water to groundwater bodies. Extreme climatic events such as droughts, heavy rainfall and flooding hamper water storage, resulting in significant water losses and deterioration of water quality. Increased temperatures and decreased precipitation lead to increased evapotranspiration, condensation and eutrophication, while sea level rise threatens coastal groundwater bodies with salinization.

The water resources of Cyprus are considered vulnerable to climate changes, since they are limited due to the semi-arid climate that characterizes this Mediterranean island. Freshwater availability depends almost entirely on rainfall which is highly variable with frequent prolonged periods of drought. The Republic of Cyprus in order to satisfy drinking water and irrigation demand, continue deliver a number of water works for the exploitation of the available freshwater resources (both surface and groundwater) and no- freshwater resources (sea water, recycled water). According to the standards of the International Commission of Large Dams (ICOLD), Cyprus is the first in Europe regarding the number of dams per square kilometre, having 108 dams and reservoirs with a combined storage capacity of 332 Mm^3 (WDD, 2011a).

The water sector currently experiences both quantitative and qualitative pressures from several environmental and socio-economic activities and practices. In specific, the impact, vulnerability and adaptation assessment for water resources in Cyprus, regarding the observed climate changes in recent past, showed the following key vulnerabilities: i) Water availability for irrigation, ii) Frequent occurrence of droughts, iii) Groundwater quality, and iv) Water availability for domestic water supply.

These impacts are expected to worsen in future period 2021–2050 as already projected by the PRECIS and ENSEMBLES regional climate models with respect to the control period 1960-1990.

6.3.7.1. Future impact assessment

The climatic factors that may have an impact on the water resources of Cyprus include the decreased rainfall and increased temperature, droughts, fluctuations in intense precipitation events.

According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2°C, while the average annual total precipitation will be slightly decreased with seasonal variations. The maximum length of dry spells (precipitation<0.5mm) is expected to increase by 10 to 12 days on average, while the heat wave days (temperature >35°C) will be increased averagely by 10-30 days on annual basis, depending on the region. Concerning future changes of annual max total rainfall over 1 day, PRECIS projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected.

The potential changes in climate and their respective impacts on water resources for the case of Cyprus are presented in Table 6.15.

Table 6.15. Relationship between climate changes and impacts on the water sector

Potential climate changes	Impact
Increased temperature	- Increased water temperatures - Increase in evaporation
Increased evapotranspiration	- Water availability reduction - Lower replenishments rates (lower groundwater levels) - Salinisation of water resources
Decreased precipitation, including increased droughts	- Decrease in runoff - More widespread water stress - Increased water pollution and deterioration of water quality due to lower dissolution of sediments, nutrients, dissolved organic carbon, pathogens, pesticides and salt - Decreased rates of groundwater recharge - Salinisation of coastal aquifers due to overpumping motivated by insufficient water supply
Increase in interannual precipitation variability	- Increase in the difficulty of flood control and reservoir utilization during the flooding season
Increase in heavy precipitation events	- Flooding - Adverse effects in quality of surface water and groundwater - Contamination of water supply - Lower replenishment rates in the aquifers of the mountain areas due to steep slopes
Increase in surface water temperature	- Increased algae growth and reduced dissolved oxygen levels in water bodies which may lead to eutrophication and loss of fish - Prolonged lake stratification with decreases in surface layer nutrient concentration and prolonged depletion of oxygen in deeper layers - Changes in mixing patterns and self-purification capacity - Salinisation of water resources
Sea level rise	- Salinisation of coastal aquifers (minor effect)

The future impacts of climate change on water resources are analysed in brief under the following categories: 1. Decrease in water availability, 2. Deterioration of water quality, 3. Increase in flood frequency and intensity, and 4. Increase in drought frequency and severity.

1. Decrease in water availability

Climate changes such as changes in temperature, precipitation patterns and snowmelt is projected to lead to major changes in yearly and seasonal water availability across Europe. More specifically, southern and south-eastern regions, which already suffer most from water stress, will be particularly exposed to reductions in water resources. Decreased summer precipitation results to a reduction of water stored in reservoirs fed with seasonal rivers. There is very high probability (80% confidence) that many regions in the Mediterranean basin will suffer a decrease in surface and groundwater resources due to climate change (Kundzewicz et al., 2007).

According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1 - 2^{o}C, while annual precipitation will have minor changes and discerned seasonal changes in precipitation. The total winter and autumn precipitation present decrease of 10-20mm per year and, a minor increase in summer precipitation reaching 5 mm on average. Considering this, increased temperatures play a more significant role in potential future changes in water availability.

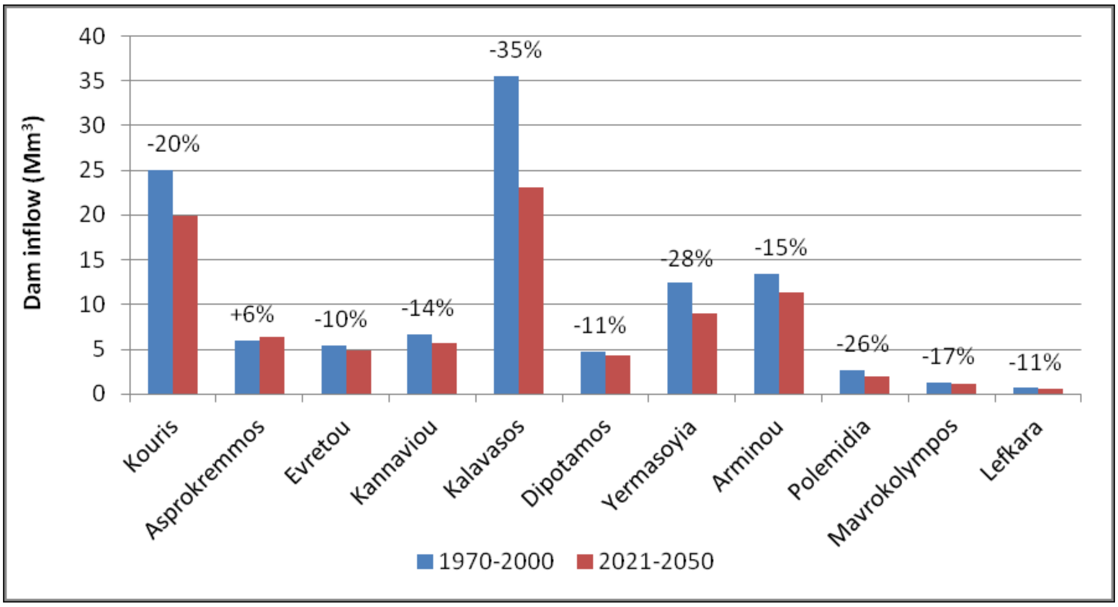
The main natural source of water in Cyprus is rainfall. The rainfall is unevenly distributed geographically with the highest in the two mountain ranges and the lowest in the eastern lowlands and coastal areas.

The climate changes are anticipated to have also an effect on evapotranspiration as well as on soil moisture, infiltration and runoff, together with the increase in water demand will in turn have a significant effect on water availability.

In general, evapotranspiration tends to decrease with reduced precipitation, but it increases with higher temperatures. It is estimated that during the period 1971-2000, 86% of rainfall returned to the atmosphere as evapotranspiration. The KNMI model predicted a general decrease in annual evapotranspiration ranging from -3% to -7% for the period 2021-2050 compared to the period 1970-2000 (CYPADAPT project).

As mentioned above, the changes in evapotranspiration and in the heavy rain events are expected to have an additional impact on river flows and thus the quantity and quality of surface water, inbounded in dams and reservoirs.

The average annual inflow to the dams during the period 1971-2000 was approximately 130Mm^3, while the respective future total dam inflow in the period 2021-2050 is expected to decrease by 23% , while the total average precipitation, according to PRECIS, is estimated to decrease only by 5%. In Figure 6.29 the change in the inflow to the main dams of Cyprus for the period 1970-2050 is presented.



* 1970-2000: Actual dam inflow (WDD, 2011a), 2021-2050: Projection

Figure 6.43. Change in inflow to the main dams of Cyprus for the period 1970-2050

The reduction in precipitation and the increase in evaporative demand will also lead to a reduction in groundwater levels. Also a change in the amount of effective rainfall and in the duration of the recharge season will alter recharge rates (Kundzewicz et al., 2007). In addition, high intensity precipitation favours runoff against groundwater recharge. Regarding future changes in high intensity precipitation, minor increases ranging from 2 to 5 mm in the annual maximum total precipitation over one day are expected in the future period (2021-2050) according to PRECIS.

The available groundwater resources in the future, as mentioned above, are estimated to be reduced by 23% on average. Again, it must be mentioned that this method does not account for future changes in runoff which could increase runoff and water losses and decrease water storage.

At this point, it has to be noted that, the water availability to rainfall continue, beside the substantial contribution of the desalination plants to domestic water demand, and of the recycled water to the agricultural demand. However, the existing and planned investments for the supply of non-freshwater resources are expected to minimize the future marginal difference between water supply and demand.

2. Deterioration of water quality

According to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), it is believed that higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution. However, there is no evidence for climate related trend in water quality (Parry et al., 2007).

Surface water bodies in Cyprus are mainly the storage reservoirs with no inflows during the summer months. As a result there is no dilution and in combination with the high evapotranspiration rates, their quality will be deteriorated. In addition the increasing temperatures enhance eutrophication rates, stratification and low levels of dissolved oxygen.

A trend in water quality deterioration is mainly observed in groundwater resources, due to the low recharge rate in combination with the low permeability of some sedimentary aquifers in Cyprus, which results in the dissolution of soluble salts and the increase in salinity (WDD, 2008). The rapid urbanization in various parts of Cyprus during the last 30 years, the uncontrolled waste discharge, the excessive use of fertilizers and pesticides, the overexploitation of many coastal aquifers gradually deteriorated the quality of Cyprus' groundwater.

The future climate changes that are anticipated to intensify the impact of water quality deterioration are the changes in water temperature, (related to the changes in air temperature), low flows or dry spells. According to PRECIS projections, for the future period 2021-2050 with respect to the control period 1960-1990, the annual maximum total precipitation over one day show minor increases ranging from 2 to 5 mm on average, while the average annual temperature in Cyprus is expected to increase by 1-2^{o}C.As far as the periods of low flows or dry spells in the future (2021-2050), it is projected that there will be a range of changes from slight decreases to an increase of up to 12 days/year on average.

3. Increase in flood frequency and intensity

According to the IPCC, increases in the intensity of precipitation, may result in more frequent and hazardous flooding events. In particular, flash and urban floods, triggered by local intense precipitation events, are likely to be more frequent throughout Europe (Christensen and Christensen, 2007; Kundzewicz et al., 2006)

Cyprus in spite of the fact that is characterized by long and frequent dry periods, also suffers from flooding events. As illustrated in Figure 6.44, the frequency of flooding events has increased considerably during the period 2000-2010 with respect to the period 1970-2000, as 61% of the total flooding events refer to that period.

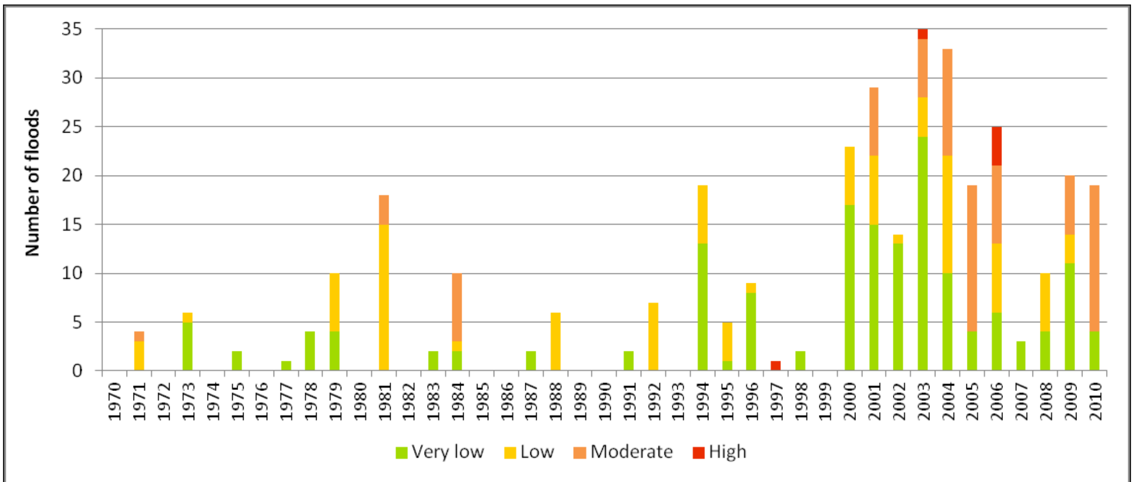


Figure 6.44. Number of flooding events per year in Cyprus (1971-2010) (WDD, 2011d)

In addition, the related hazard for each flooding event (ranked very low, low, moderate, high) in terms of adverse consequences for human health, the environment, cultural heritage and economic activity are presented.

Although a minor increase in the precipitation intensity is projected in the future, it is expected that it will further intensify the phenomenon.

4. Increase in drought frequency and severity

Droughts affect significantly both the water availability and water quality. In the future period 2021-2050, the impact of droughts will be intensified, since according to the PRECIS results the length of the drought periods is projected to increase up to 12 days/year on average.

In a study of the European Commission (2008) Cyprus is registered among the areas with highest frequencies of droughts in Europe during the period 1976 to 2006, with a large part of its territory being affected whenever droughts occurred (Figure 6.45). In Cyprus, droughts may last one or several years, the most critical of which was in the summer of 2008, with four consecutive years of low rainfall (EEA, 2010a). As can be seen in Figure 6.46, the years with precipitation above normal appear to decline, while many years with precipitation below normal were observed during the last decade with the year 2007-08 being characterized as a year of severe drought (<70% normal) and 2005-06 as a year of drought (71-80% normal).

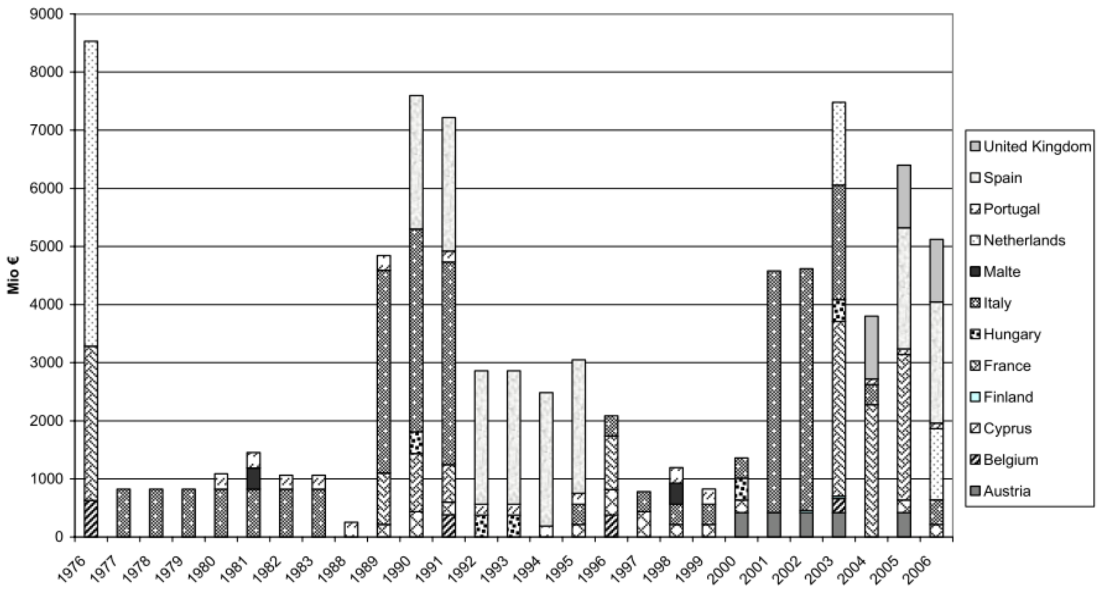
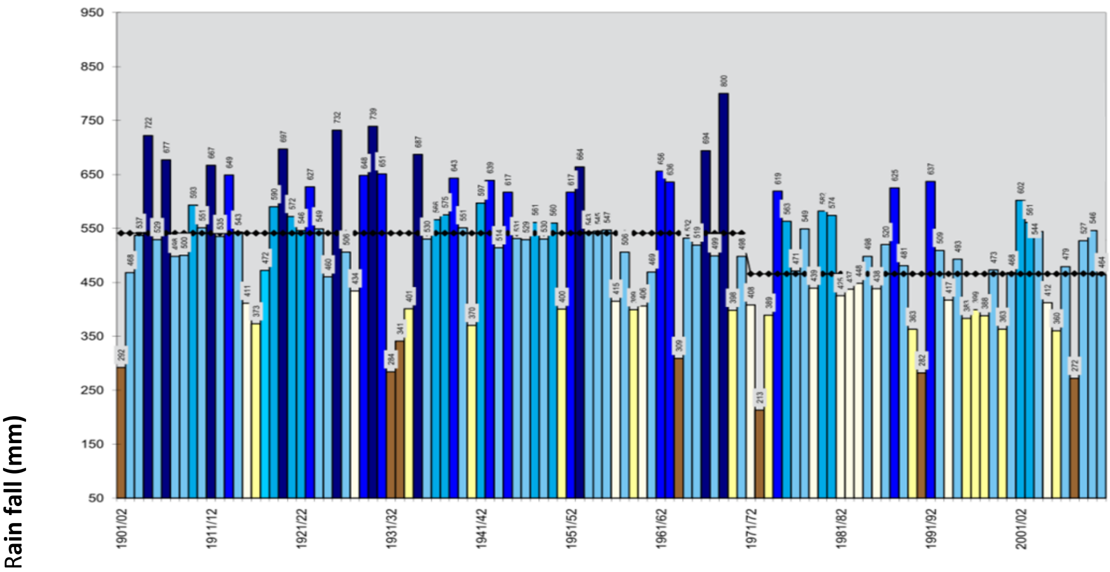


Figure 6.45. Drought impact per year and Member State (1976 – 2006) Source: EC, 2007



Hydrological years 1901/02 -2010/11

Extreme wet (>130% normal)
Wet (121-130% normal)
Above normal (111-120% normal)
Around normal (91-110% normal)
Below normal (81- 90% normal)
Drought (71-80% normal)
Severe drought (<70% normal)
Average

Figure 6.46. Mean annual precipitation in Cyprus (area under Government control) (WDD)

6.3.7.2. Future vulnerability assessment

The future vulnerability of water resources to climate change impacts is assessed in terms of their sensitivity, exposure and adaptive capacity, based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050. The vulnerability is assessed for each of the follow impact categories: 1. Water availability, 2. Water quality, 3. Floods, 4. Droughts.

1. Water availability

The sensitivity and exposure of water availability to future climate changes in Cyprus is assessed by the sensitivity of runoff/ dam inflow to changes towards the rainfall and the consequent flow variability, and by the degree of exposure to limited water supply. Additional exposure to pressures, imposed on freshwater resources by non-climatic factors, such as water demand and groundwater overexploitation also increase the vulnerability of the sector.

The relationship between rainfall and dam inflow for the future period 2021-2050, based on PRECIS projections was compared to the respective data for the period 1971-2000. The results showed: i) A decrease of 23% in the future average total dam inflow, although the average precipitation decrease is only 5%. As an example, the above relation for the catchment of the Kouris dam is given in Figure 6.47, and ii) A high variability of dam inflow, indicating so a high sensitivity of Cyprus surface water resources to climate changes. The magnitude of exposure for all the 15 main dams in Cyprus ranges from -35% to +6% in the future period 2021-2050in comparison with the period 1970-2000.

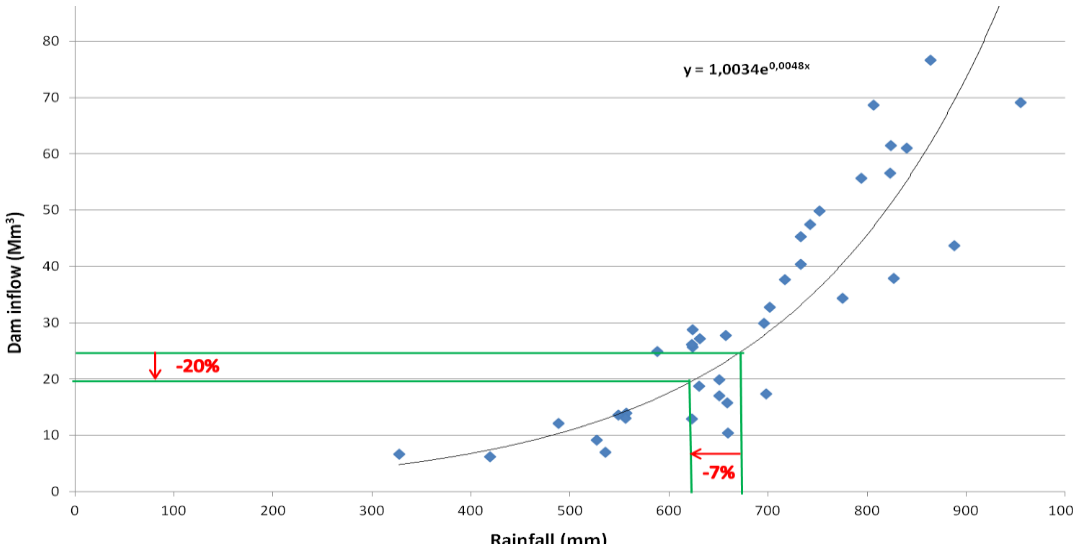


Figure 6.47. Relation between annual precipitation and annual inflow to the catchment area of the Kouris dam for the period (1970-2000)-(2021-2050)

In the recent past, the direct climate change effects observed include the diminishing precipitation and increased evapotranspiration with consecutive years of drought, which led to the depletion of surface water stored in reservoirs and the overexploitation of many aquifers especially for the irrigation of the agricultural land. The decreasing trend in ground water levels is expected to continue in future, and given that a large percent of groundwater bodies already being exposed directly or indirectly to climates changes (WDD, 2008, WDD 2011a) the Cyprus' groundwater resources exposure to climate change characterized high.

Freshwater stress, in terms of both quantity and quality, due to the decreased quantity of available freshwater resources will be worst in the future period 2021-2050 in comparison to the period 200-2010 as indicated from the following estimated indicators:

- The estimated current and future Water Stress Indicator per capita (WSI) was 284 m^3/c/y and 195 m^3/c/y respectively, both of which are considered very low, indicating that it is not possible for the case of Cyprus to rely exclusively on freshwater resources in the current situation and even more in the future

- The Water Availability Index, WAI is estimated to be approximately -0.26 and -0.1 respectively, indicating that the demand is higher than the availability of freshwater sources and that this inadequacy will be magnified in the future.
- The Water Exploitation Index (WEI) of Cyprus for the year 2007 was 64%, which is by far the highest WEI value among the European countries (EEA, 2010c). A WEI above 20 % implies that a water resource is under stress and values above 40 % indicate severe water stress and clearly unsustainable use of the water resource (Raskin et al. 1997).

Water stress is often related to the deterioration of fresh water resources in terms of both quantity and quality (Hochstrat and Kazner, 2009). Already stressed water resources are considered more vulnerable to climate changes. The difficulty facing Cyprus in order to meet water demand either for satisfying drinking water supply or for other purposes such as agriculture, tourism and industry, due to water stress, indicates the sensitivity of the sector to climate changes.

Following, the indicators used for the quantification of future water stress caused by the decreased quantity of available freshwater resources in Cyprus are presented. It is noted that, these indicators refer exclusively to the exploitation of freshwater resources, while non-freshwater resources (desalinated water, recycled water) are not taken into account

Already stressed water resources are considered more vulnerable to climate changes. The projected decreased precipitation and increased evapotranspiration due to future temperature increase will affect negatively the water availability, while the increase in demand due to population increase and the rising of living standards added an extra pressure in the already limited freshwater resources.

Taking into consideration the above, water availability is considered to have very high sensitivity and very high exposure to current and future climate changes.

Assessment of adaptive capacity

In order to combat this gap, between the increasing demands for water and the reducing water supply , due to the impacts of climate change, several adaptation measures, plans and water works have been implemented or planed by the Government. The Programme of Measures defined in the Cyprus River Basin Management Plan includes inter alia measures which are expected to reinforce Cyprus' adaptive capacity to the decreasing availability of freshwater resources and thus to climate change, are presented in Table 6.16.

Table 6.16. List of measures to adapt Cyprus' water management to climate change impacts

Adaptation measures	Implemented	Planned
Measures to increase Fresh water supply		
Reservoirs	X	
Inter-basin water transfer	X	
Artificial recharge of aquifers	X	X
Water import	X	
Diversification of water resources utilisation		
Water reuse	X	X
Desalination	X	X
Stormwater harvesting		X
Measures to decrease water consumption		
Replacement of networks	X	X
Water allocation/cuts	X	X
Use of water meters	X	X
Land consolidation	X	X
Increasing efficiency of irrigation	X	X
Control groundwater abstractions	X	
Changes in crop patterns		X
Awareness raising campaigns	X	

Economic/legal instruments		
Subsidies	X	X
Water pricing	X	X
Over consumption penalties	X	X
Other instruments		
Improving forecasting, monitoring, information -alert system	X	X

Many of the measures adopted have already alleviated the problem of water scarcity. Thus the domestic water supply is continuous with the supplement of desalinated water. As for the future situation is concerned, the sum of the average estimated freshwater and non-freshwater resources for the period 2021-2050 (341Mm^3) is expected to fully satisfy future water demand from all sectors. However desalinated water is distributed mainly in the urban centers of Cyprus through Government Water Works (GWW), while other areas, such as the mountain communities, depend solely on freshwater resources (mainly groundwater) for meeting their drinking water needs (WDD, 2009a).

As shown in Figure 6.48, total water use efficiency in Cyprus rose from 65% in 1995 to 82% in 2005-2010, placing the island among the first two countries as regards water use efficiency (Plan Bleu, 2011).

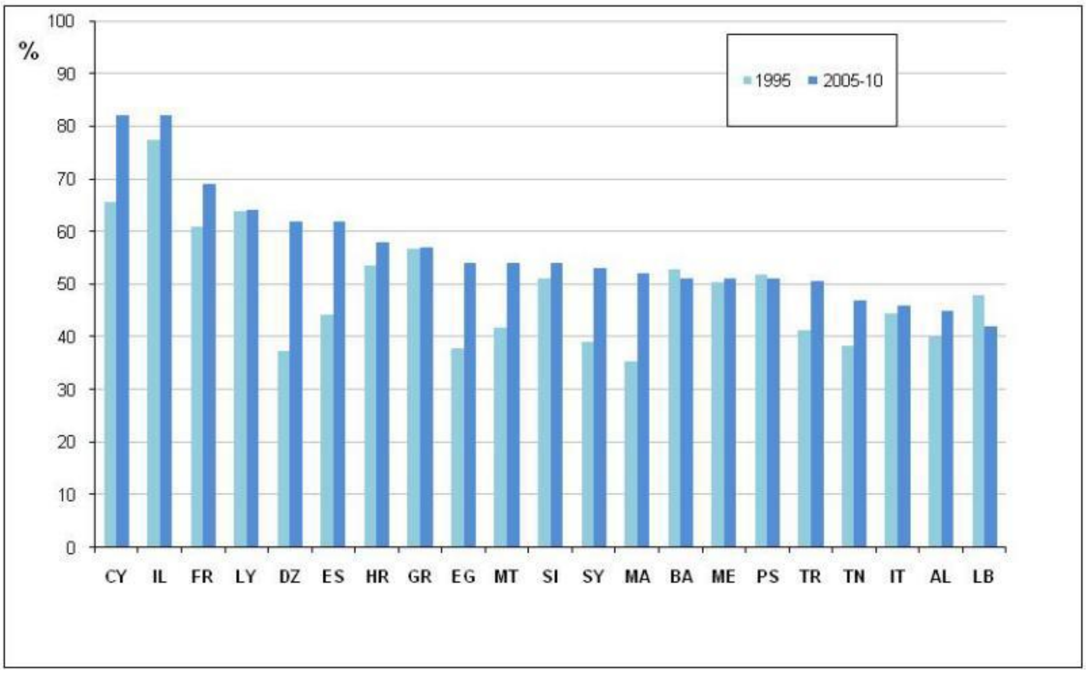


Figure 6.48a. Total water use efficiency in Mediterranean countries (1995, 2005-2010) (Plan Bleu, 2011)

The future adaptive capacity to water availability for domestic water supply in the plain and coastal areas, and in the mountain areas, is considered to be high to very high, and limited to moderate, respectively.

On the other hand, the measures applied have not yet managed to fully satisfy water demand for irrigation as agriculture constitutes the main water consumer in Cyprus. In addition water is not evenly distributed whether it is freshwater or recycled water. In particular, recycled water for irrigation is distributed only in the plain and coastal areas. While the irrigation in mountain areas depends on the water available in the storage reservoirs which are of limited capacity and during drought periods their reserves are depleted, and on private boreholes, thus resulting in the overexploitation of aquifers.

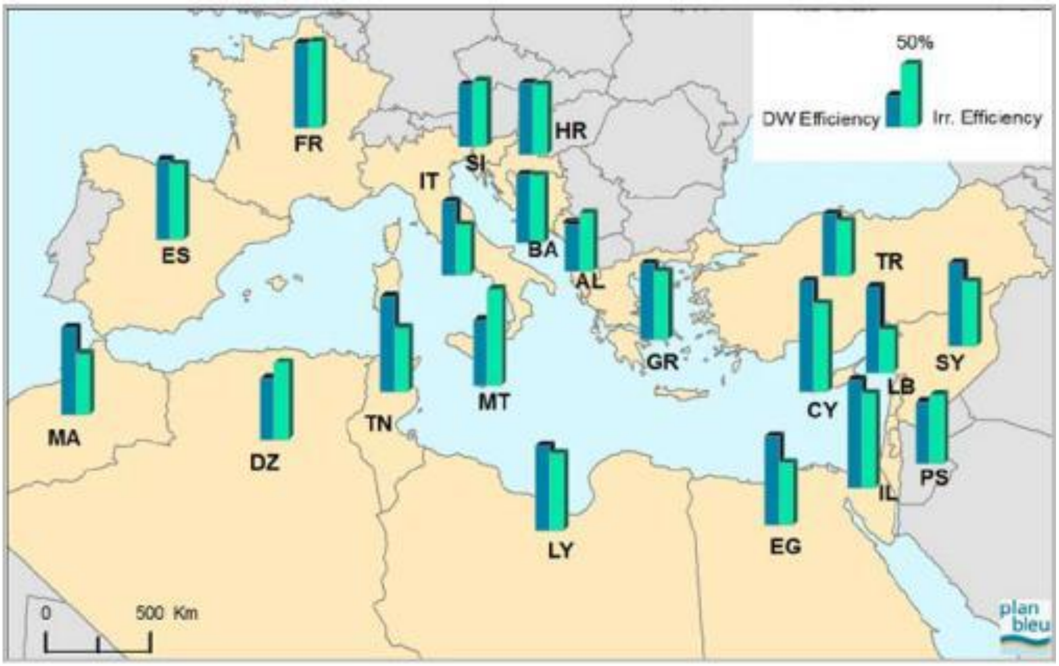


Figure 6.48b. Water use efficiency in drinking water and irrigation sectors in 2010 (Plan Bleu, 2011)

Therefore, the future adaptive capacity of Cyprus to water availability for irrigation in the plain coastal areas and in the mountain areas is considered as moderate and as limited to moderate, respectively.

Additional recommended adaptation measures (Shoukri and Zachariadis, 2012) that are considered to further enhance adaptive capacity towards this impact, include: Maintenance and repair of the water distribution systems and related infrastructure (adoption of technologies for leakage detection and control), Collection and use of rainwater, Review of the Water Policy etc.

2. Water quality

Water bodies in Cyprus are sensitive to eutrophication, stratification and low levels of dissolved oxygen as a result of increased water temperatures and decreased water flows due to reduced precipitation. In addition, heavy precipitation events and flooding adversely affect water quality. The reduction in the recharge rates due to reduced precipitation is more intense in the case of groundwater bodies, thus being more sensitive to climate changes. In addition, coastal aquifers are highly sensitive to salinization due to sea intrusion caused by their over-exploitation.

Considering the above, it was estimated that surface water bodies have moderate to high sensitivity to pollution due to climate changes while groundwater bodies have high to very high sensitivity.

The degree of water quality deterioration is mainly defined by the future climate changes, such as decreased precipitation and increased droughts, the increase in heavy precipitation events, the increase in surface water temperature and the sea level rise in Cyprus as projected in the future (2021-2050).

According to PRECIS the projections in the future period 2021-2050 (Figure 6.50), in brief are: The total annual precipitation will decrease with regional and seasonal variations. The maximum length of drought periods (consecutive days with precipitation<0.5mm) it is anticipated the central part of Cyprus by 15 days/year in the continental areas and approximately 20 days/year in the eastern part of Troodos mountain. The heavy precipitation events in the future will be without significant changes, as the annual maximum total precipitation over one day (heavy rainfall index) is expected to have a slight increase of about 2-4 mm in western, inland and mountain regions. As for changes in water temperature, these were related to the changes in air temperature. The average change in annual maximum temperature (TX) will range from +1.0°C at the eastern and northern coasts to +2.0°C in higher elevation areas and especially at the southwestern side of Troodos. Sea level changes in Cyprus are not expected to be significant.

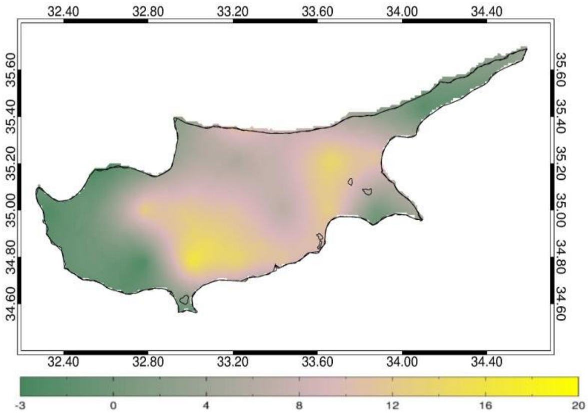


Figure 6.49. Changes in maximum length of dry spell (RR<0.5mm) between the future (2021-2050) and the control period (1961-1990)

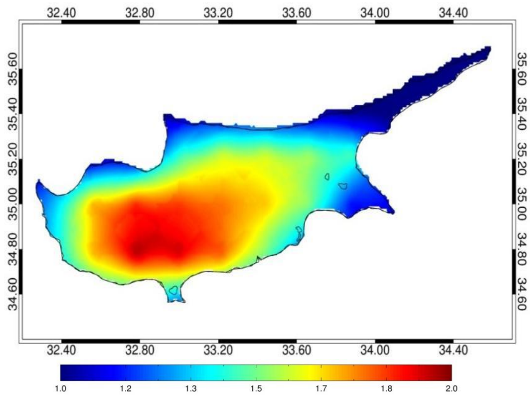


Figure 6.50. Changes in average annual maximum TX between the future (2021-2050) and the control period (1961-1990)

The exposure of the quality of water bodies in Cyprus (which, are already in bad qualitative condition) are considered more vulnerable to climate change impacts

Based on the results of the monitoring program of Cyprus' water bodies, within the implementation of the Water Frame Directive the qualitative status of the water bodies is as follows:

a) Surface water bodies: The majority of river and lake bodies of Cyprus were classified in a good or moderate ecological and chemical status (Source: WDD (7) and (8)) and all the 25 coastal water bodies were found in good or high ecological status or good ecological potential (Fisheries Department), and in good chemical status (WDD, 2011a). Furthermore, two surface water areas, in which direct or indirect disposal of urban waste water takes place, have been identified as sensitive and the surface waters with the greater relative pollution potential and thus most vulnerable are located in the central and north-western part of Cyprus (WDD, 2011a; PigWasteMan, 2007). Considering the above, it is estimated that the exposure of surface water bodies to pollution is limited to moderate.
b) Groundwater bodies: The main causes of groundwater bodies' pollution in Cyprus are agriculture, seawater intrusion, wastewater disposal and certain geological formations. From the monitoring of the 19 groundwater bodies during the period 2000-2008, 8 groundwater bodies (42%) were characterized according to the Water Framework Directive as in bad qualitative condition, based on the results of chemical analysis in the salinity levels and/or the levels of pollutants present in the groundwater bodies. In other words, the quality of groundwater bodies can be characterized as moderate to bad. Taking into account the above, the exposure of the groundwater bodies in Cyprus to deterioration of their quality is characterized as high to very high.

Assessment of adaptive capacity

To protect freshwater from pollution, a wide range of legislation which has been established in Europe, most notably the Water Framework Directive (WFD), is implemented in Cyprus.

The Programme of Measures defined in the annual report of the Cyprus River Basin Management Plan (WDD, 2011a – Annex III) includes the establishment of regulations or basic measures that should be implemented in order to achieve the objectives set out for 2015. Protected areas, Protection from point source discharges likely to cause pollution to water, Protection of groundwater bodies from salinization.

The legislation of the Cypriot Government referred as "Water Pollution Control Laws 2002- 2009" is the main tool with which all issues related to water pollution control from industrial and other activities are regulated.

Furthermore, aiming for compliance with the Urban Wastewater Treatment Directive (91/271/EEC) requirements, the wastewater collection and treatment infrastructure is being significantly expanded and upgraded.

The water policy of Cyprus on the salinization of groundwater bodies is based mainly on the prevention of seawater intrusion with the achievement of a positive balance between the abstractions and recharge, by setting proposed volumes of abstraction for each of its aquifers according to their quantitative condition. Furthermore, the measures foreseen for the achievement of a good chemical status of Cyprus groundwater bodies until 2015, in compliance with the Water Framework Directive, also contribute to this direction.

Consequently, it was estimated that the future adaptive capacity of water quality to climate changes is moderate for the case of surface water and limited to moderate for groundwater.

3. Floods

The climate projection model used for the case of Cyprus does not provide estimates for the frequency and intensity of floods in the future. Nevertheless, the annual maximum total precipitation over one day indicating heavy rainfall, which could also be associated with flood risk, will be not significantly changed, as projected the PRECIS model for the future period (2021-2050).

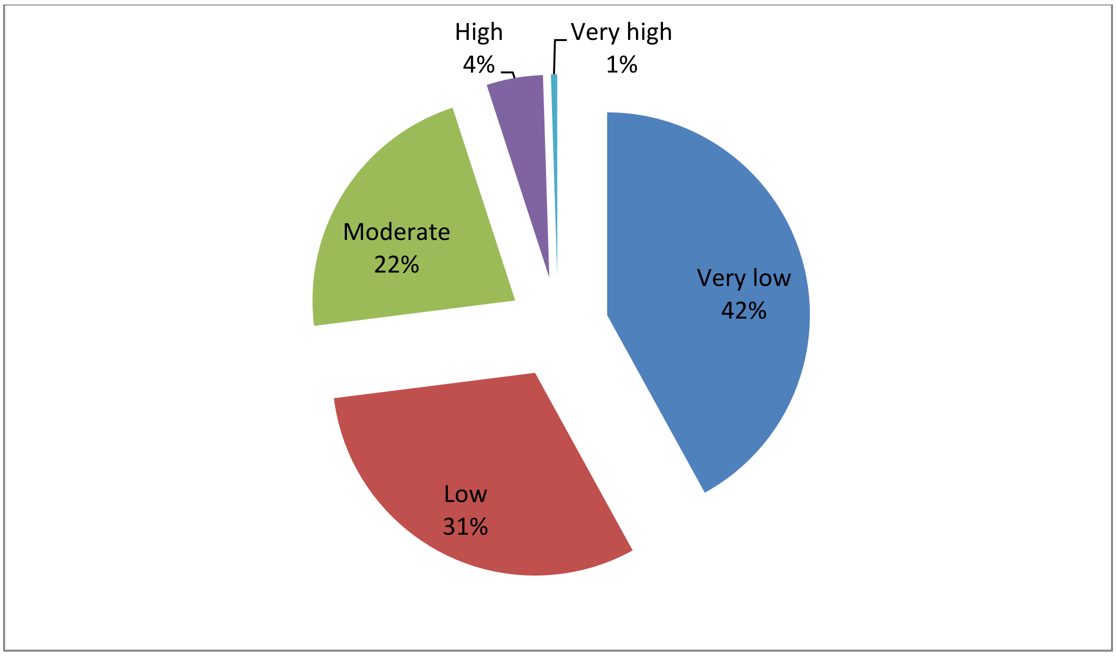


Figure 6.51. Hazard ranking of flooding events during the period 1859-2011

According to the Water Development Department (WDD), the recorded floods in Cyprus for the period 1859-2011 are characterized as urban floods (37%), flash floods (20%), river or fluvial floods (16%), pluvial floods (13%), or a combination of the above (WDD, 2011d). The distribution of floods according to their flood hazard in Cyprus in terms of adverse consequences for human health, environment, cultural heritage and economic activity for this period is presented in Figure 6.51.

The current vulnerability of Cyprus regarding flooding events will worsen with climate changes (WDD, 2011d).

The urban centers are sensitive to flood risks mainly due to their dense structuring and the restriction of green space, the elimination of natural waterways for the construction of roads, the deficient or even absent stormwater drainage system and the covering of waterways and drain entrances with garbage. On the other hand, mountain areas are less sensitive to floods, given that the inclination of terrain together with the infiltration capacity of forested areas do not allow for flooding events to take place.

This is also indicated in the "Preliminary Flood Risk Assessment" report (prepared by WDD for the compliance with the Floods Directive 2007/60/EC), where 19 areas around the island identified as

"Areas with Potential Significant Flood Risk". They mainly refer to river parts that pass through built-up areas and are characterized by frequent and significant flash floods.

To sum up, it is considered that the exposure to floods of the mountain areas of Cyprus is expected to be moderate while the exposure of urban areas is considered to be limited.

<u>Assessment of adaptive capacity</u>

Cyprus' adaptive capacity to the increasing frequency and intensity of flooding events can be estimated by the existing flood protection works and the river protection zones as well as by the projected plans for the management of future flood risks. The last two decades, a separate drainage system is being developed In Cyprus in order to collect storm water.

In addition, it must be mentioned storage reservoirs act as a flood control measure as the water is impounded in the dam and its downstream release is regulated even in the case of an overflow.

The Law 70(I)2010 on the Flood Risk Assessment, Management and Preparedness, which harmonizes the Floods Directive 2007/60/EC with the Cypriot legislative framework states that Flood Hazard maps and Flood Risk maps must be prepared by the end of 2013, while Flood Risk Management Plans must be prepared by the end of 2015.

Considering the above, the adaptive capacity of Cyprus to urban floods is estimated as moderate.

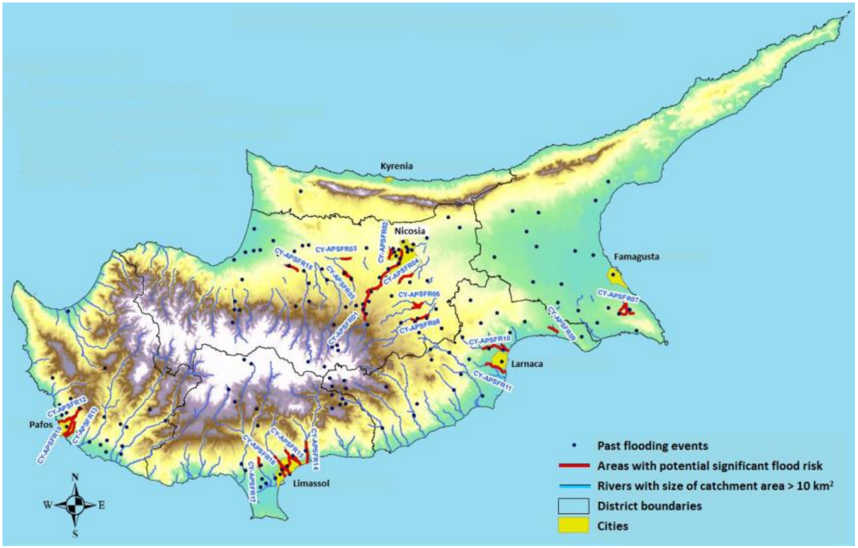


Figure 6.52. Areas with potential significant flood risk in Cyprus Source: WDD (10)

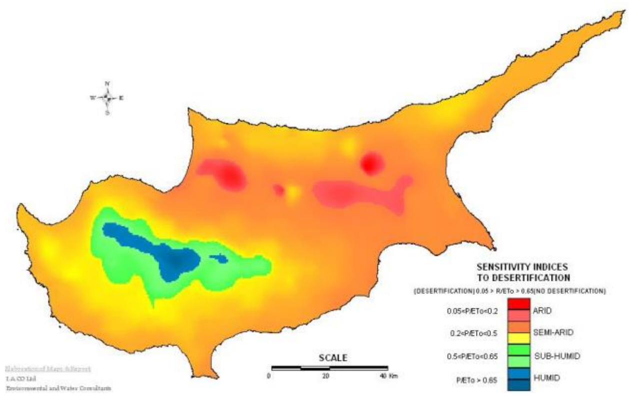


Figure 6.53. Environmentally Sensitive Areas to Desertification (IACO Ltd, 2007)

In addition, the adaptive capacity of mountain areas to floods is estimated by their inherent ability to absorb water due to the high infiltration capacity of vegetated areas and thus to prevent flooding. Thus the adaptive capacity of mountain areas to floods in mountain areas is considered high.

The maintenance and restoration of wetlands and riverbeds as natural defense against floods constitute an additional recommended adaptation measure that is considered to further enhance adaptive capacity towards this impact.

4. Droughts

Cyprus with very limited water resources is vulnerable to droughts as it has exploited most of all its natural water resources, with most of its aquifers depleted, and no perennial rivers. In order to estimate the sensitivity to droughts in Cyprus, the Department of Environment in 2007 has assigned to I.A.C.O. Ltd to define the areas threatened by desertification, by analyzing factors and processes leading to desertification and propose corrective measures. As shown in Figure 6.53 the 91% of the total area of Cyprus was characterized as critical or sensitive.

With the use of PRECIS regional climate model, the future changes (2021-2050) in the maximum length of the period with consecutive dry days (precipitation<0.5mm) per year will be increased by 10-12 days in comparison to the control period 1961-1990.

Consequently, the future exposure of Cyprus to droughts mainly is expected to be very high.

Assessment of adaptive capacity

Drought management is an essential element of water resources policy and strategies in EU but especially in drought prone areas, such as Cyprus. The Cyprus Drought Management Plan (DMP) has been prepared according to the guidelines of the European Commission (EC, 2008) Drought Management Plans (DMP), aiming to minimize the adverse impacts on the economy, social life and environment when drought appears.

Furthermore, it focuses on developing comprehensive, long-term drought preparedness policies and plans of actions that place emphasis on monitoring and managing emerging stress conditions and other hazards associated with climate variability in order to significantly reduce the risks and vulnerabilities to extreme weather events (WDD, 2011a).

Cyprus has considerably increased its adaptive capacity in coping with drought by adopting the EU guidelines on water and drought management. However, the Cyprus DMP and its Water Policy have recently implemented and have yet to be tested to prove their efficiency in achieving the abovementioned goals. For these reasons, Cyprus future adaptive capacity to droughts is considered moderate.

6.3.7.3. Assessment of overall future vulnerability

The overall future vulnerability of forests to climate changes, in terms of sensitivity, exposure, adaptive capacity is presented in Table 6.17.

