GOVERNMENT
PRINCIPALITY OF LIECHTENSTEIN

Liechtenstein's Eighth National Communication

Submission of December 2022
under the United Nations Framework Convention on Climate Change and the Kyoto Protocol

Imprint

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Foreword

The scientific evidence is obvious: Climate change has a devastating impact on our planet and is the biggest challenge of our century. In this context, Liechtenstein is fully committed to the internationally agreed goal of limiting global warming to 1.5 °C and aims to reduce the dependency on fossil fuels.

According to the report of the Intergovernmental Panel on Climate Change (IPCC) of February 2022, warming of the atmosphere is causing more frequent and more intense extreme events such as heavy rain, storms, heat and drought with disastrous consequences worldwide. Liechtenstein's temperature has increased even above global average. Limiting global warming to 1.5 °C is absolutely necessary to prevent irreversible tipping points. This requires rapid and far-reaching transitions in energy, land, and urban infrastructure as well as industrial systems.

The Liechtenstein Climate Strategy 2050, adopted by the Liechtenstein Parliament in December 2022, provides for more ambitious goals and measures leading to climate neutrality by 2050. Accordingly, Liechtenstein will raise its reduction targets by updating its nationally determined contributions prior to the climate conference in 2023.

To achieve the new reduction target, Liechtenstein will mainly focus on domestic measures but may in part also use internationally transferred mitigation outcomes. Furthermore, to reduce the emissions that the economy of Liechtenstein causes abroad, measures have been defined for sustainable consumption and a sustainable financial sector.

The energy sector accounts for around 80% of Liechtenstein's greenhouse gas emissions and is therefore a priority in the decarbonisation of the country. Measured against the reference year 1990, the emissions in this sector must be reduced by around 50% by 2030 reaching net zero by 2050. An ambitious goal that requires comprehensive measures, high investments and the support from all sectors: politics, the economy and individuals. The necessary changes will be driven by innovative ideas, new technologies and most importantly by the readiness of the general public to support the transformation. The Government of Liechtenstein is therefore continuously investing in raising public awareness for climate protection.

Sabine Monauni

Minister of the Environment
Vaduz, December 2022

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1 Executive Summary

1.1 Introduction

This report summarises basic information and activities of the Principality of Liechtenstein with respect to climate. With a population of 39,055 at the end of 2020, Liechtenstein is a small central European State in the Alpine region. Its geography and economic structure are comparable to that of its neighbouring countries, Switzerland and Austria. Liechtenstein is a constitutional hereditary monarchy on a democratic and parliamentary basis. The relations between Liechtenstein and Switzerland are very close and strongly influenced by the Customs and Currency Treaties between the two countries (Zoll-und Währungsunion). The Customs Treaty with Switzerland has significant impacts on environmental laws and strategies: Many Swiss environmental provisions and standards are also applicable in Liechtenstein or they are integrated into Liechtenstein's law on the basis of specific international treaty rules (e.g. CO_2 Act). At the same time, Liechtenstein has also implemented numerous parts of EU legislation and has participated in various EU programmes since joining the European Economic Area (EEA) in 1995.

This report follows the revision of the UNFCCC reporting guidelines on national communications for Parties included in Annex I to the Convention (see the annex to decision 6/CP.25, UNFCCC 2019).

1.2 GHG Inventory information, including information on National Systems and National Registries

Liechtenstein's greenhouse gas emissions in the year 2020 amount to 179.7 kt CO_2 equivalent (CO_2eq) excluding LULUCF sources or sinks (including LULUCF: 184.5 kt CO_2eq). This is equivalent to 4.60 t CO_2eq per capita. Total emissions in 2020 (excl. LULUCF) have declined by 21.4% compared to 1990. Compared to 2019, they decreased by 4.3%. When including LULUCF categories, total emissions decreased by 7.8% between 2019–2020 and by 21.8% between 1990–2020.

Among the different greenhouse gases, CO_2 accounts for the largest share of total emissions.

Table 1-1 shows the emissions for individual gases and sectors in Liechtenstein for the year 2020. The most important emission sources are fuel combustion activities in the Energy sector. Emissions of CH_4 and N_2O mainly originate from the sector Agriculture, and F-Gas emissions stem from the sector 2 Industrial processes and product use (IPPU) by definition. The table also provides information about international bunkers.

Table 1-1 Summary of Liechtenstein's GHG emissions in 2020 by gas and sector in CO_2eq (kt). Numbers may not add to totals due to rounding.[1]

Emissions 2020	**CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Total**
	CO_2 equivalent (kt)						
1 Energy	141.8	1.19	0.94	-	-	-	144.0
2 IPPU	0.12	NO	0.14	9.1	0.00	0.05	9.4
3 Agriculture	0.04	17.18	7.44	-	-	-	24.7
5 Waste	0.01	0.94	0.66	-	-	-	1.60
Total (excluding LULUCF)	**142.0**	**19.3**	**9.19**	**9.1**	**0.00**	**0.05**	**179.7**
4 LULUCF	4.4	NO	0.39	-	-	-	4.8
Total (including LULUCF)	**146.4**	**19.3**	**9.6**	**9.1**	**0.00**	**0.05**	**184.5**
International Bunkers	*0.93*	*0.0002*	*0.01*	-	-	-	*0.94*

A breakdown of Liechtenstein's total emissions by gas is shown in Figure 1-1 below. Figure 1-2 shows the contributions of each sector to the different greenhouse gases.

[1] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data shown here are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

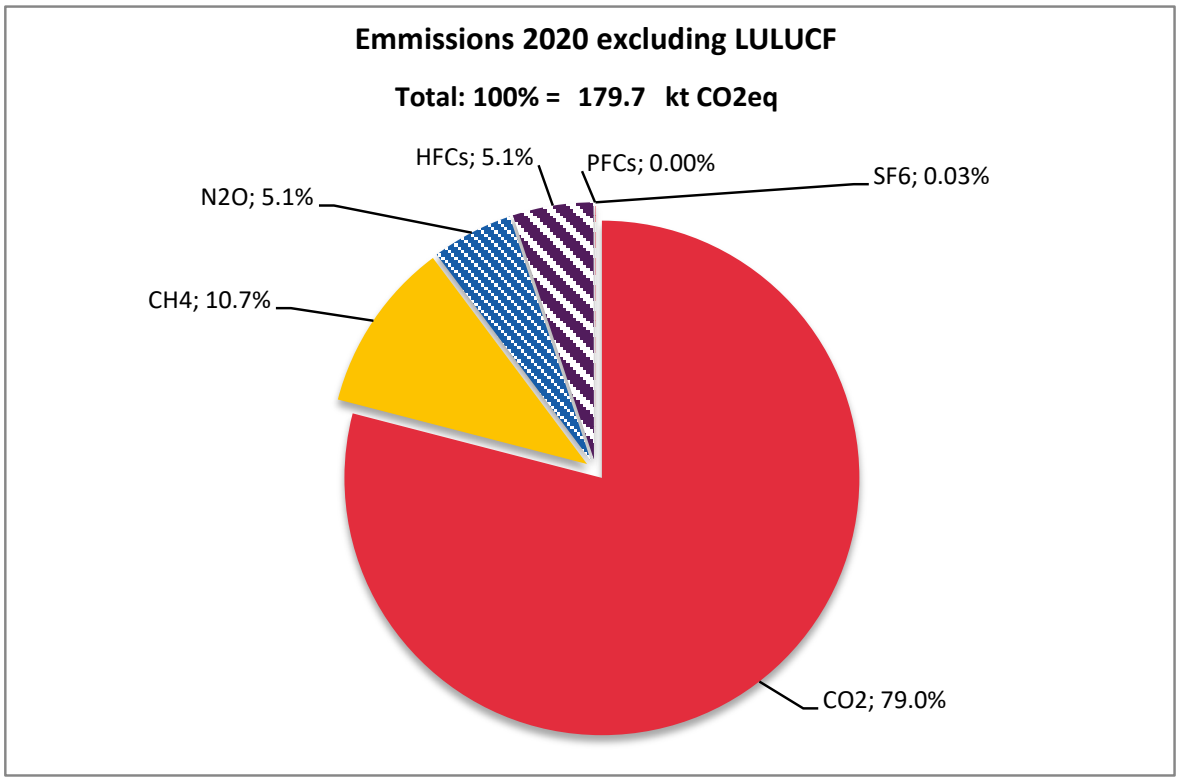

Figure 1-1 Liechtenstein's GHG emissions by gases excluding LULUCF emissions in 2020.

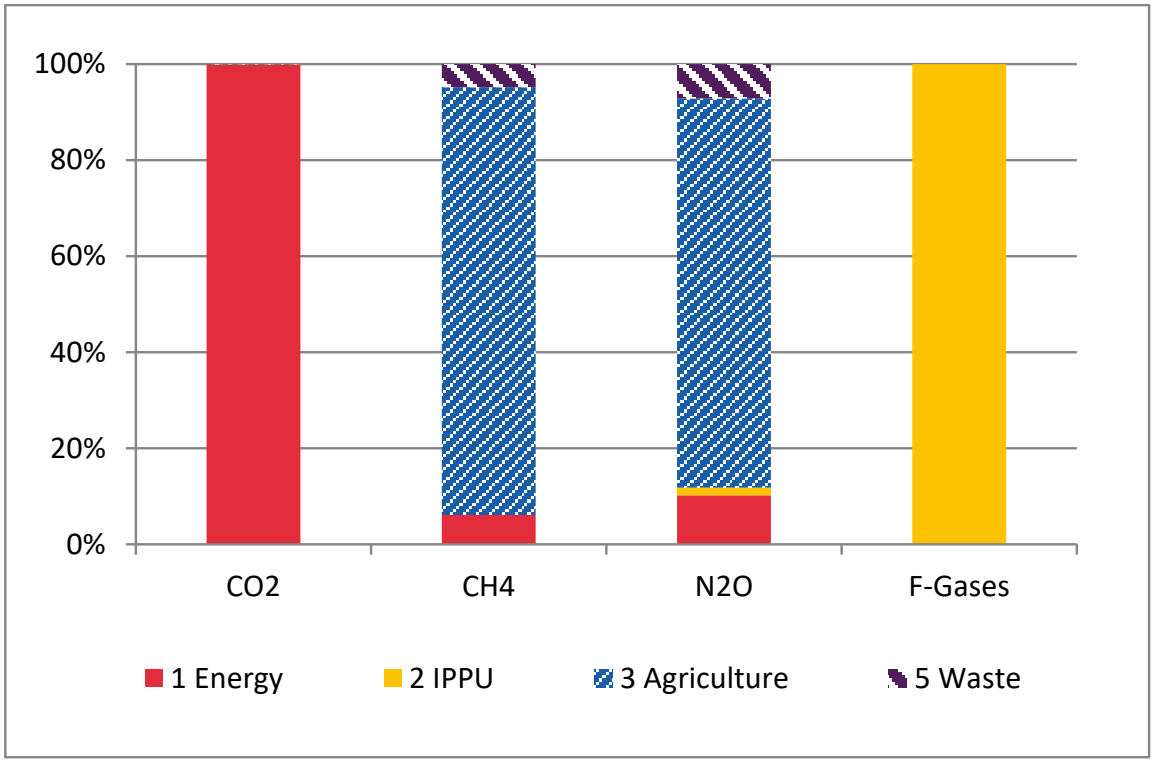

Figure 1-2 Relative contributions of the individual sectors (excluding LULUCF) to GHG emissions in 2020.

Emission trends for the individual gases can be described as follows (see also Figure 1-3):

- Total emissions (in CO_2eq) excluding LULUCF sources or sinks decreased by 21.4% from 1990 to 2020.
- Total emissions (in CO_2eq) including LULUCF show a decrease of 21.8% in 2020 compared to 1990 levels.
- CO_2 emissions (excluding net CO_2 from LULUCF) have declined by 28.6% between 1990 and 2020. In comparison to the previous reporting year 2019, CO_2 emissions (excluding net CO_2 from LULUCF) decreased by 4.7% in 2020. In general, the most important drivers of net CO_2 emissions are fuel prices and winter temperatures (heating degree days), influencing the source categories contributing to a large share of CO_2 emissions under 1A Fuel combustion (1A2 Manufacturing industries and construction, 1A3 Transport and 1A4 Other sectors). The latest developments are also influenced by changes in the CO_2 levy. The share of CO_2 emissions decreased from 87.1% in 1990 to 79.0% in 2020 (excl. LULUCF).
- CH_4 emissions (excluding CH_4 from LULUCF) have increased by 0.4% since 1990. Compared to 2019, CH_4 emissions (excluding LULUCF) show a decrease by 1.3% in 2020. The major reason for the emission development is the variation in numbers of livestock (in particular cattle), which strongly influence CH_4 emissions from enteric fermentation. Livestock numbers fell between 1990–2000 and have increased again since (but are still below the 1990 level). The share of CH_4 increased from 8.4% in 1990 to 10.7% in 2020 (excl. LULUCF).
- N_2O emissions (excluding N_2O from LULUCF) have declined by 10.5% in 2020 compared to 1990. Compared to 2019, N_2O emissions (without LULUCF) in 2020 decreased by 1.2%. The main source of N_2O emissions is agriculture (manure management and agricultural soils). The share of N_2O slightly increased from 4.5% (1990) to 5.1% (2020).
- HFC emissions increased due to their role as substitutes for CFCs. SF_6 emissions originate from electrical transformation stations and play a minor role for the total of the synthetic gases (F-Gases). PFC emissions are occurring since 1997 and are increasing on a low level. The share of the sum of all F-Gases (within total emissions excl. LULUCF) increased from 0.00005% (1990) to 5.1% (2020).

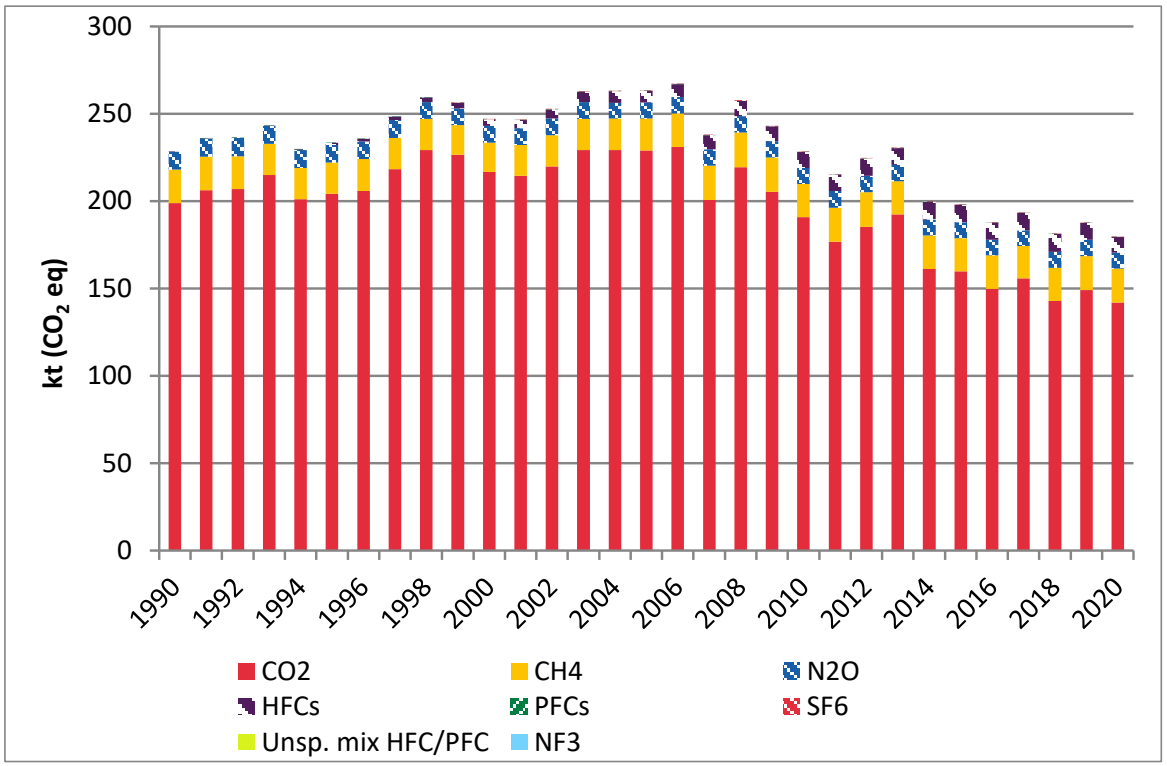

Figure 1-3 Trend of Liechtenstein's greenhouse gas emissions by gases 1990–2020. CO_2, CH_4 and N_2O correspond to the respective total emissions excluding LULUCF. Note that NF_3 emissions are not occurring.

The Government of the Principality of Liechtenstein bears the overall responsibility for Liechtenstein's National Inventory System (NIS). Based on Liechtenstein's Emission Trading Act (Emissionshandelsgesetz, EHG 2012), the Office of Environment (OE) is in charge of establishing emission inventories and is therefore also responsible for all aspects concerning establishment of the National Inventory System (NIS) under the Kyoto Protocol.

1.3 Policies and measures

Liechtenstein endeavours to enshrine the principle of sustainability in its policies. This includes the prudent use of resources and maintenance of a high quality of life.

In 2010, Liechtenstein therefore introduced an indicator-based system for annual tracking of the country's sustainable development path. The assessment is based on the sustainability definition of the Brundtland Commission which defined sustainable development as "*a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" The tracking system is comparable to the indicator-based assessment of the Swiss Federal Office of Statistics and the European system of Eurostat.

The latest assessment reports for Liechtenstein show a mixed picture concerning sustainability: The areas of health, social cohesion, education and culture, employment, energy and climate as well as natural resources show a positive trend towards sustainability. (Office of Statistics, 2020-22)

Liechtenstein has integrated climate policy into the individual sectoral policies, specifically energy policy, environment policy, transport policy, agricultural and forestry policy. All of these areas encompass measures that contribute to the reduction of greenhouse gases. To ensure a coordinated implementation the Government passed its first Climate Strategy in 2007. The Strategy requires an interdisciplinary coordination in the fields of environment, energy, building,

transportation, agriculture and forestry with respect to the development of climate policy measures. The Strategy was once revised in 2015; a new Climate Strategy is due to be published by the end of 2022. Liechtenstein's Ministry of Environment and the Office of Environment are the coordinating authorities with respect to the execution of the Strategy.

In 2018, the Liechtenstein Government took note of the Liechtenstein Climate Adaptation Strategy. The Adaption Strategy formulates goals and principles for adaptation and describes the cross-sectoral challenges and measures in adapting to climate change in Liechtenstein. With the adoption of the Liechtenstein Climate Vision 2050 in 2020, the Liechtenstein Government has decided that Liechtenstein will become climate neutral by 2050.

Because of the small size of the country, cross-border cooperation plays an important role. Especially important is the relationship with Switzerland and the cooperation among the countries in the Lake Constance area. Due to the Customs Treaty, cross-border measures and bilateral execution are simplified in many areas, because various Swiss legal acts are directly applicable in Liechtenstein pursuant to the treaty. Where Swiss legal acts apply, Liechtenstein as a rule executes the provisions similarly to a Swiss canton (e.g. Swiss Act and Ordinance on mineral oil tax). Accordingly, most policy areas are very closely linked with Swiss policy, in terms of both content and execution.

Liechtenstein's legislative and administrative main arrangements to meet its commitments under the Kyoto Protocol and Paris Agreement are to be found in the Emissions Trading Act and the CO_2 Act:

The **Emissions Trading Act** (EHG) sets up the general framework for the fulfilment of Liechtenstein's reduction obligations originating from the ratification of the Kyoto Protocol and the Paris Agreement. Liechtenstein revised the EHG in 2020, entering into force in 2021. As a part of this revision, Parliament set out Liechtenstein's climate targets in Article 4 EHG, consisting of a long-term goal to reach climate neutrality by 2050, and an interim target to reduce greenhouse gas emissions by 40% below 1990 levels by 2030. Reductions are primarily to be achieved domestically, with at least three-quarters of the target (30%) reduced in Liechtenstein. If the full 40% target cannot be met through domestic measures, the Government may participate in project activities abroad or in international emissions trading.

The **CO_2 Act** is the most comprehensive legislative measure across Liechtenstein's economy and is therefore considered one of the country's legal centrepieces to reduce greenhouse gases. It aims at reducing CO_2 emissions from the energy-related use of fossil energy sources. It does this through a combination of measures, including a CO_2 levy on thermal fuels ("Brennstoffe"), efficiency standards for passenger cars and obligations for CO_2 offsets on fuel importers.

The CO_2 Act also sets CO_2 emissions limits for new passenger cars. Following a revision of the Swiss CO_2 Act in 2018, the Liechtenstein CO_2 Act was also revised to extend these limits to delivery trucks and light semi-trailers. In addition, incentives were implemented for installations to feed more electricity into the public power grid.

The third measure in the CO_2 Act obliges entities which import (motor) fuels ("Treibstoffe") to compensate a share of up to 40% of the domestic emissions of these fuels.

In addition, the **Energy related policies and measures** are another important instrument to reduce GHG-emissions**.** In 2020, the Government adopted its "Energy Strategy 2030", following on from the earlier "Energy Strategy 2020". The strategy provides future-oriented impulses for national energy policy. It focusses on the promotion of efficient energy use (energy conservation), the use of renewable energy sources, and energy conservation.

Planned policies: In May 2022, the Liechtenstein Government started public consultation on the new Climate Strategy 2050, aiming at raising the emission reduction target for 2030 from 40% to 50% below 1990 levels and defining concrete measures designed to achieve this target. After the

public consultation is concluded, the Climate Strategy 2050 will be submitted to the Liechtenstein Parliament for approval[2]. At the same time, public consultation for the concomitant adaptation of the EHG to enshrine the reduction target of 50% compared to 1990 in law was started. The CO_2 Act will be revised with effect from 2025 as continuation of the existing act, but also to set the legal framework for the commitments under the Paris Agreement.

1.4 Projections and the total effect of measures

This section covers Liechtenstein's greenhouse gas emissions under the three scenarios 'without measures' (WOM), 'with measures' (WM) and 'with additional measures' (WAM) following the revision of the UNFCCC reporting guidelines on national communications for Parties included in Annex I to the Convention (see the annex to decision 6/CP.25).:

- The 'without measures' (WOM) scenario projection excludes all policies and measures implemented, adopted or planned after the year chosen as the starting point for that projection. For Liechtenstein's NC8, this starting year is 2008. 2008 was the year when the Energy Efficiency Act was adopted in Liechtenstein, and no other (quantifiable) measures were implemented earlier than 2008 in Liechtenstein.
- The 'with measures' (WM) scenario projection encompasses currently implemented and adopted policies and measures. In Liechtenstein, projections based on specific measures are only available for the sector Energy (1A Fuel combustion). For the waste sector projections were calculated based on past emissions and the expected growth in population. Projections for the sectors Energy (1B Fugitive emissions from fuels) as well as for IPPU (2) and Agriculture (3) were adopted from Switzerland's WM projection in its NC8 (FOEN 2022). The projections for LULUCF were assumed to be constant (mean of the latest five inventory years). The projection of international bunkers is also assumed to be constant (mean of last 10 years; note that within the last 10 years, only minor fluctuations occurred in reported emissions).
- The 'with additional measures' (WAM) scenario projection also encompasses planned policies and measures. The Climate Strategy 2050 (Government 2022) defines additional measures for the sectors Energy, IPPU, Agriculture and Waste. Projections under the WAM scenario are therefore adopted from the Climate Strategy 2050.

The energy sector dominates Liechtenstein's greenhouse gas emissions. In the year 2020, emissions from this sector amounted 80.1% of Liechtenstein's total emissions. Therefore, the focus for the elaboration of Liechtenstein's projections in its NC8 lies on the Energy sector.

The aggregated projections in CO_2 equivalents under the WM and WAM scenario are depicted in Table 1-2 and Figure 1-4 (WM) and in Table 1-3 and Figure 1-5 (WAM). The aggregated projections under the WOM scenario are also indicated in Figure 1-4 and Figure 1-5. The actual GHG emission reduction for the years 1990–2020 amounts 21.4%. From then, further reductions by 30.5% (WM scenario) and by 46.30% (WAM scenario) are projected in the years 2020–2035. The total reduction from 1990–2035 under the WM scenario is anticipated to be 45.4%, for the WAM scenario 57.8%.

[2] The Climate Strategy 2050 was adopted by the Parliament of Liechtenstein in December 2022. However, at the time of the preparation of the National Communication 8, the Climate Strategy 2050 had not yet been adopted. Therefore, it was considered as a "planned" policy and its measures were only considered in the WAM scenario.

Table 1-2 Total GHG emissions in CO_2eq by sector for the WM scenario (1990–2035; reported values for 1990–2020 from OE 2022; projected values for 2021–2035)[3]

CO_2eq
in kt CO_2 equivalent

		Reported data (GHG inventories)							Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WM)**	**228.47**	**233.54**	**247.01**	**263.64**	**228.17**	**198.15**	**179.66**	**166.53**	**143.77**	**124.83**
1	**Energy**	**201.25**	**207.06**	**220.06**	**231.45**	**193.43**	**162.18**	**143.96**	**132.45**	**112.53**	**94.19**
1A	Fuel combustion	200.89	206.46	219.23	230.37	192.30	161.03	143.17	131.26	111.34	93.00
	1A1 Energy industries	0.18	2.08	2.77	3.14	3.26	2.05	2.44	2.48	2.53	2.58
	1A2 Manufacturing industries & constr.	36.29	35.69	36.41	39.15	26.07	27.59	22.86	19.83	16.16	15.45
	1A3 Transport	76.87	82.10	91.62	81.81	77.76	61.85	52.77	52.35	44.54	35.10
	1A4 Other sectors	87.55	86.59	88.43	106.27	85.21	69.54	65.11	56.60	48.11	39.88
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
2	**Industrial processes and product use**	**0.66**	**1.77**	**4.41**	**7.49**	**9.39**	**10.48**	**9.43**	**7.80**	**4.95**	**4.26**
3	**Agriculture**	**24.90**	**23.10**	**20.91**	**23.07**	**23.73**	**23.87**	**24.67**	**24.57**	**24.49**	**24.49**
4	**LULUCF**	**7.57**	**5.33**	**25.14**	**9.39**	**21.01**	**12.21**	**4.84**	**12.35**	**12.35**	**12.35**
5	**Waste**	**1.66**	**1.62**	**1.62**	**1.63**	**1.62**	**1.62**	**1.60**	**1.72**	**1.81**	**1.90**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.49**	**0.85**	**1.20**	**0.94**	**1.04**	**1.04**	**1.04**

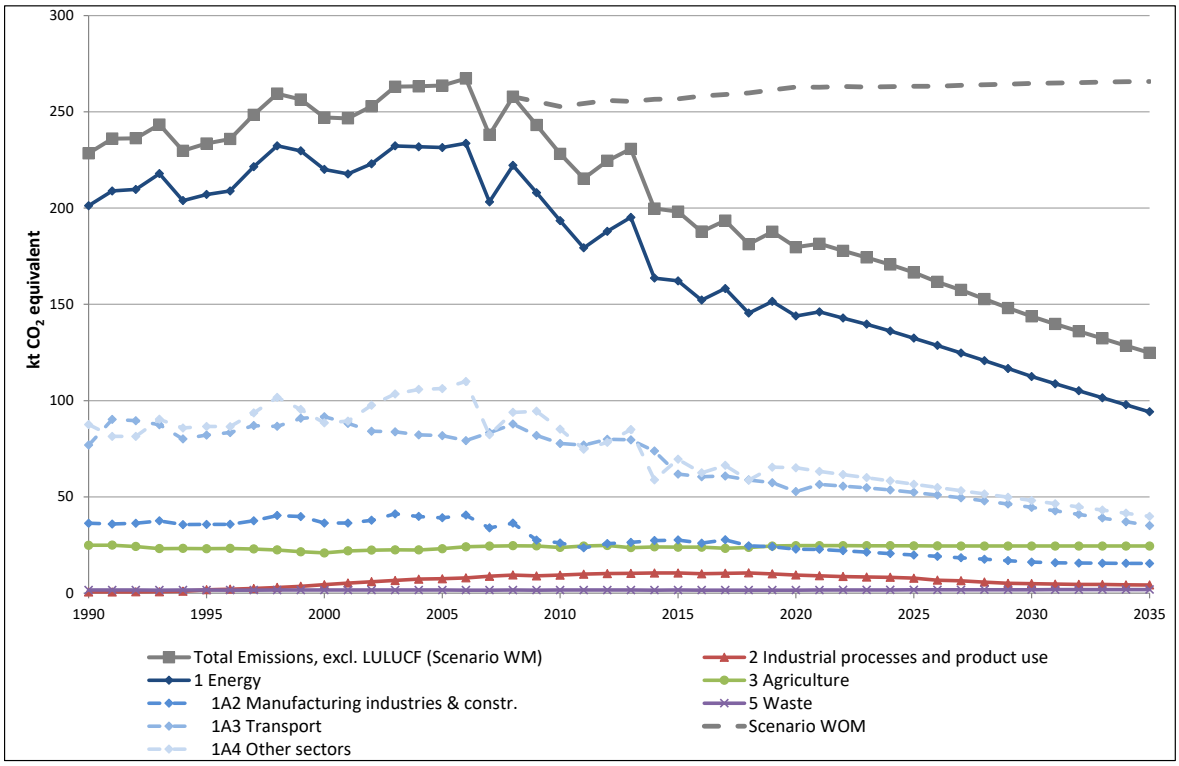

Figure 1-4 Total GHG emissions in CO_2eq by sector (excl. LULUCF) from 1990 to 2035 for the scenario WM. The dashed line in grey 2008–2035 indicates scenario WOM.

[3] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data used to prepare the projections are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

Table 1-3 Total GHG emissions in CO_2eq by sector for the WAM scenario (1990–2035; reported values for 1990–2020 from OE 2022; projected values for 2021–2035)[4]

CO_2eq
in kt CO_2 equivalent

		Reported data (GHG inventories)							Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WAM)**	**228.47**	**233.54**	**247.01**	**263.64**	**228.17**	**198.15**	**179.66**	**155.69**	**126.40**	**96.52**
1	**Energy**	**201.25**	**207.06**	**220.06**	**231.45**	**193.43**	**162.18**	**143.96**	**124.87**	**100.05**	**74.63**
1A	Fuel combustion	200.89	206.46	219.23	230.37	192.30	161.03	143.17	123.68	98.86	73.44
	1A1 Energy industries	0.18	2.08	2.77	3.14	3.26	2.05	2.44	2.48	2.53	2.58
	1A2 Manufacturing industries & constr.	36.29	35.69	36.41	39.15	26.07	27.59	22.86	17.20	13.53	12.82
	1A3 Transport	76.87	82.10	91.62	81.81	77.76	61.85	52.77	52.18	42.55	29.11
	1A4 Other sectors	87.55	86.59	88.43	106.27	85.21	69.54	65.11	51.83	40.26	28.93
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
2	**Industrial processes and product use**	**0.66**	**1.77**	**4.41**	**7.49**	**9.39**	**10.48**	**9.43**	**7.03**	**4.53**	**2.02**
3	**Agriculture**	**24.90**	**23.10**	**20.91**	**23.07**	**23.73**	**23.87**	**24.67**	**22.08**	**20.07**	**18.05**
4	**LULUCF**	**7.57**	**5.33**	**25.14**	**9.39**	**21.01**	**12.21**	**4.84**	**12.35**	**12.35**	**12.35**
5	**Waste**	**1.66**	**1.62**	**1.62**	**1.63**	**1.62**	**1.62**	**1.60**	**1.70**	**1.76**	**1.82**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.49**	**0.85**	**1.20**	**0.94**	**1.04**	**1.04**	**1.04**

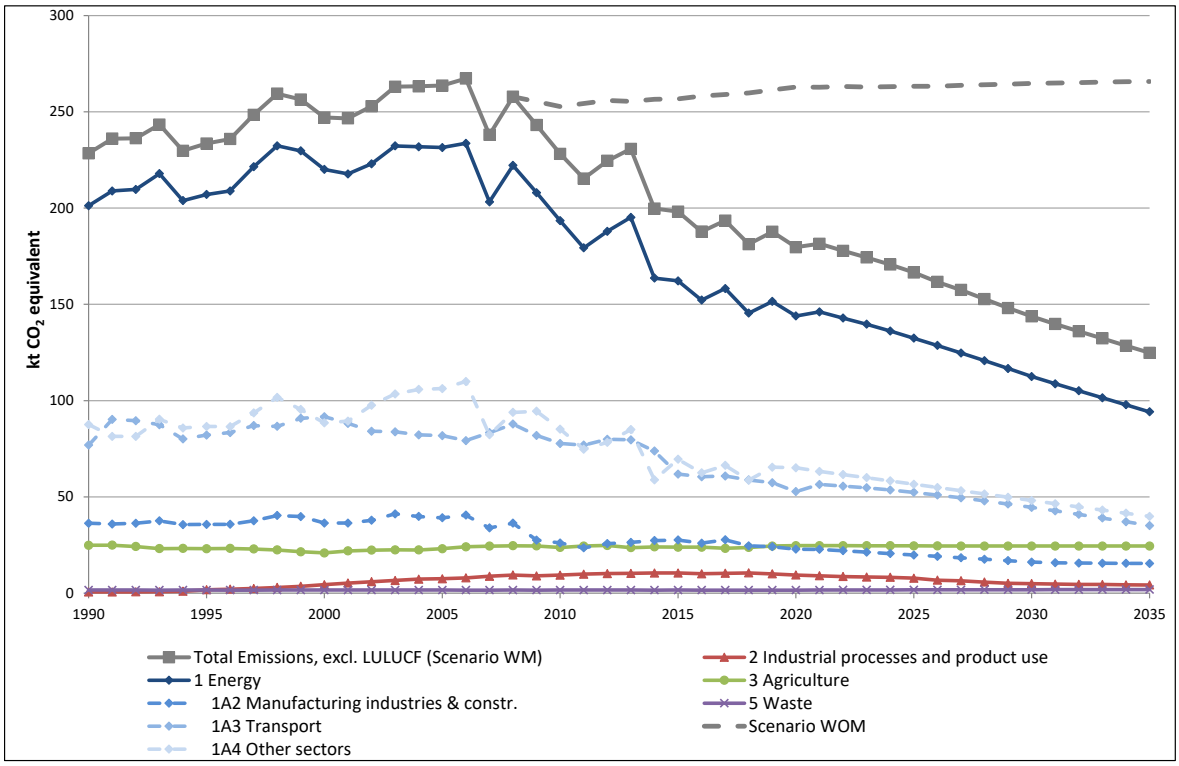

Figure 1-5 Total GHG emissions in CO_2eq by sector (excl. LULUCF) from 1990 to 2035 for the scenario WAM. The dashed line in grey 2008–2035 indicates scenario WOM.

[4] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data used to prepare the projections are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

1.5 Impacts, vulnerability assessment and adaptation

Liechtenstein is entirely located in the Alpine region as elaborated in section 2. In recent years, various research programmes on the effects of global climate warming in the Alpine region have been conducted. Trends in historical climate data up to 2019 and projections of possible developments in the 21st century indicate that noticeable changes in climatic conditions are to be expected. For Liechtenstein, the most important impacts are related to raising temperatures, such as prolonged heat waves and droughts and an increase in the risk of natural hazards (e.g. flooding, landslides, debris flows). Changes in climatic conditions are also expected to have an impact on biodiversity. Since records began in 1871 the average temperature in Liechtenstein increased by 2°C (OE 2020).

1.5.1 Climate change scenarios

Cited from FOEN (2022): *The scenarios are based on a large number of state-of-the-art European-scale regional climate model experiments available at the time of their preparation (EURO-CORDEX; Jacob et al., 2014; Kotlarski et al., 2014). Statistical methods were used to produce probabilistic multi-model estimates of future change for a range of meteorological variables. Summarized results are available for five representative Swiss regions, three scenario time periods (represent-ed by 30-year periods around the years 2035, 2060 and 2085) and three emission scenarios.*

CH2018 is based on the RCP emission scenarios that were used for the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC AR5, 2014). CH2018 also provides statistically downscaled products at two kilometres horizontal and daily temporal resolution for precipitation and temperature using a methodology that dissolved some of the limitations of the CH2011 statistical downscaling approach. For eight meteorological variables, CH2018 additionally provides ready-to-use data for 84 to 399 stations (depending on variable) in Switzerland. A major advancement with respect to the preceding CH2011 scenarios is the transient character of the data for impact applications. Results and data are available through the internet page: http://www.climate-scenarios.ch

Figure 1-6 illustrates observed seasonal temperature changes for the Principality of Liechtenstein, as well as projected seasonal temperature changes for two emission scenarios and selected time periods.

Compared to the period 1981–2010, the best estimates for a scenario without mitigation measures (RCP8.5 emission scenario) project an increase of annual mean temperature of 5°C by 2085 (uncertainty range of 3.7-5.9°C)[5]. In a scenario with stringent climate change mitigation measures (RCP2.6), an annual mean temperature increase of 1.3°C by 2085 is projected (uncertainty range of 0.7–2.1°C) (NCCS (Pub.), 2018).

Precipitation is projected to change towards the end of the 21st century (see Figure 6-2). Summer mean precipitation is projected to decrease by 15.4% (uncertainty range from -41.8% to -2.4%) in the RCP8.5 scenario (without measures) and by 0.3% (uncertainty range from -17.6% to +7.9%) in the RCP2.6 scenario (stringent mitigation measures). Winter precipitation is expected to increase by 24% (uncertainty range +1% to +46%) in the RCP8.5 scenario and by 5.1% (uncertainty range -11.6% to +19.3%) in the RCP2.6 scenario (NCCS (Pub.), 2018).

[5] Uncertainties due to climate model assumptions and natural variability are shown as the range between the 5% and 95% quantile of the model ensemble spread.

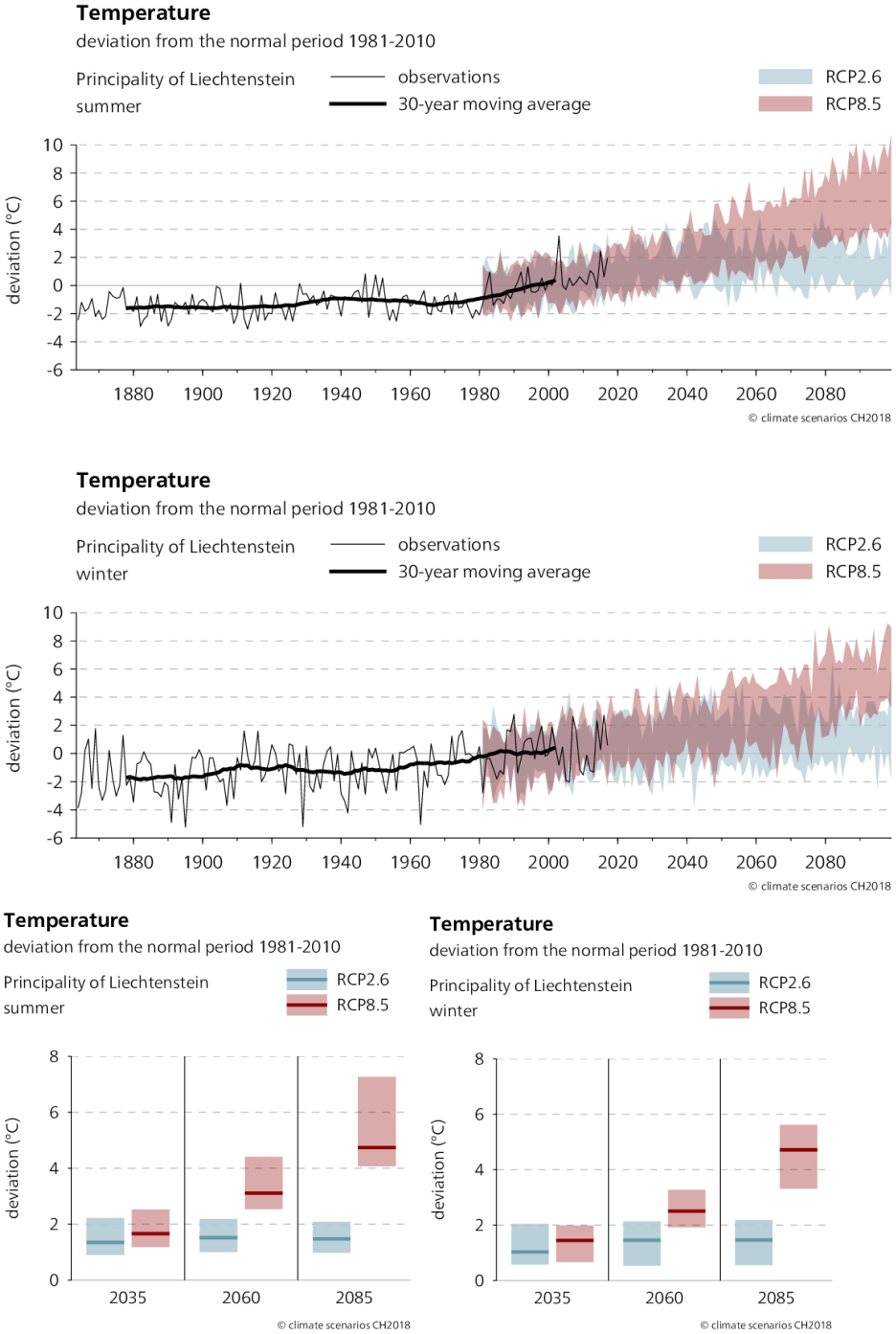

Figure 1-6 Top and middle panel: Past observed and future projected changes in seasonal temperature (°C) in the Principality of Liechtenstein. The changes are relative to the reference period 1981–2010. The thin black line displays the year-to-year difference with respect to the average of observations over the reference period, the heavy black line displays the corresponding smoothed 30-year average. The blue and red shadings indicate the range of year-to-year differences as projected by climate models for the RCP2.6 (with stringent mitigation, blue) and RCP8.5 (without mitigation, red) emission scenarios (specifically, the 5–95 percentile range for each year across the available model set). Bottom panel: Summarised change in temperature for three future reference periods in summer (bottom left panel) and winter (bottom right panel) (NCCS (Pub.) 2018).

1.5.2 Climate change impacts

Observed climatic conditions and expected developments are summarised in the factsheet on climate trends and climate change provided by the Office of Environment (OE) of Liechtenstein (OE 2022).

Cited from FOEN (2022):

Annual runoff amounts have hardly changed in the past 100 years. However, the seasonal runoff distribution has already changed in recent decades. Runoff has decreased in summer and increased in winter. This development will continue in a changing climate.

Liechtenstein is expecting a decreasing amount of snowfall (section 6.1.7). *The snowpack is a natural water reservoir which is crucially important for the seasonal water balance in Switzerland* and Liechtenstein*. The zero degree isotherm largely determines whether precipitation falls as snow, which is stored, or as rain, which immediately contributes to runoff. The average zero degree isotherm in winter has risen by 300 to 400 metres since 1961 (CH2018, 2018). The percentage of days with snowfall below 500 metres above sea level has fallen by some 40 per cent since 1961. The water quantity stored in snow in spring (snow water equivalent) below 1000 metres above sea level dropped by as much as 75 per cent in the same period (Marty et al., 2017a). As winter temperatures rise, so does the zero degree isotherm – by around 150 metres per degree Celsius temperature increase (CH2018, 2018). Consequently, the proportion of snow in total precipitation is further reduced.*

On the basis of existing observations and model results, it is possible to make some projections concerning the future climate change impacts on biodiversity in Switzerland. The tree line will shift upwards by about 400 metres in altitude with a global temperature increase of 2.2 degrees Celsius on average (Körner, 2021). Many species will not be able to keep pace with the rapidly advancing climate change. Species with low genetic variation, low reproduction rates, poor dispersal abilities and narrow ecological niches are the most vulnerable (SCNAT, 2021). Moreover, disruptions in species interactions caused by individual migration rates or phenological shifts are likely to have consequences for biodiversity (SCNAT, 2021a). The vulnerable species are displaced by more adaptable, increasingly common species, leading to a homogenisation of ecosystems.

Rising temperatures are expected to accelerate plant development. By the mid of the century, developmental stage sensitive to heat stress could thus occur five to ten days earlier in the season, which would allow current wheat varieties to partially escape from future heat periods. In maize, faster accumulation of growing degree-days would allow the crop to be harvested earlier than under current conditions (10 to 20 days by 2060, depending on emission scenario and location) (Buzzi et. al., 2021). Higher temperatures would also provide opportunities for cultivating maize in areas today still unfavourable and switching in places from early-maturing varieties to mid- to late-maturing varieties. Under rainfed cultivation, maize grain yields are projected to increase until about 2060 but to decline thereafter if climate protection measures are not implemented (Holzkämper, 2020). The beneficial effects of elevated atmospheric CO_2 concentrations could partially offset the negative impacts of heat and water stress, in wheat more than in maize (Webber et al., 2018).

Because of the projected changes in the hydrological cycle with, in particular, a decline in summer precipitation amounts and the more frequent occurrence of drought conditions (FOEN, 2021), irrigation water demand for crop production is anticipated to increase considerably.

Climate change will have significant impacts on grassland ecosystem services (Lavorel, 2019). Fodder production would profit from a projected lengthening of the growing season (CH2018, 2018), but extreme temperatures in spring and more prolonged and intense droughts in summer are likely to negatively affect grassland productivity and increase yield instability.

More frequent and intense heavy precipitation events could aggravate problems in plant production associated with soil erosion (Borrelli et al., 2020). Furthermore*, it is likely that plant production will face higher pest pressure under future climatic conditions.*

1.5.3 Assessment of risks and vulnerability to climate change

Based on the Swiss adaptation strategy (Swiss Confederation, 2012a) and risk assessments (Stöckli et al., 2015). Liechtenstein adopted relevant results in the development of its national climate change adaptation strategy (Government, 2018). It identified vulnerabilities to climate change in particular in the following areas:

Water management: Prolonged heat waves and reduced precipitation amounts in summer are expected to increase the risk of drought and water stress in agricultural production. This entails an increase in irrigation, which has negative consequences for aquatic ecosystems, e.g. if minimum discharge requirements cannot be maintained. In addition, an increase in magnitude and frequency of flood events along the river Rhine might increase the risk of damage to infrastructure and buildings.

Biodiversity, Forestry, Agriculture: Changing climatic conditions affect biodiversity and ecosystem services. Increasing temperatures favour spreading of alien and invasive species, which also entails negative impacts on agriculture and forestry. In forests, deciduous trees may spread due to increased temperatures. In addition, an increased frequency of extreme events, such as forest fires, storms, prolonged drought periods and avalanches, may affect forest vegetation (AWNL, 2011). For the agricultural sector, negative impacts are expected from an increased risk of prolonged droughts, which might result in water stress and reduced crop yields.

Health: During the heat wave in 2003, an increase in mortality by 7 % was observed in Switzerland (Grize, 2005). It can be assumed that a similar increase happened in Liechtenstein. With rising temperatures, similar events are expected to occur more frequently in future. Additionally, changing climatic conditions might also favour spreading of pathogens. Tropical diseases (malaria, dengue fever) are expected to increasingly surface in Central Europe (Swiss Confederation, 2012a), and existing diseases (e.g., borreliosis, meningitis) might spread to higher elevations, thereby affecting regions that were previously not at risk. An increased risk of natural hazards (e.g. landslides, rock fall) might also affect human health.

Tourism: Winter tourism is affected by the expected rise of the freezing level, which leads to a higher snow line. As a consequence, the skiing season may be shortened, especially for skiing areas situated between 1500 m and 2000 m above sea level, like Malbun in Liechtenstein. Consequently, the number of tourists visiting these skiing resorts is expected to decrease, which entails losses in the hotel and gastronomy sector. Reduced amounts of snowfall also require an increase in production of artificial snow, which leads to higher costs.

Energy: Changes in the runoff regime (e.g., due to changes in the snow cover and seasonal distribution of precipitation) can affect hydroelectric power production. Changes in frequency and magnitude of extreme events (e.g., drought periods, flooding) can also have negative impacts on power production. Besides electricity production, energy consumption is also affected by changing climatic conditions. Occurrence of heat waves is expected to increase and might lead to an increase in energy demand for cooling purposes.

Other areas: Global climate warming may result in economic losses not only due to direct local impacts but also by increasing the risk of supply chain disruption. More frequent occurrence of natural disasters may reduce production capacity or damage transportation infrastructure (e.g. roads, railways, airports, ports, bridges), thereby reducing availability of goods imported into Liechtenstein. On a global scale, the agricultural sector is considered to be highly vulnerable to changes in climatic conditions. Negative effects on agricultural productivity are expected due to

increased droughts and irrigation needs in regions with important contribution to global food production. Therefore, climate change may affect global food supply and prices.

1.5.4 Domestic adaptation policies and strategies

To mitigate expected negative impacts of climate change, adaptation measures are required in different areas and sectors. Adaptation is therefore an essential element of Liechtenstein's climate strategy (Government, 2015), which is currently being updated (Government, 2022).

The national climate change adaptation strategy of Liechtenstein (Government, 2018) identifies the relevant impacts related to climate change and defines measures to limit or avoid negative impacts. Liechtenstein also actively participates in international adaptation projects of the Alpine Convention[6] and the alpine space programme[7] (Climate Change Adaptation by Spatial Planning in the Alpine Space, Clisp). Liechtenstein was an official partner of the European project "C3-Alps"[8] on "Capitalising Climate Change Knowledge for Adaptation in the Alpine Space". The outcomes of this project form the foundation of the national climate change adaptation strategy (Government 2018), which focuses on the sectors of water resources management, natural hazards, agriculture, forestry, energy, tourism, biodiversity, health and land use planning. Emphasis lies on impacts of increasing risks of drought periods, heat waves, flood events and spreading of new vector borne diseases and alien invasive species. The strategy also addresses consequences of a reduced snow cover on winter tourism and the runoff regime.

1.5.5 Monitoring and evaluation framework

The implementation of adaptive measures lies within the responsibility of the respective offices and institutions and is planned according to the priorities defined in Liechtenstein's strategy for adaptation to climate change (Government, 2018).

The implementation of measures is coordinated and monitored by Liechtenstein's working group for climate change adaptation, which consists of members of the Office of Construction and Infrastructure, the Office of Civil Protection, Office of Public Health, the Food and Veterinary Office, the Office of Environment and the Office of Economic Affairs. The working group is coordinated by the Office of Environment. In annual meetings, this working group exchanges information on the state of implementation and coordinates planned and ongoing activities related to climate change adaptation. After five years, the working group will evaluate the progress and outcomes of adaptive measures and revise the adaptation strategy accordingly.

1.5.6 Progress and outcomes of adaptation action

Water resources management: Urban drainage and water supply planning are important instruments in the management of water resources in Liechtenstein. These plans are updated regularly, taking into account changes in climatic conditions that may affect supply of drinking water and urban drainage systems. Rising demand for irrigation of agricultural crops may require changes in current regulations. Liechtenstein plans to examine the need for adaptation of the existing regulatory framework on the use of ground and surface water for irrigation purposes.

Natural hazard management: The Office of Civil Protection of Liechtenstein conducted a general risk assessment, which covers also risks related to natural causes (EBP, 2012). In addition, Liechtenstein has established natural hazard maps (OCP, 2017). These maps provide regionalised

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[6] https://www.alpconv.org/en/ [1.09.2022]

[7] Climate Change Adaptation by Spatial Planning in the Alpine Space — Climate-ADAPT (europa.eu) [1.09.2022]

[8] C3-Alps – Capitalising Climate Change Knowledge for Adaptation in the Alpine Space — Climate-ADAPT (europa.eu) [1.09.2022]

information on the specific local risks of avalanches, rock fall, landslides and flooding. To address the expected increase in frequency and intensity of natural disasters, the Division of Forests and Landscape of Liechtenstein will regularly update these natural hazard maps, taking into account potential changes in frequency and magnitude of extreme events.

Agriculture: The expected increase in drought periods and extreme rainfall events are expected to reduce crop yields. In future, agricultural fields will require more irrigation. Especially during longer drought periods, the use of water for irrigation purposes conflicts with other water demands. Coordination of different interests by means of integrated water utilisation plans will therefore become more important. Under changing climatic conditions, existing recommendations for crop cultivation might not be suitable anymore. Liechtenstein is planning to examine the need for adapting these recommendations to expected future climatic conditions (Government, 2018).

A more rapid spreading of invasive species, pathogens and parasites under a warming climate are also expected to reduce crop yields. Besides crop production, animal husbandry might also be affected by existing and new pathogens. The Swiss Federal Food Safety and Veterinary Office (FSVO) provides biweekly information on the spreading of most important animal diseases. This system helps to reduce the risk of further spreading, since it enables preventive action. In analogy to the early warning system for animal diseases, the development of a similar system for plant diseases is intended. Liechtenstein is closely collaborating with the Swiss authorities.

Forestry: Liechtenstein's Alpine forests play an important role in the protection against natural hazards. Forested areas also offer other important ecosystem services, such as timber production, preservation of biodiversity and provision of recreational areas. The expected increase in draught periods especially in combination with subsequent damages caused by insects (bark beetle infestations), pathogens (viruses, bacteria, fungi), forest fire or wind storms is expected to affect provision of these ecosystem services.

Forest service plans define forest management at the local level. These plans are updated every 10 years, taking into account possible needs for adaptation of management practices to changes in climatic conditions. Liechtenstein also developed a national forest development plan in 2001 (OE, 2001), which addresses future forest management and is also periodically updated. The updated forest development plan 2030+ is currently being developed and will be published by the end of 2022[9].

Energy: The expected rise of temperature and increased risk of heat waves lead to higher demand for cooling and air conditioning. Adaptive measures in Liechtenstein focus primarily on passive cooling, which comprises structural measures in buildings, such as improved isolation and shading, and planning measures, amongst others. Use of cooling and air conditioning devices is restricted to avoid increasing energy consumption and related GHG emissions. Currently implemented regulations also allow for measures to be taken to prevent a drastic increase in energy demand for cooling purposes under future climatic conditions.

Tourism: Summer tourism will benefit from climate change related developments, since tourist destinations at higher elevations, which exhibit generally lower temperatures, might become more popular during prolonged heat waves in urban areas. However, winter tourism is strongly affected due to reduced snow cover, especially at low elevations. Adaptation measures focus primarily on diversification of touristic attractions. Promotion of new tourist activities and related marketing strategies aim at generating additional revenue that compensates for potential losses

[9] https://www.llv.li/medienmitteilungen/detail/5008/arbeiten-zur-breit-abgestutzten-waldstrategie-2030-haben-begonnen [01.09.2022]

due to a shortening of the skiing season. Emphasis lies on strategies that promote different forms of sustainable tourism (e.g., health tourism).

Biodiversity management: Liechtenstein updated its management plan for the control of invasive alien plant species (OE, 2018a). It provides a list of species that need to be controlled or watched. It also defines suitable measures to prevent alien species from invasive spreading and control measures for affected areas, such as appropriate disposal procedures. Many natural habitats that are highly susceptible to changes in climatic conditions, such as alpine and aquatic habitats and wetland areas are already under protection in Liechtenstein. The protective regulations form the necessary framework for the development and implementation of measures for the preservation of these ecosystems. The national report on the implementation of the Convention on Biodiversity (OE, 2019) documents the state of Liechtenstein's ecosystems and the progress towards the achievement of "Aichi Biodiversity Targets".

Health: Health impacts due to the expected increase in duration and frequency of heat waves can be mitigated by structural measures on buildings (e.g., isolation, shades, dimensioning of windows in new buildings) and planning measures (e.g., green areas, shading, orientation of new buildings). These measures help to reduce the need for active cooling, which would otherwise increase energy demand and related GHG emissions and should therefore be minimised. Negative impacts of prolonged heat waves can also be reduced by changes in behaviour, such as limiting strenuous activities during daytime. Switzerland provides a list of recommendations and informs about potential risks. Liechtenstein adopts these recommendations.

Increasing temperatures might lead to a spreading of vector-borne diseases. Occurrences of certain diseases need to be reported to the authorities. A list of infectious diseases requiring notification is provided by the Swiss Federal Office of Public Health. This list already includes certain diseases that might spread under warming climatic conditions (e.g., dengue fever, chikungunya fever). The Swiss regulation and recommendations are also adopted in Liechtenstein thereby allowing for an early detection of a potential spreading of new diseases.

Land use planning: Existing land use planning instruments allow coordination of different types of land use. Land use planning is closely linked to other sectors and requires close collaboration with all involved stakeholders. Therefore, land use planning instruments also plays a key role in the adaptation to climate change.

1.6 Financial, technological and capacity-building support

International solidarity is one of the priorities of Liechtenstein's foreign policy. In particular, international humanitarian assistance and development cooperation with developing countries and with countries affected by disasters and armed conflicts is a traditional focus of Liechtenstein's foreign policy. The operational tasks of International Humanitarian Cooperation and Development (IHCD) are carried out by the Office for Foreign Affairs and the Liechtenstein Development Service (LED). The overall coordination of the IHCD activities lies with the Office for Foreign Affairs. Combatting climate change is one of the focus topics of IHCD.

IHCD encompasses all forms of the humanitarian and development policy of the State of Liechtenstein and of the LED, which is a foundation under private law, controlled by the State. These activities are set out in the Law on International Humanitarian Cooperation and Development of 2007 (IHCD Act). Liechtenstein's engagement focuses on emergency and reconstruction assistance, international refugee and migration assistance as well as bilateral and multilateral development cooperation.

Liechtenstein works closely with the affected population and local organisations, with aid and development organisations in Liechtenstein, Switzerland, Austria and Germany as well as with European and international organisations. Liechtenstein, through its IHCD, maintains working

relationships with a large number of partners. The bulk of Liechtenstein's support is provided in the form of financial resources. The LED maintains three coordination offices on the ground, in Moldova, Bolivia and Zimbabwe from where it can directly supervise its projects.

In 2021, Liechtenstein's IHCD had resources of about 22.9 million Swiss francs, i.e., about 580 Swiss francs per capita. The total Official Development Assistance (ODA) amount was 25.5 million Swiss francs. The average exchange rate for USD was 0.914 in 2021. The level of official development assistance is 0.41% of gross national income (2019). Technology development and/or transfer as well as capacity-building are usually a component of programmes and projects of Liechtenstein that support developing countries in their endeavours to mitigate and adapt to climate change.

1.7 Research and systematic observation

1.7.1 Research

The Alpine Rhine Valley is an ideal object for interdisciplinary, scientifically challenging, practice-oriented and regionally anchored research projects. In line with its official mission, the University of Liechtenstein conducts application-oriented research in selected research areas. Around 800 students from over 40 countries provide an international atmosphere to the small university in the Alpine Rhine Valley. Primary responsibility for research lies with the institutes and associated institutes.

The University's mission is to offer research, education and continuing education, as well as knowledge and technology transfer for a sustainable and responsible future. The focus is on socially and ecologically relevant topics in the fields of business, business law, as well as architecture and spatial development.

In the context of natural scientific research on the country, national authorities and private organisations are also collaborating with foreign university research facilities and institutes. The goal is to gain ecological insights on a scientific basis that constitute a basis for formulating a sustainable development policy in conjunction with insights gained from economic and socio-cultural surveys and research.

Liechtenstein supports research activities abroad, with annual contributions to Switzerland (Swiss National Science Foundation, SNSF) and Austria (Austrian Science Fund, FWF), each amounting to 250,000 CHF (2021). As a member of the EEA, Liechtenstein also participates in European research programmes, but not in the Horizon Europe programme.

Public institutions in Liechtenstein are also indirectly engaged in technology research. The University of Liechtenstein contributes a budget of 14.6 million CHF to the training of experts and 3 million CHF to research as a base amount. As one of the co-owners Liechtenstein also supports the Eastern Switzerland University of Applied Sciences with an annual contribution of 580,000 CHF (2016). Liechtenstein is contributing another 600,000 CHF annually (since 2014) to the establishment of RhySearch Innovation Center—a centre for research and development, based in neighbouring Buchs, Switzerland.

Liechtenstein is engaged in several collaborations with its neighbouring States and with international bodies. Due to its small size, Liechtenstein focuses on regional linkages and is in contact with Switzerland, Austria and Germany through various international agreements.

1.7.2 Systematic observation

Liechtenstein collects a wide range of data relating to climate, both through its own measuring stations and through interregional cooperation, especially with Switzerland. Since 1974, the

largest measuring station in the country has been in operation in Vaduz, measuring the usual meteorological data.