As it can be seen from the table above, the main vulnerability for the water sector in Cyprus is related to the water availability for domestic water supply and irrigation in mountain areas. Water supply in mountain areas characterized by very high sensitivity and exposure to climate changes, while they have low adaptive capacity to cope with these changes mainly due to the insufficiency of government water works attributed to techno-economic reasons.

The other important vulnerabilities of the sector are related to the water availability for irrigation in plain and coastal areas, the groundwater quality and droughts. Additional adaptation measures are requested in order to eliminate all adverse consequences.

Table 6.17. Overall future vulnerability assessment of the water resources in Cyprus to climate changes

Impact		Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Water availability for domestic water supply	in urban areas	Very high (7)	Very high (7)	High to Very high (6)	Limited (1)
	in mountain areas	Very high (7)	Very high (7)	Limited to Moderate (2)	High (5)
Water availability for irrigation	in plain & coastal areas	Very high (7)	Very high (7)	Moderate (3)	Moderate to High (4)
	in mountain areas	Very high (7)	Very high (7)	Limited to Moderate (2)	High (5)
Water quality	of surface water bodies	Moderate to High (4)	Limited to Moderate (2)	Moderate (3)	None (-0.2)
	of groundwater bodies	High to Very high (6)	High to Very high (6)	Limited to Moderate (2)	Moderate to High (4)
Floods	in urban areas	Moderate to High (4)	Limited (1)	Moderate (3)	None (-1)
	in mountain areas	Limited (1)	Moderate (3)	High (5)	None (-3.3)
Droughts		Very high (7)	Very high (7)	Moderate (3)	Moderate to High (4)

6.4. Actions for adaptation to climate change

6.4.1. National adaptation policy

Cyprus as adopted a National Adaptation Strategy and Action Plan in May 2017.

The adaptation policy process has been aided by the CYPADAPT[52] project, which was co-financed by the EU through the LIFE+ instrument. This project started in September 2011 and was completed in March 2014. The coordinator was the Department of Environment of the Ministry of Agriculture, Rural Development and Environment, the authority responsible for climate change in Cyprus. Cyprus prepared a combined National Adaptation Strategy and Action Plan in 2014[53], which was updated and formally adopted in May 2017[54].

The Ministry of Agriculture, Rural Development Natural Resources and Environment is the central body coordinating the adaptation policy-making process and has led the preparation and adoption of the National Adaptation Strategy and Action Plan. The responsibility for the implementation of specific sectoral actions lies with the responsible authorities for each specific action (e.g. Department of Agriculture for agricultural issues). In November 2017, meetings with all the stakeholders have taken place to assess the status of implementation of the activities included in the Action Plan. The sectoral breakdown of the actions included in the strategy is presented in Table 6.18.

The contents of the National Adaptation Plan of Cyprus to climate change are the following:

- Brief presentation of the expected changes in climate worldwide and especially in Cyprus
- Brief presentation of the results of the vulnerability assessment of Cyprus to climate change for each of the eleven policy areas
- Presentation of the proposed climate change adaptation measures for each of the eleven policy areas of Cyprus

Table 6.18: Sectoral breakdown of the actions included in the strategy

	Sector	Number of actions
1	Water	7

52 http://cypadapt.uest.gr/
53 http://cypadapt.uest.gr/wp-content/uploads/20141219/deliverable_5.1_greek.pdf
54 Cyprus National Adaptation Strategy 2017

2	Soil	4
3	Biodiversity	6
4	Agriculture	6
5	Forests	4
6	Fisheries	2
7	Health	9
8	Energy	7
9	Tourism	1
10	Coastal areas	4
11	Infrastructure	6
12	Horizontal (all sectors)	1
	TOTAL	57

Stakeholders involvement

Stakeholders are involved in a dedicated process. The active engagement of stakeholders and experts (relative ministerial departments, associations, non-governmental organizations, universities, research institutes, etc.) was recognised from the beginning of the National Adaptation Strategy development as a key element for the assessment of vulnerability, the identification and evaluation of adaptation measures and most importantly, for the development of the National Adaptation Strategy. Stakeholders were involved in several phases of the project and in particular during the following: assessment of current and future impacts, adaptation and vulnerability assessment, identification and assessment of the adaptation measures the development of the National Adaptation Strategy. The Adaptation Strategy has gone through two different consultation phases before it was finalised.

Vulnerability assessment

A first vulnerability assessment on the most important economic sectors was made within the CYPADAPT project. Key climate change risks and priority policy areas were identified. Past research had already indicated that the sectors that would require priority attention on the design and application of adaptation actions for Cyprus would be water resources, coasts, biodiversity and tourism. Cyprus's first detailed Climate Change Risk Assessment (CCRA) was published in 2016[55]. It provides an overview of potential risks and opportunities of climate change for Cyprus until 2100 and its findings will inform the development of adaptation plans by the Government and the competent authorities. The vulnerability assessment has focused on 11 priority sectors. These include water resources, land use, seaside areas, biodiversity, forestry, agriculture, fisheries, tourism, energy, infrastructure and public health.

Status of implementation

The implementation of several adaptation measures has started taking place. Some autonomous adaptation actions are being undertaken at sectoral level. For example, the Institute of Agricultural Research and the Department of Forests are undertaking projects which facilitate adaptation.

There are also a number of instances of cooperation with wider regional authorities[56], municipalities, community groups and private local enterprises, including:

CAMP-Cyprus covers a local spatial dimension at the southern peri-urban coastal area of Larnaca town by implementing activities in four fields i) biodiversity, (ii) carrying capacity assessment, (iii) strategic environmental assessment and (iv) environmental economics and economic instruments. It involves the co-operation of Larnaca municipality and the communities of Pervolia, Meneou and Kiti.

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[55] http://www.moa.gov.cy/moa/environment/environmentnew.nsf/276491E82F8428E1C22580C30034ABF2/$file/Evidence-Report-v1_final.pdf

[56] Each wider region (District) comprise of a number of Municipalities

The COASTANCE project for coastal zone adaptation includes an assessment of the coastal risks and management measures for the pilot case of Mazotos area in Larnaca District.

The MAREMED project on adaptation in coastal areas, with the Larnaca District Development Agency partnering with 14 regions from five countries[57].

Monitoring & revision of the strategy

A Monitoring Strategy[58] was developed to complement the National Adaptation Strategy. In the Monitoring Strategy, and a Monitoring Team was suggested. The results of the Monitoring Strategy are expected to provide the basis for the preparation of the 2nd National Adaptation Plan. Monitoring reports are scheduled every year from 2017 to 2019. The work has started for the preparation of the 2018 update. All the stakeholders have been included throughout the process and particularly monitoring of progress of implementation of adaptation measures.

Reviews involve all stakeholders coordinated by the Department of Environment, as stated in the Council of Ministers' decision that adopted the National Adaptation Strategy and the Action Plan in May 2017.

6.4.2. EU level actions

In recognition of the shared challenges and cross-border nature of climate change, the European Union has led the development of an EU-wide framework for adaptation. The European Commission started in 2007 by adopting a Green Paper "Adapting to climate change in Europe – options for EU action"106. It was followed by the White Paper "Adapting to climate change: Towards a European framework for action"[59] in 2009. These documents led to the adoption of the 'EU strategy on adaptation to climate change'108 on 16 April 2013.

The strategy predates but does not conflict with some key objectives and commitments made by the EU at the international level, including most recently the UNFCCC Paris Agreement (Article 7), the Sustainable Development Goals and the Sendai Framework on Disaster Risk Reduction109 and also the Aichi biodiversity (CBD) targets. It is also in line with the ten priorities of the Juncker Commission.

6.4.2.1. The EU Strategy on Adaptation to Climate Change

The 'EU strategy on adaptation to climate change' was adopted by the European Commission on 16 April 2013. The overall aim is to contribute to a more climate-resilient Europe. This means enhancing the preparedness and capacity to respond to the impacts of climate change at local, regional, national and EU levels, developing a coherent approach and improving coordination. It sets out eight actions to meet the Strategy's three specific objectives:

Objective 1 Promoting action by Member States

- Action 1: Encourage all Member States to adopt comprehensive adaptation strategies
- Action 2: Provide LIFE funding to support capacity building and step up adaptation action in Europe (2013-2020)
- Action 3: Introduce adaptation in the Covenant of Mayors framework (2013/2014)

Objective 2 Better informed decision-making

- Action 4: Bridge the knowledge gap
- Action 5: Further develop Climate-ADAPT as the 'one-stop shop' for adaptation information in Europe

Objective 3 Climate-proofing EU action: promoting adaptation in key vulnerable sectors

[57] http://www.maremed.eu/index.php?act=1,2,3
[58] http://cypadapt.uest.gr//wp-content/uploads/20141219/deliverable_5.2_english.pdf
[59] COM(2009) 147 final WHITE PAPER Adapting to climate change: Towards a European framework for action http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF

- Action 6: Facilitate the climate-proofing of the Common Agricultural Policy (CAP), the Cohesion Policy and the Common Fisheries Policy (CFP)
- Action 7: Ensuring more resilient infrastructure
- Action 8: Promote insurance and other financial products for resilient investment and business decisions

Progress and outcomes of adaptation action

Since the publication of the 6th NC in 2014, the EU and its Member States have significantly increased the number of actions for coping with the impacts of climate change at international, national and local levels as well as across sectors. These have been presented in detail in the 7th National Communication & 3rd Biennial Report from the European Union under the UN Framework Convention on Climate Change (UNFCCC). The ongoing evaluation of the Strategy is expected to be published in early 2018.

7. Financial resources and transfer of technology

7.1. Introduction

Cyprus was a non-Annex I party to the UNFCCC until 1/1/2013 and a non-Annex B party to the Kyoto Protocol. Consequently, Cyprus had no obligations to allocate financial resources for assistance to developing country parties that are particularly vulnerable to climate change. Nevertheless, in 2009, along with the rest of the member states of the EU, Cyprus committed to provide finance for climate change to developing countries.

7.2. Provision of new and additional resources

CyprusAid is the Development Cooperation Service of the Republic of Cyprus, established in its current form by the Council of Ministers in 2005. CyprusAid functions within the framework of a policy making mechanism that has been put in place in order to steer Cyprus' Official Development Assistance. This policy mechanism is one that retains a high degree of centralisation in the decision making process, while at the same time allows for a more decentralized approach in the aid delivery arrangements. The mechanism comprises of a Coordination Body (CB) headed by the Minister of Foreign Affairs and having the Minister of Finance and the Permanent Secretary of the Planning Bureau as members. The CB is responsible for the setting of targets (quantitative, territorial and sectoral) on the basis of international obligations, EU policy recommendations and national priorities. The Planning Bureau is responsible for the preparation of policy preparation, as well as the management and implementation of the decisions of the CB while the MFA is responsible for representing the Republic abroad and also for publicizing the Republic of Cyprus ODA activities. A second body, headed by the Permanent Secretary of the Ministry of Foreign Affairs (MFA) and comprised of representatives of the Ministries of Finance, Commerce, Industry and Tourism, Agriculture, Natural Resources and Environment, Labour and Social Insurance, Education and Culture and the Planning Bureau, as well as representatives of civil society, acts in a consultative capacity to the Coordination Body.

According to the relevant EU ministerial decision and the necessary decision from the national council of ministers, Cyprus was going to provide €1.8 million as fast start finance. The amount was new and additional. The €1.8 million were going to be given in three years 2010-2011-2012, €0.6 million annually.

Funding was provided for the years 2010 and 2012.

No additional funding was provided after 2012.

7.3. Assistance to developing country Parties that are particularly vulnerable to climate change

CyprusAid after studying options funds and organizations implementing projects on climate change, and with the consent of the Ministry of Finance promoted cooperation with the "Global Climate Change Alliance-GCCA", a funding mechanism coordinated by the European Commission. This mechanism acts as an intermediary / coordinator for contributions and projects to tackle climate change. The choice of "GCCA" as a means of disposing of contribution of Cyprus based on that provides recognition to donors. Furthermore, the "GCCA" is an initiative of the European Commission and the substantial and political support of Member States in this, strengthens and makes this mechanism valuable in the international arena on climate change. Moreover, GCCA focuses climate support on LDCs and SIDS.

7.3.1. Funding provided in 2010

Project name: "Building Climate Resilience in Nepal"

The estimated costs of the project amounted to €19,400,000 (European Union: €8,000,000, Development Cooperation Service of the United Kingdom €10,800,000 and Cyprus €600,000). The project is implemented by the method of award of centralized management to the local office of the Office for Development Cooperation of the United Kingdom in Nepal.

The main objectives of the project are: (a) the development of an administrative infrastructure in Nepal, both at national and local level to enable the implementation of the National Adaptation Programme of Nepal to climate change and (b) promote the integration policy on climate change programs and projects of the government at national and local level and develop mechanisms to promote initiatives for climate adaptation.

The institutionalization of cooperation has been the signing of a Credit "Transfer Agreement" between the Cyprus and the European Union represented by the European Commission.

7.3.2. Funding provided in 2012

Project name: "Climate Change Adaptation and Sustainable Land Management in the Eastern Caribbean”

For 2012 the Planning Bureau has negotiated a Credit "Transfer Agreement", for funding the project in the Caribbean (Antigua & Barbuda, Dominica, Grenada, Saint Lucia, St. Christopher (St. Kitts) & Nevis St. Vincent, Grenadines, Montserrat, British Virgin Islands, Anguilla).

This project was funded by the European Commission with a contribution of €10,000,000 and the Republic of Cyprus with a contribution of €600,000.

The overall project objective was to contribute to the implementation of the provisions laid down in Article 24 of the Revised Treaty of Basseterre, which makes reference to implementation by each State Party "St. George Declaration" on the Declaration of Principles for Environmental Sustainability, which aims, among others, to achieve long-term conservation and sustainable productivity of the region's natural resources and the ecosystem.

The immediate goal of the project is to improve the resilience of the natural resources base in the region to the impacts of climate change through: (a) promoting efficient and sustainable practices and frameworks of land management and (b) promoting concrete pilot projects in order to adapt the field (especially in terms of land management) to climate change.

7.4. Activities related to transfer of technology

No activities related to transfer of technology have been implemented.

8. Research and systemic observation[60]

8.1. Introduction

The R&I system in Cyprus is relatively young and is evolving with the aim to increase its efficiency and foster cooperation between the research community and the productive sector (business and industry). The current governance system was established in 2007. The main barriers of the system relate to the inflexible governance structure, the weak coordination between the various actors involved and the absence of an explicit long-term strategy for R&I. In addition, the development of the R&I system is hindered by the weak cooperation between the research and academic community with the business world, the low involvement and investments of the private sector in R&I activities and the limited extroversion of the Cyprus R&I system.

Taking into consideration the above, the government of Cyprus promoted various initiatives and studies in order to develop a concrete proposal for restructuring and upgrading the R&I governance structure in Cyprus. Due to a wider administrative reform effort which is currently under way, decisions on the specific issue are still under preparation. It should be noted however that the gap is currently filled, to some extent, by the Council of Ministers.

Currently, 2 Strategy documents approved by the Council of Ministers are under implementation, namely the Smart Specialisation Strategy and the National European Research Area Roadmap for Cyprus 2016-2020.

8.2. General policy on and funding of research and systematic observation

8.2.1. Institutional mapping, actors and roles and responsibilities

The National Research and Innovation Council (NRIC) is the political, decision-making body of the R&I System. It is composed by a cabinet of six members/ ministers (Finance, Energy-Commerce-Industry and Tourism, Education and Culture, Transport-Communications and Works, Agriculture-Rural Development and Environment and Health) and it is chaired by the President of the Republic. The NRIC is entrusted with the responsibility of formulating long term R&I strategic priorities. Also, the Cyprus Scientific Council (CSC) is an advisory scientific body comprising of 19 reputable high calibre scientists. All three Public Universities as well as Private Universities and Public Research Institutions are represented in the CSC. This Council is responsible for advising NRIC on strategy and policy R&I matters. The existing Governance system has proven however rather inflexible and has been inactive for the past few years. The gap is currently filled, to some extent, by the Council of Ministers.

The responsibility for the design of the national R&I policy, is carried out by the DG EPCD, an independent governmental body which, administratively, is under the Minister of Finance. The major policy initiative undertaken by DG EPCD was the preparation of the Smart Specialisation Strategy of Cyprus (S3Cy). This strategy is implemented through an Action Plan that is a “dynamic” document reflecting the national Framework Programmes for R&I over the period 2016-2020. Also, another policy initiative undertaken by DG EPCD was the preparation of the National European Research Area (ERA) Roadmap for Cyprus 2016-2020. The Roadmap describes the current situation related to the implementation of ERA priorities at national level and indicates the national priorities and relevant current and future actions aiming to address the individual ERA Priorities.

R&I Policy is mainly implemented by the Research Promotion Foundation (RPF), which is the main research funding agency in Cyprus. The RPF was established in 1996 as an autonomous agency under

[60] Directorate for Research, Innovation and Lifelong Learning, Directorate General for European Programmes, Coordination and Development, Republic of Cyprus, 1409 Nicosia, Cyprus, http://www.dgepcd.gov.cy

private law, supervised by a Board of Directors, chaired by the Permanent Secretary of DG EPCD. The RPF is responsible for: (a) the provision of competitive funding for the implementation of research and technological development projects and innovation activities through the development and monitoring of national programmes and grant schemes for the implementation, inter alia, of the Action Plan of the Smart Specialisation Strategy for Cyprus, (b) the management of European research and innovation projects by establishing the network of National Contact Points (NCP) for Cyprus' participation in the EU Framework Programmes, thus providing assistance to applicants for EU research competitive funding and the implementation of international agreements in R&I and (c) the implementation of bilateral and multilateral agreements between Cyprus and other countries in the field of research and technological development.

Also, The Technology Service of MECIT, is responsible for the design and implementation of specific actions/programmes related to business innovation, on the basis of the national policy and in particular the S3Cy.

The major research activity in Cyprus is performed by the Higher Education Institutes (HEIs), Research Promotion Organizations (RPOs) including departments and Institutions of the public sector, enterprises and the private non-profit organisations. the role of public universities (University of Cyprus, Central University of Technology and Open University of Cyprus) is crucial, while the major RPOs, such as the Agricultural Research Organisation, the Cyprus Institute of Neurology and Genetics, the Cyprus Institute, the State General Laboratory, the Department of Fisheries and Marine Research and the Department of Meteorology are important research performers. Research in the Business sector is dominated by a few Enterprises in the pharmaceutical sector as well as small-medium companies and start-ups mainly in the ICT sector.

8.2.2. Main instruments, policies and programmes

Research is among the key priorities measures of the Action Plan for Growth, a main strategy document that aims at accelerating the economic recovery, creating jobs, improving the competitiveness of the business environment and promoting investments.

The main policy document for Research and Innovations currently in force is the Smart Specialisation Strategy for Cyprus (S3CY), which was approved by the Council of Ministers in March 2015. It includes an Action Plan, to be implemented over the period 2015 – 2022, with measures amounting to €144 mln, with co-financing from the European Structural and Investment Funds (ESIF). The Action Plan of S3CY is expected to also address the main issues of the R&I system in Cyprus such as the inclusion of SMEs in R&I activities and the attraction of private sector in R&I investments, the establishment of synergies between the research and academic community with the business world and the enhancement of extroversion of the Cyprus R&I system.

The main tool for the implementation of the S3CY Action Plan is the National Framework Programme for Research and Innovation RESTART 2016-2020, implemented by the Research Promotion Foundation that offers ample opportunities to all local stakeholders, including universities and research organisations, to establish consortia for the implementation of projects, thus nurturing closer links between them.

Also, another policy document currently in force, is the National "European Research Area (ERA)" Roadmap for Cyprus 2016-2020m, which was approved by the Council of Ministers in 19th of July 2017. The Roadmap describes the current situation related to the implementation of ERA priorities at national level and indicates the national priorities and relevant current and future actions aiming to address the individual ERA Priorities.

8.2.3. International Cooperation

The preparation and monitoring of bilateral and multilateral transnational agreements on the promotion of Science, Technology and Innovation (STI) Cooperation as well as the participation in International Organizations and initiatives for R&I is carried out by the DGEPCD.

Cyprus has concluded a number of STI Cooperation Agreements and Memoranda of Understanding with third countries (i.e. United States, Israel, Russia, Egypt, China, Cuba). The choice of partner-countries is decided on a case-by-case basis, taking into consideration Cyprus' external policy priorities and the interest of the Cypriot Research Community for cooperation in R&I with a specific country.

Furthermore, Cyprus is participating in international research organizations such as CERN (the European Organisation for Nuclear Energy), where it is an "associate member in the pre-stage to membership", providing, inter alia, the opportunity to national research organizations and scientists to participate in consortia for projects of mutual interest. Cyprus is also a founding member of SESAME and in fact, the only EU Member State participating as a full member, together with Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority and Turkey, providing a link between the EU and the organization, which is highly valued by the European Commission in the context of scientific diplomacy.

The implementation of bilateral and multilateral agreements between Cyprus and other countries in the field of research and technological development and the promotion of the participation of, Cyprus in European and International initiatives and organisations (COST, EUREKA, EUROSTARS, etc.) are carried out mainly by the RPF through relevant Schemes in the National Funding Programme "RESTART 2016-2020".

Specifically, the National Framework Programme "RESTART 2016-2020", under the priority "Extroversion – Open Horizons" includes 4 programmes (Bilateral Cooperation, International Collaboration-Dual targeting, EUREKA Cyprus and European Initiatives) for the enhancement of the extroversion of the R&I sector.

RPF is also the responsible agency for the promotion and the facilitation of the participation of Cypriot organizations and researchers in EU Framework Programmes by establishing the network of National Contact Points (NCP) for Cyprus' participation in the EU Framework Programmes, thus providing assistance to applicants for EU research competitive funding and the international agreements programmes in R&I.

8.2.4. Funding of research and systematic observation

The national target for R&D expenditures as a percentage of GDP is set to reach 0.50% by the year 2020. This target was set taking into account the particularities of Cyprus in terms of the size of the research community, the orientation of the economy in low value-added products and services and the very small size and low involvement of Cypriot companies in R&D activities in terms of participation and expenditure in R&D.

Cyprus ranks very low in terms of R&D expenditure, as it counts only for 0.48% of GDP for 2015. The significant fluctuations of GDP determine to a large extent the evolution of Research and Development intensity as actual investments in absolute terms remain relatively stable over the years.

Expenditures (GERD) performed by the Government in 2015 (most recent available data) was accounted to 50.6%, including the expenditures of the Public Universities which were accounted to 23%. The private sector contribution accounted to 26,4% while the contribution from abroad accounted to 23%.

By sector of performance, the higher education institutions accounted in 2015 for €42,6 million or 49,9% of total R&D expenditure, the business enterprises for €19,5 million or 22,8%, the private non-profit institutions for €12,2 million or 14,3% and the government for €11,1 million or 13,0%. In the business enterprise sector, information and communication constituted the principal source of R&D activity, with a total R&D expenditure of €10,1 million, while of importance was also the contribution of the manufacturing industry (and particularly the manufacturers of basic pharmaceutical products and preparations) with €7,3 million.

The private sector contribution to Research and Development activities is low and has been identified as a major limitation factor for the development of the field. Business Enterprise Expenditure on Research and Development (BERD) also stood very low compared to the EU average in 2015. More specifically, the indicator stood at 0.11% of GDP in 2015, far below the EU average (1.3%). Businesses performed 22.8% of GERD in 2015. In terms of R&D financing, the Cypriot private sector funded 26.4% of overall R&D expenditure in 2015 (most recent available data).

The proportions among fields of science have not changed significantly over the years. Most of the research expenditures focused on Natural sciences (€36.3 million), while Engineering sciences absorbed €19.1 million, Social sciences €13.0 million, Humanities €7.0 million, Agricultural sciences €6,7 million and Health sciences €3,1 million.

The Cyprus Government allocates institutional funding to public Higher Education Institutes (HEIs) and the Research Promotion Organisation (RPO) annually, through the state budget. HEIs have introduced mechanisms within the universities for the selection and management of research proposals.

Also, national funding schemes included in the Action Plan of the S3Cy, amounting to €144 ml and co-funded by the European Structural and Investment Funds (ESIF), are implemented mainly through the Research Promotion Foundation (RPF) and the Technology Service of the Ministry of Energy, Commerce, Industry and Tourism (MECIT).

8.3. Summary information on GCOS activities

8.3.1. Atmospheric observation

Measurements of meteorological parameters[61]

The Cyprus Department of Meteorology is a Department of the Ministry of Agriculture, Rural development and Environment and handles issues concerning the weather and climate of Cyprus.

In order for the Sector of Climatology to achieve its goals of measuring all the meteorological parameters, it operates a dense network of Meteorological Stations which includes 130 rainfall stations, 17 climatological stations, 3 synoptic station, 1 upper air station, 51 automatic stations, 2 stations measuring UV radiation and 17 radiation stations.

The Department of Meteorology also was operating a Meteorological Doppler Radar in Troodos mountains (Kykkos area) until 2009. From June 2017, the Department of Meteorology operates two new x-band Weather Radar (one in Rizoelia area in Larnaka and one in Paphos).

For information regarding the network of stations, see Figure 8.1 and Table 8.1.

Table 8.1. Type of meteorological stations in Cyprus

Type of Meteorological Stations	Number of Met. Stations
Rainfall Stations	130
Conventional Climatological Stations	17
Automatic Weather Stations	51
Radiation Stations	17
UV- Radiation Stations	2
Synoptic stations	3
Upper Air stations (Radiosonde)	1

[61] Panayiotis Michael, Met Officer, Department of Meteorology, Nikis 28, 1086 Nicosia; Tel.: +35722802915, e-mail: mpanayiotis@ms.moa.gov.cy

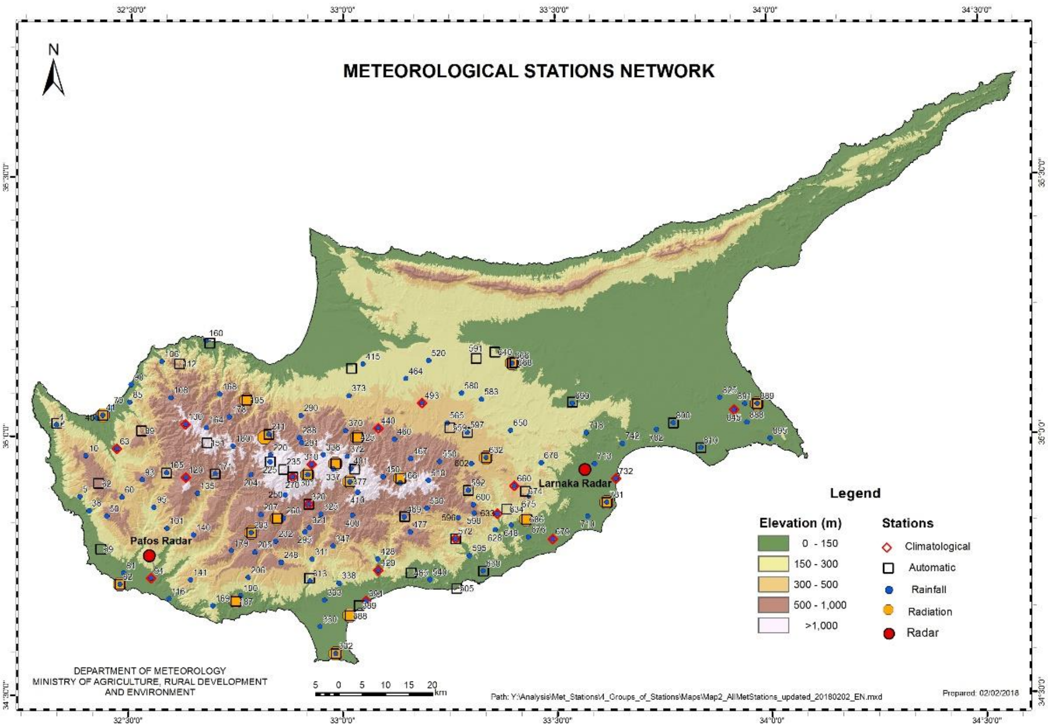

Figure 8.1. Cyprus meteorological stations network

Ground level air pollutants[62]

The Ministry of Labour &Social Security is responsible for Air Quality and Emissions Inventory in Cyprus. The Air Quality Section of the Department of Labour Inspection operates a network of 13 ambient air monitoring stations all over Cyprus as shown in Figure 8.2. The results, together with other useful information on air quality, are given to the public, on-line, through the website www.airquality.gov.cy and through indoor/outdoor information panels.

[62] Savvas Kleanthous, Senior Labour Inspection Officer, Head of Air Quality Section, Department of Labour Inspection; 12, Apelli Street, 1080 Nicosia, Cyprus; Tel: +357-22405639; e-mail: skleanthous@dli.mlsi.gov.cy

Figure 8.2. Cyprus air quality monitoring stations

8.3.2. Oceanic observation

Oceanic observation is performed by the following programmes of the Cyprus Oceanography Centre[63]:

Hydrochanges: The CIESM body coordinates and brings together all kinds of marine scientists from the Mediterranean and Black Seas. It has encouraged this initiative to increase the number of sensors in the very deep ocean for detecting climatic changes. Currently, it is an umbrella and networking agent for countries and institutions who wish to develop such long-term observing programs in the deep sea. In situ measurements of temperature and salinity, collected with adequate spatial and temporal resolutions, and with particular attention to sensitive, often long-neglected Mediterranean areas (straits and channels, zones of dense water formation, deeper parts of the basins), constitute a priority, particularly in the current context of global climate change. To this effect, our CIESM program is deploying/ monitoring an array of stations that could be viewed in time as the marine counterpart of meteorological stations. A station is composed of a short (~10 m high) subsurface mooring equipped with an autonomous CTD (1 to 2-hr sampling interval) and usually a current-meter. Moorings are set in place close to the seabed at depths ranging from 300 to 2,500 m, for periods of 1-2 years before recovery (for maintenance and calibration) and re-deployment, by scientific teams and/ or hydrographic services of participating countries. More than twenty stations are already in operation, plus those susceptible to be deployed soon, are indicated on the map below. The partner from Cyprus is the Oceanography centre.

MEDship: The CIESM body coordinates and brings together all kinds of marine scientists from the Mediterranean and Black Seas. It has encouraged this initiative to increase the number and quality of ship-based observations of physical, chemical, and biological in the Mediterranean. Special emphasis is given on the deepest layers and longest (climatic) time scales. A link has been made with a similar global initiative called 'GO-SHIP', in which high standards for data collection, analysis, and distribution are set for the global oceans. This program is actively seeking funding to be implemented, but already coordination between partners is taking place. The partner from Cyprus is the Oceanography centre.

[63] www.oceanography.ucy.ac.cy

8.3.3. Terrestrial observation

Observation System on quantity/quality of surface water[64]

The Water Development Department (WDD) is responsible for implementing the water policy of the Ministry of Agriculture, Natural Resources and Environment, to provide effective protection, rational development and sustainable management of water resources in Cyprus. In this context, the WDD implements the necessary measures to prevent the qualitative and quantitative deterioration of water bodies from contamination, pollution and uncontrolled exploitation. The WDD is also responsible for the feasibility studies, design, implementation, operation and maintenance of infrastructure, such as dams, ponds, irrigation, domestic water supply and sewerage schemes, water and wastewater treatment and recycling systems, as well as desalination plants.

In order to fulfil its mission, the Department systematically collects, classifies, archives, analyses and evaluates hydrological, hydro-geological, geotechnical and other data necessary for the protection and sustainable management of water resources in Cyprus.

In the field of quantitative monitoring of surface waters, continuous stream flow monitoring takes place at 52 hydrometric stations. In addition, the flows of 45 springs are measured on a regular basis.

Qualitative monitoring of surface waters, takes place at 45 river monitoring stations at a frequency of 9 times annually and 13 lake (reservoir) monitoring stations at a frequency of 4 and 6 times annually. Elements for biological monitoring: macroinvertebrates, phytobenthos, macrophytes and chlorophyll a. Parameters for chemical monitoring: Metals, VOCs, Pesticides, PCBs and PAHs. Additional monitoring parameters are nutrients, microbiology, ecotoxicology and physico-chemical parameters (Temp., pH, EC, DO, Turbidity).

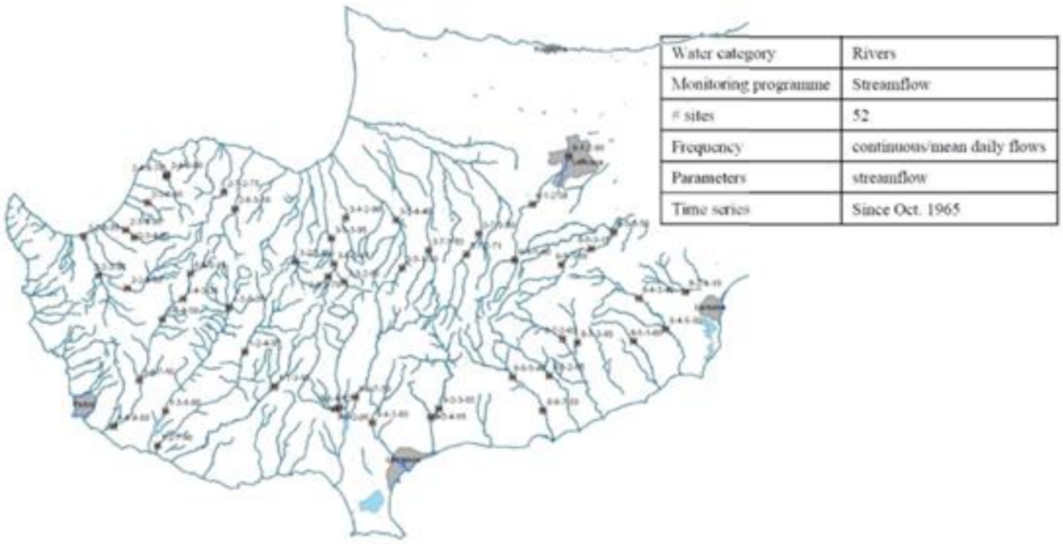

Figure 8.3. Surface waters quantitative monitoring stations[65]

[64] Water development department website, www.moa.gov.cy/wdd

[65] Gerald Dörflinger, 2011. The Cyprus Water Development Department: Water data collection, data bases, access and utilization of data by third parties; presented at Data Repositories and Computational Infrastructure for Environmental and Climate Studies in the Eastern Mediterranean 2nd DARECLIMED Workshop; available from http://www.moa.gov.cy/moa/wdd/WDD.nsf/All/24A949CC66A15BF5C22579DB0028205E/$file/DARECLIMED_G_Dorflinger_15Dec2011.pdf

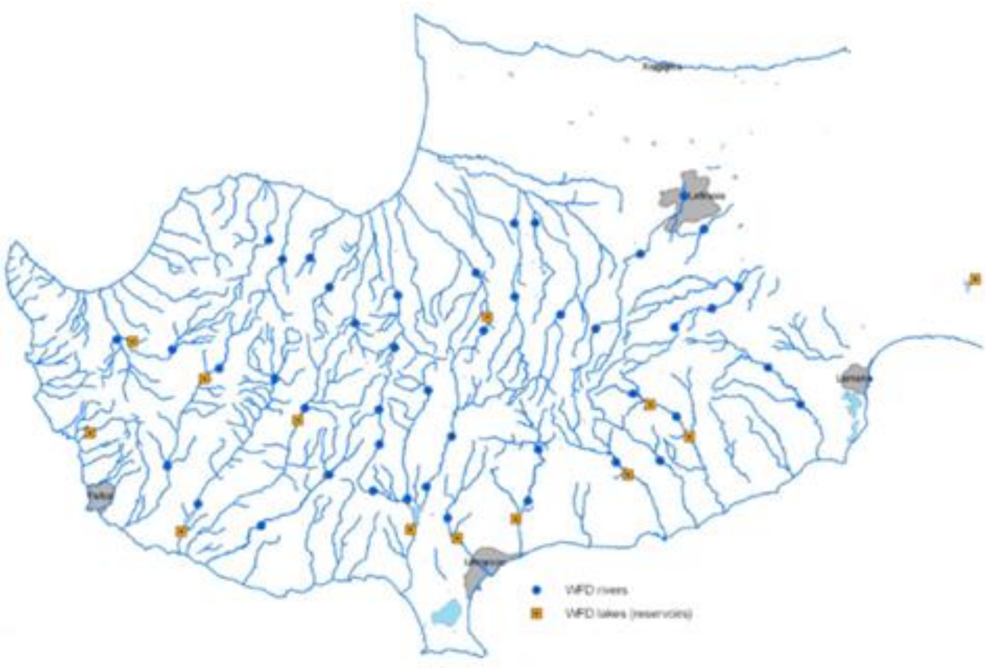

Figure 8.4. Surface waters qualitative monitoring stations

Forest ecosystem health observation[66]

Forest ecosystem health observation belongs to the responsibility of the Department of Forests. It is accomplished through the monitoring programs implemented in forest ecosystems of Cyprus. These programs are classified into three categories, depending on the agent which threats the stability of forest ecosystems:

(a) Annual surveys for quarantine harmful organisms. The survey is carried out for specific harmful organisms which are described under the Council Directive 2000/29/EC. The survey aims to the verification of the absence of pests which their introduction into the Community will cause extensive damages to forest plants and products. Surveys are carried out by plant health inspectors and the results are submitted annually to the EU.
(b) Monitoring Program for Pine Processionary Caterpillar (Thaumetopoea wilkinsonii). Pine processionary caterpillar is a very common harmful insect (defoliator) causing extensive damages to the pine ecosystems of Cyprus. Monitoring program includes the establishment of permanent plots and the annual data are very useful in application control measures.
(c) ICP Forests-Biomonitoring Program. The Department of Forests participates in the program which is one of the world's largest biomonitoring networks, where more than 40 countries are involved. Its aims are:
    - to provide a periodic overview on the spatial and temporal variation of forest condition in relation to anthropogenic and natural stress factors (in particular air pollution) by means of European-wide and national large-scale representative monitoring on a systematic network;
    - to gain a better understanding of the cause-effect relationships between the condition of forest ecosystems and anthropogenic as well as natural stress factors (in particular air pollution) by means of intensive monitoring on a number of selected permanent observation plots spread over Europe and to study the development of important forest ecosystems in Europe.

The results of the program provide information on forest health, air pollution, climate change and biodiversity.

[66] Dr. Andreas K. Christou, Senior Forest Conservator, Head of Research, Publicity & Silviculture Sector, Department of Forests, 1414, Nicosia, Cyprus, Tel.: 22819490, e-mail: achristou@fd.moa.gov.cy

8.3.4. Satellite Observation

8.3.4.1. GMES

The Republic of Cyprus as a European Union member state participates in the European program Copernicus (ex GMES). The "Regulation (EU) No 911/2010 of the European Parliament and of the Council of 22 September 2010 on the European Earth monitoring programme (GMES) and its initial operations (2011 to 2013)" set the framework of the programme.

The GMES programme is built on the research activities carried out under Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013) and the GMES Space Component Programme of ESA.

The GMES programme is comprised the following:

(a) a service component ensuring access to information in support of the following areas:
  - atmosphere monitoring,
  - climate change monitoring in support of adaptation and mitigation policies,
  - emergency management,
  - land monitoring,
  - marine environment monitoring,
  - security;

(b) a space component ensuring sustainable spaceborne observations for the service areas referred to in point (a);

(c) an in-situ component ensuring observations through airborne, seaborne and ground-based installations for the service areas referred to in point (a).

8.3.4.2. Copernicus

The Copernicus programme is the continuation program of GMES and shall be a civil, user driven programme under civil control, building on the existing national and European capacities, as well as ensuring continuity with the activities achieved under the Global Monitoring for Environment and Security (GMES). The maximum amount allocated by the European Union to implement its activities shall be EUR 3.786 million at 2011 prices for the period from 1 January 2014 to 31 December 2020.

8.3.4.3. Copernicus climate change service

The Copernicus climate change service, to be developed, shall provide information to increase the knowledge base to support adaptation and mitigation policies. It shall in particular contribute to the provision of Essential Climate Variables (ECVs), climate analyses, projections and indicators at temporal and spatial scales relevant to adaptation and mitigation strategies for the various European Union's sectorial and societal benefit areas.

The Climate Change (CC) service[67] is designed to increase the knowledge base in support of adaptation and mitigation policies. The Climate Change service will contribute to the observations, reanalyses and projections of Essential Climate Variables (ECVs) among other quantities. Series of climate impact indicators will be generated on the basis of these geophysical field and regularly updated and will then feed into various types of products (maps, reports, etc.) tailored to policy applications.

The service is organized around four complementary blocks: A Consistent Climate Data store (CDS), a Sectoral Information System (SIS), an Evaluation and Quality Control (EQC) platform and, finally, an Outreach and Dissemination (OD) platform. It will be established and its performance routinely assessed according to common practice for an operational service. The success of the implementation of the proposed service largely relies on the quality of the information flow and the overall

[67] Copernicus Progress Report October 2013 – Updated status on the services - Entr.g.2 12/11/2013 – GC-GMES-2013/22

coordination between the various blocks. Series of precise, well-defined and operational procedures have to be defined and established such that the information delivered to the end-user is fully traceable, quality controlled and disseminated within the most appropriate time. The articulation between the different public national and international institutions and the private sector to be involved in the Climate Change service through the entire production and dissemination chain is a critical element of the operations.

The logical view of the architecture of the Climate Change service has been developed and presented to the GMES Committee of December 10, 2012 and discussed in detail during the Climate Change workshop held on June 4, 2013. The latter event, where national climate experts were invited, was organized around two sessions addressing 1) the European and International initiatives related to the topic and, 2) the proposed design of the Climate Change service, respectively. The workshop was concluded with a positive evaluation of the Commission proposal by the Member States and with a shared concern to put the monitoring architecture and the operational service in place as soon as possible not to risk losing precious time and information.

The 6th FP7 space call for 2013 has prioritized research activities in support of the Climate Change service for a total budget of about 26 M€. This call was organized around five major topics and the projects under negotiation are the following:

- ERA-CLIM2: European Reanalysis of the Global Climate System (to provide consistent datasets of climate relevant parameters on a global scale for all of the 20th century).
- UERRA: Uncertainties in Ensembles of Regional Re-Analysis (to provide consistent long term datasets of climate relevant parameters on a regional scale).
- QA4ECV: Quality Assurance for Essential Climate Variables (to augment the number of available quality-assured long term ECV records and to provide methods suitable for reliable assessments of the climate quality of ECVs).
- CLIPC: Climate Information Platform for Copernicus (to enable the development, generation, comparison and ranking of climate impact indicators).
- EUCLEIA: European Climate and weather events: interpretation and attribution (To provide information on how likely high impact environmental disasters are attributable to natural climate variability or human-induced effects).

More information on the Copernicus climate change service is available at http://www.copernicus.eu /pages-principales/services/climate-change/

National Coordination

The Department of Electronic Communications (DEC) of the Ministry of Communications and Works, as the responsible department for space policy, is the national coordinator of the Copernicus programme, one of the flagship programmes for the European Space Policy sector. The role of the DEC is to coordinate the relevant governmental departments that have the knowledge and the expertise of the various services of the programme. The DEC will also contribute in the area of radiofrequencies that are related to the programme, as it is also the national frequency manager.

The services of the programme relevant to climate change issues have been allocated as follows:

- Atmosphere monitoring service: Department of Meteorology and Department of Labour Inspection
- Climate change monitoring service: Department of Environment
- Land monitoring service: Department of Lands and Surveys
- Marine environment monitoring service: Department of Fisheries and Marine Research, Department of Environment, Department of Meteorology, Cyprus Police and University of Cyprus(Cyprus Oceanography Centre)

8.3.4.4. European Space Agency

In October 2008 the Council of Ministers (Decision of No. 67.802) gave the political responsibility of the space policy sector to the Minister of the Communication and Works and tasked the DEC to be the

Executive Body to formulate and implement the national policies. DEC was also appointed as ESA counterpart for the implementation of the ESA – Cyprus cooperation.

The ESA – Cyprus Cooperation Agreement was signed by Mr Peter Hulsroj, ESA Director of Legal Affairs and External Relations and, Mr Michael Constantinides, Permanent Secretary of the Ministry of Communications and Works of Cyprus on 27 August 2009. The said agreement was ratified by Law N. 1(III)/2010 and was published in the Official Gazette of the Republic on 5/3/2010.

In 2011 technical experts from ESA visited Cyprus in order:
- to support the creation of a database of companies/institutes/universities that are interested in participating in space activities;
- to map the existing capabilities of the country;
- to facilitate the identification of areas where a specific intervention will lead to an effective participation of the industry and academia through the European Cooperating State Agreement with the European Space Agency if so requested by Cyprus.

In their analysis report the ESA experts stated that the overall assessment following the exercise is that Cyprus is a country with intellectual infrastructure and technical capabilities pertinent to space.

Existing capabilities could be used as leverage for space related activities in the areas of Earth observation, navigation and telecommunication downstream added services, possibly in ground-based long-term testing and characterization of solar generators and niche material research and turbulent flow modelling.

The mechanism for implementing the findings of the assessment will be discussed with Cyprus in order to appropriately support the conclusion of an ECS Agreement. It is recognized by both sides that the conclusion of an ECS Agreement should take place as soon as possible. However, a smooth transition between the Cooperation Agreement and the ECS Agreement should be ensured.

8.4. Research[68]

The Research Promotion Foundation (RPF) has announced in September 2016 the RESTART 2016-2020 Work Programme for Research, Technological Development and Innovation for the 2016-2020 period, which will hereinafter be referred to as “RESTART 2016-2020 Programmes”. It refers to three (3) Strategy Pillars, which reflect the strategic objectives of the RESTART 2016-2020 Programmes and to 22 specific Programmes, each having its individual specialised objectives. Moreover, it is co-funded by the Republic of Cyprus (though the RPF budget) and the European Regional Development Fund for the 2016-2020 period.

The main objectives of the RESTART 2016-2020 Programmes, which reflect on the three (3) main Strategy Pillars, are the following:
1. Smart development, with focus on selected priority sectors, through supporting the effectiveness of the RTDI System in Cyprus, its association with the productive base of the Economy, the enhancement of its extroversion and the reinforcement of its links and interoperability between its components.
2. Ensuring the sustainability and dynamics of the Research, Technological Development and Innovation (RTDI) system and to reinforce its future perspectives, focusing on excellence and on the support of human resources, especially those of the younger generation.
3. Support the operational framework of the RTDI system and production of added value resulting from research and innovation activities, through the development of supportive instruments and pilot measures, the encouragement for dissemination and exploitation of research results, and the cultivation and promotion of appropriate culture.

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The basic layout of the RESTART 2016-2020 Programmes has three (3) levels. At a first level, three (3) main Strategy Pillars are being set, which correspond to the main objectives of the RESTART 2016-2020 Programmes, as follows:

- Pillar I "Smart Growth"
- Pillar II "Sustainable RTDI System"
- Pillar III "Transformation of RTDI System"

At a second level, each Pillar is divided into Sections, each Section particularly aiming to achieve the objectives and priorities of RESTART 2016-2020 Programmes. Finally, at a third level, each Section comprises specific Programmes which are the instruments and implementation measures used to achieve the set objectives and priorities of the RESTART 2016-2020 Programmes. The Programmes may be implemented through Competitions. The table that follows shows the structure of the RESTART 2016-2020 Programmes.

Table 8.2. Structure and budget for framework programme RESTART 2016-2020

PILLAR	SECTION	PROGRAMME	BUDGET (Euros)
PILLAR I Smart Growth	**R&I Partnerships**	Integrated Projects	20.000.000
	Infrastructures	New Strategic Infrastructure Units- Young Scientists	11.000.000[69]
	Participation of Enterprises	Research in Enterprises	9.300.000
		Research in Start-Ups	1.000.000
		Proof of Concept for Technology/Knowhow Applications	1.000.000
	Extroversion – Open Horizons	Bilateral Collaborations	1.600.000
		International Collaboration- Dual Targeting	1.200.000
		EUREKA Cyprus	1.200.000
		European Initiatives- National Development	8.000.000
PILLAR II Sustainable RTDI System	**Excellence**	Excellence Hubs	17.100.000
		EUROSTARS Cyprus	2.500.000
	New Researchers, New Ideas, New Opportunities	DIDAKTOR (Post-Doctoral Researchers)	9.400.000
		Horizon 2020 – 2nd Opportunity	5.500.000
		Social Innovation	1.500.000
PILLAR III Transformation of RTDI system	**Support Mechanisms**	Innovation Vouchers	260.000
		Industrial Property	400.000
		Participation in International Brokerage Events	140.000
		Encouragement of Project Coordination in Horizon 2020	1.000.000
	Alternative Forms of Funding	Commercial Exploitation of Research Results	Stage A: 270.000 Stage B: 1.000.000
		Commercial Exploitation of Research Results by Enterprises	Stage A: 270.000 Stage B: 1.000.000
		Complementary Funding	4.000.000
	Culture	Nurturing an RTDI Culture	500.000

[69] This amount can be reduced to €8.000.000 or less in case Cypriot organisations are selected for funding in the frame of the "Spreading Excellence and Widening Participation- Teaming" Programme of the Horizon 2020 Programme. The deducted amount will be used to co-fund Teaming projects, in accordance to an existing commitment of the Republic of Cyprus.

Pillar I, “Smart Growth”, aims at smart development, focusing on the selected priority sectors, through the liaison of academic and research organisations with the productive base of the economy, the enhancement of the RTDI System’s quality and effectiveness, the enhancement of its extroversion and the reinforcement of its links and interoperability between its components.

Pillar II, “Sustainable RTDI System”, aims at ensuring the sustainability and dynamics of the RTDI System. In contrast to Pillar I which deals with the implementation of specific targeted Programmes in the Priority Sectors, Programmes of Pillar II aim at addressing the needs of the RTDI System and enhancing its prospects. The Programmes focus around “excellence”, following a bottom-up approach meaning that participants may implement projects in the scientific or technological field of their choice.

Pillar III “Transformation of RTDI System”, contrary to the first two Pillars, does not concern the implementation of RTDI Projects, but the application of policy measures for supporting and upgrading the complete RTDI System, the optimisation of its results exploitation, the promotion of research and innovation activities, and generally overcoming the main challenges of the System.

8.4.1. Priority Sectors of the Smart Specialisation Strategy

The Priority Sectors that have been selected through the study for Smart Specialisation Strategy for Cyprus (S3Cy) are the following:

- The Sectors of “Tourism” and “Energy” as the dominant priority sectors.
- The Sectors of “Agriculture- Food Industry[70]”, “Built Environment- Construction Industry”, “Transport- Shipping” and “Health”, as secondary priority sectors, and
- The Sectors of “Information and Communication Technologies”, “Sustainable Growth- Environment” and “Key Enabling Technologies (KET)” as important Horizontal Sectors which, beyond their intrinsic importance, deeply affect the qualitative development of the Priority Sectors.

Further details on the Priority Sectors, Sub-Sectors and Focus Areas are available in Annex VI.

Horizontal Priority Sectors

The emphasis of horizontal sector “Sustainable Growth- Environment” is placed upon the following areas, which present important prospects and challenges:

- Adaptation to Climate Change- Prevention and Management of Risks: Monitoring and Management Systems, Protection of Critical Infrastructures and Mitigation of Desertification
- Rational Management of Nature Resources with Emphasis on Water Resources and the Protection of Ecosystem and Biodiversity
- Conservation, Promotion and Exploitation of Cultural Heritage
- Sustainable Blue Growth

In the “Information and Communication Technologies (ICT)” horizontal priority sector, the emphasis is placed, but not limited to, on the following areas:

- Information Technologies
    - Software: innovative software, multimedia and graphics applications, knowledge and content management technologies- bigdata, language technologies, new internet applications- cloud services
    - Hardware: smart systems, optimisations of hardware and processing power, high efficiency computational systems, system interoperability, Artificial Intelligence, robotics, sensors

[70] In the framework of “Agriculture- Food Industry” Sector only activities relating to research and development in this sector, will be funded by the Research Promotion Foundation through the European Regional Development Fund. Activities relating to the active involvement of farmers in the cultivation of cooperation culture and the adoption of innovative methods and practices in order to solve problems in the field of Agriculture, will be financed by the relevant Programmes of the Ministry of Agriculture, Rural Development and Environment, via the European Agricultural Fund for Rural Development.

- Communication Technologies
    - Networks: security, high capacity, flexibility network management
    - Wireless and Satellite Communication: new generation wireless and mobile networks, mobile broadband networks, 4th generation network applications, remote sensing
    - High Speed Transmission Media: optical fibres, light wave networks
- Horizontal ICT Applications
    - Digital Tourism and Culture: tele-service, web observatories, product management and promotion , digitalisation of cultural heritage, 3D representation
    - Digital Education: e-learning, computer assisted and interactive learning
    - Digital Health and Quality of Life: health management, systems, tele-medicine, tele-examination, digital integration and assistance, ICT assisted independent living, innovative diagnostic imaging approaches
    - Promotion of Ecological Technologies: smart distribution systems, water management, environmental monitoring, smart energy applications
    - Digital Governance, Labour and Entrepreneurship: tele-working, e-commerce, citizen service systems, integrated public service management systems.

The horizontal priorities include the field of Key Enabling Technologies (KET). KETs are the technological building blocks which provide important prospects for innovation and contribute to the development and manufacturing of advanced products and the application of reforms and improvements in productivity and performance, thereby being of vital importance for the evolvement of the industry sector and for addressing significant societal challenges.

In the frame of the present Work Programme, KETs include the following fields of technology and science:

- Nanotechnology: An umbrella-term that covers the design, characterisation, production and application of structures, devices and systems by controlling shape and size at atomic, molecular and supramolecular scale. Nanotechnology holds the promise of leading to the development of smart nano- and micro- devices and systems and to radical breakthroughs in vital fields such as healthcare, energy, environment and manufacturing.
- Advanced Materials: This field refers to new reduced-cost substitutes to existing materials and to new higher added-value products and services. Advanced materials offer major improvements in a wide variety of different fields, e.g. in aerospace, transport, building and healthcare. They facilitate recycling, lowering the carbon footprint and energy demand as well as limiting the need for raw materials that are scarce.
- Advanced Manufacturing and Processing: This field is relevant to the development and supply chain of basic Key Enabling Technologies, which include nanotechnology, advanced materials, micro- and nano-electronics, photonics and industrial biotechnology. It is related to the high technology involved in manufacturing and processing, leading to the optimisation of product properties, production time, cost, energy and material consumption, efficiency of operations, waste management and environmental pollution.
- Life Sciences, Biomedical Sciences and Technology and Biotechnology: It includes the fields of life sciences, industrial biotechnology, basic and clinical medicine, biotechnology in medicine, medical engineering, environmental biotechnology, health sciences and agrosciences.
- Micro-Nanoelectronics: Deals with semiconductor components and/or highly miniaturised electronic subsystems and their integration into larger products and systems. They include the fabrication, design, packaging and testing from nano-scale transistors to micro-scale systems integrating multiple functions on a chip.
- Photonics: A multidisciplinary domain dealing with light, encompassing its generation, detection, and management. Among other things, it provides the technological basis for the economic conversion of sunlight to electricity (which is important for the production of renewable energy) and a variety of electronic components and equipment such as photodiodes, LEDs and lasers.

8.4.2. Association between Programmes and Priority Sectors

The relation between the Programmes of Pillar I with the Priority Sectors with Thematic Focus and the Horizontal Priority Sectors is shown in the Table 8.3. This is further specified in Programme descriptions.

Cyprus, through the RPF and in particular the Programme "European Initiatives – National Development", participates in the following European initiatives, which aim at coordinating the funding of research activity and the establishment of research priorities at a pan-European level, through the formulation and implementation of Joint Research Programmes:

- M.ERA-NET: Materials-Energy,
- SOLAR ERA-NET: Solar Energy
- Water Challenges for a Changing World: Environment- Tourism,
- URBAN EUROPE: Global Challenges – Local Solutions: Urban development- Construction Industry-Environment,
- Agriculture, Food Security and Climate Change (FACCE): Agriculture- Food Industry- Environment, and
- Cultural Heritage and Global Change: A New Challenge for Europe: Cultural Heritage- Tourism- ICT-Environment.

Table 8.3. Requirements for targeting of projects of pillar i in priority sectors with thematic focus and/or horizontal priority sectors

SECTION	PROGRAMME	SECTORS WITH THEMATIC FOCUS						HORIZONTAL SECTORS		
		TOURISM	ENERGY	AGRICULTURE - FOOD INDUSTRY	BUILT ENVIRONMENT-CONSTRUCTION INDUSTRY	TRANSPORT-SHIPPING	HEALTH	SUSTAINABLE GROWTH-ENVIRONMENT	ICT	KET
R&I Partnerships	Integrated Projects	X	X	X	X	X	X			
Infrastructures	New Strategic Infrastructure Units-Young Scientists	*	*	*	*	*	*	*	X	X
Participation of Enterprises	Research in Enterprises	X	X	X	X	X	X	X	X	
	Research in Start-Ups	X	X	X	X	X	X	X	X	
	Proof of Concept for Technology/ Knowhow Applications	X	X	X	X	X	X	X	X	
Extroversion- Open Horizons	Bilateral Collaborations	X	X	X	X	X	X	X	X	
	International Collaboration- Dual Targeting	X	X	X	X	X	X	X	X	
	EUREKA Cyprus	X	X	X	X	X	X	X	X	
	European Initiatives-National Development	X	X	X	X	X	X	X	X	

***** The New Strategic Infrastructure Units- Young Scientists Programme anticipates the implementation of Projects in the field of ICT and KETs, with applications in the six Thematic Priority Sectors as well as the Horizontal Sector “Sustainable Growth- Environment”.***

8.4.3. Preliminary Statistics of Submitted Proposals

According to some preliminary statistics that cover the Calls for the period September 2016 – May 2017 the 724 Proposals received can be categorised for statistical purposes to the following Scientific and Technological Fields according to the Frascati manual:

Scientific / Technological Fields	No of Proposals	Requested Funding (Euros)
Agricultural Sciences	22	8.660.981
Engineering and Technology	198	68.743.960
Humanities	38	5.674.382
Medical and Health Sciences	125	44.973.642
Natural Sciences	248	76.946.666
Social Sciences	92	15.390.884
Other – Not Applicable	1	34.212
Total	**724**	**220.424.728**

The same number categorised according to the NABS Classification of Socioeconomic Objectives is as follows:

Socioeconomic Objectives	No of Proposals	Requested Funding (Euros)
Agriculture	22	9.937.052
Culture, recreation, religion and mass media	19	5.553.129
Education	37	7.306.534
Energy	69	22.943.080
Environment (including climate change)	49	14.968.427
Exploration and exploitation of space	11	3.083.053
Exploration and exploitation of earth	3	652.912
General advancement of knowledge: R&D financed from other sources than GUF (General University Funds)	263	70.579.217
Health	178	65.685.248
Industrial production and technology	27	5.456.029
Political and social systems, structures and processes	13	1.705.073
Transport, telecommunication and other infrastructures	32	12.520.757
Not applicable	1	34.212
Total	**724**	**220.424.728**

The Proposals submitted under Pillar I “Smart Growth” can be categorised as follows to the Priority Sectors of the Smart Specialisation Strategy:

Priority Sector	No of Proposals	Requested Funding (Euros)
Tourism	15	8.316.702
Energy	42	22.483.428
Agriculture – Food Industry	22	16.137.376
Built Environment – Construction Industry	20	11.631.344
Transport – Shipping	16	10.575.200
Health	76	52.137.608
Sustainable Growth – Environment	12	1.905.174
Information and Communication Technologies	37	5.181.466
Total	**240**	**128.368.466**

The Proposals submitted under Pillar II “Sustainable RTDI System” can be categorised as follows to the Priority Sectors of the Smart Specialisation Strategy:

Priority Sector	No of Proposals	Requested Funding (Euros)
Tourism	9	1.265.361
Energy	35	7.504.280
Agriculture – Food Industry	25	4.776.876
Built Environment – Construction Industry	19	3.707.876
Transport – Shipping	4	728.040
Health	156	32.343.299
Sustainable Growth – Environment	30	6.032.368
Information and Communication Technologies	85	16.404.284
Other	120	19.259.796
Total	**240**	**92.022.214**

The Proposals submitted under all three (3) Pillars can be categorised as follows to the Priority Sectors of the Smart Specialisation Strategy:

Priority Sector	No of Proposals	Requested Funding (Euros)
Tourism	24	9.582.063
Energy	77	29.987.708
Agriculture – Food Industry	47	20.914.252
Built Environment – Construction Industry	39	15.339.252
Transport – Shipping	20	11.303.240
Health	232	84.480.908
Sustainable Growth – Environment	42	7.937.542
Information and Communication Technologies	122	21.585.750
Other	120	19.259.796
Not applicable	1	34.212
Total	**724**	**220.424.728**

8.4.4. Current Situation and Future Steps

The RPF is currently at the stage of evaluating the research proposals received. The evaluation results are expected by the end of 2017 and contracts to be signed in early 2018. Therefore, the implementation of the projects will begin in early 2018.

Moreover, the RPF continues the announcement of Calls for Proposals and more Calls are expected to be announced within 2018.

Indicatively, some of the funded projects that are relevant to climate change are the following:

SOLAR-ERA.NET

Title	Host Organisation	Starting Date	Duration	RPF Funding (€)
Design, development and application of a technologically advanced system of natural daylight and artificial PV lighting- Hybrid Light Tube	Frederick Research Center	1-Sep-14	24	96,318
PV2GRID-A next generation grid side converter with advanced control and power quality capabilities	University of Cyprus	2-Apr-15	36	84,700
EDITOR- Evaluation of the Dispatchability of a Parabolic Trough Collector System with Concrete Storage	Cyprus University of Technology	15-Feb-16	36	100,000

IPERMON- Innovative Performance Monitoring System for Improving Reliability and Optimized Levelized Cost of Electricity	University of Cyprus	1-Apr-16	36	100,000
HVolt-PV - High voltage IBC photovoltaic i-Cells and modules	University of Cyprus	1-Jun-16	24	99,996
ENHANCE - Enhanced rooftop PV integration through kinetic storage and wide area monitoring	University of Cyprus	3-Apr-17	36	200,000

JPI Cultural Heritage

Title	**Host Organisation**	**Starting Date**	**Duration**	**RPF Funding (€)**
Cultural Landscape risk Identification, Management and Assessment	Cyprus University of Technology	1-Jun-15	36	100,000
Protection of European Cultural Heritage from Geo-Hazards	Cyprus University of Technology	1-Sep-15	30	99,600

Table 8.4. Research projects related to adaptation

Institution	Project	Description	Partners
Department of Environment	LIFE UrbanProof Climate Proofing Urban Municipalities	The overall aim of the LIFE UrbanProof project is to increase the resilience of municipalities to climate change equipping them with a powerful tool for supporting better informed decision making on climate change adaptation planning. In the framework of this project, selected regional climate models and statistical downscaling techniques will be used for the assessment of climate change in the future at regional and local level. In addition, the existing and future vulnerabilities and available adaptation measures to climate change will be identified and evaluated. Following, an online decision support tool for adaptation planning will be developed where the above-mentioned information will be presented in a user-friendly, graphical layout. The tool will be applied at the four participating municipalities, where a number of small-scale green and soft adaptation measures will also be implemented based on the results of the tool. Finally, local adaptation strategies for each of the municipalities will be developed. **Funding**: EU (€1,854,000) **Duration**: 44 months **Website**: http://urbanproof.eu/en/	National Technical University of Athens (Greece), National Observatory of Athens (Greece), University of IUAV of Venice (Italy), Municipality of Reggio Emilia (Italy), Municipality of Strovolos (Cyprus), Municipality of Lakatamia (Cyprus), Municipality of Peristeri (Greece)
Dion. Toumazis & Associates	AQUAFRAGMA Self operated barrier for flood protection	This is a property scale flood protection barrier. It is an adaptation measure to the ever increasing risk of flood damage. Aquafragma is hidden in front of openings prone to flooding, such as basements, underground stations, low-lying areas etc and it emerges and prevents the entry of flood water just before flood level reaches grade level. Aquafragma is a passive system, that is, it is deployed automatically, requiring no electricity, no power, no human intervention. It utilises the hydrostatic pressure of the flood water for its deployment. The bottom hinged product is a patented one. A second patent application is currently under examination for a vertical rising barrier. **Funding**: National (€160.000) **Duration**: 2 years **Website**: www.aquafragma.com	

Table 8.5. Research projects related to climate change impacts

Institution	Project	Description	Partners
University of Cyprus	MEDEA Mitigating the Health Effects of Desert Dust Storms Using Exposure-Reduction Approaches	The "MEDEA" project is envisioned to provide the field-based evidence for the adoption of a strategic plan for mitigating the health effects of desert dust storm (DDS) events in South-Eastern Europe. Over the past decade, several studies have demonstrated that DDS in Mediterranean countries, originating mostly from the Sahara and Arabian Peninsula deserts, have been increasing in number and magnitude and linked it to desertification, climatic variability and global warming. EU legislation considers DDS impossible to prevent, implicitly harmless and discounts their contribution to daily and annual air quality standards of particulate matter up to 10 microns (PM10). However, there is increasing evidence from epidemiological studies which correlates exposure to PM10 during DDS with a significant increase in mortality and hospital admissions from cardiovascular and respiratory causes. Therefore, there is a pressing need for EU policies to reduce population exposures and increase individual, population and institutional resilience to the growing frequency and intensity of DDS. **Funding**: EU (€3.332.000) **Duration:** 4 years	Cyprus University of Technology (Cyprus), Department of Meteorology (Cyprus), Department of Labour Inspection (Cyprus), University of Crete (Greece), Soroka University Medical Centre (Israel)
Department of MeteorologyA	DISARM Drought and fIre ObServatory and eArly waRning systeM	The key purpose of DISARM project can be summarized in developing, validating and demonstrating a set of services that employs state-of-the-art observational and modeling techniques with the aim to assist interested authorities in better preventing, addressing and finally mitigating the adverse impacts of droughts and wildland fires, with the latter being intensified due to climate change. In this context, the overall objective is to deliver an innovative, integrated observation and early warning system that will serve as a key tool for protecting the environment and, consequently, promoting sustainable development in the vulnerable region of southeast Mediterranean and will provide a common action plan for the prevention and suppression of the climate-related risks of drought and wildland fires in southeast Mediterranean. **Funding**: EU (European Regional Development Fund) (€1.028.547) **Duration:** 2 years	National Observatory of Athens (Greece), The Cyprus Institute (Cyprus), University of Athens (Greece), National Institute of Meteorology and Hydrology (Bulgaria)

Table 8.6. Research projects related to climate change impacts and adaptation

Institution	Project	Description	Partners
Agricultural Research Institute	OLIVE-MIRACLE ModellIng solutions for improved and Resilient mAnagement strategies for Olive tree against future CLimatE change	During the last decades, the olive farming industry is experiencing an intensification process that carried along some radical changes in its thousands-year-old agronomic practices. These are moving from low-input traditional plantation to intensified traditional plantation and highly mechanized system. This process led to the first environmental risk caused by intensification: excessive use of water resource. The current forecasts of climate change will likely worsen this picture, and in a way that is difficult to address quantitatively. The aim of this project is to provide accurate tools to test the effectiveness of adaptation/mitigation management strategies to support long-term investment decision making on olive-tree cultivation across the Mediterranean under current and future climate. A central point will be the harmonization between farmers' and sustainable ecosystems objectives, coupling olive tree cultivation profitability with the capacity of providing environmental services, to be reached by purposely-developed simulation tools to support decision-making. Advanced modelling approaches will be used to integrate available physiological knowledge into existing and well established modelling platforms, to assess climate change impact and evaluate mitigation/adaptation strategies by tuning agro-management factors. The analysis will be based on a consistent set of data layers, including weather, soils, and current agro-management information, and it will be conducted against present and short to mid-term future scenarios of climate change. A participatory approach with stakeholders engagement will be exploited through a reiterative process to identify/validate sustainable and economic viable olive tree management practices. **Funding**: National (€ 120.000) **Duration**: 36 months **Website:** http://faccesurplus.org/research-projects/olive-miracle/	Council for Agricultural Research and Economics (Italy), Universidad de Cordoba (Spain), National Research Council (Italy)
European University of Cyprus / Center for Risk and Safety in the Environment	EU-CIRCLE A pan-European framework for strengthening Critical Infrastructure resilience to climate change	Climate related hazards (e.g. floods, storms, extreme precipitation, wildfires etc.) have the potential to destroy or substantially affect the lifespan and effective operation of European Critical Infrastructures (CI), such as energy, transportation, ICT and water infrastructures. The main strategic objective of EU-CIRCLE is to move towards an infrastructure network(s) that is resilient to today's natural hazards and prepared for the future changing climate. It aims to contribute to the EU's Adaptation Strategy through the promotion of better decision-making by addressing existing gaps in the knowledge on climate change impacts and adaptation in CIs. EU-CIRCLE aims to achieve this by defining a proper conceptual framework and development of tools for enhancing the resilience of critical infrastructures to climate stressors. **Funding**: EU (€7.283.525) **Duration**: 36 months **Website**: http://www.eu-circle.eu/	National Center for Scientific Research —Demokritos (Greece), Meteorologisk Institutt (Norway), University of Exeter (UK), Gdynia Maritime University (Poland), ARTELIA Eau et Environnement SAS (France), SATWAYS Ltd (Greece), Entente pour la forêt Méditerranéenne | Valabre (France), RINA Consulting (Italy), Državni Hidrometeorološki Zavod – Meteorological And Hydrological Service (Croatia), XUVASI Ltd (UK), MRK Management Consultants GmbH (Germany), Center for Security Studies (KEMEA) Greece, University of Salford (UK), National Protection and Rescue Directorate (Croatia), ADITESS Ltd (Cyprus), Torbay Council (UK), HMOD-Hellenic National Meteorological Service (Greece), University of Applied Sciences Velika Gorica (Croatia), University of Huddersfield (UK)

Institution	Project	Description	Partners
European University of Cyprus / Center for Risk and Safety in the Environment	EPICURO European Partnership for Urban Resilience	Civil Protection plays a central role in supporting the adaptation to climate change through building capacity to withstand disasters following a disaster risk prevention perspective, which can be performed by means of adequate territorial/urban policies, institutional and individual behaviours. Specific objectives of the project include: – Identification of EU and international best practices and technologies to improve urban resilience to disasters – Training of Civil Protection teams to increase their specialisation and role in support to decision makers, stakeholders and local communities – Active involvement of policy-makers and decision-makers in the development of local pilot actions for urban resilience improvement – Informing and training citizens about the meaning of resilience and how they can contribute to a more resilient city **Funding**: EU (€663,812) **Duration**: 24 months **Website**: http://www.epicurocp.eu/	PROVINCIA DI POTENZA (Italy), EKODOMA (Latvia), EPC Consulting Srl (Italy), TOWN AND COUNTRY PLANNING ASSOCIATION (UK), MUNICIPALITY OF VICENZA (Italy) CITY OF VEJLE (Denmark) CITY OF SALASPLIS (Latvia) CITY OF SKOPJE (FYROM) ALBA IULIA MUNICIPALITY (Romania)

Table 8.7. Research projects related to climate change mitigation

Institution	Project	Description	Partners
Cyprus University of Technology	LIFE+ORGANIKO Revamping organic farming and its products in the context of climate change mitigation strategies	The project aims at: − Developing a strategic national plan of mitigating climate change in agriculture through the advancement of organic farming and their products within the Cypriot economy. − Demonstrating the comparative performance of organic production using a series of climate mitigation indicators in the field. − Demonstrating comparative advantages of selected organic products in decreasing the body burden of organophosphate pesticides in children. − Tailoring organic farming protocols (apples and barley) of major importance for Cyprus agriculture to the local farm(er) characteristics. − Organizing the efficient transfer of the results via networking with the scientific community, stakeholders and general public in both Cyprus and Italy. − Evaluating the current situation in Cyprus (before and during project implementation) regarding technical stakeholders’ bottlenecks and consumer perceptions). **Funding:** EU (€975.951) **Duration:** 48 months **Website:** http://organikolife.com/en/	Agricultural Research Institute (Cyprus), The Department of Environment (Cyprus), The Kyoto Club (Italy)
Maritime Institute of Eastern Mediterranean – Mar.In.E.M.	PELAGOS Promoting innovative nEtworks and cLusters for mArine renewable energy synerGies in mediterranean cOasts and iSlands	The sea represents a huge resource for renewable energy (Blue Energy, BE) such as waves, tides, and marine currents. Harnessing the economic potential of this energy in a sustainable manner has been highlighted in the Commission's Blue Growth Strategy as one of key areas, where in order to build the necessary capacity and critical mass, it is necessary to involve a wide range of stakeholders. The project aims to increase the innovation capacities and cooperation of BE actors in MED through promoting a transnational cluster, bringing them together in order to develop a shared understanding of the challenges and collectively devise workable solutions. PELAGOS will establish a Cluster in Blue Energy that will promote novel technologies and provide a mix of support activities to beneficiaries such as technology providers, enterprises, financial operators, authorities, NGOs end citizens. The project will enhance internationalization of the Cluster members through a range of activities that will jointly identify opportunities of BE in Mediterranean insular and coastal regions. This will be achieved through fine-tuning of existing know-how, development of skills, identification of common business opportunities and facilitation of growth by bridging providers and users in targeted maritime industries. The development of this emerging sector can become an important part of the blue economy, fuelling economic growth in coastal regions and create new, high-quality jobs. **Funding:** European Regional Development Fund (€2.396.104) **Duration:** 30 months	Centre For Renewable Energy Sources and Saving (Greece), Italian National Agency for New Technologies, Energy and Sustainable Economic Development (Italy), University of Algarve (Portugal), CTN Marine Technology Centre (Spain), Association of Chambers of Commerce of Veneto Region (Italy), Hellenic Centre for Marine Research (Greece), Pôle Mer Méditerranée - Toulon Var Technologies (France), University of Zagreb (Croatia)

Institution	Project	Description	Partners
Maritime Institute of Eastern Mediterranean – Mar.In.E.M.	ECOPORTIL Environmental Protection of Areas Surrounding Ports using Innovation Tools of Legislation	Increasing of shipping traffic at Balkan MED area has raised critical issues concerning the environmental quality of coasts and sea water, mainly due to the extremely voluminous and complex legislation regarding the environmental protection. The legislation implementation requires modern tools for the training & education stakeholders involved at port activities, public officers and all working to ports that affect through many different ways, the coastal environment. Requirement of continuing training about environmental protection and sustainability issues is considered a major factor Ignorance, lack of organization & accessibility to the relative legislation as well as the problematic implementation of national/international legislation comprise to the gradual degradation of the environment in port areas and the surrounding coastal waters. All ECOPORTIL outputs & results, training material will be available to all EU citizens. **Funding**: European Regional Development Fund (€865.947,66) **Duration**: 30 months	Technological Educational Institute of Epirus (Greece), University of the Aegean (Greece), Bulgarian Ports Infrastructure Company (Bulgaria), National Institute of Meteorology and Hydrology - Bulgarian Academy of Sciences (Bulgaria), Albanian Institute of Transport (Albania)

Table 8.8. Research projects related to climate change impacts and mitigation of greenhouse gas emissions

Institution	Project	Description	Partners
Cyprus University of Technology	Genomite New generation sustainable tools to control emerging mite pests under climate change	In this project, for the first time, comprehensive state-of-the-art genomic, metabolomic and modelling methods will be used to develop the necessary tools and management methods for tackling spider mites that are increasingly serious pests of many important crops throughout the EU. Teams from 7 EU countries and Canada will model the performance of each organism in plant-spider mite-predators tritrophic interaction under changing climatic (CC) conditions. This will be accompanied by determination of reciprocal transcriptional and metabolomics changes in plants (tomato and strawberry) and spider mites (TSSM and TE) upon their interactions under normal and CC scenarios. In addition, we will search for elicitors and effectors of TSSM and TE that are capable of modulating plant defences. Using Systems biology approaches, we will link performance of plants and mites with genome-wide changes in their responses. Thus, our study will not only model performance of organisms involved in tritrophic interaction, but will also model processes whose changes lead to modulated performance under CC. This comprehensive knowledge can then be used to develop new tools and methods for climate-smart pest control. **Funding**: FACCE ERA-NET+ / INTERNATIONAL COOPERATION - PARTICIPATION IN COMMON EUROPEAN PROJECTS (€1.745.000) **Duration:** 24 months **Website**: http://www.emr.ac.uk/projects/the-genomite-project-draft-v2/	East Malling Research (UK), Institut National de la Recherche Agronomique (France), MaxPlanck Institut für Molekulare-Pflanzenphysiologie (Germany), University of Amsterdam (Netherlands), Universidad Politecnica de Madrid (Spain), The University of Western Ontario (Canada), Ghent University (Belgium),

9. Education, training and public awareness

9.1. Introduction

It is generally acknowledged that combating climate change will be a success only if the danger is widely known and understood by the public and especially by those who have to undertake mitigation and adaptation measures. This can be accomplished with intensive education, awareness and training efforts at all levels.

For this purpose, as part of the programme for the implementation of the Convention and the New Delhi Programme, and the relevant provisions of the Kyoto Protocol, Cyprus has carried out a series of actions, which are presented below, aiming at the integration of climate change issues at all educational levels and disciplines, the dissemination of information and promotion of participation of youth, stakeholders, and public, as well as the enhancement of cooperation and co-ordination at regional and international level to promote capacity building.

9.2. General policy toward education, training and public awareness

Climate change in the context of formal and non - formal education is an issue of interdisciplinary investigation and interconnected with all the issues of environment and sustainable development as a matter of national, regional and international interest. The consideration of climate change in this context relies on the fact that climate change is not a mono-dimensional problem, cut off from the rest of the issues, but could be the apparent cause and consequence of a chain of direct and indirect human effects on all environmental issues. Within this context the issue of climate change is examined and treated in the following ways in the Cypriot educational system.

Access of environmental information to the public is provided through the websites of the relevant Ministries and other governmental agencies. With the ratification of the Aarhus Convention, Cyprus has posed legal obligations for the access of information regarding the state of the Environment. In addition, law no. 119(I)/2004 by which Cyprus incorporated the Directive 2003/4/EC on “public access to environmental information” into national legislation, seeks to increase public access and dissemination of information, contributing to a greater public awareness in decision making and environmental protection. According to this law, “environmental information” includes information related to climate change such as: state of elements (among others air, atmosphere, water, coastal areas, biological diversity, and the interactions among them), factors (e.g. emissions, energy), policies and measures, reports, cost-benefit analyses.

The Cypriot Government gives high priority to public consultation and awareness. Draft legislation related to climate change, energy and environmental issues are open to public consultation before their adoption.

9.3. Primary, secondary and higher education

9.3.1. Curriculum on Environmental Education (EE) and Education for Sustainable Development (ESD)

Through the Curriculum of EE/ESD which is an important innovation in the educational system of Cyprus and is formatted in a uniform and systematic way in pre-primary and primary education, the issue of climate change examined through all the other related thematic units such as energy, production and consumption, urbanization, waste, water, transportation. Specifically, it is aimed that students understand in a systematic and holistic way that the problem of climate change is complex, has multiple causes and effects both locally and globally. For this purpose within the education process the issue is viewed through the social, political and cultural aspects, along with the environmental. Climate change is first examined in the immediate local environment of students and then extends through various teaching techniques, applications and examples globally.

For this purpose in the learning process a variety of methodological and pedagogical approaches (experiential learning, simulations, investigations etc) applied in order to help students understand the impact of climate change on a local and global level. Also, the pedagogical principles of Environmental Education and Education for Sustainable Development as intergenerational communication, interaction with place, holistic investigation and action community are applied for studying climate changes.

Examples of issues that are approached through the curriculum of EE/ESD on climate change are:

- Study of the effects of water scarcity at local and global level and awareness of the extent and complexity of the problem across the globe.
- Correlation of water shortage with other issues such as climate change and desertification.
- A study of the factors that contributed to the intensity of the problem of climate change.
- Reflection upon our responsibility on addressing the phenomenon of climate change and suggestion of measures to alleviate the problem.
- Investigation of the measures and actions taken at national and global level to address climate change.
- Interconnection of climate change around the world with the decline of biodiversity.
- Interconnection of the greenhouse effect and global climate change through energy consumption.
- Study of the impact of the increasing use of motorized vehicles on the environment at local and global levels (air pollution, climate change, etc.).
- Awareness of the impact of climate change on social, economic and political level.
- Cooperation of students with agencies and organizations to promote information measures, information and participation in intervention programs on climate change.

It is noted that the above issues are indicative regarding the investigation of environmental issues, since as mentioned above, the twelve thematic units of the curriculum concerning all educational levels approach systematically the issue of climate change.

Additionally, in primary education, climate changes are part of the curriculum of all the distinct subjects. Indicatively through the subject of Science includes specific unit for the atmosphere pollution and the climate changes, aiming students be able to explain the green-house effects, the causes and its role to the climate change, as well as the actions and behaviors that eliminated it. Accordingly to the subject of Greek-language the oral and writing skills, as well as the development of students literacy is pursued through texts, activities, exercises as well as other educational means that consider the climate changes.

9.3.2. Educational tools for the study of climate change

The effective investigation of climate changes in schools, prerequisite the development of the appropriate educational tools. Since climate change are systemic connected with the rest of the environmental and non-sustainable development issues, climate changes are confronted educationally and pedagogically in all the educational materials that produced for supporting the thematic Units of the Curriculum of EE/ESD. Indicatively, the educational tools "Issues in Education for Sustainable Development " and "Rational waste management", are supporting tools for the teacher and the student to study the issues of production and consumption, transportation, desertification, tourism, poverty, waste, where there is special emphasis on the study of climate change. Recently another educational package has been written from the Cyprus Pedagogical Institute on waste management where climate changes are examined in relation with vthe various aspects of waste. It is noted that the study of the issue of climate change is through the application of pedagogical techniques of Environmental Education and Education for Sustainable Development such as debate, simulations, use of new technologies, moral dilemma, concept maps, experimental investigations, bibliographic research, field study, etc. The above tools concern Primary and Secondary Education as a means to support the curriculum of EE/ESD.

In Secondary Education, where the curriculum on EE/ESD has not yet been introduced, the issue of climate change is examined and studied through various subjects. For example, it is referred to the subjects of Biology and Geography.

1st Grade Biology: Activity Book

Examination of Greenhouse effect

- The importance of plants to maintain stable amounts of carbon dioxide in the atmosphere
- Relationship of photosynthesis and greenhouse
- How the increase the amount of carbon dioxide in the atmosphere causes a rise in the average temperature of the Earth
- How humans can cope with the increase in the average temperature of the Earth
- Activity which refers to changing the behaviour of mouflon in times of scarcity

2nd Grade Biology Gymnasium: Activity Book

Topics included:

- Examination of the problem of climate change
- Investigation of the increase in average temperature in Cyprus from 1893 until today
- Investigation of the reduction of average rainfall in Cyprus from 1893 until today
- Investigation the impact of climate change on species' populations, ecosystems and ecological balance
- Human's role on the environmental of the problem of climate change
- Possible solutions, actions and behaviour changes on climate change that we can take individually or collectively
- Other environmental problems caused secondarily by climate change

Grade A Geography: Book and workbook

- "The Earth and Man "
- Emphasis in anthropogenic systems.
- The global problems and challenges to be faced by humankind as expressed by the UN.
- Understanding and interpretation of human interactions with the environment and managing the challenges facing humanity, as is climate change.

Geography, Grade B Gymnasium: Book and workbook

The curriculum of Gymnasium Grade B Geography explores locally and internationally issues related to climate change as natural, urban and rural environments, natural hazards, natural resources management energy, management waste etc. The main issues which concern the curriculum of Grade B Geography are the ways in which they relate the above influencing factors, the patterns and the changes that occur and what will be the impact on the present and future generations.

Beyond the above subjects climate changes are part of the curriculum of all the other subjects of secondary education (Physics, Chemistry, household economy, foreign languages etc) as a horizontal issue.

9.3.3. Higher Education

Several undergraduate and postgraduate programmes in Cypriot Universities deal with diverse aspects of climate change. Undergraduate programmes in Civil & Environmental Engineering and Environmental Science & Technology as well as postgraduate and doctoral programmes in Environmental Engineering, Energy Resource Management, Environmental Science, Environmental Management, and Education for Sustainable Development, contain numerous courses on climate change impacts, economics and mitigation.

9.4. Public information campaigns

One of the missions of the Department of the Environment is to inform and raise public awareness on environmental issues. Among the established campaigns that the Department of Environment organises and/or co-organises are the following:

- The Department of Environment participates every year with the established cycling tour of Nicosia in the European Mobility Week campaign which provides the opportunity to present sustainable mobility alternatives to local residents;
- The Department of Environment organized a lecture open to the public on Climate Change on Wednesday 14 October 2015 at the Cleopatra Hotel. The event was held in view of the UN Climate Change Conference (COP21). The aim of the event was to raise awareness and information about the Paris conference and the exchange of views on how Cyprus contributes to the international effort to reduce greenhouse gas emissions.
- Since 2014 the Department of Environment organizes along with other authorities and organizations the Cyprus Green Public Procurement Awards (CY GPP AWARDS) – EU Ecolabel. The CY GPP Awards is an institution that appears to have a strong response from Contracting Authorities, (State Authorities - Public Sector) and the Public Law Entities and the Local Authorities. In 2017, for the first time, beyond the Public Law Entities, the prizes were also addressed to the private sector.
- In addition to the Green Public Procurement Awards, the European Ecolabel Ecolabel is awarded to Cypriot products. The Department of Environment which is also the EMAS Competent Authority, has implemented EU EMAS in its headquarters in Nicosia with the aim of protecting the environment and its own activities and staff, limiting and reducing its impact on the environment, through the day-to-day operation of the Department, hoping to follow its example other Public Authorities.
- The Department of Environment participates annually as a co-organizer at the Earth Hour celebration held at the Presidential Palace. Households, public buildings and businesses have been involved in turning off the lights for an hour, demonstrating the need to protect the environment and take action on climate change.
- Each year the Department of Environment participates in 'Let's Do it Cyprus' campaign which is part of the 'Let's Do it World' campaign that aims to clean the natural areas of the world from rubbish. The project is implemented in 94 countries all over the world.It is based on volunteer work and the goal is to clean up the waste recorded in the island in a single day. Public and local authorities, private companies, community service companies, recycling companies, non-governmental organizations, associations and schools participate in this effort in order to protect the environment and develop environmental awareness to ensure a cleaner tomorrow.

9.5. Training programmes

9.5.1. Education and training of teachers on climate change

The Ministry of Education and Culture emphasizes the importance of education and training for teachers on Environmental Education and Education for Sustainable Development. Regarding the issue of climate change at the level of teacher education and training, emphasis is given both through mandatory education and through training of teachers to implement the curriculum of the EE/ESD. Also, optional training seminars are offered, with emphasis on the interconnection and systemic examination of environmental issues and sustainable development issues, in which climate change is a key issue for discussion and analysis. Moreover, through the training seminars, special attention is given to familiarize teachers with teaching techniques that they can apply inside and outside the school in order to study the issue of climate change. Training seminars aiming to familiarize teachers with additional educational tools and resources which assist in the implementation of the curriculum of the EE/ESD are offered, with particular emphasis on climate change. Finally, the training of teachers on the issue of climate change is experiential and is conducted in specific areas of environmental interest, through two-day and three-day training seminars at the Environmental Education Centers. The Cyprus Pedagogical Institute, as the responsible institution of the Ministry of Education and Culture for the education and training of teachers is planning to provide educational seminars specifically on climate change, with the cooperation of other agencies and services involved in the issue (Department of Environment, Meteorology Service, Energy Service, Forestry Department etc.).

9.5.2. Environmental Education Programs

All environmental education programs applied in all educational levels (Pre-primary, Primary, Secondary, Vocational and Technical Education) coordinated (Gold- Leaf , Eco Schools, Young Reporters for the Environment, Globe, Semep, Litter less, Learning about Forests) approach climate change according to the theme processed by each participating school. Climate change is approached as a separate, independent study topic or incorporated dimensions of climate change on other related issues such as for example in the study of biodiversity.

Each program has its own objectives, but the ultimate purpose of all is the development of positive attitudes and behaviors concerning the environment and sustainable development, as well as their awareness on climate change.

9.6. Resource or information centres

The issue of climate change in terms of non-formal education is approached systematically through the Network of Environmental Education Centers of the Cyprus Ministry of Education and Culture, which operates as a complementary structure of schools, with the aim of bringing environmental issues into fields of environmental interest and of transferring the learning process in terms of the environmental issues beyond and outside the context of the classroom. Specifically the issue of climate change is studied through all the Environmental Education Centers' Network (Pedoulas, Akrotiri, Athalassa and Salamiou, Kavo-Greko) under specific environmental educational programs implemented at each center. For example, at Pedoulas Environmental Education Center climate change is discussed through environmental education programs concerning the biodiversity of the forests of the Troodos, the Amiantos mine field and desertification in the region, the degradation of soils. At the Athalassa Environmental Education Center, climate change is examined in relation to urbanization, transport and Athalassa National Forest Park. At the Akrotiri Community Environmental Education Center, climatic changes are discussed in relation to the wetland and flora and fauna of the region. At the Salamiou Environmental Education Center, the issue of climate change is discussed in relation to local cultivations and at the Environmental Education Centre Kavo-Greko climate changes are examined in conjunction with the environmental degradation of the area because of the non-sustainable tourism development. An important element in the study of climate change at the non -formal level is the fact that the issue is approached through field studies, where special attention is given to experimental investigation, the interaction of students with space and with local populations. Specifically, all the programs through which the issue of climate change is examined are presented in the website of the Network for Environmental Education Centres (http://www.moec.gov.cy/dkpe/).

9.7. Involvement of the public and non-governmental organisations[71]

One of the most active campaigners for activities mainly associated with GHG mitigation is the Cyprus Energy Agency.

9.7.1. Educational presentations at schools

One of the main objectives of the Energy Agency is the systematic education/ information/ training and special attention is given to educational presentations at schools in Cyprus. Since April 2009, when the Energy Agency began its activities of education, the Energy Agency has visited more than 240 schools of all levels for educational presentations on the issues of renewable energy, energy saving and environmental protection, where 44.400 students and 3.200 teachers were attended ,. Different presentations were prepared for different levels mainly divided according to the age of

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students. These presentations are being regularly updated. A total of 3.217 t/CO_2 reduction it is expected to be achieved with this action by 2020.

Printed posters with energy saving tips

CEA continues the distribution of the poster for kids with energy saving tips to schools that educational activities take place and in other events. More than 63.000 posters have been distributed (out of 72,000).

Annual Kids Drawing Competition

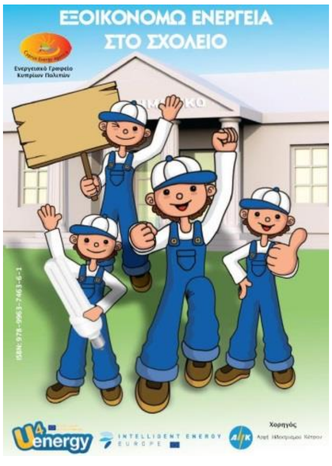
The Cyprus Energy Agency since its date of establishment (2009) has been organising the annual kids drawing competition "I draw for renewable energy, energy saving and environmental protection", which is approved by the Ministry of Education and Culture. During the period 2009-2013 CEA organized the award ceremonies for children who participated in painting competition. The chosen date for the ceremony was every June during the celebrations of the Environment Day.

Monthly Educational Quiz

The Monthly Quiz competition was available online since October 2009. The creation and operation of the monthly quiz was sponsored by the Electricity Authority of Cyprus. The quiz was available in the Kids Educational Corner on the website of CEA www.cea.org.cy.

In the competition, participated childrens aged between 6 to 12 years old. They were able to register and answer up to 10 questions on renewable energy, energy saving and energy production. At the end of each month a winner was announced and an educational award was sent by CEA. The monthly educational quiz was available on CEA's website during the period 2009-2015.

Since the date of launching the on-line quiz competition many pupils participated, and 24 winners have been awarded.



Training materials for teachers

CEA created two reports: "Notes for the elementary education teacher on RES and Energy Saving Techniques" and "Notes for the high school teachers on RES and Energy Saving Techniques". Due to lack of financial resources, both publications are available electronically only on the website of the Energy Agency www.cea.org.cy.

Energy Saving at schools competition

The CEA launched a new competition at schools since September 2011 which was approved by the Ministry of Education and Culture. In the energy saving competition participated 5 schools of elementary education (Aradippou B, Pefkios Georgiadis, Soteras C, Geroskipou B and Limassol A) that are located at 5 different districts of Cyprus. Students of selected schools were asked to write down about the electricity consumption in their schools and electricity meters were placed to metering the consumption. After an educational session of simple methods on how to save energy at schools and at home, they were asked to implement this method for a specific period. The students that proved the greater energy saving according to electricity bills of their school have received an educational personal award as well as for their school.

The competition was organised by the Cyprus Energy Agency and approved by the Ministry of Education and Culture, with the valuable help of the Cyprus University of Technology and sponsored by the Electricity Authority of Cyprus.

Working sheets (that distributed during the educational presentations and working together with kids for better understanding of the educational presentations)

The Cyprus Energy Agency created the working booklets with drawns, crosswords, word search puzzle, drawning the slogan, text completion exercises. The working booklets distributed to teachers to use it as a supplementary educational material or distributed to students as a supplementary educational material.

U4Energy – Schools in Action

The Cyprus Energy Agency has been appointed to be the National Contact Point to promote the U4Energy initiative in Cyprus. Has promoted the U4Energy school competitions and has been moderator for 2011-2012.

The U4energy competition is a unique opportunity for teachers and students to learn more about the efficient use of energy, making both short and long term actions.

For the second consecutive year elementary and secondary schools were invited to participate in this innovative competition and to contribute actively to the development of a more sustainable future. The second round of the competition U4energy has officially re-launched in September 2011 and completed in May 2012. After evaluation of applications, the schools emerged winners at both European and national level.

The schools were awarded in the award ceremony of the U4energy in Brussels, on Tuesday, November 28, 2012, in Belgian Comic Strip Centre.

The ceremony awarded the National Winners of each country and Europeans Winners. Teachers and students from Cyprus and from all European countries travelled to Brussels to attend the awards ceremony and receive their awards.