Since 1970, the Office of Civil Engineering has been measuring snow depth at 10 locations. In addition, the Office of Environmental Protection has taken water samples at various locations since the 1960s, to monitor quality and determine the groundwater table. Finally, the Eastern Swiss cantons and Liechtenstein execute a joint monitoring network of air pollutants since 2001, in order to measure the quality of air (OSTLUFT).

Due to its size and the limited resources within the national administration, Liechtenstein's engagement with regard to research and systematic observation that address international activities is very limited.

1.8 Education, training and public awareness

1.8.1 Education at schools

The Ministry of Education is responsible for the coordination of education. Relevant legislative provisions are the Education Act, the Vocational Education and Training Act and the Higher Education Act along with the corresponding ordinances.

Since 2005, environmental education officially forms part of Liechtenstein's all-encompassing educational programme. The current national curriculum for Kindergarten, Primary and Secondary School of the Principality of Liechtenstein (2018 edition) contains six subject areas, one of which is "Nature, Humans, Society". Topics such as climate change or energy production are discussed in this subject area. Based on the guiding idea of "Education for Sustainable Development", environmental education influences the content of various school subjects.

The University's Institute for Architecture and Planning and Institute for Financial Services offer several recurring and one-off courses with direct or indirect link to climate change and sustainability. The Eastern Switzerland University of Applied Sciences offers a Master of Science in Engineering with a focus on energy and environment as well as further education courses (CAS, MAS) related to renewable energy, resource efficiency, or sustainable mobility.

1.8.2 Public outreach

Public outreach is the responsibility of the individual administrative offices. In addition, some tasks are delegated to external institutions and support is provided to individual outreach campaigns by NGOs.

The Government also supports initiatives and projects in the field of environmental protection, such as the annual international competition "Constructive Alps" rewarding sustainable housing and renovations of old buildings in the Alpine region.

The population is also provided with information on specific environmental concerns through reports in the newspapers. Research and survey results concerning the condition of the mountain region and information on environmental developments and changes are regularly brought to the attention of the population by public authorities via publication series, thematic brochures, posters, and reports in newspapers. Specialised excursions with school classes, population groups, and professional organisations conducted by various public authorities constitute an important component of public outreach.

The Government also collaborates with and provides support to private institutions and NGOs, such as the LIFE Climate Foundation Liechtenstein (established in 2009), in order to provide public information and raise awareness on climate change issues.

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2 National circumstances relevant to greenhouse gas emissions and removals

2.1 Governmental structure

2.1.1 System of State and separation of powers

The Principality of Liechtenstein is a constitutional hereditary monarchy on a democratic and parliamentary basis. The power of the State is embodied in the Reigning Prince and the People. The relatively strong position of the Reigning Prince is balanced by far-reaching direct-democratic rights of the people. Separation of powers is further safeguarded by vesting separate rights in the executive branch (Government), the legislative branch (Parliament), and the judicial branch (courts).

2.1.2 Reigning Prince (Head of State)

The Reigning Prince is the Head of State and represents the State in all its relations with foreign States, notwithstanding the requisite participation of the competent Government. On the proposal of Parliament, the Reigning Prince appoints the Members of the Government. He is also responsible for appointing judges, the election of which is undertaken by Parliament on the proposal of a special selection body. On important grounds, the Reigning Prince may dissolve Parliament and dismiss the Government. The Reigning Prince may also exercise emergency powers as well as the powers of pardon, mitigation, and quashing with respect to criminal investigations. In addition, every law requires the sanction of the Reigning Prince to enter into force. In exercising his powers, the Reigning Prince is bound by the provisions of the Constitution.

2.1.3 Parliament

The Liechtenstein Parliament is elected every four years. Parliament consists of 25 Members. They are elected in universal, equal, direct, and secret elections in accordance with proportional representation. In the current legislative term (2021–2024), four parties are represented in Parliament: The Patriotic Union (VU) and the Progressive Citizens' Party (FBP) each hold 10 seats. The Free List (FL) has 3 seats and the Independents (DU) are represented with 2 seats.

The most important responsibilities of Parliament are participation in the legislative process, assent to international treaties, approval of State funds, election of judges on the proposal of the selection body, and supervision of the National Administration. Parliament elects the Government and proposes its appointment to the Reigning Prince. It can also trigger dismissal of the Government when the Government loses its confidence. Parliament constitutes a quorum if at least two thirds of its Members are present.

2.1.4 Government

The Government consists of five Ministers: the Prime Minister, the Deputy Prime Minister, and three other Ministers. The Ministers are appointed by the Reigning Prince on the

recommendation of Parliament. The Government is the supreme executive authority, to which 30 offices and several diplomatic missions abroad are subordinate. About 50 commissions and advisory councils support the work of the Administration.

2.1.5 Jurisdiction

Jurisdiction is divided into jurisdiction under public law (special jurisdiction) and ordinary jurisdiction. Jurisdiction under public law is exercised by the Administrative Court and the Constitutional Court. The Administrative Court is the instance for complaints against decisions and orders of the Government or commissions acting on the Government's behalf. The responsibilities of the Constitutional Court include in particular the protection of the rights guaranteed by the Constitution, the European Convention on Human Rights, and the human rights instruments of the United Nations to which Liechtenstein is a State party. It also reviews the constitutionality of laws and international treaties and the legality of Government ordinances.

Ordinary jurisdiction encompasses the administration of justice in civil and criminal matters. The first instance is the Liechtenstein Court of Justice in Vaduz. Before a complaint can be lodged with the Liechtenstein Court of Justice in contentious civil matters, a mediation procedure must be undertaken in the municipality of residence of the defendant. Only if the mediation procedure fails, the Liechtenstein Court of Justice will be invoked as the first instance. Ordinary jurisdiction in the first instance is exercised by individual judges. The second instance is exercised by the Court of Appeal, and the third instance by the Supreme Court. Both courts are collegial bodies.

2.1.6 Municipalities

Municipal autonomy plays an important role in Liechtenstein. The autonomous scope of authority of the 11 municipalities is laid down in article 110 of the Constitution. The eligible voters of each municipality elect a Municipal Council headed by a Mayor who, depending on the size of the municipality, exercises the office full-time or part-time. The municipal authorities conduct their affairs autonomously and manage the municipal assets. Citizens may call a referendum against their decisions.

2.1.7 Relations with Switzerland

The relations between Liechtenstein and Switzerland are very close and friendly. The two countries have concluded numerous bilateral agreements. The most important treaty is the Customs Treaty, which, together with other agreements, ensures an open border between Liechtenstein and Switzerland for goods and services, as well as passenger traffic. Also of great importance to the Liechtenstein economy is the Currency Treaty, which governs the use of the Swiss franc as the official currency in Liechtenstein.

The Customs Treaty ensures that all Swiss customs regulations and all other Swiss federal legislation shall apply to Liechtenstein to the extent to which their application is necessary for the customs union. All provisions of Swiss federal legislation that would give rise to a contribution requirement by the Swiss Confederation are exempt from this rule. In addition, all trade and customs treaties concluded between Switzerland and third countries apply to Liechtenstein pursuant to the Customs Treaty. Switzerland is also authorised to represent Liechtenstein at such negotiations and to conclude these treaties effective for Liechtenstein. In principle, the Customs Treaty is limited to the transport of goods. In the 1990s, the Customs Treaty was adapted as a consequence of European integration. Since then, Liechtenstein has been able to become a State party to international conventions and a member of international organisations relevant to the scope of the Customs Treaty, as long as Switzerland also belongs to these conventions and organisations. In addition, Liechtenstein may also join such conventions and organisations even if Switzerland does not join. This requires Liechtenstein and Switzerland to conclude a special

agreement, such as in 1994 pursuant to Liechtenstein's accession to the European Economic Area (EEA).

In addition to its effect under international law, the Customs Treaty also has symbolic significance for the particularly close relations between Liechtenstein and Switzerland. It has created the basis for legal alignment and harmonisation in the fields of economics and social law, extending far beyond the scope of the treaty. These close links manifest themselves today in a wide range of agreements and treaties, including the areas of social security, vocational training, transport, indirect taxes, and cross-border police cooperation.

The Customs Treaty is also relevant to environmental law: The bulk of Swiss environmental standards also apply to Liechtenstein. However, environmental taxes and tax incentives are not covered by the Customs Treaty, due to Liechtenstein's tax sovereignty. Liechtenstein has therefore concluded “The bilateral Agreement between the Principality of Liechtenstein and the Swiss Confederation on Environmental Levies within the Principality of Liechtenstein” to ensure a parallel levying of environmental taxes in Liechtenstein. A similar treaty framework already exists in the area of transport with respect to the Heavy Vehicle Fee (HVF).

2.1.8 Liechtenstein and the EU

The relations between Liechtenstein and the EU are close, and cooperation is intensive. Since 1 May 1995, Liechtenstein has been linked with the European Union (EU) and its member States through an extensive association agreement – the Agreement on the European Economic Area (EEA). This agreement extends the Single Market of the EU by three of the four States of the European Free Trade Association (EFTA), namely Liechtenstein, Iceland, and Norway. Since the UK’s departure on 1 February 2020, the EU now has 27 members and the EEA 30 members.

Through the EEA Agreement, the EU member States and the three EEA/EFTA States Liechtenstein, Iceland, and Norway are brought together into a Single Market, in which the same basic rules (acquis communautaire) apply to all participating States. The rules relate to the four basic freedoms (free movement of goods, free movement of persons, free movement of services, free movement of capital) and to joint competition rules.

In addition to the legal provisions concerning the Single Market, the EEA Agreement also contains horizontal and flanking policies aimed at strengthening the Single Market. These additional areas of cooperation include environmental protection, consumer protection, research and development, education, statistics, company law, and social policy. A large share of EU environmental standards therefore also applies in Liechtenstein. Liechtenstein also takes part in EU programmes in the aforementioned areas and, through its participation in committees, has a voice in the development and execution of the programmes.

2.2 Population

At the end of 2020, Liechtenstein had a population of 39,055, a third (34.5%) of whom were foreign citizens (especially Swiss, Austrians, Germans and Italians). The population density in 2020 was 242 inhabitants per km^2. Figure 2-1 indicates the development of Liechtenstein’s population between 1960 and 2020.

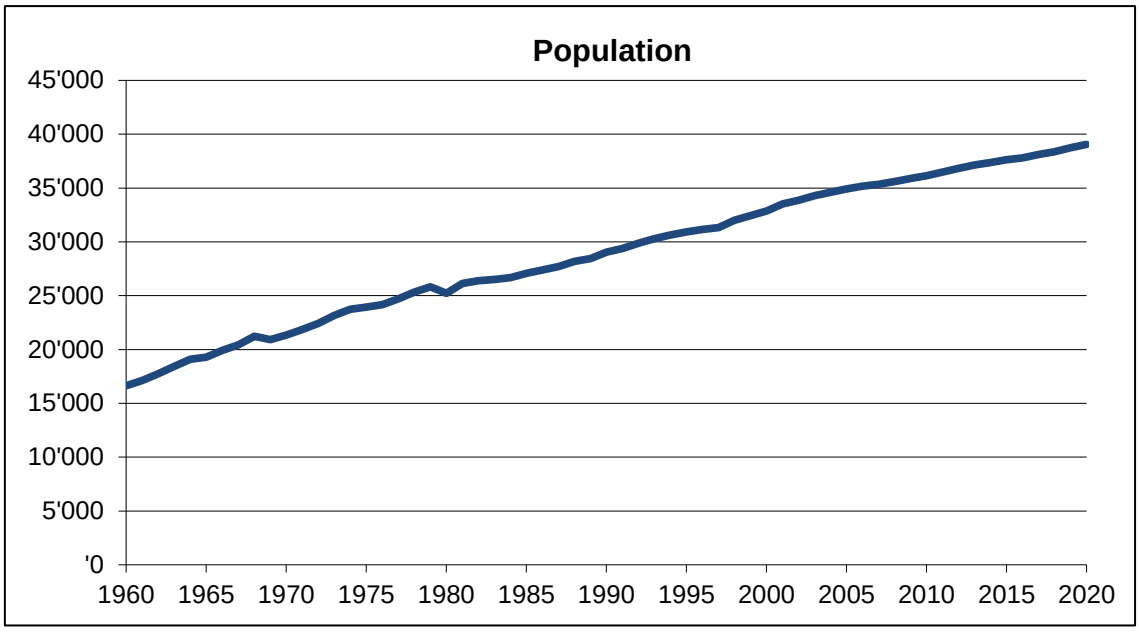


Figure 2-1 Population 1960–2020. (OS 2022, StatYearBook)

2.3 Climate

Liechtenstein has a continental climate, i.e., the weather varies considerably over the course of the year, ranging from below zero degrees Celsius to the mid-20s (monthly average). There is also a significant difference between municipalities depending on their elevation. In the capital Vaduz, at 456 meters above sea level, the average annual temperature was 11.4°C in the year 2020. The average precipitation has not changed appreciably in the last 20 years. Since records began in 1864, the Rhine Valley, where Liechtenstein is situated, has warmed by around 2°C. Heatwaves have increased in frequency (+200%) as well as intensity, and the number of days with ice/snow has declined by around 50–60%.

Precipitation levels fluctuate significantly year on year: In Vaduz, it is approximately 967 mm per year (annual average precipitation 1974–2020). Since 1889, average annual precipitation has increased by 13%, owing mostly to more, and stronger, precipitation events in the winter season. (OE 2020; OS 2021, StatYearBook)

2.4 Geography

The Principality of Liechtenstein is located between 47°02’ and 47°16’ north and 9°28’ to 9°38’ east. It is situated in the heart of Europe, between Austria and Switzerland, and covers an area of 160 km^2. The transport axes Munich-Milan and Zurich-Vienna intersect near the Principality of Liechtenstein. There are no motorways on Liechtenstein’s territory so that Liechtenstein’s road network is only of regional importance. A high mountain range (the Alps) in the east constitutes the natural border to Austria; the river Rhine marks the border to Switzerland (see Figure 2-2).

Figure 2-2 Map of the Principality of Liechtenstein

2.5 Economy

At the end of 2020, Liechtenstein had 40,328 employed persons. More than half of the work force lives abroad commuting from Switzerland, Austria or Germany to Liechtenstein. Over two thirds of the work force are foreign citizens. In 2020, 63.2% of the employed persons worked in the Services sector, 36.1% in Manufacturing and 0.6% in Agriculture and Forestry. (OS 2021, EmploymentStat) In 2020 the annual unemployment rate was 1.9%. (OS 2021, UnemploymentStat)

The gross domestic product (GDP) and the gross national income (GNI) were determined for the first time in 1998, as part of Liechtenstein's National Economic Accounting. In 2019, the GDP stood at 6.4 billion (thousand million) Swiss francs and economic growth at -2.4% (OS 2021, NatAccounts). The GNI was at 6.2 billion Swiss francs. A first estimation for the GDP in 2020 is 5.7 billion Swiss francs (OS 2022, NatAccounts). Figure 2-3 shows the development of the GDP and GNI between 1998 and 2019.

When split by economic sector, Manufacturing generated 45.8% of Gross Value Added in 2019, Services 54.1% and Agriculture 0.1%.

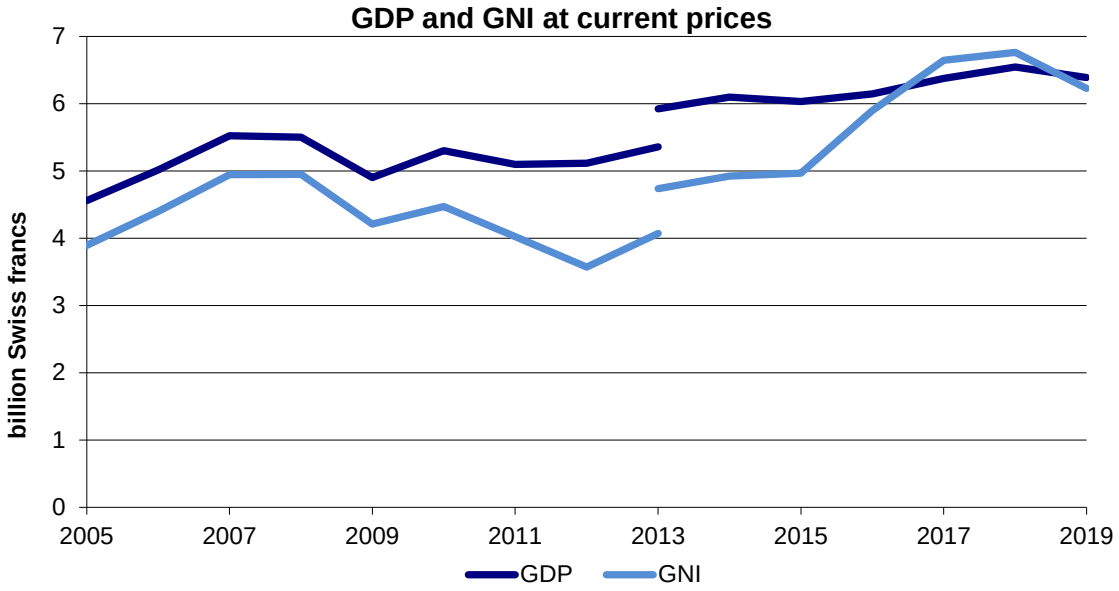


Figure 2-3 GDP and GNI at current prices 2005–2019; break in series in 2013 due to the changeover from ESA95 to ESA2010 (European System of Accounts). (OS 2021, NatAccounts)

Figure 2-4 shows the development of GDP per employed person (in full-time equivalents) and GNI per inhabitant. In 2019, GDP per employed person was 186,900 Swiss francs and GNI per inhabitant was 161,600 Swiss francs. A distinctive feature of the Liechtenstein GDP is that it derives to a considerable extent from the work done by working personnel domiciled abroad. In 2019, 56% of people at work in Liechtenstein were cross-border commuters from abroad. For this reason, it is not informative to calculate per capita GDP based on inhabitants. This would yield misleading results in comparison with other countries.

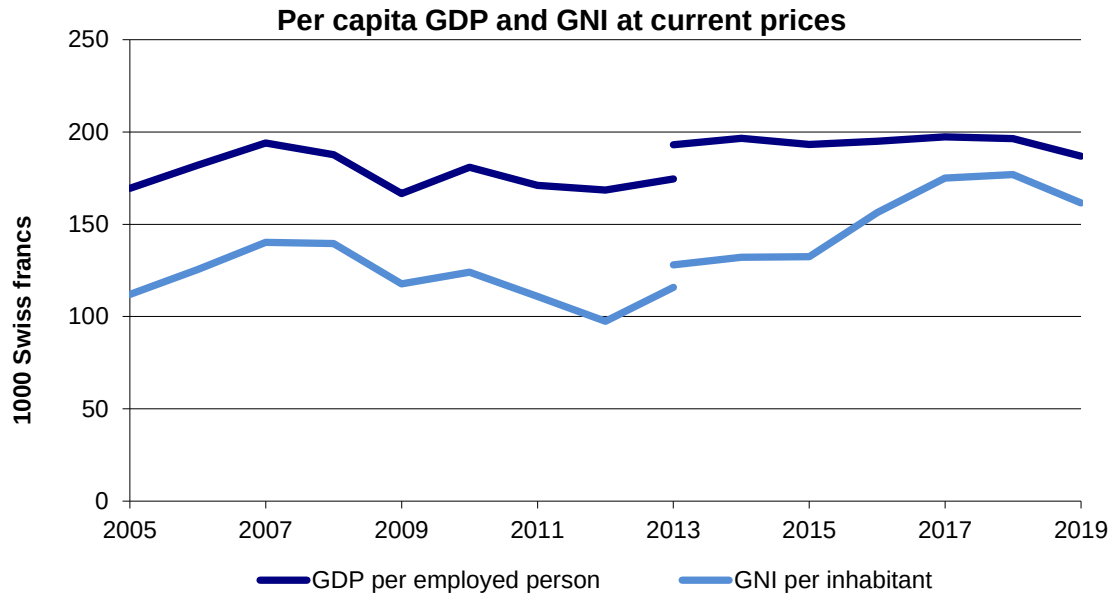


Figure 2-4 GDP at current prices per employed person (in full-time equivalents) and GNI at current prices per inhabitant 2005–2019; break in series in 2013 due to the changeover from ESA95 to ESA2010 (European System of Accounts). (OS 2021, NatAccounts)

2.6 Energy

2.6.1 Energy supply

Liechtenstein has no fossil fuel resources of its own and imports a large share of its energy. In 2020, 13% of total final energy used was sourced domestically. A slightly higher share of electricity, 26%, was produced in Liechtenstein. Liechtenstein's own supply of energy is limited to firewood, waste heat, solar thermal heat and electricity (hydroelectric power plants, photovoltaic systems, and combined heat and power (CHP) plants using biogas and natural gas).

Total final energy consumption in 2021 was 1,235 GWh (4,450 TJ), up from 1,194 GWh in 2020. Natural gas (22%) and electricity (34%) constitute the greatest share of total consumption (see Figure 2-5).

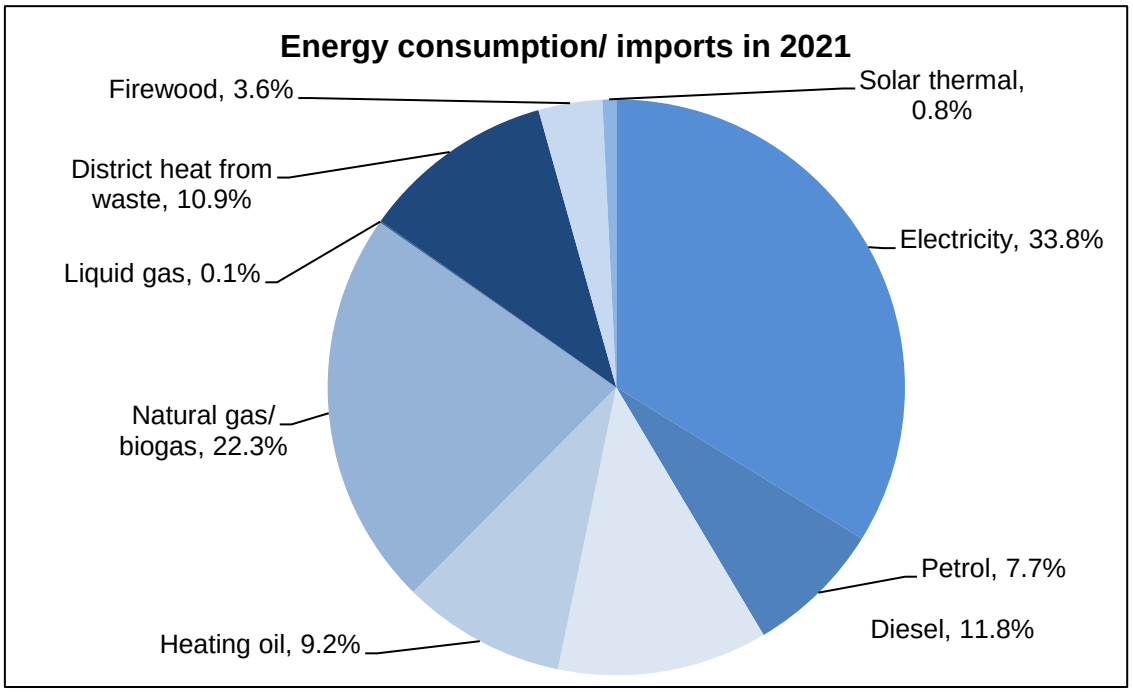


Figure 2-5 Total final energy consumption/ by source in 2021. (OS 2022, EnergyStat)

In 2021, total energy consumption per capita reached 31.4 MWh, down from 30.6 MWh/cap in 2020. Figure 2-6 illustrates energy consumption per inhabitant between 1985 and 2021. Over the last ten years, energy consumption per capita showed a decreasing trend.

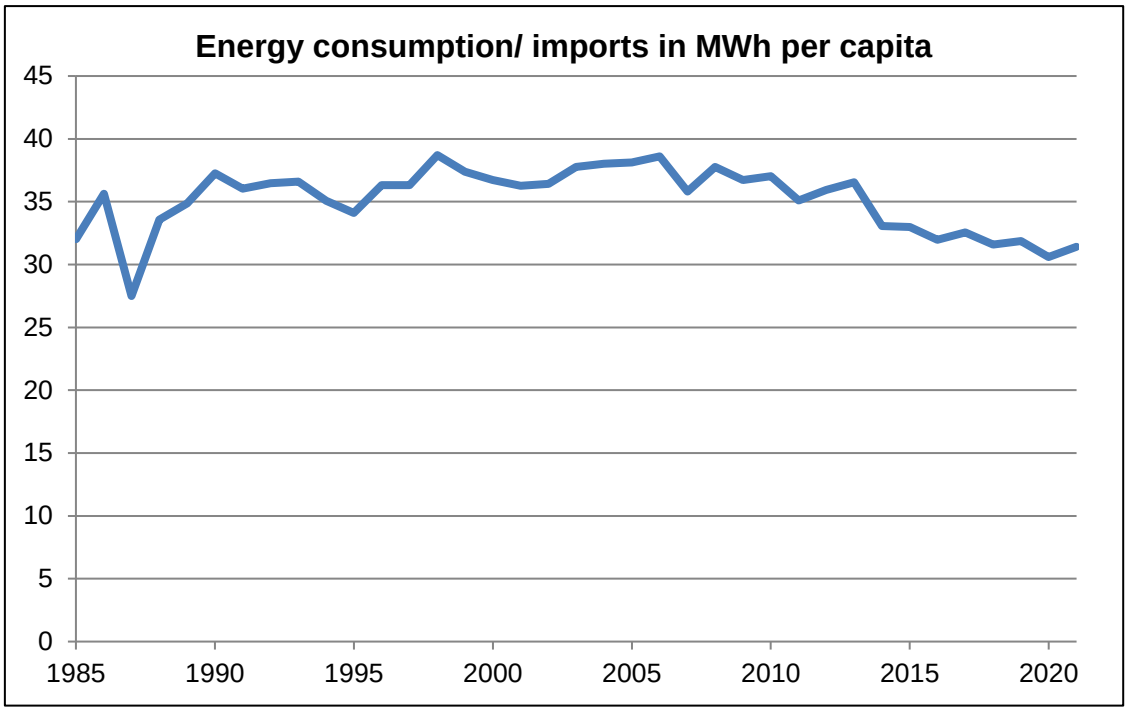


Figure 2-6 Energy consumption/ imports per capita 1985–2021. (OS 2022, EnergyStat)

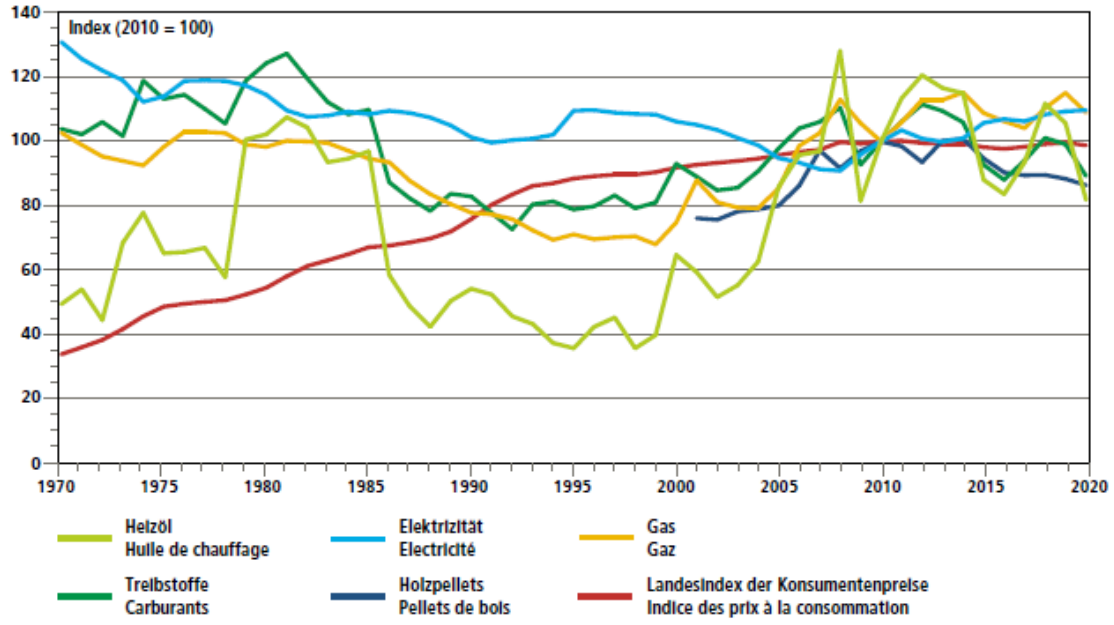
2.6.2 Energy prices

Liechtenstein does not compile its own statistics on the development of energy prices; however, energy prices are comparable to those in Switzerland. Figure 2-7 illustrates the development of real energy prices for the most important energy sources – electricity, natural gas, fuels and heating oil – in Switzerland between 1970 and 2020.

Prices for heating oil reached a historic low in the mid-1990s. Real prices of heating oil then increased from 2000 and have been stagnant, though fluctuating, since 2007.

The development of the real energy prices of petrol and natural was similar, but less pronounced, with an increase between the mid-1990s and 2008 and flat but fluctuating since then.

In contrast to the other energy sources, real electricity prices decreased slightly between the mid-90s and 2008, the increased in the following years. In 2020 the real price of electricity was similar to the 1995 level.



Translation: Heizöl=heating oil; Elektrizität=electricity; Gas=natural gas; Treibstoffe=fuels; Holzpellets=wood pellets; Landesindex der Konsumentenpreise=consumer price index

Figure 2-7 Real energy prices of the most important energy sources 1970–2020, Index 2010=100 (SFOE 2021)

2.6.3 Electricity

In 2021, 418 GWh of electricity were fed into the national grid. About three quarters (74%) of the electricity consumed in Liechtenstein is imported. Liechtenstein's own production amounted to approximately 107 GWh in 2021, up from 104 GWh in 2020, from hydroelectric plants, CHP plants, and photovoltaic systems.

2.7 Transport

The most important transport network in Liechtenstein is the road network. The only railway is a 9 km long route crossing the country from Feldkirch (Austria) to Buchs (Switzerland), operated by the Austrian Federal Railways (ÖBB). Public transport is ensured by a dense network of buses. On the Swiss side of the Liechtenstein border, there is a motorway.

Over the last thirty years, the number of motor vehicles in Liechtenstein has almost doubled. In 2021, a total of 30,538 automobiles were registered (2020: 30,434), corresponding to a degree of motorisation of around 777 automobiles per 1000 inhabitants. Figure 2-8 illustrates the development of the number of vehicles between 1970 and 2021.

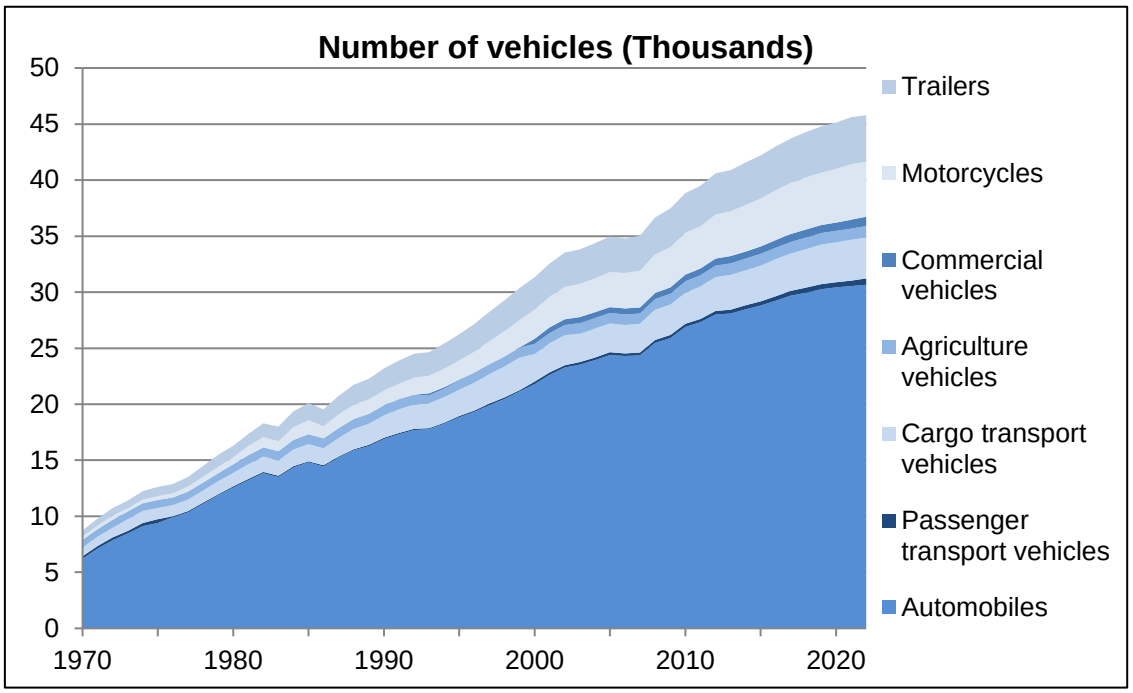


Figure 2-8 Number of vehicles 1970–2021. (OS 2021, VehicleStock)

Pursuant to decision 1753/2000/EC, which has been incorporated into the EEA Agreement, Liechtenstein is required to determine the average CO_2 emissions of automobiles newly introduced into circulation each year.

Liechtenstein also has committed to following the path established by Regulation (EC) 443/2009, which sets emission performance standards for new passenger cars. The Regulation's had a stated target for 2015 of an average CO^- emissions value for new passenger cars of 130 gCO_2/km. From 2020 onwards this Regulation sets a target of 95 gCO_2/km. The Liechtenstein fleet is not yet reaching these targets, although the strong uptake of electric and hybrid vehicles in the last two years may start to change the trend.

The average CO_2 emissions of *all* vehicles newly introduced into circulation was 106 gCO_2/km in 2021, compared to 190 g CO_2/km in 2008 (2020: 136 g CO_2/km). The emissions of *petrol* vehicles were 157 CO_2g/km (2020: 166 g CO_2/km), slightly lower on average than the 161 g CO_2/km (2020: 160 g CO_2/km) emitted by *diesel* vehicles. CO_2 emissions rise with increasing engine sizes, engine power, and vehicle weight. (OS 2022, VehicleReg) In the past years, most of the technically achieved reductions in CO_2 emissions have been cancelled out by the larger and more powerful engines and heavier vehicles that continue to be popular (see Figure 2-9). However, the proportion of fuel efficient, light vehicles rises and also the number of vehicles with alternative fuels (natural gas, hybrid, electric) has begun to increase markedly, a trend which appears to continue in 2022.

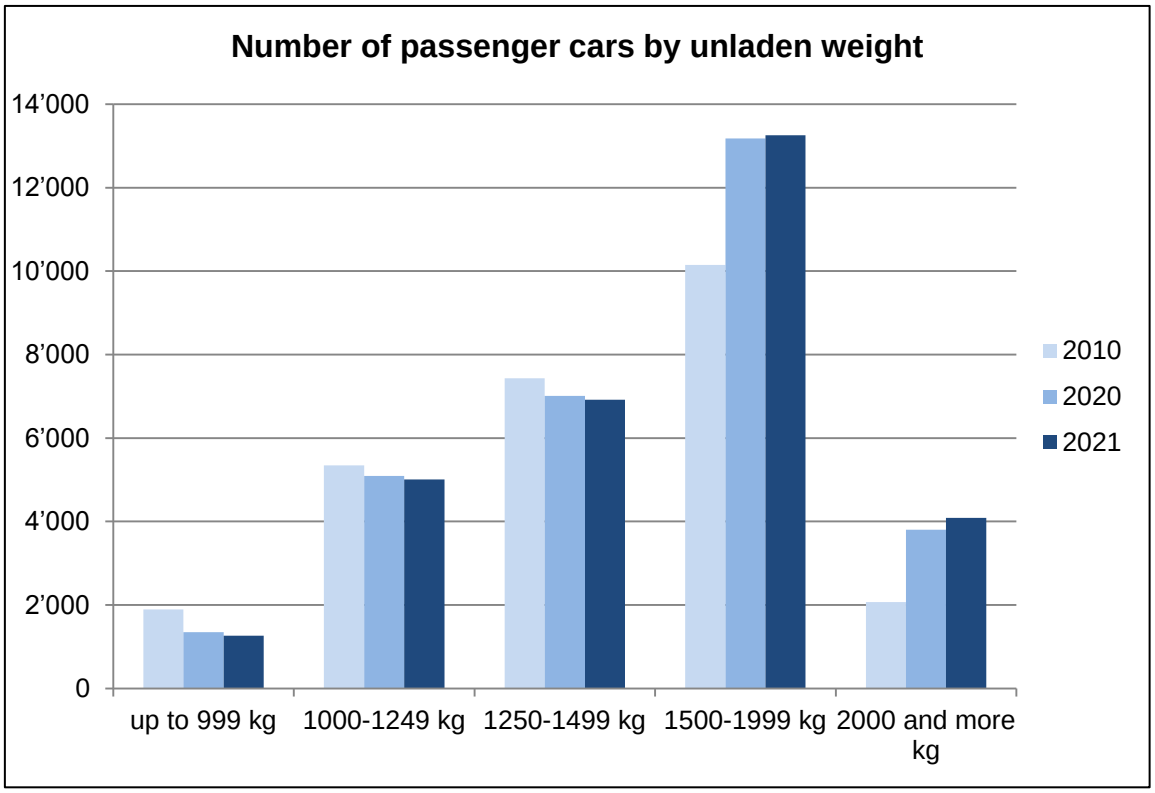


Figure 2-9 Number of passenger cars by unladen weight 2010, 2020 and 2021. (OS 2021, VehicleStock)

2.8 Industry

Liechtenstein's economy has a significant emphasis on industrial production. In 2020, the industry sector provided 36.1% of employment (OS 2021, EmploymentStat), which is, in comparison with other European countries, extraordinarily high. The most important industrial branches are mechanical engineering, electrical machinery, vehicle components, dental technology, food products as well as construction work.

Due to Liechtenstein's limited domestic market, especially the larger enterprises are heavily export-oriented. A vast majority of their manufactured goods is sold abroad. The most important export countries of Liechtenstein's industry sector are Switzerland, Germany and the USA.

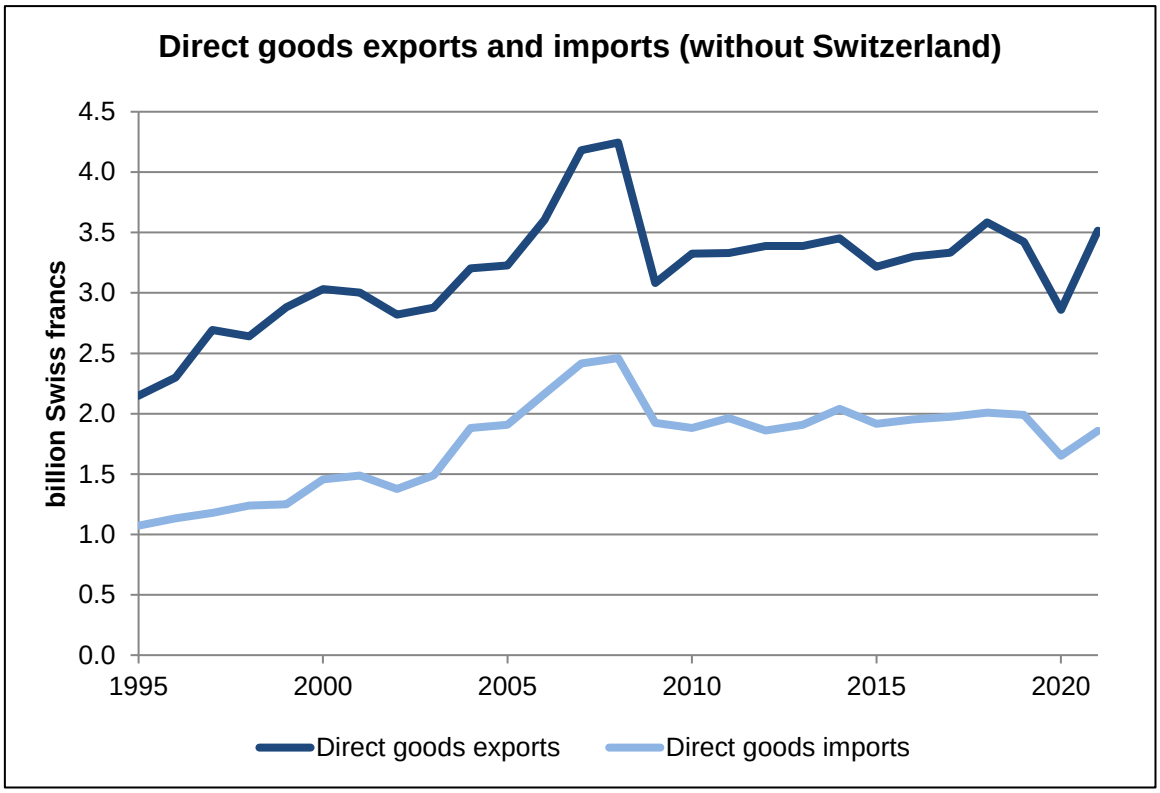


Figure 2-10 Direct goods imports and exports since 1995 in billion Swiss francs. Exchange of goods with Switzerland is not included. (OS 2022, TradeStat)

2.9 Waste

The vast majority (~90% by weight) of waste produced in Liechtenstein is inert waste from the construction sector which does not produce emissions. Households are responsible for most of the remaining 10% of waste, but none of this is landfilled: Half of all residential waste is collected for recycling, a quarter is organic waste which is composted where possible, and the remaining quarter is incinerated across the border in Switzerland. The waste incineration plant delivers energy (heat and steam) back to Liechtenstein. The dominant source of emissions in the sector is therefore sewage sludge, which constitutes around less than 0.5% of total waste by weight.

After the introduction of fees on municipal waste along the 'polluter-pays' principle in 1994 residential waste production per capita declined temporarily, then rebounded by the turn of the millennium (see Figure 2-11). There are no managed waste disposal sites in Liechtenstein. There are three landfill sites which are managed (e.g. sealing, control of water quality), but they operate exclusively for inert materials and therefore do not cause any greenhouse gas emissions. The amount of landfill volume fluctuates strongly depending on building activities and market conditions.

The transition from "landfilling in the country" to "exporting MSW and industrial waste" to Switzerland for incineration started during the 1960s and was concluded in 1974, when the last municipality in the country stopped landfilling. Before 1974, some waste (municipal and other) was landfilled along the river Rhine in sandy soils which were not suitable for agriculture. In the year 1998, those sites were recorded in a 'contaminated site register'. About 20 of all registered contaminated sites are from waste dumping. They are not managed (they are not really "landfills" but rather "contaminated sites"). No landfill gas was collected for flaring or energy recovery.

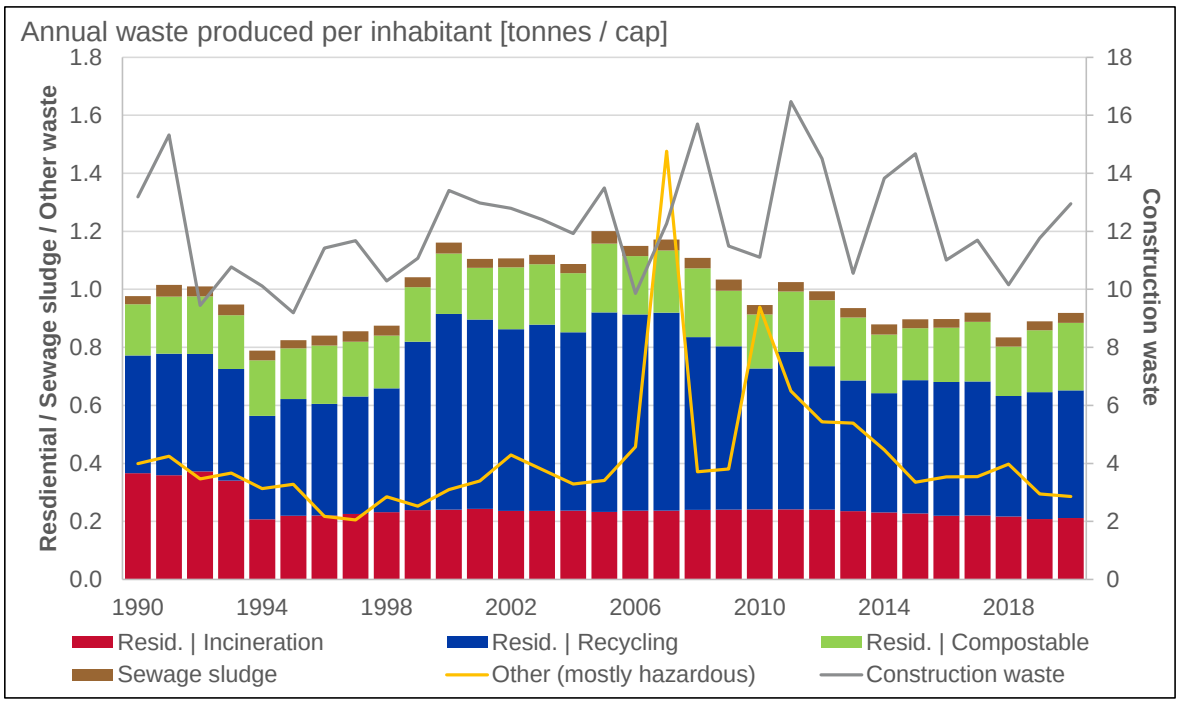


Figure 2-11 Development of waste volumes per capita with treatment paths since 1990. (OS 2021, EnvStat)

2.10 Building stock and urban structure

Between 1984 and 2014 Liechtenstein's settlement area increased by 503 hectares (40.0%) to 17.6 km^2 or 11% of the country's total area. Transport infrastructure covered 2.8% of the country's area in 2014. 4.0% of the country's area were living area. The number of residential buildings increased to 10,870 by 2020, up from 6,044 in 1980. (OS 2021, BuildingStat)

2.11 Agriculture and Forestry

The country covers 160 km^2, 42% of which is forested, 33% agricultural (cropland, pastures, plantations, alp meadows), 11% populated, and 15% unproductive (as of the end of 2014).[10] Between 1984 and 2014 the agricultural area decreased from 58.3 km^2 to 52.3 km^2. (OS 2021, EnvStat)

The abovementioned data (sections 2.10 and 2.11) originate from Liechtenstein's Land-use statistics from 2014 (published in the Environment statistics 202015) and from Liechtenstein's Buildings and dwellings statistics 2020 (OS 2021, EnvStat; OS 2021, BuildingStat)

[10] The numbers are rounded so that the sum might be higher than 100%.

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3 GHG Inventory information

3.1 Summary tables

Summary tables of the national greenhouse gas inventory in the common reporting format are provided in Annex 1.

3.2 Descriptive summary

3.2.1 Methodologies and data sources

GHG inventory

The emissions are mainly calculated based on the standard methods and procedures of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) as adopted by the UNFCCC in its Decision 24/CP.19 (UNFCCC 2014).

The emissions are modelled using country-specific activity data (AD). Country-specific emission factors are applied if available, otherwise default emission factors from the IPCC are used. For the majority of emission sources, emission factors are adopted from the Swiss GHG inventory after checking their applicability. As outlined in section 2, there is a very close relationship between Liechtenstein and Switzerland based on the Customs Treaty between the two countries (see section 2.1.7). **Therefore, a number of emission factors are adopted from Switzerland assuming that the Swiss emission factors actually represent the emission standards more accurately than default emission factors. In these cases, the emission factors are also reported as country-specific.** This assumption especially holds for:

- the energy sector, due to the same fuel quality standards, and regulations and standards for exhaust gases of combustion and motor vehicles
- the emission of F-Gases, due to similar product mixes and consumer attitudes
- agricultural emissions, due to similar stock farming and cultivation of land
- the sector LULUCF, due to similar geographic, meteorological and climatic circumstances for forestry, cropland, grassland and wetlands

In the following paragraphs, a short summary of the methods used is given for each sector.

1 Energy

- Emissions from 1A Fuel combustion: AD is taken from the National Energy Statistics (including consistency modifications) and from the census for the fuel sales of gasoline and diesel oil. The methods are country-specific.
- Emissions from 1B Fugitive emissions from fuels: The Swiss method (i.e., emission factors) is applied with country-specific AD for Liechtenstein.

2 Industrial processes and product use

- HFC and PFC emissions from 2F1 Refrigeration and air conditioning are reported and calculated by scaling Swiss emissions to Liechtenstein using country-specific AD (e.g. number of inhabitants).
- SF_6 emissions from 2G1 Electrical equipment are reported based on country-specific data.
- N_2O emissions from 2G3 Product uses are reported by scaling Swiss emissions using country-specific AD (number of inhabitants). The same method is applied for CO and NMVOC emissions from 2D3b Road paving with asphalt and 2D3c Asphalt roofing and for CO_2 emissions from 2D1 lubricant.
- Other emissions from industrial processes and product use are not occurring.

3 Agriculture

- Emissions are reported for 3A Enteric fermentation, 3B Manure management, 3D Agricultural soils and 3H urea application by applying Swiss methods (country-specific) combined with Liechtenstein specific AD as far as available.

4 LULUCF

- Emissions and removals are reported for 4A to 4G, 4(III) and 4(IV). Most of the methods and the emission factors are adopted from Switzerland, for forest land also country-specific data from Liechtenstein's National Forest Inventory are used.

5 Waste

- Emissions for 5A Solid waste disposal, 5B Biological treatment of solid waste and 5D Wastewater treatment and discharge are estimated according to IPCC (2006) with country-specific AD.
- For emissions for 5C Incineration and open burning of waste a country-specific method is used, based on CORINAIR, adapted from the Swiss NIR (FOEN 2021).

3.2.2 Brief Description of Key Categories

The key category analysis (KCA) is performed based on the automatic KCA implemented in the CRF Reporter Software. The software indicates for every source and sink category whether it is key or not (CRF Table7). The method corresponds to an Approach 1 level and trend assessment methodology with the proposed threshold of 95% as recommended by the 2006 IPCC Guidelines (IPCC 2006). The analyses lead to four results (for the latest inventory submission):

- Base year 1990 level assessment without LULUCF categories
- Base year 1990 level assessment with LULUCF categories
- Reporting year 2020 level and trend assessment without LULUCF categories
- Reporting year 2020 level and trend assessment with LULUCF categories

For every source and sink category identified as key, the corresponding emission or sink is attributed. The data of the four analyses is shown in Table 3-1 to Table 3-4.

An Approach 2 level and trend assessment has not been carried out in the current submission. The identified key categories and especially new key categories are analysed in more detail in order to identify the reasons for the category being key as well as possible needs for improvement.

3.2.2.1 GHG Inventory

KCA excluding LULUCF categories

For 2020, among a total of 196 categories (excluding LULUCF categories), eleven have been identified as Approach 1 key categories by the CRF Reporter Software (see CRF Table7 of the reporting tables) with an aggregated contribution of 96.4% of the national total emissions (see Table 3-1). Ten categories are key categories according to level assessment and nine according to trend assessment.

Within those eleven key categories, seven stem from the energy sector, contributing 79.3% to total CO_2 equivalent emissions in 2020. The other key categories are from the sectors Agriculture (three categories, contribution 12%) and Industrial Processes and Product Use IPPU (one category, contribution 5%).

The three major sources, all from the energy sector, sum up to a contribution of 64.9% of the total national emissions:

- 1A3b Road transportation, CO_2
- 1A4 Other sectors, gaseous fuels, CO_2
- 1A4 Other sectors, liquid fuels, CO_2

Compared to newest inventory year of the previous submission (reporting year 2019), no changes have occurred in the KCA for the reporting year 2020 of the current submission.

Table 3-1 List of Liechtenstein's Approach 1 key categories 2020 excluding LULUCF. Sorted by share of total emissions.

Key Category Analysis 2020 (excluding LULUCF) **IPCC Source Categories (and fuels, if applicable)**	GHG	Emissions 2020 [kt CO2eq]	Share of Total Emissions	Cumulative Total	Result of Assessment
1.A.3.b Road Transportation	CO2	52.15	29.0%	29.0%	KC Level, KC Trend
1.A.4 Other Sectors - Gaseous Fuels	CO2	34.30	19.1%	48.1%	KC Level, KC Trend
1.A.4 Other Sectors - Liquid Fuels	CO2	30.09	16.7%	64.9%	KC Level, KC Trend
3.A Enteric Fermentation	CH4	14.42	8.0%	72.9%	KC Level, KC Trend
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	11.62	6.5%	79.4%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	11.16	6.2%	85.6%	KC Level, KC Trend
2.F.1 Refrigeration and Air conditioning	F-gases	8.97	5.0%	90.6%	KC Level, KC Trend
3.D.1 Direct N2O Emissions From Managed Soils	N2O	4.45	2.5%	93.0%	KC Level, KC Trend
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2.41	1.3%	94.4%	KC Level, KC Trend
3.B Manure Management	CH4	2.77	1.5%	95.9%	KC Level
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH4	0.78	0.4%	96.4%	KC Trend

For the base year 1990, the level key category analysis is given in Table 3-2 below. There are eight level key categories. There are no changes compared to the KCA of the previous submission.

Table 3-2 List of Liechtenstein's Approach 1 key categories in 1990 excluding LULUCF. Sorted by share of total emissions.

Key Category Analysis 1990 (excluding LULUCF) **IPCC Source Categories (and fuels, if applicable)**	GHG	Emissions 1990 [kt CO_2eq]	Share of Total Emissions	Cumulative Total	Result of Assessment
1.A.4 Other Sectors - Liquid Fuels	CO2	76.71	33.6%	33.6%	KC Level
1.A.3.b Road Transportation	CO2	75.29	33.0%	66.5%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	20.99	9.2%	75.7%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	15.20	6.7%	82.4%	KC Level
3.A Enteric Fermentation	CH4	13.92	6.1%	88.5%	KC Level
1.A.4 Other Sectors - Gaseous Fuels	CO2	10.21	4.5%	92.9%	KC Level
3.D.1 Direct N2O Emissions From Managed Soils	N2O	4.72	2.1%	95.0%	KC Level
3.B Manure Management	CH4	2.93	1.3%	96.3%	KC Level

KCA including LULUCF categories

According to the 2006 IPCC Guidelines (IPCC 2006), the key category analysis including LULUCF categories is conducted on the full GHG inventory in order to identify additional key categories. The KCA including LULUCF categories is performed as an automatic approach by the CRF Reporter.

The Approach 1 key category analysis for the year 2020 including LULUCF categories consists of a total of 223 categories, of which 17 are key categories (see Table 3-3). Five categories are identified as key from the LULUCF sector and contribute with a total of 8.5% to total emissions:

- 4A1 Forest land remaining forest land, CO_2
- 4B1 Cropland remaining cropland, CO_2
- 4C2 Land converted to grassland, CO_2
- 4E2 Land converted to settlements, CO_2
- 4G Harvested wood products, CO_2

Additionally, one category from the agriculture sector is key when performing the KCA for the full inventory (including LULUCF categories):

- 3B Manure management, N_2O

Compared to the newest inventory year of the previous submission (reporting year 2019), the following changes have occurred in the KCA for the reporting year 2020 of the current submission:

- 1A3b Road Transportation (CH_4) is not a (trend) key category anymore
- 3B Manure Management (N_2O) is—in addition to level—newly also a key category according to trend assessment
- 3D2 Indirect N_2O emissions from managed soils is not a (level) key category anymore
- 4A1 Forest Land Remaining Forest Land (CO_2) is—in addition to trend—newly also a key category according to level assessment
- 4E2 Land Converted to Settlements (CO_2) is—in addition to level—newly also a key category according to trend assessment
- 4F2 Land Converted to Other Land (CO_2) is not a (trend) key category anymore

In the KCA 1990 including LULUCF categories, three key categories contributing 4.0% to total emissions are identified from the LULUCF sector (see Table 3-4):

- 4B1 Cropland remaining cropland, CO_2
- 4E2 Land converted to settlements, CO_2
- 4G Harvested wood products, CO_2

Table 3-3 List of Liechtenstein's Approach 1 key categories 2020 including LULUCF. Sorted by share of total emissions.

Key Category Analysis 2020 (including LULUCF) **IPCC Source Categories (and fuels, if applicable)**	GHG	Emissions 2020 abs. values [kt CO2eq]	Share of Total Emissions	Cumulative Total	Result of Assessment
1.A.3.b Road Transportation	CO2	52.15	26.1%	26.1%	KC Level, KC Trend
1.A.4 Other Sectors - Gaseous Fuels	CO2	34.30	17.1%	43.2%	KC Level, KC Trend
1.A.4 Other Sectors - Liquid Fuels	CO2	30.09	15.0%	58.2%	KC Level, KC Trend
3.A Enteric Fermentation	CH4	14.42	7.2%	65.4%	KC Level, KC Trend
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	11.62	5.8%	71.2%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	11.16	5.6%	76.8%	KC Level, KC Trend
2.F.1 Refrigeration and Air conditioning	F-gases	8.97	4.5%	81.3%	KC Level, KC Trend
4.A.1 Forest Land Remaining Forest Land	CO2	7.79	3.9%	85.2%	KC Level, KC Trend
3.D.1 Direct N2O Emissions From Managed Soils	N2O	4.45	2.2%	87.4%	KC Level, KC Trend
4.B.1 Cropland Remaining Cropland	CO2	3.94	2.0%	89.4%	KC Level, KC Trend
3.B Manure Management	CH4	2.77	1.4%	90.8%	KC Level
4.E.2 Land Converted to Settlements	CO2	2.69	1.3%	92.1%	KC Level, KC Trend
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2.41	1.2%	93.3%	KC Level, KC Trend
4.C.2 Land Converted to Grassland	CO2	2.35	1.2%	94.5%	KC Level, KC Trend
3.B Manure Management	N2O	1.56	0.8%	95.3%	KC Level, KC Trend
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH4	0.78	0.4%	95.7%	KC Trend
4.G Harvested Wood Products	CO2	0.18	0.1%	95.8%	KC Trend

Table 3-4 List of Liechtenstein's Approach 1 key categories 1990 including LULUCF. Sorted by share of emissions.

Key Category Analysis 1990 (including LULUCF) **IPCC Source Categories (and fuels, if applicable)**	GHG	Emissions 1990 abs. values [kt CO_2eq]	Share of Total Emissions	Cumulative Total	Result of Assessment
1.A.4 Other Sectors - Liquid Fuels	CO2	76.71	31.7%	31.7%	KC Level
1.A.3.b Road Transportation	CO2	75.29	31.1%	62.9%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	20.99	8.7%	71.6%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	15.20	6.3%	77.9%	KC Level
3.A Enteric Fermentation	CH4	13.92	5.8%	83.6%	KC Level
1.A.4 Other Sectors - Gaseous Fuels	CO2	10.21	4.2%	87.8%	KC Level
3.D.1 Direct N2O Emissions From Managed Soils	N2O	4.72	2.0%	89.8%	KC Level
4.B.1 Cropland Remaining Cropland	CO2	4.18	1.7%	91.5%	KC Level
3.B Manure Management	CH4	2.93	1.2%	92.7%	KC Level
4.E.2 Land Converted to Settlements	CO2	2.82	1.2%	93.9%	KC Level
4.G Harvested Wood Products	CO2	2.69	1.1%	95.0%	KC Level
3.D.2 Indirect N2O Emissions From Managed Soils	N2O	1.90	0.8%	95.8%	KC Level

3.2.2.2 KP-LULUCF inventory

Liechtenstein identified four key categories for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol (Afforestation, Deforestation, Forest Management and Harvested Wood Products). The approach relies on full inventory KCA (with LULUCF), KP-CRF association and qualitative assessment. More information on this is available in Liechtenstein's national inventory report 2022 (OE 2022).

3.2.3 Trends in greenhouse gas emissions and removals

This section provides an overview of Liechtenstein's GHG emissions and removals as well as their trends in the period 1990–2020 (information from the national inventory report, OE 2022).

3.2.3.1 Aggregated greenhouse gas emissions 2020

Liechtenstein's greenhouse gas emissions in the year 2020 amount to 179.7 kt CO_2 equivalent (CO_2eq) excluding LULUCF sources or sinks (including LULUCF: 184.5 kt CO_2eq). This refers to 4.60 t CO_2eq per capita.

Total emissions in 2020 (excl. LULUCF) have declined by 21.4% compared to 1990. Compared to 2019, they decreased by 4.3%. When including LULUCF categories, total emissions decreased by 7.8% between 2019–2020 and by 21.8% between 1990–2020.

Among the different greenhouse gases, CO_2 accounts for the largest share of total emissions.