Energiochi 8

The Cyprus Energy Agency was the National Contact Point to promote the Energiochi 8 initiative in Cyprus. Within the European Competition ENERGIOCHI 8, held on May 28, 2013 in Abruzzo, Italy, the Awards Ceremony. Participated in the competition two schools of Cyprus, Agios Andreas Elementary School and the First Technical School of Nicosia, while the School of Agios Andreas rewarded for its hard work. The European Competition ENERGIOCHI 8 is a special program that engages students of all classes for the academic year 2012-13. The funding is done by the Office of Energy Policy in the region of Abruzzo, in collaboration with the Ministry of Education, the Research University, the Regional Office of Education, Universities L'Aquila, Teramo, Chieti and the agency ENEA. The goal is the students to present their concerns and their sensitivity to the issues of renewable energy, energy saving and environmental protection.

9.7.2. Public information campaigns

Local Authorities and Climate change

The Cyprus Energy Agency is the official Agency for promoting and supporting the Covenant of Mayors initiative in the Local Authorities (LAs) of Cyprus. The Cyprus Energy Agency empowering the role of local authorities in the sustainable energy planning issues and implementation of local sustainable energy action plans, supports the LAs to organise Energy events and to raise awareness about climate change among their citizens.

Also, the Cyprus Energy Agency organised two major events in 2016&2017, supported by the Covenant of Mayors, Energy Cities and Local Authorities. The main aim of the events was to increase the capacity of the municipalities towards the new environmental challenges and to complete successfully energy related projects.

Printing of posters with energy saving tips

The Cyprus Energy Agency designed and printed 4.000 posters for energy saving in offices and is being distributed during the presentations contacted for municipalities office staff, governmental departments and in general for people working in offices.

The poster includes simple tips on how to save energy e.g. computer, during printing, lighting, and finally by heating and air conditioning.

RES and RUE training of targeted groups

The Cyprus Energy Agency continues conducting presentations to the citizens either to rural or urban areas in order to informed about energy efficiency and RES applications in the domestic sector, energy saving at home, bioclimatic design and garden and Smart meters.

The presentations have specific target to inform people on these matters and these presentations are also available on-line. These presentations have been updated regularly. Since the date of establishment of the Cyprus Energy Agency more than 40 Communities/Municipalities were visited by CEA staff in organised events and more than 500 people attended CEA presentations.

Moreover, the Cyprus Energy Agency has developed one new presentation about the "Eco House – A house of almost zero energy", that was presented with great success at Larnaca, Limassol and Pafos districts in collaboration with the Environment Commissioner and the Youth Boards. These presentations to the public were attended by more than 150 people.

Within 2011 the Cyprus Energy Agency has also developed two new presentations, the first one about eco-driving and the second one about energy saving practices at offices. These two presentations are conducted after requests from Municipalities or other public authorities. This new material has been commented by participants positively as they are conducted and distributed informative material. More than 175 people that belong either to municipalities' staff or to public administration have attended those presentations.

Furthermore, the American Youth Leadership Program (AYLP) together with CEA organised an «Energy Day» event (14th July 2016) where 20 high school students engage actively with short - workshops in the construction of a solar oven, solar car and understanding lighting measurements. The American Youth Leadership Program is a leadership training and exchange program for U.S. high school students and adult mentors and focuses on the theme of environment and climate change. It is supported by a grant from the US Department of State, Bureau of Educational and Cultural Affairs, and administered by Legacy International

In 2017, the Cyprus Energy Agency had a stand in the exhibition «YOUR PLANET NEEDS YOU» and gave training presentations about RES&RUE to students (pre-primary, primary, secondary and high education). The exhibition was held at the Cyprus International Fair, EXPO from the 13th of October 2017 till the 1st of December 2017 and was designed by Science Museum of London. The exhibition focuses in some of the most important contemporary issues, like worldwide reduction of natural resources, climate changes, and the need for citizenship activation for a sustainable future.

Knowledge Transfer in Cyprus

The Cyprus Energy Agency in cooperation with the Environment Agency of Austria and the Energy Service of the

Ministry of Energy, will carry out a series of actions in Cyprus to enhance the awareness of businesses and public in relation to the benefits of energy efficiency investments. The awareness actions will start from January 2018 and last for 18 months.

Educational DVD

The Cyprus Energy Agency in the context of its activities and actions and particular in education, public information, undertook the initiative to create an educational documentary, which was presented for first time to the public on Wednesday 6 June 2012 in a public event in the context of celebrations of World Environment Day.

The educational documentary highlights the current electricity generation in Cyprus from fossil fuels in power stations in Cyprus, the impact of fossil fuels on the environment and the need for a shift in the use of Renewable Energy savings and environmental protection and contribution to the fight against climate change. Essentially, the film presents the most representative figures of Cyprus, written in plain language and addresses a wide range of audience. Those who are interested can receive free educational documentary from the Cyprus Energy Agency premises.

Radio spots

Moreover, CEA has created 13 radio spots for sensitisation of all Cyprus citizens on energy saving issues. The radio spots have been on air on 3 radio channels with national coverage for 1,5 months (May-June 2012).

Media relationships

CEA has very good relations with media and was invited by the CyBC (Cyprus Broadcasting, RIK 1) several times for live interviews as well as to the other national radio emissions, local TV etc.

Outdoor Activities

The CEA participates in outdoor activities that are organized by local authorities or other organizations, events related with environmental protection or energy days. The Cyprus Energy Agency participates in the events with the giant game "energy snake" where children participated with enthusiasm. The giant game is based on res, energy saving and climate questions.

9.7.3. Resource or information centres

The projects Buy Smart + and GreenS establishes green procurement support structures in more than 15 countries participating in the two European initiatives, delivering a national language guidance, education, good practice and well-tested tools. Buy Smart+ is supported by the program “Intelligent Energy Europe”and the Greens is financed by the Horizon 2020 programme. The main objectives of Buy Smart+ and GreenS are to consolidate and mainstream green procurement in the participated member states and to transfer the know-how where green procurement is still at an early stage. The main focus of CEA is to transfer knowledge on green procurement and energy related technologies.

The Cyprus Energy Agency is the information centre for 5 products: lighting, office equipment, vehicles, air conditions, household appliances, where citizens can visit and get informed.

Within Buy Smart+ and GreenS, CEA is the support structure for green public procurement, delivering in national language consultation, training, good practice, and well-tested tools. The latter include technical guidelines on several product groups (criteria from the GPP toolkit, adapted to each member state), life cycle cost calculation tools, and training material. A wider uptake of green procurement will be achieved through directly consulting and training purchasers. Through assisting pilot projects, a critical mass of successful green procurement cases will be achieved and subsequently communicated broadly.

The major steps are:

- Green procurement helpdesks providing assistance, know-how and tools in national language
- Dedicated training offers in collaboration with national networks for the private and public sector
- Twinning approach for effective transfer of know-how to newer member states
- Assistance to green procurement pilot projects; addressing of innovative technologies in experienced countries
- Monitoring of the green procurement experiences; policy recommendations for the NEEAPs updates

Already the CEA supported technically two major projects regarding the 100% replacement of street lighting fixtures with LED , in the communities of Alohas and Polystipos and in the capital of Cyprus, Nicosia Municipality.

Under Greens Project, 4 GPP training courses were delivered to public procurers from Cyprus Energy Agency in cooperation with the Department of Environment and the Cyprus Academy of Local Government, covering the different districts of Cyprus. The target group were public procurers, public administrations and local authorities. Future GPP trainings will be organised every year by CEA.

The celebrations of the Green Public Procurement Awards, were held in Cyprus for 3rd consecutive year (13th October 2016) with high success, promoting the best practises implement by the public/local authorities in Cyprus. The CY GPP Awards were organised from the the Department of Environment, the Cyprus Energy Agency and it was supported by Greens project.

9.7.4. International Cooperation on Education, Training and Public Awareness

The CEA is partner in more than 10 European projects, details for which are available on CEA web site. Four projects have been selected for international cooperation on matters of education training and public awareness:

- SERPENTE- Surpassing Energy Targets through Efficient Public Buildings which co-financed by the European Regional Development Fund through the Interregional Cooperation Programme INTERREG IV C. The duration of the programme are 36 months. SERPENTE focuses on publicly owned and managed buildings. Exchange is carried out in 5 subgroups on specific building typologies and functions: historical buildings, social housing, sports facilities, schools, offices. The main goal of SERPENTE is to improve energy efficiency in publicly owned and managed buildings, through improved public policies (www.serpente-project.eu)
- EURONET 50/50 max builds upon the experiences and results of the IEE project EURONET 50/50 (IEE/08/710) which tested and transferred the 50/50 methodology from Germany to around 50

schools in 8 other EU Member States. The EURONET 50/50 project (www.euronet50-50.eu) successfully demonstrated how energy saving potentials in school buildings can be mobilised through addressing split incentive barriers and through strong collaboration between schools (user) and their municipalities (property manager and payer of energy bills): 50% of energy savings achieved from the energy efficiency measures taken by the pupils and teachers are returned through a financial pay-out. The other 50% will be a net saving for the public authority that pays the bills. As a result everyone wins. The concept can make a considerable contribution towards the implementation of local SEAP's in general and energy efficiency in public buildings in particular. The key objectives of EURONET 50/50 max are focused on wider dissemination of the 50/50 concept to at least six new countries around Europe and its strategic roll out, which means uptake of the concept by local, regional and national authorities and its integration into relevant strategies or plans (e.g. local or regional climate or sustainable energy strategies or plans, educational plans at all governance levels, national energy efficiency action plans or other relevant national strategies).

- TEESCHOOLS- The target of the EU of reducing by 20% its total emissions within 2020 has activated actions both in private and public sector. Renovation of buildings emerges as an urgent issue, but there is lack of knowledge on performance/cost characteristics of advanced component and systems for efficient renovation of buildings. Moreover, while incentives are given to private sector, Local Authorities face severe limitations of budget. TEESCHOOLS aims at providing new solutions to Local Authorities both in technical and financial terms to implement Nearly Zero Energy Building (NZEB) renovation activities in Mediterranean Schools.
- Climate-KIC is the EU's largest public private partnership addressing climate change through innovation to build a zero-carbon economy. It addresses climate change across four priority themes: urban areas, land use, production systems, climate metrics and finance. Education is at the heart of these themes to inspire and empower the next generation of climate leaders. Climate-KIC run programmes for students, start-ups, and innovators across Europe via centres in major cities, convening a community of the best people and organisations. Its approach starts with improving the way people live in cities. Our focus on industry creates the products required for a better living environment, and we look to optimise land use to produce the food people need. CEA is part of the Regional Innovation Scheme (RIS) in Cyprus, a consortium consisting of the Cyprus Energy Agency, Cyprus University of Technology [(www.cut.ac.cy)] and Chrysalis Leap [(www.chrysalisleap.com)]. CEA runs the Pioneers into Practice programme in Cyprus, as well as other events and workshops on Climate-KIC's thematic areas. Climate-KIC is supported by the European Institute of Innovation and Technology (EIT), a body of the European Union.
- EUREM is a standardized European EnergyManager training program comprising courses, self-learning and practical work, combined with access to the European alumni network for continued knowledge exchange. Through this project the European EnergyManager program will be accessible in 6 additional countries (Bulgaria, Cyprus, Hungary, Macedonia, Poland and Romania). The Cyprus Energy Agency is licensed to provide the training programme for European Energy Managers in Cyprus (internationally recognized).
- FIESTA - Providing technical support to the Municipality of Larnaca to produce reports on energy savings in households. House visits, energy measurements and energy consulting services with the aim of driving families with children to save energy at home, acting both in terms of energy consumption behaviour and purchasing decisions.
- COMPETE4SECAP is designed to deliver a systematic approach to energy savings in local authorities using energy management systems (EnMS) according to ISO 50001 or European Energy Award with dedicated online monitoring tool and energy saving competitions. EnMS and competitions when combined can trigger significant benefits by providing innovative and efficient way to involve municipalities that have already their SEAPs but do not act in order to foster their integrated development at local level. Trained and engaged municipal employees will be able to better implement energy efficiency projects, which then require higher investments. CEA runs the actions of the project in Cyprus with the support of four local authorities.

9.8. International Cooperation on Education, Training and Public Awareness

Please refer to previous sections

References

Ahern M.J., R.S. Kovats, P. Wilkinson, R. Fewand F. Matthies, 2005. Global health impacts of floods: epidemiological evidence. Epidemiol. Rev., 27, 36-45

Ainsworth E.A. and S.P. Long, 2005. What have we learned from 15 years of freeair CO2 enrichment (FACE)? A metaanalytic review of the responses of photosynthesis, canopy properties and plant production to rising CO2. New Phytol 165: 351-371

Alcamo J., J.M. Moreno, B. Nováky, M. Bindi, R. Corobov, R.J.N. Devoy, C. Giannakopoulos, E. Martin, J.E. Olesen, A. Shvidenko, 2007. Europe. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, page 543, Cambridge University Press, UK. Available at: http://www.ipcc.ch/pdf/assessmentreport/ar4/wg2/ar4-wg2-chapter12.pdf

Alker A., 2009. Impact of Global Warming on Infectious Disease in Cyprus. Cyprus Climate Change Assessment Papers – 2009 Compiled by the Master's Degree Candidates of the Cyprus International Institute in the "Cyprus Climate Workshop", as part of the Institute's “Global Climate Update” course, June 2009

Alpert, P., Ben-Gai, T., Baharad, A., Benjamini, Y., Yekutieli, D., Colacino, M., Diodato, L., Ramis, C., Homar, V., Romero, R., Michaelides, S. and Manes, A. (2002): The paradoxical increase of Mediterranean extreme daily rainfall in spite of decrease in total values. Geophys. Res. Lett., Vol 29, No.11, 31-1 - 31-4

Andreou E., I. Constantinou, D. Ierodiakonou, C. Stefanou, n.d. Impacts of Climate Change on Cyprus Water Supply, Agriculture, and Biodiversity Adaptation and Mitigation Measures.

Atlantis Consulting Cyprus Ltd., n.d. Study for the Assessment of the Environmental Impacts from the Operations for the Management and restoration of the Larnaca Salt Lakes CY 6000002, Action C12. DG Environment, European Commission, Ministry of Agriculture Natural Resources and Environment of the Republic of Cyprus.

Bates B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008. Climate Change and Water’. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp.

Becht M.C., M.A.L. van Tilburg, A.J.J.M. Vingerhoets, I. Nyklicek, J. deVries, C. Kirschbaum, M.H. Antoni and G.L. vanHeck, 1998. Watersnood: een verkennend onderzoek naar de gevolgen voor het welbevinden en de gezondheid van volwassenen en kinderen [Flood: a pilot study on the consequences for well-being and health of adults and children]. Tijdsch. Psychiat., 40, 277-289."

Behrens A., Georgiev A., Carraro M., 2010. Future Impacts of Climate Change across Europe. Center for European Policy Studies (CEPS). Working Document No. 324

Ben Rais Lasram F., D. Mouillot, 2009. Increasing southern invasion enhances congruence between endemic and exotic Mediterranean fish fauna. Biol Inv 11(3): 697–711

Bokszczanin A., 2000. Psychologiczne konsekwencje powodzi u dzieci I mlodziezy [Psychological consequences of floods in children and youth]. Psychol. Wychowawcza, 43, 172-181

Bruggeman A., C. Zoumides, S. Pashiardis, P. Hadjinicolaou, M.A. Lange, T. Zachariadis, 2011c. Effect of climate variability and climate change on crop production and water resources in Cyprus. Study for the Ministry of Agriculture, Natural Resources and Environment, led by the Agricultural Research Institute of Cyprus, June 2011

Bruggeman A., C. Zoumides, S. Pashiardis, P. Hadjinicolaou, M.A. Lange, T. Zachariadis, 2011d. Blue and green water use in crop production in Cyprus; exploring pathways towards climate change adaptation, CYPADAPT presentation, workshop November 2-3, 2011

Bruggeman A., C. Zoumides, S. Pashiardis, P. Hadjinicolaou, M.A. Lange, T. Zachariadis, M. Markou, A. Stylianou, A. Michaelides, 2011a. Working Paper: Economic Impact of Climate Change on the Cypriot Agricultural Sector. Nicosia: The Cyprus Institute

CDC Centers for Disease Control and Prevention, 2009. Water- and Food-borne Diseases. D.o.H.a.H.S. Internet article available at: http://www.cdc.gov/climatechange/effects/waterborne.htm

Chmielewski F.M. and T. Rotzer, 2001. Response of tree phenology to climate change across Europe, Agricultural and Forest Meteorology, 108, 101-12

Christensen J. H. and O.B. Christensen, 2007. A summary of the PRUDENCE model projections of changes in European climate by the end of this century. Climatic Change 81: 7–30

Christensen J.H. and O.B. Christensen, 2007. A summary of the PRUDENCE model projections of changes in European climate by the end of this century. Climatic Change 81: 7–30

Christou K. A., X. Hatzikyriakou, C. Nikolaou, 2001. Die-back of Cyprus cedar (Cedrus brevifolia) at Pafos forest. Proceedings International Conference Forest Research: a challenge for an integrated European approach, Thessaloniki, Greece, 27 August-1 September 2001, Volume I 2001 pp. 269-274. Available at: http://www.cabdirect.org/abstracts/20023189817.html

Clout M. and S. Lowie, 1997. Biodiversity loss due to biological invasion: Prevention and cure. World Conservation Congress Workshop on Alien Species (pp. 29-40). IUCN Species Survival Commission, North American Wetlands Conservation Council (Canada)."

Confalonieri U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich, A. Woodward, 2007. Human health. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 391-431

Cosmatos A., 2009. Global Climate Change. The Effects of Climate Change on Vector Born Diseases (Malaria) in Cyprus. Cyprus Climate Change Assessment Papers –2009 Compiled by the Master's Degree Candidates of the Cyprus International Institute in the "Cyprus Climate Workshop" as part of the Institute's "Global Climate Update" course, June 2009

Crozier M.J., 2009. Deciphering the effect of climatechange on landslide activity: Areview. Elsevier

Curriero F., K.S. Heiner, J. Samet, S. Zeger, L. Strug and J.A. Patz, 2002. Temperature and mortality in 11 cities of the Eastern United States. Am. J. Epidemiol., 155, 80-87

Cyprus Institute, 2011. Climate change and water scarcity in Cyprus, impacts and adaptation. Clico Climate Change, Hydro-conflicts and Human Security. Seventh Framework Programme.

Cyprus International Institute, Harvard School of Public Health. Retrieved from http://cyprusinstitute.us/2009/Ierodiakonou_et_al_4-Climate_Change_Papers.pdf"

CYSTAT, 2010. Agricultural statistics 2008, Series II, Nicosia. Statistical Service Republic of Cyprus Printing Office.

Davenport S., 2008. Drought in Cyprus, Weather News. Weather – November 2008, Vol. 63, No. 11. Available at: http://onlinelibrary.wiley.com/doi/10.1002/wea.345/pdf

Demetriou C., 2005. Implementation of Articles 5 & 6 of the EU Water Framework Directive 2000/60/EC The perspective from a semi-arid Mediterranean island, Coping with drought and water deficiency from research to policy making, Water Development Department of Cyprus. Proceedings of the Arid Cluster Conference, Limassol, 12-13 May 2005, pp. 11-22

Department of Environment (DoE), 2000. Fourth National Report to the United Nations Convention on Biological Diversity. Nicosia: Ministry of Agriculture, Natural Resources & Environment.

Department of Environment (DoE), 2010. Fourth National Report to the United Nations Convention on Biological Diversity. Republic of Cyprus: Ministry of Agriculture, Natural Resources and Environment.

Department of Forests (DoF), 2009b. Short-term Action Plan for the Confrontation of the Implications of Drought in Cyprus state forests – Period 2009-2010. Ministry of Agriculture, Natural Resources and Environment of Cyprus. June 2009, Nicosia.

Department of Forests (DoF), 2011a. Cyprus report: The State of the World's Forest Genetic Resources. Ministry of Agriculture, Natural Resources and Environment of Cyprus. Nicosia.

Department of Forests (DoF), 2011b. Preparation of Management Plans for "Natura 2000" Areas: Management Plan for the Rizoelia National Forest Park (CY6000006) and Alonas, Melission Forests. Ministry of Agriculture, Natural Resources and Environment of Cyprus. Available at: http://www.moa.gov.cy/moa/fd/fd.nsf/a5e0199a400ea5d8c2257060003da28b/caa9c428f48acf25c2257921003aba66?OpenDocument

Department of Forests (DoF), n.d. Department of Forests. Retrieved from http://www.moa.gov.cy/moa/fd/fd.nsf/DMLflora_en/485EE01E2C170171C2256F1C00385AF8?OpenDocument

Durkin M.S., N. Khan, L.L. Davidson, S.S. Zaman and Z.A. Stein, 1993. The effects of a natural disaster on child behaviour: evidence for posttraumatic stress. Am. J. Public Health, 83, 1549-1553

EEA, JRC, WHO, 2008. Impacts of Europe's changing climate, An indicator based assessment.

European Commission (EC), 2008. Drought Management Plan Report Including Agricultural, Drought Indicators and Climate Change Aspects. Water Scarcity and Droughts Expert Network, Technical Report - 2008 – 023. Available at: http://ec.europa.eu/environment/water/quantity/pdf/dmp_report.pdf

European Environment Agency (EEA), 2008a. Impacts of Europe's changing climate – 2008 indicator-based assessment. Copenhagen: European Commission Directorate

European Environment Agency (EEA), 2008b. EU agriculture – taking on the climate change challenge. Brussels: European Commission Directorate

European Environment Agency (EEA), 2010a. Main drought events in Europe, 2000–2009. Available at: http://www.eea.europa.eu/data-andmaps/figures/main-drought-events-ineurope-200020132009

European Environment Agency (EEA), 2010c. Water exploitation index (WEI) in Europe (1990-2007). Available at: http://www.eea.europa.eu/data-andmaps/figures/water-exploitation-index-wei-3

FAO, 2007. Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities. Food and Agriculture Organization, Geneva. Available at: ftp://ftp.fao.org/docrep/fao/009/j9271e/j9271e.pdf"

Faunt J.D., T.J. Wilkinson, P. Aplin, P. Henschke, M. Webb, R.K. Penhall, 1995.The effete in the heat: heat related hospital presentations during a ten day heat wave. Australia and New Zealand Journal of Medicine, 25:117–120

Giannakopoulos C., P. Hadjinicolaou, C. Zerefos, G. Demosthenous, 2009. Changing Energy Requirements in the Mediterranean Under Changing Climatic Conditions, Energies 2, pp.805-815

Giannakopoulos C., P. Hadjinicolaou, E. Kostopoulou, K. V. Varotsos, and C. Zerefos, 2010. Precipitation and temperature regime over Cyprus as a result of global climate change. Adv. Geosci., 23, 17–24, 2010

Hadjichambis A. and A. Della, 2007. Manuscript. Lefkosia: Agricultural Research Institute.

Hadjikyriakou G. and E. Hadjisterkotis, 2002. The adventive plants of Cyprus with new records of invasive species. XXVth International Congress of the International Union of Game biologists and Ixth International Symposium Perdix. Z. Jagdwiss

Hadjinicolaou P., C. Giannakopoulos, C. Zerefos, A.M. Lange, S. Pashiardis, J. Lelieveld, 2011. Mid-21st century climate and weather extremes in Cyprus as projected by six regional climate models. Reg Environ Change, Vol. 11, pp441–457

Hatzaki, M. , Lingis, P., Flocas, H.A., Michaelides, S., Oikonomou, C. (2008): The impact of an upper tropospheric teleconnection pattern on precipitation extremes over Cyprus. Advances in Geosciences, 16, 131-136

Hiederer R. and T. Durrant, 2010.Evaluation of BioSoil Demonstration Project Preliminary Data Analysis. Italy: JRC, ies.

Hochstrat R., Kazner C., 2009. Case study report Cyprus. Flexibility in coping with water stress and integration of different measures. TECHNEAU

IACO Ltd., 2007. National Action Plan to Combat Desertification in Cyprus, Volume I: Environmentally Sensitive Areas to Desertification Map - Executive Summary, Final Report. Nicosia: Environment Service

IFAD, 2009. Livestock and climate change factsheet. International Fund for Agricultural Development. Available at: http://www.ifad.org/lrkm/factsheet/cc.pdf

Intergovernmental Panel on Climate Change (IPCC), 2007. Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Parry, Martin L., Canziani, Osvaldo F., Palutikof, Jean P., van der Linden, Paul J., and Hanson, Clair E. (eds.)]. Cambridge University Press, Cambridge, United Kingdom, 1000 pp.

Intergovernmental Panel on Climate Change (IPCC), 2012. Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. [Field C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, Plattner G.K., S.K. Allen, M. Tignor, P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19

Ioannou A., 2010. The social role of the Agricultural Insurance Organization with data and numbers. Recordings of the radio programme “The time of the Countryside". Available at: www.oga.org.cy/images/.../koinwnikos_rolos.doc

Katsanevakis S., K. Tsiamis, G. Ioannou, N. Michailidis, A. Zenetos, 2009. Inventory of alien marine species of Cyprus. Mediterranean Marine Science 10(2): 109–133

Kirkinen J., A. Martikainen, H. Holttinen, I. Savolainen, O. Auvinen and S. Syri, 2005. ‘Impacts on the energy sector and adaptation of the electricity network business under a changing climate in Finland’, FINADAPT Working Paper 10, Finnish Environment Institute, Helsinki, pp. 12-15

Koroneos C., P. Fokaidis, N. Moussiopoulos, 2005. Cyprus energy system and the use of renewable energy sources, Energy, Volume 30, Issue 10, pages 1889-1901. Available at:. http://www.sciencedirect.com/science/article/pii/S0360544204004931

Kostopoulou E, Jones PD (2005) Assessment of climate extremes in the Eastern Mediterranean. Meteorol Atmos Phys 89: 69–85

Kostopoulou E. and P.D. Jones, 2007a. Comprehensive analysis of the climate variability in the eastern Mediterranean, Part I: Map pattern classification, Int. J. Climatol., 27, 1189–1214

Kostopoulou E. and P.D. Jones, 2007b. Comprehensive analysis of the climate variability in the eastern Mediterranean, Part II: relationships between atmospheric circulation patterns and surface climatic elements, Int. J. Climatol. , 27 (10), 1351-1371

Kostopoulou, E., C. Giannakopoulos, M. Hatzaki, A. Karali, P. Hadjinicolaou, J. Lelieveld and M.A. Lange (2014) Spatial and temporal patterns of recent and future climat extremes in the Eastern Mediterranean and Middle East region. Nat. Hazards Earth Syst. Sci. 14, 1565-1577

Kundzewicz Z.W., M. Radziejewski and I. Pińskwar, 2006. Precipitation extremes in the changing climate of Europe. Climate Research 31: 51–58

Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T. Oki, Z. Sen and I.A. Shiklomanov, 2007, 'Freshwater resources and their management. Climate Change 2007: Impacts, Adaptation and Vulnerability'. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210

Available at: http://www.ipcc.ch/pdf/assessmentreport/ar4/wg2/ar4-wg2-chapter3.pdf

Lingis, P., Michaelides, S.C. (2009): Teleconnection paterns of the Siberian Anticyclone and precipitation over Cyprus. Atmospheric Research, 94, 663- 674.

Lange A.M., 2009. Climate Change and Water Scarcity on Cyprus. Cyprus Climate Conference. Climate Change: A Challenge for Europe and Cyprus, 27th - 29th November 2009. Nicosia, Cyprus. Available at: http://www.cyprus-climate-conference.info/index.php?option=com_content&view=article&id=20&Itemid=25

Lelieveld, J., P. Hadjinicolaou, E. Kostopoulou, C. Giannakopoulos, A. Pozzer, M. Tanarhte and E. Tyrlis (2014) Model projected heat extremes and air pollution in the eastern Mediterranean and Middle East in the 21st century. Reg. Env. Change, 14, 1937-1949

Lemoine N., H.C. Schaefer, K. Böhning-Gaese, 2007. Species richness of migratory birds is influenced by global climate change. In Global Ecology and Biogeography.

Levinsky I., F. Skov, J. Svenning, C. Rahbek, 2007. Potential impacts of climate change on the distributions and diversity patterns of European mammals. In Biodiversity and Conservation

Lindner M., J. Carcia-Gonzalo, M. Kolström, T. Green, R. Reguera, 2008. Impacts of Climate Change on European Forests and Options for Adaptation. Report to the European Commission Directorate-General for Agriculture and Rural Development

Lindner M., M. Maroschek, S. Netherer, A. Kremer, A. Barbati, J. Carcia-Gonzalo, R. Seidl, S. Delzon, P. Corona, M. Kolström, J.M. Lexer, M. Marchetti, 2010. Climate change impacts, adaptive capacity, and vulnerability of European forest ecosystems. Forest Ecology and Management 259, 698–709

Lybczynska M, Christophi C and Lelieveld J. 2015, Heat-related cardiovascular mortality risk in Cyprus: a case-crossover study using a distributed lag non-linear model. Environmental Health (2015) 14:39 DOI 10.1186/s12940-015-0025-8

Maheras P., H.A. Flocas, I. Patrikas, C. Anagnostopoulou, 2001. A 40 year objective climatology of surface cyclones in the Mediterranean region: spatial and temporal distribution. Int J Climatol 21(1):109–130

Maritime Affairs, European Commission (EC), May 2009, The economics of climate change adaptation in EU coastal areas. Available at: http://ec.europa.eu/maritimeaffairs/documentation/studies/documents/cyprus_climate_change_en.pdf

Masterton J.M. and Richardson F.A. 1979. Humidex: a method of quantifying human discomfort due to excessive heat and humidity, report no. CLI 1-79. Downsview, Ontario: Atmospheric Environmental Service

Michaelides S.C., F.S. Tymvios, T. Michaelidou. Spatial and temporal characteristics of the annual rainfall frequency distribution in Cyprus. Atmospheric Research 94 (2009) 606–615

Michaelides, S., Tymvios, F., Charalambous, D: Investigation of trends in synoptic patterns over Europe with artificial neural networks. Advances in Geosciences, 23, 107-112, 2010

Michaelides S., F. Tymvios, S. Athanasatos. Trends of dust transport episodes in Cyprus using a classificartion of synoptic types established with artificial neural networks. Journal of Climatology Volume 2013, Article ID 280248,http://dx.doi.org/10.1155/2013/280248

Ministry of Agriculture, Natural Resources and Environment (MANRE), 2007. National Report on Combating Desertification – Cyprus, Environment Service, February 2007. Available at: http://archive.unccd.int/cop/reports/northmed/national/2006/cyprus-eng.pdf

Ministry of Environment of Lebanon (MoE), (2011), Vulnerability, adaptation and mitigation chapters of Lebanon‘s second national communication: Vulnerability and adaptation of human settlements and infrastructure.

Nakićenović N., R. Swart (Eds), 2000. IPCC Special Report on Emissions Scenarios. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK

Nicholls R.J., F.M.J. Hoozemans, 1996. The Mediterranean: vulnerability to coastal implications of climate change, Ocean and Coastal Management, Volume 31, Issues 2–3, pp. 105-132

Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), 2007. Factsheet Water Requirements of Livestock. Available at: http://www.omafra.gov.on.ca/english/engineer/facts/07-023.htm

Parari M., 2009. Climate Change impacts on coastal and marine habitats of Cyprus. Cyprus International Institute for the Environment and Public Health in Association with Harvard School of Public Health

Parry M.L., O.F. Canziani, J.P. Palutikof et al., 2007. Technical Summary - Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 23-78. Available at: http://www.ipcc.ch/pdf/assessmentreport/ar4/wg2/ar4-wg2-ts.pdf

Pashiardis S., 2002. Trends of precipitation in Cyprus rainfall analysis for agricultural planning, UN Food and Agriculture Organization (FAO), Climagri Workshop, on Development of a regional net-work on climate change and agriculture for the countries in the Mediterranean region, FAO’s headquarters, Rome, Italy.

Pashiardis S., 2011. Κλιματικές αλλαγές στην Κύπρο – στατιστικά στοιχεία και πορίσματα των τελευταίων 100 χρόνων [Climate change in Cyprus – statistical data and conclusions from the last 100 years]

PigWasteMan, 2007. Report on Task 5: Impact on water resources. LIFE Third Countries 2003 Project Deliverable

Plan Bleu, 2011. Mediterranean Strategy for Sustainable Development Follow-Up: Main indicators, 2011 Update. Regional Activity Centre, UNEP. Available at: http://www.planbleu.org/publications/Indicateurs_SMDD_2011_EN.pdf

Price, C., Michaelides, S.C., Pashiardis, S. and Alpert, P. (1999): Long term changes in diurnal temperature range in Cyprus. Atmospheric Research, 51, 85- 98

Proestos Y, Christophides GK, Erguler K, Tanarhte M, Waldock J, Lelieveld J. 2015 Present and future projections of habitat suitability of the Asian tiger mosquito, a vector of viral pathogens, from global climate simulation. Phil. Trans. R. Soc. B 370 : 20130554. http://dx.doi.org/10.1098/rstb.2013.0554

Raskin P., P.H. Gleick, P. Kirshen, R.G. Jr. Pontius and K. Strzepek, 1997. Comprehensive assessment of the freshwater resources of the world. Stockholm Environmental Institute, Sweden. Document prepared for the fifth session of the United Nations Commission on Sustainable Development, 1997

Secretariat of the Convention on Biological Diversity (CBD), 2007. Biodiversity and Climate Change, International Day for Biological Diversity

Shoukri E., T. Zachariadis, 2012. Climate Change in Cyprus: Impacts and Adaptation Policies. Environmental Policy Research Group Report 01-12, Cyprus University of Technology, Limassol

Sofroniou A., Bishop S. 2014. Water Scarcity in Cyprus: A Review and Call for Integrated Policy. Water 2014, 6(10), 2898-2928; doi:10.3390/w6102898

Tanarhte M,Hadjinicolaou P, Lelieveld J (2015) Heat wave characteristics in the eastern Mediterranean and Middle East using extreme value theory. Clim Res Vol. 63: 99–113, 2015

Tsintides C.T., C.S. Christodoulou, P. Delipetrou, K. Georghiou, 2007. The red data book of the Flora of Cyprus. Lefkosia: Cyprus Forestry Association.

Tymvios, F., Savvidou, K., and Michaelides, S. C.: Association of geopotential height patterns with heavy rainfall events in Cyprus, Advances in Geosciences, 23, 73-78, doi:10.5194/adgeo-23-73-2010, 2010.

Tymvios, F., S. Michaelides, D. Charalambous, A. Retalis, D. Paronis, D. G. Hadjimitsis, A. Agapiou, K. Themistokleous, and C. Skouteli. "Connection of Heat Events in Cyprus with Synoptic Upper Air Patterns." In Advances in Meteorology, Climatology and Atmospheric Physics, pp. 787-792. Springer Berlin Heidelberg, 2013

Tyrlis E., F. S. Tymvios, C. Giannakopoulos and J. Lelieveld. The role of blocking in the Summer 2014 collapse of the Etesians over the eastern Mediterranean. Journal of Geophysical Research, DOI: 10.1002/2015JD023543

Unit of Environmental Studies (n.d.). Review of biodiversity research results from Cyprus that directly contribute to the sustainable use of biodiversity in Europe. Lefkosia, Cyprus. Retrieved from: http://www.biostrat.org/Sustainable%20use%20of%20biodiversity%20-%20CY.pdf

United Nations University, 2005. Synthesis Report Baseline Survey on Sustainable Land Management in the Pamir – Alai Mountains. Retrieved from http://www.ehs.unu.edu/file/get/3480

Water Development Department (WDD), 2008. Significant Cyprus Water Management Issues Review, Tell us your opinion. Updated report after public consultation. Ministry of Agriculture, Natural Resources and Environment, Republic of Cyprus, Nicosia

Water Development Department (WDD), 2009. Economic analysis of water use, estimation of the total cost of water services, determination of current levels of cost recovery. Special report 2.1. Ministry of Agriculture, Natural Resources and Environment, Republic of Cyprus, Nicosia. Available at: http://www.moa.gov.cy/moa/wdd/wdd.nsf/all/11E4F13527A4185BC22578BD002FAB66/$file/AnalysisofWaterUses_gr.pdf?openelement

Water Development Department (WDD), 2009a. Economic analysis of water use, estimation of the total cost of water services, determination of current levels of cost recovery. Special report 2.1. Ministry of Agriculture, Natural Resources and Environment, Republic of Cyprus, Nicosia. Available at: http://www.moa.gov.cy/moa/wdd/wdd.nsf/all/11E4F13527A4185BC22578BD002FAB66/$file/AnalysisofWaterUses_gr.pdf?openelement

Water Development Department (WDD), 2011. Implementation of Articles 11, 13 and 15 of the Water Framework Directive (2000/60/EC) in Cyprus. Annex VIII - Final Report on Water Policy, Ministry of Agriculture, Natural Resources and Environment, Republic of Cyprus, Nicosia.

Water Development Department (WDD), 2011a. Cyprus River Basin Management Plan. Ministry of Agriculture, Natural Resources and Environment, Republic of Cyprus, Nicosia. Available at: http://www.moa.gov.cy/moa/wdd/wdd.nsf/guide_en/guide_en?OpenDocument

Water Development Department (WDD), 2011a. Cyprus River Basin Management Plan. Ministry of Agriculture, Natural Resources and Environment, Republic of Cyprus, Nicosia. Available at: http://www.moa.gov.cy/moa/wdd/wdd.nsf/guide_en/guide_en?OpenDocument

Wintgens T., R. Hochstrat, 2006. Report on integrated water reuse concepts. AQUAREC – EVK1-CT-2002-00130. Available at: http://www.amk.rwth-aachen.de/fileadmin/files/Forschung/Aquarec/D19_final_2.pdf

World Health Organisation (WHO), 2010. The WHO e-Atlas of disaster risk for the European Region - Volume 1. Exposure to natural hazards (version 2.0) World Health Organization

World Resources Institute. (n.d.). Biodiversity and Protected Areas - Cyprus. Retrieved from http://earthtrends.wri.org: Biodiversity and Protected Areas-Cyprus, World Resources Institute.

Zachariadis T. and P. Hadjinicolaou, 2012. The Economic Effect of Climate Change on Electricity Use – A Case Study from Cyprus. Economic Policy Paper 08-12, Economics Research Centre, University of Cyprus. http://www.ucy.ac.cy/erc/documents/DOP_8-12.pdf

Zachariadis T., 2010. Forecast of electricity consumption in Cyprus up to the year 2030: The potential impact of climate change, Energy Policy, Volume 38, Issue 2, pages 744-750. Available at: http://www.sciencedirect.com/science/article/pii/S0301421509007460"

Zenetos A., E. Meric, M. Verlaque, P. Galli, C.F. Boudouresque, A. Giangrande, M. Bilecenoglu, 2008. Additions to the annotated list of marine alien biota in the Mediterranean with special emphasis on Foraminifera and Parasites. Mediterranean Marine Science.

Zenetos A., M.E. Cinar, M.A. Pancucci-Papadopoulou, J.G. Harmelin, G. Furnari, F. Andaloro, , H. Zibrowius, 2005. Annotated list of marine alien species in the Mediterranean with records of the worst invasive species. In Mediterranean Marine Science

Zittis, G., P. Hadjinicolaou, M. Fnais and J. Lelieveld (2015) Projected changes of heat wave characteristics in the eastern Mediterranean and the Middle East. Reg. Environ. Change, doi: 10.1007/s10113-014-0753-2

Annex I: BIENNIAL REPORT

A1. Introduction

This report constitutes the second Biennial Report of Cyprus, as required by Decision 2/CP.17 of the Conference of the Parties under the United Nations Framework Convention on Climate Change (UNFCCC).

A2. Information on GHG emissions and trends, GHG inventory including information on national inventory system

Please refer to Chapter 2 of the National Communication.

A2.1. Introduction and summary information from the national GHG inventory

Please refer to Chapter 3 of the National Communication.

A2.2. National inventory arrangements

A2.2.1. Summary information on national inventory arrangements

Please refer to Chapter 3.3 of the National Communication.

A2.2.2. Summary information on changes to national inventory arrangements since the last National Communication or Biennial report

The national inventory arrangements and the QA/QC procedures have been restructured in 2017, to meet the requirements of CMP and COP Decisions relevant to national systems and QA/QC. The most important change is that the legal framework defining the roles-responsibilities and the co-operation between the DoE Inventory team and the designated contact points of the competent Ministries was formalized by Council of Ministers' Decision adopted 15/11/2017 entitled "Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities". The above-mentioned Decision includes a description of each entity's responsibilities, concerning the inventory preparation, data providing or other relative information. This formal framework has improved the collaboration between the entities involved, assuring the timely collection and quality of the activity data required and solving data access restriction problems raised due to confidentiality issues.

A3. Quantified economy-wide emission reduction target

This section explains the EU 2020 emission reduction target under the UNFCCC and the target compliance architecture set up within the EU in order to meet that target. It also gives an overview of other EU emission reduction targets that are helping achieve the quantified economy-wide emission reduction target under the UN.

A3.1. Description of the 2020 EU pledge (QEERT)

In 2010, the EU submitted a pledge to reduce its GHG emissions by 2020 by 20 % compared to 1990 levels, in order to contribute to achieving the ultimate objective of the UNFCCC: 'to stabilise GHG concentrations at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system'[72], or, in other words, to limit the global temperature increase to less than 2°C compared to temperature levels before industrialization (FCCC/CP/2010/7/Add.1). The EU had also committed to raising this target to a 30 % emission reduction by 2020 compared with 1990 levels, provided that other developed countries also commit to achieving comparable emission reductions,

[72] First steps to a safer future: Introducing the United Nations Framework Convention on Climate Change http://unfccc.int/essential/_background/convention/items/6036.php

and that developing countries contribute adequately, according to their responsibilities and respective capabilities.

This offer was reiterated in the submission to the UNFCCC by the EU-28 and Iceland on 30 April 2014[73].

The definition of the Convention target for 2020 is documented in the revised note provided by the UNFCCC Secretariat on the 'Compilation of economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention' (FCCC/SB/2011/INF.1/Rev.1 of 7 June 2011). In addition, the EU provided additional information relating to its quantified economy wide emission reduction target in a submission as part of the process of clarifying the developed country Parties' targets in 2012 (FCCC/AWGLCA/2012/MISC.1).

The EU's accounting rules for the target under the UNFCCC are more ambitious than the current rules under the Kyoto Protocol, for example, including international aviation, and adding an annual compliance cycle for emissions under the Effort Sharing Decision (ESD) or higher Clean Development Mechanism (CDM) quality standards under the EU Emissions Trading System (EU ETS) (FCCC/TP/2013/7). Accordingly, the following assumptions and conditions apply to the EU's 20 % target under the UNFCCC:

- The EU Convention pledge does not include emissions/removals from Land Use, Land Use Change and Forestry, but it is estimated to be a net sink over the relevant period. EU inventories also include information on emissions and removals from LULUCF in accordance with relevant reporting commitments under the UNFCCC. Accounting for LULUCF activities only takes place under the Kyoto Protocol;
- The target covers the gases CO2, CH4, N2O, HFCs, PFCs and SF6;
- The target refers to 1990 as a single base year for all covered gases and all Member States. Emissions from international aviation to the extent it is included in the EU ETS are included in the target[74];
- A limited number of CERs, ERUs and units from new market-based mechanisms may be used to achieve the target (see Section 2.2.2.3): in the ETS, the use of international credits is capped (up to 50 % of the reduction required from EU ETS sectors by 2020). Quality standards also apply to the use of international credits in the EU ETS, including a ban on credits from LULUCF projects and certain industrial gas projects. In the ESD sectors, the annual use of international credits is limited to up to 3 % of each Member State's ESD emissions in 2005, with a limited number of Member States being permitted to use an additional 1 % from projects in Least Developed Countries (LDCs) or Small Island Developing States (SIDS), subject to conditions;
- The Global Warming Potentials (GWPs) used to aggregate GHG emissions up to 2020 under EU legislation were those based on the Second Assessment Report of the IPCC when the target was submitted. In accordance with the CMP Decision to revise the GWPs to those from the IPCC Fourth Assessment Report (AR4) revised GWPs from AR4 were adopted for the EU ETS. The revised GWPs were taken into account for the revision of the ESD target. For the implementation until 2020, GWPs from AR4 will be used consistently with the UNFCCC reporting guidelines for GHG inventories.

Table I3.1. Key facts of the Convention target of the EU-28

Parameters	Target
Base year	1990
Target Year	2020

[73] European Union, its Member States and Iceland submission pursuant to par 9 of decision 1/CMP.8' http://ec.europa.eu/clima/policies/international/negotiations/docs/eu_submission_20140430_en.pdf

[74] In the EU, the sum of emissions covered by categories 1.A.3.a 'domestic aviation' and memo item 'international bunkers - aviation' go beyond the scope of the EU target, as emissions from international aviation are included in the EU Climate and Energy Package and the EU target under the UNFCCC to the extent to which aviation is part of the EU ETS.

Emission Reduction Target	-20 % in 2020 compared to 1990
Gases covered	CO2, CH4, N2O, HFCs, PFCs, SF6
Global Warming Potential	AR4
Sectors Covered	All IPCC sources and sectors, as measured by the full annual inventory and international aviation to the extent it is included in the EU ETS.
LULUCF	Accounted under KP, reported in EU inventories under the Convention. Assumed to produce net removals
Use of international credits (JI and CDM)	Possible subject to quantitative and qualitative limits.
Other	Conditional offer to move to a 30 % reduction by 2020 compared to 1990 levels as part of a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.

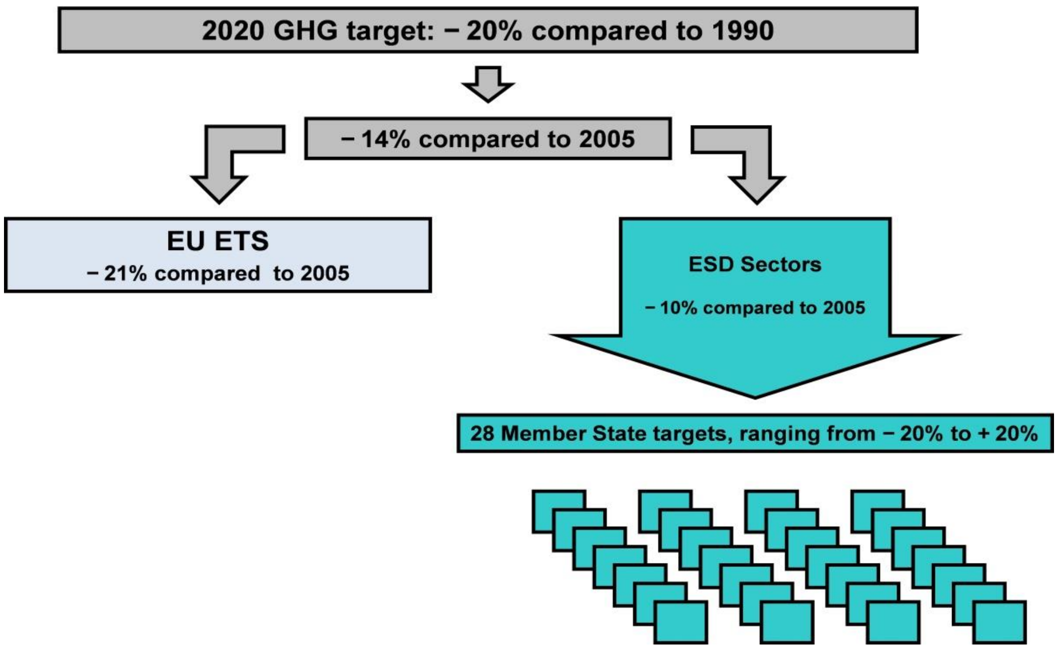
A3.2. The EU target compliance architecture

A3.2.1. The 2020 climate and energy package

In 2009 the EU established internal rules under its "2020 climate and energy package" [75]- these underpin the EU implementation of the target under the Convention. The package introduced a clear approach to achieving the 20 % reduction of total GHG emissions from 1990 levels, which is equivalent to a 14 % reduction compared to 2005 levels. This 14 % reduction objective is divided between the ETS and ESD sectors. These two sub-targets are:

- a 21 % reduction target compared to 2005 for emissions covered by the ETS (including domestic and international aviation);
- a 10 % reduction target compared to 2005 for ESD sectors, shared between the 28 Member States (MS) through individual national GHG targets.

The distribution of the total target across the ETS and ESD is shown in Figure I3.1.



[75] http://ec.europa.eu/clima/policies/package/index_en.htm

Figure I3.1. GHG targets under the 2020 climate and energy package (Source: European Commission)

Under the revised EU ETS Directive (Directive 2009/29/EC), a single ETS cap covers the EU Member States and three participating non-EU countries (Norway, Iceland and Liechtenstein), and there are no further individual caps by country. Allowances allocated in the EU ETS from 2013 to 2020 decrease by 1.74 % annually, starting from the average level of allowances issued by Member States for the second trading period (2008–2012).

The three non-EU countries participating in EU ETS (Norway, Iceland and Liechtenstein) are also subject to a similarly defined cap and the same annual decrease in allowance allocation. The vast majority of emissions within the EU which fall outside the scope of the EU ETS are addressed under the Effort Sharing Decision (ESD) (Decision No 406/2009/EC). The ESD covers emissions from all sources outside the EU ETS, except for emissions from domestic and international aviation (which were included in the EU ETS from 1 January 2012), international maritime emissions, and emissions and removals from land use, land-use change and forestry (LULUCF). It thus includes a diverse range of small-scale emitters in a wide range of sectors: transport (cars, trucks), buildings (in particular heating), services, small industrial installations, fugitive emissions from the energy sector, emissions of fluorinated gases from appliances and other sources, agriculture and waste. Such sources accounted for 55 % of total GHG emissions in the EU in 2013[76].

While the EU ETS target is to be achieved by the EU as a whole, the ESD target was divided into national targets to be achieved individually by each Member State (see Figure 3-2). Under the Effort Sharing Decision, national emission targets for 2020 are set, expressed as percentage changes from 2005 levels. These changes have been transferred into binding quantified annual reduction targets for the period from 2013 to 2020 (Commission Decisions 2013/162/EU and 2013/634/EU), denominated in Annual Emission Allocations (AEAs). At country level, 2020 targets under the ESD range from -20 % to +20 %, compared to 2005 levels. ESD targets for 2020 for each EU Member State are shown in Figure I3.2.

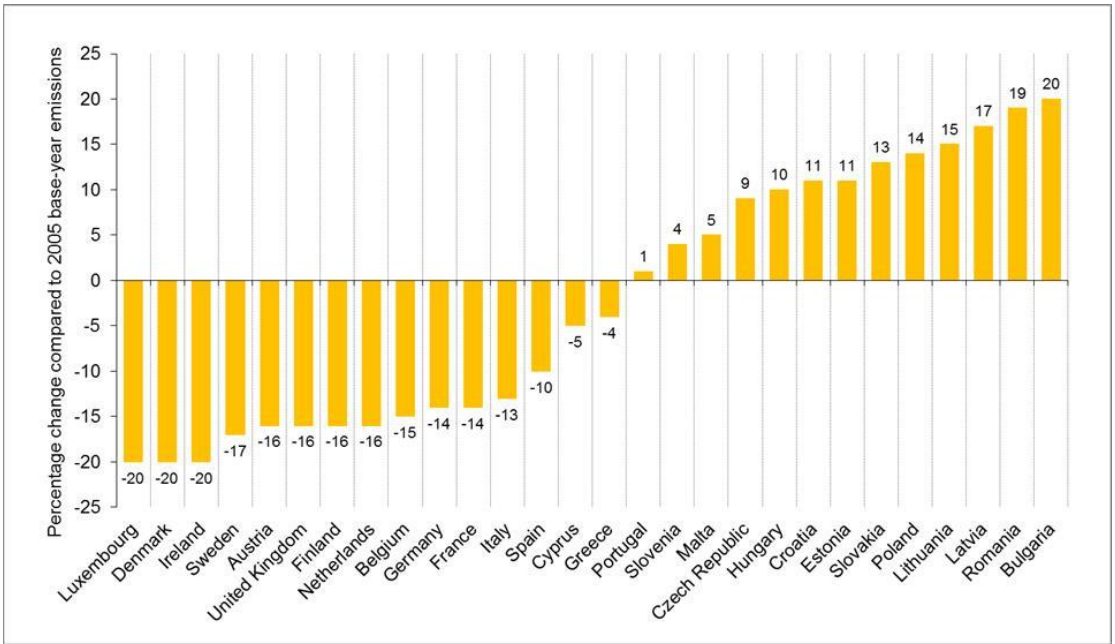


Figure I3.2 National 2020 GHG emission limits under the ESD, relative to 2005 emissions levels (Source: EU Decision No 406/2009/EC, Annex 2)

[76] European Commission. Commission Staff Working Document - Accompanying the document: Report from the Commission to the European Parliament and the Council on evaluating the implementation of Decision No. 406/2009/EC pursuant to its Article 14. (SWD(2016) 251 final). 2016. https://ec.europa.eu/transparency/regdoc/rep/10102/2016/EN/10102-2016-251-EN-F1-1-ANNEX-1.PDF

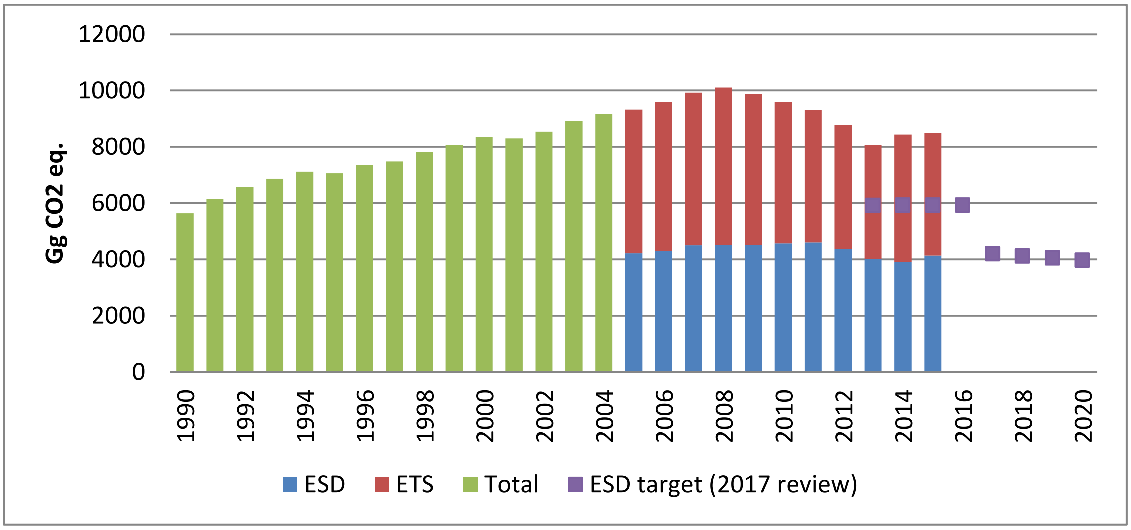
The target levels have been set on the basis of Member States' relative Gross Domestic Product per capita. In addition, different levels of development in the EU-28 are taken into account by the provision of several flexibility options. Up to certain limitations, the ESD allows Member States to make use of flexibility provisions for meeting their annual targets: carry-over of over-achievements to subsequent years within each Member State, transfers of AEAs between Member States and the use of international credits (credits from Joint Implementation and the Clean Development Mechanism). MS exceeding their annual AEA, even after taking into account the flexibility provisions and the use of JI/CDM credits, will face inter alia a penalty – a deduction from their emission allocation of the following year (excess emissions, multiplied by 1.08).

A3.2.1.1. Cyprus' reduction target under the ESD

Cyprus is committed to reducing its emissions in sectors covered under the Effort Sharing Decision (ESD, non-ETS) by 5% compared to 2005 emissions. The quantified annual reduction targets set by EU Decisions[77] for Cyprus are 5.92 million AEA in 2013, reducing to 3.97 million in 2020 (according to AR4 GWPs). The cumulative amount of AEAs for the period 2013-2020 is set at 40.0 Mt CO_2 eq. The annual allocation is presented in Table I3.2 and Figure I3.3.

Table I3.2. Cyprus' ESD annual emission allocations (t CO_2 eq.) for the period 2013–2020, using GWPs calculated applying GWP from the AR4, according to Commission Decision 2017/1471

Year	Annual Emission Allocations (t CO_2 eq.)
2013	5 919 071
2014	5 922 555
2015	5 926 039
2016	5 929 524
2017	4 196 633
2018	4 122 837
2019	4 049 042
2020	3 975 247
TOTAL	**40 040 948**



[77] Commission Decision of 26 March 2013 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council (2013/162/EU) available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013D0162;
Commission Decision (EU) 2017/1471 of 10 August 2017 amending Decision 2013/162/EU to revise Member States' annual emission allocations for the period from 2017 to 2020 available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2017.209.01.0053.01.ENG

Figure I3.3. Cyprus' total greenhouse gas emissions for the period 1990-2015, including a breakdown of the emissions 2008-2015 in emissions under ETS and emissions under ESD (non-ETS) and the ESD target for 2013-2020 (Gg CO_2 eq).

A3.2.2. Monitoring on progress to 2020 targets

For the monitoring of GHG emissions at the EU and the Member State level, the Monitoring Mechanism Regulation has been adopted, see section 2.2.2.1 of the EU's second Biennial Report. Also for the effective operation of the EU ETS, robust, transparent, consistent and accurate monitoring and reporting of greenhouse gas emissions are essential, therefore an annual procedure of monitoring, reporting and verification (MRV) at the installation level is implemented. For a description of the requirements contained therein, please refer to section 2.2.2.1 of the EU's second Biennial Report. Installation and aircraft operators have to monitor, report and verify their annual emissions in accordance with two EU Regulations, the Monitoring and Reporting Regulation (MRR) and the Accreditation and Verification Regulation (AVR). For a description of the requirements contained therein, please refer to in section 2.2.2.2 of the EU's second Biennial Report.

Monitoring, reporting and verification of the ESD targets mainly takes place through the submission of the national GHG inventories by MS. Chapter III of the Commission Implementing Regulation 749/2014 sets out strict criteria by which MS national GHG inventories GHG emissions are reviewed annually at the EU-level. Based on this review, the European Commission issues an implementing decision on MS ESD emissions in the given year, which might lead to MS inter alia facing penalties as described above.

A3.2.3. Accounting for Market-based Mechanisms under the 2020 QEERT target

Please refer to Section 5.4 of the 7th National Communication.

A3.2.3. Other EU emission reduction targets

In addition to the EU target under the Convention, the EU also committed to a legally binding quantified emission limitation reduction commitment for the second commitment period of the Kyoto Protocol (2013 - 2020). In Table I3.3 all relevant GHG reduction targets for the EU and their key facts are displayed in an overview. On the left, the table includes the international commitments under the Kyoto Protocol and the UNFCCC. On the right, the EU commitments under the Climate and Energy Package are included.

A4. Progress in achievement of the quantified economy-wide emission reduction targets

Please refer to Section 5.3.1 of the 7th National Communication.

A5. Projections

Please refer to Chapter 5 of the 7th National Communication.

A6. Provision of financial, technological and capacity building support to developing countries

Please refer to Chapter 7 of the 7th National Communication.

Table I3.3. Overview of EU targets

	International commitments			EU domestic legislation	
	Kyoto Protocol		UNFCCC	Climate and Energy Package	
				EU ETS	ESD
Target year of period	First commitment period (2008-2012)	Second commitment period (2013-2020)	2020	2013-2020	2013-2020
Emission reduction Target	-8%	-20%	-20%	-21 % compared to 2005 for ETS emissions	Annual targets by MS. In 2020 -10 % compared to 2005 for non-ETS emissions
Further targets	-	-	Conditional target of - 30 % if other Parties take on adequate commitments	Renewable Energy Directive: 20 % share of renewable energy of gross final energy consumption; Energy Efficiency Directive : Increase energy efficiency by 20 %	
Base year	1990 KP Flexibility rules (Art 3(5)) regarding F-Gases and Economies in Transition	1990, but subject to flexibility rules. 1995 or 2000 may be used as the base year forNF3	1990	1990 for overall emission reduction target; 2005 for renewable energy and energy efficiency target; as well as for targets broken down into ETS and non-ETS emissions	
LULUCF	Included ARD and other activities if elected	Includes ARD and forest management, other activities if elected (new accounting rules)	Excluded	Excluded	
Aviation	Domestic aviation included. International aviation excluded	Domestic aviation included. International aviation excluded	Aviation in the scope of the EU ETS included. In practice total aviation emissions considered	Domestic and international aviation included, as in the scope of EU ETS	Aviation generally excluded, some domestic aviation included (operators below ETS de minimis thresholds)
Use of international Credits	Use of KP flexible mechanisms subject to KP rules	Use of KP flexible mechanisms subject to KP rules	Subject to quantitative and qualitative limits	Subject to quantitative and qualitative limits	Subject to quantitative and qualitative limits
Carry-over of units from preceding periods	Not applicable	Subject to KP rules including those agreed in the Doha Amendment	Not applicable	EU ETS allowances can be banked into subsequent ETS trading periods since the second trading period	No carry-over from previous period

	International commitments			EU domestic legislation	
	Kyoto Protocol		UNFCCC	Climate and Energy Package	
				EU ETS	ESD
Gases covered	CO2, CH4, N2O, HFCs, PFCs, SF6	CO2, CH4, N2O, HFCs, PFCs, SF6, NF3	CO2, CH4, N2O, HFCs, PFCs, SF6	CO2, CH4, N2O, HFCs, PFCs, SF6[78]	
Sectors included	Annex A of KP (Energy, IPPU, agriculture, waste), LULUCF according to KP accounting rules for CP1	Annex A of KP (Energy, IPPU, agriculture, waste), LULUCF according to KP accounting rules for CP2	Energy, IPPU, agriculture, waste, aviation in the scope of the EU ETS	Power & heat generation, energy-intensive industry sectors, aviation (Annex 1 of ETS directive)	Transport (except aviation), buildings, non-ETS industry, agriculture (except forestry) and waste
GWPs used	IPCC SAR	IPCC AR4	IPCC AR4	IPCC AR4	IPCC AR4

[78] In its third trading period, the EU ETS however only covers the gases CO2, N2O, CH4 and C2F6.

Annex II: Summary tables of GHG emissions for Cyprus in the common reporting format for the whole of the reporting period of the NIR2017 (1990-2015)

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1990
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	4520.60	691.75	308.95	NO,NE	NO	0.03	NO	NO	5521.32
1. Energy	3895.60	10.55	34.51						3940.66
A. Fuel combustion (sectoral approach)	3895.60	10.55	34.51						3940.66
1. Energy industries	1761.49	1.71	3.98						1767.17
2. Manufacturing industries and construction	512.20	0.88	1.72						514.80
3. Transport	1180.52	5.40	27.80						1213.71
4. Other sectors	430.40	2.53	0.98						433.91
5. Other	11.00	0.04	0.03						11.06
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	723.58	NE,NA,NO	41.30	NO,NE	NO	0.03	NO	NO	764.91
A. Mineral industry	717.24								717.24
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	6.30	NE,NA	NE,NA						6.30
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				NO,NE					NO,NE
G. Other product manufacture and use	0.04	NE	41.30			0.03			41.37
H. Other									
3. Agriculture	1.82	308.39	220.81						531.02
A. Enteric fermentation		196.97							196.97
B. Manure management		111.07	71.72						182.79
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	148.99						148.99
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.35	0.11						0.45
G. Liming	NO								NO
H. Urea application	1.82								1.82
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-100.39	0.04	0.03						-100.32
A. Forest land	-100.39	0.04	0.03						-100.32
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	372.77	12.29						385.06
A. Solid waste disposal	NA,NO	258.34							258.34
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		114.43	12.29						126.72
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	915.95	0.47	8.38						924.79
Aviation	733.16	0.13	6.11						739.40
Navigation	182.79	0.34	2.26						185.39
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	17.95								17.95
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									5621.64
Total CO_2 equivalent emissions with land use, land-use change and forestry									5521.32
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1991
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)(1)	4987.71	702.57	308.98	0.00	NO	0.03	NO	NO	5999.29
1. Energy	4423.58	11.12	36.24						4470.94
A. Fuel combustion (sectoral approach)	4423.58	11.12	36.24						4470.94
1. Energy industries	1824.04	1.76	4.29						1830.09
2. Manufacturing industries and construction	938.38	1.29	2.68						942.35
3. Transport	1178.56	5.56	28.19						1212.31
4. Other sectors	470.37	2.48	1.05						473.89
5. Other	12.23	0.04	0.03						12.30
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	682.02	NE,NA,NO	42.47	0.00	NO	0.03	NO	NO	724.51
A. Mineral industry	676.36								676.36
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	5.61	NE,NA	NE,NA						5.61
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				0.00					0.00
G. Other product manufacture and use	0.04	NE	42.47			0.03			42.54
H. Other									
3. Agriculture	1.47	313.68	218.15						533.30
A. Enteric fermentation		195.66							195.66
B. Manure management		117.70	72.10						189.80
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	145.95						145.95
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.32	0.10						0.42
G. Liming	NO								NO
H. Urea application	1.47								1.47
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-119.36	0.13	0.08						-119.15
A. Forest land	-119.36	0.13	0.08						-119.15
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	377.65	12.04						389.69
A. Solid waste disposal	NA,NO	262.74							262.74
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		114.91	12.04						126.94
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:(2)									
International bunkers	1046.15	0.49	9.12						1055.75
Aviation	869.85	0.15	7.25						877.25
Navigation	176.30	0.34	1.87						178.50
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	15.45								15.45
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									6118.43
Total CO_2 equivalent emissions with land use, land-use change and forestry									5999.29
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

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CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)(1)	5356.50	731.65	341.51	0.00	NO	0.03	NO	NO	6429.70
1. Energy	4748.14	11.45	38.54						4798.13
A. Fuel combustion (sectoral approach)	4748.14	11.45	38.54						4798.13
1. Energy industries	2120.79	2.06	4.89						2127.74
2. Manufacturing industries and construction	726.57	0.79	1.77						729.12
3. Transport	1324.53	5.80	30.60						1360.93
4. Other sectors	561.45	2.75	1.24						565.44
5. Other	14.81	0.05	0.04						14.90
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	732.89	NE,NA,NO	43.57	0.00	NO	0.03	NO	NO	776.50
A. Mineral industry	726.77								726.77
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	6.08	NE,NA	NE,NA						6.08
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				0.00					0.00
G. Other product manufacture and use	0.04	NE	43.57			0.03			43.65
H. Other									
3. Agriculture	1.92	334.57	245.90						582.38
A. Enteric fermentation		200.52							200.52
B. Manure management		133.73	76.09						209.81
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	169.72						169.72
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.32	0.10						0.41
G. Liming	NO								NO
H. Urea application	1.92								1.92
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-126.46	0.04	0.03						-126.39
A. Forest land	-126.46	0.04	0.03						-126.39
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	385.60	13.48						399.08
A. Solid waste disposal	NA,NO	267.47							267.47
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		118.13	13.48						131.61
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
Memo items:(2)									
International bunkers	1030.73	0.50	9.01						1040.25
Aviation	845.00	0.15	7.04						852.19
Navigation	185.74	0.36	1.96						188.06
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	15.25								15.25
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								

Total CO_2 equivalent emissions without land use, land-use change and forestry	6556.09
Total CO_2 equivalent emissions with land use, land-use change and forestry	6429.70
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
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CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)(1)	5622.70	759.87	362.21	0.01	NO	0.04	NO	NO	6744.82
1. Energy	4926.99	11.57	39.03						4977.59
A. Fuel combustion (sectoral approach)	4926.99	11.57	39.03						4977.59
1. Energy industries	2242.99	2.18	5.18						2250.35
2. Manufacturing industries and construction	768.41	0.84	1.88						771.14
3. Transport	1342.09	5.75	30.68						1378.52
4. Other sectors	558.13	2.75	1.25						562.13
5. Other	15.37	0.05	0.04						15.46
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	805.08	NE,NA,NO	44.55	0.01	NO	0.04	NO	NO	849.67
A. Mineral industry	795.32								795.32
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	9.74	NE,NA	NE,NA						9.74
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				0.01					0.01
G. Other product manufacture and use	0.01	NE	44.55			0.04			44.60
H. Other									
3. Agriculture	1.60	353.63	264.99						620.22
A. Enteric fermentation		209.32							209.32
B. Manure management		144.01	81.23						225.24
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	183.66						183.66
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.31	0.10						0.40
G. Liming	NO								NO
H. Urea application	1.60								1.60
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-110.97	0.32	0.21						-110.43
A. Forest land	-110.97	0.32	0.21						-110.43
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	394.34	13.44						407.78
A. Solid waste disposal	NA,NO	272.85							272.85
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		121.49	13.44						134.93
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:(2)									
International bunkers	874.81	0.44	7.55						882.79
Aviation	717.63	0.13	5.98						723.73
Navigation	157.18	0.31	1.57						159.06
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	15.15								15.15
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									6855.26
Total CO_2 equivalent emissions with land use, land-use change and forestry									6744.82
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	5862.16	771.88	351.28	0.28	NO	0.05	NO	NO	6985.64
1. Energy	5134.26	11.95	40.83						5187.04
A. Fuel combustion (sectoral approach)	5134.26	11.95	40.83						5187.04
1. Energy industries	2370.90	2.27	5.50						2378.67
2. Manufacturing industries and construction	782.00	0.84	1.89						784.73
3. Transport	1395.25	6.08	32.15						1433.48
4. Other sectors	570.29	2.70	1.26						574.26
5. Other	15.82	0.05	0.04						15.91
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	841.29	NE,NA,NO	45.42	0.28	NO	0.05	NO	NO	887.03
A. Mineral industry	827.93								827.93
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	13.34	NE,NA	NE,NA						13.34
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				0.28					0.28
G. Other product manufacture and use	0.01	NE	45.42			0.05			45.48
H. Other									
3. Agriculture	1.70	353.77	250.83						606.30
A. Enteric fermentation		212.63							212.63
B. Manure management		140.94	81.01						221.96
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	169.75						169.75
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.19	0.06						0.25
G. Liming	NO								NO
H. Urea application	1.70								1.70
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-115.09	0.84	0.55						-113.71
A. Forest land	-115.09	0.84	0.55						-113.71
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	405.33	13.65						418.97
A. Solid waste disposal	NA,NO	278.42							278.42
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		126.91	13.65						140.55
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	930.85	0.53	7.94						939.32
Aviation	736.27	0.13	6.14						742.53
Navigation	194.58	0.40	1.80						196.79
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	15.40								15.40
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7099.35
Total CO_2 equivalent emissions with land use, land-use change and forestry									6985.64
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1995
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) (1)	5721.42	795.25	397.62	1.64	NO	0.06	NO	NO	6915.99
1. Energy	5038.75	12.80	41.82						5093.38
A. Fuel combustion (sectoral approach)	5038.75	12.80	41.82						5093.38
1. Energy industries	2166.14	2.09	4.91						2173.15
2. Manufacturing industries and construction	770.90	0.80	1.81						773.51
3. Transport	1482.01	6.26	33.67						1521.94
4. Other sectors	602.54	3.59	1.38						607.52
5. Other	17.17	0.06	0.04						17.27
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	807.75	NE,NA,NO	46.19	1.64	NO	0.06	NO	NO	855.64
A. Mineral industry	794.60								794.60
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	13.14	NE,NA	NE,NA						13.14
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				1.64					1.64
G. Other product manufacture and use	0.01	NE	46.19			0.06			46.26
H. Other									
3. Agriculture	1.54	369.82	295.06						666.42
A. Enteric fermentation		221.98							221.98
B. Manure management		147.64	84.02						231.66
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	210.98						210.98
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.20	0.06						0.26
G. Liming	NO								NO
H. Urea application	1.54								1.54
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry (1)	-126.62	0.33	0.22						-126.08
A. Forest land	-126.62	0.33	0.22						-126.08
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	412.30	14.33						426.63
A. Solid waste disposal	NA,NO	284.39							284.39
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		127.91	14.33						142.24
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items: (2)									
International bunkers	1024.37	0.59	8.78						1033.74
Aviation	807.72	0.14	6.73						814.59
Navigation	216.65	0.44	2.05						219.15
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	33.26								33.26
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7042.07
Total CO_2 equivalent emissions with land use, land-use change and forestry									6915.99
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	6028.78	815.95	363.79	2.70	NO	0.07	NO	NO	7211.28
1. Energy	5288.94	13.58	43.45						5345.97
A. Fuel combustion (sectoral approach)	5288.94	13.58	43.45						5345.97
1. Energy industries	2281.12	2.21	5.20						2288.53
2. Manufacturing industries and construction	829.30	0.88	2.03						832.21
3. Transport	1532.13	6.40	34.68						1573.20
4. Other sectors	628.34	4.02	1.50						633.86
5. Other	18.06	0.06	0.04						18.17
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	865.80	NE,NA,NO	46.91	2.70	NO	0.07	NO	NO	915.46
A. Mineral industry	852.59								852.59
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	13.17	NE,NA	NE,NA						13.17
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				2.70					2.70
G. Other product manufacture and use	0.04	NE	46.91			0.07			47.01
H. Other									
3. Agriculture	1.38	384.79	259.20						645.37
A. Enteric fermentation		228.44							228.44
B. Manure management		156.15	87.72						243.87
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	171.42						171.42
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.20	0.06						0.26
G. Liming	NO								NO
H. Urea application	1.38								1.38
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-127.34	0.54	0.36						-126.43
A. Forest land	-127.34	0.54	0.36						-126.43
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	417.04	13.87						430.91
A. Solid waste disposal	NA,NO	291.10							291.10
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		125.94	13.87						139.81
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									
Memo items:[(2)]									
International bunkers	1056.46	0.70	9.26						1066.42
Aviation	773.55	0.14	6.45						780.13
Navigation	282.91	0.56	2.81						286.29
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	37.76								37.76
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7337.71
Total CO_2 equivalent emissions with land use, land-use change and forestry									7211.28
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	6155.11	823.43	352.58	5.21	NO	0.07	NO	NO	7336.41
1. Energy	5453.52	13.40	44.77						5511.69
A. Fuel combustion (sectoral approach)	5453.52	13.40	44.77						5511.69
1. Energy industries	2410.95	2.34	5.49						2418.77
2. Manufacturing industries and construction	772.52	0.79	1.80						775.11
3. Transport	1598.27	6.61	35.96						1640.83
4. Other sectors	652.82	3.61	1.48						657.91
5. Other	18.96	0.06	0.05						19.07
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	832.39	NE,NA,NO	47.53	5.21	NO	0.07	NO	NO	885.21
A. Mineral industry	819.39								819.39
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	12.96	NE,NA	NE,NA						12.96
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				5.21					5.21
G. Other product manufacture and use	0.04	NE	47.53			0.07			47.64
H. Other									
3. Agriculture	1.10	384.60	245.76						631.46
A. Enteric fermentation		223.31							223.31
B. Manure management		161.02	90.70						251.72
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	154.97						154.97
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.27	0.08						0.36
G. Liming	NO								NO
H. Urea application	1.10								1.10
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-131.90	0.78	0.52						-130.60
A. Forest land	-131.90	0.78	0.52						-130.60
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	424.65	14.01						438.65
A. Solid waste disposal	NA,NO	297.98							297.98
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		126.66	14.01						140.67
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	1069.16	0.75	9.40						1079.32
Aviation	761.12	0.13	6.34						767.60
Navigation	308.04	0.62	3.06						311.72
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	31.16								31.16
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7467.01
Total CO_2 equivalent emissions with land use, land-use change and forestry									7336.41
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1998
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)(1)	6466.22	828.62	380.08	10.62	NO	0.07	NO	NO	7685.60
1. Energy	5793.70	14.07	46.99						5854.76
A. Fuel combustion (sectoral approach)	5793.70	14.07	46.99						5854.76
1. Energy industries	2643.21	2.57	6.09						2651.87
2. Manufacturing industries and construction	776.49	0.82	1.86						779.16
3. Transport	1674.88	6.80	37.44						1719.12
4. Other sectors	678.93	3.81	1.56						684.29
5. Other	20.20	0.07	0.05						20.31
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	785.74	NE,NA,NO	48.07	10.62	NO	0.07	NO	NO	844.49
A. Mineral industry	776.99								776.99
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	8.70	NE,NA	NE,NA						8.70
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				10.62					10.62
G. Other product manufacture and use	0.04	NE	48.07			0.07			48.18
H. Other									
3. Agriculture	0.84	381.46	268.78						651.08
A. Enteric fermentation		216.25							216.25
B. Manure management		164.92	90.79						255.71
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	177.90						177.90
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.29	0.09						0.38
G. Liming	NO								NO
H. Urea application	0.84								0.84
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-114.05	2.66	1.75						-109.65
A. Forest land	-114.05	2.66	1.75						-109.65
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	430.44	14.48						444.92
A. Solid waste disposal	NA,NO	305.09							305.09
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		125.35	14.48						139.83
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:(2)									
International bunkers	1110.02	0.73	10.40						1121.16
Aviation	801.51	0.14	6.68						808.33
Navigation	308.52	0.59	3.72						312.83
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	34.01								34.01
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7795.25
Total CO_2 equivalent emissions with land use, land-use change and forestry									7685.60
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1999
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)(1)	6699.94	826.58	364.94	16.97	NO	0.07	NO	NO	7908.49
1. Energy	6054.67	14.61	48.52						6117.80
A. Fuel combustion (sectoral approach)	6054.67	14.61	48.52						6117.80
1. Energy industries	2826.94	2.75	6.40						2836.09
2. Manufacturing industries and construction	802.06	0.88	1.94						804.87
3. Transport	1718.84	7.05	38.53						1764.42
4. Other sectors	686.09	3.87	1.60						691.55
5. Other	20.76	0.07	0.05						20.88
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	792.05	NE,NA,NO	48.60	16.97	NO	0.07	NO	NO	857.68
A. Mineral industry	782.35								782.35
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	9.63	NE,NA	NE,NA						9.63
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				16.97					16.97
G. Other product manufacture and use	0.06	NE	48.60			0.07			48.73
H. Other									
3. Agriculture	0.92	374.67	253.07						628.66
A. Enteric fermentation		214.73							214.73
B. Manure management		159.62	91.03						250.65
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	161.95						161.95
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.31	0.10						0.41
G. Liming	NO								NO
H. Urea application	0.92								0.92
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-147.70	0.02	0.01						-147.67
A. Forest land	-147.70	0.02	0.01						-147.67
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	437.28	14.74						452.02
A. Solid waste disposal	NA,NO	312.20							312.20
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		125.09	14.74						139.82
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:(2)									
International bunkers	1304.43	1.10	11.74						1317.26
Aviation	820.14	0.14	6.84						827.12
Navigation	484.28	0.96	4.90						490.14
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	32.96								32.96
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8056.16
Total CO_2 equivalent emissions with land use, land-use change and forestry									7908.49
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2000
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)(1)	7012.79	848.24	365.59	25.20	NO	0.08	NO	NO	8251.89
1. Energy	6280.25	14.73	49.89						6344.87
A. Fuel combustion (sectoral approach)	6280.25	14.73	49.89						6344.87
1. Energy industries	2954.60	2.87	6.70						2964.18
2. Manufacturing industries and construction	818.73	0.99	2.14						821.86
3. Transport	1760.10	7.17	39.35						1806.62
4. Other sectors	725.39	3.62	1.64						730.66
5. Other	21.43	0.07	0.05						21.55
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	813.99	NE,NA,NO	49.11	25.20	NO	0.08	NO	NO	888.38
A. Mineral industry	802.92								802.92
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	10.96	NE,NA	NE,NA						10.96
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				25.20					25.20
G. Other product manufacture and use	0.12	NE	49.11			0.08			49.30
H. Other									
3. Agriculture	1.67	382.37	248.26						632.31
A. Enteric fermentation		224.21							224.21
B. Manure management		157.89	93.09						250.97
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	155.09						155.09
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.28	0.09						0.36
G. Liming	NO								NO
H. Urea application	1.67								1.67
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-83.13	5.71	3.76						-73.66
A. Forest land	-83.13	5.71	3.76						-73.66
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	445.44	14.56						460.00
A. Solid waste disposal	NA,NO	319.38							319.38
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		126.06	14.56						140.62
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:(2)									
International bunkers	1439.04	1.37	12.88						1453.29
Aviation	832.57	0.15	6.94						839.66
Navigation	606.47	1.22	5.94						613.63
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	29.16								29.16
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8325.55
Total CO_2 equivalent emissions with land use, land-use change and forestry									8251.89
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2002
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)(1)	6992.45	914.88	394.93	47.77	NO	0.08	NO	NO	8350.11
1. Energy	6327.64	15.62	52.10						6395.36
A. Fuel combustion (sectoral approach)	6327.64	15.62	52.10						6395.36
1. Energy industries	2998.47	2.90	7.00						3008.37
2. Manufacturing industries and construction	775.29	1.00	2.12						778.42
3. Transport	1800.54	7.74	41.26						1849.55
4. Other sectors	732.57	3.91	1.67						738.15
5. Other	20.76	0.07	0.05						20.88
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	832.32	NE,NA,NO	50.21	47.77	NO	0.08	NO	NO	930.39
A. Mineral industry	819.31								819.31
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	12.97	NE,NA	NE,NA						12.97
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				47.77					47.77
G. Other product manufacture and use	0.03	NE	50.21			0.08			50.33
H. Other									
3. Agriculture	0.42	439.20	277.74						717.35
A. Enteric fermentation		251.64							251.64
B. Manure management		187.31	104.83						292.14
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	172.84						172.84
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.24	0.07						0.31
G. Liming	NO								NO
H. Urea application	0.42								0.42
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-167.93	0.05	0.04						-167.84
A. Forest land	-167.93	0.05	0.04						-167.84
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	460.01	14.83						474.84
A. Solid waste disposal	NA,NO	334.81							334.81
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		125.20	14.83						140.03
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:(2)									
International bunkers	1371.67	1.04	12.75						1385.47
Aviation	938.20	0.16	7.82						946.18
Navigation	433.48	0.88	4.93						439.29
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	40.56								40.56
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8517.95
Total CO_2 equivalent emissions with land use, land-use change and forestry									8350.11
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [1]	7378.30	909.74	393.13	59.40	NO	0.09	NO	NO	8740.66
1. Energy	6713.26	16.70	55.68						6785.63
A. Fuel combustion (sectoral approach)	6713.26	16.70	55.68						6785.63
1. Energy industries	3224.91	3.12	7.30						3235.33
2. Manufacturing industries and construction	802.63	1.13	2.34						806.11
3. Transport	1907.06	8.45	44.28						1959.79
4. Other sectors	757.33	3.92	1.70						762.96
5. Other	21.32	0.07	0.05						21.44
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	836.08	NE,NA,NO	50.87	59.40	NO	0.09	NO	NO	946.44
A. Mineral industry	821.77								821.77
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	14.29	NE,NA	NE,NA						14.29
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				59.40					59.40
G. Other product manufacture and use	0.02	NE	50.87			0.09			50.98
H. Other									
3. Agriculture	0.73	430.60	272.22						703.55
A. Enteric fermentation		244.59							244.59
B. Manure management		185.73	99.50						285.22
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	172.64						172.64
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.28	0.09						0.36
G. Liming	NO								NO
H. Urea application	0.73								0.73
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry [1]	-171.77	0.24	0.16						-171.37
A. Forest land	-171.77	0.24	0.16						-171.37
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	462.21	14.21						476.42
A. Solid waste disposal	NA,NO	343.01							343.01
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		119.20	14.21						133.40
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items: [2]									
International bunkers	1393.31	0.95	12.28						1406.55
Aviation	1003.43	0.18	8.36						1011.97
Navigation	389.88	0.77	3.92						394.57
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	51.96								51.96
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [3]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8912.04
Total CO_2 equivalent emissions with land use, land-use change and forestry									8740.66
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2004
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	7604.53	904.89	384.55	77.60	NO	0.10	NO	NO	8971.67
1. Energy	6872.89	17.62	59.45						6949.96
A. Fuel combustion (sectoral approach)	6872.89	17.62	59.45						6949.96
1. Energy industries	3283.44	3.21	7.76						3294.41
2. Manufacturing industries and construction	880.45	1.19	2.49						884.13
3. Transport	2007.42	9.29	47.62						2064.33
4. Other sectors	681.20	3.77	1.52						686.49
5. Other	20.39	0.15	0.05						20.59
B. Fugitive emissions from fuels	NO,NE	0.00	NE,NO						0.00
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0.00	NE,NO						0.00
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	903.06	NE,NA,NO	51.61	77.60	NO	0.10	NO	NO	1032.37
A. Mineral industry	885.26								885.26
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	17.76	NE,NA	NE,NA						17.76
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				77.60					77.60
G. Other product manufacture and use	0.04	NE	51.61			0.10			51.75
H. Other									
3. Agriculture	0.95	422.28	258.75						681.98
A. Enteric fermentation		242.82							242.82
B. Manure management		179.19	94.68						273.87
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	163.99						163.99
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.27	0.08						0.35
G. Liming	NO								NO
H. Urea application	0.95								0.95
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-172.36	0.46	0.30						-171.60
A. Forest land	-172.36	0.46	0.30						-171.60
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	464.53	14.44						478.97
A. Solid waste disposal	NA,NO	351.36							351.36
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		113.18	14.44						127.61
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	1086.91	0.46	9.64						1097.01
Aviation	916.45	0.16	7.64						924.25
Navigation	170.46	0.30	2.00						172.76
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	46.41								46.41
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9143.28
Total CO_2 equivalent emissions with land use, land-use change and forestry									8971.67
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2005
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	7782.49	883.47	357.91	103.28	NO	0.12	NO	NO	9127.27
1. Energy	7048.90	18.39	61.39						7128.69
A. Fuel combustion (sectoral approach)	7048.90	18.39	61.39						7128.69
1. Energy industries	3471.84	3.40	8.05						3483.29
2. Manufacturing industries and construction	908.28	1.21	2.54						912.04
3. Transport	2045.15	9.84	49.39						2104.38
4. Other sectors	604.60	3.79	1.36						609.75
5. Other	19.03	0.15	0.05						19.23
B. Fugitive emissions from fuels	NO,NE	NO,NE	NE,NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NE,NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	912.11	NE,NA,NO	52.36	103.28	NO	0.12	NO	NO	1067.86
A. Mineral industry	894.48								894.48
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	17.60	NE,NA	NE,NA						17.60
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				103.28					103.28
G. Other product manufacture and use	0.03	NE	52.36			0.12			52.51
H. Other									
3. Agriculture	0.97	393.41	229.78						624.16
A. Enteric fermentation		228.47							228.47
B. Manure management		164.77	87.49						252.25
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	142.24						142.24
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.18	0.05						0.23
G. Liming	NO								NO
H. Urea application	0.97								0.97
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[1]	-179.48	0.15	0.10						-179.22
A. Forest land	-179.48	0.15	0.10						-179.22
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	471.51	14.27						485.78
A. Solid waste disposal	NA,NO	359.91							359.91
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		111.61	14.27						125.88
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1762.63	2.02	15.81						1780.46
Aviation	845.58	0.15	7.05						852.78
Navigation	917.05	1.87	8.77						927.69
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	44.12								44.12
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [3]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9306.49
Total CO_2 equivalent emissions with land use, land-use change and forestry									9127.27
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2006
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	7972.28	887.81	375.14	156.10	NO	0.12	NO	NO	9391.46
1. Energy	7228.89	19.22	63.44						7311.54
A. Fuel combustion (sectoral approach)	7228.89	19.22	63.44						7311.54
1. Energy industries	3653.38	3.48	8.34						3665.20
2. Manufacturing industries and construction	865.33	1.13	3.15						869.62
3. Transport	2031.33	10.30	50.37						2091.99
4. Other sectors	664.90	4.14	1.53						670.57
5. Other	13.95	0.17	0.04						14.16
B. Fugitive emissions from fuels	NO,NE	NO,NE	NE,NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NE,NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	922.43	NE,NA,NO	53.34	156.10	NO	0.12	NO	NO	1132.00
A. Mineral industry	902.66								902.66
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	19.75	NE,NA	NE,NA						19.75
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				156.10					156.10
G. Other product manufacture and use	0.02	NE	53.34			0.12			53.48
H. Other									
3. Agriculture	1.17	402.24	244.01						647.41
A. Enteric fermentation		229.93							229.93
B. Manure management		172.14	85.51						257.64
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	158.45						158.45
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.17	0.05						0.22
G. Liming	NO								NO
H. Urea application	1.17								1.17
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-180.21	0.37	0.25						-179.59
A. Forest land	-180.21	0.37	0.25						-179.59
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NE,NA,NO	465.98	14.11						480.09
A. Solid waste disposal	NE,NA	368.39							368.39
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		97.60	14.11						111.70
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	1782.26	1.94	18.33						1802.53
Aviation	850.39	0.15	7.09						857.63
Navigation	931.87	1.79	11.24						944.90
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	49.02								49.02
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9571.04
Total CO_2 equivalent emissions with land use, land-use change and forestry									9391.46
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2007
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CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)(1)	8341.17	903.16	370.16	182.93	NO	0.14	NO	NO	9797.57
1. Energy	7544.83	21.00	67.10						7632.93
A. Fuel combustion (sectoral approach)	7544.83	21.00	67.10						7632.93
1. Energy industries	3801.67	3.63	8.64						3813.94
2. Manufacturing industries and construction	923.04	1.34	2.74						927.12
3. Transport	2163.78	11.16	54.16						2229.10
4. Other sectors	636.02	4.71	1.52						642.25
5. Other	20.32	0.15	0.05						20.53
B. Fugitive emissions from fuels	NO,NE	NO,NE	NE,NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NE,NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	912.72	NE,NA,NO	54.62	182.93	NO	0.14	NO	NO	1150.41
A. Mineral industry	894.20								894.20
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	18.50	NE,NA	NE,NA						18.50
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				182.93					182.93
G. Other product manufacture and use	0.02	NE	54.62			0.14			54.78
H. Other									
3. Agriculture	1.11	411.93	230.85						643.89
A. Enteric fermentation		234.63							234.63
B. Manure management		177.15	87.85						264.99
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	142.96						142.96
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.16	0.05						0.20
G. Liming	NO								NO
H. Urea application	1.11								1.11
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-117.48	3.47	2.29						-111.72
A. Forest land	-117.48	3.47	2.29						-111.72
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	466.76	15.29						482.06
A. Solid waste disposal	NA,NO	377.51							377.51
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		89.25	15.29						104.55
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:(2)									
International bunkers	1702.69	1.79	16.29						1720.77
Aviation	836.61	0.15	6.97						843.73
Navigation	866.09	1.65	9.32						877.05
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	72.36								72.36
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9909.29
Total CO_2 equivalent emissions with land use, land-use change and forestry									9797.57
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2008
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	8459.66	897.40	357.17	216.65	NO	0.15	NO	NO	9931.03
1. Energy	7707.43	21.94	70.23						7799.59
A. Fuel combustion (sectoral approach)	7707.43	21.94	70.23						7799.59
1. Energy industries	3967.29	3.80	8.94						3980.03
2. Manufacturing industries and construction	900.33	1.35	2.73						904.41
3. Transport	2205.49	11.77	57.00						2274.26
4. Other sectors	591.69	4.79	1.45						597.94
5. Other	42.62	0.23	0.11						42.96
B. Fugitive emissions from fuels	NO,NE	NO,NE	NE,NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NE,NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	912.42	NE,NA,NO	56.08	216.65	NO	0.15	NO	NO	1185.31
A. Mineral industry	896.05								896.05
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	16.35	NE,NA	NE,NA						16.35
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				216.65					216.65
G. Other product manufacture and use	0.02	NE	56.08			0.15			56.26
H. Other									
3. Agriculture	0.54	401.34	214.91						616.78
A. Enteric fermentation		226.19							226.19
B. Manure management		175.02	81.88						256.89
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	132.99						132.99
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.14	0.04						0.18
G. Liming	NO								NO
H. Urea application	0.54								0.54
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-160.73	0.12	0.08						-160.53
A. Forest land	-160.73	0.12	0.08						-160.53
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	474.01	15.88						489.88
A. Solid waste disposal	NA,NO	386.43							386.43
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		87.58	15.88						103.45
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	1663.84	1.69	16.80						1682.33
Aviation	867.50	0.15	7.23						874.89
Navigation	796.34	1.54	9.56						807.44
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	132.79								132.79
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									10091.56
Total CO_2 equivalent emissions with land use, land-use change and forestry									9931.03
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2009
Submission 2017 v2
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	8194.33	895.35	355.39	249.22	NO	0.16	NO	NO	9694.45
1. Energy	7631.28	22.55	70.91						7724.74
A. Fuel combustion (sectoral approach)	7631.28	22.55	70.91						7724.74
1. Energy industries	3992.47	3.85	9.24						4005.56
2. Manufacturing industries and construction	795.92	1.18	2.38						799.49
3. Transport	2205.81	12.01	57.62						2275.44
4. Other sectors	616.80	5.35	1.62						623.76
5. Other	20.29	0.15	0.05						20.49
B. Fugitive emissions from fuels	NO,NE	NO,NE	NE,NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NE,NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	739.97	NE,NA,NO	57.66	249.22	NO	0.16	NO	NO	1047.01
A. Mineral industry	724.20								724.20
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	15.75	NE,NA	NE,NA						15.75
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				249.22					249.22
G. Other product manufacture and use	0.02	NE	57.66			0.16			57.85
H. Other									
3. Agriculture	1.14	399.70	210.90						611.74
A. Enteric fermentation		225.56							225.56
B. Manure management		173.99	78.88						252.87
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	131.98						131.98
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.16	0.05						0.20
G. Liming	NO								NO
H. Urea application	1.14								1.14
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-178.06	0.20	0.13						-177.73
A. Forest land	-178.06	0.20	0.13						-177.73
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	472.90	15.78						488.68
A. Solid waste disposal	NA,NO	396.04							396.04
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		76.86	15.78						92.64
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									
Memo items:[(2)]									
International bunkers	1507.86	1.48	13.99						1523.33
Aviation	818.73	0.14	6.82						825.69
Navigation	689.14	1.34	7.16						697.64
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	148.46								148.46
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9872.18
Total CO_2 equivalent emissions with land use, land-use change and forestry									9694.45
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	7837.64	915.18	374.73	280.66	NO	0.15	NO	NO	9408.37
1. Energy	7402.01	21.43	71.42						7494.87
A. Fuel combustion (sectoral approach)	7402.01	21.43	71.42						7494.87
1. Energy industries	3868.00	3.73	8.94						3880.67
2. Manufacturing industries and construction	697.26	1.17	2.29						700.71
3. Transport	2253.25	12.24	58.81						2324.30
4. Other sectors	563.22	4.15	1.33						568.70
5. Other	20.29	0.15	0.05						20.49
B. Fugitive emissions from fuels	NO,NE	NO,NE	NE,NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NE,NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	602.16	NE,NA,NO	59.09	280.66	NO	0.15	NO	NO	942.06
A. Mineral industry	584.95								584.95
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	17.19	NE,NA	NE,NA						17.19
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				280.66					280.66
G. Other product manufacture and use	0.02	NE	59.09			0.15			59.27
H. Other									
3. Agriculture	0.74	409.98	226.76						637.48
A. Enteric fermentation		235.35							235.35
B. Manure management		174.42	80.80						255.23
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	145.90						145.90
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.21	0.06						0.27
G. Liming	NO								NO
H. Urea application	0.74								0.74
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-167.26	0.74	0.49						-166.03
A. Forest land	-167.26	0.74	0.49						-166.03
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	483.02	16.96						499.98
A. Solid waste disposal	NA,NO	407.48							407.48
B. Biological treatment of solid waste		0.79	0.57						1.36
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		74.76	16.39						91.15
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	1423.68	1.32	13.81						1438.81
Aviation	835.79	0.15	6.97						842.90
Navigation	587.89	1.17	6.85						595.90
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	142.57								142.57
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9574.40
Total CO_2 equivalent emissions with land use, land-use change and forestry									9408.37
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2[(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	7526.79	907.15	359.07	313.24	NO	0.15	NO	NO	9106.40
1. Energy	7111.28	21.36	69.32						7201.96
A. Fuel combustion (sectoral approach)	7111.28	21.36	69.32						7201.96
1. Energy industries	3710.04	3.60	8.64						3722.28
2. Manufacturing industries and construction	579.91	0.82	1.68						582.41
3. Transport	2181.59	12.04	57.45						2251.08
4. Other sectors	613.11	4.73	1.48						619.33
5. Other	26.63	0.18	0.07						26.87
B. Fugitive emissions from fuels	NO,NE	NO,NE	NE,NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NE,NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	584.48	NE,NA,NO	60.67	313.24	NO	0.15	NO	NO	958.54
A. Mineral industry	572.05								572.05
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	12.41	NE,NA	NE,NA						12.41
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				313.24					313.24
G. Other product manufacture and use	0.02	NE	60.67			0.15			60.84
H. Other									
3. Agriculture	0.91	407.27	211.03						619.21
A. Enteric fermentation		241.14							241.14
B. Manure management		165.84	79.64						245.48
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	131.30						131.30
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.29	0.09						0.37
G. Liming	NO								NO
H. Urea application	0.91								0.91
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-169.87	0.60	0.40						-168.87
A. Forest land	-169.87	0.60	0.40						-168.87
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	477.91	17.65						495.55
A. Solid waste disposal	NA,NO	406.82							406.82
B. Biological treatment of solid waste		1.50	1.07						2.57
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		69.59	16.58						86.17
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	1487.14	1.39	13.48						1502.00
Aviation	861.43	0.15	7.18						868.76
Navigation	625.71	1.24	6.29						633.24
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	157.83								157.83
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2[(3)]	NE,NO								