Table 3-1 shows the emissions for individual gases and sectors in Liechtenstein for the year 2020. The most important emission sources are fuel combustion activities in the Energy sector. Emissions of CH_4 and N_2O mainly originate from the sector Agriculture, and F-Gas emissions stem from the sector 2 Industrial processes and product use (IPPU) by definition. The table also provides information about international bunkers.

Table 3-5 Summary of Liechtenstein's GHG emissions in 2020 by gas and sector in CO_2eq (kt). Numbers may not add to totals due to rounding.[11]

Emissions 2020	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (kt)						
1 Energy	141.8	1.19	0.94	-	-	-	144.0
2 IPPU	0.12	NO	0.14	9.1	0.00	0.05	9.4
3 Agriculture	0.04	17.18	7.44	-	-	-	24.7
5 Waste	0.01	0.94	0.66	-	-	-	1.60
Total (excluding LULUCF)	**142.0**	**19.3**	**9.19**	**9.1**	**0.00**	**0.05**	**179.7**
4 LULUCF	4.4	NO	0.39	-	-	-	4.8
Total (including LULUCF)	**146.4**	**19.3**	**9.6**	**9.1**	**0.00**	**0.05**	**184.5**
International Bunkers	*0.93*	*0.0002*	*0.01*	-	-	-	*0.94*

A breakdown of Liechtenstein's total emissions by gas is shown in Figure 3-1 below. Figure 3-2 shows the contributions of each sector to the different greenhouse gases.

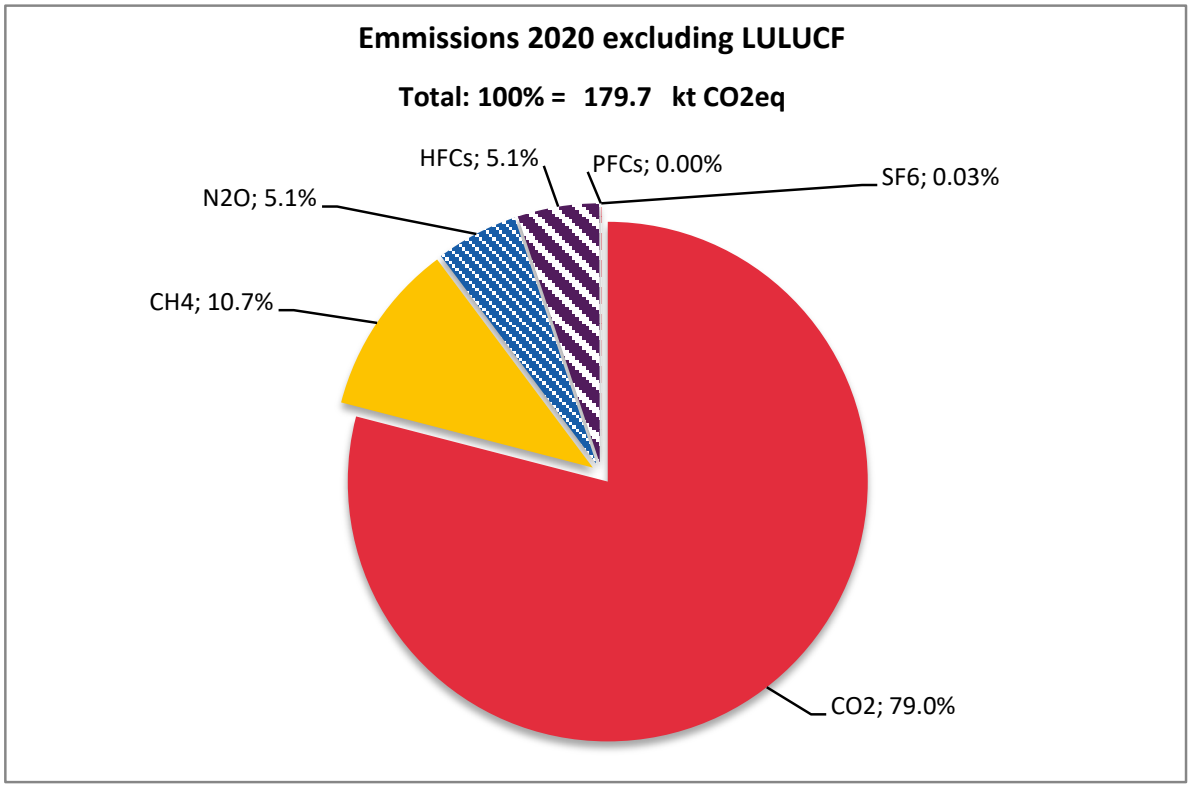

Figure 3-1 Liechtenstein's GHG emissions by gases excluding LULUCF emissions in 2020.

[11] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data shown here are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

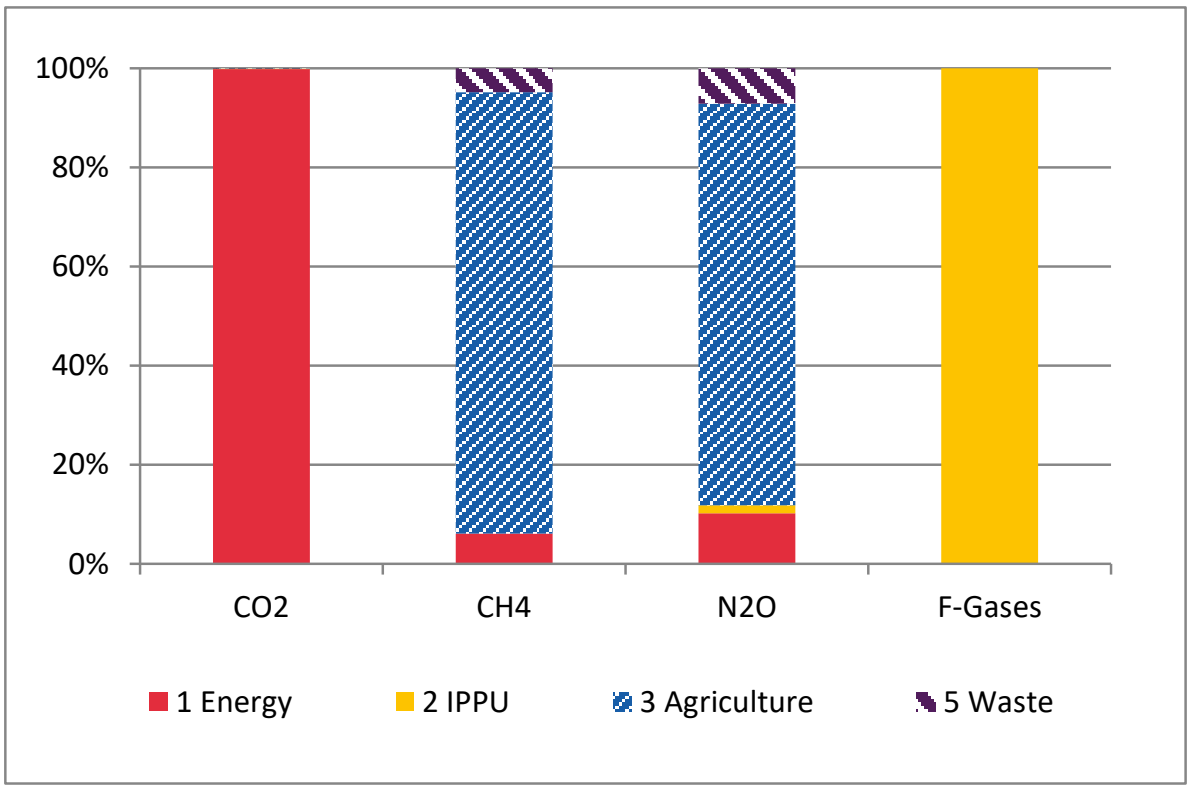

Figure 3-2 Relative contributions of the individual sectors (excluding LULUCF) to GHG emissions in 2020.

3.2.3.2 Emission trends by gas

Emission trends 1990–2020 by gas are summarised in Table 3-6 and in Figure 3-3.

Table 3-6 Summary of Liechtenstein's GHG emissions in CO_2eq (kt) by gas, 1990–2020. The last column shows the percentage change in emissions in 2020 as compared to the base year 1990. HFC emissions have increased by about a factor of 86,000 in 2020 compared to 1990.[12]

Greenhouse Gas Emissions	**1990**	**1995**	**2000**	**2005**	**2010**
	CO_2 equivalent (kt)				
CO_2 emissions incl. net CO_2 from LULUCF	206.2	209.2	241.7	238.0	211.4
CO_2 emissions excl. net CO_2 from LULUCF	199.0	204.2	216.9	229.0	190.8
CH_4 emissions incl. CH_4 from LULUCF	19.2	17.9	16.7	18.5	19.0
CH_4 emissions excl. CH_4 from LULUCF	19.2	17.9	16.7	18.5	19.0
N_2O emissions incl. N_2O from LULUCF	10.6	10.5	9.8	9.5	9.7
N_2O emissions excl. N_2O from LULUCF	10.3	10.2	9.5	9.1	9.3
HFCs	0.0	1.2	3.9	6.7	9.0
PFCs	NO	0.0	0.0	0.1	0.1
SF_6	NO	NO	0.1	0.3	0.0
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
NF_3	NO	NO	NO	NO	NO
Total (including LULUCF)	236.0	238.9	272.1	273.0	249.2
Total (excluding LULUCF)	228.5	233.5	247.0	263.6	228.2

Greenhouse Gas Emissions	**2011**	**2012**	**2013**	**2014**	**2015**
	CO_2 equivalent (kt)				
CO_2 emissions incl. net CO_2 from LULUCF	201.1	209.9	209.7	178.3	171.6
CO_2 emissions excl. net CO_2 from LULUCF	176.8	185.3	192.5	161.3	159.8
CH_4 emissions incl. CH_4 from LULUCF	19.4	19.8	19.0	19.2	19.0
CH_4 emissions excl. CH_4 from LULUCF	19.4	19.8	19.0	19.2	19.0
N_2O emissions incl. N_2O from LULUCF	10.1	10.0	9.6	9.6	9.6
N_2O emissions excl. N_2O from LULUCF	9.7	9.5	9.2	9.1	9.2
HFCs	9.4	9.8	9.8	10.0	10.1
PFCs	0.1	0.0	0.0	0.0	0.0
SF_6	0.0	0.0	0.2	0.1	0.0
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
NF_3	NO	NO	NO	NO	NO
Total (including LULUCF)	**240.1**	**249.5**	**248.3**	**217.2**	**210.4**
Total (excluding LULUCF)	**215.3**	**224.5**	**230.7**	**199.7**	**198.1**

Greenhouse Gas Emissions	**2016**	**2017**	**2018**	**2019**	**2020**	**1990-2020**
	CO_2 equivalent (kt)					**%**
CO_2 emissions incl. net CO_2 from LULUCF	159.8	167.1	164.9	161.0	146.4	-29.0%
CO_2 emissions excl. net CO_2 from LULUCF	149.8	155.8	143.0	149.0	142.0	-28.6%
CH_4 emissions incl. CH_4 from LULUCF	19.1	18.6	18.9	19.6	19.3	0.4%
CH_4 emissions excl. CH_4 from LULUCF	19.1	18.6	18.9	19.6	19.3	0.4%
N_2O emissions incl. N_2O from LULUCF	9.4	9.4	9.6	9.7	9.6	-9.4%
N_2O emissions excl. N_2O from LULUCF	9.0	9.0	9.2	9.3	9.2	-10.5%
HFCs	9.8	10.0	10.2	9.7	9.1	see caption
PFCs	0.0	0.0	0.0	0.0	0.0	-
SF_6	0.0	0.0	0.1	0.0	0.1	-
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	-
NF_3	NO	NO	NO	NO	NO	-
Total (including LULUCF)	**198.2**	**205.2**	**203.7**	**200.1**	**184.5**	**-21.8%**
Total (excluding LULUCF)	**187.8**	**193.5**	**181.3**	**187.7**	**179.7**	**-21.4%**

[12] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data shown here are based on the CRF Tables

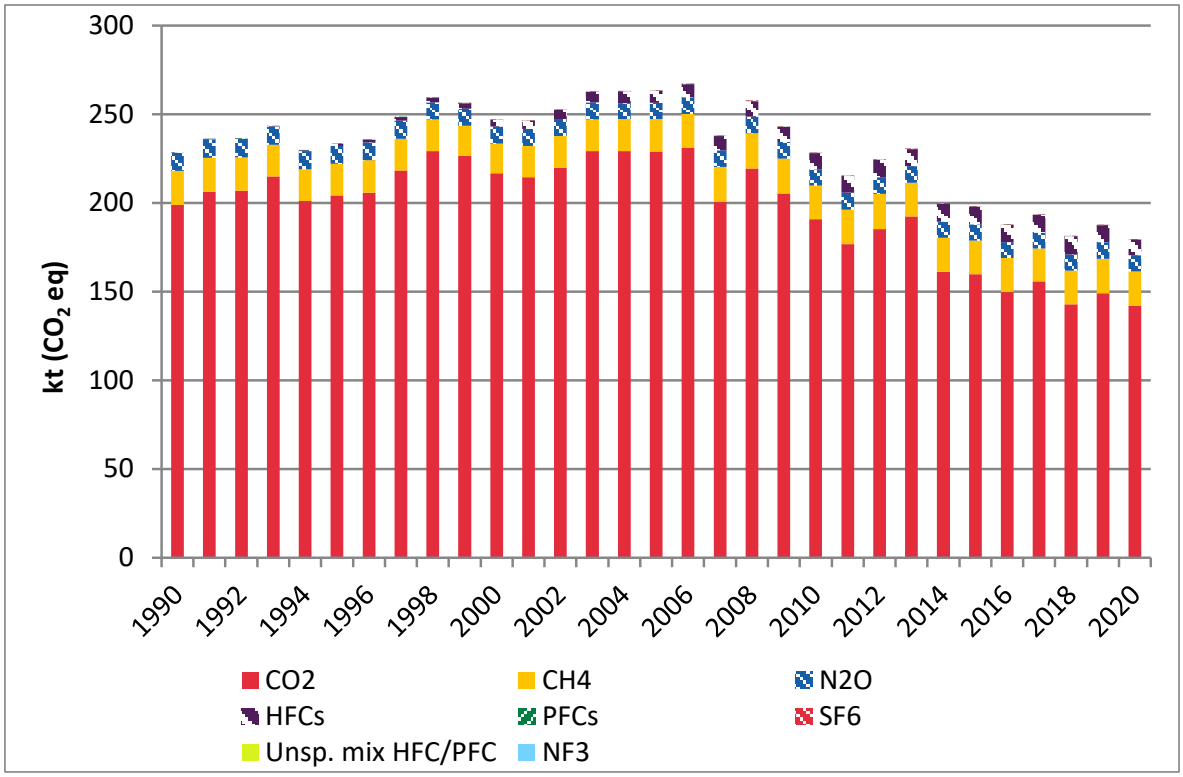

Figure 3-3 Trend of Liechtenstein's greenhouse gas emissions by gases 1990–2020. CO_2, CH_4 and N_2O correspond to the respective total emissions excluding LULUCF. Note that NF_3 emissions are not occurring.

Emission trends for the individual gases can be described as follows:

- Total emissions (in CO_2eq) excluding LULUCF sources or sinks decreased by 21.4% from 1990 to 2020.
- Total emissions (in CO_2eq) including LULUCF show a decrease of 21.8% in 2020 compared to 1990 levels.
- CO_2 emissions (excluding net CO_2 from LULUCF) have declined by 28.6% between 1990 and 2020. In comparison to the previous reporting year 2019, CO_2 emissions (excluding net CO_2 from LULUCF) decreased by 4.7% in 2020. In general, the most important drivers of net CO_2 emissions are fuel prices and winter temperatures (heating degree days), influencing the source categories contributing to a large share of CO_2 emissions under 1A Fuel combustion (1A2 Manufacturing industries and construction, 1A3 Transport and 1A4 Other sectors). The latest developments are also influenced by changes in the CO_2 levy. The share of CO_2 emissions decreased from 87.1% in 1990 to 79.0% in 2020 (excl. LULUCF).
- CH_4 emissions (excluding CH_4 from LULUCF) have increased by 0.4% since 1990. Compared to 2019, CH_4 emissions (excluding LULUCF) show a decrease by 1.3% in 2020. The major reason for the emission development is the variation in numbers of livestock (in particular cattle), which strongly influence CH_4 emissions from enteric fermentation. Livestock numbers have been reduced between 1990–2000 and have increased again since (however, still being below

Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

the 1990 level). The share of CH_4 increased from 8.4% in 1990 to 10.7% in 2020 (excl. LULUCF).

- N_2O emissions (excluding N_2O from LULUCF) have declined by 10.5% in 2020 compared to 1990. Compared to 2019, N_2O emissions (without LULUCF) in 2020 decreased by 1.2%. The main source of N_2O emissions is agriculture (manure management and agricultural soils). The share of N_2O slightly increased from 4.5% (1990) to 5.1% (2020).
- HFC emissions increased due to their role as substitutes for CFCs. SF_6 emissions originate from electrical transformation stations and play a minor role for the total of the synthetic gases (F-Gases). PFC emissions are occurring since 1997 and are increasing on a low level. The share of the sum of all F-Gases (within total emissions excl. LULUCF) increased from 0.00005% (1990) to 5.1% (2020).

3.2.3.3 Emission trends by sector

Table 3-7 shows emission trends for all major source and sink categories. As the largest share of emissions originated from sector 1 Energy, the table shows the contributions of the source categories attributed to it in more detail (1A1-1A5, 1B).

Table 3-7 Summary of Liechtenstein's GHG emissions by source and sink categories in CO_2eq (kt), 1990–2020. The last column shows changes in emissions (%) in 2020 compared to 1990. [13]

Source and Sink Categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (kt)									
1 Energy	**201.3**	**208.9**	**209.7**	**217.9**	**203.9**	**207.1**	**208.9**	**221.5**	**232.3**	**229.7**
1A1 Energy industries	0.2	0.9	1.9	2.0	1.8	2.1	2.6	2.5	2.9	2.9
1A2 Manufacturing ind. & constr.	36.3	35.9	36.3	37.6	35.6	35.7	35.8	37.6	40.3	39.8
1A3 Transport	76.9	90.3	89.6	87.5	80.1	82.1	83.4	87.0	86.7	90.8
1A4 Other sectors	87.6	81.4	81.4	90.3	85.8	86.6	86.5	93.6	101.7	95.4
1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B Fugitive emissions from fuels	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8
2 IPPU	**0.7**	**0.6**	**0.7**	**0.8**	**1.0**	**1.8**	**2.1**	**2.5**	**3.0**	**3.6**
3 Agriculture	**24.9**	**24.9**	**24.2**	**23.1**	**23.3**	**23.1**	**23.3**	**22.9**	**22.5**	**21.5**
5 Waste	**1.7**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**
Total (excluding LULUCF)	***228.5***	***236.0***	***236.2***	***243.4***	***229.7***	***233.5***	***235.8***	***248.4***	***259.4***	***256.4***
4 LULUCF	**7.6**	**-8.1**	**2.8**	**-0.5**	**18.6**	**5.3**	**-2.9**	**8.4**	**0.8**	**-0.3**
Total (including LULUCF)	***236.0***	***228.0***	***239.0***	***242.9***	***248.4***	***238.9***	***232.9***	***256.9***	***260.2***	***256.1***

Source and Sink Categories	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (kt)									
1 Energy	**220.1**	**217.7**	**223.0**	**232.3**	**231.8**	**231.5**	**233.6**	**203.2**	**222.1**	**208.0**
1A1 Energy industries	2.8	2.9	2.5	2.8	3.0	3.1	2.9	2.6	2.9	3.0
1A2 Manufacturing ind. & constr.	36.4	36.4	37.9	41.2	39.8	39.1	40.5	33.9	36.3	27.5
1A3 Transport	91.6	88.2	84.1	83.8	82.2	81.8	79.2	83.4	87.8	81.9
1A4 Other sectors	88.4	89.4	97.6	103.5	105.8	106.3	109.9	82.3	93.9	94.5
1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B Fugitive emissions from fuels	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.2	1.1
2 IPPU	**4.4**	**5.3**	**5.9**	**6.6**	**7.3**	**7.5**	**8.0**	**8.8**	**9.4**	**9.0**
3 Agriculture	**20.9**	**21.9**	**22.3**	**22.5**	**22.5**	**23.1**	**24.1**	**24.4**	**24.7**	**24.5**
5 Waste	**1.6**	**1.6**	**1.6**	**1.7**	**1.7**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**
Total (excluding LULUCF)	***247.0***	***246.6***	***252.9***	***263.0***	***263.2***	***263.6***	***267.2***	***238.1***	***257.8***	***243.1***
4 LULUCF	**25.1**	**2.2**	**3.2**	**7.2**	**9.3**	**9.4**	**14.2**	**23.2**	**25.4**	**22.4**
Total (including LULUCF)	***272.1***	***248.8***	***256.0***	***270.2***	***272.6***	***273.0***	***281.4***	***261.3***	***283.2***	***265.5***

Source and Sink Categories	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	CO_2 equivalent (kt)									
1 Energy	**193.4**	**179.3**	**187.9**	**195.2**	**163.6**	**162.2**	**152.2**	**158.2**	**145.4**	**151.5**
1A1 Energy industries	3.3	3.1	2.8	3.0	2.5	2.0	2.2	2.1	2.2	3.4
1A2 Manufacturing ind. & constr.	26.1	23.6	25.7	26.4	27.3	27.6	26.0	27.7	24.6	24.1
1A3 Transport	77.8	76.9	79.9	79.6	73.8	61.8	60.5	60.8	58.8	57.4
1A4 Other sectors	85.2	74.7	78.3	84.9	58.9	69.5	62.5	66.4	58.6	65.4
1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B Fugitive emissions from fuels	1.1	1.1	1.1	1.2	1.1	1.1	1.2	1.2	1.2	1.2
2 IPPU	**9.4**	**9.9**	**10.2**	**10.3**	**10.5**	**10.5**	**10.1**	**10.4**	**10.5**	**10.0**
3 Agriculture	**23.7**	**24.5**	**24.8**	**23.6**	**24.0**	**23.9**	**23.9**	**23.3**	**23.7**	**24.5**
5 Waste	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**
Total (excluding LULUCF)	***228.2***	***215.3***	***224.5***	***230.7***	***199.7***	***198.1***	***187.8***	***193.5***	***181.3***	***187.7***
4 LULUCF	**21.0**	**24.7**	**25.0**	**17.6**	**17.5**	**12.2**	**10.4**	**11.7**	**22.4**	**12.4**
Total (including LULUCF)	***249.2***	***240.1***	***249.5***	***248.3***	***217.2***	***210.4***	***198.2***	***205.2***	***203.7***	***200.1***

Source and Sink Categories	2020	1990-2020
	CO_2eq (kt)	%
1 Energy	**144.0**	**-28.5%**
1A1 Energy industries	2.4	1285.1%
1A2 Manufacturing ind. & constr.	22.9	-37.0%
1A3 Transport	52.8	-31.4%
1A4 Other sectors	65.1	-25.6%
1A5 Other	NO	-
1B Fugitive emissions from fuels	0.8	114.4%
2 IPPU	**9.4**	**1321.0%**
3 Agriculture	**24.7**	**-0.9%**
5 Waste	**1.6**	**-3.2%**
Total (excluding LULUCF)	***179.7***	***-21.4%***
4 LULUCF	**4.8**	**-36.1%**
Total (including LULUCF)	***184.5***	***-21.8%***

A graphical representation of the data in the table above is given in Figure 3-4.

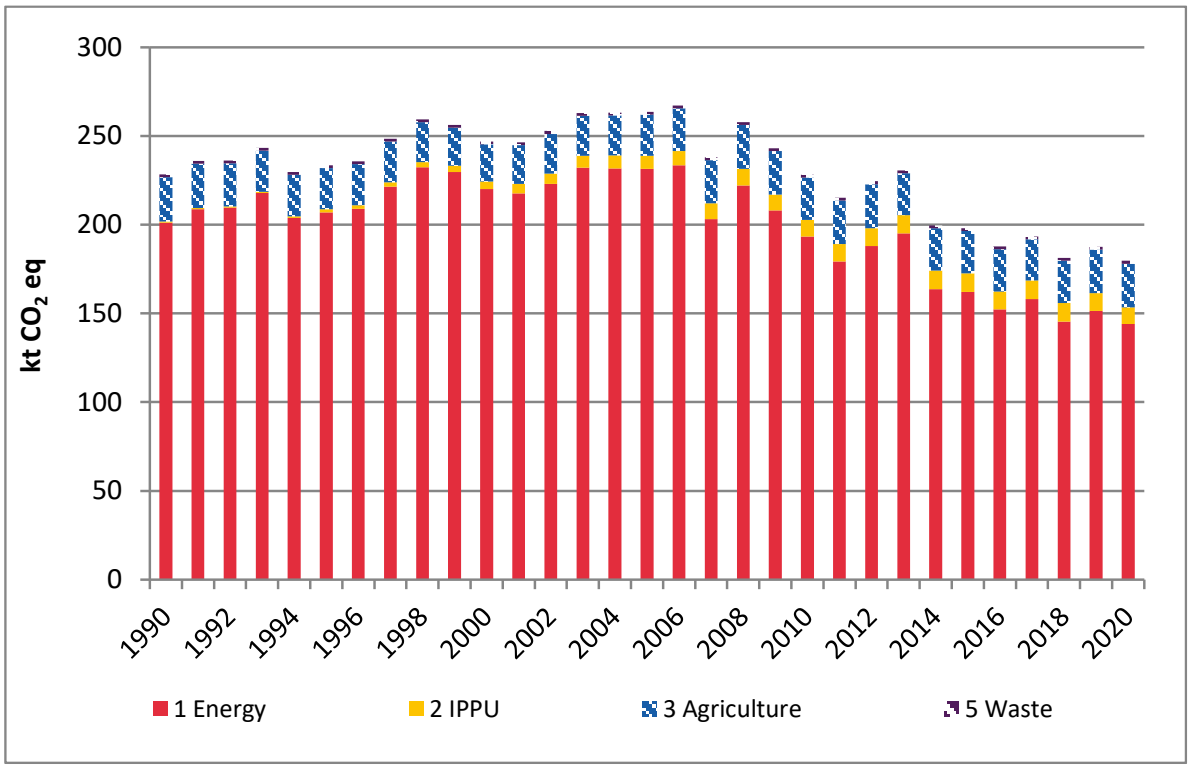

Figure 3-4 Trend of Liechtenstein's greenhouse gas emissions by main source categories in CO_2eq (kt), 1990–2020 (excl. net CO_2 from LULUCF).

The following emission trends are characteristic within the sectors:

Sector 1 Energy: In 2020, 80.1% of Liechtenstein's GHG emissions (excluding LULUCF) originate from sector 1 Energy, which is 0.6 percentage points less than in 2019. The share of sector 1 Energy in the total emissions declined by 8.0 percentage points since 1990. Also, the total emissions of the sector 1 Energy clearly decreased in comparison to 1990 levels (by 28.5%). The source categories within sector 1 Energy show the following trends between 1990 and 2020:

- 1A1 Energy industries: Since 1990, Liechtenstein's gas-grid has been extended and natural gas has replaced oil as the main heating fuel in buildings. Total emissions have increased by about a factor of 14 since 1990 due to the addition of gas-using CHP plants.
- 1A2 Manufacturing industries and construction: Total emissions from this source category have declined by 37.0% since 1990. Gaseous fuels are the more important energy carrier in Liechtenstein in 2020. In 2020, emissions from gaseous fuels decreased by 23.5% compared to 1990 and by 8.8% compared to 2019. Liquid fuel emissions decreased by 46.8% compared to 1990.
- 1A3 Transport: Up to 2006, fuel consumption in road transportation was mostly in line with a general development of road-vehicle kilometres of all vehicle categories. Total emissions have started decreasing since 2012. Between 2019 and 2020, emissions of 1A3 decreased by 8.0%.

[13] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data shown here are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

A part of this rather large decrease can be attributed to the Covid-19 pandemic, since working from home reduced motorised private transport. The overall trend shows a decrease of 31.4% (1990–2020). The decrease is mainly related to fuel tourism, as fuel prices are often lower in neighbouring countries (SFOE 2018).

- 1A4 Other sectors: GHG emissions in source category 1A4 have slightly decreased by 0.5% compared to the previous reporting year 2019. An important driver of emissions from category 1A4 are heating degree days, which generally correlate well with the use of heating fuels (see Figure 3-5). Various emission reduction measures in Liechtenstein are influencing fuel consumption. For instance, the increase in the CO_2 levy in 2016, which caused an increase in sales of heating oil in 2015 and a reduced apparent consumption in 2016 and subsequently again an increase in 2017. The fuel levy was further increased in 2018. Also, in 2018, the relative reduction of sales of heating oil is stronger than the relative decrease of heating degree days, and, vice versa, the increase of heating oil sales in 2019 is higher as would have been expected due to the increase of heating degree days. Another factor is the installation of a district heating pipeline in 2009, which contributed to the stronger declining trend in CO_2 emissions in comparison to the trend in heating degree days. The observed difference in the trends of CO_2 emissions and heating degree days is an indication of a decoupling between heating activities and CO_2 emissions.

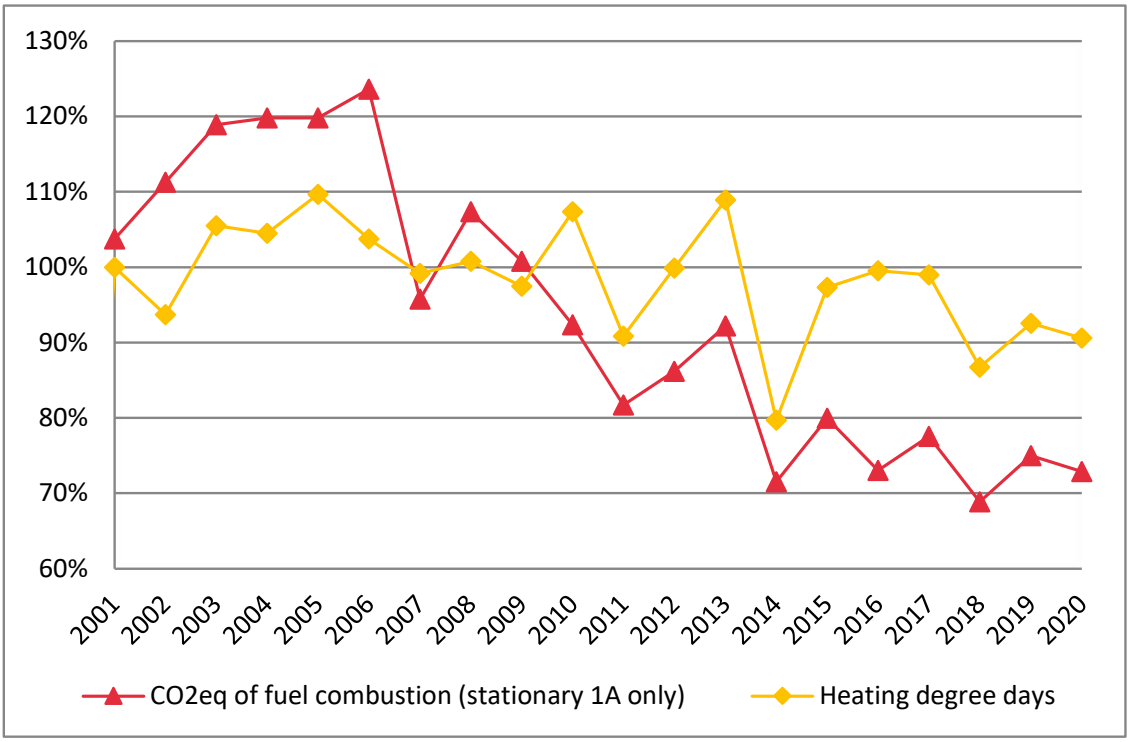

Figure 3-5 Relative trend for CO_2 emissions from 1A Fuel Combustion compared with the number of heating degree days. The drop of emissions in 2007 is driven by high oil and gas prices.

- 1A5 Other (mobile): Liechtenstein does not have any emissions under source category 1A5 because Liechtenstein has no army.

- 1B Fugitive emissions from fuels: In parallel with the installation and subsequent extension of Liechtenstein's gas supply network since 1990, fugitive emissions have strongly increased over the period 1990–2020 (114.4%). An error in the activity data leads to a reduction of emissions

by 34% between 2019 and 2020. This error will be corrected in the next submission of the GHG-inventory[14].

Sector 2 Industrial processes and product use: Due to the lack of heavy industry within the borders of Liechtenstein, there are only small sources of F-Gases and emissions are low. Still, the use of F-Gases has increased substantially throughout the period 1990–2020, which leads to a relative increase of emissions in sector 2 by approximately a factor of 14. The most important source category is 2F Product uses as substitutes for ozone-depleting substances (ODS) due to the replacement of CFCs with HFCs. The main factor influencing the increase in HFC emissions in refrigeration and air conditioning are the increasing population of Liechtenstein (34.5 per cent increase in 2020 compared with 1990, see Figure 2-1), the increasing number of households in Liechtenstein (67 per cent increase), the increasing number of persons employed in the industrial and service sectors (105 per cent increase) and the increasing number of registered cars (80 per cent).

Sector 3 Agriculture: In 2020, emissions are below the 1990 level by 0.9%. The main parameter influencing CH_4 and N_2O emissions from enteric fermentation are animal numbers (in particular cattle and swine). A second relevant development in enteric fermentation is the increasing productivity of dairy cattle (high-yield cattle), which results in higher (per animal) emission factors. The emissions from manure management also closely follow the development of the cattle population. Under the agricultural soils category, the emissions from animal manure applied to soils is the most important subcategory and also depends on the cattle population number, as well as a change in husbandry systems from stall towards loose housing systems (in the course of the agricultural policy reforms during the 1990s and the early twenty-first century).

Sector 4 LULUCF: Figure 3-6 shows CO_2 emissions or removals by sources and sinks from LULUCF categories in Liechtenstein. The dominant categories when looking at the changes in CO_2 emissions are gain and loss of living biomass in forests. There is a considerable annual variation of loss of living biomass in forests dependent on the wood harvesting rate and storm events. The reasons for the relatively high net CO_2 emissions in 1990 and 2000 are the European storms Vivian (February 1990) and Lothar (December 1999), respectively, which caused great damages in the forest stands and markedly increased harvesting. In January 1994, the Rhine valley and especially Liechtenstein was hit by a strong foehn storm with large wind speed (see http://www.sturmarchiv.ch).

In a medium-term perspective, harvesting rates in Liechtenstein's forests appeared to expand between 2001 and 2008 mainly due to increased use of wood for energy use. Harvesting rates started to decline after 2012 due to international and domestic economic framework conditions. In 2018, harvesting rates were relatively high due to salvage logging on areas affected by storms and pests.

The total net emissions decreased by 36% between 1990 and 2020.

[14] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data shown here is based on the CRF Tables Liechtenstein submitted in April 2022.

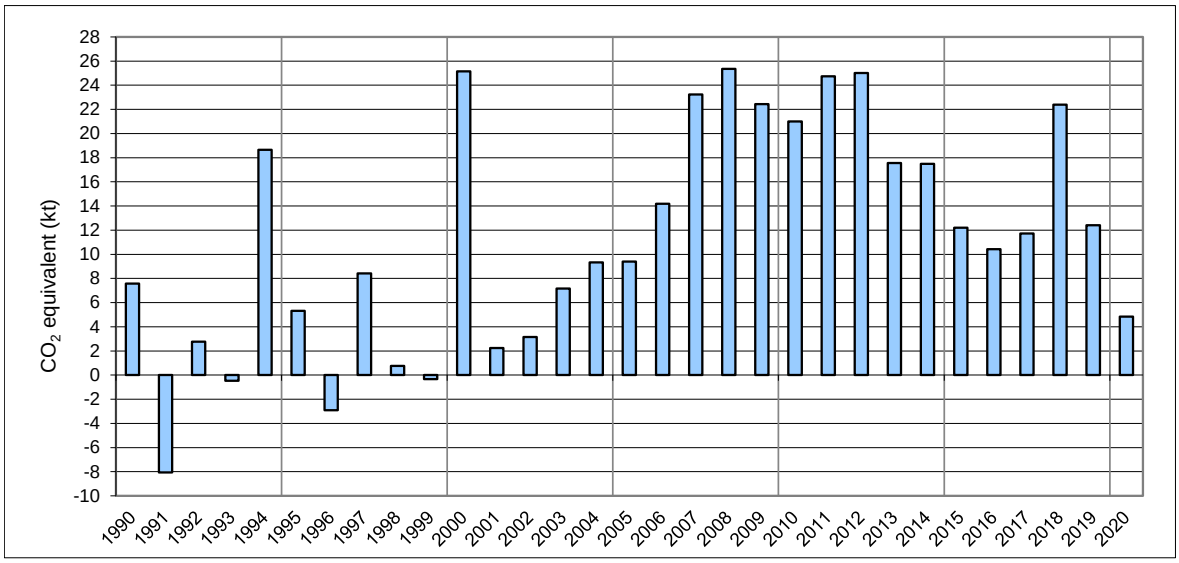

Figure 3-6 Liechtenstein's CO_2 emissions/removals of source category 4 LULUCF 1990–2020 in kt CO_2eq.

Sector 5 Waste: In Liechtenstein, the Waste sector only contributes marginally to emissions, since all non-reusable municipal solid waste is exported to a Swiss incineration plant. The waste sector shows a decrease between 1990 and 2020 (3.2%). The development of the greenhouse gas emissions is dominated by source category 5D Wastewater treatment and discharge. In this category, sewage gas was used as fuel for boilers or co-generation until 2014. Since then, all sewage gas has been upgraded and supplied to the gas grid, which results in significantly lower greenhouse gas emissions in this source category. In source category 5A Solid waste disposal, a steady decrease of greenhouse gas emissions can be observed due to an end to landfilling in 1974.

3.2.3.4 Emission trends for precursor greenhouse gases and SO_2

Liechtenstein is member of the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) and submits data on air pollutants including indirect GHG.

For the precursor substances NO_x, CO and NMVOC, as well as for the gas SO_2, data from the current state of knowledge in air pollution reporting is shown in Table 3-8. The system boundaries for the road transportation sector categories are not the same as under the UNFCCC reporting, because Liechtenstein uses the territorial approach under the CLRTAP and the sales principle for the UNFCCC reporting, which limits comparability of the two data sets.

Table 3-8 Development of NO_x, CO, NMVOC and SO_x emissions (in t) as of submission 2021 (OE 2021f).

Precursor gases and SO_2	1990	1995	2000	2005	2010
	tonnes				
NO_x	619	575	541	498	397
CO	1'536	937	742	591	596
NMVOC	1'294	820	560	377	341
SO_x	117	72	45	34	20

Precursor gases and SO_2	2011	2012	2013	2014	2015
	tonnes				
NO_x	389	382	376	350	335
CO	599	590	538	533	541
NMVOC	335	333	321	313	305
SO_x	16	15	14	9	9

Precursor gases and SO_2	2016	2017	2018	2019	1990-2019
	tonnes				%
NO_x	308	288	273	255	-59%
CO	518	492	522	490	-68%
NMVOC	298	294	289	291	-78%
SO_x	8	7	7	7	-94%

The complete CLRTAP Inventory data can be found on the internet (see OE 2021f): https://www.ceip.at/status-of-reporting-and-review-results/2021-submission.

3.2.3.5 Emission trends in KP-LULUCF inventory

Table 3-9 and Figure 3-7 illustrate the total net emissions occurring from activities under KP-LULUCF. Deforestation and Harvested Wood Products (HWP) are emission sources over the whole period 2008–2020 while afforestation is a sink.

Table 3-9 Development of net CO_2eq emissions of afforestation and reforestation, deforestation and forest management in Liechtenstein.

KP-LULUCF	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	CO_2 equivalent (kt)												
Afforestation	-0.30	-0.30	-0.31	-0.31	-0.32	-0.32	-0.32	-0.33	-0.33	-0.34	-0.34	-0.35	-0.35
Deforestation	4.21	4.30	4.40	4.49	4.58	4.68	4.77	4.87	4.96	4.80	4.63	4.46	4.29
Forest Mangement	13.70	10.59	9.03	12.85	13.13	5.46	5.38	-0.06	-1.91	-0.23	11.15	1.16	-6.32
HWP	0.04	0.13	0.21	0.21	0.21	0.20	0.20	0.19	0.19	0.19	0.18	0.18	0.18
Total	17.65	14.71	13.33	17.24	17.61	10.03	10.03	4.68	2.92	4.42	15.62	5.46	-2.21

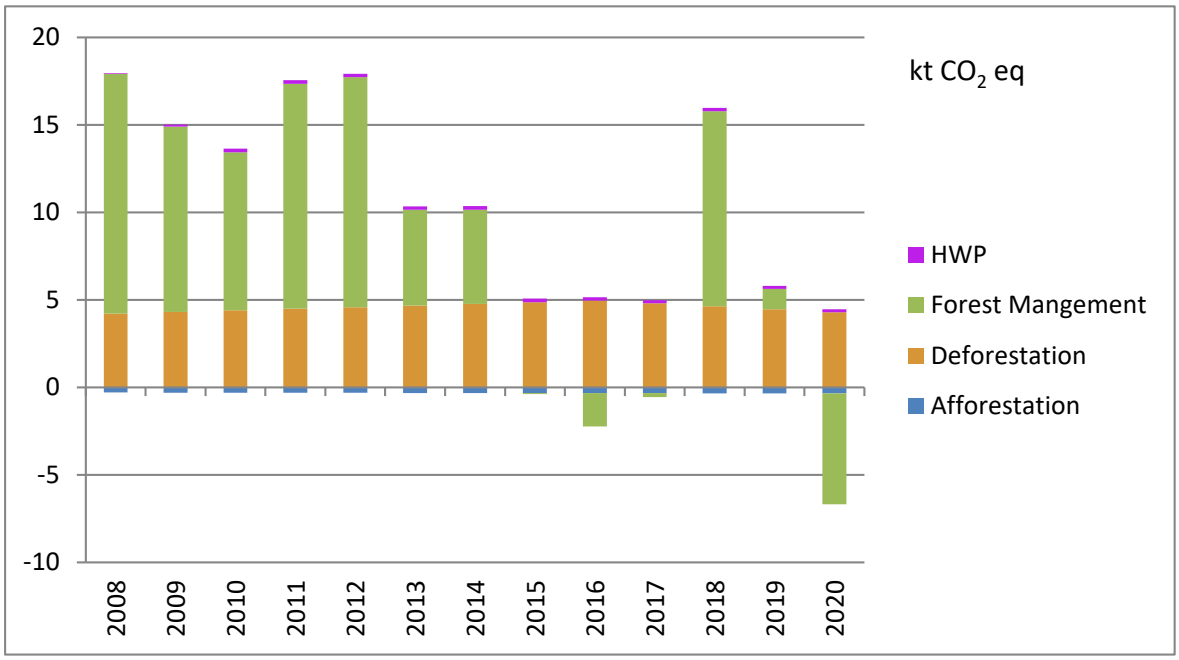

Figure 3-7 Trend of emissions of afforestation and reforestation, deforestation and forest management in Liechtenstein.

3.2.4 Recalculations

Some emissions have been recalculated due to updates in the respective sectors. For the base year 1990, the recalculations carried out in the submission of the national inventory 2022 (see OE 2022, section 10) lead to an increase of 0.015% in the national total emissions (excluding LULUCF categories). By contrast, the national total emissions of the year 2019 increased by 0.3% due to the recalculations (excluding LULUCF categories).

3.2.5 Data for activities under Article 3, Paragraph 3 and 4 of the Kyoto Protocol (KP-LULUCF)

Accounting periodicity for activities under Article 3, paragraph 3:

The information is provided in accordance with Decision 15/CP.10 (FCCC/CP/2004/10/Add.2) and based on the information given in Liechtenstein's Initial Report (OEP 2006a) and the Corrigendum to the Initial Report of 19 September 2007 (OEP 2007b).

For activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol, the Marrakech Accords (in the annex to decision 16/CMP.1) list the definitions to be specified by Parties. Liechtenstein's definitions for Forest, Afforestation and Deforestation are specified in the corrigendum to Liechtenstein's Initial Report (OEP 2007b, see there in section 4) and is still valid for the second commitment period: Liechtenstein applies the forest definition of the Swiss Land Use Statistics (AREA) of the Swiss Federal Statistical Office. AREA provides an excellent data base to derive accurate, detailed information of not only forest areas, but all types of land use and land cover. Thus, AREA offers a comprehensive, consistent and high-quality data set to estimate the surface area of the different land use categories in reporting under the Kyoto Protocol. Table 3-10 shows the activity coverage and the pools reported for the activities under Article 3, paragraph 3 and Forest Management under paragraph 4 of the Kyoto Protocol. The change in area between the previous and the current inventory year is shown in KP (LULUCF) NIR 2 - Land Transition Matrix 2020.

Table 3-10 KP(LULUCF), CRF table NIR 2, Submission 2022

Table NIR 2. LAND TRANSITION MATRIX
Areas and changes in areas between the previous and the current inventory year[1], [2]

	ARTICLE 3.3 ACTIVITIES		ARTICLE 3.4 ACTIVITIES						
	Afforestation and reforestation	Deforestation	Forest management[5]	Cropland management (if elected)	Grazing land management (if elected)	Revegetation (if elected)	Wetland drainage and rewetting (if elected)	Other[6]	Total area at the end of the previous inventory year[7]
	(kha)								
Article 3.3 activities									
Afforestation and reforestation	0.04	NO							0.04
Deforestation		0.26							0.26
Article 3.4 activities									
Forest management		0.01	6.24						6.25
Cropland management[3] (if elected)	NA		NA	NA	NA	NA	NA		NA
Grazing land management[3] (if elected)	NA		NA	NA	NA	NA	NA		NA
Revegetation[3] (if elected)	NA		NA	NA	NA	NA	NA		NA
Wetland drainage and rewetting[3] (if elected)	NA		NA	NA	NA	NA	NA		NA
Other[4]	NA	NA	NA	NA	NA	NA	NA	9.51	9.51
Total area at the end of the current inventory year	0.04	0.26	6.24	NA	NA	NA	NA	9.51	16.05

[1] This table should be used to report land area and changes in land area subject to the various activities in the inventory year. For each activity it should be used to report area change between the end of the previous inventory year and the end of the current inventory year. For example, the total area of land subject to forest management in the previous inventory year and which was deforested in the current inventory year, should be reported in the deforestation column and in the forest management row.

[2] In accordance with relevant decisions. Some of the transitions in the matrix are not possible and the cells concerned have been shaded.

[3] Lands subject to cropland management, grazing land management, revegetation or wetland drainage and rewetting that after 2013 are subject to activities other than those under Article 3.3 and 3.4, should still be tracked and reported under cropland management, grazing land management,

[4] Other refers to the area that is reported under Article 3.3 or 3.4 in the current inventory for the first time. This footnote does not apply to the cell belonging to the column and the row "other" to "other".

[5] Changes in area from cropland management, grazing land management, revegetation and wetland drainage and rewetting to forest management should be reported only in the case of carbon equivalent forest conversions.

[6] "Other", in this column, is the area of the country that has never been subject to any activity under Article 3.3 or 3.4

[7] The value in the cell of row "Total area at the end of the current inventory year" corresponds to the total land area of a country. The total land area should be the same for the current inventory year and the previous inventory year in this matrix.

The net CO_2eq emissions add up to -2.21 kt. The corrected forest management reference level 2013–2020 is 0.36 kt CO_2eq.

Table 3-11 Summary table afforestation and reforestation, deforestation, forest management and HWP. FMRL: Forest Management Reference Level, incl. technical corrections.

Activity, year 2020	**Area** kha	**Net CO_2 emission/removal** kt CO_2	**N_2O emission** kt N_2O	**Net CO_2 eq emission/removal** kt CO_2 eq
A.1 Afforestation	0.036	-0.35	NO	-0.35
A.2 Deforestation	0.255	4.23	0.00022	4.29
B.1 Forest managment (FM)	6.243	-6.32	NO	-6.32
4.C HWP from FM	---	0.18	NO	0.18
Total emission/removal		-2.27	0.00022	-2.21
B.1.1 FMRL 2013-2020	---			0.36

FMRL: Forest Management Reference Level, incl. Technical corrections

3.3 National inventory arrangements

3.3.1 National entity

The Office of Environment (OE) is in charge of establishing emission inventories and is therefore also responsible for all aspects concerning the establishing of the National Inventory System (NIS) under the Kyoto Protocol. Its project manager is:

Karin Jehle
Gerberweg 5, P.O. Box 684, 9490 Vaduz, Principality of Liechtenstein
karin.jehle@llv.li; Tel.: +423 236 6196

3.3.2 National Registry

Directive 2009/29/EC was adopted in 2009 and provides for the centralisation 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, which is not applicable in Liechtenstein. 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 (25) 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. With the transition to the Paris protocol, the national registry will be retired in 2023. Liechtenstein initiated discussions with the EU about the shaping of a registry under Article 6.4.

The platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

1. Each Party retains its organisation designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
2. Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
3. Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
4. Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
5. The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;
6. The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;
7. All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:
    a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);

b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorised manipulation;
d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

Thus, the following changes to Liechtenstein's national registry have occurred in 2012:

In accordance with the SIAR Reporting Requirements and Guidance for Registries a high-level description for each change should be provided as test plans, test reports and readiness documentation. The required documents are confidential and accessible for assessors only ("documentation annexed to this submission"). Therefore, the documents which are mentioned in the below table are not available within this document.

The following changes to the national registry of Liechtenstein have occurred in 2021. Note that the 2021 SIAR confirms that previous recommendations have been implemented and included in the annual report.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	There was a change in the cooperation arrangement during the reported period as the United Kingdom of Great Britain and Northern Ireland no longer operate their registry in a consolidated manner within the Consolidated System of EU registries, CS EUR.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There have been 6 new EUCR releases (versions 12.4, 13.0.2, 13.2.1, 13.3.3 , 13.5.1 and 13.5.2) after version 11.5 (the production version at the time of the last Chapter 14 submission). No changes were applied to the database, whose model is provided in Annex A. No change was required to the application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The changes that have been introduced with versions 12.4, 13.0.2, 13.2.1, 13.3.3, 13.5.1 and 13.5.2 compared with version 11.5 of the national registry are presented in Annex B. It is to be noted that each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and are carried out prior to the relevant major release of the version to Production (see Annex B). No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No changes regarding security were introduced.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change to the registry internet address during the reported period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	No change during the reported period.

3.3.2.1 Publicly Accessible Information

Pursuant to paragraphs 44 to 48 in section I.E of the annex to decision 13/CMP.1, Liechtenstein makes non-confidential information available publicly using a Registry Homepage and/or user interface. In Liechtenstein, the following information is considered as non-confidential and publicly accessible on the website

https://unionregistry.ec.europa.eu/euregistry/LI/public/reports/publicReports.xhtml

13/CMP.1 annex II paragraph 45 Account information	The requested information is publicly available for all accounts. The data of operator holding accounts can be viewed online at: https://unionregistry.ec.europa.eu/euregistry/LI/public/reports/publicReports.xhtml The data of all accounts can be viewed online at: https://unionregistry.ec.europa.eu/euregistry/LI/public/reports/publicReports.xhtml Representative name and contact information is classified as confidential due to Article 83 paragraph 8 and 9 Registry Regulation No. 1193/2011.
13/CMP.1 annex II paragraph 46 Joint implementation project information	This is information is available on the website: https://www.llv.li/inhalt/12414/amtsstellen/genehmigte-projekte
13/CMP.1 annex II paragraph 47 Unit holding and transaction information	The information requested in (a), (d), (f) and (l) is classified as confidential due to Article 83 paragraph 1 Registry Regulation No. 1193/2011 as well as national data protection law and therefore not publicly available. Transactions of units within the most recent five-year period are also classified as confidential, therefore the transactions provided are only those completed more than five years in the past. The information requested in (b), (c), (e), (g), (h), (i), (j) and (k) is publicly available at https://unionregistry.ec.europa.eu/euregistry/LI/public/reports/publicReports.xhtml (b) In 2020 there was no issuance of AAU. (c) In 2020 no ERUs were issued. (e) No RMUs were issued for the reporting year 2020 in 2021. For the current reporting year, no verified units for issuance RMUs are available at the time of submission. (g) No RMUs were cancelled on the basis of activities under Article 3, paragraph 3 and 4 in the reported year. (h) No ERU, CER, AAU and RMU were cancelled on the basis of activities under Article 3, paragraph 1 in the reported year. (i) In 2020, no AAU, no ERU and no CER were voluntary cancelled. No RMU was cancelled. (j) In 2020, no ERUs, no CERs, no AAUs, and no RMUs, no tCER, no lCER were retired. (k) There was no actual carry over of ERU, CER, AAU or RMU from the previous commitment period. The planned carry-over will include 42,984 AAUs.

13/CMP.1 annex II paragraph 48

Authorised legal entities information

The following legal entities are authorised by the Member State to hold Kyoto units:

	Legal entities authorised by Liechtenstein to hold units
AAU	Federal Government, TA
ERU	Each account holder of OHA, PHA, TA and NHA
CER	Each account holder of OHA, PHA, TA and NHA
RMU	Federal Government only, TA
tCER	Federal Government only, TA
lCER	Federal Government only, TA

OHA: Operator Holding Account (installation and aircraft)

PHA: Person Holding Account

TA: Trading Account

NHA: National Holding Account

Additionally, all required information on Article 6 projects (JI) would be available on the internet website of the Office of Environment (OE) if there would be such a project in Liechtenstein. So far, there are no JI projects in Liechtenstein (https://www.llv.li/inhalt/11315/amtsstellen/projects-approved-by-liechtenstein). This information comprises names of projects, host counties, available documents and dates.

Personalised data and some information of individual holding accounts are considered commercially sensitive and their disclosure may prejudice competitiveness. Information on acquiring and transferring accounts of legal entities (companies) is therefore regarded as personal data. According to article 36 of the national Act on Data Protection (Datenschutzgesetz vom 4. Oktober 20018, LGBl Nr. 2725) public authorities may disclose personal data if there is a legal basis or if there is an overriding public interest. Neither case is fulfilled and therefore the registry of Liechtenstein cannot make the information on acquiring and / or transferring accounts publicly available. All related information is considered confidential and therefore paragraphs 44–40 of the Annex to Decision 13/CMP.1 are not applicable.

3.3.2.2 Internet address

The URL of the interface for the national registry of Liechtenstein is:

www.emissionshandelsregister.li and alias www.emissionstradingregistry.li

3.3.2.3 Commitment period reserve (CPR)

Parties are required by decision 11/CMP.1 under the Kyoto Protocol and paragraph 18 of Decision 1/CMP.8 to establish and maintain a commitment period reserve as part of their responsibility to manage and account for their assigned amount. The commitment period reserve equals the lower of either 90% of a Party's assigned amount pursuant to Article 3(7bis), (8) and (8bis) or 100% of its most recently reviewed inventory, multiplied by 8.

The assigned amount is 1,556,044 t CO_2eq, therefore the commitment period reserve should read as 90% of the assigned amount which equals to 1,400,440 t CO_2eq. The calculation based on the most recently reviewed inventory, which was in 2022, would result in a higher value. Using the

actual emission of 2020 (NIR 2022) of 179,659 t CO_2eq times 8 would result in 1,437,272 t CO_2eq, which is higher than the CPR based on 90% of the assigned amount.

3.3.3 Institutional, legal and procedural arrangements

The Office of Environment (OE) is in charge of compiling the emission data and bears overall responsibility for Liechtenstein's national greenhouse gas inventory. In addition to the OE, the Office of Economic Affairs (OEA), the Office of Statistics (OS) and the Office of Construction and Infrastructure (OCI) participate directly in the compilation of the inventory. Several other administrative and private institutions are involved in inventory preparation.

Liechtenstein forms a customs and monetary union with its neighbouring country Switzerland, governed by a customs treaty (Government 1980). See section 2.1.7 for further information. Accordingly, for the determination of its GHG emissions, Liechtenstein appreciates having been authorised to adopt a number of Swiss methods and Swiss emission factors.

As part of a comprehensive project, the Government mandated its Office of Environment (OE) in 2005 to design and establish the NIS in order to ensure full compliance with the reporting requirements of the UNFCCC and its Kyoto Protocol. With regard to the provisions of Art. 5.1 of the Kyoto Protocol, the project encompasses the following elements:

- Collaboration and cooperation of the different offices involved in data collection
- Upgrading and updating of a central GHG emissions data base
- Setting up a simplified QA/QC system
- Official consideration and approval of the data

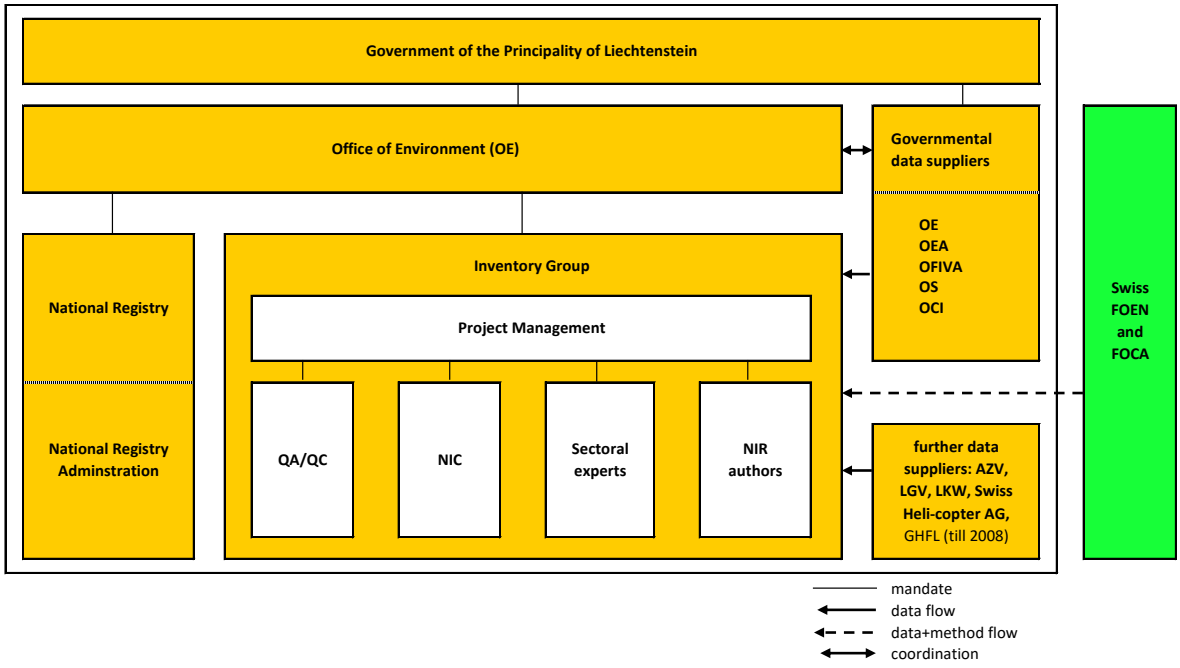

Figure 3-8 National Inventory System: Institutional setting and data suppliers. OE: Office of Environment; OEA: Office of Economic Affairs; OFIVA: Office of Food Inspections and Veterinary Affairs; OS: Office of Statistics: OCI: Office of Construction and Infrastructure; AZV: Liechtenstein's wastewater administration union; GHFL: Corporate society for the Storage of Gas Oil in the Principality of Liechtenstein; LGV: Liechtenstein's gas utility; LKW: Liechtenstein's electric power company; FOEN: Swiss Federal Office of the Environment; FOCA: Swiss Federal Office of Civil Aviation.

The Government of the Principality of Liechtenstein bears the overall responsibility for the NIS. By Liechtenstein's Emission Trading Act (Emissionshandelsgesetz, Government 2012), the Office of Environment (OE) is in charge of establishing emission inventories and is therefore also responsible for all aspects concerning the establishing of the National Inventory System (NIS) under the Kyoto Protocol. The responsibility of the OE for establishing the NIS is also described in the report of Government to Parliament for ratifying the Kyoto Protocol. The Government mandated the realisation of the NIS to its Office of Environment (OE). Note that the Office of Environment was reorganised in 2013. The Office of Agriculture (OA), the Office of Forest, Nature and Land Management (OFNLM) and the Office of Environmental Protection (OEP) have been merged into the Office of Environment (OE). The former Office of Land Use Planning (SLP) was reorganised in 2013 and the Local Land Use Planning Bureau has been incorporated into the Office of Construction and Infrastructure (OCI).