Total CO_2 equivalent emissions without land use, land-use change and forestry	9275.27
Total CO_2 equivalent emissions with land use, land-use change and forestry	9106.40
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)(1)	7000.08	896.58	351.76	356.67	NO	0.16	NO	NO	8605.24
1. Energy	6624.15	20.35	64.57						6709.07
A. Fuel combustion (sectoral approach)	6624.15	20.35	64.57						6709.07
1. Energy industries	3545.93	3.43	8.05						3557.40
2. Manufacturing industries and construction	456.89	0.43	0.98						458.30
3. Transport	2010.19	11.50	54.02						2075.72
4. Other sectors	590.86	4.84	1.46						597.15
5. Other	20.29	0.15	0.05						20.49
B. Fugitive emissions from fuels	NO,NE	NO,NE	NE,NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NE,NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	539.39	NE,NA,NO	60.94	356.67	NO	0.16	NO	NO	957.16
A. Mineral industry	527.75								527.75
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	11.62	NE,NA	NE,NA						11.62
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				356.67					356.67
G. Other product manufacture and use	0.02	NE	60.94			0.16			61.12
H. Other									
3. Agriculture	0.55	385.70	207.56						593.81
A. Enteric fermentation		235.17							235.17
B. Manure management		150.30	73.26						223.57
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	134.23						134.23
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.23	0.07						0.30
G. Liming	NO								NO
H. Urea application	0.55								0.55
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-164.01	0.66	0.43						-162.92
A. Forest land	-164.01	0.66	0.43						-162.92
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	489.88	18.26						508.13
A. Solid waste disposal	NA,NO	429.03							429.03
B. Biological treatment of solid waste		2.30	1.64						3.94
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		58.55	16.62						75.16
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:(2)									
International bunkers	1452.28	1.34	14.39						1468.01
Aviation	832.18	0.15	6.94						839.26
Navigation	620.11	1.19	7.45						628.75
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	133.96								133.96
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 (3)	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8768.17
Total CO_2 equivalent emissions with land use, land-use change and forestry									8605.24
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	6314.71	873.55	324.19	363.98	NO	0.15	NO	NO	7876.57
1. Energy	5711.65	18.43	58.49						5788.58
A. Fuel combustion (sectoral approach)	5711.65	18.43	58.49						5788.58
1. Energy industries	2829.73	2.73	6.56						2839.01
2. Manufacturing industries and construction	537.46	0.50	1.14						539.10
3. Transport	1808.42	10.69	49.48						1868.60
4. Other sectors	512.60	4.35	1.26						518.21
5. Other	23.44	0.17	0.06						23.66
B. Fugitive emissions from fuels	NO,NE	NO,NE	NE,NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NE,NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	774.80	NE,NA,NO	60.37	363.98	NO	0.15	NO	NO	1199.30
A. Mineral industry	765.27								765.27
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	9.52	NE,NA	NE,NA						9.52
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				363.98					363.98
G. Other product manufacture and use	0.02	NE	60.37			0.15			60.54
H. Other									
3. Agriculture	0.79	362.08	187.31						550.18
A. Enteric fermentation		224.23							224.23
B. Manure management		137.67	67.81						205.48
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	119.44						119.44
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.19	0.06						0.24
G. Liming	NO								NO
H. Urea application	0.79								0.79
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-172.54	0.22	0.15						-172.17
A. Forest land	-172.54	0.22	0.15						-172.17
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other	NO	NO	NO						NO
5. Waste	NA,NO	492.81	17.87						510.68
A. Solid waste disposal	NA,NO	441.24							441.24
B. Biological treatment of solid waste		1.96	1.40						3.37
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		49.61	16.46						66.07
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									
Memo items:[(2)]									
International bunkers	1531.23	1.59	14.40						1547.22
Aviation	775.83	0.14	6.47						782.44
Navigation	755.40	1.46	7.93						764.78
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	127.60								127.60
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8048.74
Total CO_2 equivalent emissions with land use, land-use change and forestry									7876.57
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	6704.74	868.25	317.85	367.56	NO	0.15	NO	NO	8258.55
1. Energy	5882.93	18.20	57.91						5959.03
A. Fuel combustion (sectoral approach)	5882.93	18.20	57.91						5959.03
1. Energy industries	2940.32	2.83	6.85						2950.00
2. Manufacturing industries and construction	690.47	0.99	1.98						693.44
3. Transport	1760.88	10.42	47.90						1819.20
4. Other sectors	456.28	3.85	1.08						461.21
5. Other	34.98	0.12	0.09						35.19
B. Fugitive emissions from fuels	NE,NO	NE,NO	NE,NO						NE,NO
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NE,NO	NE,NO	NE,NO						NE,NO
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	995.03	NE,NA,NO	59.63	367.56	NO	0.15	NO	NO	1422.37
A. Mineral industry	985.87								985.87
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	9.16	NE,NA	NE,NA						9.16
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				367.56					367.56
G. Other product manufacture and use	0.01	NE	59.63			0.15			59.78
H. Other									
3. Agriculture	0.41	355.56	181.79						537.75
A. Enteric fermentation		222.73							222.73
B. Manure management		132.66	66.47						199.13
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	115.27						115.27
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.17	0.05						0.22
G. Liming	NO								NO
H. Urea application	0.41								0.41
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry[(1)]	-173.63	0.24	0.16						-173.22
A. Forest land	-173.63	0.24	0.16						-173.22
B. Cropland	NE,NO	NE,NO	NE						NE,NO
C. Grassland	NE,NO	NE,NO	NE						NE,NO
D. Wetlands	NE,NO	NE,NO	NE,NO						NE,NO
E. Settlements	NE,NO	NE	NE,NO						NE,NO
F. Other land	NE,NO	NE	NE,NO						NE,NO
G. Harvested wood products	NE,NO								NE,NO
H. Other									
5. Waste	NA,NO	494.26	18.37						512.62
A. Solid waste disposal	NA,NO	450.25							450.25
B. Biological treatment of solid waste		2.96	2.12						5.07
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		41.05	16.25						57.31
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	1509.74	1.55	14.16						1525.45
Aviation	776.41	0.14	6.47						783.02
Navigation	733.33	1.42	7.68						742.43
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	125.07								125.07
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NE,NO						
Indirect CO_2 [(3)]	NE,NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8431.78
Total CO_2 equivalent emissions with land use, land-use change and forestry									8258.55
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
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GREENHOUSE GAS SOURCE AND	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
SINK CATEGORIES	CO_2 equivalent (kt)								
Total (net emissions)(1)	6718.46	876.95	335.04	367.97	NO	0.15	NO	NO	8298.56
1. Energy	5988.87	19.33	59.05						6067.25
A. Fuel combustion (sectoral approach)	5988.87	19.33	59.05						6067.25
1. Energy industries	3023.00	2.93	6.85						3032.78
2. Manufacturing industries and construction	573.24	0.77	1.57						575.58
3. Transport	1829.51	10.60	49.20						1889.32
4. Other sectors	540.85	4.96	1.36						547.17
5. Other	22.27	0.08	0.05						22.40
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO,NE						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO,NE						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	897.44	NO,NE,NA	59.63	367.97	NO	0.15	NO	NO	1325.19
A. Mineral industry	886.72								886.72
B. Chemical industry	NO	NO	NO						NO
C. Metal industry	NO	NO							NO
D. Non-energy products from fuels and solvent use	10.70	NE,NA	NE,NA						10.70
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				367.97					367.97
G. Other product manufacture and use	0.01	NE	59.63			0.15			59.79
H. Other									
3. Agriculture	0.40	362.01	196.89						559.30
A. Enteric fermentation		224.40							224.40
B. Manure management		137.29	64.38						201.67
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	132.40						132.40
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0.32	0.10						0.42
G. Liming	NO								NO
H. Urea application	0.40								0.40
I. Other carbon-containing fertilizers	NO								NO
J. Other									
4. Land use, land-use change and forestry(1)	-168.25	0.09	0.06						-168.11
A. Forest land	-168.25	0.09	0.06						-168.11
B. Cropland	NO,NE	NO,NE	NE						NO,NE
C. Grassland	NO,NE	NO,NE	NE						NO,NE
D. Wetlands	NO,NE	NO,NE	NO,NE						NO,NE
E. Settlements									
F. Other land	NO,NE	NE	NO,NE						NO,NE
G. Harvested wood products	NE								NE
H. Other									
5. Waste	NO,NA	495.52	19.42						514.94
A. Solid waste disposal	NO,NA	458.32							458.32
B. Biological treatment of solid waste		4.39	3.14						7.52
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		32.81	16.28						49.09
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:(2)									
International bunkers	1519.22	1.64	14.09						1534.95
Aviation	751.79	0.13	6.27						758.19
Navigation	767.43	1.51	7.82						776.76
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	134.35								134.35
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 (3)	NO,NE								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8466.67
Total CO_2 equivalent emissions with land use, land-use change and forestry									8298.56
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

Annex III: BaU scenario - activity data

Table III1. BaU scenario - activity data (2016-2023)

	2016	2017	2018	2019	2020	2021	2022	2023
GDP real	3.03	3.6	3	2.7	2.7	2.5	2.5	2.3
ENERGY								
ELECTRICITY (%)								
RES	10%	10%	10%	10%	10%	10%	11%	11%
Natural gas	0%	0%	0%	0%	0%	0%	0%	0%
HFO	76%	76%	76%	76%	76%	76%	75%	75%
Diesel	14%	14%	14%	14%	14%	14%	14%	14%
ELECTRICITY - PRIMARY FUEL CONSUMPTION (TJ)								
RES	1535	1604	1666	1726	1787	1887	1991	2094
Natural gas	0	0	0	0	0	0	0	0
HFO	35877	35757	35751	35745	35739	35718	35696	35673
Diesel	6406	6526	6532	6538	6544	6566	6588	6610
TOTAL	43818	43887	43950	44009	44071	44170	44274	44377
INDUSTRY FUEL CONSUMPTION (TJ)								
LPG	273	283	292	300	308	316	323	331
Diesel	429	445	458	471	484	496	508	520
RFO	959	994	1024	1052	1081	1108	1136	1162
Pet-coke	3976	4121	4246	4363	4482	4594	4709	4818
Coal	21	21	22	23	23	24	24	25
Industrial waste (non RES)	662	686	707	727	747	765	784	803
Biomass	555	575	593	609	626	641	657	672
RESIDENTIAL FUEL CONSUMPTION (TJ)								
Other kerosene	613	636	655	673	691	709	726	743
Diesel/gas oil	2795	2891	2972	3047	3124	3174	3225	3271
LPG	1656	1716	1768	1817	1866	1913	1961	2006
Solid Biomass	130	135	139	143	147	150	154	158
Charcoal	236	245	252	259	266	273	280	286
RES	2519	2618	2704	2785	2868	2967	3069	3169
COMMERCIAL FUEL CONSUMPTION (TJ)								
diesel	645	662	676	687	699	712	726	738
LPG	520	539	555	571	586	601	616	630
solid biomass	15	16	16	16	17	17	18	18
gas biomass	12	12	13	13	14	14	14	15

	2016	2017	2018	2019	2020	2021	2022	2023
charcoal	207	215	221	227	233	239	245	251
solar thermal	433	455	476	496	516	534	551	568
ROAD TRANSPORT FUEL CONSUMPTION (TJ)								
Gasoline (TJ)	15682	16254	16749	17209	17681	18123	18576	19003
Diesel (TJ)	11739	12075	12347	12588	12833	13154	13483	13793
Biodiesel (TJ)	370	476	586	699	819	840	861	880
IPPU								
Total Clinker (tn)	1648256	2000000	2000000	2000000	2000000	2000000	2000000	2000000
slaked lime production (t)	3502	3824	4145	4466	4787	5109	5430	5751
ceramics (t)	111561	150000	163918	186509	209100	209100	209100	209100
imports soda ash (t)	447	470	489	510	534	558	583	609
Lubricant (kt)	8	8	8	8	8	8	8	8
Paraffin Wax (TJ)	13	13	13	13	13	13	13	13
Solvent Use NMVOCs (kt)								
dry cleaning	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672
coating applications	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346
chemical products	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988
asphalt roofing	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806
domestic solvent use	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744
road paving with asphalt	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263
printing	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197
Population forecast	854802	859982.6	865255.4	870654.4	876257.8	881841.1	887353.3	892781.4
AGRICULTURE								
kg milk/ day	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027
% pregnant	72	72	72	72	72	72	72	72
dairy cattle population	28502	29785	29785	29785	29785	34202	34202	34202
other cattle population	64408	66663	66663	66663	66663	70849	70849	70849
sheep population	304187	313313	316354	319396	319396	334606	334606	334606
goats population	246624	254023	256489	258955	258955	271286	271286	271286
horses population	401	401	401	401	401	401	401	401
mules & asses population	349	349	349	349	349	349	349	349
swine population	352179	355701	359223	359223	362744	373310	373310	373310
Poultry population	64408454	66662750	66662750	66662750	66662750	70849299	70849299	70849299
manure management								

	2016	2017	2018	2019	2020	2021	2022	2023
dairy cattle								
solid storage	95%	95%	95%	94%	94%	94%	94%	93%
anaerobic digester	5%	5%	6%	6%	6%	6%	7%	7%
other cattle								
solid storage	95%	95%	95%	94%	94%	94%	94%	93%
anaerobic digester	5%	5%	6%	6%	6%	6%	7%	7%
market swine								
anaerobic digester	50%	49%	48%	48%	47%	46%	45%	44%
aerobic treatment	50%	51%	52%	53%	53%	54%	55%	56%
breeding swine								
anaerobic digester	50%	49%	48%	48%	47%	46%	45%	44%
aerobic treatment	50%	51%	52%	53%	53%	54%	55%	56%
sheep								
solid storage	100%	100%	100%	100%	99.8%	99.5%	99.3%	99.0%
anaerobic digester					0.2%	0.5%	0.7%	1.0%
goats								
solid storage	100%	100%	100%	100%	99.8%	99.5%	99.3%	99.0%
anaerobic digester					0.2%	0.5%	0.7%	1.0%
horses								
solid storage	100%	100%	100%	100%	100%	100%	100%	100%
mules & asses								
solid storage	100%	100%	100%	100%	100%	100%	100%	100%
poultry								
solid storage	85%	84%	84%	83%	83%	82%	81%	81%
anaerobic digester	15%	16%	16%	17%	18%	18%	19%	19%
Crop production (t/yr)								
Wheat	6902	36774	37482	38189	38896	38896	38896	38896
Barley	2907	2907	2907	2907	2907	2907	2907	2907
Oats	352	352	352	352	352	352	352	352
Beans & pulses (legumes)	4000	4000	4000	4000	4000	4000	4000	4000
Potatoes (tubers)	122803	122803	122803	122803	122803	122803	122803	122803
cultivated area (ha)								
Wheat	8386	12448.8	12688.2	12927.6	13167	13167	13167	13167
Barley	14536	14536	14536	14536	14536	14536	14536	14536

	2016	2017	2018	2019	2020	2021	2022	2023
Oats	367	367	367	367	367	367	367	367
Beans & pulses (legumes)	498	498	498	498	498	498	498	498
Potatoes (tubers)	5041	5041	5041	5041	5041	5041	5041	5041
FracBURN (kg N/kg crop-N)	10%	10%	10%	10%	10%	10%	10%	10%
FSN (kg N in fertilizer)	8073000	8073000	8073000	8073000	8073000	8073000	8073000	8073000
dry sludge applied on land (kg)	5453697	5453697	5453697	5453697	5453697	5453697	5453697	5453697
WASTE								
Municipal solid waste production								
Total MSW production (1000t) - wet mass	545	563.79	573.07	581.43	589.52	598.37	607.2	616.31
Annual per capita production (kg/cap)	642	655.58	662.31	667.81	672.77	678.55	684.28	690.33
Total permanent population at the end of year	854800	859982.6	865255.4	870654.4	876257.8	881841.1	887353.3	892781.4
MSW to disposal sites (1000t wet mass)	409.96	423.78	430.75	437.03	443.12	449.77	456.40	463.25
MSW to disposal sites (% of total)	75%	75%	75%	75%	75%	75%	75%	75%
composting (1000t)	26.72	32.12	32.45	32.72	32.96	33.24	33.52	33.82
composting (%)	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%
Compost for backfilling (1000t)	16.77	20.16	20.36	20.53	20.69	20.86	21.04	21.23
composting (%)	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%
TOTAL composting (1000t)	43.49	52.27	52.81	53.25	53.65	54.11	54.56	55.05
composting (%)	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
recycling (1000t)	73.25	88.05	88.95	89.69	90.35	91.13	91.90	92.71
recycling (%)	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%
per capita production to disposal sites (kg/cap)	483	493	498	502	506	510	514	519
POPULATION								
Regional Population (1000 persons)								
Lefkosia	332.2	334.2	336.3	338.4	340.5	342.7	344.9	347.0
Ammochostos	47	47.3	47.6	47.9	48.2	48.5	48.8	49.1
Larnaca	144.9	145.8	146.7	147.6	148.5	149.5	150.4	151.3
Lemesos	239.4	240.9	242.3	243.8	245.4	247.0	248.5	250.0
Pafos	91.3	91.9	92.4	93.0	93.6	94.2	94.8	95.4
TOTAL	854.8	860.0	865.3	870.7	876.3	881.8	887.4	892.8
Urban Population (1000 persons)								
Lefkosia	244.2	245.7	247.2	248.7	250.3	251.9	253.5	255.1
Ammochostos		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Larnaca	85.7	86.2	86.7	87.3	87.9	88.4	89.0	89.5

	2016	2017	2018	2019	2020	2021	2022	2023
Lemesos	182.6	183.7	184.8	186.0	187.2	188.4	189.6	190.7
Pafos	64.4	64.8	65.2	65.6	66.0	66.4	66.9	67.3
TOTAL	576.9	580.4	584.0	587.6	591.4	595.1	598.9	602.5
Rural Population (1000 persons)								
Lefkosia	88	88.5	89.1	89.6	90.2	90.8	91.4	91.9
Ammochostos	47	47.3	47.6	47.9	48.2	48.5	48.8	49.1
Larnaca	59.2	59.6	59.9	60.3	60.7	61.1	61.5	61.8
Lemesos	56.8	57.1	57.5	57.9	58.2	58.6	59.0	59.3
Pafos	26.9	27.1	27.2	27.4	27.6	27.8	27.9	28.1
TOTAL	277.9	279.6	281.3	283.1	284.9	286.7	288.5	290.2
composition of waste to disposal sites								
Food	49%	49%	49%	49%	49%	49%	49%	49%
Garden	8%	8%	8%	8%	8%	8%	8%	8%
Paper	27%	27%	27%	27%	27%	27%	27%	27%
Wood	3%	3%	3%	3%	3%	3%	3%	3%
Textile	11%	11%	11%	11%	11%	11%	11%	11%
Nappies	0%	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	2%	2%	2%	2%	2%	2%	2%	2%
Domestic wastewater management								
not well managed, centralised, overloaded aerobic (Ui)	95%	95%	95%	95%	95%	95%	95%	95%
septic system (Ui)	5%	5%	5%	5%	5%	5%	5%	5%
Industrial production (t)								
alcohol	629	629	629	629	629	629	629	629
beer	32764	32764	32764	32764	32764	32764	32764	32764
soft drinks	10807	10807	10807	10807	10807	10807	10807	10807
dairy products	99762	99762	99762	99762	99762	99762	99762	99762
meat & poultry	79735	79735	79735	79735	79735	79735	79735	79735
soaps & detergents	7300	7300	7300	7300	7300	7300	7300	7300
vegetable oils	12640	12640	12640	12640	12640	12640	12640	12640
vegetables, fruits & juices	57861	57861	57861	57861	57861	57861	57861	57861
wine	11008	11008	11008	11008	11008	11008	11008	11008
not well managed, centralised, overloaded aerobic								
alcohol	97%	97%	97%	97%	97%	97%	97%	97%
beer	80%	80%	80%	80%	80%	80%	80%	80%

	2016	2017	2018	2019	2020	2021	2022	2023
soft drinks	96%	96%	96%	96%	96%	96%	96%	96%
dairy products	95%	95%	95%	95%	95%	95%	95%	95%
meat & poultry	94%	94%	94%	94%	94%	94%	94%	94%
soaps & detergents	100%	100%	100%	100%	100%	100%	100%	100%
vegetable oils	99%	99%	99%	99%	99%	99%	99%	99%
vegetables, fruits & juices	99%	99%	99%	99%	99%	99%	99%	99%
wine	100%	100%	100%	100%	100%	100%	100%	100%
Anaerobic								
alcohol	3%	3%	3%	3%	3%	3%	3%	3%
beer	20%	20%	20%	20%	20%	20%	20%	20%
soft drinks	4%	4%	4%	4%	4%	4%	4%	4%
dairy products	5%	5%	5%	5%	5%	5%	5%	5%
meat & poultry	6%	6%	6%	6%	6%	6%	6%	6%
soaps & detergents	0%	0%	0%	0%	0%	0%	0%	0%
vegetable oils	1%	1%	1%	1%	1%	1%	1%	1%
vegetables, fruits & juices	1%	1%	1%	1%	1%	1%	1%	1%
wine	0%	0%	0%	0%	0%	0%	0%	0%

Table III2. BaU scenario - activity data (2024-2031)

	2024	2025	2026	2027	2028	2029	2030	2031
GDP real	2.3	2.1	2.1	2	2	2	2	2
ENERGY								
ELECTRICITY (%)								
RES	11%	12%	12%	12%	12%	13%	13%	14%
Natural gas	88%	88%	87%	87%	87%	86%	86%	85%
HFO	0%	0%	0%	0%	0%	0%	0%	0%
Diesel	1%	1%	1%	1%	1%	1%	1%	1%
ELECTRICITY - PRIMARY FUEL CONSUMPTION (TJ)								
RES	2201	2308	2417	2529	2643	2761	2883	3099
Natural gas	43224	43981	44751	45489	46239	47001	47774	48334
HFO	0	0	0	0	0	0	0	0
Diesel	393	395	396	397	399	400	401	405
TOTAL	45818	46683	47564	48415	49281	50162	51059	51838
INDUSTRY FUEL CONSUMPTION (TJ)								

	2024	2025	2026	2027	2028	2029	2030	2031
LPG	338	346	353	360	367	374	382	390
Diesel	532	543	554	565	577	588	600	612
RFO	1189	1214	1239	1264	1289	1315	1341	1368
Pet-coke	4928	5032	5137	5240	5345	5452	5561	5672
Coal	25	26	27	27	28	28	29	29
Industrial waste (non RES)	821	838	856	873	890	908	926	945
Biomass	688	702	717	731	746	761	776	792
RESIDENTIAL FUEL CONSUMPTION (TJ)								
Other kerosene	760	776	792	808	824	841	858	875
Diesel/gas oil	3316	3356	3395	3432	3468	3505	3542	3590
LPG	2052	2095	2139	2182	2226	2270	2316	2362
Solid Biomass	161	165	168	171	175	178	182	185
Charcoal	293	299	305	311	317	324	330	337
RES	3271	3370	3472	3573	3676	3783	3892	3992
COMMERCIAL FUEL CONSUMPTION (TJ)								
diesel	751	762	773	784	794	805	816	832
LPG	645	658	672	685	699	713	727	742
solid biomass	19	19	19	20	20	21	21	21
gas biomass	15	15	16	16	16	16	17	17
charcoal	257	262	267	273	278	284	290	295
solar thermal	586	603	620	638	655	673	692	706
ROAD TRANSPORT FUEL CONSUMPTION (TJ)								
Gasoline (TJ)	19440	19848	20265	20670	21084	21505	21935	22374
Diesel (TJ)	14110	14406	14709	15003	15303	15609	15921	16240
Biodiesel (TJ)	901	920	939	958	977	996	1016	1037
IPPU								
Total Clinker (tn)	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000
slaked lime production (t)	6072	6394	6715	7036	7357	7679	8000	8000
ceramics (t)	209100	209100	209100	209100	209100	209100	209100	209100
imports soda ash (t)	635	662	689	717	746	776	807	840
Lubricant (kt)	8	8	8	8	8	8	8	8
Paraffin Wax (TJ)	13	13	13	13	13	13	13	13
Solvent Use NMVOCs (kt)								
dry cleaning	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672

	2024	2025	2026	2027	2028	2029	2030	2031
coating applications	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346
chemical products	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988
asphalt roofing	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806
domestic solvent use	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744
road paving with asphalt	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263
printing	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197
Population forecast	898068.2	903198.7	908137.8	912879.6	917398	921705	925816.6	929721.8
AGRICULTURE								
kg milk/ day	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027
% pregnant	72	72	72	72	72	72	72	72
dairy cattle population	34202	34202	34202	34202	34202	34202	34202	34202
other cattle population	70849	70849	70849	70849	70849	70849	70849	70849
sheep population	334606	334606	334606	334606	334606	334606	334606	334606
goats population	271286	271286	271286	271286	271286	271286	271286	271286
horses population	401	401	401	401	401	401	401	401
mules & asses population	349	349	349	349	349	349	349	349
swine population	373310	373310	373310	373310	373310	373310	373310	373310
Poultry population	70849299	70849299	70849299	70849299	70849299	70849299	70849299	70849299
manure management								
dairy cattle								
solid storage	93%	93%	93%	92%	92%	92%	92%	91%
anaerobic digester	7%	7%	8%	8%	8%	8%	9%	9%
other cattle								
solid storage	93%	93%	93%	92%	92%	92%	92%	91%
anaerobic digester	7%	7%	8%	8%	8%	8%	9%	9%
market swine								
anaerobic digester	43%	43%	42%	41%	40%	39%	38%	38%
aerobic treatment	57%	58%	58%	59%	60%	61%	62%	63%
breeding swine								
anaerobic digester	43%	43%	42%	41%	40%	39%	38%	38%
aerobic treatment	57%	58%	58%	59%	60%	61%	62%	63%
sheep								
solid storage	98.8%	98.6%	98.3%	98.1%	97.9%	97.6%	97.4%	97.1%
anaerobic digester	1.2%	1.4%	1.7%	1.9%	2.1%	2.4%	2.6%	2.9%

	2024	2025	2026	2027	2028	2029	2030	2031
goats								
solid storage	98.8%	98.6%	98.3%	98.1%	97.9%	97.6%	97.4%	97.1%
anaerobic digester	1.2%	1.4%	1.7%	1.9%	2.1%	2.4%	2.6%	2.9%
horses								
solid storage	100%	100%	100%	100%	100%	100%	100%	100%
mules & asses								
solid storage	100%	100%	100%	100%	100%	100%	100%	100%
poultry								
solid storage	80%	79%	79%	78%	78%	77%	76%	76%
anaerobic digester	20%	21%	21%	22%	23%	23%	24%	24%
Crop production (t/yr)								
Wheat	38896	38896	38896	38896	38896	38896	38896	38896
Barley	2907	2907	2907	2907	2907	2907	2907	2907
Oats	352	352	352	352	352	352	352	352
Beans & pulses (legumes)	4000	4000	4000	4000	4000	4000	4000	4000
Potatoes (tubers)	122803	122803	122803	122803	122803	122803	122803	122803
cultivated area (ha)								
Wheat	13167	13167	13167	13167	13167	13167	13167	13167
Barley	14536	14536	14536	14536	14536	14536	14536	14536
Oats	367	367	367	367	367	367	367	367
Beans & pulses (legumes)	498	498	498	498	498	498	498	498
Potatoes (tubers)	5041	5041	5041	5041	5041	5041	5041	5041
FracBURN (kg N/kg crop-N)	10%	10%	10%	10%	10%	10%	10%	10%
FSN (kg N in fertilizer)	8073000	8073000	8073000	8073000	8073000	8073000	8073000	8073000
dry sludge applied on land (kg)	5453697	5453697	5453697	5453697	5453697	5453697	5453697	5453697
WASTE								
Municipal solid waste production								
Total MSW production (1000t) - wet mass	625.52	634.91	644.69	654.77	665.46	676.68	688.54	693.73
Annual per capita production (kg/cap)	696.52	702.96	709.90	717.26	725.38	734.16	743.71	746.17
Total permanent population at the end of year	898068.2	903198.7	908137.8	912879.6	917398	921705	925816.6	929721.8
MSW to disposal sites (1000t wet mass)	470.18	477.23	484.58	492.16	500.20	508.63	517.54	521.44
MSW to disposal sites (% of total)	75%	75%	75%	75%	75%	75%	75%	75%
composting (1000t)	34.12	34.44	34.78	35.14	35.54	35.97	36.43	36.56
composting (%)	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%

	2024	2025	2026	2027	2028	2029	2030	2031
Compost for backfilling (1000t)	21.42	21.61	21.83	22.05	22.30	22.57	22.87	22.94
composting (%)	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%
TOTAL composting (1000t)	55.54	56.05	56.61	57.19	57.84	58.54	59.30	59.50
composting (%)	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
recycling (1000t)	93.54	94.41	95.34	96.33	97.42	98.60	99.88	100.21
recycling (%)	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%
per capita production to disposal sites (kg/cap)	524	528	534	539	545	552	559	561
POPULATION								
Regional Population (1000 persons)								
Lefkosia	349.0	351.0	352.9	354.8	356.5	358.2	359.8	361.3
Ammochostos	49.4	49.7	49.9	50.2	50.4	50.7	50.9	51.1
Larnaca	152.2	153.1	153.9	154.7	155.5	156.2	156.9	157.6
Lemesos	251.5	253.0	254.3	255.7	256.9	258.1	259.3	260.4
Pafos	95.9	96.5	97.0	97.5	98.0	98.4	98.9	99.3
TOTAL	898.1	903.2	908.1	912.9	917.4	921.7	925.8	929.7
Urban Population (1000 persons)								
Lefkosia	256.6	258.0	259.4	260.8	262.1	263.3	264.5	265.6
Ammochostos	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Larnaca	90.0	90.6	91.0	91.5	92.0	92.4	92.8	93.2
Lemesos	191.8	192.9	194.0	195.0	196.0	196.9	197.8	198.6
Pafos	67.7	68.0	68.4	68.8	69.1	69.4	69.8	70.0
TOTAL	606.1	609.6	612.9	616.1	619.1	622.1	624.8	627.5
Rural Population (1000 persons)								
Lefkosia	92.5	93.0	93.5	94.0	94.4	94.9	95.3	95.7
Ammochostos	49.4	49.7	49.9	50.2	50.4	50.7	50.9	51.1
Larnaca	62.2	62.6	62.9	63.2	63.5	63.8	64.1	64.4
Lemesos	59.7	60.0	60.3	60.7	61.0	61.2	61.5	61.8
Pafos	28.3	28.4	28.6	28.7	28.9	29.0	29.1	29.3
TOTAL	292.0	293.6	295.2	296.8	298.3	299.7	301.0	302.3
composition of waste to disposal sites								
Food	49%	49%	49%	49%	49%	49%	49%	49%
Garden	8%	8%	8%	8%	8%	8%	8%	8%
Paper	27%	27%	27%	27%	27%	27%	27%	27%
Wood	3%	3%	3%	3%	3%	3%	3%	3%

	2024	2025	2026	2027	2028	2029	2030	2031
Textile	11%	11%	11%	11%	11%	11%	11%	11%
Nappies	0%	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	2%	2%	2%	2%	2%	2%	2%	2%
Domestic wastewater management								
not well managed, centralised, overloaded aerobic (Ui)	95%	95%	95%	95%	95%	95%	95%	95%
septic system (Ui)	5%	5%	5%	5%	5%	5%	5%	5%
Industrial production (t)								
alcohol	629	629	629	629	629	629	629	629
beer	32764	32764	32764	32764	32764	32764	32764	32764
soft drinks	10807	10807	10807	10807	10807	10807	10807	10807
dairy products	99762	99762	99762	99762	99762	99762	99762	99762
meat & poultry	79735	79735	79735	79735	79735	79735	79735	79735
soaps & detergents	7300	7300	7300	7300	7300	7300	7300	7300
vegetable oils	12640	12640	12640	12640	12640	12640	12640	12640
vegetables, fruits & juices	57861	57861	57861	57861	57861	57861	57861	57861
wine	11008	11008	11008	11008	11008	11008	11008	11008
not well managed, centralised, overloaded aerobic								
alcohol	97%	97%	97%	97%	97%	97%	97%	97%
beer	80%	80%	80%	80%	80%	80%	80%	80%
soft drinks	96%	96%	96%	96%	96%	96%	96%	96%
dairy products	95%	95%	95%	95%	95%	95%	95%	95%
meat & poultry	94%	94%	94%	94%	94%	94%	94%	94%
soaps & detergents	100%	100%	100%	100%	100%	100%	100%	100%
vegetable oils	99%	99%	99%	99%	99%	99%	99%	99%
vegetables, fruits & juices	99%	99%	99%	99%	99%	99%	99%	99%
wine	100%	100%	100%	100%	100%	100%	100%	100%
Anaerobic								
alcohol	3%	3%	3%	3%	3%	3%	3%	3%
beer	20%	20%	20%	20%	20%	20%	20%	20%
soft drinks	4%	4%	4%	4%	4%	4%	4%	4%
dairy products	5%	5%	5%	5%	5%	5%	5%	5%
meat & poultry	6%	6%	6%	6%	6%	6%	6%	6%
soaps & detergents	0%	0%	0%	0%	0%	0%	0%	0%
vegetable oils	1%	1%	1%	1%	1%	1%	1%	1%

	2024	2025	2026	2027	2028	2029	2030	2031
vegetables, fruits & juices	1%	1%	1%	1%	1%	1%	1%	1%
wine	0%	0%	0%	0%	0%	0%	0%	0%

Table III3. BaU scenario - activity data (2032-2040)

	2032	2033	2034	2035	2036	2037	2038	2039	2040
GDP real	2	2	2	2	2	2	2	2	2
ENERGY									
ELECTRICITY (%)									
RES	14%	15%	16%	17%	17%	18%	19%	19%	20%
Natural gas	85%	84%	83%	83%	82%	81%	81%	80%	79%
HFO	0%	0%	0%	0%	0%	0%	0%	0%	0%
Diesel	1%	1%	1%	1%	1%	1%	1%	1%	1%
ELECTRICITY - PRIMARY FUEL CONSUMPTION (TJ)									
RES	3322	3554	3793	4040	4295	4560	4833	5115	5406
Natural gas	48897	49463	50032	50605	51180	51757	52338	52921	53506
HFO	0	0	0	0	0	0	0	0	0
Diesel	408	411	415	418	422	425	429	433	437
TOTAL	52627	53428	54240	55063	55897	56742	57600	58468	59349
INDUSTRY FUEL CONSUMPTION (TJ)									
LPG	397	405	413	422	430	439	447	456	466
Diesel	624	637	650	662	676	689	703	717	731
RFO	1395	1423	1452	1481	1510	1541	1571	1603	1635
Pet-coke	5786	5901	6019	6140	6263	6388	6516	6646	6779
Coal	30	31	31	32	32	33	34	34	35
Industrial waste (non RES)	964	983	1003	1023	1043	1064	1085	1107	1129
Biomass	807	824	840	857	874	891	909	927	946
RESIDENTIAL FUEL CONSUMPTION (TJ)									
Other kerosene	892	910	928	947	966	985	1005	1025	1046
Diesel/gas oil	3639	3688	3737	3788	3838	3890	3941	3994	4046
LPG	2409	2457	2507	2557	2608	2660	2713	2767	2823
Solid Biomass	189	193	197	201	205	209	213	217	222
Charcoal	343	350	357	364	372	379	387	395	402
RES	4095	4200	4309	4419	4533	4649	4768	4890	5015
COMMERCIAL FUEL CONSUMPTION (TJ)									

	2032	2033	2034	2035	2036	2037	2038	2039	2040
diesel	849	866	883	901	919	937	956	975	964
LPG	757	772	787	803	819	835	852	869	887
solid biomass	22	22	23	23	24	24	25	25	26
gas biomass	17	18	18	19	19	19	20	20	20
charcoal	301	307	313	320	326	333	339	346	353
solar thermal	720	734	749	764	779	795	811	827	875
ROAD TRANSPORT FUEL CONSUMPTION (TJ)									
Gasoline (TJ)	22822	23278	23744	24218	24703	25197	25701	26215	26739
Diesel (TJ)	16564	16896	17234	17578	17930	18288	18654	19027	19408
Biodiesel (TJ)	1057	1078	1100	1122	1144	1167	1191	1215	1239
IPPU									
Total Clinker (tn)	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000
slaked lime production (t)	8000	8000	8000	8000	8000	8000	8000	8000	8000
ceramics (t)	209100	209100	209100	209100	209100	209100	209100	209100	209100
imports soda ash (t)	874	909	946	984	1024	1065	1108	1153	1200
Lubricant (kt)	8	8	8	8	8	8	8	8	8
Paraffin Wax (TJ)	13	13	13	13	13	13	13	13	13
Solvent Use NMVOCs (kt)									
dry cleaning	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672	0.052672
coating applications	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346	1.617346
chemical products	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988	0.00988
asphalt roofing	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806	0.009806
domestic solvent use	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744	0.202744
road paving with asphalt	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263	0.002263
printing	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197	0.247197
Population forecast	933446.7	936994.3	940408.6	943707.7	946900.7	950017.4	953088.1	956091.7	959063.2
AGRICULTURE									
kg milk/ day	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027	19.26027
% pregnant	72	72	72	72	72	72	72	72	72
dairy cattle population	34202	34202	34202	34202	34202	34202	34202	34202	34202
other cattle population	70849	70849	70849	70849	70849	70849	70849	70849	70849
sheep population	334606	334606	334606	334606	334606	334606	334606	334606	334606
goats population	271286	271286	271286	271286	271286	271286	271286	271286	271286
horses population	401	401	401	401	401	401	401	401	401

	2032	2033	2034	2035	2036	2037	2038	2039	2040
mules & asses population	349	349	349	349	349	349	349	349	349
swine population	373310	373310	373310	373310	373310	373310	373310	373310	373310
Poultry population	70849299	70849299	70849299	70849299	70849299	70849299	70849299	70849299	70849299
manure management									
dairy cattle									
solid storage	91%	91%	91%	90%	90%	90%	90%	89%	89%
anaerobic digester	9%	9%	10%	10%	10%	10%	11%	11%	11%
other cattle									
solid storage	91%	91%	91%	90%	90%	90%	90%	89%	89%
anaerobic digester	9%	9%	10%	10%	10%	10%	11%	11%	11%
market swine									
anaerobic digester	37%	36%	35%	34%	33%	32%	32%	31%	30%
aerobic treatment	63%	64%	65%	66%	67%	67%	68%	69%	70%
breeding swine									
anaerobic digester	37%	36%	35%	34%	33%	32%	32%	31%	30%
aerobic treatment	63%	64%	65%	66%	67%	67%	68%	69%	70%
sheep									
solid storage	96.9%	96.7%	96.4%	96.2%	96.0%	95.7%	95.5%	95.2%	95%
anaerobic digester	3.1%	3.3%	3.6%	3.8%	4.0%	4.3%	4.5%	4.8%	5%
goats									
solid storage	96.9%	96.7%	96.4%	96.2%	96.0%	95.7%	95.5%	95.2%	95%
anaerobic digester	3.1%	3.3%	3.6%	3.8%	4.0%	4.3%	4.5%	4.8%	5%
horses									
solid storage	100%	100%	100%	100%	100%	100%	100%	100%	100%
mules & asses									
solid storage	100%	100%	100%	100%	100%	100%	100%	100%	100%
poultry									
solid storage	75%	74%	74%	73%	73%	72%	71%	71%	70%
anaerobic digester	25%	26%	26%	27%	28%	28%	29%	29%	30%
Crop production (t/yr)									
Wheat	38896	38896	38896	38896	38896	38896	38896	38896	38896
Barley	2907	2907	2907	2907	2907	2907	2907	2907	2907
Oats	352	352	352	352	352	352	352	352	352
Beans & pulses (legumes)	4000	4000	4000	4000	4000	4000	4000	4000	4000

	2032	2033	2034	2035	2036	2037	2038	2039	2040
Potatoes (tubers)	122803	122803	122803	122803	122803	122803	122803	122803	122803
cultivated area (ha)									
Wheat	13167	13167	13167	13167	13167	13167	13167	13167	13167
Barley	14536	14536	14536	14536	14536	14536	14536	14536	14536
Oats	367	367	367	367	367	367	367	367	367
Beans & pulses (legumes)	498	498	498	498	498	498	498	498	498
Potatoes (tubers)	5041	5041	5041	5041	5041	5041	5041	5041	5041
FracBURN (kg N/kg crop-N)	10%	10%	10%	10%	10%	10%	10%	10%	10%
FSN (kg N in fertilizer)	8073000	8073000	8073000	8073000	8073000	8073000	8073000	8073000	8073000
dry sludge applied on land (kg)	5453697	5453697	5453697	5453697	5453697	5453697	5453697	5453697	5453697
WASTE									
Municipal solid waste production									
Total MSW production (1000t) - wet mass	703.18	712.62	722.07	731.52	740.96	750.41	759.86	769.31	778.75
Annual per capita production (kg/cap)	753.31	760.54	767.83	775.15	782.52	789.89	797.26	804.64	811.99
Total permanent population at the end of year	933446.7	936994.3	940408.6	943707.7	946900.7	950017.4	953088.1	956091.7	959063.2
MSW to disposal sites (1000t wet mass)	528.55	535.65	542.75	549.85	556.95	564.05	571.15	578.25	585.35
MSW to disposal sites (% of total)	75%	75%	75%	75%	75%	75%	75%	75%	75%
composting (1000t)	36.91	37.26	37.62	37.98	38.34	38.70	39.06	39.42	39.78
composting (%)	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%
Compost for backfilling (1000t)	23.16	23.38	23.61	23.83	24.06	24.29	24.51	24.74	24.97
composting (%)	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%
TOTAL composting (1000t)	60.07	60.64	61.23	61.81	62.40	62.98	63.57	64.16	64.75
composting (%)	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
recycling (1000t)	101.17	102.14	103.12	104.10	105.09	106.08	107.07	108.06	109.05
recycling (%)	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%	13.4%
per capita production to disposal sites (kg/cap)	566	572	577	583	588	594	599	605	610
POPULATION									
Regional Population (1000 persons)									
Lefkosia	362.8	364.1	365.5	366.8	368.0	369.2	370.4	371.6	372.7
Ammochostos	51.3	51.5	51.7	51.9	52.1	52.2	52.4	52.6	52.7
Larnaca	158.2	158.8	159.4	160.0	160.5	161.0	161.6	162.1	162.6
Lemesos	261.4	262.4	263.4	264.3	265.2	266.1	266.9	267.8	268.6
Pafos	99.7	100.1	100.4	100.8	101.1	101.5	101.8	102.1	102.4
TOTAL	933.4	937.0	940.4	943.7	946.9	950.0	953.1	956.1	959.1

	2032	2033	2034	2035	2036	2037	2038	2039	2040
Urban Population (1000 persons)									
Lefkosia	266.7	267.7	268.7	269.6	270.5	271.4	272.3	273.1	274.0
Ammochostos	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Larnaca	93.6	93.9	94.3	94.6	94.9	95.2	95.6	95.9	96.2
Lemesos	199.4	200.2	200.9	201.6	202.3	202.9	203.6	204.2	204.9
Pafos	70.3	70.6	70.8	71.1	71.3	71.6	71.8	72.0	72.3
TOTAL	630.0	632.4	634.7	636.9	639.1	641.2	643.2	645.3	647.3
Rural Population (1000 persons)									
Lefkosia	96.1	96.5	96.8	97.2	97.5	97.8	98.1	98.4	98.7
Ammochostos	51.3	51.5	51.7	51.9	52.1	52.2	52.4	52.6	52.7
Larnaca	64.6	64.9	65.1	65.4	65.6	65.8	66.0	66.2	66.4
Lemesos	62.0	62.3	62.5	62.7	62.9	63.1	63.3	63.5	63.7
Pafos	29.4	29.5	29.6	29.7	29.8	29.9	30.0	30.1	30.2
TOTAL	303.5	304.6	305.7	306.8	307.8	308.9	309.9	310.8	311.8
composition of waste to disposal sites									
Food	49%	49%	49%	49%	49%	49%	49%	49%	49%
Garden	8%	8%	8%	8%	8%	8%	8%	8%	8%
Paper	27%	27%	27%	27%	27%	27%	27%	27%	27%
Wood	3%	3%	3%	3%	3%	3%	3%	3%	3%
Textile	11%	11%	11%	11%	11%	11%	11%	11%	11%
Nappies	0%	0%	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	2%	2%	2%	2%	2%	2%	2%	2%	2%
Domestic wastewater management									
not well managed, centralised, overloaded aerobic (Ui)	95%	95%	95%	95%	95%	95%	95%	95%	95%
septic system (Ui)	5%	5%	5%	5%	5%	5%	5%	5%	5%
Industrial production (t)									
alcohol	629	629	629	629	629	629	629	629	629
beer	32764	32764	32764	32764	32764	32764	32764	32764	32764
soft drinks	10807	10807	10807	10807	10807	10807	10807	10807	10807
dairy products	99762	99762	99762	99762	99762	99762	99762	99762	99762
meat & poultry	79735	79735	79735	79735	79735	79735	79735	79735	79735
soaps & detergents	7300	7300	7300	7300	7300	7300	7300	7300	7300
vegetable oils	12640	12640	12640	12640	12640	12640	12640	12640	12640
vegetables, fruits & juices	57861	57861	57861	57861	57861	57861	57861	57861	57861

	2032	2033	2034	2035	2036	2037	2038	2039	2040
wine	11008	11008	11008	11008	11008	11008	11008	11008	11008
not well managed, centralised, overloaded aerobic									
alcohol	97%	97%	97%	97%	97%	97%	97%	97%	97%
beer	80%	80%	80%	80%	80%	80%	80%	80%	80%
soft drinks	96%	96%	96%	96%	96%	96%	96%	96%	96%
dairy products	95%	95%	95%	95%	95%	95%	95%	95%	95%
meat & poultry	94%	94%	94%	94%	94%	94%	94%	94%	94%
soaps & detergents	100%	100%	100%	100%	100%	100%	100%	100%	100%
vegetable oils	99%	99%	99%	99%	99%	99%	99%	99%	99%
vegetables, fruits & juices	99%	99%	99%	99%	99%	99%	99%	99%	99%
wine	100%	100%	100%	100%	100%	100%	100%	100%	100%
Anaerobic									
alcohol	3%	3%	3%	3%	3%	3%	3%	3%	3%
beer	20%	20%	20%	20%	20%	20%	20%	20%	20%
soft drinks	4%	4%	4%	4%	4%	4%	4%	4%	4%
dairy products	5%	5%	5%	5%	5%	5%	5%	5%	5%
meat & poultry	6%	6%	6%	6%	6%	6%	6%	6%	6%
soaps & detergents	0%	0%	0%	0%	0%	0%	0%	0%	0%
vegetable oils	1%	1%	1%	1%	1%	1%	1%	1%	1%
vegetables, fruits & juices	1%	1%	1%	1%	1%	1%	1%	1%	1%
wine	0%	0%	0%	0%	0%	0%	0%	0%	0%

NOTES:

- If activity data is not presented in the tables above; projection is made using real GDP forecast (Table I1, first row)
- HFO to diesel ratio assumed same as latest available information (2016)
- remove from HFO increase of RES
- from 2024 only Moni diesel
- assuming 40% for combustion of natural gas
- Cement production: assuming full capacity of 2000000 from first year of projection
- Lime production: increase to 8000 in 2030 - constant thereafter
- Ceramics: full capacity of approx. 2000000 from 2020
- 2F & 2G1: 2014 average per capita emissions (t/cap) of the four countries with cyprus population forecast
- 2G4: assuming constant emissions as 2015
- Population forecast from Ministry of Finance (Maria Matsi)
- MSW production: 2017-2030 from strategic plan for municipal solid waste (table VI, pg. 167); 2031-2040 continue trend

- Annual per capita production (kg/cap): divide total waste production by total population forecast
- diesel consumption road transport (Gg) for Urea-based catalysts: same as diesel consumption from transport

Annex IV: WEM scenario - activity data

Table IV1. WEM scenario - activity data (2016-2024)

	2016	2017	2018	2019	2020	2021	2022	2023	2024
E1 - natural gas									
RES	9.7%	9.8%	9.8%	9.9%	10%	10.3%	10.6%	10.9%	11.2%
Natural gas	0.0%	0.0%	0.0%	0.0%	0.0%	88.9%	88.6%	88.3%	88.0%
HFO	76.4%	76.3%	76.2%	76.2%	76.1%	0.0%	0.0%	0.0%	0.0%
Diesel	13.9%	13.9%	13.9%	13.9%	13.9%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY									
RES	1535	1604	1666	1726	1787	1887	1991	2094	2201
Natural gas	0	0	0	0	0	40707	41584	42396	43224
HFO	35877	35757	35751	35745	35739	0	0	0	0
Diesel	6406	6526	6532	6538	6544	389	391	392	393
E2 - RES in electricity									
RES	9.7%	10.5%	11.3%	12.2%	13%	13.7%	14.4%	15.1%	15.8%
Natural gas	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	83.4%
HFO	76.4%	75.6%	74.7%	73.9%	73.1%	72.4%	71.7%	71.0%	0.0%
Diesel	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	0.8%
WM (TJ) PRIMARY									
RES	1535	1727	1920	2117	2324	2510	2704	2901	3105
Natural gas	0	0	0	0	0	0	0	0	40964
HFO	35877	35702	35640	35578	35514	35459	35403	35346	0
Diesel	6406	6581	6643	6705	6769	6824	6880	6937	415
E3 - EE in industry									
LPG	269	279	288	296	304	312	320	328	336
Diesel	423	438	452	465	478	490	503	515	528
RFO	945	980	1010	1038	1068	1096	1125	1152	1180
Pet-coke	3917	4063	4189	4306	4426	4543	4663	4777	4893
Coal	20	21	22	22	23	24	24	25	25
Industrial waste (non RES) and other fuels	652	677	698	717	737	757	777	796	815
Biomass	547	567	585	601	618	634	651	667	683
E4 - EE residential new buildings									
Residential new buildings	4073	4073	4073	4073	4073	3864	3655	3446	3237
consumption with E4 (TJ)	3876	4166	4417	4650	4889	5322	5761	6186	6617
TJ									
Other kerosene	299	321	341	359	377	411	444	477	510

	2016	2017	2018	2019	2020	2021	2022	2023	2024
Diesel/gas oil	1363	1462	1546	1624	1704	1839	1973	2101	2227
LPG	807	868	920	968	1018	1108	1200	1288	1378
Solid Biomass	63	68	72	76	80	87	94	101	108
Charcoal	115	124	131	138	145	158	171	184	196
RES	1229	1324	1407	1484	1565	1719	1878	2035	2197
E5 - EE residential energy upgrade									
Residential new buildings	120	120	120	120	120	120	120	120	120
consumption with E5 (TJ)	7829	8119	8370	8603	8842	9066	9296	9513	9734
TJ									
Other kerosene	604	626	646	664	682	699	717	734	751
Diesel/gas oil	2753	2849	2930	3005	3082	3133	3184	3230	3276
LPG	1631	1691	1743	1792	1842	1888	1936	1981	2027
Solid Biomass	128	133	137	141	145	148	152	156	159
Charcoal	232	241	249	255	263	269	276	282	289
RES	2481	2580	2666	2746	2830	2928	3030	3130	3232
E6 - EE residential solar panels replacement									
Residential solar panels replacement	4	4	4	4	4	4	4	4	4
consumption with E6 (TJ)	7945	8235	8486	8719	8958	9182	9411	9628	9850
TJ									
Other kerosene	613	635	655	673	691	708	726	743	760
Diesel/gas oil	2794	2889	2971	3046	3122	3173	3224	3269	3315
LPG	1655	1715	1767	1816	1866	1912	1960	2005	2051
Solid Biomass	130	135	139	143	146	150	154	157	161
Charcoal	236	244	252	259	266	273	279	286	292
RES	2518	2616	2702	2783	2866	2966	3068	3168	3270
E7 - EE tertiary new buildings									
Tertiary new buildings reductions (TJ)	467	467	467	467	467	450	433	416	399
consumption with E7 (TJ)	1365	1432	1490	1544	1599	1667	1737	1804	1872
TJ									
diesel	481	499	514	528	541	561	581	600	619
RFO	0	0	0	0	0	0	0	0	0
LPG	387	406	423	438	454	473	493	512	531
solid biomass	11	12	12	13	13	14	14	15	15
gas biomass	9	9	10	10	10	11	11	12	12

	2016	2017	2018	2019	2020	2021	2022	2023	2024
charcoal	154	162	168	174	181	188	196	204	211
solar thermal	323	343	362	381	400	420	441	462	483
E8 - EE tertiary energy upgrade									
Tertiary buildings energy upgrade	198	198	198	198	198	198	198	198	198
consumption with E8 (TJ)	1634	1701	1759	1813	1868	1919	1972	2022	2073
TJ									
diesel	575	593	607	620	632	646	660	672	685
RFO	0	0	0	0	0	0	0	0	0
LPG	464	483	499	514	530	545	560	574	588
solid biomass	13	14	14	15	15	16	16	17	17
gas biomass	11	11	12	12	12	13	13	13	14
charcoal	185	192	199	205	211	217	223	228	234
solar thermal	386	408	428	447	467	484	501	518	535
E9 - EE in public buildings									
Public buildings	14	12	10	8	6	6	6	6	6
consumption with E9 (TJ)	1818	1887	1947	2003	2060	2112	2165	2215	2266
TJ									
diesel	640	658	672	685	697	710	724	736	749
RFO	0	0	0	0	0	0	0	0	0
LPG	516	535	553	568	585	599	614	629	643
solid biomass	15	15	16	16	17	17	18	18	19
gas biomass	12	12	13	13	13	14	14	15	15
charcoal	205	213	220	226	233	239	245	250	256
solar thermal	430	452	473	494	515	532	550	567	585
E10 - industry (alternative fuels)									
LPG	4%	4%	4%	4%	4%	4%	4%	4%	4%
Diesel	6%	6%	6%	6%	6%	6%	6%	6%	6%
RFO	14%	14%	14%	14%	14%	14%	14%	14%	14%
Pet-coke	58%	57%	57%	56%	56%	55%	55%	55%	55%
Coal	0%	0%	0%	0%	0%	0%	0%	0%	0%
Industrial waste (non RES) and other fuels	10%	10%	10%	10%	10%	10%	10%	10%	10%
Biomass	8%	9%	9%	10%	10%	10.2%	10.4%	10.6%	10.8%
TJ									
LPG	273	283	292	300	308	316	323	331	338

	2016	2017	2018	2019	2020	2021	2022	2023	2024
Diesel	429	445	458	471	484	496	508	520	532
RFO	959	994	1024	1052	1081	1108	1136	1162	1189
Pet-coke	3976	4086	4175	4253	4304	4396	4490	4576	4665
Coal	21	21	22	23	23	24	24	25	25
Industrial waste (non RES) and other fuels	662	686	707	727	775	794	814	833	852
Biomass	555	609	663	718	775	810	847	883	920
E11 - RES in residential									
RES heating and cooling	31%	32%	33%	34%	35%	35%	36%	36%	36%
WM consumption (%)									
Other kerosene	8%	8%	8%	8%	8%	8%	8%	8%	8%
Diesel/gas oil	35%	35%	34%	33%	32%	32%	31%	31%	31%
LPG	21%	21%	21%	21%	21%	21%	21%	21%	21%
Solid Biomass	2%	2%	2%	2%	2%	2%	2%	2%	2%
Charcoal	3%	3%	3%	3%	3%	3.0%	3.0%	3.0%	3.0%
RES	32%	32%	33%	34%	35%	35.3%	35.6%	35.9%	36.2%
TJ									
Other kerosene	613	636	655	673	691	709	726	743	760
Diesel/gas oil	2795	2872	2874	2866	2855	2899	2943	2982	3021
LPG	1656	1716	1768	1817	1866	1913	1961	2006	2052
Solid Biomass	130	135	139	143	147	150	154	158	161
Charcoal	236	245	252	259	266	273	280	286	293
RES	2519	2636	2802	2966	3137	3243	3352	3458	3567
E12 - RES in commercial									
RES heating and cooling	21%	22%	23%	24%	25%	25%	26%	26%	26%
WM consumption (%)									
Diesel/gas oil	35%	35%	35%	34%	34%	34%	33%	33%	33%
RFO	0%	0%	0%	0%	0%	0%	0%	0%	0%
LPG	28%	28%	28%	28%	28%	28%	28%	28%	28%
solid biomass	1%	1%	1%	1%	1%	1%	1%	1%	1%
gas biomass	1%	1%	1%	1%	1%	0.7%	0.7%	0.7%	0.7%
charcoal	11%	11%	11%	11%	11%	11.3%	11.3%	11.3%	11.3%
solar thermal	24%	24%	24%	25%	25%	25.3%	25.6%	25.9%	26.2%
TJ									
diesel	645	662	676	687	699	710	721	731	741

	2016	2017	2018	2019	2020	2021	2022	2023	2024
RFO	0	0	0	0	0	0	0	0	0
LPG	520	539	555	571	586	601	616	630	645
solid biomass	15	16	16	16	17	17	18	18	19
gas biomass	12	12	13	13	14	14	14	15	15
charcoal	207	215	221	227	233	239	245	251	257
solar thermal	433	455	476	496	516	536	556	575	595
T1 - biofuels									
Gasoline (TJ)	15682	16254	16749	17209	17681	18123	18576	19003	19440
Total Diesel (TJ)	12109	12551	12933	13288	13652	13993	14343	14673	15011
Diesel (TJ)	11739	12075	12347	12588	12833	13154	13483	13793	14110
Biodiesel (TJ)	370	476	586	699	819	840	861	880	901
Biodiesel (%)	3.1%	3.8%	4.5%	5.3%	6%	6%	6%	6%	6%
I1 - F-gases									
reduction of emissions	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%	0.0%
A1 - Anerobic digestion									
waste management									
dairy cattle									
solid storage	95%	95%	94%	94%	93%	93%	92%	92%	91%
anaerobic digester	5%	6%	6%	7%	7%	8%	8%	9%	9%
other cattle									
solid storage	95%	95%	94%	94%	93%	93%	92%	92%	91%
anaerobic digester	5%	6%	6%	7%	7%	8%	8%	9%	9%
market swine									
anaerobic digester	50%	49%	48%	47%	46%	45%	44%	43%	42%
aerobic treatment	50%	51%	52%	53%	54%	55%	56%	57%	58%
breeding swine									
anaerobic digester	50%	49%	48%	48%	47%	46%	45%	44%	43%
aerobic treatment	50%	51%	52%	53%	53%	54%	55%	56%	57%
sheep									
solid storage	100%	100%	100%	100%	99.5%	99.0%	98.6%	98.1%	97.6%
anaerobic digester					0.5%	1.0%	1.4%	1.9%	2.4%
goats									
solid storage	100%	100%	100%	100%	99.5%	99.0%	98.6%	98.1%	97.6%
anaerobic digester					0.5%	1.0%	1.4%	1.9%	2.4%

	2016	2017	2018	2019	2020	2021	2022	2023	2024
poultry									
solid storage	85%	85%	84%	84%	83%	83%	83%	82%	82%
anaerobic digester	15%	15%	16%	16%	17%	17%	18%	18%	18%
W1 - sorting									
40% sorting at source from 2021									
MSW to disposal sites (1000t wet mass)	410	424	431	437	443	450	456	463	470
reduction of waste to landfill from 2021 due to sorting (W1)						40%	40.0%	40.0%	40.0%
W1 MSW to disposal sites (1000t wet mass)						270	274	278	282
W1 MSW to disposal sites (%)						60%	60%	60%	60%
W2 - organics to landfill									
15% of organics to landfill from 2021									
BaU waste per capita (kg)						679	684	690	697
W2 composition of waste to disposal sites									
Food						14%	14%	14%	14%
Garden						2%	2%	2%	2%
Paper						52%	52%	52%	52%
Wood						6%	6%	6%	6%
Textile						21%	21%	21%	21%
Nappies						0%	0%	0%	0%
Plastics, other inert						4%	4%	4%	4%
W2 MSW to disposal sites (%)						33%	33%	33%	33%
W3 - composting									
increase composting						5%	5.0%	5.0%	5.0%
W3 composting (1000t)						34	34	35	35
BaU Compost for backfilling (1000t)	17	20	20	21	21	21	21	21	21
W3 TOTAL composting (1000t)	17	20	20	21	21	55	55	56	56
W4 - anaerobic digestion									
increase AD to 5% in 2021 and keep constant						10%	10.0%	10.0%	10.0%
W4 AD (1000t)						67.85	68.43	69.03	69.65
W5 - biogas recovery									
biogas recovery from deep unmanaged and managed anaerobic disposal sites (%)						20%	20%	20%	20%

Table IV2. WEM scenario - activity data (2025-2033)

	2025	2026	2027	2028	2029	2030	2031	2032	2033
E1 - natural gas									
RES	11.5%	11.8%	12.1%	12.4%	12.7%	13%	13.7%	14.4%	15.1%
Natural gas	87.7%	87.4%	87.1%	86.8%	86.5%	86.2%	85.5%	84.8%	84.1%
HFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Diesel	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY									
RES	2308	2417	2529	2643	2761	2883	3099	3322	3554
Natural gas	43981	44751	45489	46239	47001	47774	48334	48897	49463
HFO	0	0	0	0	0	0	0	0	0
Diesel	395	396	397	399	400	401	405	408	411
E2 - RES in electricity									
RES	16.5%	17.2%	17.9%	18.6%	19.3%	20%	20.7%	21.4%	22.1%
Natural gas	82.7%	82.0%	81.3%	80.6%	79.9%	79.2%	78.5%	77.8%	77.1%
HFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Diesel	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY									
RES	3311	3524	3741	3965	4196	4435	4682	4937	5201
Natural gas	41473	41985	42459	42935	43414	43894	44376	44859	45345
HFO	0	0	0	0	0	0	0	0	0
Diesel	418	422	425	429	433	437	440	444	448
E3 - EE in industry									
LPG	344	351	359	366	374	382	389	397	405
Diesel	540	552	563	575	587	600	612	624	636
RFO	1206	1233	1259	1286	1313	1340	1367	1394	1422
Pet-coke	5002	5112	5220	5330	5442	5556	5668	5781	5897
Coal	26	26	27	28	28	29	29	30	31
Industrial waste (non RES) and other fuels	833	852	870	888	907	926	944	963	982
Biomass	698	713	729	744	759	775	791	807	823
E4 - EE residential new buildings									
Residential new buildings	3028	2819	2610	2401	2192	1983	1983	1983	1983
consumption with E4 (TJ)	7033	7453	7867	8286	8709	9135	9358	9585	9816
TJ									
Other kerosene	543	575	607	639	672	705	722	739	757

	2025	2026	2027	2028	2029	2030	2031	2032	2033
Diesel/gas oil	2346	2464	2577	2689	2800	2910	2962	3015	3068
LPG	1465	1552	1638	1726	1814	1903	1949	1996	2044
Solid Biomass	115	122	129	136	142	149	153	157	161
Charcoal	209	221	234	246	259	271	278	285	291
RES	2356	2519	2683	2850	3022	3197	3294	3393	3495
E5 - EE residential energy upgrade									
Residential new buildings	120	120	120	120	120	120	120	120	120
consumption with E5 (TJ)	9941	10152	10358	10567	10781	10999	11221	11448	11680
TJ									
Other kerosene	767	783	799	815	832	848	866	883	901
Diesel/gas oil	3316	3356	3393	3430	3467	3504	3552	3601	3650
LPG	2070	2114	2157	2201	2245	2291	2337	2384	2432
Solid Biomass	163	166	169	173	176	180	184	187	191
Charcoal	295	301	308	314	320	327	333	340	347
RES	3330	3431	3532	3635	3741	3850	3950	4053	4158
E6 - EE residential solar panels replacement									
Residential solar panels replacement	4	4	4	4	4	4	4	4	4
consumption with E6 (TJ)	10056	10268	10473	10683	10896	11114	11337	11564	11795
TJ									
Other kerosene	776	792	808	824	841	857	875	892	910
Diesel/gas oil	3354	3394	3430	3467	3504	3541	3589	3637	3687
LPG	2094	2138	2181	2225	2269	2315	2361	2408	2457
Solid Biomass	164	168	171	175	178	182	185	189	193
Charcoal	299	305	311	317	324	330	337	343	350
RES	3369	3471	3571	3675	3781	3890	3991	4094	4199
E7 - EE tertiary new buildings									
Tertiary new buildings reductions (TJ)	382	365	349	332	315	298	298	298	298
consumption with E7 (TJ)	1936	2002	2066	2132	2198	2265	2316	2368	2422
TJ									
diesel	636	654	670	687	704	721	738	754	771
RFO	0	0	0	0	0	0	0	0	0
LPG	550	568	586	605	624	643	657	672	687
solid biomass	16	16	17	17	18	19	19	19	20
gas biomass	13	13	14	14	14	15	15	16	16

	2025	2026	2027	2028	2029	2030	2031	2032	2033
charcoal	219	226	233	241	248	256	262	268	274
solar thermal	503	525	546	567	589	612	625	639	654
E8 - EE tertiary energy upgrade									
Tertiary buildings energy upgrade	198	198	198	198	198	198	198	198	198
consumption with E8 (TJ)	2121	2170	2217	2265	2315	2365	2416	2468	2522
TJ									
diesel	697	708	719	730	742	753	769	786	803
RFO	0	0	0	0	0	0	0	0	0
LPG	602	616	629	643	657	671	686	701	716
solid biomass	17	18	18	19	19	19	20	20	21
gas biomass	14	14	15	15	15	15	16	16	17
charcoal	240	245	250	256	262	267	273	279	285
solar thermal	551	568	585	603	620	639	652	666	681
E9 - EE in public buildings									
Public buildings	6	6	6	6	6	6	6	6	6
consumption with E9 (TJ)	2313	2362	2409	2458	2507	2557	2608	2661	2714
TJ									
diesel	760	771	782	792	803	814	831	847	864
RFO	0	0	0	0	0	0	0	0	0
LPG	657	670	684	698	712	726	740	755	770
solid biomass	19	19	20	20	21	21	21	22	22
gas biomass	15	15	16	16	16	17	17	17	18
charcoal	261	267	272	278	283	289	295	301	307
solar thermal	601	619	636	654	672	690	704	718	733
E10 - industry (alternative fuels)									
LPG	4%	4%	4%	4%	4%	4%	4%	4%	4%
Diesel	6%	6%	6%	6%	6%	6%	6%	6%	6%
RFO	14%	14%	14%	14%	14%	14%	14%	14%	14%
Pet-coke	55%	54%	54%	54%	54%	54%	53%	53%	53%
Coal	0%	0%	0%	0%	0%	0%	0%	0%	0%
Industrial waste (non RES) and other fuels	10%	10%	10%	10%	10%	10%	10%	10%	10%
Biomass	11.0%	11.2%	11.4%	11.6%	11.8%	12%	12.2%	12.4%	12.6%
TJ									
LPG	346	353	360	367	374	382	390	397	405

	2025	2026	2027	2028	2029	2030	2031	2032	2033
Diesel	543	554	565	577	588	600	612	624	637
RFO	1214	1239	1264	1289	1315	1341	1368	1395	1423
Pet-coke	4745	4827	4905	4985	5066	5148	5231	5316	5402
Coal	26	27	27	28	28	29	29	30	31
Industrial waste (non RES) and other fuels	870	888	906	924	943	962	981	1000	1020
Biomass	957	995	1033	1072	1112	1154	1197	1240	1286
E11 - RES in residential									
RES heating and cooling	37%	37%	37%	37%	38%	38%	38%	39%	39%
WM consumption (%)									
Other kerosene	8%	8%	8%	8%	8%	8%	8%	8%	8%
Diesel/gas oil	30%	30%	30%	29%	29%	29%	28%	28%	28%
LPG	21%	21%	21%	21%	21%	21%	21%	21%	21%
Solid Biomass	2%	2%	2%	2%	2%	2%	2%	2%	2%
Charcoal	3.0%	3.0%	3.0%	3.0%	3.0%	3%	3.0%	3.0%	3.0%
RES	36.5%	36.8%	37.1%	37.4%	37.7%	38%	38.4%	38.8%	39.2%
TJ									
Other kerosene	776	792	808	824	841	858	875	892	910
Diesel/gas oil	3054	3087	3118	3148	3178	3208	3227	3245	3263
LPG	2095	2139	2182	2226	2270	2316	2362	2409	2457
Solid Biomass	165	168	171	175	178	182	185	189	193
Charcoal	299	305	311	317	324	330	337	343	350
RES	3672	3780	3887	3997	4110	4225	4355	4488	4625
E12 - RES in commercial									
RES heating and cooling	27%	27%	27%	27%	28%	28%	28%	28%	28%
WM consumption (%)									
Diesel/gas oil	32%	32%	32%	31%	31%	31%	31%	31%	31%
RFO	0%	0%	0%	0%	0%	0%	0%	0%	0%
LPG	28%	28%	28%	28%	28%	28%	28%	28%	28%
solid biomass	1%	1%	1%	1%	1%	1%	1%	1%	1%
gas biomass	0.7%	0.7%	0.7%	0.7%	0.7%	1%	0.7%	0.7%	0.7%
charcoal	11.3%	11.3%	11.3%	11.3%	11.3%	11%	11.3%	11.3%	11.3%
solar thermal	26.5%	26.8%	27.1%	27.4%	27.7%	28%	28.0%	28.0%	28.0%
TJ									
diesel	750	759	767	775	783	790	806	822	839

	2025	2026	2027	2028	2029	2030	2031	2032	2033
RFO	0	0	0	0	0	0	0	0	0
LPG	658	672	685	699	713	727	742	757	772
solid biomass	19	19	20	20	21	21	21	22	22
gas biomass	15	16	16	16	16	17	17	17	18
charcoal	262	267	273	278	284	290	295	301	307
solar thermal	614	634	654	675	696	718	732	747	761
T1 - biofuels									
Gasoline (TJ)	19848	20265	20670	21084	21505	21935	22374	22822	23278
Total Diesel (TJ)	15326	15648	15961	16280	16605	16937	17276	17622	17974
Diesel (TJ)	14406	14709	15003	15303	15609	15921	16240	16564	16896
Biodiesel (TJ)	920	939	958	977	996	1016	1037	1057	1078
Biodiesel (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%
I1 - F-gases									
reduction of emissions	0.0%	0.0%	0.0%	0.0%	0.0%	5%	5.0%	5.0%	5.0%
A1 - Anerobic digestion									
waste management									
dairy cattle									
solid storage	91%	90%	90%	89%	89%	88%	88%	87%	87%
anaerobic digester	10%	10%	11%	11%	12%	12%	13%	13%	14%
other cattle									
solid storage	91%	90%	90%	89%	89%	88%	88%	87%	87%
anaerobic digester	10%	10%	11%	11%	12%	12%	13%	13%	14%
market swine									
anaerobic digester	41%	40%	39%	38%	36%	35%	34%	33%	32%
aerobic treatment	59%	60%	61%	63%	64%	65%	66%	67%	68%
breeding swine									
anaerobic digester	43%	42%	41%	40%	39%	38%	38%	37%	36%
aerobic treatment	58%	58%	59%	60%	61%	62%	63%	63%	64%
sheep									
solid storage	97.1%	96.7%	96.2%	95.7%	95.2%	94.8%	94.3%	93.8%	93.3%
anaerobic digester	2.9%	3.3%	3.8%	4.3%	4.8%	5.2%	5.7%	6.2%	6.7%
goats									
solid storage	97.1%	96.7%	96.2%	95.7%	95.2%	94.8%	94.3%	93.8%	93.3%
anaerobic digester	2.9%	3.3%	3.8%	4.3%	4.8%	5.2%	5.7%	6.2%	6.7%

	2025	2026	2027	2028	2029	2030	2031	2032	2033
poultry									
solid storage	81%	81%	80%	80%	80%	79%	79%	78%	78%
anaerobic digester	19%	19%	20%	20%	20%	21%	21%	22%	22%
W1 - sorting									
40% sorting at source from 2021									
MSW to disposal sites (1000t wet mass)	477	485	492	500	509	518	521	529	536
reduction of waste to landfill from 2021 due to sorting (W1)	40%	40.0%	40.0%	40.0%	40.0%	40%	40.0%	40.0%	40.0%
W1 MSW to disposal sites (1000t wet mass)	286	291	295	300	305	311	313	317	321
W1 MSW to disposal sites (%)	60%	60%	60%	60%	60%	60%	60%	60%	60%
W2 - organics to landfill									
15% of organics to landfill from 2021									
BaU waste per capita (kg)	703	710	717	725	734	744	746	753	761
W2 composition of waste to disposal sites									
Food	14%	14%	14%	14%	14%	14%	14%	14%	14%
Garden	2%	2%	2%	2%	2%	2%	2%	2%	2%
Paper	52%	52%	52%	52%	52%	52%	52%	52%	52%
Wood	6%	6%	6%	6%	6%	6%	6%	6%	6%
Textile	21%	21%	21%	21%	21%	21%	21%	21%	21%
Nappies	0%	0%	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	4%	4%	4%	4%	4%	4%	4%	4%	4%
W2 MSW to disposal sites (%)	33%	33%	33%	33%	33%	33%	33%	33%	33%
W3 - composting									
increase composting	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
W3 composting (1000t)	35	35	36	36	37	37	37	38	38
BaU Compost for backfilling (1000t)	22	22	22	22	23	23	23	23	23
W3 TOTAL composting (1000t)	57	57	58	59	59	60	60	61	61
W4 - anaerobic digestion									
increase AD to 5% in 2021 and keep constant	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
W4 AD (1000t)	70.30	70.99	71.73	72.54	73.42	74.37	74.62	75.33	76.05
W5 - biogas recovery									
biogas recovery from deep unmanaged and managed anaerobic disposal sites (%)	20%	20%	20%	20%	20%	20%	20%	20%	20%

Table IV3. WEM scenario - activity data (2034-2040)

	2034	2035	2036	2037	2038	2039	2040
E1 - natural gas							
RES	15.8%	16.5%	17.2%	17.9%	18.6%	19.3%	20%
Natural gas	83.4%	82.7%	82.0%	81.3%	80.6%	79.9%	79.2%
HFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Diesel	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY							
RES	3793	4040	4295	4560	4833	5115	5406
Natural gas	50032	50605	51180	51757	52338	52921	53506
HFO	0	0	0	0	0	0	0
Diesel	415	418	422	425	429	433	437
E2 - RES in electricity							
RES	22.8%	23.5%	24.2%	24.9%	25.6%	26.3%	27%
Natural gas	76.4%	75.7%	75.0%	74.3%	73.6%	72.9%	72.2%
HFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Diesel	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY							
RES	5473	5754	6044	6343	6652	6970	7299
Natural gas	45832	46320	46809	47300	47791	48283	48776
HFO	0	0	0	0	0	0	0
Diesel	452	456	461	465	469	474	478
E3 - EE in industry							
LPG	413	421	430	438	447	456	465
Diesel	649	662	675	689	703	717	731
RFO	1451	1480	1509	1539	1570	1602	1634
Pet-coke	6015	6135	6258	6383	6511	6641	6774
Coal	31	32	32	33	34	34	35
Industrial waste (non RES) and other fuels	1002	1022	1042	1063	1085	1106	1128
Biomass	839	856	873	891	909	927	945
E4 - EE residential new buildings							
Residential new buildings	1983	1983	1983	1983	1983	1983	1983
consumption with E4 (TJ)	10052	10293	10538	10789	11044	11305	11570
TJ							
Other kerosene	775	794	813	832	852	872	893

	2034	2035	2036	2037	2038	2039	2040
Diesel/gas oil	3122	3176	3230	3286	3341	3398	3454
LPG	2093	2144	2195	2247	2300	2354	2410
Solid Biomass	164	168	172	176	181	185	189
Charcoal	298	306	313	320	328	336	344
RES	3599	3705	3815	3927	4042	4160	4281
E5 - EE residential energy upgrade							
Residential new buildings	120	120	120	120	120	120	120
consumption with E5 (TJ)	11916	12156	12402	12652	12908	13168	13434
TJ							
Other kerosene	919	938	957	976	996	1016	1036
Diesel/gas oil	3700	3751	3802	3853	3905	3958	4011
LPG	2482	2532	2583	2635	2688	2742	2798
Solid Biomass	195	199	203	207	211	215	220
Charcoal	354	361	368	376	383	391	399
RES	4266	4376	4489	4605	4724	4846	4971
E6 - EE residential solar panels replacement							
Residential solar panels replacement	4	4	4	4	4	4	4
consumption with E6 (TJ)	12031	12272	12517	12768	13023	13284	13549
TJ							
Other kerosene	928	947	966	985	1005	1025	1045
Diesel/gas oil	3736	3786	3837	3888	3940	3992	4045
LPG	2506	2556	2607	2659	2712	2767	2822
Solid Biomass	197	201	205	209	213	217	222
Charcoal	357	364	372	379	387	394	402
RES	4307	4418	4531	4647	4766	4888	5013
E7 - EE tertiary new buildings							
Tertiary new buildings reductions (TJ)	298	298	298	298	298	298	298
consumption with E7 (TJ)	2476	2532	2588	2646	2705	2765	2826
TJ							
diesel	789	806	824	843	861	880	872
RFO	0	0	0	0	0	0	0
LPG	703	719	735	751	768	785	802
solid biomass	20	21	21	22	22	23	23
gas biomass	16	17	17	17	18	18	19

	2034	2035	2036	2037	2038	2039	2040
charcoal	280	286	292	299	306	312	319
solar thermal	669	684	699	714	730	747	791
E8 - EE tertiary energy upgrade							
Tertiary buildings energy upgrade	198	198	198	198	198	198	198
consumption with E8 (TJ)	2576	2632	2688	2746	2805	2865	2926
TJ							
diesel	820	838	856	874	893	912	903
RFO	0	0	0	0	0	0	0
LPG	731	747	763	779	796	813	831
solid biomass	21	22	22	22	23	23	24
gas biomass	17	17	18	18	18	19	19
charcoal	291	297	304	310	317	324	331
solar thermal	696	711	726	741	757	774	819
E9 - EE in public buildings							
Public buildings	6	6	6	6	6	6	6
consumption with E9 (TJ)	2768	2824	2880	2938	2997	3057	3118
TJ							
diesel	882	899	917	936	954	974	962
RFO	0	0	0	0	0	0	0
LPG	786	801	818	834	851	868	885
solid biomass	23	23	24	24	25	25	26
gas biomass	18	18	19	19	20	20	20
charcoal	313	319	325	332	339	345	352
solar thermal	747	762	778	793	809	825	873
E10 - industry (alternative fuels)							
LPG	4%	4%	4%	4%	4%	4%	4%
Diesel	6%	6%	6%	6%	6%	6%	6%
RFO	14%	14%	14%	14%	14%	14%	14%
Pet-coke	53%	53%	52%	52%	52%	52%	52%
Coal	0%	0%	0%	0%	0%	0%	0%
Industrial waste (non RES) and other fuels	10%	10%	10%	10%	10%	10%	10%
Biomass	12.8%	13.0%	13.2%	13.4%	13.6%	13.8%	14%
TJ							
LPG	413	422	430	439	447	456	466

	2034	2035	2036	2037	2038	2039	2040
Diesel	650	662	676	689	703	717	731
RFO	1452	1481	1510	1541	1571	1603	1635
Pet-coke	5489	5578	5668	5759	5851	5946	6041
Coal	31	32	32	33	34	34	35
Industrial waste (non RES) and other fuels	1041	1062	1083	1104	1127	1149	1172
Biomass	1332	1380	1429	1480	1532	1586	1641
E11 - RES in residential							
RES heating and cooling	40%	40%	40%	41%	41%	42%	42%
WM consumption (%)							
Other kerosene	8%	8%	8%	8%	8%	8%	8%
Diesel/gas oil	27%	27%	26%	26%	26%	25%	25%
LPG	21%	21%	21%	21%	21%	21%	21%
Solid Biomass	2%	2%	2%	2%	2%	2%	2%
Charcoal	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3%
RES	39.6%	40.0%	40.4%	40.8%	41.2%	41.6%	42%
TJ							
Other kerosene	928	947	966	985	1005	1025	1046
Diesel/gas oil	3280	3297	3313	3328	3342	3356	3369
LPG	2507	2557	2608	2660	2713	2767	2823
Solid Biomass	197	201	205	209	213	217	222
Charcoal	357	364	372	379	387	395	402
RES	4766	4910	5059	5211	5367	5528	5692
E12 - RES in commercial							
RES heating and cooling	28%	28%	28%	28%	28%	28%	32%
WM consumption (%)							
Diesel/gas oil	31%	31%	31%	31%	31%	31%	27%
RFO	0%	0%	0%	0%	0%	0%	0%
LPG	28%	28%	28%	28%	28%	28%	28%
solid biomass	1%	1%	1%	1%	1%	1%	1%
gas biomass	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	1%
charcoal	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11%
solar thermal	28.0%	28.0%	28.0%	28.0%	28.0%	28.0%	32%
TJ							
diesel	856	873	890	908	926	945	839

	2034	2035	2036	2037	2038	2039	2040
RFO	0	0	0	0	0	0	0
LPG	787	803	819	835	852	869	887
solid biomass	23	23	24	24	25	25	26
gas biomass	18	19	19	19	20	20	20
charcoal	313	320	326	333	339	346	353
solar thermal	777	792	808	824	841	858	1000
T1 - biofuels							
Gasoline (TJ)	23744	24218	24703	25197	25701	26215	26739
Total Diesel (TJ)	18334	18700	19074	19456	19845	20242	20647
Diesel (TJ)	17234	17578	17930	18288	18654	19027	19408
Biodiesel (TJ)	1100	1122	1144	1167	1191	1215	1239
Biodiesel (%)	6%	6%	6%	6%	6%	6%	6%
I1 - F-gases							
reduction of emissions	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	10%
A1 - Anerobic digestion							
waste management							
dairy cattle							
solid storage	86%	86%	85%	85%	84%	84%	83%
anaerobic digester	14%	15%	15%	16%	16%	17%	17%
other cattle							
solid storage	86%	86%	85%	85%	84%	84%	83%
anaerobic digester	14%	15%	15%	16%	16%	17%	17%
market swine							
anaerobic digester	31%	30%	29%	28%	27%	26%	25%
aerobic treatment	69%	70%	71%	72%	73%	74%	75%
breeding swine							
anaerobic digester	35%	34%	33%	32%	32%	31%	30%
aerobic treatment	65%	66%	67%	67%	68%	69%	70%
sheep							
solid storage	92.9%	92.4%	91.9%	91.4%	91.0%	90.5%	90%
anaerobic digester	7.1%	7.6%	8.1%	8.6%	9.0%	9.5%	10%
goats							
solid storage	92.9%	92.4%	91.9%	91.4%	91.0%	90.5%	90%
anaerobic digester	7.1%	7.6%	8.1%	8.6%	9.0%	9.5%	10%

	2034	2035	2036	2037	2038	2039	2040
poultry							
solid storage	78%	77%	77%	76%	76%	75%	75%
anaerobic digester	23%	23%	23%	24%	24%	25%	25%
W1 - sorting							
40% sorting at source from 2021							
MSW to disposal sites (1000t wet mass)	543	550	557	564	571	578	585
reduction of waste to landfill from 2021 due to sorting (W1)	40.0%	40%	40%	40%	40%	40%	40%
W1 MSW to disposal sites (1000t wet mass)	326	330	334	338	343	347	351
W1 MSW to disposal sites (%)	60%	60%	60%	60%	60%	60%	60%
W2 - organics to landfill							
15% of organics to landfill from 2021							
BaU waste per capita (kg)	768	775	783	790	797	805	812
W2 composition of waste to disposal sites							
Food	14%	14%	14%	14%	14%	14%	14%
Garden	2%	2%	2%	2%	2%	2%	2%
Paper	52%	52%	52%	52%	52%	52%	52%
Wood	6%	6%	6%	6%	6%	6%	6%
Textile	21%	21%	21%	21%	21%	21%	21%
Nappies	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	4%	4%	4%	4%	4%	4%	4%
W2 MSW to disposal sites (%)	33%	33%	33%	33%	33%	33%	33%
W3 - composting							
increase composting	5.0%	5%	5%	5%	5%	5%	5%
W3 composting (1000t)	38	39	39	39	40	40	41
BaU Compost for backfilling (1000t)	24	24	24	24	25	25	25
W3 TOTAL composting (1000t)	62	63	63	64	64	65	66
W4 - anaerobic digestion							
increase AD to 5% in 2021 and keep constant	10.0%	10%	10%	10%	10%	10%	10%
W4 AD (1000t)	76.78	77.52	78.25	78.99	79.73	80.46	81.20
W5 - biogas recovery							
biogas recovery from deep unmanaged and managed anaerobic disposal sites (%)	20%	20%	20%	20%	20%	20%	20%

Annex V: WAM scenario - activity data

Table V1. WAM scenario - activity data (2016-2024)

	2016	2017	2018	2019	2020	2021	2022	2023	2024
E1 - natural gas									
RES (BaU)	9.7%	9.8%	9.8%	9.9%	10%	10.3%	10.6%	10.9%	11.2%
Natural gas	0.0%	0.0%	0.0%	0.0%	0.0%	88.9%	88.6%	88.3%	88.0%
HFO	76.4%	76.3%	76.2%	76.2%	76.1%	0.0%	0.0%	0.0%	0.0%
Diesel	13.9%	13.9%	13.9%	13.9%	13.9%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY									
RES	1535	1604	1666	1726	1787	1887	1991	2094	2201
Natural gas	0	0	0	0	0	40707	41584	42396	43224
HFO	35877	35757	35751	35745	35739	0	0	0	0
Diesel	6406	6526	6532	6538	6544	389	391	392	393
E2 - RES in electricity									
RES	9.7%	11.3%	12.8%	14.4%	16%	17.1%	18.2%	19.3%	20.4%
Natural gas	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	78.8%
HFO	76.4%	74.8%	73.2%	71.7%	70.1%	69.0%	67.9%	66.8%	0.0%
Diesel	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	0.8%
WM (TJ) PRIMARY									
RES	1535	1851	2174	2509	2860	3133	3418	3708	4009
Natural gas	0	0	0	0	0	0	0	0	38704
HFO	35877	35646	35526	35401	35272	35179	35083	34985	0
Diesel	6406	6637	6757	6882	7011	7104	7200	7298	439
E3 - EE in industry									
EE reduction in industry (existing companies)	102	100	99	98	97	97	97	97	97
consumption with E3 (TJ)	6773	7025	7243	7445	7653	7847	8046	8233	8425
TJ									
LPG	269	279	288	296	304	312	320	327	335
Diesel	423	438	452	465	478	490	502	514	526
RFO	945	980	1010	1038	1068	1095	1122	1148	1175
Pet-coke	3917	4063	4189	4306	4426	4538	4653	4761	4872
Coal	20	21	22	22	23	23	24	25	25
Industrial waste (non RES) and other fuels	652	677	698	717	737	756	775	793	812

	2016	2017	2018	2019	2020	2021	2022	2023	2024
Biomass	547	567	585	601	618	633	649	664	680
E4 - EE residential new buildings									
Residential new buildings	4073	4073	4073	4073	4073	4073	4073	4073	4073
consumption with E4 (TJ)	3876	4166	4417	4650	4889	5113	5343	5559	5781
TJ									
Other kerosene	299	321	341	359	377	394	412	429	446
Diesel/gas oil	1363	1462	1546	1624	1704	1767	1830	1888	1946
LPG	807	868	920	968	1018	1065	1113	1158	1204
Solid Biomass	63	68	72	76	80	84	87	91	95
Charcoal	115	124	131	138	145	152	159	165	172
RES	1229	1324	1407	1484	1565	1652	1742	1829	1919
E5 - EE residential energy upgrade									
Residential new buildings	120	120	120	120	120	120	120	120	120
consumption with E5 (TJ)	7829	8119	8370	8603	8842	9066	9296	9513	9734
TJ									
Other kerosene	604	626	646	664	682	699	717	734	751
Diesel/gas oil	2753	2849	2930	3005	3082	3133	3184	3230	3276
LPG	1631	1691	1743	1792	1842	1888	1936	1981	2027
Solid Biomass	128	133	137	141	145	148	152	156	159
Charcoal	232	241	249	255	263	269	276	282	289
RES	2481	2580	2666	2746	2830	2928	3030	3130	3232
E6 - EE residential solar panels replacement									
Residential solar panels replacement	4	4	4	4	4	4	4	4	4
consumption with E6 (TJ)	7945	8235	8486	8719	8958	9182	9411	9628	9850
TJ									
Other kerosene	613	635	655	673	691	708	726	743	760
Diesel/gas oil	2794	2889	2971	3046	3122	3173	3224	3269	3315
LPG	1655	1715	1767	1816	1866	1912	1960	2005	2051
Solid Biomass	130	135	139	143	146	150	154	157	161
Charcoal	236	244	252	259	266	273	279	286	292
RES	2518	2616	2702	2783	2866	2966	3068	3168	3270

	2016	2017	2018	2019	2020	2021	2022	2023	2024
E7 - EE tertiary new buildings									
Tertiary new buildings	467	467	467	467	467	467	467	467	467
consumption with E7 (TJ)	1365	1432	1490	1544	1599	1650	1703	1753	1804
TJ									
diesel	640	658	672	685	697	710	724	736	749
RFO	0	0	0	0	0	0	0	0	0
LPG	516	535	553	568	585	599	614	629	643
solid biomass	15	15	16	16	17	17	18	18	19
gas biomass	12	12	13	13	13	14	14	15	15
charcoal	205	213	220	226	233	239	245	250	256
solar thermal	430	452	473	494	515	532	550	567	585
E8 - EE tertiary energy upgrade									
Tertiary buildings energy upgrade	198	198	198	198	198	198	198	198	198
consumption with E8 (TJ)	1634	1701	1759	1813	1868	1919	1972	2022	2073
TJ									
diesel	575	593	607	620	632	646	660	672	685
RFO	0	0	0	0	0	0	0	0	0
LPG	464	483	499	514	530	545	560	574	588
solid biomass	13	14	14	15	15	16	16	17	17
gas biomass	11	11	12	12	12	13	13	13	14
charcoal	185	192	199	205	211	217	223	228	234
solar thermal	386	408	428	447	467	484	501	518	535
E9 - EE in public buildings									
Public buildings	14	12	10	8	6	6	6	6	6
consumption with E9 (TJ)	1818	1887	1947	2003	2060	2112	2165	2215	2266
TJ									
diesel	640	658	672	685	697	710	724	736	749
RFO	0	0	0	0	0	0	0	0	0
LPG	516	535	553	568	585	599	614	629	643
solid biomass	15	15	16	16	17	17	18	18	19
gas biomass	12	12	13	13	13	14	14	15	15

	2016	2017	2018	2019	2020	2021	2022	2023	2024
charcoal	205	213	220	226	233	239	245	250	256
solar thermal	430	452	473	494	515	532	550	567	585
E10 - industry (alternative fuels)									
LPG	4%	4%	4%	4%	4%	4%	4%	4%	4%
Diesel	6%	6%	6%	6%	6%	6%	6%	6%	6%
RFO	14%	14%	14%	14%	14%	14%	14%	14%	14%
Pet-coke	58%	57%	57%	56%	56%	55%	55%	54%	54%
Coal	0%	0%	0%	0%	0%	0%	0%	0%	0%
Industrial waste (non RES) and other fuels	10%	10%	10%	10%	10%	10%	10%	10%	10%
Biomass	8%	9%	9%	10%	10%	10.5%	11.0%	11.5%	12.0%
TJ									
LPG	273	283	292	300	308	316	323	331	338
Diesel	429	445	458	471	484	496	508	520	532
RFO	959	994	1024	1052	1081	1108	1136	1162	1189
Pet-coke	3976	4086	4175	4253	4304	4372	4441	4501	4562
Coal	21	21	22	23	23	24	24	25	25
Industrial waste (non RES) and other fuels	662	686	707	727	775	794	814	833	852
Biomass	555	609	663	718	775	834	896	958	1023
E11									
RES heating and cooling	31%	32%	33%	34%	35%	36%	36%	37%	37%
WM consumption (%)									
Other kerosene	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%
Diesel/gas oil	35.2%	34.9%	33.9%	32.9%	31.9%	31.4%	30.9%	30.4%	29.9%
LPG	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%
Solid Biomass	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Charcoal	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
RES	31.7%	32.0%	33.0%	34.0%	35.0%	35.5%	36.0%	36.5%	37.0%
TJ									
Other kerosene	613	636	655	673	691	709	726	743	760
Diesel/gas oil	2795	2872	2874	2866	2855	2880	2905	2924	2942
LPG	1656	1716	1768	1817	1866	1913	1961	2006	2052