The Office of Environment (OE) plays a major role in the National Inventory System and is acting as the National Registry Administrator. Its representative, the head of the OE, is the registered National Focal Point. He also coordinates, in cooperation with the responsible head of the unit, the data flow from the governmental data suppliers to the Inventory Group.

The Inventory Group consists of the project manager, the person responsible for the QA/QC activities, the National Inventory Compiler (NIC), who is represented by the project manager and his assistant. In addition, several external experts belong to the Inventory Group: Sectoral specialists for modelling the greenhouse gas emissions and removals and the NIR authors.

Among the governmental data suppliers are:

- Office of Economic Affairs (OEA)
- Office of Statistics (OS)
- Office of Construction and Infrastructure (Local Land Use Planning Bureau)
- Office of the Environment (OE)

Further data suppliers are:

- Liechtenstein's Gas Utility / Liechtensteinische Gasversorgung (LGV)
- Electric power company / Liechtensteinische Kraftwerke (LKW)
- Abwasserzweckverband (AZV)
- Heliport Balzers (Swiss Helicopter AG and Rotex Helicopter AG)
- Swiss Federal Office for the Environment (FOEN)
- Swiss Federal Office of Civil Aviation (FOCA)

Until its closure in 2008, the cooperative society for the storage of heating oil in the Principality of Liechtenstein (Genossenschaft für Heizöl-Lagerhaltung im Fürstentum Liechtenstein, GHFL) delivered data on the annual storage of fuels.

3.3.4 Overview of inventory planning, preparation and management

Inventory planning, preparation, and management are well-established in Liechtenstein and follow an annual cycle according to an official schedule (Table 3-12). The planning of the inventory starts with the initial reporting meeting in June, where the head of the inventory group and quality manger, the project manager/NIC, the project manager assistant as well as the emission modeler and the NIR authors participate. At the initial meeting, the work scheduled and priorities with regard to inventory development are set. Decisions regarding planned improvements are taken as well using the latest key category analysis to prioritise the enhancements. Source and

sink categories, which are key categories and hence need an additional improvement because of the recommendation by the ERT (expert review team), are usually scheduled for implementation in the next annual submission (priority 1), unless specified otherwise. All other potential improvements are planned to be implemented (priority 2) depending on available resources. The entire data compilation process lasts from June to October. Normally, the UN review is conducted in September. The findings of the ERT typically lead to corrections of errors, or to modifications, in the methods. In October, another meeting of the core group takes place, where potential improvements of the inventory are analysed. Decisions about modifications are taken and the progress of data compilation is discussed. The compilation includes multiple quality control activities, in particular quality checks of different versions of the reporting tables (CRF) from October to December. At the end of this process, improvements are realised, the final version of inventory data is generated, and the inventory development plan (IDP) is updated.

After inventory preparation, the NIR is additionally passed through a multistage quality control cycle (see Table 3-12). NIR authors, the emission modeler, the head of the inventory group, the project manager and the project manager assistant as well as additional members of the Office of Environment (OE) and sector experts review the drafts of the NIR mutually. Thus, a maximum of quality assurance can be achieved. If the internal review suggests large revisions, they are included in the inventory development plan for future improvements. Inventory material is archived after submission by the OE and sectoral experts, by the contributing authors and by the QA/QC officer.

Table 3-12 Annual cycle of inventory planning, preparation and management.

Process	Month											
	June	July	August	September	October	November	December	January	February	March	April	May
Initial meeting												
Data compilation												
CRF as 1st draft version												
QC of the CRF 1st draft version												
CRF as complete draft												
QC of the complete CRF draft												
Final CRF version												
Preparation of the NIR												
1st draft version NIR												
QC 1st draft version NIR												
2nd draft version NIR												
QC 2nd draft version NIR												
Final version NIR												
Submission final NIR and final CRF's												
Official UN review process												
Archiving												

3.3.5 Data collection, processing and storage, including for KP-LULUCF inventory

Figure 3-9 illustrates the simplified data flow leading to the CRF tables required for reporting under the UNFCCC and under the Kyoto Protocol.

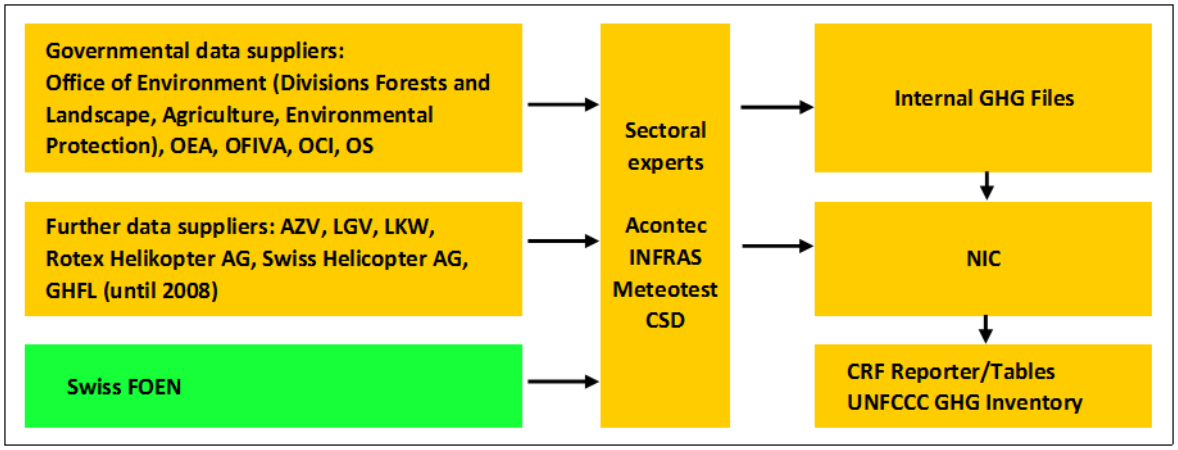

Figure 3-9 Data suppliers and data collection for setting up the UNFCCC GHG Inventory (see Glossary for abbreviations).

Cooperation with the Swiss Federal Office for the Environment (FOEN)

The Swiss Federal Office for the Environment (FOEN) is the agency that has the lead within the Swiss federal administration regarding climate policy and its implementation. The FOEN and Liechtenstein's OE cooperate in the inventory preparation.

- Due to the Customs Treaty of the two states, the import statistics in the Swiss overall energy statistics (SFOE 2021) also includes the fossil fuel consumption of the Principality of Liechtenstein, except for gas consumption of Liechtenstein. Therefore, FOEN corrects its fuel consumption data by subtracting Liechtenstein's liquid fuel consumption from the data provided in the Swiss overall energy statistics to avoid double-counting. To that aim, OE calculates its energy consumption and provides FOEN with the data.
- FOEN, on the other hand, provides a number of methods and emission factors to OE, mainly for transportation, agriculture, LULUCF, F-Gases, and industrial processes and product use. Liechtenstein has benefitted to a large extent from the methodological support by the inventory core group within the FOEN and its willingness to share data and spreadsheet-tools in an open manner. Its kind support is herewith highly appreciated.

3.3.6 Quality assurance, quality control and verification plan

According to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) the major elements of a quality assurance/quality control (QA/QC) and verification system are:

- Participation of an inventory compiler who is also responsible for coordinating QA/QC and verification activities and definition of roles/responsibilities within the inventory
- A QA/QC plan
- General QC procedures that apply to all inventory categories
- Category-specific QC procedures
- QA and review procedures
- QA/QC system interaction with uncertainty analyses
- Verification activities
- Reporting, documentation, and archiving procedures

The implementation status of these quality elements is described in the following sections. Please note that Liechtenstein's QA/QC system accounts for the **specific circumstances of the Principality of Liechtenstein:** Due to the small size of the State, not every process, data flow and arrangement needs to be established by a formal agreement due to short "distances" within the administration and due to a high degree of acquaintance between the persons involved. Therefore, the National System manages with a limited number of written documents.

The QA/QC activities are coordinated by the Mr. Stefan Hassler, Director of the Office of Environment (e-mail: stefan.hassler@llv.li, phone: +423 236 61 97). The QA/QC activities are organised within the Inventory Group, see Figure 3-8.

Operational tasks are delegated to the NIR lead author. She distributes checklists to the project manager being also the National Inventory Compiler, to the sectoral experts and to other NIR authors. They fill in the procedures that they carried out. The lists are then sent back to the quality manager, who confirms the performance of the QA/QC activities. The activities are documented in the NIR (see OE 2022, Annex 8).

The quality management shall enable the party to principally fulfil the requirements of the articles 3, 5 and 7 of the Kyoto Protocol. Specifically, it shall ensure and improve the quality of GHG inventory that means a continuous improvement **of transparency, consistency, comparability, completeness and confidence.** In detail, it serves

- to provide checks to ensure data integrity, correctness and completeness;
- to identify errors and omissions;
- to reduce the uncertainties of the emission estimates;
- to document and archive inventory material.

3.3.6.1 Quality assurance/quality control (QA/QC) procedures applied

Quality assurance (QA) activites

According to IPCC (2006), quality assurance (QA) comprises activities outside of the actual inventory compilation. QA procedures include reviews and audits to assess the quality of the inventory, to determine the conformity of the procedures taken, and to identify areas where improvements could be made. QA procedures are used in addition to the general and category-specific QC procedure. It is important to use QA reviewers that have not been involved in preparing the inventory (IPCC 2006).

Liechtenstein's NIS quality management system follows a Plan-Do-Check-Act-Cycle (PDCA-cycle), which is a generally accepted model for pursuing a systematic quality performance according to international standards. This approach is in accordance with procedures described in decision 19/CMP.1 and in the 2006 IPCC Guidelines (IPCC 2006).

- Liechtenstein carries out the following QA activities:
- Internal review: The draft NIR is passing an internal review. The project manager, also being the NIC, the project manager assistant, specialised staff members of the climate unit and other staff member of the OE are proofreading the NIR or parts of it (all personnel not directly involved in the preparation of a particular section of the inventory). They document their findings in checklists, which are sent back to the NIR authors (see OE 2022, Annex 8).
- The Swiss inventory management involves external experts for sectoral QA activities to review the Swiss GHG inventory. Since a number of Swiss methods and Swiss emission factors are used for the preparation of the Liechtenstein inventory as well, the results of the Swiss QA activities are checked and analysed by Liechtenstein's experts as well. Positive reviews may be interpreted as positive for Liechtenstein too, and problematic findings must not only be taken

into account in Switzerland but also in Liechtenstein. The following sectors have already been reviewed:

- A consulting group (not involved in the GHG emission modelling) was mandated to review the two sectors Energy and former Industrial Processes with respect to methods, activity data, emission factors, CRF tables and NIR chapters (Eicher and Pauli 2006). The results were documented in a review report and communicated to Liechtenstein's Inventory Group. Regarding the topics influencing GHG emissions, only minor issues were identified. The main issue of the Swiss inventory was the problem of insufficient transparency, which has been solved in recent years. Concerning Industrial Processes of Liechtenstein, emissions in 2F1 and 2F7 were affected by the findings above. Other industrial processes are not occurring in Liechtenstein. The consequences for the main findings were evaluated for Liechtenstein's GHG inventory and for the NIR for submission December 2006.
- The Swiss Federal Institute of Technology (ETH) was mandated to review the methane emissions of agriculture with respect to methods, activity data and emission factors. The results were documented in two reports (Soliva 2006, 2006a) and communicated to Liechtenstein's Inventory Group. The consequences of the main findings have been evaluated for Liechtenstein's GHG inventory and for the NIR for submission in December 2006.
- The waste sector of Switzerland was reviewed by a peer expert group in 2009. The reviewers concluded that waste related emissions are calculated in a plausible way and that results from the report are plausible. The emission factors as well as activity data are based on reliable and solid sources. For details, see Rytec (2010). The share of fossil matter in municipal waste has been determined in an extended measuring campaign during 2011 (Mohn 2011). The consequences of the main findings have been evaluated for Liechtenstein's GHG inventory and have been accounted for in the submission in April 2013.
- An expert peer review of the LULUCF sector of the Swiss GHG inventory took place in 2010. The reviewers concluded that "the LULUCF sector of the Swiss greenhouse gas inventory is proved to be of superior quality, good applicatory characteristics and scientifically sound applied definitions and methodology". For details, see V(2011).
- In addition, in 2012, a Swiss national review of the former sector 2 Industrial Processes took place (CSD 2013). The final report has been evaluated and suggestions for improvement were implemented in the subsequent submissions of both, Switzerland's and Liechtenstein's, reports.
- For the Swiss NIR, an annual internal review takes place shortly before the submission. Every chapter of the NIR is being proofread by specialists not involved in the emission modelling or in the NIR editing. The internal review is organised by the quality officer and the results are compiled by the same person that is also compiling Liechtenstein's NIR (NIR author F. Weber, INFRAS). The results of the Swiss review are therefore communicated to Liechtenstein's Inventory Group. If methods and results are affected, which are also relevant for Liechtenstein, the consequences are taken into account accordingly. This procedure has been performed in the previous and the current submissions (May and December 2006, May 2007, February 2008, April for the years 2009-2014, April and May 2016 and April 2017, 2018, 2019,2020 and 2021). It will also be repeated for future submissions.

- The applicability of Swiss methodologies and emission factors to Liechtenstein's GHG inventory was reviewed as well: before Swiss methods were applied, they were discussed with the experts of Liechtenstein's administration. This process took place before the submission in December 2006 for the sectors energy, former industrial processes, former solvent and other product use, agriculture, waste, for the sector LULUCF and before the submission in February 2008. Since then, the issue is a permanent point on the agenda of the

annual kick-off meetings of the Inventory Group. Potential modifications or updates of the Swiss emission factors are discussed and checked upon their applicability for Liechtenstein's GHG inventory.

- For the sector LULUCF, a new external reviewer was mandated in 2012 (Meteotest 2012). The entire LULUCF sector was revised and brought in line with the IPCC methodology.

Quality control (QC) activities

General QC procedures include generic quality checks related to calculations, data processing, completeness, and documentation that are applicable to all inventory source and sink categories (IPCC 2006).

The following QC activities are carried out:

- The annual cycle for inventory preparation contains meetings of the inventory group and meetings of governmental and other data suppliers with the OE. In these meetings, the activities, responsibilities and schedule for the inventory preparation process are being organised and determined.
- Regular meetings within the Office of Environment (OE) in particular between Karin Jehle (project manager) and Stefan Hassler Director of the Office of Environment/quality manager) take place. Beside technical issues also political topics are discussed. As needed, important information is referred to the department or ministry.

The project manager, also operating as the national inventory compiler (NIC), the sectoral experts, and the NIR authors accomplish a number of QC activities:

- The NIR authors check the emission results produced by the sectoral experts, for consistency of cross-cutting parameters, correctness of emissions aggregation, and completeness of the GHG inventory. They compare the methods used with 2006 IPCC Guidelines (IPCC 2006), check the correct compiling of the methods in the NIR, the correct transcription of CRF data into NIR data tables and figures, the consistency between data tables and text in the NIR as well as the completeness of references in the NIR. In addition, they are responsible for the correctness of the key source, the uncertainty analysis and the complete implementation of specific planned improvements of the inventory development plan.
- The sectoral experts check the description of methods, numbers and figures in the NIR. They further incorporate recommendations by the ERT into respective text passages.
- The NIC checks the integrity of the database files, the consistency of time series, as well as the correct and complete inputs into the CRF Reporter. A final data check is done by a comparison of random data fields with the provided data modelling.
- Further staff members of the OE carry out a proof reading of single sectors.
- The project manager executes an overall check on the GHG inventory and the NIR: monitoring of the GHG emission modelling and key category analysis. The project manager checks the NIR for correctness, completeness, transparency and quality, checks for the complete archiving of documents and the completeness of the CRF submission documents.
- In order to provide an overview and to increase transparency, all authors, experts, and involved staff members of Liechtenstein's government are listed in a separate table together with specific descriptions about their responsibilities. This table is available for the entire reporting period and helps to improve the QC management in general.
- The CRF Reporting Tables for the current submission, exported from the CRF Reporter software, underwent an iterative quality control in a triple check:

  - The emissions of the year 2020 were compared with those of the year 2019 within the current Reporting Table Summary2.
  - The emissions of the year 2019 were compared between the current Reporting Table Summary2 of submission 2022 and the Reporting Table Summary2 of submission 2021.
  - The emissions of the base year 1990 were compared between the current Reporting Table Summary2 of submission 2022 and the Reporting Table Summary2 of the submission 2021.
- In the first step, the CRF Reporting Tables Summary2 are compared using Excel. For the comparable emissions and sinks the ratios in percent were calculated and the deviations from 100% were analysed. The findings due to this check were discussed among the core group members and the modelling specialists. In the second step, anomalies in data were investigated within more detailed CRF tables (e.g. Table1.A(a)s1) and explanations for those were sought. This procedure usually leads to the identification of errors in data, which are subsequently corrected before the submission.

The current NIR passed several quality controls. Table 3-12 illustrates the official quality control procedure of Liechtenstein's NIR. The first internal NIR draft is cross-checked by the NIR authors in terms of correctness, completeness, consistency and layout. The Office of environment (OE) and the emission modeller review the entire NIR as external experts, because experts of the OE and the emission modeller are not directly involved in updating the NIR. They check the first draft of the NIR in detail and provide detailed feedback on data, interpretation, completeness, consistency, transparency and implementation of the issues given by Liechtenstein's inventory development plan. The review forms for the OE experts and the emission modeller are attached in Annex 8 of the NIR. Afterwards, the NIR authors improve the NIR, considering the revisions made by the OE experts, and prepare the second internal draft, which also undergoes an internal cross-check. This second NIR draft is again reviewed by the OE and the emission modeller and their inputs implemented. The NIR authors complete the final NIR version, including last internal cross-checks. The Office of Environment (OE) carries out a last check and then submits the official National Inventory Report (NIR). This process guarantees the compliance of the QA/QC requirements according to the IPCC guidelines (IPCC 2006).

3.3.6.2 Verification activities

Verification activities were conducted in various steps of the development of the inventory. As Liechtenstein compiles its inventory in close collaboration with Switzerland concerning the methods and models used, continuous comparison between the two inventories is taking place.

In many cases, the same emission factors as in the Swiss NIR are applied. Therefore, these factors are checked when copied from the Swiss NIR and correlation thus depends on activity data. As both countries have used similar methodologies, feature comparable economic structures, similar liquid/gaseous fuels mixes and vehicle fleet compositions, the comparison of total per capita CO_2 emissions indicates completeness of source categories:

- If the national total emissions (without LULUCF) of the two countries are compared, very similar and highly correlated trends may be found. In 1990, Liechtenstein's emissions were 0.43% of the Swiss emissions. After a slight increase between 1993 and 2009, this share is 0.39% in 2016. In the same years, the share of inhabitants slightly changed from 0.43% to 0.45%. This may be interpreted as a simple form of verification, since Liechtenstein has used the same or similar methods and EF for many sectors, in which activity data is linked to the number of inhabitants. (Simultaneously, it shows that the per capita emissions in Liechtenstein were reduced more strongly in Liechtenstein than in Switzerland.)

- Another indirect verification may be derived from the ambient air pollutant concentration measurements. Liechtenstein is integrated in a monitoring network of the Eastern cantons of Switzerland (www.ostluft.ch). The results are commonly analysed and published (OSTLUFT 2021). They show that the local air pollution levels of NO_2, O_3 and PM10 in Liechtenstein vary in the same range as in the Swiss neighbouring measurement sites (FOEN 2021c).

3.3.6.3 Treatment of confidentiality issues

In Liechtenstein, all activity data and emission factors are publicly available and not subject to confidentiality limits. However, some emission factors used from Switzerland might see confidentiality restrictions in the Swiss NIR and thus also for this report.

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4 Policies and measures

This section describes policies and measures implemented or planned to be implemented in Liechtenstein in order to achieve the emission reduction commitments agreed on in the national and international context. Section 4.1 provides information related to the policymaking process in the context of environmental and climate policy, including the general framework of environmental legislation. Section 4.2 focusses on policies and measures that cross sector boundaries. The subsequent sections are organised by sector and present individual mitigation actions.

4.1 Policymaking process

Liechtenstein endeavours to enshrine the principle of sustainability in its policies. This includes the prudent use of resources and maintenance of a high quality of life.

In 2010, Liechtenstein therefore introduced an indicator-based system for annual tracking of the country's sustainable development path. The assessment is based on the sustainability definition of the Brundtland Commission which defined sustainable development as "*a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" The tracking system is comparable to the indicator-based assessment of the Swiss Federal Office of Statistics and the European system of Eurostat.

The latest assessment reports for Liechtenstein show a mixed picture concerning sustainability: The areas of health, social cohesion, education and culture, employment, energy and climate as well as natural resources show a positive trend towards sustainability. The areas of living conditions, international cooperation and economy show no clear trend and are assessed as neutral. The transport indicators, however, are not pointing towards sustainability. The increasing motorisation rate and the decreased use of sustainable transport modes have led to an unsustainable development in the area of mobility. (Office of Statistics, 2020-22)

This tracking of the country's sustainable development also serves as an incentive for the development of respective policies and measures, especially in areas where an unsustainable development can be observed. To the extent possible, Liechtenstein also tries to contribute to the solution of global environmental problems. The goal of mitigating climate change enjoys a high political priority in this regard, constituting a primary field of action in Liechtenstein's environmental policy. Progress on mitigation was included as a goal in the Government programme for the political term 2021–2025.

Liechtenstein has integrated climate policy into the individual sectoral policies, specifically energy policy, environment policy, transport policy, agricultural and forestry policy. All of these areas encompass measures that contribute to the reduction of greenhouse gases. To ensure a coordinated implementation the Government passed its first Climate Strategy in 2007. The Strategy requires an interdisciplinary coordination in the fields of environment, energy, building, transportation, agriculture and forestry with respect to the development of climate policy measures. The Strategy was once revised in 2015; a new Climate Strategy is due to be published

by the end of 2022. Liechtenstein's Ministry of Environment and the Office of Environment are the coordinating authorities with respect to the execution of the Strategy.

In 2018, the Liechtenstein Government took note of the Liechtenstein Climate Adaptation Strategy. The Adaption Strategy formulates goals and principles for adaptation and describes the cross-sectoral challenges and measures in adapting to climate change in Liechtenstein. With the adoption of the Liechtenstein Climate Vision 2050 in 2020, the Liechtenstein Government has decided that Liechtenstein will become climate neutral by 2050.

Because of the small size of the country, cross-border cooperation plays an important role. Especially important is the relationship with Switzerland and the cooperation among the countries in the Lake Constance area. Due to the Customs Treaty, cross-border measures and bilateral execution are simplified in many areas, because various Swiss legal acts are directly applicable in Liechtenstein pursuant to the treaty. Where Swiss legal acts apply, Liechtenstein as a rule executes the provisions similarly to a Swiss canton (e.g., Swiss Act and Ordinance on mineral oil tax). Accordingly, most policy areas are very closely linked with Swiss policy, in terms of both content and execution.

Pursuant to the cross-border cooperation with Switzerland, Liechtenstein and Switzerland concluded "The bilateral Agreement between the Principality of Liechtenstein and the Swiss Confederation on Environmental Levies within the Principality of Liechtenstein" in 2009. The agreement enables Liechtenstein to implement several environmental levies of Switzerland into national law while using the existing infrastructure of the Swiss authorities for the execution of the respective national laws. The Ministry of Environment and the Office of Environment and the Office for Foreign Affairs are the competent authorities with respect to the execution of the bilateral agreement.

One of the core elements of Liechtenstein's Policies and Measures (PaMs) is the linkage to energy conservation throughout the various sectors. The targeted reduction of fossil fuel use aims at a modification of longer-term trends in anthropogenic GHG emissions and thereby also serves the objective of the Climate Convention. As Liechtenstein is a small country, every national PaM also reflects a regional PaM due to many linkages to EU or Swiss legislation.

Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures are dealt with on a case-by-case basis. Violations of a law can be punished. Information in cases of non-compliance under domestic law foresees that in terms of breach of data delivery obligation (i.e., in order to prepare the NIR) "the Office of Environmental Protection may sanction the responsible persons up to 30,000 Swiss Francs in accordance with Art. 89 para 1 and Art. 73 Environmental Protection Act".

4.2 Cross-sectoral policies and measures

4.2.1 Overview

As mentioned above, Liechtenstein has anchored its climate related policies and measures within individual sectoral policies. However, the Climate Strategy adopted in 2007, and revised in 2015, requires a coordinated approach by the competent ministries when drafting sectoral legislation.

The responsibility for monitoring the individual measures or policies rests with the respective administration offices in charge of their execution. These authorities provide annual reports of their activities (not only climate change related) to the Liechtenstein Parliament and the public.

While policies and measures addressed in sections 4.3 to 4.8 may have small implications beyond their specific policy domain, the policies and measures presented in section 4.2 are clearly cross-sectoral in nature and thus discussed separately in the following.

Summary of policies and measures (NA = not applicable)

Name of policy or measure	**Objective and/or activity affected**	**GHG affected**	**Type of instru-ment**	**Status of implementation**	**Implementing entity or entities**	**Estimate of mitigation impact** (for a particular year, not cumulative, in CO_2 eq.)	
						2020	2025
Climate Strategy	Definition of a clear and transparent strategy for climate policy in Liechtenstein with precise action fields and measures to fulfil the requirements of the 2nd commitment period of the Kyoto Protocol	all	Planning Measure	Implemented 2007 Revised in 2015	Government of Liechtenstein	NA	NA
Climate Vision 2050	Definition of the target to reach climate neutrality by 2050.	all	Planning Measure	Adopted in 2020	Government of Liechtenstein	NA	NA
Climate Strategy 2050 (*)	Definition of the increase in the emission reduction target for 2030 from 40% to 50% below 1990 and concrete measures to achieve this target and the target of the Climate Vision 2050	all	Planning Measure	Planned **	Government of Liechtenstein	NA	22.77 kt CO_2 eq
Environ-mental Protection Act	Legal basis for all regulations and ordinances, especially with respect to air pollution and waste treatment	all	Law	Implemented 2008	Office of Environment	NA	NA
Action Plan Air	Plan for measures according to air pollution control regulations within the Environmental Protection Act	All	Planning measure	In force since 2007	Office of Environment	NA	NA
Emissions regulations	Emissions regulations for stationary facilities (heating industry)	CO_2, pre-cursor gases	Law	Implemented 1987, Revised 1992 and 2005		NA	NA
Water Protection Act	Cap on maximum number of cattle per land area	CH_4, N_2O	Law	Implemented 2003	Office of Environment	NA	NA
Emissions Trading Act	Implementation of Directive 2003/87/EC, Directive 2004/101/EC and Directive 2009/20/EC goal of climate neutrality by 2050 legally enshrined	all	Law	Implemented 2008 and revised in 2012, 2020	Office of Environment	NA	NA
CO_2 Act	Implementation of ecological steering levy modelled by Switzerland, reduction of CO2 emissions from fossil fuels and inducement for an economical use of energy and renewable energies, Introduction of emissions regulations for new passenger cars delivery trucks and light semi-trailers, establishment of compensation requirements for emissions from mobile fuels	CO_2	Steering Levy, Law	Implemented 2008, revised in 2013, 2018, 2022 To be revised in 2025	Office of Environment, Swiss Federal Office for the Environment	NA	NA
Climate protection platform as part of the Environment Commission of the International Lake Constance	Coordination, exchange of information	All	Data Collection	2005: Status Report on climate protection on Lake Constance with recommendations for activities 2005: Guidelines with practical examples 2006: Status Report on efficient energy conversion	Office of Environment	NA	NA

Conference				and use 2007: Status Report on impact of climate change and potential adaptation strategies 2009: Status Report on renewable energies 2011: Status Report on economic conditions for energy efficiency and renewable energies 2018: Status Report on building regulations and energy requirements 2020: Status Report on decarbonisation of the building sector 2021: Status Report on Low-Tech-Buildings in the Lake Constance region			
Deep Geothermal Energy	Use of geological heat from deep thermal aquifers for electric power and heating	CO_2	Planning measure	Geophysical investigation 2008 – 2010 analysis finalised 2011	Office of Environment	NA	NA
Elaboration of a hydro geological map as a basis for using near surface geothermal heat	Use of near surface geothermal energy for heating purposes	CO_2, precurs or gases	Data Collection	2005 Completion of Map, in force since March 2006, Revisions according to the state of knowledge		NA	NA
* Policies and measures marked with an asterisk (*) are considered in the WAM, rather than the WM, scenario ** The Climate Strategy 2050 was adopted by the Parliament of Liechtenstein in December 2022. However, at the time of the preparation of the National Communication 8, the Climate Strategy 2050 had not yet been adopted. Therefore, it was considered as a "planned" policy and its measures were only considered in the WAM scenario.							

4.2.2 Emissions Trading Act

The Emissions Trading Act (Emissionshandelsgesetz or EHG) sets up the general framework for the fulfilment of Liechtenstein's reduction obligations originating from the ratification of the Kyoto Protocol and the Paris Agreement. Liechtenstein revised the EHG in 2020, entering into force in 2021. As a part of this revision, Parliament set out Liechtenstein's climate targets in Article 4 EHG, consisting of a long-term goal to reach climate neutrality by 2050, and an interim target to reduce greenhouse gas emissions by 40% below 1990 levels by 2030. Reductions are primarily to be achieved domestically, with at least three-quarters of the target (30%) reduced in Liechtenstein. If the full 40% target cannot be met through domestic measures, the Government may participate in project activities abroad or in international emissions trading.

With the preparation of the Climate Strategy 2050, the Government is planning to raise the 2030 target by 10%, meaning Liechtenstein would aim to reduce its overall greenhouse gas emissions by 50% below 1990 levels by 2030, and 40 % by domestic measures. The tightening of this target is currently in public consultation.

In addition, the EHG implements Directive 2003/87/EC (Emissions Trading Directive) into national law. Until 2021, this obliged two industrial installations to participate in the European Emissions Trading Scheme which Liechtenstein therefore participated in, from 2013 to 2020. Following a revision of the Emission Trading Act in 2020, due to the implementation of Directive (EU) 2018/410 amending Directive 2003/87/EC, these two installations were removed from the EU ETS

in 2021, as Directive (EU) 2018/410 allows Member States to exclude small installations from the scheme. However, since all installations excluded from the EU Emission Trading Scheme are still covered under the CO_2 Act, this ensures that effective measures are imposed upon all installations emitting greenhouse gas emissions irrespective of the size.

Due to this revision, and the associated exclusion of all installations from the EU-ETS, the EHG has become a less significant measure in Liechtenstein's climate policy. However, it encompasses the overall climate targets until 2030 and 2050 and is hence of central importance.

4.2.3 CO_2 Act

The CO_2 Act is the most comprehensive legislative measure across Liechtenstein's economy and is therefore considered one of the country's legal centrepieces to reduce greenhouse gases. It aims at reducing CO_2 emissions from the energy-related use of fossil energy sources. It does this through a combination of measures, including a CO_2 levy on thermal fuels ("Brennstoffe"), efficiency standards for passenger cars and obligations for CO_2 offsets on fuel importers.

The Liechtenstein CO_2 Act is an integral part of the bilateral Agreement on Environmental Levies between the Principality of Liechtenstein and the Swiss Confederation. Central elements of the levy system are executed by Swiss authorities, such as the application of the levy through Swiss customs authorities or the granting of levy exemptions through the Swiss Federal Office for the Environment. Through this bilateral Agreement, Liechtenstein profits from being part of the Swiss levy system; while also being legally bound to implement the Swiss measures into Liechtenstein law.

The CO_2 levy on thermal fuels (oil, gas, coal) was introduced in 2008. The levy covers all sectors of the economy (except motor fuels such as petrol and diesel) as well as private households and is intended to promote the efficient use of fossil fuels in stationary applications.

Around two thirds of the levy revenues originating from the industrial and commercial sector are returned to it by granting subsidies to employers' obligations under the "Old Age and Survivors Insurance" (Alters- und Hinterlassenenversicherung, AHV), with the remaining one-third earmarked for environmental policy measures, such as the feed-in tariffs for renewable energy production. However, the CO_2 Act is being revised in 2022 to simplify administration of the levy revenues.

Liechtenstein bases the expected reduction by the CO_2 levy on the Swiss calculation, being fully integrated into its system. To achieve the reduction targets, the CO_2 Ordinance was revised in parallel with the Swiss CO_2 Ordinance to increase the CO_2 levy to up to CHF 120 per tonne CO_2 as of 2022.

The CO_2 Act also sets CO_2 emissions limits for new passenger cars. Following a revision of the Swiss CO_2 Act in 2018, the Liechtenstein CO_2 Act was also revised to extend these limits to delivery trucks and light semi-trailers. In addition, incentives were implemented for installations to feed more electricity into the public power grid.

The third measure in the CO_2 Act obliges entities which import (motor) fuels ("Treibstoffe") to compensate a share of up to 40% of the domestic emissions of these fuels.

In alignment with the planned comprehensive revision of the Swiss CO_2 Act, Liechtenstein planned to revise its CO_2 Act entering into force in 2022, in order to achieve the set climate targets for 2030 and 2050 (see Emissions Trading Act). However, since the revised Swiss CO_2 Act was rejected in the Swiss popular referendum, the revision of the Liechtenstein CO_2 Act was put on hold as well. The existing measures have been prolonged until 2025, when the new revision is expected to be adopted.

4.2.4 Environmental Protection Act

In Liechtenstein, environmental policies are framed within the so-called Environmental Protection Act (Umweltschutzgesetz) of 2008. The Act summarised a set of individual legislative measures in order to streamline procedures within environmental law. The Act is a legislative framework which governs the main aspects of environmental protection, e.g., air pollution and waste treatment. It is comparable to the Swiss Federal Act on the Protection of the Environment. The Act is the legal basis for further ordinances and regulations and thereby influences long-term trends in anthropogenic GHG emissions and removals and thus contributes to the objective of the Convention. It contains the following fundamental principles:

- Precautionary principle: Environmental damages are to be limited at an early stage
- Polluter-pays-principle: Polluters causing detrimental effects have to bear the costs for measures for the protection of the environment
- Principle of holistic approach: Environmental problems must be understood and tackled integrally and coherently
- Cooperation principle: Authorities and the economy collaborate as far as possible to achieve the goals of environmental protection

With respect to climate and air quality related measures (see Air Quality Ordinance, Luftreinhalte-verordnung) the Environmental Protection Act constitutes the legal basis for setting emission limits, for example for combustion installations within industry and households. The principles applied within the Environmental Protection Act guarantee that the associated measures are linked to the most efficient and up-to-date technical solutions. As such, the act governs the limitation of emissions for stationary installations, the maximum air pollution level, measures to be taken in the event emissions thresholds are exceeded, and the requirements on engine and heating fuel. An important element is the obligation to provide information to the public.

Requirements on petrol and diesel oil, but also thresholds for particulate matter, are regulated by an Ordinance on Air Pollution: the annual average emissions limit for sulphur dioxide is 20 micrograms/m^3. The sale of leaded petrol has been prohibited since 2000. The lead content in unleaded petrol is 0.005 g/l, and the share of carcinogenic benzene may not exceed 1%. The sulphur content in diesel and petrol may not exceed 0.01 g/kg.

With regard to waste treatment the Environmental Protection Act requires the separate disposal of different types of waste. At the level of an ordinance, the Government may require that certain waste be recycled, if such recycling improves the ecological balance. The requirements are also based on the polluter-pays-principle. Non-recycled waste is incinerated in the waste incineration plant in Buchs, Switzerland and the energy generated is reused.

The Environmental Protection Act also provides the legal basis for the so called “Action Plan Air” a measure plan effective since 2007 with the aim to reduce a range of emissions. The Action Plan Air itself is not legally binding but provides proposals that have to be considered for future decisions by the Government.

4.2.5 Environmental levies

With regard to environmental levies, Liechtenstein has concluded the already mentioned "bilateral Agreement between the Principality of Liechtenstein and the Swiss Confederation on Environmental Levies within the Principality of Liechtenstein” with Switzerland. Environmental levies on pollutants serve to "internalise" external costs, and to reduce the costs of pollution to society by increasing the proportion paid by polluters themselves.

The bases for the different environmental levies are found in the following legal acts:

- Act on the tax for the rehabilitation of contaminated sites (ASAG),
- Act on the incentive tax on petrol and diesel oil with a sulphur content of more than 0.001 % (BDSG),
- Act on the incentive tax on "extra light" heating oil with a sulphur content of more than 0.1 % (HELG),
- Act on the incentive tax on volatile organic compounds (VOCG)
- CO_2 Act.

The bilateral Agreement also enables Liechtenstein to use the existing infrastructure of the Swiss authorities for the execution of the respective national laws.

Liechtenstein's primary legislative and administrative arrangements to meet its commitments under the Kyoto Protocol are contained in the Emissions Trading Act and the CO_2 Act (see below, sections 4.2.2 and 4.2.3). The implementation of the Emissions Trading Act and the CO_2 Act are further detailed in the Emissions Trading Ordinance and the CO_2 Ordinance.

In 2007, the Government notified its Designated National Authority as well as its Designated Focal Point to the UNFCCC secretariat and in 2008 the "National Guidelines for Approving Projects in Accordance with Article 6 and Article 12 of the Kyoto Protocol" were established.

Legislative arrangements, guidelines and further information on Liechtenstein's climate policy are available on the Office of Environment's website, http://www.au.llv.li.

4.2.6 Policies planned

In May 2022, the Liechtenstein Government started public consultation on the new Climate Strategy 2050, aiming at raising the emission reduction target for 2030 from 40% to 50% below 1990 levels and defining concrete measures designed to achieve this target. After the public consultation is concluded, the Climate Strategy 2050 will be submitted to the Liechtenstein Parliament for approval[15]. At the same time, public consultation for the concomitant adaptation of the EHG to enshrine the reduction target of 50% compared to 1990 in law was started. The CO_2 Act will be revised with effect from 2025 as continuation of the existing act, but also to set the legal framework for the commitments under the Paris Agreement.

4.3 Energy

In 2020, the Government adopted its "Energy Strategy 2030", following on from the earlier "Energy Strategy 2020". The strategy provides future-oriented impulses for national energy policy. It focusses on the promotion of efficient energy use (energy conservation), the use of renewable energy sources, and energy conservation. It contains three main targets:

- an increase in the share of renewable energy in total final energy use from 22% in 2019 to 30% by 2030,
- an increase in energy efficiency to reduce final energy demand by 20% below 2008 levels by 2030 and

[15] The Climate Strategy 2050 was adopted by the Parliament of Liechtenstein in December 2022. However, at the time of the preparation of the National Communication 8, the Climate Strategy 2050 had not yet been adopted. Therefore, it was considered as a "planned" policy and its measures were only considered in the WAM scenario.

- a 40% reduction in GHG emissions below 1990 levels by 2030.

The Energy Strategy 2030 sets out a range of measures covering all energy-related sectors. The measures are implemented through a range of legal instruments briefly discussed below.

The Energy Strategy 2030 also addressed the need to minimise adverse effects of its proposed measures as required by Art. 2 paragraph 3 of the Kyoto Protocol. The proposed set of measures has been checked against its compatibility with economic as well as social requirements.

Legal instruments implementing measures in the Energy Strategy 2030

The Energy Efficiency Act and the relevant Ordinance (both from May 2008), as well as the Energy Ordinance to the Construction Act (Aug 2007), constitute the legal framework for the implementation of measures related to buildings. They contain the following key elements:

- Target values for the insulation of buildings (heat insulation requirements), for devices such as heaters, air conditioners and ventilation systems and requirements for the maintenance of such devices. These measures are governed by the revised Construction Act and relevant ordinances.
- Creation of an Energy Commission which advises the Government on energy policy and communicates its views on all fundamental questions of energy policy. The Energy Commission consists of experts from all relevant areas (architecture, energy industry, other industries, manufacturing and trades, administrative offices, environmental organisations).
- A Bureau of Energy Consumption and Conservation (‘Energiefachstelle’) has been established within the Office of Economic Affairs. The Bureau advises municipalities and private parties on all areas of energy conservation, is responsible for the approval and administration of subsidy applications and implements energy policy strategies. The Bureau provides information to the public through lectures, radio discussions, and personal interactions.
- Subsidies are available for energy conservation in buildings, especially for renovation of old buildings, building services installations, combined heat and power (CHP) plants, and solar thermal and electric installations.

The Government intends to support the measures for implementing the objectives set out in the energy strategy with financial resources and advice. In addition, municipalities increasingly supplement national Energy Efficiency Act subsidies with their own funds.

In collaboration with the forestry sector, an increasing number of public buildings are heating using wood pellets. The Act and Ordinance on the Liberalisation of the Electricity Market provide mechanisms for prosumers to feed locally produced renewable electricity into the grid. The Liechtenstein Power Authority also offers several "green electricity” labels. All of Liechtenstein’s eleven municipalities have received the “European energy award” (Energiestadt).

The annual publication of Liechtenstein’s energy statistics by the Office of Statistics serves as a monitoring tool to evaluate the effect of the respective policies. The Bureau of Energy Consumption and Conservation (‘Energiefachstelle’) was responsible for the implementation and monitoring of measures set out in the Energy Strategy 2020 and maintains this responsibility for the Energy Strategy 2030. The Bureau uses the energy statistics and its data on approved subsidies to provide annual monitoring reports to Parliament.

Policies implemented: The following measures are the focus of the efforts to promote energy conservation, efficiency and use of renewable sources as set out in the Energy Strategy 2030:

- Renovation of old buildings:
  Many older buildings are poorly insulated. Subsidies of up to CHF 200,000 may be granted for insulation.
- Promotion of the “Minergie” standard:
  The standard requires buildings to offer a high level of comfort, economic efficiency, and low energy consumption. Monitored ventilation systems also optimise air quality. In Liechtenstein, the standard is used for all new publicly-owned buildings.
- Residential heating installations:
  If the building shell already fulfills the requirements for modern insulation, then residential heating installations with low consumption or operating with renewable energy can further reduce energy use. State subsidies may be granted up to CHF 20,000.
- Solar collectors:
  Thermal solar collectors can produce most of the warm water needed, thereby reducing heating oil and electricity consumption. The State subsidises such collectors with a contribution of CHF 250 per square metre.
- Photovoltaics:
  Photovoltaic systems generating electricity are subsidised with a contribution of CHF 400–650 per unit of installed capacity (kW). The maximum subsidy per system is CHF 400,000. The generated electricity can be fed into the power grid either at a fixed feed-in-tariff of CHF 0.10 per kWh or variable market prices. The subsidy system will be changed into a system more closely linked to market prices in 2023.
- Demonstration facilities:
  Liechtenstein law also provides for the promotion of demonstration facilities, with which public understanding of energy conservation is enhanced and the use of new technology and new technical possibilities is demonstrated.
- District heating:
  Liechtenstein is continuously extending its district heating network. The main network connects both residential and industrial end users in the municipalities of Vaduz and Schaan to waste heat streams from the waste incineration plant in neighbouring Switzerland which incinerates all of Liechtenstein’s non-recyclable and non-compostable municipal waste. Additional networks are currently being developed in the centres of several other municipalities (Balzers, Malbun, Triesen, Ruggell, Eschen, Mauren) which will carry heat from biomass heating plants, gas-fired CHPs and heat pumps.
- Finally, a hydrogeological map has been developed as a foundation for using near-surface geothermal energy for heating purposes.

In 2021, CHF 974,680 were contributed to the renovation of old buildings, CHF 978,925 to residential heating installations, CHF 12,553 to solar thermal systems, CHF 72,750 to heat pumps for hot water heating, CHF 3,880,986 to solar photovoltaic systems, CHF 249,930 to Minergie standard buildings and CHF 3,281,542 to demonstration facilities and other measures. In addition to this, almost all of Liechtenstein’s municipalities provide additional funds to projects subsidised at the national level pursuant to the Energy Efficiency Act.

Liechtenstein is unable to provide further information on economic and social requirements with which its PaMs need to be compatible and how these requirements contribute to minimise climate change effects and adverse effects of PaMs on international trade and social, environmental and economic impacts as no data are available.

Policies planned: As described above, the Government has formulated a new Climate Strategy which underwent public consultation in 2022. If adopted by Parliament[16], it would provide these additional measures in the Energy Sector:

- Phase-out of fossil fuel based heating systems for new buildings
  Oil and gas based heating systems, still the majority in Liechtenstein, are being increasingly replaced by heat pumps in new and existing buildings (as well as connections to the district heating network for buildings within its reach). A complete ban on fossil systems would speed up this trend and give planning certainty.
- Obligation for photovoltaic installations in all new buildings

Summary of policies and measures in energy sector (NO = not occurring, NA = not applicable)

Name of policy or measure	**Objective and/or activity affected**	**GHG affected**	**Type of instrument**	**Status of implementation**	**Implementing entity or entities**	**Estimate of mitigation impact, by gas** (reduction for a particular year, c.f.previous year, not cumulative in CO_2 eq.)	
						2020	2025
Liechtenstein Energy Strategy 2030 (Energie-strategie 2030)	Governmental Strategy that targets a sustainable energy supply, energy efficiency and net zero emissions Including policies on: Building standards, support for Minergie buildings, district heating network	Primarily CO_2	Planning measure	Implemented 2020	Government of Liechtenstein / Office of Economic Affairs	2.56 kt CO_2 eq †	3.49 kt CO_2 eq †
Energy Efficiency Act (Energie-effizienzgesetz EEG)	Aims for the reduction of energy, the smart and economic use of energy as well as the promotion of renewable energy sources. Promotion of building insulation (renovation of old buildings), residential technical installations (space heating and warm water), solar energy (thermal solar collectors and photovoltaics) and demonstration facilities.	Primarily CO_2	Fiscal Measure (Subsidy)	Implemented 2008	Office of Economic Affairs	NA	NA
Energy Ordinance to Construction Act (Energieverordnung)	New buildings, renovations and installations must comply with minimum insulation values, according to Ordinance / SIA Norm 380/1 and other minimum requirements. The Construction Act is scheduled for extension in 2023/24. This should strengthen requirements in line with Swiss MuKen 2014[17] and the EU EPBD II[18], notably regarding nearly-zero energy building standards.	CO_2	Regulation	Implemented 2007 Extension planned in 2023/24	Building and Fire Safety Authority	NA	NA
Green electricity tariff (LiStrom Öko)	Auditing (SQS) and certification of all domestic production sites according to "naturemade" product mixture of renewable energy sources	CO_2	Promotion by Liechtenstein Power Authority	Implemented 2004	LPA	NA	NA

[16] The Climate Strategy 2050 was adopted by the Parliament of Liechtenstein in December 2022. However, at the time of the preparation of the National Communication 8, the Climate Strategy 2050 had not yet been adopted. Therefore, it was considered as a "planned" policy and its measures were only considered in the WAM scenario.

[17] MuKen 2014 ("Mustervorschriften der Kantone im Energiebereich") are a set of guidelines for energy efficiency in buildings at the province (Kanton) level in Switzerland. It contains 28 elements spelling out standards for energy efficient building envelopes, building services and energy generation in buildings.

[18] The EU Energy Performance of Building Directive recast, or EU Directive 2010/31/EU, sets out rules for the determination of standards for nearly-zero energy buildings and steps to speed up adoption of these standards throughout the European building stock.

	(hydropower plant) and new renewable energy sources (photovoltaic systems)		(Liechtensteinische Kraftwerke LKW)				
Participation of municipalities in the European Energy Award label (Energie-stadt)	Reduction of CO_2 emissions on the level of municipalities by increased use of renewable energy and energy-efficient technologies for all premises. Since 2012 all 11 municipalities are certified with the European Energy Award.	CO_2, precursor gases	Labelling			NA	NA

† Shown are estimated emission reductions per year, in comparison to the emissions in the previous year. The values differ a little from the values shown in the originally published Energy Strategy 2030 (Government, 2020) due to modifications undertaken as laid out in section 5.3.2.

4.4 Transport policy

The guiding principle of Liechtenstein's transport policy is to make a positive contribution to the attractiveness of its cities and regions and to maintain living standards in Liechtenstein. This is also the aim of the Liechtenstein Mobility Concept drafted by the Liechtenstein government in 2020. In addition, the Mobility Concept considered Liechtenstein's goals and aims as set out in the Climate Vision 2050. The Mobility Concept is the heart of the national transport policy, outlining various measures and key projects run by the government to contend with and balance out various mobility needs and challenges while maintaining quality of life. With its adoption in 2020, the Mobility Concept replaced the national transport policy "Mobiles Liechtenstein 2015".

Unlike the national transport policy of 2015, the Mobility Concept is subject to an annual review, entailing detailed monitoring and evaluation processes. As the Mobility Concept was adopted in 2020, and is therefore a rather "young" policy, the implementation of the measures contained therein and the follow-up evaluation of effectiveness of said implemented measures is still at the very beginning. As a result, there is a certain lack of accurate data with regard to the effective reduction of CO_2 emissions resulting from the implementation of the Mobility Concept at the time of writing.

The Mobility Concept's interventions are expected to lend strong support to the aims of national climate policy. The Concept contains four comprehensive packages of measures and ten specific key projects. The first package focusses on enhancing public and non-motorised transport. The second package aims at increasing the efficiency of existing infrastructure. Both packages are expected to reduce motorised traffic and thus CO_2 emissions. Some of the most notable interventions set out in the first and second package of measures are, for example:

1. Expanded availability of the bus services of the national public transport company LIEmobil, which should boost the use of public transport;
2. Optimisation of connecting links of public transport and bicycle traffic (e.g. rent-a-bike at bus stops, sufficient bike parking spaces);
3. Introducing a step-by-step mandatory e-mobility-regime for LIEmobil by replacing all their conventionally motorised busses with alternatives;
4. Fostering digitalised solutions for easier access of tickets and timetables of public transport;
5. Expansion of the cycle routes network, including closing gaps within said network;
6. Prioritisation of public transportation vehicles by introducing transit signal priority systems;
7. Evaluation of public support for deployment of passenger cars with alternative propulsion systems;
8. Evaluation of a mandatory introduction of corporate mobility management in state-owned companies;

9. Supporting local companies with the introduction of corporate mobility management;
10. Introduction of a general obligation to charge for use of public parking spaces;
11. Improved monitoring of traffic congestion, congestion lengths and time losses at traffic hot spots;

The above-mentioned measures are currently in the process of implementation. Whereas some of them will require long-term planning and thorough assessment (occasionally including amendments of laws), some of them can be implemented directly. Since the adoption of the Mobility Concept in 2020, the government has:

- started a programme to replace conventionally powered busses for public transport with e-busses;
- initiated a comprehensive cycle routes network concept;
- explored options for road pricing concepts;
- introduced a system for the prioritisation of public transportation vehicles;
- initiated a review of the national corporate mobility management legislation;

In addition, Liechtenstein cooperates with its neighbouring countries Switzerland and Austria (especially Swiss canton of St. Gallen and Austrian federal state Vorarlberg) to ensure smooth public transport across national borders. Liechtenstein advocates strongly for the enhancement of public transportation routes, the extension and/or preservation of existing train stops in the surrounding area, as well as increased frequency of public transport via trains and busses.

Liechtenstein is also a member of various international commissions and organisations that intend to boost public transport in the area of Lake Constance, such as the International Lake Constance Conference ("Internationale Bodenseekonferenz"), the Zurich Process, the Interreg Alpine Rhine-Lake Constance-Upper Rhine ("Interreg Alpenrhein–Bodensee–Hochrhein"), etc. Liechtenstein also started the pilot project "AMIGO", a programme initiated by the Interreg Alpenrhein-Bodensee-Hochrhein that aims to motivate employees to use environmentally friendly transport modes for their commute to work.

Besides the measures and projects set out in the Mobility Concept, Liechtenstein is using motor vehicle tax policy to achieve a certain steering effect.

Since emissions from **aviation** in Liechtenstein are of minor importance (with only 0.45% of national total, excl. LULUCF) no specific national policies exist to address these sources. The respective emissions stem from only one small heliport. **No** international **shipping** activities occur in Liechtenstein. Based on national circumstances Liechtenstein does **NOT** promote and implement ICAO and IMO decisions to limit emissions from aviation and marine bunker fuels.

Policies implemented:

Heavy Vehicle Fee

Liechtenstein introduced a Heavy Vehicle Fee which, analogous to its Swiss role model, is based on the polluter-pays-principle. The tax is assessed by balancing the distance driven with the total weight of the vehicle. As a result, productivity in road traffic is increased, which contributes to a large-scale shift of heavy goods traffic from road to rail, and in this way also eases the burden on roads in Liechtenstein.

Promotion of green vehicles

Vehicles with environmentally friendly engines (solar, electric, and/or hybrid vehicles) are exempt from the motor vehicle tax. This relative discount creates greater incentives to purchase and use such vehicles.

As a member of the European Economic Area, Liechtenstein must also implement the EU regulations in this area. The focus is on the EURO norms (exhaust regulations) and on measures to promote energy-efficient vehicles, especially by introduction of a labelling system. The goal is to reduce CO_2 emissions, precursor substances and N_2O emissions.

Road pricing

In March 2022, the Liechtenstein Parliament urged the Liechtenstein Government to assess and review applicable options for road pricing via postulate. The official reply to this postulate is still open at the time of writing.

Introduction of CO_2 emissions regulation for passenger cars

In 2012, Liechtenstein introduced CO_2 emissions regulations that apply to new passenger cars. The regulations were incorporated in the revised CO_2 Act in late 2013. Liechtenstein importers are required to reduce the level of CO_2 emissions from cars registered for the first time in Liechtenstein to an average of 118 $gCO_{2\text{-eq}}$ per kilometre by 2021 (and 186 $gCO_{2\text{-eq}}$ per kilometre for heavy vehicles, respectively). It should be noted that the CO_2 Act stipulates stricter targets (95/147 $gCO_{2\text{-eq}}$ per kilometre) but leaves it to the Liechtenstein Government to grant temporary exemptions to meet the applicable Swiss norms as set out in the Swiss CO_2 Act. This is a result of the Liechtenstein-Swiss Customs Union. If the CO_2 emissions per kilometre exceed the target level, a respective penalty applies.

Introduction of an obligation for importers of motor fuels to compensate the fuel-based emissions

According to the Liechtenstein CO_2 Act, producers and importers of fossil motor fuels are required to use domestic measures to compensate for 15% of the CO_2 emissions caused by the combustion of these fuels by 2022 and in total for 17% (also by measures abroad).

The resulting surcharge required to finance respective compensations projects may not exceed CHF 0.05 per litre of petrol/diesel fuel. This framework basically also applies to importers of motor fuels in Liechtenstein. However, due to the high administrative workload such a compensations system would cause for Liechtenstein authorities, and the corresponding relatively low reduction potential of the country in absolute terms, importers may pay the surcharge directly to the Government instead.

Summary of policies and measures in transport sector (NA = not applicable)

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status of implementation	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative,in CO_2 eq.)	
						2020	2025
Heavy Vehicle Fee	Relocation of goods transport from road to railways and reduction of transalpine road transport	CO_2, pre-cursor gases	Fiscal measure	Implemented 2001	Finance Administration	NA	NA
Promotion of solar, electric, natural gas and/or hybrid vehicles	Vehicle tax waived for electric, natural gas and hybrid vehicles	CO_2, pre-cursor gases	Fiscal measure	Implemented 1999	Driver and Vehicle Licensing Office	NA	NA

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status of implementation	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative,in CO_2 eq.)	
						2020	2025
Construction and operation of three public natural gas stations	Infrastructure for providing fuel to private vehicles	CO_2	Investment measure, Infra-structure measure	Implemented 2007	Office of Building Construction and Spatial Planning	NA	NA
Supply of biogas into natural gas fueling station	Supply of CO_2-free fuel for the natural gas filling stations	CO_2, pre-cursor gases	Investment measures, Infra-structure measure	Implemented 2013	Office of Building Construction and Spatial Planning, Bureau of Energy Consumption and Conservation; Office of Environment	NA	NA
PEMO project: Sustainable commuter mobility	Establishment of cooperative action of non motorised resp. human powered mobility and public transportation as well as private companies and municipalities in the cross-border region of Liechtenstein, Switzerland, Austria and Germany with a focus on daily commuters	CO_2, pre-cursor gases	Institutional measures	Started in 2016	Office of Building Construction and Spatial Planning	NA	NA
Exhaust regulations	Adoption of the European exhaust regulations (EURO norms) and fuel regulations, Continuous reduction of road traffic emissions	Pre-cursor gases	Law	Implemented 1993	Driver and Vehicle Licensing Office	NA	NA
Promotion non motorised resp. human powered mobility	The pedestrian network is being expanded continuously and made more attractive	CO_2, pre-cursor gases	Institutional measures	Started 2014; Ongoing	Ministry for Infrastructure and Justice, Office of Building Construction and Spatial Planning	NA	NA
Zoning requirements	Limitation of the number of parking spaces for new buildings, where justified by municipal or national planning.	CO_2, pre-cursor gases	Law	Implemented 2003	Office of Building Construction and Spatial Planning	NA	NA
Internal Mobility Management for State Authority	Reduction of commuter traffic volume by increased usage of public transport and bicycle	CO_2, pre-cursor gases	Institutional measure	Implemented 2008	Office of Building Construction and Spatial Planning	NA	NA
Promotion of public transport	Continuous expansion of frequency of public transport, both in Liechtenstein as well as cross-border	CO_2, pre-cursor gases	Institutional measure, fiscal measure	Ongoing	Ministry of Infrastructure and Justice; Office of Building Construction and Spatial Planning	NA	NA
Promotion of bicycle transport	Initiation of a comprehensive bicycle network	CO_2, pre-cursor gases	Infra-structure measure	Planning of the necessary infra-structure	Ministry for Infrastructure and Justice	NA	NA
Prioritisation scheme for public transport	Implementation of priority transit signals for public transport vehicles	CO_2, pre-cursor gases	Infra-structure measure	Implementation of necessary infra-structure	Ministry for Infrastructure and Justice, Office of Building Construction and Spatial Planning	NA	NA

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status of implementation	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative,in CO_2 eq.)	
						2020	2025
Extension of Mobility Management Act	Review of the Mobility Management Act for the country of Liechtenstein to assess possible extension of Act to apply to all state-owned companies	CO_2, pre-cursor gases	Law, institutional measure, fiscal measure	Initiation of legislative review of Mobility Management Act	Ministry for Infrastructure and Justice	NA	NA
Promotion of environ-mentally friendly commute ("AMIGO")	Implementation of Interreg-project AMIGO to motivate state employees to use non-motorised vehicles for commuting	CO_2, pre-cursor gases	Institutional measure	First pilot project completed; reporting expected	Ministry for Infrastructure and Justice, Office of Building Construction and Spatial Planning	NA	NA

4.5 Industrial processes and product use (IPPU)

The key GHG emission reduction policies in the industry sector control CO_2 emissions from fossil fuel use and are implemented under the CO_2 Act (see section 4.2 on cross-sectoral policies and measures).

With the signing of the Kigali Amendment to the Montreal Protocol in 2020, Liechtenstein has committed to reduce its emissions of F-Gases to 15% below the average level in the period 2011–2013. This target is also incorporated in the Liechtenstein Climate Strategy 2050, which is currently in public consultation. Emissions of F-Gases and precursor gases – such as non-methane volatile organic compounds (NMVOCs) – are subject to different specific policies and measures.

For NMVOCS, due to the Customs Treaty, the relevant Swiss provisions apply directly in Liechtenstein. These include the Swiss Ordinance on Chemical Risk Reduction which provides measures to control emissions of persistent substances with high global warming potential values, e.g. in the fields of refrigerants, but also compressed gas containers and plastic foams.

Another applicable Swiss Ordinance concerns the Movement of Toxic Waste according to which waste containing hydrofluorocarbons (HFCs) counts as special waste. The movement of such waste is hence controlled, subject to licence and must be carried out in an environmentally sound manner.

Additional relevant measures can be found in the Ordinances on Air Pollution Control and on the Incentive Tax on Volatile Organic Compounds.

Summary of policies and measures in IPPU sector (NA = not applicable)

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status of implementation	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 eq.)	
						2020	2025
Swiss Ordinance on Chemical Risk Reduction	Reduction in use and emissions of F-Gases. Regulations relating to, inter alia, compressed gas containers, plastic foams, solvents containing PFCs, HFCs or HFEs, refrigerants, extinguishing agents, and SF_6 in electrical distribution equipment	all F-Gases	regulatory	implemented in 2003 (strengthening planned)	Office of Environment	NA	NA

4.6 Agriculture

International challenges, as well as the changes in agricultural policies, require strong flexibility from Liechtenstein's farmers. The demand for more efficient and sustainable farming procedures is constantly growing. International liberalisation of world markets has also led to some deregulation in Liechtenstein. In addition, the agricultural sector has to provide an increasing number of services that are not remunerated by markets but required by public interests. The Agricultural Law, adopted in 2008, addresses the above-mentioned issues and promotes the trend towards greater ecological agriculture in Liechtenstein. To maintain soil fertility, the environmental impact is minimised by environmentally friendly forms of production, such as integrated production and organic farming. Landscape maintenance and conservation are also considered as a task of agriculture and their importance will continue to increase.

By means of the Agriculture Law Liechtenstein aims to promote environmentally friendly and animal-friendly agriculture as well as permanent pastures on swampy and mixed soils. In the case of wildflower meadows, the preservation of which is of particular interest to nature conservation, the demands on ecological cultivation are even higher. In parallel with Switzerland, the Ecological Performance Certificate was introduced for environmentally friendly cultivation and welfare oriented animal husbandry. All registered farms operate according to these principles. Direct payments are only paid if the practice corresponds to the provisions of the animal protection legislation and the environmental protection provisions. The use of agricultural aids (fertilisers, pesticides) is strictly regulated.

Since 2002, farming of animals consuming roughage is supported through the Direct Payment System. Livestock increased since 2016 (average of 82.1 head of cattle per farm in 2020 as opposed to 75.5 head of cattle in 2016). Liechtenstein's agriculture primarily relies on animal husbandry, which generates 70% of agricultural revenue.

The Water Protection Act, which entered into force in 2003 and is comparable to the Swiss law, specifies a cap on the maximum number of cattle allowed per land area.

In line with the Agriculture Law, Government submits an agricultural policy report to Parliament every four years which tracks the economic situation of domestic farms and addresses the further development and orientation of agricultural policy for subsequent years. The latest agricultural policy report of 2022, which is currently in public consultation, is expected to introduce measures relevant to climate change mitigation and adaptation. The measures of the agricultural policy report of 2022 will complement the Liechtenstein Climate Strategy 2050.

Summary of policies and measures in Agriculture sector (NA = not applicable)

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status of implementation	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 eq.)	
						2020	2025
Ecological equalisation payments in agriculture	Product-independent contributions for conversions to ecological cultivation methods	CH_4, N_2O	Fiscal measure (direct payments)	Implemented 1996	Office of Environment	NA	NA
Preservation of soil for agricultural use	Agriculture: permanent protection of soil for agricultural use from misuse	CH_4, N_2O	Law	Implemented 1992	Office of Environment	NA	NA
Water Protection Act	Cap on maximum number of cattle per land area	CH_4, N_2O	Law	Implemented 2003	Office of Environment	NA	NA

4.7 Forestry

Covering an area of around 6,700 ha (43% of the country's territory), forests play a significant role in Liechtenstein. For this reason, sustainability in forestry has been accorded great importance ever since the introduction of the Forestry Regulations in 1865. Important goals of the current Forestry Act (1991) include the qualitative and quantitative (prohibition of clearing) preservation of forest stocks and the promotion of nature-friendly forest management. The Forest Act and the associated Forestry Ordinance (1995) stipulate that forests fulfil various functions. Besides the legally enshrined welfare function of the forest, which includes its positive effects on climate, these also stipulate that the forest and its management, respectively, must, inter alia, serve the protection of nature which includes, inter alia, preservation of biodiversity. They also contain a legal obligation for a sustainable management of forests, with due consideration of all of their functions.

In addition to the Forestry Act, international agreements (such as the 1993 Helsinki Ministerial Conference on the Protection of Forests in Europe) provide the basis for modern forest management. The natural rejuvenation of forests with local tree species appropriate to the location, the promotion of graded forest stock structures, and the ecological improvement of the edges of forests are only some examples. In general, the promotion of biological diversity in forests is becoming an increasingly important part of Liechtenstein forest management. Being a signatory of FOREST EUROPE, Liechtenstein has signed the Bratislava Ministerial Declaration of 2021, committing, inter alia, to preservation of forest biodiversity.

Liechtenstein now maintains forest reserves encompassing 19% of the forest area (1,274 ha), where all forms of forestry activities are prohibited as well as special forest areas of about 479 ha (7%) to preserve old and traditional forms of forest management or rare forest communities.

In June 2001, Liechtenstein published a National Forest Programme. With the programme, Liechtenstein reacted to international obligations to promote sustainable forest management. With a view to meeting sustainable development goals, the National Forest Program encompasses the following principles in particular: respect for national sovereignty and self-responsibility in the use of resources, compatibility with domestic legal provisions, compliance with obligations arising from international conventions and agreements, establishment of partnerships and participation of all interested groups, use of a holistic approach to the preservation and cultivation of forests, and selection of a long-term and iterative planning, implementation, and monitoring process.

The entire Liechtenstein forest stock is certified according to the criteria of the Forest Stewardship Council (FSC, SGS-FM/COC-0764).

Summary of policies and measures in forestry sector (NA = not applicable)

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status of implementation	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative in CO_2 eq.)	
						2020	2025
Cultivation regulations in the Forestry Act	Sustainable cultivation of forests	CO_2 (sinks)	Law	Implemented 1991 Last update: 2015	Office of Environment	NA	NA
Forest Regulation	Performance target	CO_2 (sinks)	Law	Implemented 1995 Last update: 2015	Office of Environment	NA	NA
Ordinance on forest reserves and protected areas	Performance target	CO_2 (sinks)	Law	Implemented 2000 Last update: 2007	Office of Environment	NA	NA
Forest Inventory 1998 and National Forest Programme (2002–2012)	Binding specifications for future use of forests; development of a Forest Inventory 2010	CO_2 (sinks)	Planning measures, Law	Implemented 2001	Office of Environment	NA	NA
FSC certification of the entire forest stock	Performance target	CO_2 (sinks)	Operational planning	Implemented 2001	Office of Environment	NA	NA

4.8 Waste Management

In Liechtenstein, the Ministry of Environment together with the Office of Environment is responsible for developing legislation and policies to ensure the recovery and environmentally sound disposal of waste, coordinating the planning of waste disposal facilities and implementing the policy framework in close collaboration with the eleven municipalities. The basis for waste legislation in Liechtenstein is the Environmental Protection Act (2008) (see also Section 4.2.4).

Because of the Customs Treaty with Switzerland the Swiss waste law also applies in Liechtenstein and there is no custom control between Liechtenstein and Switzerland. The borders are controlled by Swiss authorities. The Swiss Federal Office for the Environment (FOEN) monitors the import, export and transit of waste and hazardous waste for Liechtenstein. Switzerland is a member of the OECD and the Basel Convention and therefore carries out these controls according to the OECD and the Basel Convention-Decisions. The authorities of Liechtenstein will be informed in every case and have the possibility to refuse unwanted exports, imports and transits of waste under control.

In addition, the Ordinance on the Reduction of Risks relating to the use of certain particularly dangerous substances, preparations and articles (Chemical Risk Reduction Ordinance, ORRChem)

contains special regulations in terms of restrictions and prohibitions for handling certain types of chemicals. Pursuant to the Customs Treaty, these provisions are also applicable to Liechtenstein.

Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) is a European Union Regulation (2006). The aim of REACH is to improve the protection of human health and the environment by holding industry responsible for managing the risks from chemicals and for providing safety information on the substances. The Regulation also requires the progressive substitution of the most dangerous chemicals (referred to as "substances of very high concern") with suitable alternatives. REACH entered into force in 2008. The regulation and its related ordinances are also applicable in Liechtenstein.

The Waste Management Plan which also includes the Waste Prevention Programme was passed by the government in January 2020. The Waste Management Plan contains different measures concerning collaboration, disposal and biogenic waste for each municipality and for the Office of Environmental Protection. The Waste Management Plan mainly concentrates on the landfill planning. There is also a plan to develop a nationwide concept for the energetic recovery and reuse of compost. The Waste Prevention Programme includes measures to reduce the amount of waste by awareness-raising measures and dissemination of information to the public.

Summary of policies and measures in waste management sector (NA = not applicable)

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status of implementation	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative,in CO_2 eq.)	
						2020	2025
Environmental Protection Act	Legal basis for all regulations and ordinances, especially with respect to air pollution and waste treatment	all	Law	Implemented 2008	Office of Environmental Protection	NA	NA
REACH	Manufacturers and importers are required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database run by the European Chemicals Agency (ECHA)	all	Law	2007	Office of Environmental Protection	NA	NA
Ordinance on Prevention and disposal of waste	Interdiction of landfilling of combustible waste	CH_4, CO_2	Law	implemented since 2016	Office of Environmental Protection	NA	NA

4.9 International cooperation

International cooperation is an important pillar of Liechtenstein's climate policy, given the small size of the country and its limited capacities. Liechtenstein ratified the Climate Convention on 22 June 1994 and the Kyoto Protocol on 3 December 2004, thereby taking on the obligation of reducing its greenhouse gas emissions during the period of 2008–2012 by 8% relative to 1990. On 23 February 2015 Liechtenstein accepted the Doha Amendment of the Kyoto Protocol and therefore is committed to a second period from 2013 to 2020. In 2020 Liechtenstein reached its target to reduce its greenhouse gas emissions by at least 20% compared to 1990. On 20 September 2017, Liechtenstein ratified the Paris Agreement and is committed to reducing its greenhouse gas emissions by 40% below 1990 levels by 2030, making use of market mechanisms to reach its goal.

Liechtenstein is also State party to several other environmental agreements. The following agreements relevant to climate protection should be mentioned in this context:

- Vienna Convention for the Protection of the Ozone Layer;
- Montreal Protocol on Substances that Deplete the Ozone Layer;
- Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, particularly in Africa;
- Convention on Environmental Impact Assessment in a Transboundary Context;
- Convention on the Protection of the Alps and its protocols on spatial planning and sustainable development, mountain farming, conservation of nature and landscape preservation, mountain forests, tourism, soil protection, energy, transport, and settlement of disputes;
- Member of the International Renewable Energy Agency (IRENA) since 2009.

Another climate related agreement is the Convention on Long-Range Transboundary Air Pollution. Liechtenstein has also ratified seven of the eight protocols, namely those concerning Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30%, Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes, Further Reduction of Sulphur Emissions, Persistent Organic Pollutants (POPs), Heavy Metals and Control of Nitrogen Oxides or their Transboundary Fluxes. In 1999, Liechtenstein also signed the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone.

4.10 Policies and measures no longer in place

Until 2010 the Government supported private purchases of electric scooters and electric bicycles by up to 50% of the costs. This achieved an increased substitution of short automobile rides.

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5 Projections and the total effect of policies and measures

This section covers Liechtenstein's greenhouse gas emissions under the three scenarios 'without measures' (WOM), 'with measures' (WM) and 'with additional measures' (WAM) according to the guidelines for the preparation of national communications (UNFCCC 2019):

- The 'without measures' (WOM) scenario projection excludes all policies and measures implemented, adopted or planned after the year chosen as the starting point for that projection. For Liechtenstein's NC8, this starting year is 2008. 2008 was the year when the Energy Efficiency Act was adopted in Liechtenstein, and no other (quantifiable) measures were implemented earlier than 2008 in Liechtenstein.
- The 'with measures' (WM) scenario projection encompasses currently implemented and adopted policies and measures. In Liechtenstein, projections based on specific measures are only available for the sector Energy (1A Fuel combustion). For the waste sector projections were calculated based on past emissions and the expected growth in population. Projections for the sectors Energy (1B Fugitive emissions from fuels) as well as for IPPU (2) and Agriculture (3) were adopted from Switzerland's WM projection in its NC8 (FOEN 2022). The projections for LULUCF were assumed to be constant (mean of the latest five inventory years). The projection of international bunkers is also assumed to be constant (mean of last 10 years; note that within the last 10 years, only minor fluctuations occurred in reported emissions).
- The 'with additional measures' (WAM) scenario projection also encompasses planned policies and measures. The Climate Strategy 2050 (Government 2022) defines additional measures for the sectors Energy, IPPU, Agriculture and Waste. Projections under the WAM scenario are therefore adopted from the Climate Strategy 2050.

Liechtenstein's greenhouse gas emissions primarily originate the Energy sector, responsible for 80.1% of Liechtenstein's total emissions in 2020 (see section 3.2.3). Therefore, the focus for the elaboration of Liechtenstein's projections in its NC8 lies on the Energy sector.

Section 5.1 describes the legal basis, included measures and the WOM, WM and WAM projections disaggregated by sector and gas. Section 5.2 depicts the aggregate effect of policies and measures (see section 4 for more detail on these measures), and section 5.3 gives an insight into the methods applied for the projections.

5.1 Projections

5.1.1 Legal basis

The general legal basis for measures considered under the WM and WAM scenarios are described in section 4. The following acts directly impact (total) greenhouse gas emissions in Liechtenstein:

- Environment: Environmental Protection Act

- Climate: Emissions Trading Act and CO_2 Act
- Energy: Energy Efficiency Act
- Transport: HVF, promotion of public transport and green vehicles/fuels
- Agriculture / Forestry: Forestry Act
- Waste: Environmental Protection Act, Technical ordinance on waste

Based on these acts, a number of policies and measures have already been implemented, are currently being implemented or are planned (see section 4).

5.1.2 Policies and measures considered

This section gives an overview over estimated mitigation impacts of included policies and measures (see section 4).

Figure 5-1 shows the main drivers of the WM, WOM and WAM scenarios. Until 2035, a slight increase in population is expected and the number of employees also shows an increasing trend, especially the number of employees commuting from outside Liechtenstein.

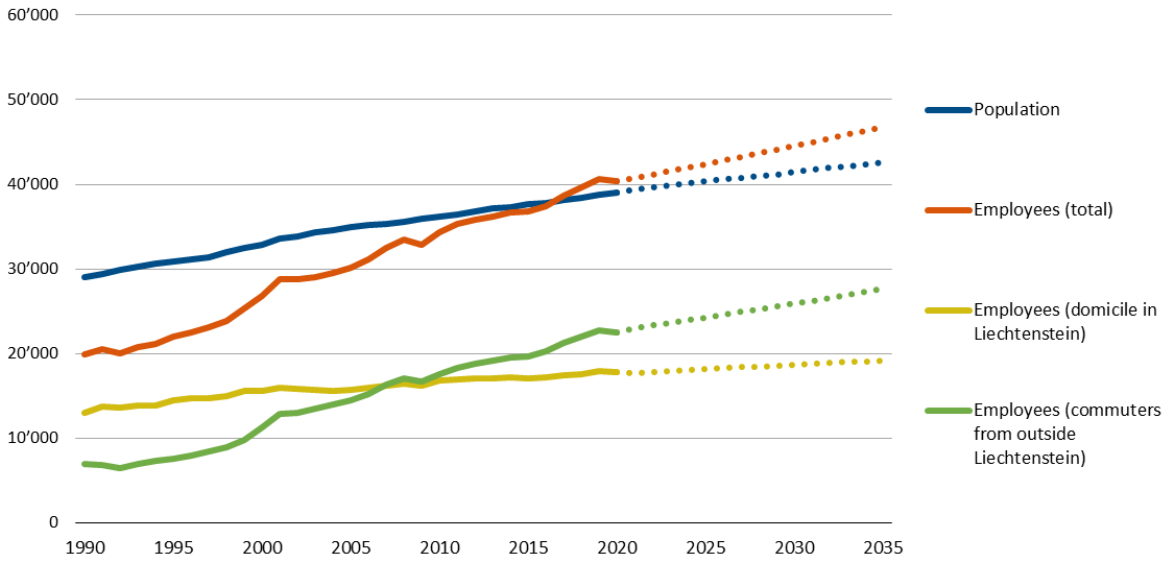

Figure 5-1 Past and projected development of the population and employees in Liechtenstein (adopted from the Climate Strategy 2050; Government 2022).

Sector 1 Energy

The greenhouse gas reduction measures described in this section are taken from the Energy Efficiency Act (EEG 2008) and from Liechtenstein's Energy Strategy (Government 2020).

Under the **Energy Efficiency Act** (EEG 2008, see also section 4.3), Liechtenstein introduced various measures to counter rising energy consumption. The most relevant measures in place are subsidies for the refurbishment of old buildings, solar thermal and photovoltaic systems and the substitution of conventional fossil heating systems by heat pumps and wood firing. In addition, municipalities in Liechtenstein individually complement these national measures.

Liechtenstein's Energy Strategy 2030, and the related long-term low-emissions development strategy "Energy Vision 2050", consist of a package of energy related measures. The strategy is aimed at delivering three targets:

- reduction of greenhouse gas emissions by 40% in 2030 below 1990 levels, of which at least 30% within the country. For 2050, a reduction of 80% below 1990 is set, including a 100% reduction in the energy sector.
- An increase in the share of renewable energy which should reach 30%, of which at least 17% within the country (compared with 8% in 2008 and 22% in 2018). The target for 2050 is 58%.
- A reduction in final energy use of 20% below 2008 levels (2018 achieved reduction level: 8%). The target for 2050 is 40% below 2008 levels.

In 2021, the Government published its first annual monitoring report under the new Energy Strategy 2030 and appeared to be on track to achievement of the goals, though most of the implementation period still lies ahead (Government 2021).

Table 5-1 shows the measures considered in the energy sector for scenarios WM and WAM. Table 5-2 shows the aggregated effect of those measures in the energy sub-sectors. Note that the measure on subsidy of photovoltaic systems is not shown as it only impacts emissions reductions of imported electricity.

Table 5-1 Energy sector measures considered for projections of emissions. Shown are cumulative reductions per 5-year period relative to emissions in the last year of the previous period (negative sign refers to an increase instead of a reduction).

Sector	Measure	Scenario	Expected emission reductions in period [t CO2eq]			
			2021–2025	2026–2030	2031–2035	Total
1A4	Energy efficiency through building retrofits	WM	1,258	1,250	1,250	3,758
		WAM	1,258	1,250	1,250	3,758
1A4	Incentivisation of 'Minergie' building standard	WM	21	22	22	65
		WAM	21	22	22	65
1A4	Wood pellet heating	WM	1,175	1,175	1,175	3,525
		WAM	1,645	1,763	1,763	5,170
1A4	Heat pumps	WM	4,489	4,000	4,000	12,489
		WAM	6,089	6,000	6,000	18,089
1A4	Solar thermal collectors	WM	-846	-842	-	-1,688
		WAM	-846	-842	-	-1,688
1A4	Heat pump boilers	WM	342	345	345	1,032
		WAM	342	345	345	1,032
1A4	Minimum standards for new buildings	WM	177	443	443	1,064
		WAM	177	443	443	1,064
1A3	Electric vehicle incentivisation	WM	4,813	7,812	9,441	22,066
		WAM	4,989	9,629	13,433	28,052
1A2 1A4	Efficiency standards for electrical equipment and illumination	WM	1,365	1,365	-	2,730
		WAM	1,365	1,365	-	2,730
1A2	Efficiency measures in industry and commerce	WM	95	66	66	226
		WAM	95	66	66	226
1A2	Heat recovery in industry and district heat deployment	WM	2,665	3,331	645	6,641
		WAM	2,665	3,331	645	6,641
1A1	Combined heat and power	WM	-40	-50	-50	-139
		WAM	-40	-50	-50	-139
1A2 1A4	Biomass heat plants	WM	-	-	-	-
		WAM	3,285	-	-	3,285
1A2 1A4	Biogas use	WM	-	-	-	-
		WAM	1,643	-	-	1,643

Table 5-2 Aggregated effect of energy measures. Shown are cumulative reductions per 5-year period relative to emissions in the last year of the previous period.

Sector	Measure	Scenario	Expected emission reductions in period [t CO2eq]			
			2021–2025	2026–2030	2031–2035	Total
1A1	Energy industries (total)	WM	-40	-50	-50	-139
		WAM	-40	-50	-50	-139
1A2	Manufacturing industries and constr	WM	3,033	3,670	711	7,414
		WAM	5,661	3,670	711	10,042
1A3	Transport (total)	WM	5,011	7,812	9,441	22,264
		WAM	5,187	9,629	13,433	28,250
1A4	Other sectors (total)	WM	7,709	7,486	7,235	22,430
		WAM	12,078	10,073	9,823	31,974
1A5	Other (total)	WM	*NO*	*NO*	*NO*	*NO*
		WAM	*NO*	*NO*	*NO*	*NO*
1A	Fuel combustion (total)	WM	15,515	18,918	17,338	**51,770**
		WAM	22,689	23,323	23,918	**69,929**

No projections for sector 1B Fugitive emissions from fuel use are available for Liechtenstein. Therefore, the Swiss projections were adopted. Due to the bilateral agreement on environmental levies between Switzerland and Liechtenstein (see section 4.1 the Swiss projections are comparable to the circumstances in Liechtenstein.

5.1.3 'Without Measures' (WOM) scenario

The WOM scenario for Liechtenstein's NC8 is based on the WOM scenario from Liechtenstein's Biennial Report 4 (BR4, OE 2020). The starting year for the WOM is 2008, in alignment with the starting year for the WOM scenario in Liechtenstein's BR4. 2008 was the year when the Energy Efficiency Act was adopted in Liechtenstein, and no other (quantifiable) measures were implemented earlier than 2008 in Liechtenstein. The WOM scenario assumes that no measures were or will be implemented in the years 2008–2035.

The projection of the WOM scenario is shown in section 5.2.1.

5.1.4 'With Measures' (WM) scenario

The most relevant reduction potentials in the WM scenario are in the Energy sector. The potentials are based on values in the Energy Strategy 2030, in combination with most recent reported values, where available, and input from the experts at the Bureau of Energy Consumption and Conservation.

The projections under the WM scenario for the greenhouse gases CO_2, CH_4, N_2O and F-Gases are shown below. Note that no projections are available for precursor gases and SO_2. NF_3 is not occurring (NO) in Liechtenstein.

5.1.4.1 Projection of CO_2 emissions in the WM scenario

Table 5-3 and Figure 5-2 show the development of CO_2 emissions between 1990 and 2035.

From 1990 to 2020 (reported values), CO_2 emissions (excl. LULUCF) decreased by 28.6%. CO_2 emissions are dominated by the energy sector. Fluctuations in emissions mainly stem from different weather conditions (warm and cold winters) and fluctuating heating degree days influencing category 1A4 Other sectors.

From 2020 to 2035, a further reduction of CO_2 emissions (excl. LULUCF) by 33.1% is expected. A major share of these projected reductions is attributed to sector 1A4 Other sectors, 1A3 Transport and 1A2 Manufacturing industries and construction, and in particular to the measures

from the Energy Strategy 2030: (energetic) renovation of buildings, heating pumps and electric mobility.

In total, the reduction of CO_2 emissions (excl. LULUCF) under the WM scenario in the period 1990-2035 is assumed to amount 52.3%.

Table 5-3 CO_2 emissions by sector for the WM scenario (1990–2035; reported values for 1990-2020 from OE 2022; projected values for 2021-2035)[19]

	CO_2 in kt CO_2eq										
		Reported data (GHG inventories)							**Projections**		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WM)**	**198.97**	**204.20**	**216.86**	**228.99**	**190.83**	**159.77**	**142.00**	**130.95**	**112.17**	**95.00**
1	**Energy**	**198.70**	**203.98**	**216.63**	**228.73**	**190.63**	**159.58**	**141.82**	**130.80**	**112.06**	**94.90**
1A	Fuel combustion	198.70	203.98	216.63	228.73	190.63	159.58	141.82	130.80	112.06	94.90
	1A1 Energy industries	0.12	2.00	2.67	3.03	3.15	2.02	2.41	2.45	2.49	2.54
	1A2 Manufacturing industries & constr.	36.19	35.60	36.31	39.03	25.98	27.49	22.77	19.75	16.10	15.39
	1A3 Transport	75.36	80.30	89.84	81.08	77.08	61.31	52.21	51.80	44.07	34.73
	1A4 Other sectors	87.02	86.09	87.82	105.58	84.41	68.76	64.43	56.80	49.39	42.23
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	**Industrial processes and product use**	**0.20**	**0.16**	**0.17**	**0.20**	**0.15**	**0.14**	**0.12**	**0.10**	**0.06**	**0.06**
3	**Agriculture**	**0.06**	**0.05**	**0.05**	**0.05**	**0.04**	**0.05**	**0.04**	**0.04**	**0.04**	**0.04**
4	**LULUCF**	**7.27**	**5.04**	**24.80**	**9.00**	**20.59**	**11.78**	**4.45**	**11.36**	**11.36**	**11.36**
5	**Waste**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.48**	**0.84**	**1.19**	**0.93**	**1.04**	**1.04**	**1.04**

[19] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data used to prepare the projections are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

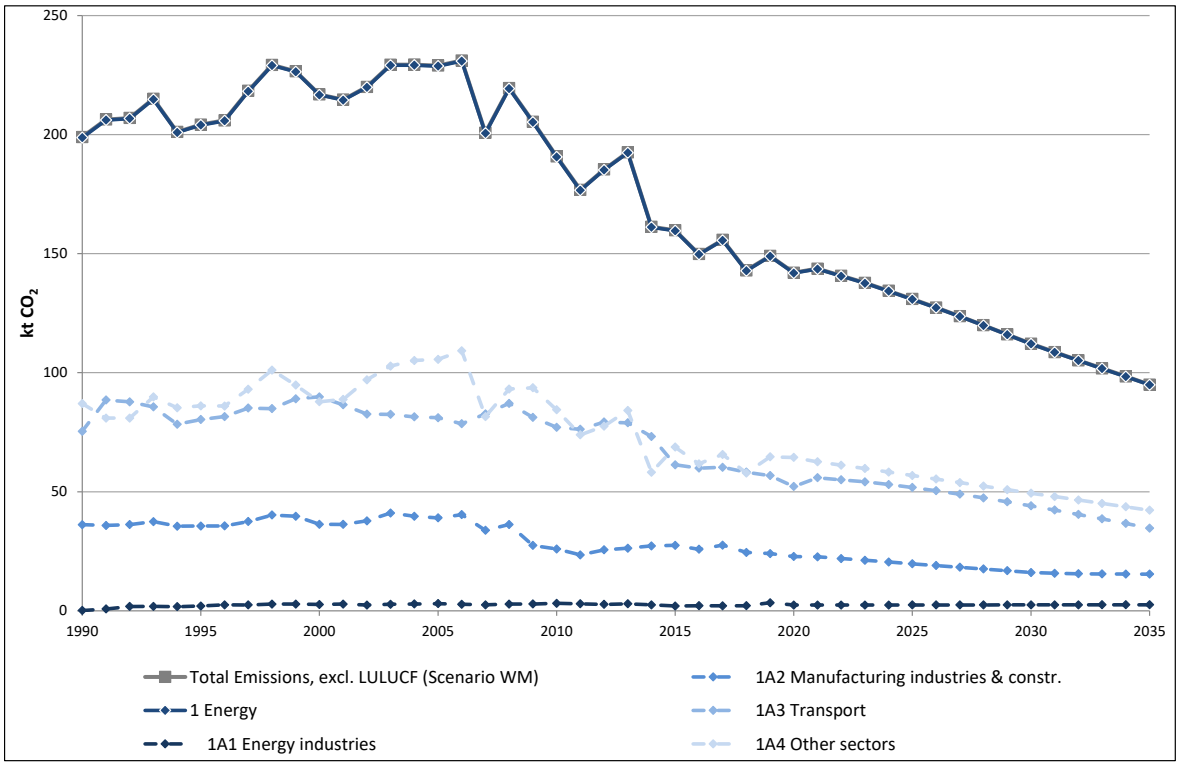

Figure 5-2 CO_2 emissions by sector (excl. LULUCF) from 1990 to 2035 for the scenario WM. Sectors IPPU, Agriculture and Waste cause negligible CO_2-emissions compared to the Energy sector. Thus, the CO_2-emissions from these sectors are not shown separately on the graph.

5.1.4.2 Projection of CH_4 emissions in the WM scenario

Table 5-4 and Figure 5-3 show the development of CH_4 emissions between 1990 and 2035.

From 1990 to 2020 (reported values), CH_4 emissions (excl. LULUCF) increased by 0.4%. The main contributor to CH_4 emissions is the sector Agriculture, where animal numbers have a high influence on emissions (especially source category 3A Enteric fermentation).

From 2020 to 2035, a further increase of CH_4 emissions (excl. LULUCF) by 1.7% is expected. This increase is mainly driven by the increase of fugitive CH_4 emissions in sector 1B. An error in the preparation of the GHG-inventory in submission 2022 led to an underestimation of CH_4 emissions by 0.4kt CO_2eq in the year 2020 in sector 1B (OE 2022). Until 2035, CH_4 emissions in sector 1B are expected to be constant at the level of 2019 (i.e. by 0.4 kt CO_2eq higher compared to the emissions reported for the year 2020).

From 2020 to 2035, agricultural CH_4 emissions are expected to decrease and CH_4 emissions from the waste sector are expected to increase.

In total, the increase of CH_4 emissions (excl. LULUCF) under the WM scenario in the period 1990–2035 is assumed to amount 2%.

Table 5-4 CH_4 emissions by sector for the WM scenario (1990-2035; reported values for 1990–2020 from OE 2022; projected values for 2021–2035)[20]

	CH_4 in kt CO_2eq										
		Reported data (GHG inventories)							**Projections**		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WM)**	**19.24**	**17.92**	**16.69**	**18.49**	**19.01**	**19.01**	**19.31**	**19.68**	**19.62**	**19.63**
1	**Energy**	**1.28**	**1.31**	**1.52**	**1.70**	**1.70**	**1.63**	**1.19**	**1.56**	**1.51**	**1.47**
1A	Fuel combustion	0.91	0.71	0.69	0.62	0.57	0.48	0.41	0.37	0.33	0.28
	1A1 Energy industries	0.00	0.02	0.03	0.04	0.04	0.02	0.03	0.03	0.03	0.03
	1A2 Manufacturing industries & constr.	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
	1A3 Transport	0.63	0.41	0.34	0.22	0.15	0.09	0.07	0.07	0.06	0.05
	1A4 Other sectors	0.27	0.25	0.30	0.34	0.37	0.35	0.30	0.27	0.23	0.20
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
2	**Industrial processes and product use**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
3	**Agriculture**	**16.85**	**15.57**	**14.13**	**15.75**	**16.36**	**16.45**	**17.18**	**17.12**	**17.06**	**17.06**
4	**LULUCF**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
5	**Waste**	**1.11**	**1.05**	**1.04**	**1.04**	**0.95**	**0.93**	**0.94**	**1.00**	**1.05**	**1.11**
Memo item	**International bunkers (aviation)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

[20] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data used to prepare the projections are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

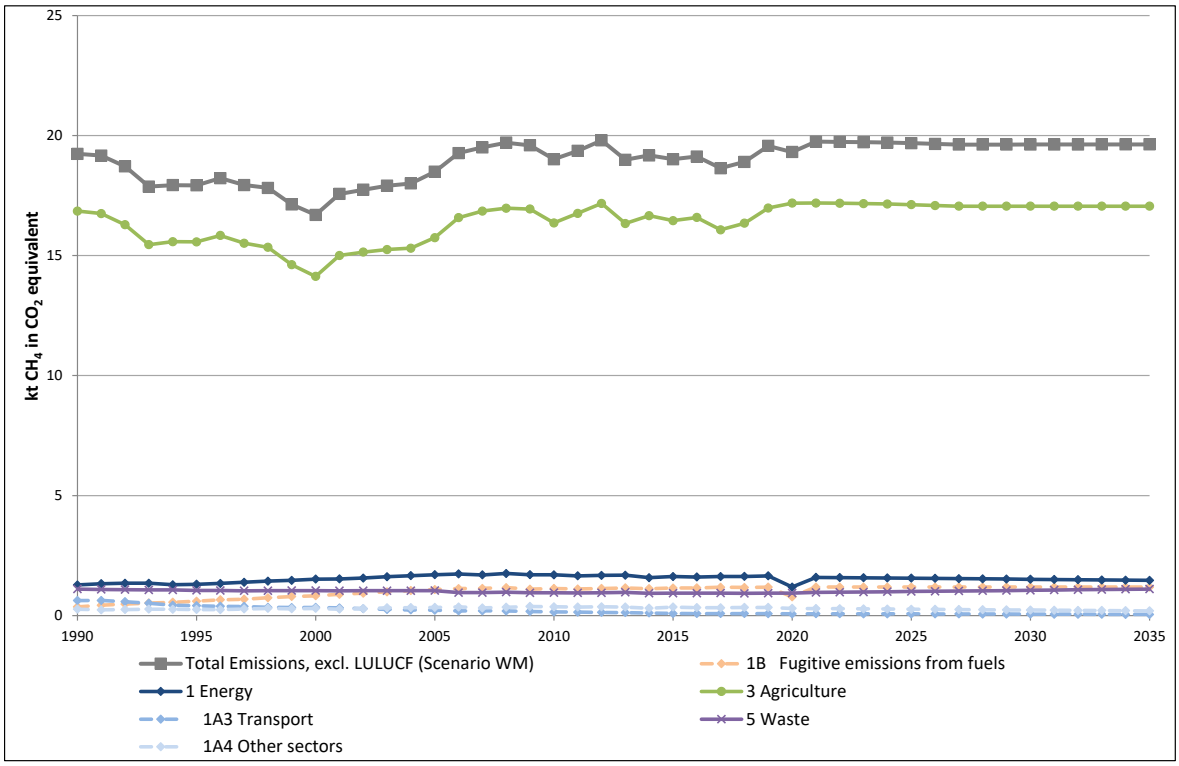

Figure 5-3 CH_4 emissions by sector (excl. LULUCF) from 1990 to 2035 for the scenario WM

5.1.4.3 Projection of N_2O emissions in the WM scenario

Table 5-5 and Figure 5-4 show the development of N_2O emissions between 1990 and 2035.

From 1990 to 2020 (reported values), N_2O emissions (excl. LULUCF) decreased by 10.5%. Similar to CH_4, the main contributor to N_2O emissions is the sector Agriculture, where animal numbers have a high influence on emissions (especially source category 3B Manure Management and 3D Agricultural Soils).

From 2020 to 2035, a further reduction of N_2O emissions (excl. LULUCF) by 3.6% is expected. Similar to CH_4, agricultural N_2O emissions are expected to decrease and N_2O emissions from the waste sector are expected to increase.

In total, the reduction of N_2O emissions (excl. LULUCF) under the WM scenario in the period 1990–2035 is assumed to amount 13.8%.

Table 5-5 N_2O emissions by sector for the WM scenario (1990–2035; reported values for 1990–2020 from OE 2022; projected values for 2021–2035)

	N_2O in kt CO_2eq										
		Reported data (GHG inventories)							Projections		
IPCC	Source/Sink Categories	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Total	Emissions, excl. LULUCF (Scenario WM)	10.27	10.18	9.48	9.12	9.29	9.17	9.19	9.12	8.96	8.86
1	Energy	1.28	1.77	1.91	1.02	1.10	0.97	0.94	0.88	0.76	0.62
1A	Fuel combustion	1.28	1.77	1.91	1.02	1.10	0.97	0.94	0.88	0.76	0.62
	1A1 Energy industries	0.05	0.06	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00
	1A2 Manufacturing industries & constr.	0.09	0.08	0.08	0.09	0.08	0.09	0.08	0.07	0.06	0.06
	1A3 Transport	0.89	1.39	1.44	0.51	0.52	0.45	0.48	0.48	0.41	0.32
	1A4 Other sectors	0.26	0.25	0.31	0.35	0.43	0.43	0.38	0.33	0.29	0.25
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
2	Industrial processes and product use	0.46	0.37	0.27	0.24	0.20	0.16	0.14	0.12	0.08	0.06
3	Agriculture	7.99	7.48	6.74	7.28	7.33	7.37	7.44	7.41	7.39	7.39
4	LULUCF	0.30	0.29	0.34	0.39	0.41	0.43	0.39	1.00	1.00	1.00
5	Waste	0.54	0.56	0.57	0.58	0.66	0.68	0.66	0.71	0.74	0.78
Memo item	International bunkers (aviation)	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01

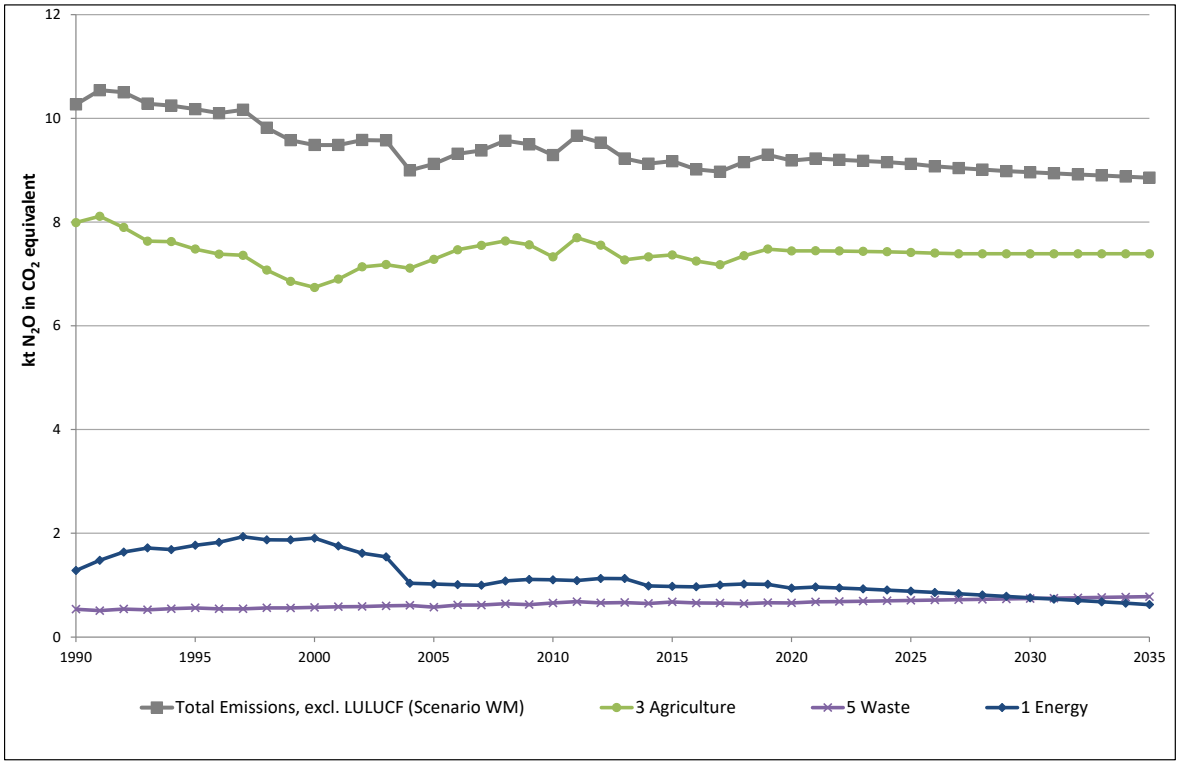

Figure 5-4 N_2O emissions by sector (excl. LULUCF) from 1990 to 2035 for the scenario WM

5.1.4.4 Projection of F-Gas emissions in the WM scenario

Table 5-6 and Figure 5-5 show the development of F-Gas emissions (HFC, PFC and SF_6) between 1990 and 2035.

From 1990 to 2020 (reported values), F-Gas emissions increased by a factor of about 87,000. F-Gas emissions reached a peak in 2018 and have decreased slightly thereafter. F-Gas emissions are vastly dominated by HFC.

From 2020 to 2035, F-Gas emissions are expected to decrease by 54.9%.

In total, F-Gas emissions in the period 1990–2035 under the WM scenario are assumed to increase by a factor of about 39,000. However, the increasing trend is expected to have stopped in 2018.

Table 5-6 F-Gas emissions (HFC, PFC, SF6) by sector for the WM scenario (1990–2035; reported values for 1990–2020 from OE 2022; projected values for 2021–2035)

	HFC, PFC and SF_6 in kt CO_2eq										
		Reported data (GHG inventories)							**Projections**		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WM)**	**0.00**	**1.24**	**3.97**	**7.04**	**9.03**	**10.19**	**9.17**	**7.58**	**4.81**	**4.14**
2F	Product uses as ODS substitutes	0.00	1.24	3.97	7.04	9.03	10.19	9.17	7.58	4.81	4.14
	HFC	0.00	1.24	3.87	6.73	8.95	10.13	9.11	7.53	4.78	4.11
	PFC	NO	0.00	0.01	0.05	0.05	0.01	0.00	0.00	0.00	0.00
	SF_6	NO	NO	0.09	0.26	0.02	0.04	0.05	0.04	0.03	0.02

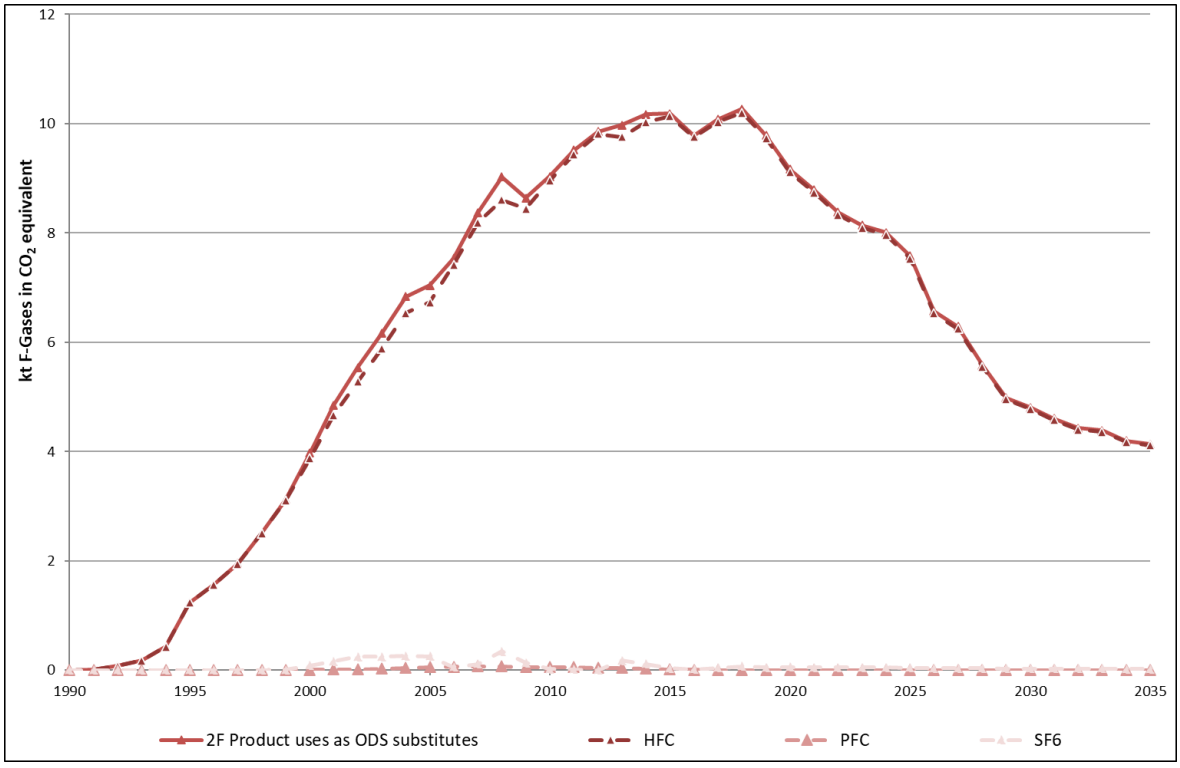

Figure 5-5 F-Gas emissions (HFC, PFC, SF_6) by sector from 1990 to 2035 for the scenario WM

5.1.5 'With Additional Measures' (WAM) scenario

The WAM scenario includes further or more ambitious measures from the Climate Strategy 2050 (Government 2022), which defines measures for all sectors with the aim to reach climate neutrality in 2050.

The projections under the WAM scenario for the greenhouse gases CO_2, CH_4, N_2O and F-Gases are shown below. Note that no projections are available for precursor gases and SO_2. NF_3 is not occurring (NO) in Liechtenstein.

5.1.5.1 Projection of CO_2 emissions in the WAM scenario

Table 5-7 and Figure 5-6 show the development of CO_2 emissions between 1990 and 2035.

From 1990 to 2020 (reported values), CO_2 emissions (excl. LULUCF) decreased by 28.6%. CO_2 emissions are dominated by the energy sector. Fluctuations in the development of emissions stem mostly from different weather conditions (warm and cold winters) and fluctuating heating degree days influencing category 1A4 Other sectors.

From 2020 to 2035, a further reduction of CO_2 emissions (excl. LULUCF) by 45.8% is expected.

The main reason for this is the expected reduction in emissions in the Energy sector. The reductions represent an estimate of the expected impact of measures defined in the Climate Strategy 2050 (Government 2022), such as the ban of oil and gas heating systems and the adjustment of the motor vehicle tax for fossil fuel vehicles.

In total, the reduction of CO_2 emissions (excl. LULUCF) under the WAM scenario in the period 1990–2035 is assumed to amount 61.3%.

Table 5-7 CO_2 emissions by sector for the WAM scenario (1990-2035; reported values for 1990-2020 from OE 2022; projected values for 2020-2035)[21]

	CO_2 in kt CO_2eq										
		Reported data (GHG inventories)							Projections		
IPCC	Source/Sink Categories	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Total	**Emissions, excl. LULUCF (Scenario WAM)**	**198.97**	**204.20**	**216.86**	**228.99**	**190.83**	**159.77**	**142.00**	**123.82**	**100.69**	**76.98**
1	**Energy**	**198.70**	**203.98**	**216.63**	**228.73**	**190.63**	**159.58**	**141.82**	**123.69**	**100.58**	**76.91**
1A	Fuel combustion	198.70	203.98	216.63	228.73	190.63	159.58	141.82	123.69	100.58	76.91
	1A1 Energy industries	0.12	2.00	2.67	3.03	3.15	2.02	2.41	2.45	2.49	2.54
	1A2 Manufacturing industries & constr.	36.19	35.60	36.31	39.03	25.98	27.49	22.77	17.13	13.48	12.77
	1A3 Transport	75.36	80.30	89.84	81.08	77.08	61.31	52.21	51.63	42.10	28.81
	1A4 Other sectors	87.02	86.09	87.82	105.58	84.41	68.76	64.43	52.48	42.51	32.79
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	**Industrial processes and product use**	**0.20**	**0.16**	**0.17**	**0.20**	**0.15**	**0.14**	**0.12**	**0.09**	**0.06**	**0.03**
3	**Agriculture**	**0.06**	**0.05**	**0.05**	**0.05**	**0.04**	**0.05**	**0.04**	**0.04**	**0.03**	**0.03**
4	**LULUCF**	**7.27**	**5.04**	**24.80**	**9.00**	**20.59**	**11.78**	**4.45**	**11.36**	**11.36**	**11.36**
5	**Waste**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.48**	**0.84**	**1.19**	**0.93**	**1.04**	**1.04**	**1.04**

[21] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data used to prepare the projections are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

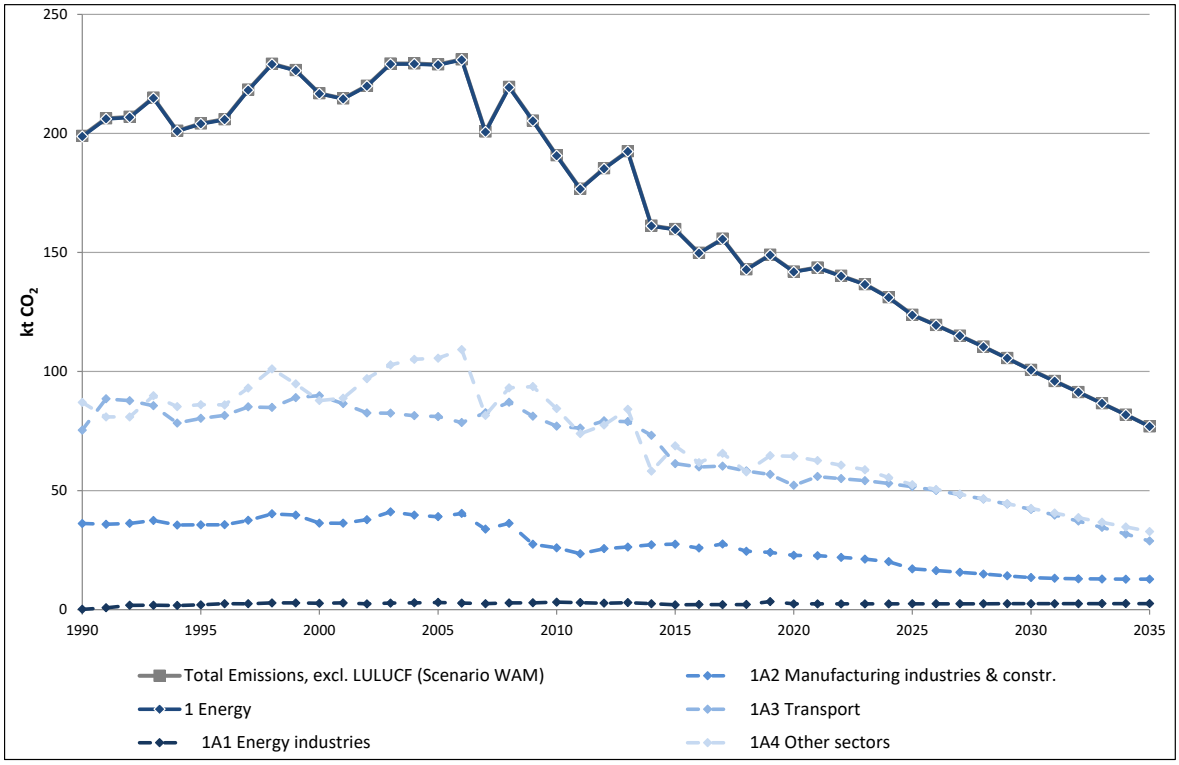

Figure 5-6 CO_2 emissions by sector (excl. LULUCF) from 1990 to 2035 for the scenario WAM

5.1.5.2 Projection of CH_4 emissions in the WAM scenario

Table 5-8 and Figure 5-7 show the development of CH_4 emissions between 1990 and 2035.

From 1990 to 2020 (reported values), CH_4 emissions (excl. LULUCF) increased by 0.4%. The main contributor to CH_4 emissions is the sector Agriculture, where animal numbers have a high influence on emissions (especially source category 3A Enteric fermentation).

From 2020 to 2035, a reduction of CH_4 emissions (excl. LULUCF) by 22.1% is expected. The main reason for this is the expected reduction in agricultural emissions due to measures defined in the Climate Strategy 2050 (Government 2022), e.g., training programmes and improvements in animal husbandry.

In total, the reduction of CH_4 emissions (excl. LULUCF) under the WAM scenario in the period 1990–2035 is assumed to amount 21.8%.

Table 5-8 CH_4 emissions by sector for the WAM scenario (1990–2035; reported values for 1990–2020 from OE 2022; projected values for 2021–2035)[22]

	CH_4 in kt CO_2eq										
		Reported data (GHG inventories)							Projections		
IPCC	Source/Sink Categories	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Total	Emissions, excl. LULUCF (Scenario WAM)	19.24	17.92	16.69	18.49	19.01	19.01	19.31	17.91	16.48	15.05
1	Energy	1.28	1.31	1.52	1.70	1.70	1.63	1.19	1.54	1.48	1.41
1A	Fuel combustion	0.91	0.71	0.69	0.62	0.57	0.48	0.41	0.35	0.29	0.23
	1A1 Energy industries	0.00	0.02	0.03	0.04	0.04	0.02	0.03	0.03	0.03	0.03
	1A2 Manufacturing industries & constr.	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00
	1A3 Transport	0.63	0.41	0.34	0.22	0.15	0.09	0.07	0.07	0.06	0.04
	1A4 Other sectors	0.27	0.25	0.30	0.34	0.37	0.35	0.30	0.25	0.20	0.15
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
2	Industrial processes and product use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3	Agriculture	16.85	15.57	14.13	15.75	16.36	16.45	17.18	15.38	13.98	12.57
4	LULUCF	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5	Waste	1.11	1.05	1.04	1.04	0.95	0.93	0.94	0.99	1.03	1.06
Memo item	International bunkers (aviation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

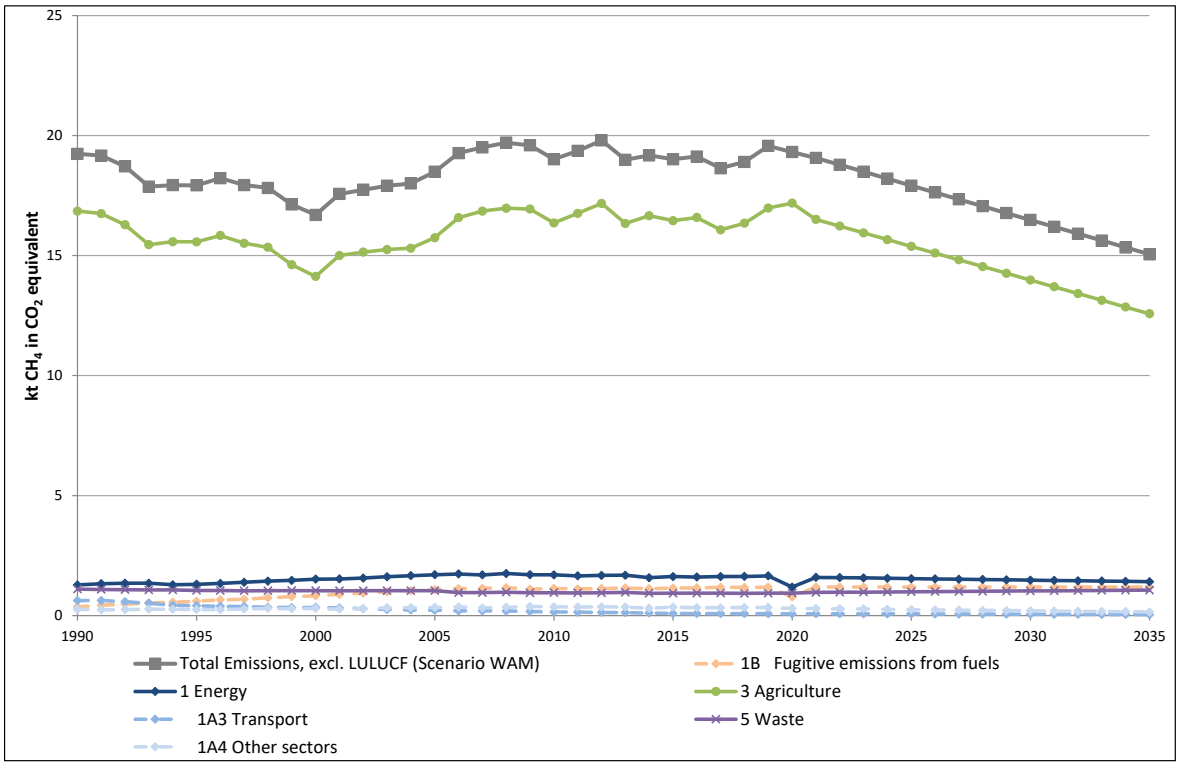

Figure 5-7 CH_4 emissions by sector (excl. LULUCF) from 1990 to 2035 for the scenario WAM

[22] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data used to prepare the projections are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

5.1.5.3 Projection of N_2O emissions in the WAM scenario

Table 5-9 and Figure 5-8 show the development of N_2O emissions between 1990 and 2035.

From 1990 to 2020 (reported values), N_2O emissions (excl. LULUCF) decreased by 10.5%. Similar to CH_4, the main contributor to N_2O emissions is the sector Agriculture, where animal numbers have a high influence on emissions (especially source category 3B Manure Management and 3D Agricultural soils).

From 2020 to 2035, a further reduction of N_2O emissions (excl. LULUCF) by 26.7% is expected. The main reason for this is the expected reduction in agricultural emissions du to measures defined in the Climate Strategy 2050 (Government 2022), e.g. improved soil management.

In total, the reduction of N_2O emissions (excl. LULUCF) under the WAM scenario in the period 1990–2035 is assumed to amount 34.5%.

Table 5-9 N_2O emissions by sector for the WAM scenario (1990-2035; reported values for 1990-2020 from OE 2022; projected values for 2021-2035)

	N_2O in kt CO_2eq										
		Reported data (GHG inventories)							**Projections**		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WAM)**	**10.27**	**10.18**	**9.48**	**9.12**	**9.29**	**9.17**	**9.19**	**8.31**	**7.53**	**6.73**
1	**Energy**	**1.28**	**1.77**	**1.91**	**1.02**	**1.10**	**0.97**	**0.94**	**0.85**	**0.69**	**0.51**
1A	Fuel combustion	1.28	1.77	1.91	1.02	1.10	0.97	0.94	0.85	0.69	0.51
	1A1 Energy industries	0.05	0.06	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00
	1A2 Manufacturing industries & constr.	0.09	0.08	0.08	0.09	0.08	0.09	0.08	0.06	0.05	0.05
	1A3 Transport	0.89	1.39	1.44	0.51	0.52	0.45	0.48	0.48	0.39	0.27
	1A4 Other sectors	0.26	0.25	0.31	0.35	0.43	0.43	0.38	0.31	0.25	0.19
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
2	**Industrial processes and product use**	**0.46**	**0.37**	**0.27**	**0.24**	**0.20**	**0.16**	**0.14**	**0.11**	**0.07**	**0.03**
3	**Agriculture**	**7.99**	**7.48**	**6.74**	**7.28**	**7.33**	**7.37**	**7.44**	**6.66**	**6.06**	**5.45**
4	**LULUCF**	**0.30**	**0.29**	**0.34**	**0.39**	**0.41**	**0.43**	**0.39**	**1.00**	**1.00**	**1.00**
5	**Waste**	**0.54**	**0.56**	**0.57**	**0.58**	**0.66**	**0.68**	**0.66**	**0.70**	**0.72**	**0.75**
Memo item	**International bunkers (aviation)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**

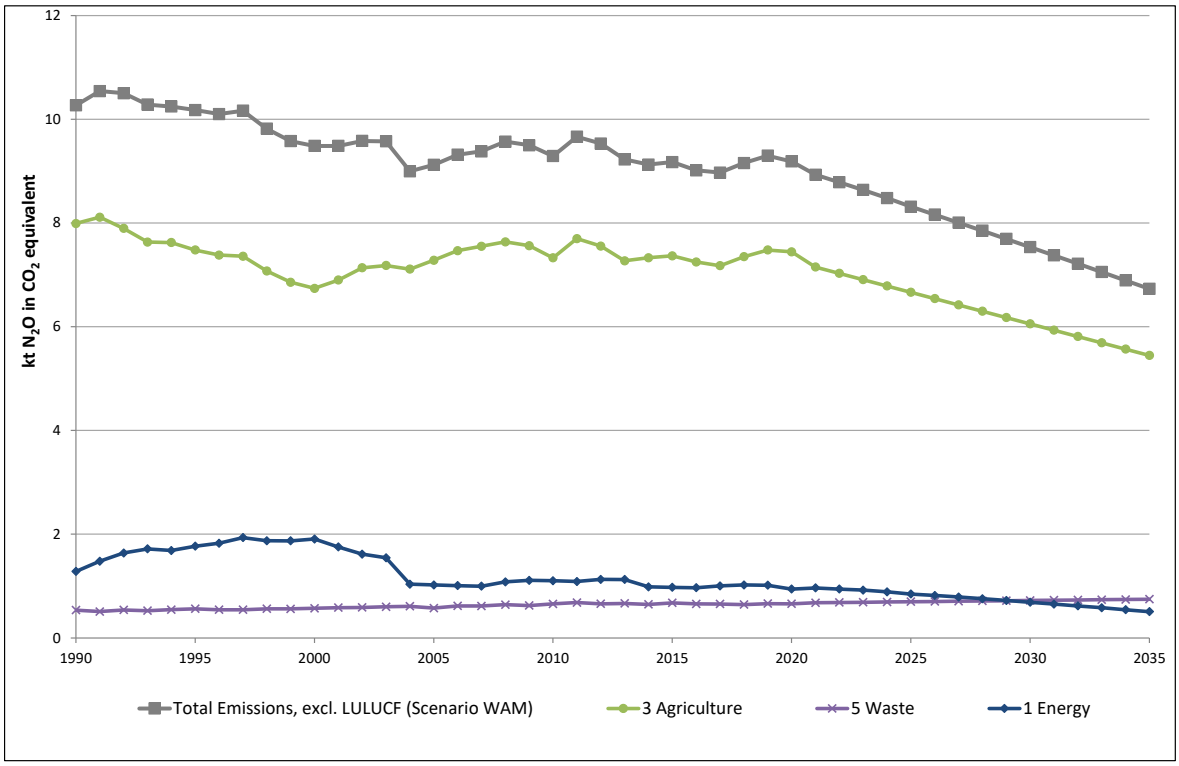

Figure 5-8 N_2O emissions by sector (excl. LULUCF) from 1990 to 2035 for the scenario WAM

5.1.5.4 Projection of F-Gas emissions in the WAM scenario

Table 5-10 and Figure 5-9 show the development of F-Gas emissions (HFC, PFC and SF_6) between 1990 and 2035.