	2016	2017	2018	2019	2020	2021	2022	2023	2024
Solid Biomass	130	135	139	143	147	150	154	158	161
Charcoal	236	245	252	259	266	273	280	286	293
RES	2519	2636	2802	2966	3137	3261	3390	3516	3646
E12									
RES heating and cooling	21%	22%	23%	24%	25%	26%	26%	27%	27%
WM consumption (%)									
Diesel/gas oil	35.2%	34.9%	34.5%	34.2%	33.8%	33.3%	32.8%	32.3%	31.8%
RFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LPG	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%
solid biomass	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
gas biomass	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
charcoal	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%
solar thermal	23.6%	24.0%	24.3%	24.7%	25.0%	25.5%	26.0%	26.5%	27.0%
TJ									
diesel	645	662	676	687	699	706	713	718	723
RFO	0	0	0	0	0	0	0	0	0
LPG	520	539	555	571	586	601	616	630	645
solid biomass	15	16	16	16	17	17	18	18	19
gas biomass	12	12	13	13	14	14	14	15	15
charcoal	207	215	221	227	233	239	245	251	257
solar thermal	433	455	476	496	516	540	564	588	613
Transport - T1 (biofuels)									
Gasoline (TJ)	15682	16254	16749	17209	17681	18123	18576	19003	19440
Total Diesel (TJ)	12109	12551	12933	13288	13652	13993	14343	14673	15011
Diesel (TJ)	11739	12075	12347	12588	12833	13098	13368	13617	13870
Biodiesel (TJ)	370	476	586	699	819	896	975	1056	1141
Biodiesel (%)	3.1%	3.8%	4.5%	5.3%	6%	6%	7%	7%	8%
Transport - T4 (RES)									
Gasoline	56%	56%	56%	56%	56%	56%	55%	55%	54%
Diesel	42%	42%	42%	41%	41%	40%	40%	39%	39%
Biodiesel	1%	2%	2%	2%	3%	3%	3%	3%	3%

	2016	2017	2018	2019	2020	2021	2022	2023	2024
RES	0%	0%	0%	0%	0.9%	1.8%	2.7%	3.6%	4.5%
TJ									
Gasoline (TJ)	15682	16254	16749	17209	17538	17831	18127	18391	18657
Diesel (TJ)	11739	12075	12347	12588	12690	12862	13034	13180	13327
Biodiesel (TJ)	370	476	586	699	819	840	861	880	901
Industrial - I1 (F-gases)									
reduction of emissions	0%	0%	0%	0%	5%	5.0%	5.0%	5.0%	5.0%
Agriculture - A1 (Anerobic digestion)									
waste management									
dairy cattle									
solid storage	95%	94%	94%	93%	92%	91%	91%	90%	89%
anaerobic digester	5%	6%	7%	7%	8%	9%	10%	10%	11%
other cattle									
solid storage	95%	94%	94%	93%	92%	91%	91%	90%	89%
anaerobic digester	5%	6%	7%	7%	8%	9%	10%	10%	11%
market swine									
anaerobic digester	50%	49%	48%	46%	45%	44%	43%	41%	40%
aerobic treatment	50%	51%	53%	54%	55%	56%	58%	59%	60%
breeding swine									
anaerobic digester	50%	49%	48%	46%	45%	44%	43%	41%	40%
aerobic treatment	50%	51%	53%	54%	55%	56%	58%	59%	60%
sheep									
solid storage	100%	100%	100%	100%	99.0%	98.1%	97.1%	96.2%	95.2%
anaerobic digester					1.0%	1.9%	2.9%	3.8%	4.8%
goats									
solid storage	100%	100%	100%	100%	99.0%	98.1%	97.1%	96.2%	95.2%
anaerobic digester					1.0%	1.9%	2.9%	3.8%	4.8%
poultry									
solid storage	85%	85%	85%	84%	84%	84%	84%	84%	83%
anaerobic digester	15%	15%	15%	16%	16%	16%	16%	16%	17%
Waste - W1 (sorting)									

	2016	2017	2018	2019	2020	2021	2022	2023	2024
40% sorting at source from 2021									
MSW to disposal sites (1000t wet mass)	10807	10807	10807	10807	10807	10807	10807	10807	10807
reduction of waste to landfill from 2021 due to sorting (W1)						40%	43.8%	47.5%	51.3%
W1 MSW to disposal sites (1000t wet mass)						6484	6079	5674	5268
W1 MSW to disposal sites (%)						60%	56%	53%	49%
Waste - W2 (organics to landfill)									
15% of organics to landfill from 2021; 10% in 2035									
BaU waste per capita (kg)						679	684	690	697
W2 composition of waste to disposal sites									
Food						14%	14%	14%	13%
Garden						2%	2%	2%	2%
Paper						52%	52%	53%	53%
Wood						6%	6%	6%	6%
Textile						21%	21%	21%	21%
Nappies						0%	0%	0%	0%
Plastics, other inert						4%	4%	4%	4%
W2 MSW to disposal sites (%)						33%	33%	33%	33%
Waste - W3 (composting)									
increase composting						5%	5.4%	5.7%	6.1%
W3 composting (1000t)						34	37	39	42
BaU Compost for backfilling (1000t)	17	20	20	21	21	21	21	21	21
W3 TOTAL composting (1000t)	17	20	20	21	21	55	58	61	64
Waste - W4 (anaerobic digestion)									
increase AD to 5% in 2021 and keep constant						10%	12.1%	14.3%	16.4%
W4 AD (1000t)						67.85	83.09	98.62	114.43
Waste - W5 (biogas recovery)									
biogas recovery from deep unmanaged and managed anaerobic disposal sites (%)						30%	30%	30%	30%

Table V2. WAM scenario - activity data (2025-2033)

	2025	2026	2027	2028	2029	2030	2031	2032	2033
E1 - natural gas									
RES (BaU)	11.5%	11.8%	12.1%	12.4%	12.7%	13%	13.7%	14.4%	15.1%
Natural gas	87.7%	87.4%	87.1%	86.8%	86.5%	86.2%	85.5%	84.8%	84.1%
HFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Diesel	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY									
RES	2308	2417	2529	2643	2761	2883	3099	3322	3554
Natural gas	43981	44751	45489	46239	47001	47774	48334	48897	49463
HFO	0	0	0	0	0	0	0	0	0
Diesel	395	396	397	399	400	401	405	408	411
E2 - RES in electricity									
RES	21.5%	22.6%	23.7%	24.8%	25.9%	27%	27.8%	28.6%	29.4%
Natural gas	77.7%	76.6%	75.5%	74.4%	73.3%	72.2%	71.4%	70.6%	69.8%
HFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Diesel	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY									
RES	4314	4630	4953	5286	5631	5987	6288	6599	6919
Natural gas	38964	39219	39429	39631	39826	40013	40361	40707	41050
HFO	0	0	0	0	0	0	0	0	0
Diesel	445	451	458	464	471	478	484	489	495
E3 - EE in industry									
EE reduction in industry (existing companies)	97	97	97	97	97	97	97	97	97
consumption with E3 (TJ)	8603	8786	8964	9145	9330	9518	9711	9907	10107
TJ									
LPG	342	349	356	363	371	378	386	394	401
Diesel	537	548	559	571	582	594	606	618	631
RFO	1200	1226	1250	1276	1301	1328	1354	1382	1410
Pet-coke	4976	5081	5184	5289	5396	5505	5616	5730	5845
Coal	26	26	27	27	28	28	29	30	30
Industrial waste (non RES) and other fuels	829	846	864	881	899	917	936	954	974

	2025	2026	2027	2028	2029	2030	2031	2032	2033
Biomass	694	709	723	738	753	768	784	800	816
E4 - EE residential new buildings									
Residential new buildings	4073	4073	4073	4073	4073	4073	4073	4073	4073
consumption with E4 (TJ)	5988	6199	6405	6614	6828	7046	7268	7495	7726
TJ									
Other kerosene	462	478	494	510	527	544	561	578	596
Diesel/gas oil	1997	2049	2098	2147	2195	2244	2301	2358	2415
LPG	1247	1291	1334	1377	1422	1467	1514	1561	1609
Solid Biomass	98	101	105	108	112	115	119	123	126
Charcoal	178	184	190	196	203	209	216	223	229
RES	2006	2095	2184	2275	2369	2466	2558	2653	2751
E5 - EE residential energy upgrade									
Residential new buildings	120	120	120	120	120	120	120	120	120
consumption with E5 (TJ)	9941	10152	10358	10567	10781	10999	11221	11448	11680
TJ									
Other kerosene	767	783	799	815	832	848	866	883	901
Diesel/gas oil	3316	3356	3393	3430	3467	3504	3552	3601	3650
LPG	2070	2114	2157	2201	2245	2291	2337	2384	2432
Solid Biomass	163	166	169	173	176	180	184	187	191
Charcoal	295	301	308	314	320	327	333	340	347
RES	3330	3431	3532	3635	3741	3850	3950	4053	4158
E6 - EE residential solar panels replacement									
Residential solar panels replacement	4	4	4	4	4	4	4	4	4
consumption with E6 (TJ)	10056	10268	10473	10683	10896	11114	11337	11564	11795
TJ									
Other kerosene	776	792	808	824	841	857	875	892	910
Diesel/gas oil	3354	3394	3430	3467	3504	3541	3589	3637	3687
LPG	2094	2138	2181	2225	2269	2315	2361	2408	2457
Solid Biomass	164	168	171	175	178	182	185	189	193
Charcoal	299	305	311	317	324	330	337	343	350
RES	3369	3471	3571	3675	3781	3890	3991	4094	4199

	2025	2026	2027	2028	2029	2030	2031	2032	2033
E7 - EE tertiary new buildings									
Tertiary new buildings	467	467	467	467	467	467	467	467	467
consumption with E7 (TJ)	1852	1901	1948	1996	2045	2096	2147	2199	2253
TJ									
diesel	760	771	782	792	803	814	831	847	864
RFO	0	0	0	0	0	0	0	0	0
LPG	657	670	684	698	712	726	740	755	770
solid biomass	19	19	20	20	21	21	21	22	22
gas biomass	15	15	16	16	16	17	17	17	18
charcoal	261	267	272	278	283	289	295	301	307
solar thermal	601	619	636	654	672	690	704	718	733
E8 - EE tertiary energy upgrade									
Tertiary buildings energy upgrade	198	198	198	198	198	198	198	198	198
consumption with E8 (TJ)	2121	2170	2217	2265	2315	2365	2416	2468	2522
TJ									
diesel	697	708	719	730	742	753	769	786	803
RFO	0	0	0	0	0	0	0	0	0
LPG	602	616	629	643	657	671	686	701	716
solid biomass	17	18	18	19	19	19	20	20	21
gas biomass	14	14	15	15	15	15	16	16	17
charcoal	240	245	250	256	262	267	273	279	285
solar thermal	551	568	585	603	620	639	652	666	681
E9 - EE in public buildings									
Public buildings	6	6	6	6	6	6	6	6	6
consumption with E9 (TJ)	2313	2362	2409	2458	2507	2557	2608	2661	2714
TJ									
diesel	760	771	782	792	803	814	831	847	864
RFO	0	0	0	0	0	0	0	0	0
LPG	657	670	684	698	712	726	740	755	770
solid biomass	19	19	20	20	21	21	21	22	22
gas biomass	15	15	16	16	16	17	17	17	18

	2025	2026	2027	2028	2029	2030	2031	2032	2033
charcoal	261	267	272	278	283	289	295	301	307
solar thermal	601	619	636	654	672	690	704	718	733
E10 - industry (alternative fuels)									
LPG	4%	4%	4%	4%	4%	4%	4%	4%	4%
Diesel	6%	6%	6%	6%	6%	6%	6%	6%	6%
RFO	14%	14%	14%	14%	14%	14%	14%	14%	14%
Pet-coke	53%	53%	52%	52%	51%	51%	50%	50%	49%
Coal	0%	0%	0%	0%	0%	0%	0%	0%	0%
Industrial waste (non RES) and other fuels	10%	10%	10%	10%	10%	10%	10%	10%	10%
Biomass	12.5%	13.0%	13.5%	14.0%	14.5%	15%	15.5%	16.0%	16.5%
TJ									
LPG	346	353	360	367	374	382	390	397	405
Diesel	543	554	565	577	588	600	612	624	637
RFO	1214	1239	1264	1289	1315	1341	1368	1395	1423
Pet-coke	4615	4667	4715	4763	4811	4860	4908	4956	5004
Coal	26	27	27	28	28	29	29	30	31
Industrial waste (non RES) and other fuels	870	888	906	924	943	962	981	1000	1020
Biomass	1088	1155	1223	1294	1367	1442	1520	1601	1684
E11									
RES heating and cooling	38%	38%	39%	39%	40%	40%	40.5%	41.0%	41.5%
WM consumption (%)									
Other kerosene	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%
Diesel/gas oil	29.4%	28.9%	28.4%	27.9%	27.4%	26.9%	26.4%	25.9%	25.4%
LPG	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%
Solid Biomass	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Charcoal	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
RES	37.5%	38.0%	38.5%	39.0%	39.5%	40.0%	40.5%	41.0%	41.5%
TJ									
Other kerosene	776	792	808	824	841	858	875	892	910
Diesel/gas oil	2953	2964	2971	2977	2982	2986	2989	2991	2992
LPG	2095	2139	2182	2226	2270	2316	2362	2409	2457

	2025	2026	2027	2028	2029	2030	2031	2032	2033
Solid Biomass	165	168	171	175	178	182	185	189	193
Charcoal	299	305	311	317	324	330	337	343	350
RES	3773	3903	4034	4168	4306	4447	4593	4743	4897
E12									
RES heating and cooling	28%	28%	29%	29%	30%	30%	30%	30%	30%
WM consumption (%)									
Diesel/gas oil	31.3%	30.8%	30.3%	29.8%	29.3%	28.8%	28.8%	28.8%	28.8%
RFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LPG	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%
solid biomass	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
gas biomass	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
charcoal	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%
solar thermal	27.5%	28.0%	28.5%	29.0%	29.5%	30.0%	30.0%	30.0%	30.0%
TJ									
diesel	727	730	733	735	737	739	754	769	784
RFO	0	0	0	0	0	0	0	0	0
LPG	658	672	685	699	713	727	742	757	772
solid biomass	19	19	20	20	21	21	21	22	22
gas biomass	15	16	16	16	16	17	17	17	18
charcoal	262	267	273	278	284	290	295	301	307
solar thermal	638	663	688	714	741	769	784	800	816
Transport - T1 (biofuels)									
Gasoline (TJ)	19848	20265	20670	21084	21505	21935	22374	22822	23278
Total Diesel (TJ)	15326	15648	15961	16280	16605	16937	17276	17622	17974
Diesel (TJ)	14100	14333	14556	14782	15011	15244	15549	15860	16177
Biodiesel (TJ)	1226	1314	1405	1498	1594	1694	1728	1762	1797
Biodiesel (%)	8%	8%	9%	9%	10%	10%	10%	10%	10%
Transport - T4 (RES)									
Gasoline	54%	53%	53%	52%	52%	51%	51%	51%	51%
Diesel	38%	38%	37%	37%	36%	36%	36%	36%	36%
Biodiesel	3%	3%	3%	3%	3%	3%	3%	3%	3%

	2025	2026	2027	2028	2029	2030	2031	2032	2033
RES	5.5%	6.4%	7.3%	8.2%	9.1%	10%	10.0%	10.0%	10.0%
TJ									
Gasoline (TJ)	18889	19122	19338	19555	19773	19992	20392	20799	21215
Diesel (TJ)	13447	13566	13671	13774	13877	13978	14257	14542	14833
Biodiesel (TJ)	920	939	958	977	996	1016	1037	1057	1078
Industrial - I1 (F-gases)									
reduction of emissions	5.0%	5.0%	5.0%	5.0%	5.0%	10%	10.0%	10.0%	10.0%
Agriculture - A1 (Anerobic digestion)									
waste management									
dairy cattle									
solid storage	88%	88%	87%	86%	85%	85%	84%	83%	82%
anaerobic digester	12%	13%	13%	14%	15%	16%	16%	17%	18%
other cattle									
solid storage	88%	88%	87%	86%	85%	85%	84%	83%	82%
anaerobic digester	12%	13%	13%	14%	15%	16%	16%	17%	18%
market swine									
anaerobic digester	39%	38%	36%	35%	34%	33%	31%	30%	29%
aerobic treatment	61%	63%	64%	65%	66%	67%	69%	70%	71%
breeding swine									
anaerobic digester	39%	38%	36%	35%	34%	33%	31%	30%	29%
aerobic treatment	61%	63%	64%	65%	66%	67%	69%	70%	71%
sheep									
solid storage	94.3%	93.3%	92.4%	91.4%	90.5%	89.5%	88.6%	87.6%	86.7%
anaerobic digester	5.7%	6.7%	7.6%	8.6%	9.5%	10.5%	11.4%	12.4%	13.3%
goats									
solid storage	94.3%	93.3%	92.4%	91.4%	90.5%	89.5%	88.6%	87.6%	86.7%
anaerobic digester	5.7%	6.7%	7.6%	8.6%	9.5%	10.5%	11.4%	12.4%	13.3%
poultry									
solid storage	83%	83%	83%	83%	82%	82%	82%	82%	81%
anaerobic digester	17%	17%	17%	18%	18%	18%	18%	18%	19%
Waste - W1 (sorting)									

	2025	2026	2027	2028	2029	2030	2031	2032	2033
40% sorting at source from 2021									
MSW to disposal sites (1000t wet mass)	10807	10807	10807	10807	10807	10807	10807	10807	10807
reduction of waste to landfill from 2021 due to sorting (W1)	55%	56.0%	57.0%	58.0%	59.0%	60%	61.0%	62.0%	63.0%
W1 MSW to disposal sites (1000t wet mass)	4863	4755	4647	4539	4431	4323	4215	4107	3999
W1 MSW to disposal sites (%)	45%	44%	43%	42%	41%	40%	39%	38%	37%
Waste - W2 (organics to landfill)									
15% of organics to landfill from 2021; 10% in 2035									
BaU waste per capita (kg)	703	710	717	725	734	744	746	753	761
W2 composition of waste to disposal sites									
Food	13%	13%	12%	12%	12%	12%	11%	11%	11%
Garden	2%	2%	2%	2%	2%	2%	2%	2%	2%
Paper	53%	53%	53%	54%	54%	54%	54%	55%	55%
Wood	6%	6%	6%	6%	6%	6%	6%	6%	6%
Textile	22%	22%	22%	22%	22%	22%	22%	22%	22%
Nappies	0%	0%	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	4%	4%	4%	4%	4%	4%	4%	4%	4%
W2 MSW to disposal sites (%)	33%	33%	33%	33%	33%	33%	33%	33%	33%
Waste - W3 (composting)									
increase composting	6.4%	6.8%	7.1%	7.5%	7.9%	8.2%	8.6%	8.9%	9.3%
W3 composting (1000t)	45	48	51	54	58	61	64	67	71
BaU Compost for backfilling (1000t)	22	22	22	22	23	23	23	23	23
W3 TOTAL composting (1000t)	67	70	73	77	80	84	87	90	94
Waste - W4 (anaerobic digestion)									
increase AD to 5% in 2021 and keep constant	18.6%	20.7%	22.9%	25.0%	27.1%	29.3%	31.4%	33.6%	35.7%
W4 AD (1000t)	130.55	147.05	163.94	181.34	199.27	217.80	234.51	252.90	271.62
Waste - W5 (biogas recovery)									
biogas recovery from deep unmanaged and managed anaerobic disposal sites (%)	30%	30%	30%	30%	30%	30%	30%	30%	30%

Table V3. WAM scenario - activity data (2034-2040)

	2034	2035	2036	2037	2038	2039	2040
E1 - natural gas							
RES (BaU)	15.8%	16.5%	17.2%	17.9%	18.6%	19.3%	20%
Natural gas	83.4%	82.7%	82.0%	81.3%	80.6%	79.9%	79.2%
HFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Diesel	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY							
RES	3793	4040	4295	4560	4833	5115	5406
Natural gas	50032	50605	51180	51757	52338	52921	53506
HFO	0	0	0	0	0	0	0
Diesel	415	418	422	425	429	433	437
E2 - RES in electricity							
RES	30.2%	31.0%	31.8%	32.6%	33.4%	34.2%	35%
Natural gas	69.0%	68.2%	67.4%	66.6%	65.8%	65.0%	64.2%
HFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Diesel	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
WM (TJ) PRIMARY							
RES	7249	7590	7942	8304	8678	9064	9461
Natural gas	41391	41729	42064	42396	42724	43049	43369
HFO	0	0	0	0	0	0	0
Diesel	500	506	512	518	524	531	537
E3 - EE in industry							
EE reduction in industry (existing companies)	97	97	97	97	97	97	97
consumption with E3 (TJ)	10311	10519	10732	10948	11169	11394	11624
TJ							
LPG	410	418	426	435	444	453	462
Diesel	643	656	670	683	697	711	725
RFO	1438	1467	1497	1527	1558	1589	1621
Pet-coke	5963	6084	6207	6332	6460	6590	6723
Coal	31	31	32	33	33	34	35
Industrial waste (non RES) and other fuels	993	1013	1034	1055	1076	1098	1120

	2034	2035	2036	2037	2038	2039	2040
Biomass	832	849	866	884	901	920	938
E4 - EE residential new buildings							
Residential new buildings	4073	4073	4073	4073	4073	4073	4073
consumption with E4 (TJ)	7962	8203	8449	8699	8955	9215	9481
TJ							
Other kerosene	614	633	652	671	691	711	731
Diesel/gas oil	2473	2531	2590	2649	2709	2770	2830
LPG	1658	1708	1760	1812	1865	1919	1975
Solid Biomass	130	134	138	142	146	151	155
Charcoal	236	244	251	258	266	274	281
RES	2851	2953	3058	3166	3277	3391	3508
E5 - EE residential energy upgrade							
Residential new buildings	120	120	120	120	120	120	120
consumption with E5 (TJ)	11916	12156	12402	12652	12908	13168	13434
TJ							
Other kerosene	919	938	957	976	996	1016	1036
Diesel/gas oil	3700	3751	3802	3853	3905	3958	4011
LPG	2482	2532	2583	2635	2688	2742	2798
Solid Biomass	195	199	203	207	211	215	220
Charcoal	354	361	368	376	383	391	399
RES	4266	4376	4489	4605	4724	4846	4971
E6 - EE residential solar panels replacement							
Residential solar panels replacement	4	4	4	4	4	4	4
consumption with E6 (TJ)	12031	12272	12517	12768	13023	13284	13549
TJ							
Other kerosene	928	947	966	985	1005	1025	1045
Diesel/gas oil	3736	3786	3837	3888	3940	3992	4045
LPG	2506	2556	2607	2659	2712	2767	2822
Solid Biomass	197	201	205	209	213	217	222
Charcoal	357	364	372	379	387	394	402
RES	4307	4418	4531	4647	4766	4888	5013

	2034	2035	2036	2037	2038	2039	2040
E7 - EE tertiary new buildings							
Tertiary new buildings	467	467	467	467	467	467	467
consumption with E7 (TJ)	2307	2362	2419	2477	2536	2596	2657
TJ							
diesel	882	899	917	936	954	974	962
RFO	0	0	0	0	0	0	0
LPG	786	801	818	834	851	868	885
solid biomass	23	23	24	24	25	25	26
gas biomass	18	18	19	19	20	20	20
charcoal	313	319	325	332	339	345	352
solar thermal	747	762	778	793	809	825	873
E8 - EE tertiary energy upgrade							
Tertiary buildings energy upgrade	198	198	198	198	198	198	198
consumption with E8 (TJ)	2576	2632	2688	2746	2805	2865	2926
TJ							
diesel	820	838	856	874	893	912	903
RFO	0	0	0	0	0	0	0
LPG	731	747	763	779	796	813	831
solid biomass	21	22	22	22	23	23	24
gas biomass	17	17	18	18	18	19	19
charcoal	291	297	304	310	317	324	331
solar thermal	696	711	726	741	757	774	819
E9 - EE in public buildings							
Public buildings	6	6	6	6	6	6	6
consumption with E9 (TJ)	2768	2824	2880	2938	2997	3057	3118
TJ							
diesel	882	899	917	936	954	974	962
RFO	0	0	0	0	0	0	0
LPG	786	801	818	834	851	868	885
solid biomass	23	23	24	24	25	25	26
gas biomass	18	18	19	19	20	20	20

	2034	2035	2036	2037	2038	2039	2040
charcoal	313	319	325	332	339	345	352
solar thermal	747	762	778	793	809	825	873
E10 - industry (alternative fuels)							
LPG	4%	4%	4%	4%	4%	4%	4%
Diesel	6%	6%	6%	6%	6%	6%	6%
RFO	14%	14%	14%	14%	14%	14%	14%
Pet-coke	49%	48%	48%	47%	47%	46%	46%
Coal	0%	0%	0%	0%	0%	0%	0%
Industrial waste (non RES) and other fuels	10%	10%	10%	10%	10%	10%	10%
Biomass	17.0%	17.5%	18.0%	18.5%	19.0%	19.5%	20%
TJ							
LPG	413	422	430	439	447	456	466
Diesel	650	662	676	689	703	717	731
RFO	1452	1481	1510	1541	1571	1603	1635
Pet-coke	5052	5100	5148	5196	5243	5291	5338
Coal	31	32	32	33	34	34	35
Industrial waste (non RES) and other fuels	1041	1062	1083	1104	1127	1149	1172
Biomass	1769	1858	1949	2043	2141	2241	2344
E11							
RES heating and cooling	42.0%	42.5%	43.0%	43.5%	44.0%	44.5%	45%
WM consumption (%)							
Other kerosene	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%
Diesel/gas oil	24.9%	24.4%	23.9%	23.4%	22.9%	22.4%	21.9%
LPG	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%	20.8%
Solid Biomass	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Charcoal	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
RES	42.0%	42.5%	43.0%	43.5%	44.0%	44.5%	45.0%
TJ							
Other kerosene	928	947	966	985	1005	1025	1046
Diesel/gas oil	2991	2990	2987	2983	2977	2970	2962
LPG	2507	2557	2608	2660	2713	2767	2823

	2034	2035	2036	2037	2038	2039	2040
Solid Biomass	197	201	205	209	213	217	222
Charcoal	357	364	372	379	387	395	402
RES	5055	5217	5384	5556	5732	5913	6099
E12							
RES heating and cooling	30%	30%	30%	30%	30%	30%	35%
WM consumption (%)							
Diesel/gas oil	28.8%	28.8%	28.8%	28.8%	28.8%	28.8%	23.8%
RFO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LPG	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%
solid biomass	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
gas biomass	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
charcoal	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%
solar thermal	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	35.0%
TJ							
diesel	800	816	832	849	866	883	745
RFO	0	0	0	0	0	0	0
LPG	787	803	819	835	852	869	887
solid biomass	23	23	24	24	25	25	26
gas biomass	18	19	19	19	20	20	20
charcoal	313	320	326	333	339	346	353
solar thermal	832	849	866	883	901	919	1093
Transport - T1 (biofuels)							
Gasoline (TJ)	23744	24218	24703	25197	25701	26215	26739
Total Diesel (TJ)	18334	18700	19074	19456	19845	20242	20647
Diesel (TJ)	16500	16830	17167	17510	17860	18218	18582
Biodiesel (TJ)	1833	1870	1907	1946	1984	2024	2065
Biodiesel (%)	10%	10%	10%	10%	10%	10%	10%
Transport - T4 (RES)							
Gasoline	51%	51%	51%	51%	51%	51%	51%
Diesel	36%	36%	36%	36%	36%	36%	36%
Biodiesel	3%	3%	3%	3%	3%	3%	3%

	2034	2035	2036	2037	2038	2039	2040
RES	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10%
TJ							
Gasoline (TJ)	21640	22073	22514	22964	23424	23892	24370
Diesel (TJ)	15130	15432	15741	16056	16377	16704	17039
Biodiesel (TJ)	1100	1122	1144	1167	1191	1215	1239
Industrial - I1 (F-gases)							
reduction of emissions	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	15%
Agriculture - A1 (Anerobic digestion)							
waste management							
dairy cattle							
solid storage	82%	81%	80%	79%	79%	78%	77%
anaerobic digester	19%	19%	20%	21%	22%	22%	23%
other cattle							
solid storage	82%	81%	80%	79%	79%	78%	77%
anaerobic digester	19%	19%	20%	21%	22%	22%	23%
market swine							
anaerobic digester	28%	26%	25%	24%	23%	21%	20%
aerobic treatment	72%	74%	75%	76%	77%	79%	80%
breeding swine							
anaerobic digester	28%	26%	25%	24%	23%	21%	20%
aerobic treatment	72%	74%	75%	76%	77%	79%	80%
sheep							
solid storage	85.7%	84.8%	83.8%	82.9%	81.9%	81.0%	80%
anaerobic digester	14.3%	15.2%	16.2%	17.1%	18.1%	19.0%	20%
goats							
solid storage	85.7%	84.8%	83.8%	82.9%	81.9%	81.0%	80%
anaerobic digester	14.3%	15.2%	16.2%	17.1%	18.1%	19.0%	20%
poultry							
solid storage	81%	81%	81%	81%	80%	80%	80%
anaerobic digester	19%	19%	19%	19%	20%	20%	20%
Waste - W1 (sorting)							

	2034	2035	2036	2037	2038	2039	2040
40% sorting at source from 2021							
MSW to disposal sites (1000t wet mass)	10807	10807	10807	10807	10807	10807	10807
reduction of waste to landfill from 2021 due to sorting (W1)	64.0%	65%	65%	65%	65%	65%	65%
W1 MSW to disposal sites (1000t wet mass)	3891	3782	3782	3782	3782	3782	3782
W1 MSW to disposal sites (%)	36%	35%	35%	35%	35%	35%	35%
Waste - W2 (organics to landfill)							
15% of organics to landfill from 2021; 10% in 2035							
BaU waste per capita (kg)	768	775	783	790	797	805	812
W2 composition of waste to disposal sites							
Food	10%	10%	10%	10%	10%	10%	10%
Garden	2%	2%	2%	2%	2%	2%	2%
Paper	55%	55%	55%	55%	55%	55%	55%
Wood	6%	6%	6%	6%	6%	6%	6%
Textile	22%	22%	22%	22%	22%	22%	22%
Nappies	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	4%	4%	4%	4%	4%	4%	4%
W2 MSW to disposal sites (%)	33%	33%	33%	33%	33%	33%	33%
Waste - W3 (composting)							
increase composting	9.6%	10%	10%	10%	10%	10%	10%
W3 composting (1000t)	74	78	78	79	80	80	81
BaU Compost for backfilling (1000t)	24	24	24	24	25	25	25
W3 TOTAL composting (1000t)	98	101	102	103	104	105	106
Waste - W4 (anaerobic digestion)							
increase AD to 5% in 2021 and keep constant	37.9%	40%	40%	40%	40%	40%	40%
W4 AD (1000t)	290.68	310.06	313.01	315.96	318.90	321.85	324.80
Waste - W5 (biogas recovery)							
biogas recovery from deep unmanaged and managed anaerobic disposal sites (%)	30%	30%	30%	30%	30%	30%	30%

Annex VI: Priority Sectors of Cyprus RPF

VI1. Priority Sectors with Thematic Focus

The description of the Focus Areas **is explanatory and not restrictive**.

Table VI.1a PRIORITY SECTOR "TOURISM"	
A.	**Sustainable Tourism Development**
A.1	**The Social, Economic and Environmental Dimension of Tourism**
A.2	**Assessment and Monitoring of Tourist Bearing Capacity**
B.	**Specific Forms of Tourism**
B.1	**Promoting Special Forms of Tourism-** Enriching Tourism Experience Indicative areas: *Conference and Incentive Tourism, Sport Tourism, Cycling Tourism, Golf Tourism, Wedding and Honeymoon trips, Hiking Tourism, Cultural Tourism, Religious Tourism, Health Tourism (Medical & Wellness), Agro-Tourism, Educational Tourism (Learning), Cruising, Gastronomic Tourism & Wine Tourism, Diving Tourism and Gambling Tourism*
B.2	**Mitigating Seasonal Variation** through the development of special forms of Tourism
Γ.	**Digital Age and Tourism**
C.1	**Optimising the Tourist experience** through the use of ICT
C.2	**Social Networks and electronic booking systems as competitive advantages**
D.	**Organisation, Management and Promotion of the Tourism Product**
D.1	**Tourism Satellite Account Tables**- Instrument for monitoring competitiveness
D.2	**System Organisation for Managing and Promoting** the Tourism Product

Table VI.b PRIORITY SECTOR "ENERGY"	
A.	**Development of New or Optimised Technologies for Renewable Energy Sources**
A.1	**Solar Energy** Indicative areas: Solar Photovoltaic Technologies, solar, crystalline-silicon-based *solar cells, thin films and deposition techniques, development of solid aggregate PV systems, advanced materials, and procedures of creation/transportation of results during processing, concentrated solar energy, high concentration technologies, thermal solar energy storage, co-production of electricity and desalinated water using solar energy.*
A.2	**Technologies for Solar Heating and Cooling** Indicative areas: *Heat Pump Technologies for heating and cooling, co-production and biomass systems for hot water and heating, photovoltaic systems and co-production systems for energy production, integration of solar systems in buildings, research for the development of new materials for storage, optimised transportation of heating, insulation and optimised collectors.*
A.3	**Wind Energy** Indicative areas: *Modelling and simulation studies for new procedures and optimised use of wind energy for the production of electricity, research for materials used in wind systems, fluid mechanics for wind application, and new CFD modelling techniques.*
B.	**Innovative Applications of Renewable Energy Sources**
B.1	**Solar Thermal Technologies** Indicative areas: *Solar heating and cooling, great scale systems, district heating systems, co-production of electricity and desalinated water using solar energy, seasonal heating storing.*
B.2	**Solar Photovoltaic** Indicative areas: *Efficiency studies, integration systems in new and existing buildings, new photovoltaic architecture systems for increased efficiency, photovoltaic collectors, reliability of natural characteristics of solar cells.*
B.3	**Innovative Renewable Energy Sources applications in tourism, agriculture, livestock, fish-farming, etc.**
C.	**Exploitation of Hydrocarbons**
C.1	**Natural Gas Storage**

C.2	**Natural Gas Use**
D.	**Efficient Use- Energy Saving**
D.1	**Developing Innovative and cost Effective Technologies** for Optimised Use of Energy in New and Existing Buildings
D.2	**ICT Systems for Monitoring Energy Consumption and Optimising Efficiency in Urban Environments and Transportation**
D.3	**Networks for Energy Transportation and Distribution** Indicative areas: *managing, monitoring, distribution, network control, smart networks, measuring sensors, data management for optimal system control. Optimal integration of Renewable Energy Sources (RES) in the electricity distribution system, new technologies for energy transformation, optimised management coordination of various types of RES.*

Table VI.1c PRIORITY SECTOR "AGRICULTURE- FOOD INDUSTRY»	
A.	**Competitiveness of Agricultural and Livestock Production**
A.1	**New Technologies, ICT and Robotics** in Agricultural and Rural Production
A.2	**Utilisation of Biotechnology in Agriculture, Aquaculture and Livestock** Indicative areas: *increase of efficiency of plants and livestock, use of biological resources in agriculture and livestock systems, molecular genetics and reproduction of plants*
A.3	**Protected Designation of Origin,** Geographical Indication and Traditional Products
B.	**Food Quality and Safety**
B.1	**Addressing Nutritional Chain Risks** in all stages: Farm, Harvest, Transport, Processing, Market, Consumer
B.2	**Food Quality and Safety** Indicative areas: *monitoring indicators, risk analysis and critical control point systems, food metabolic profile, etc.*
C.	**Livestock Development**
C.1	**Optimal Animal Management and Nutrition Practices** to Ensure Safety and Quality of livestock Products
D.	**Climate Change: Agriculture and Food**
D.1	**The Impact of Climate Change on Agro-climatic Zones of Cyprus** Indicative areas: *complete monitoring system, simulation and observation models for the monitoring of agriculture and livestock with the use of GPS*
D.2	**Food Systems Risk Analysis** Indicative areas: *imbalances due to natural phenomena and its relation with the market- quantification of impacts on resource availability for sufficient production, food quality and safety*
E.	**Environmental and Socio-Economic Dimension**
E.1	**Effective Use of Biodiversity and Ecosystems** Indicative areas: evaluation of interactivity and viable management of food production*, effective use in intensive agricultural systems, etc. Sustainable management of resources and waste: management of soil, water resources, animal waste, recycled water, etc.*
E.2	**Optimal Use of Water Resources** Indicative areas: measures to face pollutants, ensuring the quality, best use and saving of water supplies.
E.3	**Exploitation of Renewable Energy Sources** in Agricultural Production

Table VI.1d PRIORITY SECTOR "BUILT ENVIRONMENT- CONSTRUCTION INDUSTRY"	
A.	**Sustainable Urban Development**
A.1	**Urban Networks, Infrastructures and Connectivity** Indicative areas: knowledge, mobility, transports, *ICT, energy, utility projects, waste management, etc.-implementations of previous urban technologies*
B.	**Contemporary Construction and Infrastructure Design**
B.1	**High Energy Efficient** and Environmentally Friendly **Buildings**
B.2	**Cultural Heritage Buildings** Indicative areas: *maintenance, restoration, integration, promotion and reutilisation of the cultural heritage buildings in the urban built environment and urban life*
B.3	**Upgrading Existing Buildings** Indicative areas: optimised use of existing buildings, *anti-seismic upgrade and energy efficiency upgrade, modification of use, use of smart managing systems, accessibility, etc.*
C.	**Planning and Management of Building and Infrastructure Construction**

C.1	**Exploiting Sustainable Construction Methods** Indicative areas: *use of building materials with high additional value, reduction of resource consumption, reduction of environmental impacts and increase of reutilisation of available resources*
D.	**Construction Materials**
D.1	**Development of Innovative and Smart Construction Materials** Indicative areas: *materials with high additional value, with reutilisation ability, based on knowledge and on the needs of each client*
D.2	**Exploitation of Local Raw Materials** in the Manufacture of Construction Materials

Table VI.1e PRIORITY SECTOR "TRANSPORT-SHIPPING"	
A.	**Contemporary Public Transport**
A.1	**Development of Urban Transport Systems and Modern Public Transport** Indicative areas: increase of attractiveness and quality of urban public transports, traffic management in the urban and interurban network, optimised functioning and maintenance of transport infrastructure
A.2	**Energy Saving** Indicative areas: use of alternative fuel forms, "green" cars, etc.
B.	**Maritime Transport/Shipping**
B.1	**Managing, Planning and Developing Ports** Indicative areas: improving the quality of function, better use of capacity, etc.
B.2	**Maritime and Coastal Tourism**
C.	**Sustainable Transport Development**
C.1	**Intelligent Transport Systems**
C.2	**Safe Transport Development** Indicative areas: *road safety, avoiding marine accidents, optimisation of security level of air transports*

Table VI.1f PRIORITY SECTOR "HEALTH"	
A.	**E-Health**
A.1	**Integrated Health Information System** Indicative areas: *Complete national system for management, monitoring and evaluation of illnesses, Electronic Patient Register*
A.2	**Safety and Quality Assurance of Health Services** Indicative areas: *Development of National Quality and Safety Indicators, Evaluation of Patients, Customers and Professionals Satisfaction, National Quality Clinical Control System- traceability*
A.3	**Digital Mapping of Health** Indicative areas: *Geographic distribution of diagnostic centres and specialties, Information systems for management and connection of medical centres, biological databases- advanced computational instruments and software: data mining, management, efficient use of information taken off the biological data, implementation of computerised system of medicine management*
B.	**Clinical and Genetic Investigation and Treatment of Diseases**
B.1	**Monitoring- Management- Care** Indicative areas: *Modern Systems of Primary Patient Care (with non-transmittable diseases): monitoring, primary care, management after cure, palliative care, etc. Early stage detected and curable forms of diseases: frequency, mortality, detection in later stages, check-ups*
B.2	**Diagnosis- Prevention/ Risk Factors/ Treatment** Indicative areas: *Prevention/ Treatment (diagnosis, cure) – Causes of the appearance of diseases in the Cypriot population, understanding quality/quantity connections between diet and phenotype/genotype, gene-expression and risk factors, exposure to environmental factors, psychological disorders, treatment of diseases and increase of productivity, quality, safety and effectiveness of intervention and early detention programmes, modern mapping methods*
B.3	**Molecular and Medical Genetics (Medical Translational Research)** Indicative areas: *Research on the human genome of the Cypriot population and utilisation in treatment of diseases, complete approach for the understanding and cure of mechanisms involved in diseases- gene therapy, advanced DNA and protein sequence, structure and modelling technologies, ability to comprehend the complicated biological mechanisms that lead to pathology, playing an important role in supporting the process of discovery of new medicinal and treatment targets*
B.4	**Promoting Public Health and Quality of Life**

	Indicative areas: *Healthy and active ageing, the impact of exercise, nutrition and climate change-Biomonitoring and Risk Assessment, Impacts of the financial crisis on public health*
C.	**Development of Safe and Effective Pharmaceuticals.**
C.1	**Molecular Diagnosis and Development of Specialised Pharmaceuticals**
D.	**Medical Tourism**
D.1	**Development of Preventive Medicine, Climatic Therapy, Plastic and Aesthetic Surgery and In-Vitro Fertilization.**

VI2. Calls for Proposals announced by the RPF

The RPF, within the Framework of the Programmes RESTART 2016-2020, has announced Calls for Proposals for the following Programmes:

PROGRAMME	Programme TOTAL Budget	CALL	Call Budget	Call Announcement Date	Call Deadline
Integrated Projects	20,000,000	Call 1	12,000,000	16-Sep-2016	27-Jan-2017
New Strategic Infrastructure Units - Young Scientists	11,000,000	Call 1	8,000,000	2-Dec-2016	31-Mar-2017
Research in Enterprises	9,300,000	Call 1	4,000,000	16-Sep-2016	20-Jan-2017
Research in Start-Ups	1,000,000	Call 1	250,000	2-Dec-2016	24-Feb-2017
Proof of Concept for Technological and Knowledge Applications	1,000,000	Call 1	250,000	8-Jun-2017	1-Dec-2017
Bilateral Collaborations	1,600,000	Cyprus-France	30,000	15-Nov-2016	16-Jan-2017
European Initiatives - National Development	8,000,000	Solar Eranet	400,000	5-Dec-2016	15-Jun-2017
		SUGI – FWE Nexus	400,000	19-Dec-2016	21-Sep-2017
		M-ERA.NET 2	400,000	14-Mar-2017	10-Nov-2017
		AAL	400,000	15-Feb-2017	25-May-2017
		JPICH - Digital Heritage	400,000	24-Apr-2017	23-Jun-2017
		ERANETMED	400,000	15-May-2017	17-Jul-2017
		JPICH – Heritage in Changing Environments	400,000	4-Sep-2017	1-Dec-2017
Excellence Hubs	17,100,000	Call 1	10,100,000	2-Dec-2016	10-Mar-2017
EUROSTARS Cyprus	2,500,000	Call 1	400,000	31-Jan-2017	3-Mar-2017
		Call 2	400,000	14-Jul-2017	15-Sep-2017
DIDAKTOR (Post Doctoral Researchers)	9,400,000	Call 1	4,800,000	16-Sep-2016	13-Jan-2017
Horizon 2020 - 2nd Opportunity - MSCA	5,500,000	Call 1	5,500,000	16-Sep-2016	1-Jul-2019
Horizon 2020 - 2nd Opportunity - ERC Starting Grant					

Horizon 2020 - 2nd Opportunity - ERC Consolidator Grant					
Horizon 2020 - 2nd Opportunity - SME Insrument - Phase I					
Horizon 2020 - 2nd Opportunity - SME Insrument - Phase II					
Social Innovation	**1,500,000**	**Call 1**	**600,000**	**20-Jun-2017**	**13-Oct-2017**
Industrial Property	**400,000**	**Call 1**	**400,000**	**5-Jul-2017**	**30-Sep-2020**
Participation in International Brokerage Events	**140,000**	**Call 1**	**140,000**	**12-Jun-2017**	**30-Sep-2020**
Encouragement of Project Coordination in Horizon 2020	**1,000,000**	**Call 1**	**1,000,000**	**16-Sep-2016**	**30-Sep-2020**
Complementary Funding	**4,000,000**	**Call 1**	**4,000,000**	**16-Sep-2016**	**30-Sep-2020**
Nurturing a RTDI Culture	**500,000**	**Students in Research Competition**	**8,200**	**20-Jan-2017**	**19-Jun-2017**
		Cyprus Research Award – Distinguished Researcher	**0**	**8-May-2107**	**10-Jul-2017**
		Cyprus Research Award – Young Researcher	**105,000**	**8-May-2107**	**10-Jul-2017**

It should be noted that the SOLAR-ERA.NET Cofund Joint Call comprises four topics:

- Innovative and low-cost PV manufacturing issues
- Advanced PV products and applications
- PV system integration
- CSP cost reduction and system integration.

The M-ERA.NET Call for Proposals focuses on addressing materials research and innovation including materials for low carbon energy technologies and related production technologies in the following thematic priorities:

- Integrated computational materials engineering
- Innovative surfaces, coatings and interfaces
- High performance composites
- Multifunctional materials
- New strategies for advanced material-based technologies in health applications
- Materials for additive manufacturing

The SUGI – FWE Nexus was established by the Joint Programming Initiative Urban Europe and the Belmont Forum. It aims to bring together the fragmented research and innovation expertise across the globe to find innovative new solutions to the Food-Water-Energy (FWE) Nexus challenge for a sustainable urbanization. The SUGI – FWE Nexus Call covers the following three topics:

- Robust Knowledge, Indicators and Assessments
- Multi-level Governance and Management

- Managing Strategies and Solutions

The ERANETMED Call aims at **strengthening international cooperation** on research and innovation in the Mediterranean and enhance Euro -Mediterranean research networks tackling the **challenge of water** in rural and remote areas in coastal zones and inlands (**sustainable water management**).

The JPICH Digital Heritage Call will support research projects across the following broad headings:

- The Critical: Engagements with Digital Heritage
- The Curatorial: Communities and Digital Heritage
- Safeguarding Digital Heritage

The JPICH Heritage in Changing Environments Call will include three main topics:

- CHANGING PHYSICAL ENVIRONMENTS
- CHANGING SOCIAL AND ECONOMIC ENVIRONMENTS
- CHANGING POLITICAL AND CULTURAL ENVIRONMENTS

More information regarding the rest of the calls can be found at https://iris.research.org.cy/#/calls.