From 1990 to 2020 (reported values), F-Gas emissions increased by a factor of about 87,000. F-Gas emissions reached a peak in 2018 and have decreased slightly thereafter. F-Gas emissions are vastly dominated by HFC.

From 2020 to 20355, F-Gas emissions are expected to decrease by 78.6%, which is the reduction reported in the Climate Strategy 2050 (Government 2022) for the IPPU sector, if the measures defined in the Climate Strategy 2050 are implemented.

In total, F-Gas emissions in the period 1990–2035 under the WAM scenario are assumed to increase by a factor of about 19,000. However, the increasing trend is expected to have stopped in 2018.

Table 5-10 F-Gas emissions (HFC, PFC, SF6) by sector for the WAM scenario (1990-2035; reported values for 1990-2020 from OE 2022; projected values for 2021-2035)

	HFC, PFC and SF_6 in kt CO_2eq										
		Reported data (GHG inventories)							**Projections**		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WAM)**	**0.00**	**1.24**	**3.97**	**7.04**	**9.03**	**10.19**	**9.17**	**6.84**	**4.40**	**1.96**
2F	Product uses as ODS substitutes	0.00	1.24	3.97	7.04	9.03	10.19	9.17	6.84	4.40	1.96
	HFC	0.00	1.24	3.87	6.73	8.95	10.13	9.11	6.80	4.37	1.95
	PFC	NO	0.00	0.01	0.05	0.05	0.01	0.00	0.00	0.00	0.00
	SF_6	NO	NO	0.09	0.26	0.02	0.04	0.05	0.04	0.03	0.01

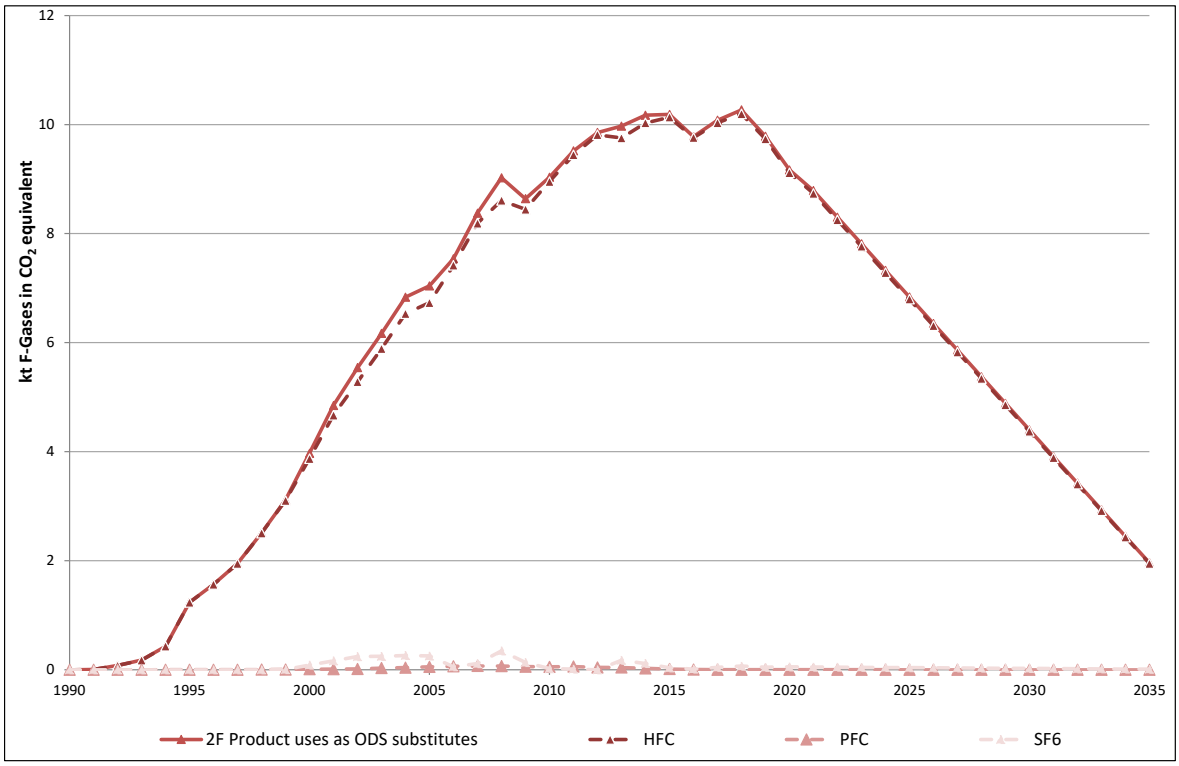

Figure 5-9 F-Gas emissions (HFC, PFC, SF_6) by sector from 1990 to 2035 for the scenario WAM

5.2 Assessment of aggregate effect of policies and measures

5.2.1 Aggregate effect in the WOM scenario

Table 5-11 shows the development of total GHG emissions in CO_2 equivalent between 1990 and 2035 for the WOM scenario. The WOM scenario is included in the figures depicting the developments under the WM and WAM scenarios (Figure 5-10 and Figure 5-11, respectively).

Under the WOM scenario, an increase of emissions by 16.3% is assumed for the time period 1990–2035. Between 1990-2008 (starting year of the WOM projection), emissions increased by 12.8%. From 2008 to 2035, emissions are expected to increase by 3.1%.

Table 5-11 Total GHG emissions in CO_2eq by sector for the WOM scenario (1990-2035)

CO_2eq
in kt CO_2 equivalent

		Reported data (GHG inventories)							Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WOM)**	**228.47**	**233.54**	**247.01**	**263.64**	**252.77**	**256.70**	**262.82**	**263.20**	**264.76**	**265.75**
1	**Energy**	**201.25**	**207.06**	**220.06**	**231.45**	**217.39**	**218.79**	**223.44**	**223.46**	**224.46**	**224.68**
1A	Fuel combustion	200.89	206.46	219.23	230.37	216.10	217.27	221.69	221.48	222.25	222.25
	1A1 Energy industries	0.18	2.08	2.77	3.14	2.60	2.60	2.60	2.60	2.60	2.60
	1A2 Manufacturing industries & constr.	36.29	35.69	36.41	39.15	36.78	36.78	36.78	36.78	36.78	36.78
	1A3 Transport	76.87	82.10	91.62	81.81	84.09	80.60	81.02	80.81	81.58	81.58
	1A4 Other sectors	87.55	86.59	88.43	106.27	92.63	97.29	101.29	101.29	101.29	101.29
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.36	0.60	0.83	1.09	1.29	1.52	1.75	1.98	2.21	2.44
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.36	0.60	0.83	1.09	1.29	1.52	1.75	1.98	2.21	2.44
2	**Industrial processes and product use**	**0.66**	**1.77**	**4.41**	**7.49**	**9.97**	**12.25**	**12.82**	**13.19**	**13.65**	**14.31**
3	**Agriculture**	**24.90**	**23.10**	**20.91**	**23.07**	**23.73**	**23.87**	**24.67**	**24.55**	**24.55**	**24.55**
4	**LULUCF**	**7.57**	**5.33**	**25.14**	**9.39**	**21.01**	**12.21**	**4.84**	**12.35**	**12.35**	**12.35**
5	**Waste**	**1.66**	**1.62**	**1.62**	**1.63**	**1.67**	**1.79**	**1.90**	**2.01**	**2.10**	**2.21**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.49**	**0.85**	**1.20**	**0.94**	**1.04**	**1.04**	**1.04**

5.2.2 Aggregate effect in the WM scenario

Figure 5-10 and Table 5-12 show the development of total GHG emissions in CO_2 equivalent between 1990 and 2035 for the WM scenario. The total reduction from 1990–2035 under the WM scenario is expected to be 44.1%.

Table 5-12 Total GHG emissions in CO2eq by sector for the WM scenario (1990-2035; reported values for 1990–2020 from OE 2022; projected values for 2021–2035)[23]

CO_2eq
in kt CO_2 equivalent

		Reported data (GHG inventories)							Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WM)**	**228.47**	**233.54**	**247.01**	**263.64**	**228.17**	**198.15**	**179.66**	**167.33**	**145.57**	**127.63**
1	**Energy**	**201.25**	**207.06**	**220.06**	**231.45**	**193.43**	**162.18**	**143.96**	**133.25**	**114.33**	**96.99**
1A	Fuel combustion	200.89	206.46	219.23	230.37	192.30	161.03	143.17	132.06	113.14	95.80
	1A1 Energy industries	0.18	2.08	2.77	3.14	3.26	2.05	2.44	2.48	2.53	2.58
	1A2 Manufacturing industries & constr.	36.29	35.69	36.41	39.15	26.07	27.59	22.86	19.83	16.16	15.45
	1A3 Transport	76.87	82.10	91.62	81.81	77.76	61.85	52.77	52.35	44.54	35.10
	1A4 Other sectors	87.55	86.59	88.43	106.27	85.21	69.54	65.11	57.40	49.91	42.68
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
2	**Industrial processes and product use**	**0.66**	**1.77**	**4.41**	**7.49**	**9.39**	**10.48**	**9.43**	**7.80**	**4.95**	**4.26**
3	**Agriculture**	**24.90**	**23.10**	**20.91**	**23.07**	**23.73**	**23.87**	**24.67**	**24.57**	**24.49**	**24.49**
4	**LULUCF**	**7.57**	**5.33**	**25.14**	**9.39**	**21.01**	**12.21**	**4.84**	**12.35**	**12.35**	**12.35**
5	**Waste**	**1.66**	**1.62**	**1.62**	**1.63**	**1.62**	**1.62**	**1.60**	**1.72**	**1.81**	**1.90**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.49**	**0.85**	**1.20**	**0.94**	**1.04**	**1.04**	**1.04**

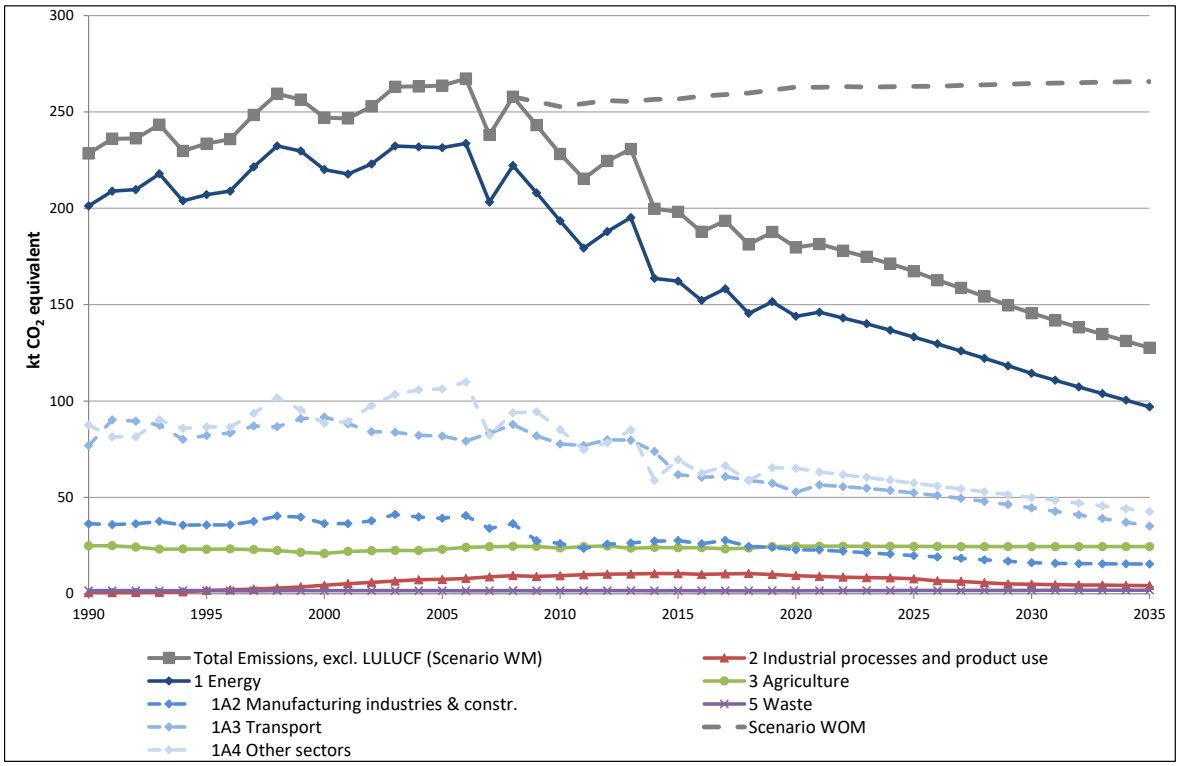

Figure 5-10 Total GHG emissions in CO_2eq by sector (excl. LULUCF) from 1990 to 2035 for the scenario WM

[23] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data used to prepare the projections are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

5.2.3 Aggregate effect in the WAM scenario

Table 5-13 and Figure 5-11 show the development of total GHG emissions in CO_2 equivalent between 1990 and 2035 for the WAM scenario. The total reduction from 1990–2035 under the WAM scenario is expected to be 55.9%.

Table 5-13 Total GHG emissions in CO2eq by sector for the WAM scenario (1990-2035; reported values for 1990-2020 from OE 2022; projected values for 2021-2035)[24]

CO_2eq
in kt CO_2 equivalent

		Reported data (GHG inventories)							Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Total	**Emissions, excl. LULUCF (Scenario WAM)**	**228.47**	**233.54**	**247.01**	**263.64**	**228.17**	**198.15**	**179.66**	**156.89**	**129.10**	**100.72**
1	**Energy**	**201.25**	**207.06**	**220.06**	**231.45**	**193.43**	**162.18**	**143.96**	**126.07**	**102.75**	**78.83**
1A	Fuel combustion	200.89	206.46	219.23	230.37	192.30	161.03	143.17	124.88	101.56	77.64
	1A1 Energy industries	0.18	2.08	2.77	3.14	3.26	2.05	2.44	2.48	2.53	2.58
	1A2 Manufacturing industries & constr.	36.29	35.69	36.41	39.15	26.07	27.59	22.86	17.20	13.53	12.82
	1A3 Transport	76.87	82.10	91.62	81.81	77.76	61.85	52.77	52.18	42.55	29.11
	1A4 Other sectors	87.55	86.59	88.43	106.27	85.21	69.54	65.11	53.03	42.96	33.13
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.36	0.60	0.83	1.09	1.13	1.15	0.78	1.19	1.19	1.19
2	**Industrial processes and product use**	**0.66**	**1.77**	**4.41**	**7.49**	**9.39**	**10.48**	**9.43**	**7.03**	**4.53**	**2.02**
3	**Agriculture**	**24.90**	**23.10**	**20.91**	**23.07**	**23.73**	**23.87**	**24.67**	**22.08**	**20.07**	**18.05**
4	**LULUCF**	**7.57**	**5.33**	**25.14**	**9.39**	**21.01**	**12.21**	**4.84**	**12.35**	**12.35**	**12.35**
5	**Waste**	**1.66**	**1.62**	**1.62**	**1.63**	**1.62**	**1.62**	**1.60**	**1.70**	**1.76**	**1.82**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.49**	**0.85**	**1.20**	**0.94**	**1.04**	**1.04**	**1.04**

[24] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data used to prepare the projections are based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

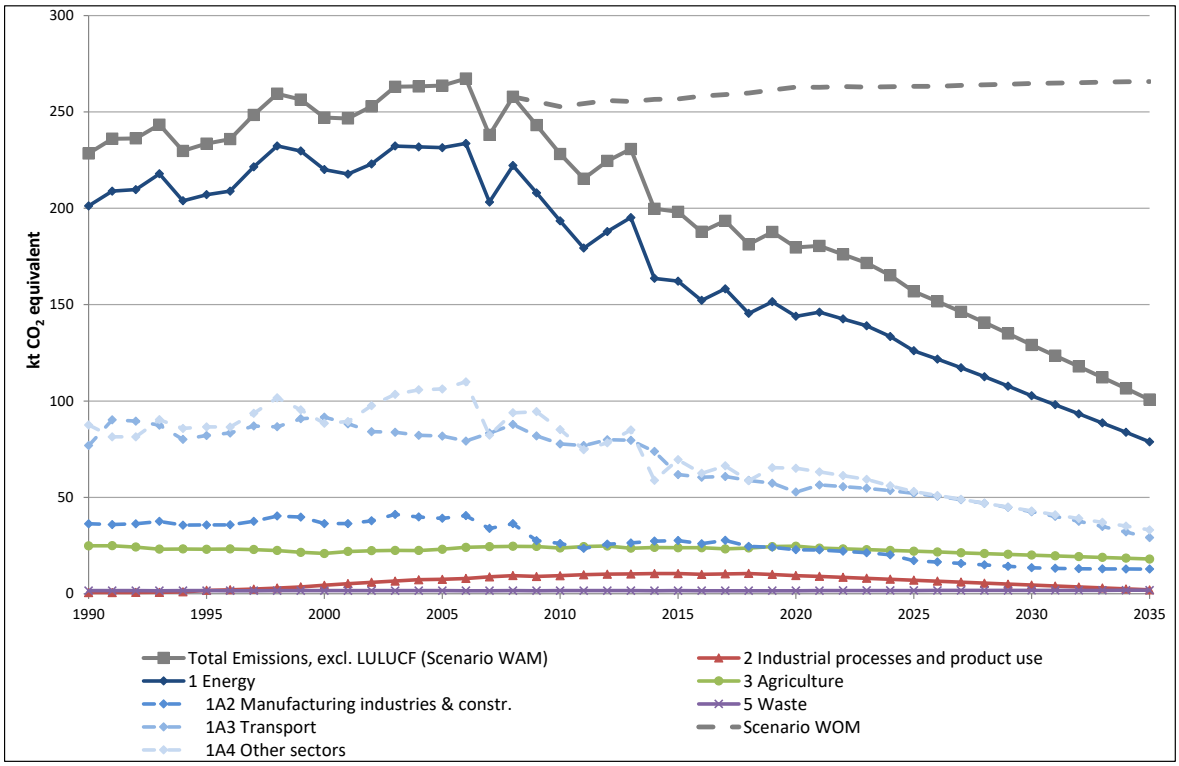

Figure 5-11 Total GHG emissions in CO_2eq by sector (excl. LULUCF) from 1990 to 2035 for the scenario WAM

5.2.4 Total effect of currently implemented and adopted policies and measures

Table 5-14 shows the total effect of currently implemented and adopted policies and measures by sector. The effect is calculated based on the difference between GHG-emissions under the WM and under the WOM scenario. The total effect of currently implemented and adopted policies and measures is estimated to amount to a reduction of 83.2 kt CO_2eq in 2020 and a reduction of 138.1 kt CO_2eq in 2035. The currently implemented and adopted policies and measures are mainly affecting the emission in the sector Energy. A smaller effect of currently implemented and adopted policies and measures is also noticeable in the sector IPPU. Effects in the sector Agriculture and Waste are negligible, since there are no currently implemented and adopted policies and measures which lead to strong reductions in these sectors.

Table 5-14 Total effect of currently implemented and adopted policies and measures by sector. Shown is the difference in GHG-emissions between the WM and the WOM scenario in kt CO_2eq.

Difference in GHG-emissions (excl. LULUCF), scenario WM - scenario WOM											
IPCC	Source/Sink Categories	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Total	annual difference in kt CO2eq	0	0	0	0	-24.6	-58.6	-83.2	-95.9	-119.2	-138.1
1	Energy	0	0	0	0	-24.0	-56.6	-79.5	-90.2	-110.1	-127.7
2	Industrial processes and product use	0	0	0	0	-0.6	-1.8	-3.4	-5.4	-8.7	-10.1
3	Agriculture	0	0	0	0	0.0	0.0	0.0	0.0	-0.1	-0.1
4	LULUCF	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
5	Waste	0	0	0	0	-0.1	-0.2	-0.3	-0.3	-0.3	-0.3
Memo item	International bunkers (aviation)	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0

5.2.5 Total additional effect of planned policies and measures

Table 5-15 shows the total additional effect of planned policies and measures. The additional effect is calculated based on the difference between GHG-emissions under the WAM and under the WM scenario. The total additional effect of planned policies and measures is estimated to

amount to a reduction of 26.9 CO_2eq in 2035, primarily from the energy sector. This stems from the planned policies and measures in the Climate Strategy 2050 (Government 2022) which aim to reduce the energy-related GHG-emissions to zero by 2050.

As GHG-emissions from the sectors IPPU, Agriculture and Waste are much lower compared to emissions from the Energy sector, a smaller effect of the planned policies and measures is expected in these sectors. The planned policies and measures in the Climate Strategy 2050 (Government 2022) aim to reduce the agricultural emissions by 52% until 2050. In the sector IPPU the Climate Strategy 2050 (Government 2022) aims to reduce emissions to 15% of the level in the years 2011–2013 by 2036 (in line with the Kigali Amendment). According to the Climate Strategy 2050 (Government 2022), GHG-emissions in the Waste sector are expected to increase slightly until 2050, despite technical optimisations, as the population is expected to increase further. Therefore, the effect of planned policies and measures is negligible in the Waste sector.

Table 5-15 Total additional effect of planned policies and measures by sector. Shown is the difference in GHG-emissions between the WAM and the WM scenario in kt CO_2eq.

Difference in GHG-emissions (excl. LULUCF), scenario WAM - scenario WM											
IPCC	Source/Sink Categories	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Total	annual difference in kt CO2eq	0	0	0	0	0.0	0.0	0.0	-10.4	-16.5	-26.9
1	Energy	0	0	0	0	0.0	0.0	0.0	-7.2	-11.6	-18.2
2	Industrial processes and product use	0	0	0	0	0.0	0.0	0.0	-0.8	-0.4	-2.2
3	Agriculture	0	0	0	0	0.0	0.0	0.0	-2.5	-4.4	-6.4
4	LULUCF	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
5	Waste	0	0	0	0	0.0	0.0	0.0	0.0	0.0	-0.1
Memo item	International bunkers (aviation)	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0

5.3 Methodology

5.3.1 Method for differentiating specific greenhouse gases

The initial calculation of the projections of Liechtenstein's greenhouse gas emissions is based on total emissions in CO_2 equivalent, not split out by gas. After this initial calculation, the differentiated projection for specific greenhouse gases (CH_2, CH_4, N_2O and F-Gases) is conducted based on factors derived from the latest NIR (OE 2022). These factors describe—for each source category—the share of a specific gas (e.g., CH_4) compared to total CO_2 equivalent emissions in the year 2020. The projection of the total emissions in CO_2eq is then multiplied with these factors to calculate the gas-specific projection.

The factors for CO_2, CH_4 and N_2O are depicted in Table 5-16, the ones for F-Gases (HFC, PFC and SF6) in Table 5-17.

Table 5-16 Factors describing the share of CO_2, CH_4 and N_2O emissions in total CO_2eq emissions, based on the newest reported values (year 2020) in Liechtenstein's national inventory (OE 2022)

IPCC	Source/Sink Categories	**CO_2 factor** (share of CO_2 compared to total CO_2eq)	**CH_4 factor** (share of CH_4 compared to total CO_2eq)	**N_2O factor** (share of N_2O compared to total CO_2eq)	**F-Gases factor** (share of F-Gas compared to total CO_2eq)	**sum**
1	**Energy**					
1A	Fuel combustion					
	1A1 Energy industries	0.987	0.011	0.001	NO	1.000
	1A2 Manufacturing industries & constr.	0.996	0.000	0.004	NO	1.000
	1A3 Transport	0.990	0.001	0.009	NO	1.000
	1A4 Other sectors	0.990	0.005	0.006	NO	1.000
	1A5 Other	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels					
	1B1 Solid fuels	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.000	1.000	NO,NA	NO	1.000
2	**Industrial processes and product use**	**0.013**	**NO**	**0.015**	**0.972**	**1.000**
3	**Agriculture**	**0.002**	**0.697**	**0.302**	**NO**	**1.000**
4	**LULUCF**	**0.919**	**NO**	**0.081**	**NO**	**1.000**
5	**Waste**	**0.006**	**0.584**	**0.410**	**NO**	**1.000**
Memo item	**International bunkers (aviation)**	**0.992**	**0.000**	**0.008**	**NO**	**1.000**

Table 5-17 Factors describing the share of HFC, PFC and SF6 emissions compared to the total CO_2eq emissions, based on the newest reported values (year 2020) in Liechtenstein's national inventory (OE 2022)

IPCC	Source/Sink Categories	**HFC factor** (share of HFC compared to total CO_2eq)	**PFC factor** (share of PFC compared to total CO_2eq)	**SF_6 factor** (share of SF_6 compared to total CO_2eq)	**sum**
2F	Product uses as ODS substitutes	0.994	0.000	0.006	1.000

5.3.2 Methods for projecting the emissions from the Energy sector (1A Fuel combustion)

The projections of emissions from the Energy sector are based on Liechtenstein's Energy Strategy 2030 (Government 2020), in combination with most recent reported values, where available, and input from the experts at the Bureau of Energy Consumption and Conservation.

The basis for the projections is the central 'Aktiv' scenario Energy Strategy 2030, which is characterised by a reduction of energy consumption, an enhancement of renewable energy sources and a reduction of CO_2 emissions (see Table 5-18 for details). The 'Aktiv' scenario defines a package of measures, implemented stepwise until 2030, in order to reach the 2030 greenhouse gas emission target. In collaboration with the above mentioned experts, the impact of these measures beyond 2030 was estimated to extend projections to 2035.

Table 5-18 Objectives 2030 of Liechtenstein's Energy Strategy 2030 (Aktiv scenario, base year 2008)

	Base year	Base year value	Target value 2030
Energy demand	2008	1,344 GWh	1,075 GWh *(-20%)*
Share of renewables in total final energy demand	2008	8%	30%
Greenhouse gas emissions	1990	232.7 kt CO_2eq	137.2 kt CO_2eq *(-40%)* 160.1 kt CO_2eq domestically *(-30%)*

The specific measures implemented in the projection are described and explained in section 4.3.

Projections 2021-2030

The Energy Strategy 2030 provides annual greenhouse gas reduction potentials (CO_2eq) between the years 2021 and 2030 for most measures. The expected emission reduction per measure for the WM scenario was based on these values in the Energy Strategy 2030, subject to the following modifications:

- The measures had to be assigned to the sub-categories of the Energy sector (i.e. 1A1, 1A2, 1A3, 1A4 and 1A5).
- Reduction potentials of some measures had to be divided between industry and households in order to match the NFR structure (in particular categories 1A2 and 1A4). Where possible, the shares were taken from Liechtenstein's NIR 2020 (OE 2022). Else, the shares were estimated by the expert of the Bureau of Energy Consumption and Conservation[25].
- For some measures, the potential was increased based on draft assessment of actually achieved values in the first year (2021) and/or faster than expected developments, some of which are also expected to continue due to recent market changes, e.g. for heat pumps, district heat and the adoption of electric vehicles in the early years of the strategy
- For some measures, the potential was decreased based on draft assessment of actually achieved values in the first year (2021) and/or differences in methodology between the Energy Strategy and the modelling approach used here, e.g. measures for new buildings, space heating with wood firing and electric vehicles in the later years of the strategy.

[25] Expert judgement by J. Senn, Bureau of Energy Consumption and Conservation, see (Senn 2022).

- The additional biomass heat plant and biogas plant were moved to the WAM due to very high uncertainties on their implementation.

These modifications mostly balanced out leading an overall emission reduction close to the level foreseen in the Energy Strategy 2030.

The projection was undertaken on the basis of the reported emissions 2020 (from Liechtenstein's NIR 2022, OE 2022). The yearly emission reduction potentials were (consecutively) subtracted from the emissions value in 2020 to estimate the projected emissions for the years 2021–2030. A correction was made for 2021 values for the transport sector to reflect early assessments of the likely 2021 emissions inventory which shows that 2020 was likely an outlier in Transport due to the Covid-19 pandemic.

Projections 2030-2035

For the projections 2030–2035, the yearly greenhouse gas reduction potentials (CO_2eq) from the Energy Strategy 2030 were extrapolated. The extrapolations were estimated by expert judgements (see footnote 25):

- The measure solar thermal collectors was discontinued as it is not expected to play a major role in the future, being superseded by PV in combination with heat pumps.
- The measure electric cars was extended with a continuing, though slowing increase towards saturation of the new vehicle market around 2035.
- The measure district heating was ramped down after 2030 over five years due to high uncertainty and a much higher level before 2030 than assumed originally in the Energy Strategy.
- The measure standards for electrical equipment/illumination was not continued due to missing knowledge about potential reductions and high uncertainties.
- All other measures were continued at the same level as 2030 until 2035.

5.3.3 Methods for projecting the emissions from further sectors

Sector 1B Fugitive emissions from fuels

No projections for Liechtenstein are available for fugitive emissions from fuels. Therefore, the Swiss NC8 (FOEN 2022) projection of this sector was adopted for Liechtenstein in the WM and WAM scenario. Due to the bilateral agreement on environmental levies between Switzerland and Liechtenstein (see section 4.1), the Swiss projections are comparable to the circumstances in Liechtenstein.

Sector 2 Industrial processes and product use (IPPU)

No projections for Liechtenstein are available for emissions from Industrial processes and product use. Therefore, the Swiss NC8 (FOEN 2022) projection of this sector was adopted for Liechtenstein in the WM scenario. Due to the similar population structure and level of motorisation in Liechtenstein and Switzerland, which has a high influence on F-Gas emissions (refrigerators/cars), the Swiss projections are comparable to the circumstances in Liechtenstein.

The Climate Strategy 2050 (Government 2022) provides projections for emissions from the sector IPPU. These projections are considered in the WAM scenario.

Sector 3 Agriculture

No projections for Liechtenstein are available for emissions from agriculture. Therefore, the Swiss NC8 (FOEN 2022) projection of this sector was adopted for Liechtenstein in the WM scenario. Due to the similar agricultural structure in Liechtenstein and Switzerland (e.g., direct payment systems), the Swiss projections are comparable to the circumstances in Liechtenstein.

The Climate Strategy 2050 (Government 2022) provides projections for emissions from the sector Agriculture. These projections are considered in the WAM scenario.

Sector 4 Land use, land use change and forestry (LULUCF)

No projections for Liechtenstein are available for emissions from LULUCF. Sources and sinks have shown high fluctuations in the past decades, in particular due to fluctuations of the amount of living biomass on forest land. Accordingly, the projection in the WM and WAM scenario was simplified by keeping total LULUCF emissions on a constant level from 2021–2035, based on the average of the reported net emissions of the last five inventory years (2016–2020).

Sector 5 Waste

The Climate Strategy 2050 (Government 2022) provides projections for emissions from the sector Waste. These projections are considered in the WAM scenario.

In the WM scenario, emissions in sectors 5A, 5B and 5C are expected to increase similarly as in the WAM scenario. For sector 5D Waste water treatment and discharge, a factor based on the GHG-emissions per inhabitant is calculated for the year 2020. This factor is used together with the projected development of Liechtenstein's population (see Figure 5-1) to project the GHG-emissions for the years 2021-2035.

Note that in Liechtenstein, the emissions from the waste sector are minor: municipal solid waste and compost are exported to municipal solid waste incineration and composting plants in Switzerland, and there is only one operating wastewater treatment plant (in Bendern) (see also section 2.9).

5.3.4 Main differences compared to previous submissions

Compared to the projected GHG-emissions presented in Liechtenstein's fourth biennial report (BR4) (OE 2020) the following most important changes and improvements regarding methodology and assumptions were implemented in the projections under the different scenarios.

WOM scenario:

- IPPU: In Liechtenstein's BR4, the emission projection of the sector IPPU was adopted from the projection of total emissions from the sector IPPU according to Switzerland's NC7 (WOM scenario) (FOEN 2018). Since in Liechtenstein only F-Gas emissions are relevant (and no other emission sources from sector IPPU), the projection in Liechtenstein's NC8 was based on the F-Gas emission projection of Switzerland's NC8 (FOEN 2022) instead of the projection of total emissions from the sector IPPU.
- Agriculture: In Liechtenstein's BR4, the emission projection of the sector Agriculture was adopted from Liechtenstein's NC7 Since these projections were outdated, the projections in Liechtenstein's NC8 are based on reported data and projections from Switzerland's NC8 (FOEN 2022). From 1990–2020, emissions reported in the NIR (OE 2022) are adopted for the WOM scenario, as no other projections were available and so far, no mitigation measures were implemented in the agricultural sector. For the years 2021–2035, projections of emissions in the sector Agriculture under the WOM scenario are adopted from the Swiss NC8 (FOEN 2022).
- Waste: In Liechtenstein's BR4, the emission projection of the sector Waste was extrapolated based on the reported data until 2008. The projection was outdated, as GHG-emissions in the Waste sector are expected to increase due to population growth. In Liechtenstein's NC8, GHG-emissions in sectors 5A, 5B and 5C are expected to increase from 2009–2035, as projected in Liechtenstein's Waste Plan (Liechtensteiner Abfallplanung 2012–2070, Government 2011). For sector 5D Waste water treatment and discharge, a factor based on the GHG-emissions per inhabitant was calculated for the year 2008. This factor is used

together with the past and projected development of Liechtenstein's population (see Figure 5-1) to project the GHG-emissions for the years 2009–2035.

WM scenario:

- IPPU: In Liechtenstein's BR4, the emission projection of the sector IPPU was adopted from the projection of total emissions from the sector IPPU according to Switzerland's NC7 (WM scenario) (FOEN 2018). Since in Liechtenstein only F-Gas emissions are relevant (and no other emission sources from sector IPPU), the projection in Liechtenstein's NC8 was based on the F-Gas emission projection of Switzerland's NC8 (FOEN 2022) instead of the projection of total emissions from the sector IPPU.
- Waste: In Liechtenstein's BR4, the projections in the sector Waste were based on the Liechtenstein's Waste Plan (Liechtensteiner Abfallplanung 2012-2070, Government 2011). In Liechtenstein's NC8 the Waste Plan was not used to project GHG-emissions in the sector Waste, as some of the underlying assumptions, particularly for the sector 5D Waste water treatment and discharge are outdated (the assumptions were discussed with an expert from the OE). In the WM scenario, emissions in sectors 5A, 5B and 5C are expected to increase similarly as in the WAM scenario. For sector 5D Waste water treatment and discharge, a factor based on the GHG-emissions per inhabitant is calculated for the year 2020. This factor is used together with the projected development of Liechtenstein's population (see Figure 5-1) to project the GHG-emissions for the years 2021-2035.

WAM scenario:

In Liechtenstein's BR4, projections in the WAM scenario were generally based on the WEM scenario, and additional policies and measures were included compared to the WEM scenario based on expert judgements. In Liechtenstein's NC8, the projections of GHG-emissions for the sectors IPPU, Agriculture and Waste are adopted from the Climate Strategy 2050 (Government 2022). For the sector Energy, expert judgement was used to estimate the expected impact of measures of the Climate Strategy 2050.

5.3.5 Sensitivity Analysis

Uncertainties in modelling assumptions in the Energy sector were estimated at the level of measures as follows:

- For the measures on new buildings, the uncertainty reflects the lack of data on the share of new buildings replacing previously existing heated building area.
- For the measure on building retrofits, the upper uncertainty bound is set higher to reflect the difference between the (reduced) central assumption, based on recently achieved values, and the highest historically achieved rate.
- For the measures on replacing heating systems in buildings the uncertainty reflects the (uneven) range of historically achieved values.
- For the measure on electric vehicles the uncertainty reflects a range of possible shares of full electric vs hybrid electric vehicles.

For all other measures, as well as other sectors (IPPU, Agriculture and Waste), an uncertainty of 30% was assumed for the low emission and high emission scenario.

Figure 5-12 shows the results of the sensitivity analysis. In 2035 the total GHG-emissions may deviate by -25% or +17% from the reference emissions expected under the WM scenario.

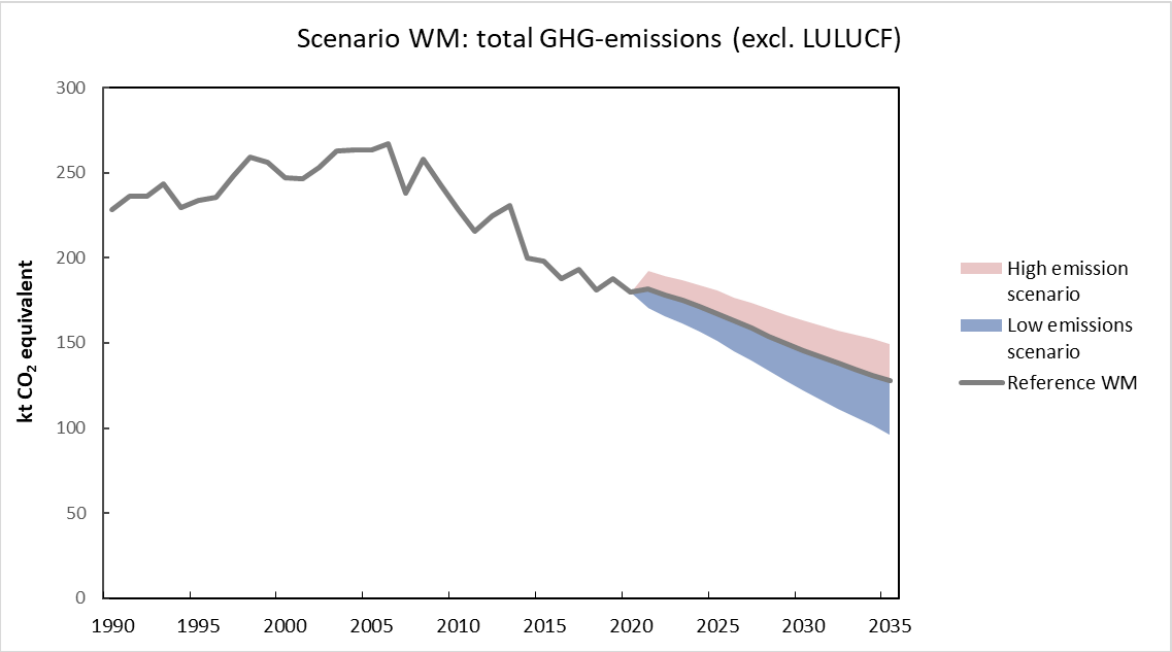

Figure 5-12 Sensitivity analysis for the WM scenario. Shown are the total GHG-emissions (excl. LULUCF) in kt CO_2eq for the reference WM scenario and the high emissions and low emission scenario.

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6 Vulnerability assessment, climate change impacts and adaptation measures

Liechtenstein is entirely located in the Alpine region as elaborated in section 2. In recent years, various research programmes on the effects of global climate warming in the Alpine region have been conducted. Trends in historical climate data up to 2019 and projections of possible developments in the 21st century indicate that noticeable changes in climatic conditions are to be expected. For Liechtenstein, the most important impacts are related to rising temperatures, such as prolonged heat waves and droughts and an increase in the risk of natural hazards (e.g. flooding, landslides, debris flows). Changes in climatic conditions are also expected to have an impact on biodiversity.

The expected future impacts of climate change have primarily been studied in Switzerland and are mainly based on the Swiss Climate Change Scenarios 2018 (CH2018, 2018) which also cover the area of Liechtenstein. Observed climatic conditions and expected developments are summarised in the factsheet on climate trends and climate change published by the Office of Environment (OE) of Liechtenstein (OE 2020).

To mitigate expected negative impacts of climate change, adaptation measures are required in different areas. Adaptation is therefore an essential element of Liechtenstein's climate strategy (Government 2015). In May 2022, the Liechtenstein Government opened a public consultation on the Liechtenstein Climate Strategy 2050, aimed at raising the emission reduction target for 2030 from 40% to 50% below 1990 levels and defining concrete measures in order to achieve this target (Government 2022).The national climate change adaptation strategy of Liechtenstein (Government 2018) identifies the relevant impacts related to climate change and defines measures to limit or avoid negative impacts.

6.1 Climate modelling, projections and scenarios

6.1.1 Climate Change scenarios

The official scenarios on climate change currently used in Switzerland (CH2018 Climate Scenarios for Switzerland) were launched in 2018 (CH2018, 2018). CH2018 and its follow-up activities are a focus area of the National Centre for Climate Services established in 2015 (http://www.nccs.ch). The CH2018 scenarios were realized in a co-design framework including the Swiss Federal Institute of Technology Zurich (ETH Zurich), with the Centre for Climate Systems Modelling (C2SM) and Meteo¬Swiss as the two leading institutions, and also integrating further partners such as the University of Bern (CH2018, 2018). The CH2018 climate scenarios present a consolidated view on projected future climate change in Switzerland.[26] Because the north-eastern region of Switzerland

[26] All paragraphs adopted from Switzerland's *8th* National communication (FOEN 2022) are indicated in italic.

also includes the principality of Liechtenstein, findings and conclusions within "CH2018" are deemed valid for the expected future development in Liechtenstein. Therefore, respective paragraphs from Switzerland's *8th* National Communication (FOEN 2022) are adopted.

The scenarios are based on a large number of state-of-the-art European-scale regional climate model experiments available at the time of their preparation (EURO-CORDEX; Jacob et al., 2014; Kotlarski et al., 2014). Statistical methods were used to produce probabilistic multi-model estimates of future change for a range of meteorological variables. Summarized results are available for five representative Swiss regions, three scenario time periods (represent-ed by 30-year periods around the years 2035, 2060 and 2085) and three emission scenarios.

*CH2018 is based on the RCP emission scenarios that were used for the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC AR5, 2014). CH2018 also provides statistically downscaled products at two kilometres horizontal and daily temporal resolution for precipitation and temperature using a methodology that dissolved some of the limitations of the CH2011 statistical downscaling approach. For eight meteorological variables, CH2018 additionally provides ready-to-use data for 84 to 399 stations (depending on variable) in Switzerland. A major advancement with respect to the preceding CH2011 scenarios is the transient character of the data for impact applications. Results and data are available through the internet page*http://www.climate-scenarios.ch.

The CH2018 scenarios serve as a basis for climate change impact studies in Switzerland. The currently most comprehensive study, 'Hydro-CH2018', was led by the Oeschger Centre for Climate Change Research and the Swiss Federal Office for the Environment. It investigated quantitative impacts of climate change with a focus on hydrology (FOEN, 2021). The CH2018 scenarios also were an important input for the further development of the national climate adaptation strategy (see section 6.3).

With the sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC AR6, 2021) and additional global and regional climate model projections available, current efforts relate to the integration of most recent state-of-the-art knowledge and data resources into the Swiss climate scenario landscape. In addition, output from novel climate model projections that allow to simulate the sub-daily (i.e. hourly) character of climate change at high spatial resolution is increasingly becoming available. In the Swiss follow-up scenario project, such simulations will be integrated and will improve understanding of high-impact extreme events under changing climatic conditions. This project will again be realized in a co-design framework between MeteoSwiss and the Swiss Federal Institute of Technology Zurich (ETH Zurich), and is planned to involve several partner institutions and stakeholders from academia and federal offices (from FOEN 2022).

6.1.2 Expected temperature changes

Figure 6-1 illustrates observed seasonal temperature changes for the Principality of Liechtenstein, as well as projected seasonal temperature changes for two emission scenarios and selected time periods.

Compared to the period 1981–2010, the best estimates for a scenario without mitigation measures (RCP8.5 emission scenario) project an increase of annual mean temperature of 5°C by 2085 (uncertainty range of 3.7-5.9°C)[27]. In a scenario with stringent climate change mitigation measures (RCP2.6), an annual mean temperature increase of 1.3°C by 2085 is projected (uncertainty range of 0.7-2.1°C) (NCCS (Pub.), 2018).

[27] Uncertainties due to climate model assumptions and natural variability are shown as the range between the 5% and 95% quantile of the model ensemble spread.

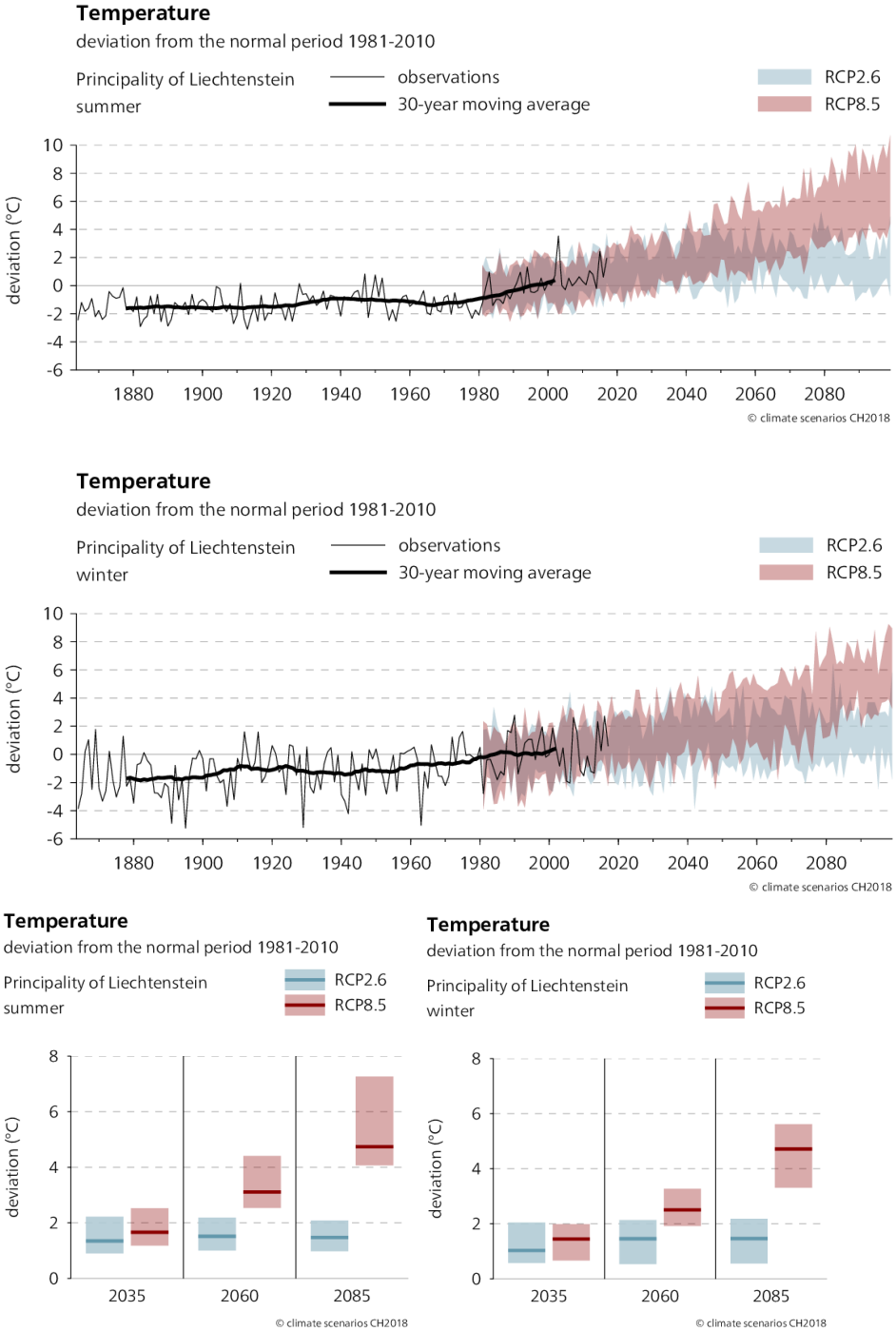

Figure 6-1 Top and middle panel: Past observed and future projected changes in seasonal temperature (°C) in the Principality of Liechtenstein. The changes are relative to the reference period 1981–2010. The thin black line displays the year-to-year difference with respect to the average of observations over the reference period, the heavy black line displays the corresponding smoothed 30-year average. The blue and red shadings indicate the range of year-to-year differences as projected by climate models for the RCP2.6 (with stringent mitigation, blue) and RCP8.5 (without mitigation, red) emission scenarios (specifically, the 5–95 percentile range for each year across the available model set). Bottom panel: Summarised change in temperature for three future reference periods in summer (bottom left panel) and winter (bottom right panel) (NCCS (Pub.) 2018).

The projected increase in temperature for Switzerland is consistent with large-scale warming over Europe for all seasons. In winter there is increased warming in northern Europe, partly due to a

decrease in snow cover (polar amplification). In summer, stronger warming is projected to take place in southern Europe, partly driven by drier surface conditions and changes in atmospheric stratification and circulation (mediterranean amplification, see also Brogli et al., 2019) (from FOEN 2022).

6.1.3 Expected precipitation changes

Precipitation is projected to change towards the end of the 21st century (see Figure 6-2). Summer mean precipitation is projected to decrease by 15.4% (uncertainty range from -41.8% to -2.4%) in the RCP8.5 scenario (without measures) and by 0.3% (uncertainty range from -17.6% to +7.9%) in the RCP2.6 scenario (stringent mitigation measures). Winter precipitation is expected to increase by 24% (uncertainty range +1% to +46%) in the RCP8.5 scenario and by 5.1% (uncertainty range -11.6% to +19.3%) in the RCP2.6 scenario (NCCS (Pub.), 2018).

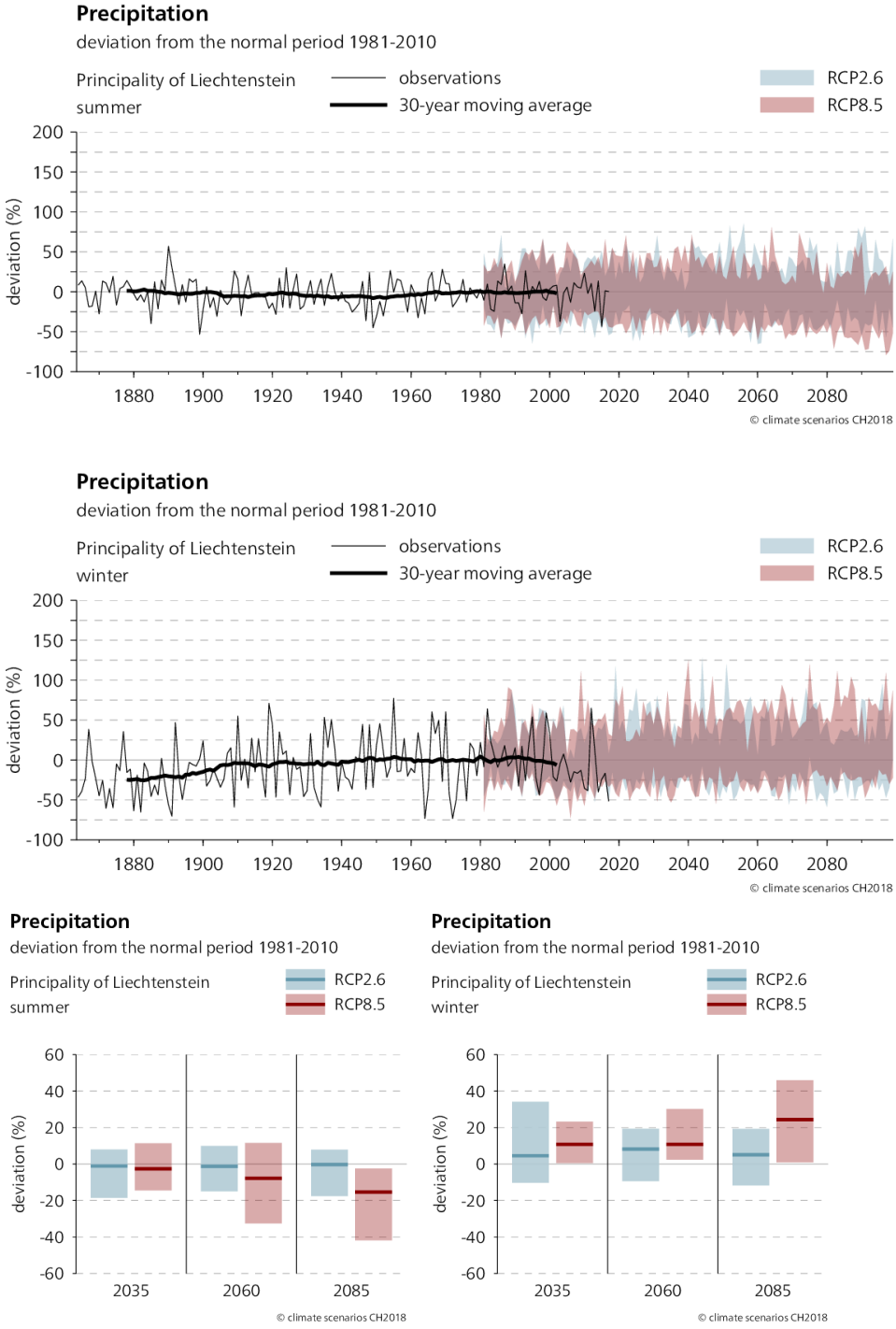

Figure 6-2 Top and middle panel: Past observed and future projected changes in seasonal precipitation (%) in the Principality of Liechtenstein. The changes are relative to the reference period 1981–2010. The thin black line displays the year-to-year difference with respect to the average of observations over the reference period, the heavy black line displays the corresponding smoothed 30-year average. The blue and red shadings indicate the range of year-to-year differences as projected by climate models for the RCP2.6 (with stringent mitigation, blue) and RCP8.5 (without mitigation, red) emission scenarios (specifically, the 5–95 percentile range for each year across the available model set). Bottom panel: Summarised change in precipitation for three future reference periods in summer (bottom left panel) and winter (bottom right panel) (NCCS (Pub.), 2018).

Liechtenstein lies in the centre of Europe, next to Switzerland. *Northern Europe will likely get wetter and southern Europe is expected to get drier, which is consistent with global-scale patterns and processes that find a drying in the subtropics and wetter conditions in high latitudes. In between those opposing trends, precipitation in the alpine region could either increase or decrease at the annually integrated scale, but show significant changes in the individual seasons (see also Rajczak and Schär, 2017). In summer, the mediterranean drying will likely encompass the Alps and Central Europe and will significantly affect Switzerland. The expected decrease in mean summer precipitation is primarily due to a lower number of wet days, while the average intensity of precipitation remains at a balanced to slightly increasing level. Consequently, the probability of prolonged periods of consecutive dry days increases. In winter, a tendency for increasing precipitation amounts is already identifiable in the observed records (see also* Figure 6-2*). This increase is expected to further continue as the climate warms (from FOEN 2022).*

6.1.4 Temperature extremes

By the end of the 21st century it is very likely that the frequency, duration and intensity of summer warm spells and heat waves in Switzerland will increase significantly. The projected intensification is strongest for the RCP8.5 scenario. Extreme temperatures in Switzerland are expected to rise stronger than mean seasonal temperatures. CH2018 provides a set of threshold based climatic indicators that describe hot conditions (e.g. present-day and future projected numbers of tropical nights and hot days for specific locations and regions) (from FOEN 2022).

As shown in Figure 6-3, in Vaduz the number of hot days (maximum temperature above 30°C) is expected to increase from 6.1 to 42.3 days per year by 2085 based on the RCP8.5 scenario and to 12.8 days per year based on the RCP2.6 scenario. Simultaneously, the number of tropical nights (minimum temperature above 20°C) is expected to increase from 1.4 to 30.5 (RCP8.5) and to 4.4 (RCP2.6) days per year (NCCS (Pub.), 2018).

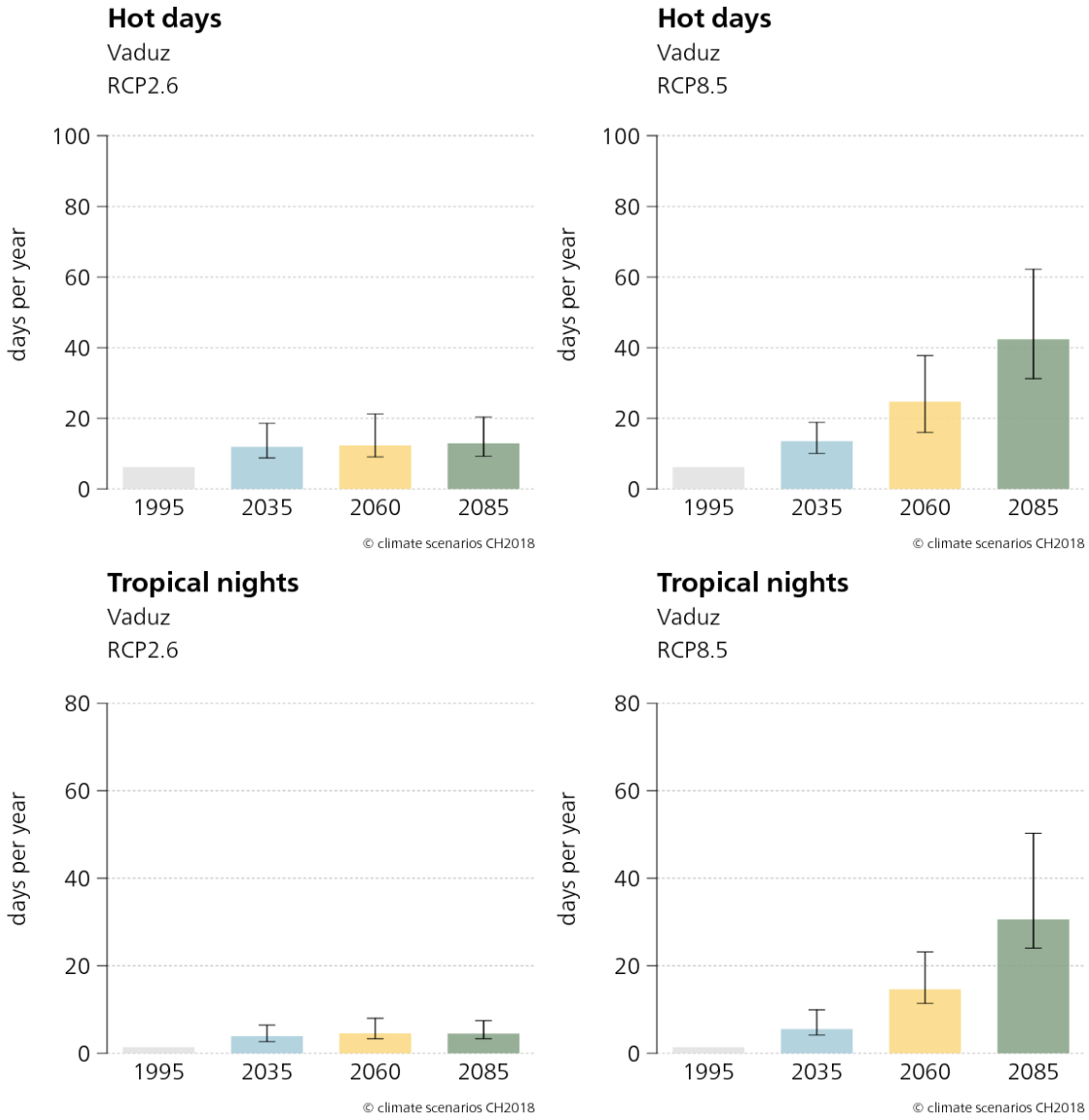

Figure 6-3 Top panel: Projected number of hot days (maximum temperature > 30°C) per year in Vaduz based on the RCP2.6 scenario (left panel) and RCP8.5 scenario (right panel) for three different reference periods. Bottom panel: Projected number of tropical nights (minimum temperature > 20°C) per year in Vaduz based on the RCP2.6 scenario (left panel) and RCP8.5 scenario (right panel) for three different reference periods (NCCS (Pub.), 2018).

In winter, the number of cold nights and days is likely to decrease significantly. In Vaduz the number of frost days (minimum temperature below 0°C) is projected to decrease from 80.3 days to 32 (RCP8.5) and to 67.7 (RCP2.6) days per year (NCCS (Pub.), 2018).

6.1.5 Precipitation extremes and droughts

Consistent with theory and assessments at global to European level, heavy to extreme precipitation events are projected to intensify (Rajczak et al., 2017). Some of this intensification is already evident in observational records of recent decades (Scherrer et al., 2016) and is in line with physical principles that imply an increased moisture absorption capacity of the atmosphere under warming conditions. While the relative intensification of heavy precipitation events is consistent with projected changes in mean precipitation in winter, sign and magnitude of changes in heavy and mean precipitation are not proportionate or even opposite in summer, illustrating the complexity of changes in precipitation characteristics (from FOEN 2022).

Figure 6-4 shows the expected seasonal changes in daily precipitation in north-eastern Switzerland (including Liechtenstein).

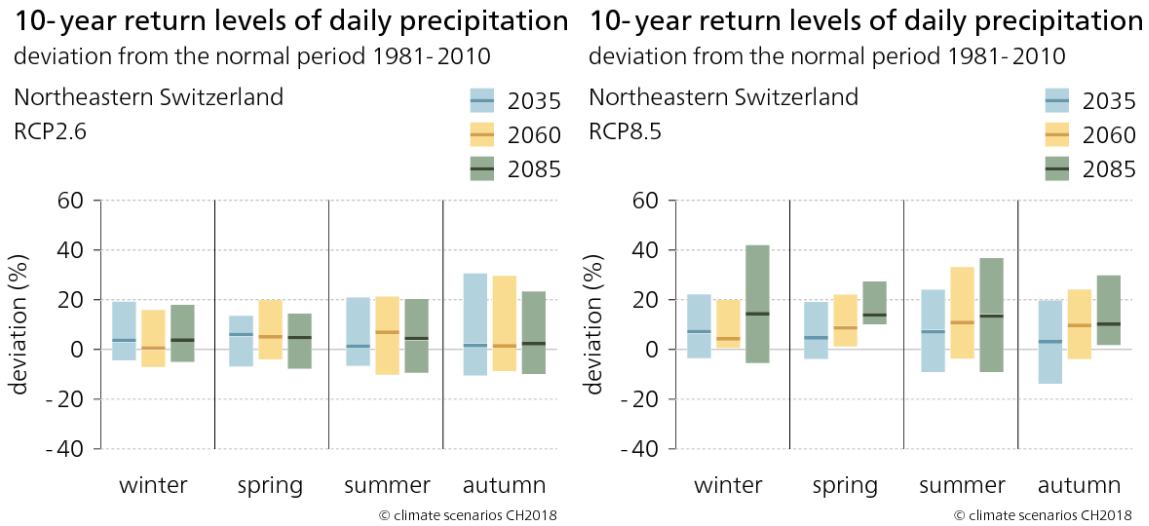

Figure 6-4 Projected change in seasonal 10-year return levels of daily precipitation in north-eastern Switzerland (including Liechtenstein) for the RCP2.6 emission scenario (left panel) and the RCP8.5 emission scenario (right panel) and three future scenario reference periods with respect to 1981–2010 (NCCS (Pub.), 2018).

In line with decreasing mean summer precipitation, the potential for longer summer dry spells is likely to increase (CH2018, 2018), indicating a growing risk of drought for Switzerland. However, model uncertainties in projected changes of droughts are larger than for changes in temperature and precipitation extremes. Parallel to the general changes in precipitation and a rising zero degree line over Switzerland [and Liechtenstein]*, a shift from solid (snow) to liquid (rain) precipitation is expected as temperatures rise. This has implications for hydrology, e.g. with regard to water storage, runoff and seasonal hydropower production (FOEN, 2021; NCCS and FOEN, 2021) (from FOEN 2022).*

6.1.6 Wind storms

Confidence in projections of windiness in Central Europe remain relatively low and no robust projection for changes in wind or extreme wind storms—originating from either Föhn[28] or winter storms—can be made (from FOEN 2022).

6.1.7 Other climate indicators and altitudinal differences in climate scenarios

The CH2018 climate scenarios were assessed with respect to altitudinal differences. Selected climatic indicators (number of summer days, tropical nights, frost days and days with fresh snowfall) were analysed for the Principality of Liechtenstein (Figure 6-5):

[28] https://en.wikipedia.org/wiki/Foehn_wind [15.09.2022]

- The number of hot days is expected to increase at all levels until 2085. In the lower areas (< 800 m a.s.l.) the number of hot days increases by 15 days based on the RCP2.6 and by 57 days based on the RCP8.5 scenario. Above 1500 m a.s.l. 2.5 (RCP2.6) or 17.4 (RCP8.5) more hot days are expected in 2085.
- The number of tropical nights is expected to increase from 1 to 3.3 (RCP2.6) or 27 (RCP8.5) by 2085 in the lower areas (< 800 m a.s.l). In 2085 between 800-1200 m a.s.l 0.9 (RCP2.6) or 14.5 tropical nights (RCP8.5) are expected. Above 1500 m a.s.l no tropical nights are expected based on the RCP2.6 scenario and 1.2 tropical nights are expected based on the RCP8.5 scenario in 2085.
- The number of frost days is expected to decrease at all levels until 2085. Based on the RCP8.5 scenario frost days decrease by 51 days below 800 m a.s.l and by 73 days above 1500 m a.s.l. Based on the RCP2.6 scenario frost days decrease by 15 days below 800 m a.s.l and by 22 days above 1500 m a.s.l.
- The number of days with fresh snow days below 800 m a.s.l show a reduction of 11 days (RCP8.5) or 3 days (RCP2.6). At higher altitudes the reduction of fresh snow days is more pronounced (> 1500 m a.s.l -15 (RCP2.6) or -35 (RCP8.5) days).

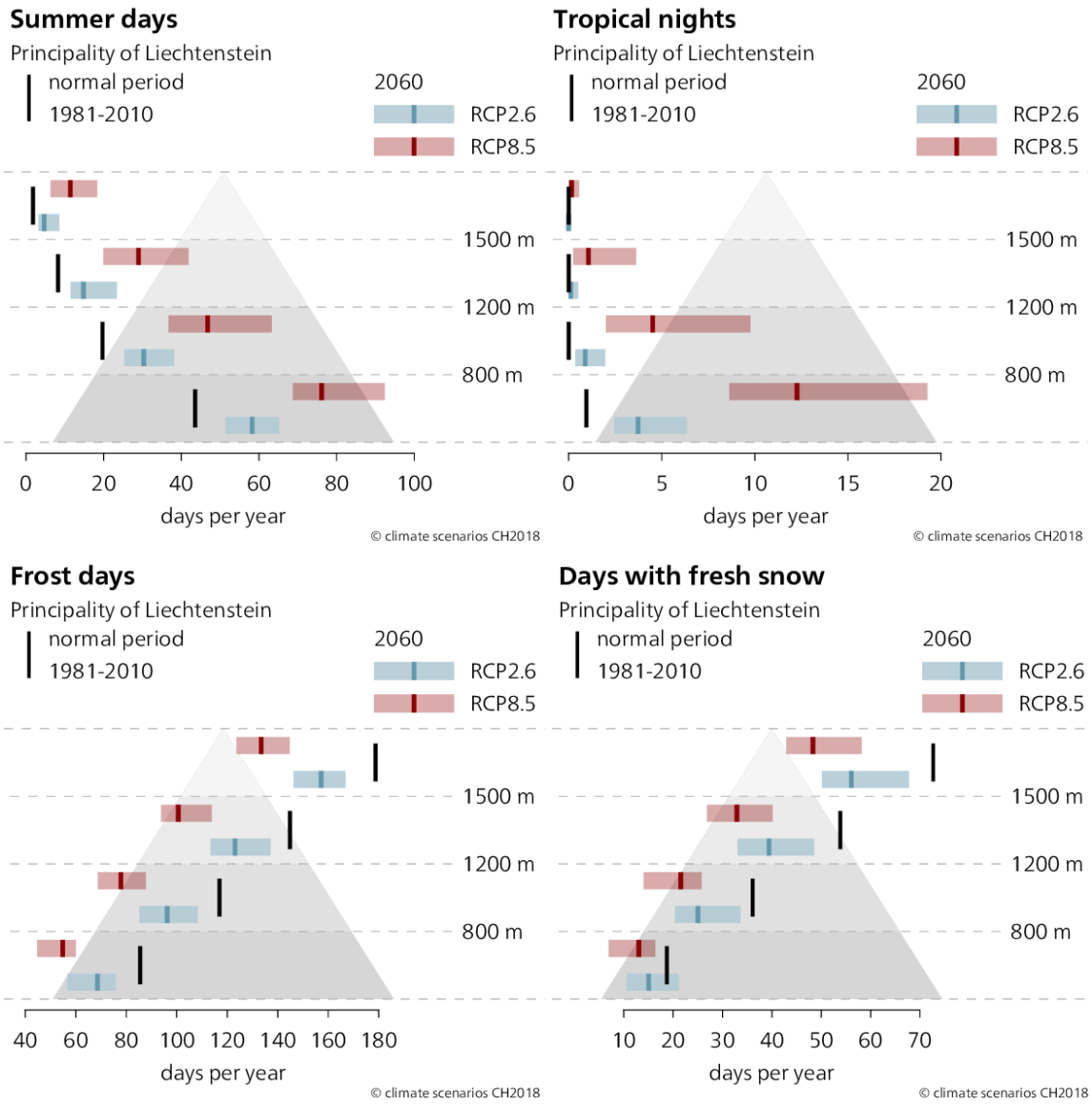

Figure 6-5 Expected future changes in climate indicators based on the RCP2.6 (blue) and RCP8.5 (red) at different altitudes and the normal period 1981-2010 (black) in the Principality of Liechtenstein. Top left: Number of summer days (maximum temperature above 25 °C). Top right: Number of tropical nights (minimum temperature above 20 °C). Bottom left: Number of frost days (maximum temperature below 0 °C). Bottom right: Number of days with fresh snow (NCCS (Pub.), 2018)

6.2 Climate change impacts

Data on observed trends in climatic conditions and climate extremes are provided by the Federal Office of Meteorology and Climatology of Switzerland (MeteoSwiss), which operates a high resolution atmospheric observation network and provides homogenised temperature and precipitation data, which meet international monitoring and quality standards. This network also includes a measurement station in Vaduz. These data form the basis for assessing the current impacts of changes in climatic parameters.

Based on the climate scenarios (section 6.1.1), potential future impacts of climate change are assessed. As the Swiss climate change impact studies also cover the alpine area with similar

conditions as in Liechtenstein, relevant paragraphs are adopted from Switzerland's *8th* National Communication (FOEN 2022).

6.2.1 Observed changes in temperature

Liechtenstein's climate is directly connected to the topography of the Upper Rhine Valley and characterised by warm down-slope winds. The mean annual temperature at the SwissMetNet[29] station of Vaduz is 10.6 °C for the current standard reference period 1991-2020 (MeteoSwiss, 2022a). Since temperature records began in 1871 the average temperature in Liechtenstein has increased by 2 °C (OE 2020).

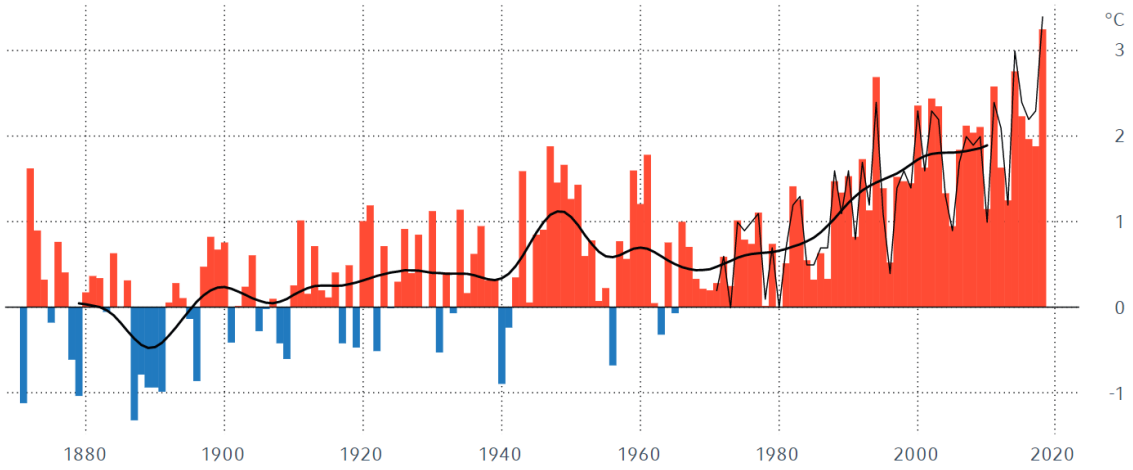

Figure 6-6 Past evolution of temperature (°C) in the Rhine Valley and Vaduz 1871–2019. The bars show the deviations relative to the reference period 1971–1900. Positive deviations are indicated by red bars, negative deviations are indicated by blue bars. The bold black line indicates the 20-years smoothed average. Data from the monitoring station in Vaduz are indicated by the thin black line (OE 2020).

6.2.2 Observed changes in precipitation

In Liechtenstein, systematic recording of precipitation began in 1961 at the SwissMetNet Station in Vaduz. In Switzerland, measurements date back to the middle of the 19th century. Compared to long-term changes of mean temperatures (see section 6.2.1), trends in mean precipitation amounts (Figure 6-7) are less pronounced.

In order to provide data from before 1961, Figure 6-7 includes data from the geographically closest monitoring station in the Rhine Valley in Switzerland. The annual total precipitation in the Rhine Valley shows a significant increase of 13% over of the last 130 years (OE 2020).

[29] SwissMetNet is the official meteorological monitoring network of the Swiss Federal Office of Meteorology and Climatology MeteoSwiss. The station at Vaduz is part of the Swiss network.

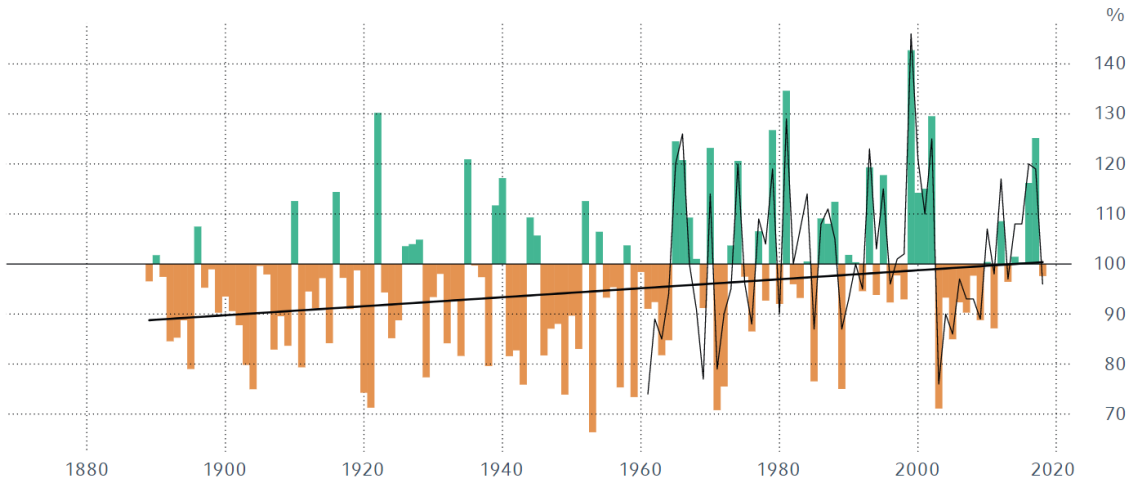

Figure 6-7 Past evolution of annual precipitation amount (%) in the Rhine Valley 1889–2019. (close to Vaduz). The bars show the deviations relative to the reference period 1961–1990. Positive deviations are indicated by green bars, negative deviations are indicated by brown bars. The bold black line indicates the linear trend from 1889–2019. Data from the monitoring station in Vaduz are indicated by the thin black line (OE 2020).

6.2.3 Impacts on the hydrological cycle and water resources

Liechtenstein's water resources are affected by changes in precipitation regime and temperature. Potential impacts of climate change are currently assessed in Switzerland. *Within the National Center for Climate Services priority theme 'Hydrologcial basis for climate change', run by the Swiss Federal Office for the Environment, the effects of climate change on the water balance in Switzerland during the 20th and 21th centuries were studied (NCCS and FOEN, 2021). The primary aim of this project was to present scenarios with enhanced spatial and temporal resolution for the hydrological cycle and runoff in the different climate regions and altitudes in Switzerland up to 2100, taking into account the most recent climate scenarios (CH2018, 2018). On this basis, changes in extreme runoff values (high and low water), water temperatures, water resources and their annual distribution and finally the consequences for water management could be assessed.*

From the CH2018 climate scenarios up to 22 climate model chains were selected. They correspond to an increase in greenhouse gas emissions based on the emission scenarios RCP 2.6 (resolute mitigation action in line with the Paris agreement target) and RCP 8.5 (no additional climate change mitigation) of the fifth assessment report of the Intergovernmental Panel on Climate Change. Several hydrological models were used to model snow and glacier melt, runoff, groundwater recharge or water temperature.

Climate change affects the entire water balance: precipitation and runoff alter, temperatures and evaporation increase, the glaciers melt ever faster, less snow falls in winter, causing a lack of water from snowmelt in the summertime. Climate change is also altering the filling rate of water reservoirs over the year, and the contribution from snow and glacier melt is generally decreasing. The climate-related storage changes are overlaid in the short term by the prevailing weather conditions and human abstraction (from FOEN 2022).

6.2.3.1 Changes in runoff

Annual runoff amounts have hardly changed in the past 100 years. However, the seasonal runoff distribution has already changed in recent decades. Runoff has decreased in summer and increased in winter. This development will continue in a changing climate.

In addition to the above-mentioned changes, the snowpack will form later in the year and melt earlier. As a result, runoff and groundwater recharge will increase in the winter months, whereas there will be less meltwater in spring and summer. In summer, higher temperatures will cause the glaciers to melt faster, meaning that the watercourses supplied by these glaciers will carry more water. However, this will only be a temporary phenomenon: meltwater from small glaciers is already starting to decrease again, with large glaciers expected to follow suit by 2050 at the latest. The combined effect of these developments is that in the future almost all watercourses will carry more water in winter(from FOEN 2022). Figure 6-8 shows exemplary changes in the seasonal runoff of the river Rhine with different runoff regimes

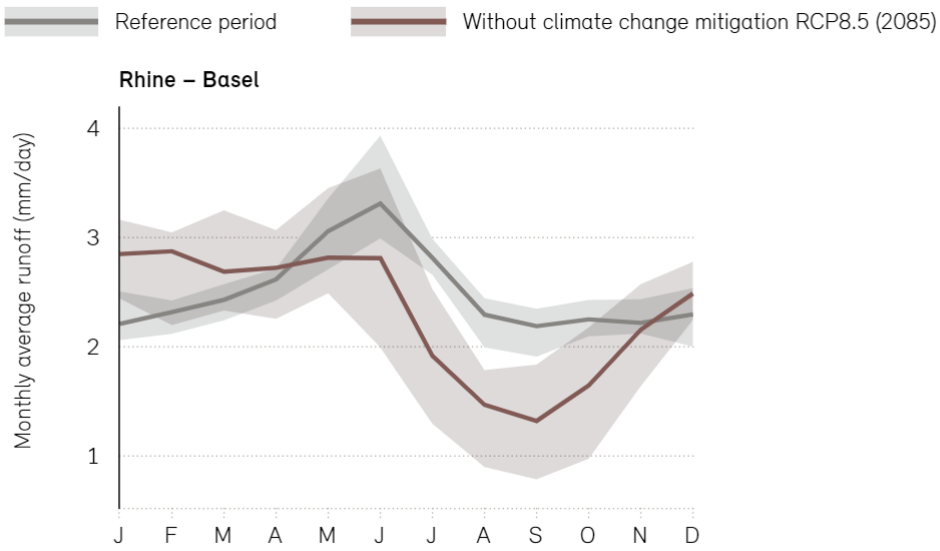

Figure 6-8 Change in average monthly runoff in the river Rhine in Basel. The hydrological scenarios (median and range of uncertainty) were calculated with the model PREHVAH-UniBE and PREVAH-WSL for the reference period 1981–2010 (grey) and for the RCP8.5 scenario (without climate change mitigation) for the end of the century (red). (FOEN, 2021).

In the absence of climate change mitigation measures, winter runoff will increase by between 10 and 50 per cent by the end of the century, while in summer (and autumn) it will decline by 30 to 50 per cent compared to today. With resolute climate change mitigation, the changes can be largely limited. Total annual runoff will probably only decline by around 10 per cent. The seasonal dynamics of groundwater levels and spring discharge rates will also change, with high and low phases becoming more pronounced. Water levels and discharge rates will become higher in winter and lower in summer (from FOEN 2022).

6.2.3.2 Water shortages in summer

The hydrological scenarios show that, in general, water levels will drop significantly in summer and autumn. This applies to both surface waters and groundwater. All altitudes and regions will be affected by the decline, but especially the Alps and alpine foothills. In the absence of climate change mitigation measures, summer runoff will be on average 30 to 50 per cent lower than today by the end of the century and up to 60 per cent lower than present-day glacier streams. At the same time, dry spells and heat waves will become more frequent in summer and last for longer. Without climate change mitigation, summer low flow at altitudes below 1,500 metres above sea level will decrease by 30 per cent during dry spells by the end of the century. This increases the risk that springs, wetlands, streams and smaller rivers will dry up more frequently during periods of

low rainfall. In addition, life in and around waters will be impacted more often by insufficient water depth and high temperatures. Some streams and rivers are likely to dry up completely during dry periods in the summer, especially small and medium size watercourses. The amount of usable water will diminish in summer due to climate change. If, at the same time, more river water or groundwater is used for irrigating crops or for cooling purposes, this may trigger temporary regional water shortages. Already today, these two types of water use are restricted during dry spells in summer. Until now, high-altitude alpine streams and rivers have usually had low flow in winter, when the water is stored in snowpack. In the future, regions above 2,000 metres above sea level will see runoff increase when water levels are low in winter[30]. At altitudes between 1,500 and 2,000 metres above sea level, climate change may shift the low flow season from winter to summer and autumn (from FOEN 2022).

6.2.3.3 Impacts on water temperature and water quality

Watercourses and lakes have become significantly warmer in recent decades. Mean water temperatures in Swiss rivers and streams have risen by between one and two degrees Celsius since 1970 (Figure 6-9). *The hot summers of 2003, 2015 and 2018 saw record-breaking temperatures at many stations and in summer 2018 there were new records at 25 out of 83 monitoring stations (FOEN et al., 2019). Temperatures well over 25 degrees Celsius were recorded in the Upper Rhine, Limmat, Thur and the Rhone below Lake Geneva, among others. High water temperatures can cause stress in many aquatic organisms and in extreme cases can be fatal. Outbreaks of certain diseases are also linked to higher water temperatures. Since the 1980s, more and more water bodies have experienced temperatures that are critical for outbreaks such as Proliferative Kidney Disease (PKD) in trout. In addition, these warm periods are lasting longer and longer. The total number of days per year with temperatures above 15 degrees Celsius has increased by an average of 20 days in four decades, with even greater warming observed in some regions (Michel et al., 2019) (from FOEN 2022).*

[30] In Liechtenstein, only a small part of the area is above 2,000 metres above sea level. So, changes in runoff at this elevation are not expected to have a strong impact on the runoff at lower elevations.

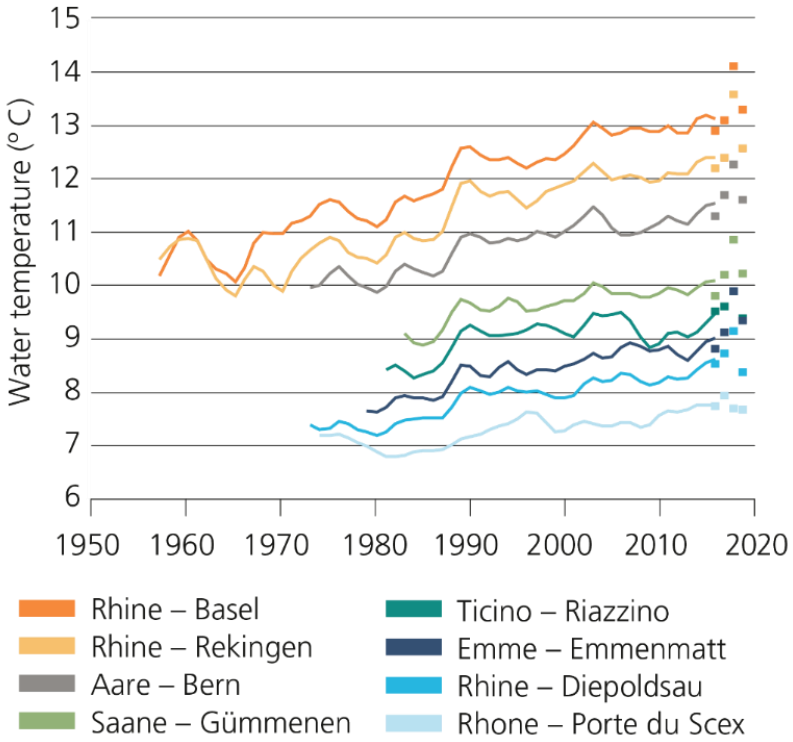

Figure 6-9 Mean annual water temperature at different in Swiss watercourses 1954-2020. Moving averages (over seven years) are shown as lines, the last four annual averages are shown as dots (from FOEN 2022 based on NCCS and FOEN 2021)

Rivers and streams in all parts of Switzerland [and Liechtenstein] *are expected to continue warming. Without climate change mitigation, summer water temperatures in watercourses could rise by three to nine degrees Celsius by the end of this century. However, if stringent climate change mitigation measures are implemented, warming in summer is likely to remain below three degrees Celsius compared with present levels. In winter, too, warming will be less pronounced. Climate change will also result in more low flow periods in summer, with streams and river sections drying up more and more frequently. The combined effect of warming and water scarcity is likely to lead to major changes in ecosystems very quickly (from FOEN 2022).*

6.2.4 Impacts on the cryosphere

6.2.4.1 Snow and zero degree isotherm

Liechtenstein is expecting a decreasing amount of snowfall (section 6.1.7). *The snowpack is a natural water reservoir which is crucially important for the seasonal water balance in Switzerland* [and Liechtenstein]. *According to model calculations, in the 1981–2010 reference period some 40 per cent (22 cubic kilometres) of the total annual runoff came from the snowpack (FOEN, 2021). The snowpack builds up in the alpine region over the winter and normally reaches its peak in March. The ensuing snowmelt dominates discharge in many catchments in spring and early summer.*

The zero degree isotherm largely determines whether precipitation falls as snow, which is stored, or as rain, which immediately contributes to runoff. It also defines the elevation below which snow and glacier melt can occur. The average zero degree isotherm in winter has risen by 300 to 400 metres since 1961 (CH2018, 2018). The percentage of days with snowfall below 500 metres above sea level has fallen by some 40 per cent since 1961. The water quantity stored in snow in spring (snow water equivalent) below 1000 metres above sea level dropped by as much as 75 per cent in the same period (Marty et al., 2017a). As winter temperatures rise, so does the zero degree

isotherm – by around 150 metres per degree Celsius temperature increase (CH2018, 2018). Consequently, the proportion of snow in total precipitation is further reduced. The addition of new snow to the permanent snowpack starts later in the year and is limited to higher elevations, while snowmelt starts earlier in spring. The maximum snow volume will shift from March to February. While temperature rises, the expected increase in winter precipitation will only have a positive impact on the snowpack at very high elevations. It will not compensate for the general decrease in snow volumes. With stringent climate change mitigation, the hydrological scenarios show a 42 per cent decrease in the average annual amount of water stored in the snowpack by the end of the century. Without climate change mitigation, the decrease is expected to reach 78 per cent (from FOEN 2022).

6.2.4.2 Permafrost

Within the Principality of Liechtenstein only small areas are covered by permafrost (see Permafrost Web-GIS[31]). The related changes due to rising temperatures are adopted from Switzerland 8th National Communication (FOEN 2022).

Permafrost is defined as subsoil with a temperature below zero degrees Celsius throughout the year. Permafrost is widespread in the Alps above an altitude of around 2,500 metres. It lies hidden in icy talus slopes and moraines, rock glaciers and steep rock faces with ice-filled pores and clefts. Systematic monitoring of permafrost is performed since the year 2000 by the Swiss Permafrost Monitoring Network (PERMOS). It now also includes other landforms like debris or steep rock slopes. Observations in the Swiss Alps over the past two decades show a general rise in permafrost temperatures (Figure 6-10)*, a decrease in the ice content and an increase in rock glacier flow rates (PERMOS, 2021). Analyses of documented rockfall events (PERMOS, 2016) with starting zones at high elevations indicate that the frequency of events with volumes of one million cubic kilometres or more has increased since the beginning of the 21st century, as compared to the 20th century (Huggel et al., 2012). A further temperature increase in line with the CH2018 scenarios will cause warming or complete thawing of cleft ice in rock faces. Temperatures in ice rich debris slopes and rock glaciers will rise as well, increasing the depth of the active layer. The warming of the outer 50 metres of frozen rock faces can be attributed to the temperature rise in the 20th century. In the future, it will penetrate into greater depths and increase the thermal imbalance. For summits and ridges, such effects will be particularly pronounced as the warming may penetrate from different sides (Noetzli and Gruber, 2009) (from FOEN 2022).*

31 Karten der Schweiz - Schweizerische Eidgenossenschaft - map.geo.admin.ch [15.09.2022]

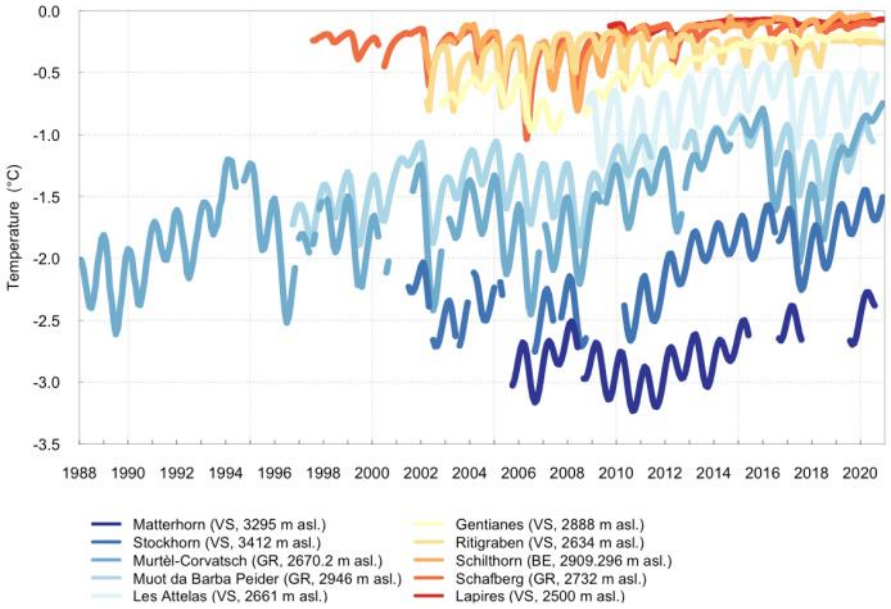

Figure 6-10 Borehole temperature at selected boreholes of the PERMOS network. The temperatures at 10 meters depth are shown (from FOEN 2022 based on PERMOS 2021).

6.2.5 Natural hazards

6.2.5.1 Floods

Floods in Switzerland are predominantly caused by extreme precipitation, sometimes in connection with snowmelt and/or high lake levels[32]. In the last 500 years, flood-rich and flood-poor periods have alternated. Since the 1970s, Switzerland is in a period of high flood frequency. However, no direct relationship was found between flood frequency and mean air temperature (Schmocker-Fackel and Naef, 2010). The comparison of flood patterns in different European countries suggests that changes in the large-scale atmospheric circulation are responsible for variations in flood frequency. Clear statements about future changes in atmospheric circulation and thus about changes in extreme and very rare precipitation events in the Alpine region are not yet possible (CH2018, 2018). In recent times, an increased number of floods has also been observed in many other parts of Europe. The last 30 years have seen the most floods in Europe for 500 years. This is all the more remarkable because flood phases in Europe in the past tended to occur in cool climatic periods, while the last 30 years have been warmer than average. The current flood phase is unique in climatic terms (Blöschl et al., 2020).

As climate change progresses, the precipitation potential increases. Global climate models also show that in the future, without climate change mitigation, more atmospheric humidity will be transported towards the Alps. Thus, the potential for more intensive precipitation and floods will increase (Brönnimann et al., 2018).

A high zero degree line during the event is necessary for the occurrence of large floods in the alpine catchments and the major Swiss rivers. In most Swiss catchments, floods therefore now mainly occur in summer and autumn. The projected temperature increase will lead to a rise in the zero degree line, which in turn will extend the flood season and tend to increase the volume and extent of floods in the alpine region (FOEN, 2021). The hydrological scenarios do not yet provide any reliable information on how the frequency of floods and flood runoff will change.

[32] In Liechtenstein, heavy precipitation sometimes in connection with snowmelt is the main reason for flood events.

Nevertheless, various climate-related processes indicate that floods and surface runoff will increase in the course of climate change (FOEN, 2021) (from FOEN 2022).

6.2.5.2 Rockfalls slope, debris flow and landslides

Changes in temperature and precipitation are likely to have a range of secondary effects on the occurrence of natural hazards, in particular in mountain environments. However, while there is theoretical evidence for increased mass movement activity as a result of projected climate change, the effects are currently difficult to demonstrate in observational data (Stoffel and Huggel, 2012).

Processes related to warming of permafrost (Hasler, 2011) may increase the frequency and magnitude of rock fall. In combination with the increasing availability of sediments, the deepening of active layers, the retreat of glaciers and the possibility of flood waves from mountain lakes due to rock falls, new and complex hazardous situations may arise in regions where they have not been observed before.

Important effects on slope stability are also related to the warming and thawing of permafrost. The probability of rock instability and the incidence of large (more than 1 million cubic metres) rock falls is likely to increase in a warming climate (Huggel, 2009).

Changes in sediment supply and land use are other key factors in the frequency and magnitude of mass movements. Recent observations in the Swiss Alps indicate that sediment supply can indeed change significantly as a result of permafrost degradation of rock and boulder slopes or due to mass movements associated with other processes (Huggel et al., 2012). As such, warming has been reported to indirectly affect the magnitude and frequency of debris flows, as greater amounts of sediment become available (Lugon and Stoffel, 2010). The volume of debris flows in many parts of the Swiss Alps has risen by one order of magnitude since the early 20th century (Stoffel, 2010) and is likely to further increase with ongoing permafrost degradation. The actual triggering conditions of debris flows have been shown to occur less frequently today as compared to most of the 20th century (Schneuwly-Bollschweiler and Stoffel, 2012) and are not expected to increase in the future (Stoffel et al., 2014). Despite uncertainties, recent developments at high-elevation sites clearly show that events beyond historical experience are likely to occur as climate change continues.

At lower elevations, landslides could occur more frequently in winter and spring as a result of warmer temperatures and larger precipitation sums (Lopez Saez et al., 2013). The occurrence of debris flows and shallow landslides in the Prealps, Plateau and Jura mountains depends on the incidence of intense thunderstorms or long-lasting, persistent rainfall. Such conditions are likely to become more frequent, in particular in winter and spring. As a consequence, in the decades to come a shift might be expected not only in the frequency but also in the seasonality of debris flows and shallow landslides (from FOEN 2022).

6.2.5.3 Damage due to extreme events

In Switzerland, floods and debris flows caused damage amounting to 13.4 billion Swiss francs between 1972 and 2020. A further billion Swiss francs in damage was caused by landslides and other fall processes, with total damage corresponding to an average loss of around 295 million Swiss francs per year. A few individual events were mainly responsible for the extent of the damage.

6.2.6 Water management

The results of the Hydro-CH2018 project (FOEN, 2021; NCCS and FOEN, 2021) show that climate change will intensify the pressure on management of the Swiss water resources. All three divisions of water management – water use, water protection and flood protection – are significantly

affected by climate change. Measures already implemented contribute to preparing the water sector for the future climate. Further adaptations to climate change must follow.

6.2.6.1 Water use

Water is among the most vital resources for life and the economy. It is used as drinking water, for irrigation, for energy production and in industry. Around 80 per cent of Switzerland's drinking water is obtained from groundwater resources and 20 per cent from lakes.[33] *Switzerland's groundwater resources are under pressure due to settlement development and diffuse substance inputs, particularly on the Central Plateau and in the main alpine valleys. More frequent and prolonged droughts pose additional challenges for the various water-consuming sectors, as they will compete for limited resources during such periods.*

Due to water-saving measures in households and in the industry, and despite population growth, water consumption from public water suppliers has been slightly declining since the 1990s. In the near future, water demand from households and the industry is expected to remain at the current level (Freiburghaus, 2015). Serious water shortages in public water supply are not expected over the next decade. However, dry and hot spells can temporarily lead to high peak demand and thus to local problems for public water supplies. Where necessary, peak demand must be reduced during dry periods, e.g. by temporarily restricting secondary water uses such as watering green areas, filling swimming pools, or washing cars.

Climate change also affects Switzerland's agricultural production. In the past decade, irrigated areas for agricultural production have significantly increased. During the past dry spells in 2015 and 2018, public drinking water net-works were also used for agricultural irrigation. This led to problems for suppliers, as their infrastructure is not designed for the peak demand of the agricultural sector. To avoid such problems, water for agriculture must be provided by separate water distribution infrastructure, which is independent from public drinking water networks.

In Switzerland [and Liechtenstein]*, more than half of the electricity is generated by hydropower (FOEN, 2021). In the second half of the century, climate change will lead to a seasonal shift of runoff to winter and therefore affect electricity production, especially for run-of-river power plants. By the end of the century, the annual production from run-of-river power plants is expected to decrease slightly; winter production will increase by about 8 per cent (SCCER-SoE, 2019). In order to strengthen security of electricity supply, especially in winter, Switzerland will increase its renewable electricity production, including hydropower. Existing hydropower plants will be expanded and new plants will be constructed in the forthcoming decades.*

Importantly, surface waters as well as groundwater resources are increasingly used for cooling and heating purposes in many regions. High river water temperatures in summer negatively affect aquatic organisms. Especially during heat waves, cooling capacities for industrial purposes are limited due to water protection regulations (from FOEN 2022)

6.2.6.2 Water protection

Ecologically intact water bodies will be better able to cope with climate change and meet the diverse demands of society. It is therefore important to protect water resources from overexploitation and from contamination by pollutants and fertilisers. In addition, rivers, lakes and groundwater must be kept in, or restored to, a state that is as natural as possible.

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[33] Liechtenstein's drinking water is obtained from springs or groundwater resources (https://www.llv.li/inhalt/11466/amtsstellen/trinkwassertrinkwasserkontrolle [15.09.2022])

Rising water temperatures are further increasing the pressure on natural resources, such as biotopes, thus endangering indispensable ecosystem services (SCNAT, 2021). The existence of cold-loving fish species such as trout and grayling is threatened in large parts of the Central Plateau. Over a fifth of endangered or extinct species in Switzerland are linked to water bodies, and a further fifth to riparian areas and wetlands (FOEN, 2017b) (from FOEN 2022).

6.2.6.3 Flood protection

More frequent and intense heavy precipitation as well as the climate-related increase in sediment transport intensify the risks from flood and surface runoff. As the population grows and the landscape is used more intensively, more and more assets and property will be at risk from natural hazards. Integrated risk management has proven an effective way of dealing with risks from natural hazards in Switzerland. The federal government, cantons and municipalities have drawn conclusions from past flood events and introduced additional flood protection measures that have proven effective in recent years (from FOEN 20202).

6.2.7 Biodiversity

Biodiversity is mostly similar to the biodiversity of adjacent regions in Switzerland. Therefore, the respective paragraphs are adopted from Switzerland's 8th National Communication (FOEN 2022).
Despite continued and enhanced efforts for protection and recovery, the biodiversity in Switzerland still is not in a satisfactory state. Since 1900, biodiversity has been steadily declining. More than one third of all analysed species are threatened, the quality and area of valuable habitats has declined, and regional characteristics are disappearing (FOEN, 2019). Climate change is aggravating ongoing stressors for habitats, species and within species diversity (i.e. genetic diversity) also in Switzerland. In turn, stopping and reversing habitat loss and environmental degradation are recognised as the most cost-effective measures for slowing biodiversity decline and greenhouse gas emissions (IPBES, 2018) (from FOEN 2022).

6.2.7.1 Diversity of habitats

The Alps are home to a wide range of habitats and species. Biodiversity in the Alps is also particularly affected by climate change due to the wide altitudinal zonation and the related significance of temperature for the habitat. Climatic changes displace the ranges of species and modifies habitats. Climate change also indirectly affects biodiversity in the Alps by enabling more intensive agriculture at higher altitudes and altering patterns of use for leisure and tourism (four season recreation). Also, more renewable energy infrastructure such as hydropower dams are built in areas previously devoid of constructions (FOEN, 2017b).

Changes in climate indicator values (mean temperature and humidity) are particularly pronounced in settlement areas. Today, the vegetation in this habitat increasingly consists of species that are heat and drought indicators. Settlement areas are heating up faster than forests and agricultural areas (Heer, 2021) (from FOEN 2022).

6.2.7.2 Diversity of species

A clear trend toward warmer temperatures can be seen when looking at the long-term changes in water temperatures in Swiss waterbodies (FOEN, 2021). In standing waters, for example, 11 per cent of water beetle species and 33 per cent of dragonflies are threatened with extinction as a result of temperature increase, while 63 per cent of dragonflies benefit from temperature warming (FOEN, 2021). Climate change requires some species to shift their range to cooler water bodies that tend to be higher up. However, the streams are not always ecologically connected, especially when infrastructure blocks species movements. In a changing climate, good connectivity is particularly important for the survival of many species (Altermatt et al., 2013). As cold-blooded animals, fish cannot regulate body temperature, but are directly dependent on water

temperature. Typically, cold-water species cannot tolerate temperatures above 25 degrees Celsius (Lessard and Hayes, 2003). The brown trout is an example of how climate change affects fish that depend on cool and oxygen-rich waters. Their population has declined sharply in Switzerland in recent years (FOEN, 2021). Because physical barriers restrict longitudinal migration in mountain regions, an upward habitat shift in effect implies habitat reduction, suggesting the likelihood of an overall population decrease. Extensive brown trout catch data documenting an altitudinally dependent decline indicate that such a climate-related population decrease has in fact already occurred (Hari et al., 2005).

Climate change also strongly alters phenology, i.e. the temporal occurrence of certain development processes over the course of the year (Altermatt, 2010; Vitasse et al., 2021). For example, an earlier hatching of aquatic insects and an earlier spring bloom of phyto- and zooplankton are already observed today as a result of the temperature increase (Everall et al., 2015). This can disrupt interactions between different species within an ecosystem. If higher animals in the food chain – such as fish, birds or mammals – are not able to adapt their development processes to the new food supply in time, the necessary food will be missing, e.g. for the rearing and development of offspring. Such effects of climate change across several levels of the food pyramid are complex and operate on longer-term time scales (Van Asch et al., 2013). In alpine watercourses, the overall diversity of habitat conditions is decreasing as a result of the increase in water temperature and the decrease in meltwater (FOEN, 2021).

In general, a tendency towards earlier phenological spring phases is observed in various plant species throughout Switzerland. Climate change also alters the distribution of plant species. When periods of water shortage become more frequent, this favors drought-resistant species and allows them to spread at the expense of less tolerant species. Some species may colonize higher elevation sites to avoid heat stress. Such developments have the effect of changing the species composition. A comparison of early biodiversity monitoring surveys (2003–2007) with the most recent ones (2013–2018) shows that the number of both native and non-native plants is increasing at the milder sites of the Central Plateau and Pre-Alps. However, the increase is greater for non-native species. Higher temperatures favor the spread of alien plants in particular (Scherrer et al., 2022).

The spread of alien plants in meadows and pastures of the mountain area is a relatively new phenomenon (FOEN, MeteoSwiss, NCCS, 2020a/2020b). Data are available on the composition of the alpine flora, covering a period of more than 100 years. Over this observation period, the number of plant species on mountain peaks has increased significantly (Rixen and Wipf, 2017). Under the pressure of climate change, which is particularly pronounced in the alpine region, mountain plants of lower altitudes are expanding their range to higher altitudes, causing an increase in the number of species there. This development has accelerated in recent years (FOEN, MeteoSwiss, NCCS, 2020a/2020b).

The effects of climate change on birds and other animal groups are complex. On the one hand, direct physiological mechanisms are at work; on the other hand, there are indirect effects as a result of altered habitats, shifted competitive relationships, or phenological shifts (SCNAT, 2021a). Interactions between species in an ecosystem are disrupted or interrupted, for example when the activity of pollinators no longer coincides with the flowering season or when predators miss their prey in terms of time or space (FOEN, 2021; SCNAT, 2021). The effects are both species-specific and age-dependent. For example, a warmer and drier summer can have a positive or negative effect. The chicks of nest fledglings such as the rock ptarmigan survive better, but the adult rock ptarmigan become heat stressed (SCNAT, 2021a). Climate change is already causing substantial changes in native breeding birds. A comparison of the altitudinal distribution of the 71 most common Swiss bird species between 1995 and 2015 shows that around two thirds of the species have significantly expanded their range upwards within 20 years. The center of the average altitudinal occurrence increased by 24 metres. Alpine species in particular show strong changes:

Those 10 species that had the highest mean distribution in the first study period increased by an average of 51 metres in altitude towards the summit (SCNAT, 2021a).

As with breeding birds and the Swiss Bird Index (SBI)[34], the trend for butterfly species studied has been diverging over the last 30 years. It is mainly the warmth-loving species that have increased. The cold-loving species of the high mountains, such as the glacier butterfly, on the other hand, are decreasing. As a result of climate warming, species that prefer higher temperatures tend to expand their distribution, while species that are adapted to low temperatures decline. As the area, and thus also the available habitat, in the mountains decreases towards the top, the populations of upward-migrating species inevitably decrease (SCNAT, 2021a). For specialised and cold-loving species, survival is becoming increasingly difficult as climate change progresses. The winners include generalists and warmth-loving species.

Overall, biodiversity is coming under additional pressure as climate change progresses (FOEN, 2021). A comprehensive review of more than 2000 species of animals, plants and fungi shows that most species in the European alps are not able to overcome the 60 to 70 metres of altitude per decade that would be necessary for them to continue living under their normal climatic conditions. Furthermore, earlier snowmelt and increasingly warmer spring days lead to asynchronies in spring activities, which threatens species interactions and long-term ecosystem functioning (Vitasse et al., 2021) (from FOEN 2022).

6.2.7.3 Diversity of genes

Climate change means that many species have to adapt to changing climatic conditions or migrate to new areas where they find a climate that suits them (Holderegger and Segelbacher, 2016). Only those individuals can cope with the new environmental conditions that have the appropriate genetic make-up with matching alleles in sufficient frequency and when they can be inherited. But even if a species persists in climate change, it will have much lower genetic diversity. For example, while 67 per cent of the macroinvertebrate species studied will survive, only 16–35 per cent of the genetic variation within species will survive (FOEN, 2021). High genetic diversity thus is one of the basic prerequisites to adapt to new environmental conditions (Guntern, 2016; Holderegger and Segelbacher, 2016). If a population has greater genetic diversity, it has a higher chance that one of its alleles will be well adapted to future changes in environmental conditions. In addition, populations with low genetic diversity are more susceptible to the consequences of inbreeding and genetic drift in the longer term than large populations are (Holderegger and Segelbacher, 2016) (from FOEN 2022).

6.2.7.4 Projections for biodiversity

On the basis of existing observations and model results, it is possible to make some projections concerning the future climate change impacts on biodiversity in Switzerland. The tree line will shift upwards by about 400 metres in altitude with a global temperature increase of 2.2 degrees Celsius on average (Körner, 2021). Many species will not be able to keep pace with the rapidly advancing climate change. Species with low genetic variation, low reproduction rates, poor dispersal abilities and narrow ecological niches are the most vulnerable (SCNAT, 2021). Moreover, disruptions in species interactions caused by individual migration rates or phenological shifts are likely to have consequences for biodiversity (SCNAT, 2021a). The vulnerable species are displaced by more adaptable, increasingly common species, leading to a homogenisation of ecosystems. Under the current path of global warming averaging 3.2 degrees Celsius by 2100, about 49 per cent of insect species, 44 per cent of plant species and 26 per cent of vertebrate species would lose more than

34 www.vogelwarte.ch/en/projects/population-trends/sbi-state/ [15.09.2022]

half of their range (Warren et al., 2018). Native species are more at risk, while non-native invasive species benefit. Peatlands, forests, dry meadows, springs, water bodies and rocks have a high proportion of species with narrow ecological niches and are therefore considered climate-sensitive (SCNAT, 2021).

Biodiversity in Switzerland [and Liechtenstein] *depends on protected areas, priority areas, ecological networking and sustainable land use. The federal government and cantons have already taken several specific measures to conserve and promote biodiversity. Examples include the inventories of biotopes of national importance, the financing of forest reserves and biodiversity priority areas in agricultural areas and participation in the renaturation of bodies of water. Although the area designated for biodiversity has increased in the last 25 years, it is still not large enough to stop the population losses of endangered species and the decline of rare habitats.*

6.2.8 Forest and forestry

Liechtenstein's forests are mostly similar to the forests of adjacent regions in Switzerland. Therefore, the respective paragraphs are adopted from Switzerland's 8th National Communication (FOEN 2022). *Forest ecosystems and the goods and services they provide can be significantly affected by climate change through drought, heat waves, forest fires, storms or biotic calamities such as bark beetle infestations. Compared to the slow processes that occur in forests (tree growth, seed dispersal, genetic adaptation, etc.), climate change is occurring at a speed that overwhelms potential natural adaptation processes of forests. Important forest products and services such as wood production and protection against natural hazards could be reduced as a result.*

Climate change acts in different ways on tree species and the composition of forests. It weakens the vigour of drought sensitive species and favours the competitiveness of more drought resistant species. Because the tree line is mainly determined by summer temperatures (Körner and Paulsen, 2004), warmer conditions induce an upward shift. However, the upward shift of the tree line observed since 1900 is not only driven by climatic changes but also by the abandonment of pastures at high altitudes (Gehrig-Fasel et al., 2007; Vittoz et al., 2008). Due to changes in minimum air temperature in spring (less extreme cold events), European ash (Fraxinus excelsior), silver fir (Abies alba Mill.), wild cherry (Prunus avium L.), sycamore (Acer pseudoplatanus L.), sessile oak (Quercus petraea), and European beech (Fagus sylvatica L.) are successfully regenerating at and beyond the upper elevational limits of adult individuals (Vitasse et al., 2012), but this implies an enhanced risk due to late frost events (Vitasse et al., 2014; Vitasse et al., 2018).

In the inner-alpine dry valleys climate variability is now the main driving factor for vegetational changes (Rigling and Dobbertin, 2011; Rigling et al., 2013). Whereas the scots pine (Pinus sylvestris L.) now shows high mortality related to enhanced drought events (Etzold et al., 2016), the sub-mediterranean pubescent oak (Quercus pubescens Willd.) has locally increased in abundance. The growth of pines in drought events is not only reduced, but also the quality of the wood built under water stress is lower, as the hydraulic properties are more vulnerable to drought (Eilmann et al., 2011).

On the Central Plateau, the Norway spruce (Picea abies L.) covers wide areas outside its natural limits, which are characterized by a colder and wetter climate. In the dry year 2003, growth in the lowlands was reduced, whereas it was enhanced at higher and hence colder elevations (Dobbertin, 2005). In the hot and dry year 2018, even sudden drought-induced mortality of Norway spruce was observed (Arend et al., 2021). European beech (Fagus sylvatica L.) (Braun et al., 2021) and the silver fir (Abies alba) showed serious drought damages, too (FOEN et al., 2019).

Considerable drought induced tree damage and mortality was detected after 2018 in large parts of Europe (Schuldt et al., 2020). The symptoms included exceptionally low foliar water potentials crossing the threshold for xylem hydraulic failure in many species, widespread leaf discoloration

and premature leaf shedding. Strong drought-legacy effects were detected in 2019, which implies that the physiological recovery of trees was impaired after the 2018 drought event, leaving them highly vulnerable to secondary drought impacts such as insect or fungal pathogen attacks. Mortality of trees triggered by the 2018 events is likely to continue for several years.

An important factor enhancing the impacts of drought on trees is the deposition of nitrogen in forests. Evaluations reveal that the combination of drought stress and nitrogen deposition amplifies the effects of drought on trees (Braun et al., 2017). The mean annual nitrogen deposition in forests in Switzerland is about 20 kilograms (Meteotest, 2019), with much higher rates in agricultural regions in the lowlands.

In some cases, climate change increases the ability of neophytes to invade forests and to act as 'invasive aliens'. The tree-of-heaven (Ailanthus altissima) becomes invasive in the south-alpine region of Switzerland (Ticino and Grisons). In the northern regions, the tree-of-heaven is found mainly in areas influenced by the warm Föhn winds or in towns (Gurtner et al., 2015)[35]. It is especially successful on shallow, rocky and dry sites, where other tree species are less competitive (Knüsel et al., 2019). The leaves of the tree-of-heaven are toxic and game avoid to feed on them, which is an advantage for invasive spreading into the forests.

The reported findings are consistent with current knowledge on the ecophysiology of trees (Arend et al., 2016). However, the future forest composition is difficult to predict, since the influence of climate change on the forests is modified by a lot of other factors like local and regional site conditions, the influence of pests, diseases, insects and, especially at higher elevations, changes in agricultural practices (Zimmermann et al., 2016). If the development proceeds as observed and predicted by climate models (CH2018, 2018), a substantial shift in tree species composition will occur, favouring more drought tolerant trees like oak species, whereas trees adapted to colder and wetter climate like the Norway spruce will be restricted to sites at higher elevations (from FOEN 2022).

6.2.9 Agriculture

6.2.9.1 Plant Production

Rising temperatures are expected to accelerate plant development. In wheat, advancement rates of the heading date could range between 0.2 days per decade, under moderate warming, and 2.6 days per decade, under emission scenarios that do not foresee an effective abatement of greenhouse gas emissions (Rogger et al., 2021). By the mid of the century, developmental stage sensitive to heat stress could thus occur five to ten days earlier in the season, which would allow current wheat varieties to partially escape from future heat periods.

In maize, faster accumulation of growing degree-days would allow the crop to be harvested earlier than under current conditions (10 to 20 days by 2060, depending on emission scenario and location) (Buzzi et. al., 2021). Higher temperatures would also provide opportunities for cultivating maize in areas today still unfavourable and switching in places from early-maturing varieties to mid- to late-maturing varieties. Under rainfed cultivation, maize grain yields are projected to increase until about 2060 but to decline thereafter if climate protection measures are not implemented (Holzkämper, 2020). The beneficial effects of elevated atmospheric CO_2 concentrations could partially offset the negative impacts of heat and water stress, in wheat more than in maize (Webber et al., 2018).

[35] The Rhine valley and Liechtenstein are frequently affected by Föhn winds.

Because of the projected changes in the hydrological cycle with, in particular, a decline in summer precipitation amounts and the more frequent occurrence of drought conditions (FOEN, 2021), irrigation water demand for crop production is anticipated to increase considerably. In a case study for western Switzerland, irrigation requirements for maize cultivation were simulated to increase by as much as to 40 per cent until the end of the century, with large variations depending on chosen varieties and management (Holzkämper, 2020). More recently, the potential increase in irrigation water requirements was assessed for a range of crops (Eisenring et al., 2021). In potato cultivation, for instance, the expected increase in water requirements until 2060 was estimated in between 10 and 40 per cent, depending on emission scenario and location.

Climate change will have significant impacts on grassland ecosystem services (Lavorel, 2019). Fodder production would profit from a projected lengthening of the growing season (CH2018, 2018), but extreme temperatures in spring and more prolonged and intense droughts in summer are likely to negatively affect grassland productivity and increase yield instability. As production stability and grassland multi-functionality are related to plant species richness (Haughey et al., 2018; Suter et al., 2021), larger impacts of drought are likely to occur in species-poor grasslands than in botanically diverse pastures and meadows. In numerical experiments, management was found to significantly control grassland responses to drought, with vegetation dynamics less affected by increasing aridity under extensive management (Moulin and Calanca, 2021).

More frequent and intense heavy precipitation events could aggravate problems in plant production associated with soil erosion (Borrelli et al., 2020). An earlier high-resolution assessment for current climatic conditions indicated that about 12 per cent of the current agricultural area is exposed to moderate potential erosion risk, while 43 per cent is exposed to high potential erosion risk (Prasuhn et al., 2013) (from FOEN 2022).

6.2.9.2 Insect pests

It is likely that plant production will face higher pest pressure under future climatic conditions. An increase in the number of generations per year is expected for many native pest species, but a few could also suffer from higher temperatures. An example of the latter is the carrot fly (Chamaepsila rosae) whose developmental cycle was found to be significantly hampered by critically high soil temperatures on the Central Plateau during 2006, 2013, 2015 and 2017 (Agroscope, 2018).

Climate change probably will lead to the establishment of non-indigenous, potentially invasive insect pests. A Europe-wide study of the effects of warming on the potential range of 64 agricultural insect pests found that current climatic conditions in Switzerland and Liechtenstein *are already suitable for the establishment of 30 of these species, and that an additional 12 species could prosper under conditions projected for the second half of the century (Grünig et al., 2020a). The study also indicated that the number of overlaps of insect pests with their host plants would increase with climate change, and that the area of regions where these overlaps are possible would also grow significantly in the future.*

A second study (Grünig et al., 2020b) examined the climate niches of quarantine organisms and already established insect pests. The study identified two main groups of pests: those undergoing winter diapause and those that lack strategies for overwintering. The results further indicated a critical lower threshold (close to minus one degree Celsius) for the average monthly mean temperature of the coldest month for the second group. It was concluded that rapid rise in pest pressure could take place in areas where warming leads to average minimum winter temperatures above this threshold.

As with native insect pests, invasive insect pests are expected to have larger habitats and higher development rates under future climate conditions. A species that is currently under close monitoring is the highly polyphagous brown marmorated stinkbug (Halyomorpha halys Stål). Native to East Asia and invasive in Europe and North America, it can damage a wide variety of

fruit and vegetable crops. In Switzerland, it has been of concern to farmers since about 2015. A model-based assessment of the potential distribution and seasonal occurrence of the marmorated stink bug (Stoeckli et al., 2020) disclosed that the potential range is likely to expand further in the future, allowing the marmorated stink bug to find suitable living conditions throughout northwestern Switzerland and in many alpine valleys (from FOEN 2022).

6.2.10 Energy

6.2.10.1 Impacts on heating degree day and cooling degree day

Heating degree days provide an indication of the heating requirement for buildings. For a particular year, heating degree days are defined as the sum of the daily differences between the mean outside temperature from a room temperature of 20 degrees Celsius for days with an outside temperature of 12 degrees Celsius or less. Cooling degree days are counted when the mean daily temperature exceeds 18.3 degrees Celsius. They provide an indication of the energy demand for air conditioning. Climate change is likely to modify both heating degree and cooling degree days. Figure 6-11 *shows the expected evolution of heating degree days and cooling degree days computed from the CH2018 scenarios (CH2018, 2018) for the years 2030, 2040 and 2050 using two emissions scenarios (RCP 2.6 and RCP 4.5) in respect to the reference year 2020 (from FOEN 2022).*

In Liechtenstein, a similar evolution is expected.

Generally speaking, global warming leads to a decrease in heating energy demand in Switzerland, which is partly countered by an increased energy demand for space cooling.

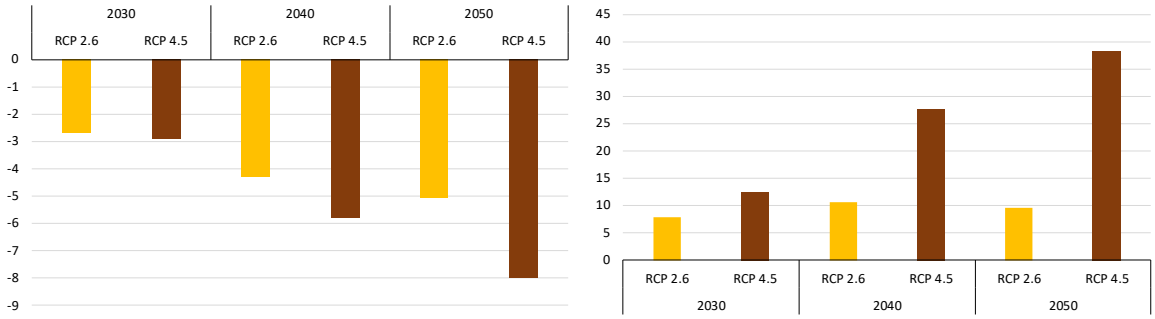

Figure 6-11 Changes in % of Heating Degree Days (HDDs) (left) and Cooling Degree Days (CDDs)(right) in respect to the reference year 2020 in scenarios with stringent (RCP2.6) and with moderate (RCP4.5) climate change mitigation (from FOEN 2022 according to Prognos et al. (2020)).

6.2.10.2 Impacts of changes in heating and cooling degree days on energy consumption and economic welfare

Using an economic model, a study by Vöhringer et al. (2019) simulated the impacts of the future changes of heating degree days and cooling degree days for the year 2060. Decrease in heating demand will lower the energy consumption of oil and natural gas, which are mostly used in Switzerland [and Liechtenstein] *for heating. In contrast, the increase of cooling demand will boost electricity consumption. The aggregated impacts are a decrease of oil and gas use, and an increase of electricity use. The actual impact on electricity consumption depends heavily on the spread of air conditioning in Switzerland in future decades. From an economic point of view, the effect of decreasing heating energy consumption strongly outweighs the effect of increasing cooling energy demand. Thus, the net effect leads to lower household expenditures in the order of*

963 million to 1,599 million Swiss francs in 2060, depending on the underlying emissions scenario. In addition to the economic benefits, CO_2 emissions are reduced by 2.1 to 3.4 per cent. These results are in line with the findings of other studies that expect climate change to lead to decreasing energy demand in colder regions and increasing energy demand in warmer regions of the world (Isaac and van Vuuren, 2009) (from FOEN 2022).

6.2.10.3 Influence of climate change on hydroelectric power production

The impacts of climate change on hydropower production were investigated as part of a study on the impacts of climate change on Swiss water bodies (FOEN, 2021). The hydrological scenarios Hydro-CH2018 formed the basis for the study. Hydropower is dependent on the volumes of water flowing in watercourses and their seasonal distribution, and is thus strongly affected by the impacts of climate change. Discharges are determined on one hand by precipitation and on the other hand by atmospheric temperature. Climate change affects both aspects. Higher temperatures lead to more evaporation and thus to reduced runoff. In addition, higher temperatures change the seasonal distribution of runoff (Lanz and Wechsler, 2020).

It is currently expected that the climate-induced change in evaporation, amount and duration of snow cover and glacier melt will have a rather positive impact on the operation of run-of-river power plants in the coming decades. In winter, they should benefit from increased inflow, as precipitation falls more as rain and less as snow. This will potentially allow them to produce more electricity (Savelsberg et al., 2018). As reservoirs at lower altitudes (below 2,000 metres above sea level) refill more quickly (or empty more slowly) in winter with the transition to a rainfall-dominated runoff regime, this strengthens production in the winter period. For reservoirs with a catchment area above 2,000 metres above sea level, the changes in winter are likely to be smaller, because at this altitude no fundamental changes in the discharge regime are expected during the 21st century (Lanz and Wechsler, 2020).

The run-of-river power plants on the rivers of the alpine valleys and the Central Plateau will also benefit from a winter increase in discharge (SCCER-SoE, 2019). Above 1,400 metres elevation, the increase could be more than 30 per cent (Schaefli et al., 2019, SCCER-SoE, 2019), but starting from a relatively low level. Despite the winter increase, annual production will tend to decrease, as both precipitation and snowmelt water will decrease significantly in summer (SCCER-SoE, 2019). Run-of-river power plants are directly affected by summer drought because, unlike storage power plants, they can only use the currently flowing water volumes.

The change between dry and wet years could have a greater impact on hydropower production than the long-term changes due to climate change (Savelsberg et al., 2018). The Swiss Federal Office for the Environment (FOEN, 2016a) has examined the impact of the dry summer and autumn of 2015 on hydropower production. After an above-average spring, the run-of-river power plants produced significantly less electricity than usual in the second half of 2015 due to the drought. Thanks to higher natural inflows from glaciated catchment areas and the early use of water stored in reservoirs in the autumn of 2015, overall electricity production from hydropower was still above the average of the previous years. An analysis of the impacts of the summer 2018, which was also hot and dry, showed a similar result. However, there was a small shortfall in production of 0.8 per cent compared to the average of the last ten years (FOEN et al., 2019). This experience has to be taken into account with regard to supply security during winter months, when Switzerland depends on electricity imports[36] (from FOEN 2022).

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[36] Liechtenstein depends on electricity imports from neighbouring countries. About 75% of Liechtenstein's electricity consumption is covered by electricity imports, the rest is produced in the-country (hydropower or PV) (SFOE 2022; https://energeiaplus.com/2022/07/14/wie-die-schweiz-und-liechtenstein-bei-der-energie-zusammenspannen/ [15.09.2022]) .

6.2.10.4 Influence of climate change on the thermal use of waters

Rivers, lakes and groundwater represent enormous heat reservoirs. In autumn and winter, they can be used as a heat source and thus form a CO_2-neutral option for the replacement of fossil energies. A positive consequence of global warming is that more heating energy can be extracted from warmer waters during the cold season. Depending on the season, water bodies warm up to different degrees. The heat utilisation potential of watercourses should increase slightly in winter (higher average winter temperature, higher winter discharge) (Lanz, 2020). In addition to rivers and lakes, also groundwater is used thermally. Groundwater bodies react very differently to changes in atmospheric temperature, depending on how strongly they are influenced by infiltration from surface waters (Figura, 2013). Groundwater with a stable temperature throughout the year makes the most sense for thermal use and is also suitable for combined cooling and heating. Although these mostly lower-lying groundwater sources will also gradually warm with climate change, they will still be significantly cooler than the atmosphere in mid-summer and significantly warmer in winter. In contrast, the extraction of heat for heating buildings can have a positive effect, as it contributes to the cooling of groundwater bodies. However, it became apparent in 2018 that the thermal usability of groundwater can also be impaired by drought. For example, the canton of St. Gallen reported that some heat pumps had operating problems in November and December 2018 due to low groundwater levels. Such problems also occurred in the canton of Glarus (EBP, 2019).
Water bodies can also be used for cooling, but not all cantons in Switzerland allow cooling with groundwater. Due to the warming of the water bodies, their cooling potential dwindles in summer. This mainly affects the river water, which can no longer be used for cooling in hot summers when the water temperature approaches 25 degrees Celsius. In addition, the demand for building and process cooling may increase in warmer summers and during hot spells. However, most existing cooling systems can still be optimised in terms of construction and energy consumption, so that cooling energy demand does not necessarily have to increase significantly even at higher temperatures (Lanz, 2020). Despite climate change, the demand for cooling remains many times lower than the demand for heating. According to the Energy Perspectives 2050+, the demand for heating in 2050 is expected to be between 74 and 85 terawatt-hours while the demand for cooling is expected to be between three and four terawatt-hours (Prognos et al., 2020) (from FOEN 2022).

6.2.11 Health

6.2.11.1 Extreme events

The projected increase in the frequency and intensity of heat waves in combination with high tropospheric ozone concentrations represents the greatest direct risk of climate change to public health in Switzerland [and Liechtenstein]*. The potential impact first became apparent during the hot summer of 2003. High ambient temperatures caused almost 1000 additional deaths between June and August 2003. The 2003 heat wave mostly affected the elderly and was more pronounced in cities where it was exacerbated by the urban heat island effect (Grize et al., 2005). Excess deaths due to heat were also observed during the hot summers of 2015, 2018, and 2019. Most of the extra deaths occurred in people aged 75 years and older (Ragettli and Röösli, 2020; Ragettli and Röösli, 2021b).*

Heat waves and single hot days are not only related to excess mortality but also to increased morbidity. In Switzerland, the summer of 2015 was the second warmest summer (after 2003) since the beginning of measurements 150 years ago (MeteoSwiss, 2016). A study which analysed daily counts of emergency hospital admissions in 2015 in relation to previous years (Ragettli et al., 2019) reported close to 2,800 additional cases (+2.4 [1.6–3.2] per cent, 95 per cent confidence interval) in the period June–August 2015. During days with most extreme temperatures, increased emergency hospital admissions were observed mainly for pneumonia, certain infection diseases

and diseases of the genitourinary system. A recent study on short-term associations between ambient temperature and mental health hospitalizations in the city of Bern (Bundo et al., 2021) also reported that high temperatures negatively affect the mental status in psychiatric patients.

Additional direct effects of climate change on health are expected from the increase of other extreme events such as floods, mudslides and, possibly, storms. In view of the well-developed emergency measures of civil protection in Switzerland [and Liechtenstein]*, the health effects should be manageable. However, extreme events may entail severe psychological consequences for the directly affected population which are often underestimated and may last longer (from FOEN 2022).*

6.2.11.2 Allergies and vector-borne diseases

Throughout Switzerland [and Liechtenstein]*, the starting dates of the pollen season have shifted between 1990 and 2020 to earlier periods of the year for several allergenic pollen types (hazel, oak, grasses, nettle/hemp) (Glick et al., 2021). In addition to these species, significant trends were found in a 50-year analysis (1969–2020) of Basel pollen levels (Gehrig et al., 2021). The same two analyses found an overall increase in pollen season intensity (calculated as the annual pollen integral) for most trees (hazel, birch, oak, beech, alder, yew, ash, hornbeam, plane, poplar) and nettle/hemp (Glick et al., 2021; Gehrig et al., 2021). Similar trends in pollen season onset, duration and intensity were reported in an analysis which included data from across Europe (Ziska, 2019), where pollen season shifts have been attributed to temperature rise and CO_2 increase. Moreover, due to climate change related habitat changes, highly allergenic non-native species (e.g. mugwort and ragweed) may settle in Switzerland* [and Liechtenstein]*, further intensifying the pollen season. People sensitised to a variety of different pollen may start suffering earlier from hay fever or asthma symptoms and for a prolonged period of the year, as pollen production starts earlier in the year and the amount of pollen increases.*

To date, there is no clear evidence that an increase in the prevalence of allergic diseases is causally linked to increasing pollen concentrations in the air. However, it is to be expected that the combination of widespread prevalence and increased intensity of the pollen season would adversely affect the quality of life of many.

Another important potential health risk of climate change is the occurrence of vector-borne diseases. The diseases result from a transmission of an infectious agent through an animal vector (mosquito, tick) usually through biting or touching. Increasing temperatures favour growth of vectors and replication rates of infectious agents, e.g. viruses. In Switzerland [and Liechtenstein]*, the most common vector-borne diseases are tick-borne encephalitis (FSME) and Lyme disease. In recent years, outbreaks of some vector-borne diseases, such as Dengue and Chikungunya fever have been observed in neighbouring countries such as Italy and France, and the respective vector (the mosquito Aedes aegypti) is present in Switzerland, too. However, future developments are still highly uncertain as many other factors such as human behaviour, population density, international trade and global tourism affect disease transmission (from FOEN 2022).*

6.2.12 Tourism

Liechtenstein's tourism focusses on alpine tourism. Therefore, the reflections and data on Switzerland's alpine tourism also provide relevant information for Liechtenstein. *With climate change progressing, the altitudinal threshold for snow-reliability will continue to rise. Without climate mitigation measures, the natural snow cover will be reduced by around 40 per cent at an altitude of 1500 to 2000 metres above sea level by 2060 (CH2018, 2018). Profitability is decreasing everywhere due to the shortening of the ski season, the increasing cost of artificial snow production, the decreasing number of guests due to uncertain snow conditions and the decreasing motivation for winter sports, triggered by the lack of wintery atmosphere on the Central Plateau (Bandi, 2021).*

Based on the altitude of the station, the Swiss ski resorts currently considered to be snow-reliable have been assessed for an average temperature increase of one, two and four degrees Celsius. It appears that the number of ski resorts with economically sufficient snow conditions may drop by at least one fifth for a regional temperature rise of two degrees Celsius. Under this scenario and seen from a national tourism perspective, the number of affected resorts is not so significant. In case of a regional four degrees Celsius rise in temperature, low elevation ski resorts will be extremely affected while many high-altitude ski resorts remain snow-reliable (Abegg et al., 2007).

Climate change scenarios show that snow days may decline by 50 per cent at an altitude of 1500 metres and in the lowlands snow is predicted to disappear almost entirely (Marty et al., 2017b). Already today, small ski resorts at low altitudes only operate when snow cover is sufficient. Their room for manoeuvre but also the pressure to generate revenue are comparatively low. Medium-sized ski resorts are most affected by the decreasing snow reliability in terms of profitability, as they cannot easily afford to invest in artificial snow compared to larger ski resorts at higher altitudes (Bandi, 2021).

Changing conditions in summer may create new opportunities for the tourism sector. Pleasant temperatures at higher altitudes and a tendency towards less rainfall can help reposition the alpine region as a summer holiday destination. At the same time, numerous places at lakes and rivers might become an alternative to seaside holiday resorts at the Mediterranean Sea, which tend to lose attractiveness as excessive heat and drought conditions become more frequent (Swiss Confederation, 2020a).

Climate-related changes in natural hazards are another element that is important for tourist destinations in the mountains. The melting of permafrost destabilises the subsoil. This can affect infrastructures located at high altitudes. Hotel and restaurant buildings, cable car masts, avalanche barriers, etc. are at risk if they are anchored in permafrost (FOEN, 2017a). A related problem is the frequency of rock fall and debris flows which will increase due to the combination of melting glaciers, melting permafrost, rising snow line and more intense precipitation. This may pose an additional risk to mountaineers and hikers at high altitudes (from FOEN 2022).

6.3 Assessment of risks and vulnerability to climate change

In 2018, Liechtenstein published its first national climate change adaptation strategy (Government, 2018). The strategy is based on the Swiss adaptation strategy (Swiss Confederation, 2012a) and risk assessments (Stöckli et al. 2015).

As stipulated in the Swiss adaptation strategy (Swiss Confederation, 2012a) (see section 6.4 in FOEN 2022), Switzerland shall minimise the risks of climate change, take advantage of opportunities arising as a result of climate change and increase its adaptive capacity by implementing targeted measures. (from FOEN 2022).

Climate-related risks and opportunities were assessed a comprehensive Swiss project lasting from 2010 until 2017 including:

- Development of a method to systematically assess and compare the risks and opportunities;
- Carrying out eight case studies in different regions of Switzerland (amongst others for the region of canton Grisons (Stöckli et al. 2015), which is adjacent to Liechtenstein);
- Evaluating and prioritising the risks and opportunities at the national level in a synthesis report (FOEN, 2017a).

In its 2018 assessment, Liechtenstein identified vulnerabilities to climate change in particular in the following areas:

Water management: Prolonged heat waves and reduced precipitation amounts in summer are expected to increase the risk of drought and water stress in agricultural production. This entails an increase in irrigation, which has negative consequences for aquatic ecosystems, e.g., if minimum discharge requirements cannot be maintained. In addition, an increase in magnitude and frequency of flood events along the river Rhine might increase the risk of damage to infrastructure and buildings.

Biodiversity, Forestry, Agriculture: Changing climatic conditions affect biodiversity and ecosystem services. Increasing temperatures favour spreading of alien and invasive species, which also entails negative impacts on agriculture and forestry. In forests, deciduous trees may spread due to increased temperatures. In addition, an increased frequency of extreme events, such as forest fires, storms, prolonged drought periods and avalanches, may affect forest vegetation (AWNL 2011). For the agricultural sector, negative impacts are expected from an increased risk of prolonged droughts, which might result in water stress and reduced crop yields.

Health: During the heat wave in 2003, an increase in mortality by 7 % was observed in Switzerland (Grize 2005). It can be assumed that a similar increase happened in Liechtenstein. With rising temperatures, similar events are expected to occur more frequently in future. Additionally, changing climatic conditions might also favour spreading of pathogens. Tropical diseases (malaria, dengue fever) are expected to increasingly surface in Central Europe (Swiss Confederation, 2012a), and existing diseases (e.g., borreliosis, meningitis) might spread to higher elevations, thereby affecting regions that were previously not at risk. An increased risk of natural hazards (e.g. landslides, rock fall) might also affect human health.

Tourism: Winter tourism is affected by the expected rise of the freezing level, which leads to a higher snow line. As a consequence, the skiing season may be shortened, especially for skiing areas situated between 1500 m and 2000 m above sea level, like Malbun in Liechtenstein. Consequently, the number of tourists visiting these skiing resorts is expected to decrease, which entails losses in the hotel and gastronomy sector. Reduced amounts of snowfall also require an increase in production of artificial snow, which leads to higher costs.

Energy: Changes in the runoff regime (e.g., due to changes in the snow cover and seasonal distribution of precipitation) can affect hydroelectric power production. Changes in frequency and

magnitude of extreme events (e.g., drought periods, flooding) can also have negative impacts on power production. Besides electricity production, energy consumption is also affected by changing climatic conditions. Occurrence of heat waves is expected to increase and might lead to an increase in energy demand for cooling purposes.

Other areas: Global climate warming may result in economic losses not only due to direct local impacts but also by increasing the risk of supply chain disruption. More frequent occurrence of natural disasters may reduce production capacity or damage transportation infrastructure (e.g., roads, railways, airports, ports, bridges), thereby reducing availability of goods imported into Liechtenstein. On a global scale, the agricultural sector is considered to be highly vulnerable to changes in climatic conditions. Negative effects on agricultural productivity are expected due to increased droughts and irrigation needs in regions with important contribution to global food production. Therefore, climate change may affect global food supply and prices.

6.4 Domestic adaptation policies and strategies

To mitigate expected negative impacts of climate change, adaptation measures are required in different areas and sectors. Adaptation is therefore an essential element of Liechtenstein's climate strategy (Government 2015), which is currently being updated (Government 2022).

The national climate change adaptation strategy of Liechtenstein (**Government, 2018**) identifies the relevant impacts related to climate change and defines measures to limit or avoid negative impacts. Liechtenstein also actively participates in international adaptation projects of the Alpine Convention[37] and the alpine space programme[38] (Climate Change Adaptation by Spatial Planning in the Alpine Space, Clisp). Liechtenstein was an official partner of the European project "C3-Alps"[39] on "Capitalising Climate Change Knowledge for Adaptation in the Alpine Space". The outcomes of this project form the foundation of the national climate change adaptation strategy (Government, 2018). In the following, first, the C3-Alps project "Capitalising Climate Change Knowledge for Adaptation in the Alpine Space" is presented. Then, the adaptation strategy of Liechtenstein is outlined.

6.4.1 C3-Alps - Capitalising Climate Change Knowledge for Adaptation in the Alpine Space

6.4.2 Project Framework

C3-Alps is a European project funded by the Alpine Space Programme under the European Territorial Cooperation 2007-2013. C3-Alps started in January 2012 and ran until December 2014. The lead partners were the Umweltbundesamt and the Federal Environment Agency Austria. The partnership was composed of 17 Project Partners from Austria (4), Italy (4), Germany (3), Switzerland (2), France (1), Slovenia (1), the Principality of Liechtenstein (1) plus UNEP's regional office for Europe, and included international organisations, national and regional government authorities, national agencies, provinces/regions, research institutions and institutes of applied sciences.

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[37] https://www.alpconv.org/en/ [1.09.2022]

[38] Climate Change Adaptation by Spatial Planning in the Alpine Space — Climate-ADAPT (europa.eu) [1.09.2022]

[39] C3-Alps – Capitalising Climate Change Knowledge for Adaptation in the Alpine Space — Climate-ADAPT (europa.eu) [1.09.2022]

6.4.3 Project Description

C3-Alps synthesised, transferred, and implemented in policy and practice, the results of previous Alpine Space projects on climate change adaptation. The capitalisation approach aimed at

- generating new and directly usable forms of state-of-the-art synthesis adaptation knowledge in the Alps, harmonised across sectors and useful to adaptation decision-makers,
- providing effective and tailor-made communication and transfer to target groups,
- enhancing effectiveness of adaptation policy and governance frameworks, and
- initiating, supporting and pioneering tailored and cross-cutting adaptation processes, strategies, action plans and decision support in pilot regions and municipalities.

From a national perspective, the project's further aim was to strengthen climate change adaptation in Liechtenstein. In close co-operation between the Office of Environment, sub-contractor CIPRA International and the relevant departments of the national administration, the abovementioned national climate change adaptation strategy was developed and finalised in 2018 (OE, 2018).

6.4.4 Liechtenstein's climate change adaptation strategy

The national climate change adaptation strategy covers the sectors of water resources management, natural hazards, agriculture, forestry, energy, tourism, biodiversity, health and land use planning (Government, 2018). The strategy emphasises the impacts of increased risks of drought periods, heat waves, flood events and spreading of new vector borne diseases and alien invasive species. The strategy also addresses consequences of a reduced snow cover on winter tourism and the runoff regime. The following sections summarise ongoing and planned activities related to climate change adaptation.

6.5 Monitoring and evaluation framework

The implementation of adaptive measures lies within the responsibility of the respective offices and institutions and is planned according to the priorities defined in Liechtenstein's strategy for adaptation to climate change (Government, 2018).

The implementation of measures is coordinated and monitored by Liechtenstein's working group for climate change adaptation, which consists of members of the office of construction and infrastructure, the office of civil protection, office of public health, the office of food safety and veterinary, the office of environment and the office for economic affairs. The working group is coordinated by the office of environment. In annual meetings, this working group exchanges information on the state of implementation and coordinates planned and ongoing activities related to climate change adaptation. After five years, the working group will evaluate the progress and outcomes of adaptive measures and revise the adaptation strategy accordingly.

6.6 Progress and outcomes of adaptation action

The following sections summarize planned and ongoing activities related to climate change adaptation.

6.6.1 Water resources management

Urban drainage and water supply planning are important instruments in the management of water resources in Liechtenstein. These plans are updated regularly, taking into account changes in climatic conditions that may affect supply of drinking water and urban drainage systems.

Rising demand for irrigation of agricultural crops may require changes in current regulations. Liechtenstein plans to examine the need for adaptation of the existing regulatory framework on the use of ground and surface water for irrigation purposes.

In Liechtenstein, a continuous monitoring network for water temperatures is in place and impacts on aquatic biodiversity are regularly monitored. Impacts of increased use of water for cooling and heating purposes and related impacts on groundwater temperatures are currently under assessment.

In addition, an integrated water utilisation plan is implemented in certain regions of Liechtenstein. These plans coordinate competing demands for water in situations of limited water supply. If in future an increase in drought periods is observed, it is planned to implement similar plans in other regions that are affected by water shortage.

6.6.2 Natural hazard management

The office for civil protection of Liechtenstein conducted a general risk assessment, which covers also risks related to natural causes (EBP, 2012). In addition, Liechtenstein has established natural hazard maps (OCP, 2017). These maps provide regionalised information on the specific local risks of avalanches, rock fall, landslides and flooding. To address the expected increase in frequency and intensity of natural disasters, the Division of Forests and Landscape of Liechtenstein will regularly update these natural hazard maps, taking into account potential changes in frequency and magnitude of extreme events.

In addition, a statistical evaluation of extreme precipitation events was performed. The results show that currently there is no need to adjust dimensioning requirements of urban drainage systems in Liechtenstein.

The Federal Office for the Environment Switzerland (FOEN) operates a model for the prediction of discharge and water levels for the river Rhine. This model is continuously improved, thereby improving early warning systems for flood events also in Liechtenstein.

The Office for Civil Protection also provides emergency planning in case of avalanches, flooding and forest fires as well as a database for all protective structures against flooding, rock fall and avalanches.

6.6.3 Agriculture

The agricultural sector benefits from a prolonged growing season. However, the expected increase in drought periods, extreme rainfall events and a more rapid spreading of invasive species, pathogens and parasites under a warming climate are expected to reduce crop yields. Besides crop production, also animal husbandry might be affected by existing and new pathogens.

The Swiss Federal Food Safety and Veterinary Office (FSVO) provides biweekly information on the spreading of most important animal diseases. This system helps to reduce the risk of further spreading, since it enables preventive action. In analogy to the early warning system for animal diseases, the development of a similar system for plant diseases is intended. Liechtenstein is closely collaborating with the Swiss authorities.

In future, agricultural fields will require more irrigation. Especially during longer drought periods, the use of water for irrigation purposes conflicts with other water demands. Coordination of

different interests by means of integrated water utilisation plans will therefore become more important (see also section 6.6.1).

In Switzerland, *the implications of climate change for animal health and performance are investigated in the broader context of the "One Health" approach. Key research questions have been identified in a preliminary study commissioned by the Swiss Federal Food Safety and Veterinary Office (SAFOSO, 2019). The report includes a qualitative assessment of the relevance of climate change for aspects connected to animal production, ranging from forage quality to animal diseases.* Liechtenstein will examine these recommendations and adopt relevant recommendations. If necessary, adaptation to the specific local circumstances is considered.

Under changing climatic conditions, existing recommendations for crop cultivation might not be suitable anymore. Liechtenstein is planning to examine the need for adapting these recommendations to expected future climatic conditions (Government, 2018).

Measures for protection against soil erosion during extreme rainfall events and wind storms are already implemented. By reducing wind speeds, these measures also help to reduce loss of water, thereby reducing the risk of drought conditions.

6.6.4 Forestry

Liechtenstein's alpine forests play an important role in the protection against natural hazards. Forested areas also offer other important ecosystem services, such as timber production, preservation of biodiversity and provision of recreational areas. The expected increase in drought periods, especially in combination with subsequent damages caused by insects (bark beetle infestations), pathogens (viruses, bacteria, fungus), forest fire or wind storms, is expected to affect provision of these ecosystem services.

Conditions of forests in Liechtenstein are evaluated regularly with respect to the provision of different ecosystem services. Forest service plans define forest management at the local level. These plans are updated every 10 years, taking into account possible needs for adaptation of management practices to changes in climatic conditions. Liechtenstein also developed a national forest development plan in 2001 (OE, 2001), which addresses future forest management and is also periodically updated. The updated forest development plan 2030+ is currently being developed and will be published by the end of 2022[40].

Especially in areas that are sensitive to changes in climatic conditions and in areas that are important for protection against natural hazards, artificial regeneration of forests is required. In order support adaptation of these forests to more frequent drought conditions and elevated risks of storms, tree species need to be selected in accordance with expected future environmental conditions (e.g., conversion of spruce and fir stocks into mixed deciduous and coniferous forests).

6.6.5 Energy

The expected rise in temperature and increased risk of heat waves are expected to lead to higher demand for cooling and air conditioning. Adaptive measures in Liechtenstein focus primarily on passive cooling, which comprises structural measures in buildings, such as improved isolation and shading, and planning measures, amongst others. Under current regulations, use of cooling and air conditioning devices is restricted to avoid increasing energy consumption and related GHG

[40] https://www.llv.li/medienmitteilungen/detail/5008/arbeiten-zur-breit-abgestutzten-waldstrategie-2030-haben-begonnen [01.09.2022]

emissions. Current regulations also allow for measures to be taken to prevent a drastic increase in energy demand for cooling purposes under future climatic conditions.

A few years ago, one of Liechtenstein's hydroelectric power plants (Samina) was transformed into a pumped-storage plant. This measure increases flexibility in power production and facilitates adaptation to expected changes in the runoff regime due to climate change (Government, 2018).

6.6.6 Tourism

Summer tourism in Liechtenstein is expected to benefit from climate change related developments. Tourist destinations at higher elevations, which exhibit generally lower temperatures, might become more popular if heat waves occur more frequently in urban areas. However, winter tourism is strongly affected due to reduced snow cover, especially in skiing resorts at low to medium altitudes.

To some extent, the production of artificial snow enables compensation of reduced snow cover, but only up to a certain temperature threshold. At higher temperatures production of artificial snow is currently not feasible. In addition, the energy consumption is high and therefore a substantial increase in artificial snow production would not be in line with Liechtenstein's energy strategy (see section 4.3). Therefore, adaptation measures focus primarily on diversification of tourist attractions to compensate for a shorter skiing season. Promotion of new tourist activities and related marketing strategies aim at generating additional revenue that compensates for potential losses due to a shortening of the skiing season. Emphasis lies on strategies that promote different forms of sustainable tourism (e.g., health tourism).

Another crucial element is transfer of knowledge among affected areas on possible adaptation measures for the tourism sector. Experience from existing pilot projects on climate adaptation in Swiss tourist destinations will be considered in the future development of tourist services and tourist attractions (Government, 2018).

6.6.7 Biodiversity management

Liechtenstein updated its management plan for the control of invasive alien plant species (OE, 2018a). It provides a list of species that needs to be controlled or watched. It also defines suitable measures to prevent alien species from invasive spreading and control measures for affected areas, such as appropriate disposal procedures.

Many natural habitats that are highly susceptible to changes in climatic conditions, such as alpine and aquatic habitats and wetland areas, are already under protection in Liechtenstein. The protective regulations form the necessary framework for the development and implementation of measures for the preservation of these ecosystems. The national report on the implementation of the Convention on Biodiversity (OE, 2019) documents the state of Liechtenstein's ecosystems and the progress towards the achievement of "Aichi Biodiversity Targets".

According to the Water Framework Directive[41] of the EU, the ecologic state of all large water courses needs to be assessed regularly. Recent assessments in Liechtenstein based on indicator species show that deficits still exist for a number of rivers and streams. In particular, there is a lack

[41] https://www.llv.li/inhalt/117899/amtsstellen/wasserrahmenrichtlinie [23.08.2022]

of structural diversity (OE 2015b). Liechtenstein is planning to implement targeted revitalisation measures to improve conditions in aquatic habitats (Government, 2018).

6.6.8 Health

Health impacts due to the expected increase in duration and frequency of heat waves can be mitigated by structural measures on buildings (e.g., isolation, shades, dimensioning of windows in new buildings) and planning measures (e.g., green areas, shading, orientation of new buildings). Liechtenstein plans to promote implementation of such measures by providing financial incentives (e.g., for energy-efficient refurbishment of existing buildings) and regulations and standards for new buildings. These measures help to reduce the need for active cooling, which would increase energy demand and should therefore be minimised. Negative impacts of prolonged heat waves can also be reduced by changes in behaviour, such as limiting strenuous activities during daytime. Switzerland provides a list of recommendations[42] and informs about potential risks. Liechtenstein adopts these recommendations.

The expected increase in water temperatures might lead to an increase in microbial pollution in drinking water resources. The continuous monitoring system for the quality of drinking water that is currently implemented in Liechtenstein allows detection of potential microbial pollution and implementation of necessary corrective measures in case of elevated pollution levels. It also enables identification of potential future changes in pollution levels thereby providing a basis for further adaptation measures.

Ozone levels might rise under future climatic conditions, which would entail a higher risk of respiratory diseases. Ozone concentrations are measured continuously and, in collaboration with Switzerland, model simulations are performed, which provide information on spatial distribution. In case of elevated concentrations over longer time periods, the population is informed about the risks and protective measures.

Increasing temperatures might lead to a spreading of vector-borne diseases that currently do not exist in Liechtenstein. The Swiss Federal Office of Public Health provides a list of infectious diseases requiring notification[43]. This list already includes certain diseases that might spread under warming climatic conditions (e.g., dengue fever, chikungunya fever). The Swiss regulation and recommendations are also adopted in Liechtenstein, thereby allowing for an early detection of a potential spreading of new diseases. The need for further measures is assessed in collaboration with Switzerland. If Switzerland adopts concrete measures for surveillance and control of specific vector organisms, Liechtenstein will examine whether similar measures are also necessary in Liechtenstein. Currently, the focus lies on providing regular information on potential new risks to medical professionals and on drafting recommendations on how to address these risks (Government, 2018).

6.6.9 Land use planning

Existing land use planning instruments implemented in Liechtenstein allow coordination of different land uses. Land use planning is closely linked to other sectors and requires close collaboration with all involved stakeholders. Therefore, existing land use planning instruments also play a key role in the adaptation to climate change. For example, green areas in urban environments exhibit a cooling effect and provide shade thereby reducing potential negative

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[42] https://www.bag.admin.ch/bag/de/home/gesund-leben/umwelt-und-gesundheit/hitze.html [23.08.2022]

[43] https://www.bag.admin.ch/bag/de/home/krankheiten/infektionskrankheiten-bekaempfen/meldesysteme-infektionskrankheiten/meldepflichtige-ik.html [23.08.2022]

impacts on human health due to prolonged heat waves. Improved circulation of air in urban areas also improves air quality, which lowers the risk of respiratory diseases. In addition, planning measures help to reduce the risk of damages due to natural hazards. For example, designation of flood retention areas and mapping of zones at risk of damage due to natural hazards (e.g., landslides, rock fall, avalanches) help to limit damages on buildings and infrastructure (Government, 2018).

6.6.10 Cross sectoral measures

Monitoring: Continuous observation of climatic change and related impacts are an essential prerequisite in the assessment of risks and vulnerabilities. Based on data from existing monitoring networks, both new risks and changes in frequency or intensity of existing risks can be detected, which allows planning and implementation of adaptive measures already at an early stage. MeteoSwiss operates a dense monitoring network that provides data on meteorological and climatic conditions in Liechtenstein and neighbouring areas. In addition, monitoring systems for natural hazards, biodiversity and forest development are implemented in Liechtenstein, which allows assessment of climate impacts at the sectoral level.

Knowledge-sharing: Exchange of knowledge on climate related risks and sharing of experience in the development and implementation of adaptive measures facilitates adaptation to climate change. Liechtenstein is actively participating in international networks (e.g., Lake Constance Conference[44], International Water Body Protection Commission for Lake Constance[45]) that address impacts of climate change on water resource management (e.g. IGKB, 2015).

Scientific research: The consequences of climate change and related impacts at the sectoral level are the subject of ongoing research projects. Therefore, an improved assessment of climate change impacts strongly relies on scientific studies. Liechtenstein will take into account new evidence from scientific research and pilot projects in the future development of adaptation measures. If necessary, active participation in research projects is considered.

Information and awareness rising: Raising awareness on risks and impacts of climate change are a prerequisite for successful implementation of adaptive measures. Therefore, frequent exchange of information with stakeholders from all sectors will be promoted. To this end, Liechtenstein will provide practical information material that can support decision making processes at the sectoral level (Government, 2018).

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[44] https://www.bodenseekonferenz.org/de/home [1.09.2022]

[45] http://www.igkb.org/aktuelles/klimbo-klimawandel-am-bodensee/ [1.09.2022]

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7 Financial, technological and capacity-building support

Liechtenstein is not a Party included in Annex II to the Convention and is therefore not obliged to adopt measures and fulfil obligations as defined in Article 4, paragraphs 3, 4 and 5, of the Convention. However, Liechtenstein would like to provide the following information on provision of support required under the Convention. In addition, the following section also serves to provide information as required by Art. 10 and 11 of the Kyoto Protocol.

7.1 Finance

7.1.1 Introduction

International solidarity is one of the priorities of Liechtenstein's foreign policy. In particular, international humanitarian assistance and development cooperation with developing countries and with countries affected by disasters and armed conflicts is a traditional focus of Liechtenstein's foreign policy. The operational tasks of International Humanitarian Cooperation and Development (IHCD) are carried out by the Office for Foreign Affairs and the Liechtenstein Development Service (LED). The overall coordination of the IHCD activities lies with the Office for Foreign Affairs. Combatting climate change is one of the focus topics of IHCD.

An intact environment and sustainable use of natural resources are necessary preconditions for the social and economic development of a region. Not only the shortage of certain natural resources, but also the lack of access to these resources, constitutes a growing problem for many poor regions. IHCD seeks to protect the environment and natural resources as a basis of life also for coming generations.

IHCD encompasses all forms of the humanitarian and development policy of the State of Liechtenstein and of the LED, which is a foundation under private law, controlled by the State. These activities are set out in the Law on International Humanitarian Cooperation and Development of 2007 (IHCD Act). Liechtenstein's engagement focuses on emergency and reconstruction assistance, international refugee and migration assistance as well as bilateral and multilateral development cooperation.

Liechtenstein works closely with the affected population and local organisations, with aid and development organisations in Liechtenstein, Switzerland, Austria and Germany as well as with European and international organisations. Liechtenstein, through its IHCD, maintains working relationships with a large number of partners. The bulk of Liechtenstein's support is provided in the form of financial resources. The LED maintains three coordination offices on the ground, in Moldova, Bolivia and Zimbabwe from where it can directly supervise its projects.

Emergency and Reconstruction Assistance offers short-term, urgent assistance in the event of natural disasters, political crises, and armed conflicts. The primary focus is preserving human Life and protecting the affected population. Additionally, the medium-term development of social structures and infrastructure is supported to facilitate a quick return to normal life. The urgency

of the situation is the main criterion for Emergency and Reconstruction Assistance. Accordingly, there are no geographic priorities. However, special attention is paid to emergency situations that are largely ignored and underfunded by the international community. Liechtenstein is a member of the Good Humanitarian Donorship (GHD) group. This international initiative is dedicated to compliance with key principles of humanitarian engagement.

International Refugee and Migration Assistance is based on a sustainable and comprehensive approach to dealing with global refugee and migration issues. Bilateral activities focus on the Balkan countries. People in need of protection, including minorities, receive support for local integration and long-term improvement of their living conditions. As part of a holistic view of migration, possibilities of circular migration, readmission agreements, and visa questions are also discussed. At the multilateral level, compliance with international legal, human rights, and humanitarian standards for refugees, internally displaced persons, returnees, stateless persons, and other migrants is promoted. In addition, climate displacement has also been an area of specific activities.

The largest pillar of IHCD is **Bilateral Development Cooperation**, which is the responsibility of the Liechtenstein Development Service (LED). For this purpose, the LED receives about 65 % of the overall resources each year, most of which are used for development projects with local partners (Southern Partners) or partner organisations from Europe (Northern Partners). In Chişinău (Republic of Moldova), La Paz (Bolivia), and Harare (Zimbabwe), the LED maintains its own coordination offices. The LED is currently engaged in eleven priority countries. These are Bolivia, Burkina Faso, Cambodia, Mali, Moldova, Mozambique, Peru, Senegal, Tanzania, Zambia and Zimbabwe. Thematically, the LED focusses on rural development and education. Human rights, social justice, gender equality, climate, and the protection of the environment and resources are important crosscutting themes. In addition, the LED deploys human resources from Liechtenstein to development projects and arranges internships. Further fields of its work are public relations and awareness-raising through publications, exhibitions, and educational work in schools. The cooperation between the Liechtenstein Government and the LED, a foundation under private law, is governed by an ownership strategy, which is supplemented and further specified by annual performance mandates. The LED foundation council decides on individual projects.

Multilateral Development Cooperation is used to fund projects of international organisations or internationally operating non-governmental organisations. This type of engagement is useful especially for problems of a global or cross-border nature, where the international community jointly seeks solutions. In contrast to the LED projects, which are mainly directed to the local level, this track focusses on the improvement of the national and international framework. Focus areas are the protection and promotion of human rights, good governance, the rule of law as well as environment, sustainable development, and climate change).

7.1.2 Provision of financial resources (including under Art. 11 of the Kyoto Protocol)

In 2021, Liechtenstein's IHCD had resources of about 22.9 million Swiss francs, i.e. about 580 Swiss francs per capita. The total Official Development Assistance (ODA) amount was 25.5 million Swiss francs. The average exchange rate for USD was 0.914 in 2021. The level of official development assistance is 0.41% of gross national income (2019).

An overview of Liechtenstein's financial contributions as part of its International Humanitarian Cooperation and Development in 2021 can be found in the 2021 Annual Report of the

Government to Parliament (pp. 106-113).[46] The following table provides an overview of contributions related to the environment in 2021. Financial contributions in 2020 and 2019 are provided in Annex 3.

[46] See https://www.llv.li/files/srk/ii_2_aeusseres_bildung_und_sport.pdf (in German).

Table 7-1 Provision of public financial support: summary information for 2021

									2021
Allocation channel	Domestic currency (CHF)					USD[47]			
	Core/general	Climate-specific				Core/general	Climate-specific		
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels:										
Multilateral climate change funds				50’000					45’700	
Other multilateral climate change funds										
Multilateral financial institutions, including regional development banks				17’801					16’270	
Specialized United Nations bodies				33’421					30’546	
Total contributions through bilateral, regional and other channels			3’576’036	223’742	18’832			3’268’496	204’500	17’212
Total			**3’576’036**	**324’964**	**18’832**			**3’268’496**	**297’016**	**17’212**

[47] Conversion of national currency (Swiss Franc, CHF) according to OECD annual exchange rate data, available at: https://data.oecd.org/conversion/exchange-rates.htm (2021: CHF/USD: 0.914).

Table 7-2 Provision of public financial support: contributions through multilateral channels in 2021

Donor funding	Total amount				Status	Funding source	Financial instrument	Type of support	Sector
	Core/general		Climate-specific						
	Domestic currency (CHF)	USD[48]	Domestic currency (CHF)	USD	Committed Disbursed	ODA OOF Other	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and sanitation Cross-cutting Other Not applicable
Multilateral climate change funds									
1. Global Environment Facility 2. Least Developed Countries Fund 3. Special Climate Change Fund 4. Adaptation Fund 5. Green Climate Fund 6. UNFCCC Trust Fund for Supplementary Activities 7. Other multilateral climate change funds	50'000	45'700			Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Subtotal	**50'000**	**45'700**							
Multilateral financial institutions, including regional development banks									
1. World Bank 2. International Finance Corporation 3. African Development Bank 4. Asian Development Bank									

[48] Conversion of national currency (Swiss Franc, CHF) according to OECD annual exchange rate data, available at: https://data.oecd.org/conversion/exchange-rates.htm (2021: CHF/USD: 0.914).

5. European Bank for Reconstruction and Development							
6. Inter-American Development Bank							
7. Other:							
a. International Union for the Conservation of Nature (IUCN)	15’520	14’185	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
b. International Renewable Energy Agency (IRENA)	1’281	1’171	Disbursed	ODA OOF	Grant	Cross-cutting	Cross-cutting
c. Ramsar Convention on Wetlands	1’000	914	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Subtotal	**17’801**	**16’270**					
Specialized United Nations bodies							
1. United Nations Development Programme (UNDP) (specific programmes)	25’000	22’850	Disbursed	ODA OOF	Grant	Cross-cutting	Cross-cutting
2. United Nations Environment Programme (UNEP)	3’137	2’867	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
3. Other:							
a. United Nations Framework Convention on Climate Change (UNFCCC)	2’245	2’052	Disbursed	ODA OOF	Grant	Cross-cutting	Not applicable
b. Convention on Biological Diversity (CBD)	2’390	2’184	Disbursed	ODA	Grant	Cross-cutting	Not-applicable
c. Convention on long-range transboundary air pollution	526	481	Disbursed	ODA	Grant	Cross-cutting	Not-applicable
d. Convention on the Conservation of Migratory Species of Wild Animals	123	112	Disbursed	ODA	Grant	Cross-cutting	Not-applicable
Subtotal	**33’421**	**30’546**					
Total	**101’222**	**92’516**					

Table 7-3 Provision of public financial support: contributions through bilateral, regional and other channels in 2021

Recipient country/region/project/programme/activity	Total amount		Status	Funding source	Financial instrument	Type of support	Sector	Additional information
	Climate-specific		Committed Disbursed	ODA OOF Other	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and sanitation Cross-cutting Other	Partner
	Domestic currency (CHF)	USD[49]						
Study on climate-included relocations	100’000	91’400	Disbursed	ODA	Grant	Adaptation	Cross-cutting	Displacement Solutions
Adaptation to climate change through protecting and enriching local natural woodlands and forests in Malipati, Chiredzi District	80’235	73’335	Disbursed	ODA	Grant	Cross-cutting	Forestry	SAFIRE
Permanent Secretariat of the Alpine Convention	18’832	17’212	Disbursed	OOF	Grant	Other	Cross-cutting	Secretariat of the Alpine Convention
Scholarship Program on sustainable energy production in Africa	70’000	63’980	Committed	ODA	Grant	Cross-cutting	Energy	LISD
Long-term comparison of organic agriculture systems	800’000	731’200	Disbursed	ODA	Grant	Adaptation	Agriculture	FiBL
House and Land Property (HLP) and Displacement	98’226	89’779	Disbursed	ODA	Grant	Adaptation	Other	NRC
Response to climate-related security risks in Eastern Europe	15’000	13’710	Disbursed	ODA	Grant	Adaptation	Other	OSCE

[49] Conversion of national currency (Swiss Franc, CHF) according to OECD annual exchange rate data, available at: https://data.oecd.org/conversion/exchange-rates.htm (2021: CHF/USD: 0.914).

Strengthening climate information in the pacific	50’000	45’700	Disbursed	ODA	Grant	Adaptation	Other	Red Cross Red Crescent Climate Centre
AMACE: Food security in Northern Mozambique	858’410	784’587	Disbursed	ODA	Grant	Adaptation	Agriculture	HELVETAS
Access to drinking water in rural communities of Mozambique	224’657	205’336	Disbursed	ODA	Grant	Adaptation	Water and sanitation	Inter Aide
Farmer Communication Programme	450’000	411’300	Disbursed	ODA	Grant	Adaptation	Agriculture	BioVision
Food security of rural population in 6 regions of Senegal	544’925	498’061	Disbursed	ODA	Grant	Adaptation	Agriculture	Horizon 3000
Participative research in agroecology in Nioro du Rip in Senegal	73’507	67’185	Disbursed	ODA	Grant	Cross-cutting	Agriculture	Horizon 3000
Integrated Food Security Programme in Matabeleland South	114’925	105’041	Disbursed	ODA	Grant	Adaptation	Agriculture	Pro Africa Development
Programme for institutional development and food security	182’475	166’782	Disbursed	ODA	Grant	Adaptation	Agriculture	Organisation of Collective Co-Operations in Zimbabwe
Strengthening Livelihood Options for Women (Phase I)	137’418	125’600	Disbursed	ODA	Grant	Adaptation	Agriculture	Zimbabwe Women’s Bureau
Total	**3’818’610**	**3’490’210**						

7.2 Technology development and transfer

Technology development and/or transfer is often a component of programmes and projects that support developing countries in their endeavours to mitigate and adapt to climate change. Due to the country's size and its limited resources within the administration Liechtenstein has not set up a particular "transfer-of-technology" framework.

7.3 Capacity-building

Capacity-building is an essential component of almost all of Liechtenstein's programmes and projects that support developing countries in their endeavours to mitigate and adapt to climate change. Due to the highly integrated character, it is not possible for Liechtenstein to single out the capacity-building components of all its development cooperation projects and programmes.

As part of the global effort, Liechtenstein continuously strengthened its cooperation with the private sector and has developed several public private partnerships that foster capacity-building.

All activities and projects related to capacity building or the transfer of technology take place within the framework of IHCD (see section 7.1 for details). Capacity building and transfer of technology are, however, not specially mentioned in the law. Regarding capacity building or the transfer of technology, there are no specific focus countries. Focus countries exist only within the different categories of IHCD.

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8 Research and systematic observation

8.1 General policy on and funding of research and systematic observation

8.1.1 Basic research

The Alpine Rhine Valley is an ideal object for interdisciplinary, scientifically challenging, practice-oriented and regionally anchored research projects. In line with its official mission, the University of Liechtenstein conducts application-oriented research in selected research areas. Around 800 students from over 40 countries provide an international atmosphere to the small university. Primary responsibility for research lies with the institutes and associated institutes.

The University's mission is to offer research, education and continuing education, as well as knowledge and technology transfer for a sustainable and responsible future. The focus is on socially and ecologically relevant topics in the fields of business, business law, as well as architecture and spatial development. Two of the University's institutes are directly involved in the examination of sustainable and ecological developments within their specific fields of activities. The Institute for Architecture and Planning is doing research on sustainable buildings and sustainable spatial planning. The Institute for Finance examines sustainable investments, including on impact of investments, integration of ESG criteria in investments, or sustainability risks.

In the context of natural scientific research on the country, national authorities and private organisations are also collaborating with foreign university research facilities and institutes. The goal is to gain ecological insights on a scientific basis that constitute a basis for formulating a sustainable development policy in conjunction with insights gained from economic and socio-cultural surveys and research.

Liechtenstein supports research activities abroad, with annual contributions to Switzerland (Swiss National Science Foundation, SNSF) and Austria (Austrian Science Fund, FWF), each amounting to CHF 250,000 (2021). As a member of the EEA, Liechtenstein also participates in European research programmes, but not in the Horizon Europe programme. Some research is done in conjunction with other Alpine countries by participating in Interreg projects. Interreg has four strands to stimulate cooperation between regions in the European Union and beyond, funded by the European Regional Development Fund with almost EUR 10 billion for the period 2021–2027.

Actions relating to research and systematic observation addressing international activities are limited to a membership of the IPCC. Liechtenstein is not a member of WMO.

8.1.2 Technological research

Public institutions in Liechtenstein are also indirectly engaged in technology research. The University of Liechtenstein contributes a budget of CHF 14.6 million to the training of experts and around CHF 3 million to research as a base amount. Approximately 2/3 of these sums are dedicated to economic institutes and 1/3 to the Institute for Architecture and Planning.

Liechtenstein also supports the Eastern Switzerland University of Applied Sciences with annual contributions that depend on the numbers of students from Liechtenstein (estimations for the academic year 2020/2021: CHF 1,490,000).

Liechtenstein is contributing another approx. CHF 500,000 annually (CHF 515,993 in 2021) to the RhySearch Innovation Center—a centre for research and development, based in neighbouring Buchs, Switzerland. The activities of RhySearch are dedicated to small and mid-sized enterprises within the Rhine valley and focus amongst others on the development of new energy systems.

8.1.3 Direct international engagement

Liechtenstein is engaged in several collaborations with its neighbouring States and with international bodies and advocates cross-border coordination of land use planning. Liechtenstein is involved in the Interreg Alpine Space as well as the Interreg Alpenrhein-Bodensee-Hochrhein. Priorities in the period 2021–2027 include “climate resilient and green alpine region” and “carbon neutral and resource sensitive alpine region” for the former and “a greener Europe”, which includes climate protection, for the latter.

Due to its small size, Liechtenstein focusses on regional linkages and is in contact with Switzerland, Austria and Germany through various international agreements.

8.2 Research

The Institute for Architecture and Planning of the University of Liechtenstein is engaged in several research initiatives such as “The Circular Brick – Reconstructing Forgotten Alternatives” and “Buildings as virtual material storages” related to recycling building materials, “mobility: Everyday Mobility at Uni Li” on sustainable mobility, or “The Global Peripheries Project” on inequality and spatial planning.

The Institute for Finance is also involved in several research projects that cover the environmental and social aspects of financial markets. The “Chair in Business Administration, Banking and Financial Management” has a research focus on sustainable investments. Current research projects include “From ESG Integration to Impact Investing”, “Corporate Social Responsibility and Risk: Perspectives on Materiality, Trust and Investor Preferences”, and “Sustainable Finance, Investors’ Preferences and Shareholder Value”.

The University of Liechtenstein sits on the board of LIFE Climate Foundation, a not-for-profit organisation that promotes a sustainable and credible advancement of climate and environmental protection through an effective inclusion of financial intermediaries and the general public.

8.3 Systematic observation

Liechtenstein collects a wide range of data relating to climate, both through its own measuring stations and through interregional cooperation, especially with Switzerland. The data is fed into the Global Climate Observing System (GCOS). Since 1974, the largest measuring station in the country has been in operation in Vaduz, measuring the usual meteorological data (air pressure, air temperature, relative humidity, wind direction, wind strength, precipitation, sunshine duration etc.). A private company has also measured similar data at several locations since 1997.

Since 1970, the Office of Civil Protection has measured snow depth at around 10 locations. In addition, the Office of Environment has taken water samples at various locations since the 1960s, to monitor quality and determine the groundwater table.

Since 2001, the Eastern Swiss cantons and Liechtenstein execute a joint monitoring network of air pollutants, to measure the quality of air (OSTLUFT). The cooperation under OSTLUFT is founded

on a contractual basis. The organisation's tasks are the monitoring of the air quality, the attribution of measured air pollutant concentrations to the emission sources and to evaluate the effects of reduction measures in the OSTLUFT region.

Due to its size and the limited resources within the national administration, Liechtenstein's engagement with regard to research and systematic observation that address international activities is very limited.

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9 Education, training and public awareness

9.1 Education at schools

The Ministry of Education is responsible for the coordination of education. Relevant legislative provisions are the Education Act, the Vocational Education and Training Act and the Higher Education Act along with the corresponding ordinances.

Since 2005, environmental education officially forms part of Liechtenstein's all-encompassing educational programme. The current national curriculum for Kindergarten, Primary and Secondary School of the Principality of Liechtenstein (2018 edition) contains six subject areas, one of which is "Nature, Humans, Society". At the centre of this subject area is the pupils' engagement with the world. To be able to orientate themselves in the world, to understand it, to actively shape it and to act responsibly in it, students acquire and deepen fundamental knowledge and skills. Topics such as climate change or energy production are discussed in this subject area. Based on the guiding idea of "Education for Sustainable Development", topics such as natural environment and resources, global development and peace, or economy and consumption are integrated in all six subject areas. Thanks to this approach, environmental education influences the content of various school subjects, finding application beyond traditional environmental subjects such as "Biology", e.g. "Economy and Policy".

The project "Energy and Climate Pioneers Liechtenstein" provides an opportunity to all classes from kindergarten to high school to learn about the topics of climate and energy in n age- and curriculum-appropriate way. It is implemented in the period 2019 to 2024 and offers direct support to teachers to implement elements of the guiding idea "Education for Sustainable Development" of Liechtenstein's curriculum. The project is embedded in the initiative "Pioneers for a Sustainable Liechtenstein", in which children and young people throughout the country are being sensitised to the topics of sustainability and climate protection and motivated to make their own contribution.

In addition to the abovementioned, various school projects on environmental education were conducted at Liechtenstein schools. These included "The Climate Day", "Young Energy" and "Looping" at various schools. In 2022 young students from Liechtenstein won first and second place in the "Der Grüne Zweig" awards organised by WWF Ost with their projects "Green Event - Planken Rockt" and "Experience nature - shape nature - learn from nature".

Teachers are provided with exemptions and support for assuming responsibility for instruction on environmental issues. The environmental focal points initiate and support concrete environmental projects at their schools. This has resulted in forest days, school gardens, environmentally friendly recess areas, field trips, and much more.

The Office of Education promotes environmental consciousness, amongst others through the publication of various teaching materials (e.g., "School on the Farm") and the organisation of specific continuing education courses for teachers. In addition, several national and international events covering environmental topics are organised on a regular basis, for example the

participation of a group of students in the “Youth Parliament of the Alpine Convention” (YPAC, since 2006) or of the organisation of events for Environment Day in June.

The Institute for Architecture and Planning offers several recurring and one-off courses with a direct or indirect link to climate change, e.g. “climate change and the built environment”, “sustainable construction processes”, or “regenerative environments”.

Similarly, the Institute for Financial Services also has several recurring and one-off courses related to sustainability such as “sustainable finance”, “corporate governance and ethics”, or “responsible investment related public policy initiatives”.

The Eastern Switzerland University of Applied Sciences, of which Liechtenstein is a co-owner, offers a Master of Science in Engineering with a focus on energy and environment as well as further education courses (CAS, MAS) related to renewable energy, resource efficiency, or sustainable mobility.

Education at schools is also a topic with regard to climate related capacity building support in developing countries.

9.2 Public outreach

Public outreach is the responsibility of the individual administrative offices. In addition, some tasks are delegated to external institutions and support is provided to individual outreach campaigns by NGOs.

The Government also supports initiatives and projects in the field of environmental protection: In 2022, the Swiss Confederation and the Principality of Liechtenstein awarded the “Constructive Alps” awards for the sixth time—an architecture competition worth 50,000 Euros that recognises sustainable building and renovation in the Alpine region. Architects and building developers were invited to submit buildings built between 2017–2021 that contribute to achieving the "net zero" climate goal in the region. The jury will decide by autumn which projects will be awarded prizes. In addition, there will be an award for the public's favourite.

The population is also provided with information on specific environmental concerns through reports in the newspapers. Research and survey results concerning the condition of the mountain region and information on environmental developments and changes are regularly brought to the attention of the population by public authorities via publication series, thematic brochures, posters, and reports in newspapers. Specialised excursions with school classes, population groups, and professional organisations conducted by various public authorities constitute an important component of public outreach.

The Office of Environment distributes an annual environmental protection calendar to residents. Each year, the environmental protection calendar focusses on a different environmental topic. School children participate in the production of the calendar, by contributing a drawing on the calendar’s theme, sensitising them to the topic.

The national inventory allows to provide precise data on greenhouse gas emissions for the public. In addition, the network of measuring stations on air quality (OSTLUFT) mentioned in section 8, provides precise information on air pollutants and sources. The compiled data is published each year in a report.

9.3 Cooperation with private institutions and NGOs

Since 2012, the Government provides financial support to the LIFE Climate Foundation Liechtenstein (established in 2009) on a regular basis. The aim of the LIFE Climate Foundation Liechtenstein is to act as a driving force in constructively shaping the development and promotion

of market-based instruments in the field of climate protection and thus to contribute to the achievement of the global climate protection goals. The Not-for-Profit foundation concluded a cooperation agreement with the Swiss Climate Foundation. Since 2012, Liechtenstein based SMEs are eligible to apply for financial (upfront) support if they implement efficiency measures or if they seek financial help for the development of innovative projects that demonstrate a GHG mitigation impact. Additionally, LIFE Climate Foundation aims to further strengthen public awareness by organising events and workshops which cover climate change and other ecological topics. The foundation acts within the framework of a Public-Private Partnership. The participation of business representatives as well as from science and policy sectors provides important access to the relevant actors and driving forces within environmental and carbon markets. Further information is available on http://www.climatefoundation.li/.

Various institutions are also engaged in public information and education. In particular, these include the Liechtenstein Environmental Protection Society (www.lgu.li), the Solar Society (www.solargenossenschaft.li) and the Liechtenstein Transport Association (www.vcl.li).

Another important institution in this field is CIPRA (International Commission for the Protection of the Alps), which is headquartered in Liechtenstein. Since its founding in 1952, CIPRA has been bringing people and organisations together across cultural, geographic, political and language divides, who share a commitment to sustainable development in the Alps. Through a wide variety of projects it demonstrates how e.g. climate change mitigation and adaptation measures can be implemented without harming nature.

References

LIFE Climate Foundation, 2017: www.climatefoundation.li

Schulamt des Fürstentums Liechtenstein, 2018: Liechtensteiner Lehrplan basierend auf dem Lehrplan 21: https://fl.lehrplan.ch/lehrplan_printout.php?e=1&k=1

Swiss Climate Foundation, 2017: www.climatefoundation.ch

Youth Parliament of the Alpine Convention, 2017: http://www.lg-vaduz.li/Angebote/YPACJugendparlament/tabid/168/Default.aspx

10 Annex

Annex 1: Summary and trend tables for Liechtenstein's Greenhouse Gas Inventory

Summary 1.A: Summary Report for National Greenhouse Gas Inventories (2020)

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES
(Sheet 1 of 3)

Inventory 2020
Submission 2022 v1
LIECHTENSTEIN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]	PFCs[1]	Unspecified mix of HFCs and PFCs[1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)			(kt)					
Total national emissions and removals	146.44	0.77	0.03	9.11	0.00	NO	0.00	NO	NO,NE,NA	NO,NE,NA	0.14	NO,NE
1. Energy	141.82	0.05	0.00						NO,NE	NO,NE	NO,NE	NO,NE
A. Fuel combustion Reference approach(2)	144.16											
Sectoral approach(2)	141.82	0.02	0.00						NO,NE	NO,NE	NO,NE	NO,NE
1. Energy industries	2.41	0.00	0.00						NO,NE	NO,NE	NO,NE	NO,NE
2. Manufacturing industries and construction	22.77	0.00	0.00						NO,NE	NO,NE	NO,NE	NO,NE
3. Transport	52.21	0.00	0.00						NO,NE	NO,NE	NO,NE	NO,NE
4. Other sectors	64.43	0.01	0.00						NE	NE	NE	NE
5. Other	NO	NO	NO						NO	NO	NO	NO
B. Fugitive emissions from fuels	0.00	0.03	NO,NA						NO	NO	NO	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.00	0.03	NO,NA						NO	NO	NO	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	0.12	NO	0.00	9.11	0.00	NO	0.00	NO	NO	NO	0.14	NO
A. Mineral industry	NO								NO	NO	NO	NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	0.12	NO	NO						NO	NO	0.14	NO
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				9.11	0.00							
G. Other product manufacture and use	NO	NO	0.00		NO		0.00		NO	NO	NO	NO
H. Other[3]	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given at the end of the table on sheet 3.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES
(Sheet 2 of 3)

Inventory 2020
Submission 2022 v1
LIECHTENSTEIN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs [1]	PFCs[1]	Unspecified mix of HFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)			(kt)					
3. Agriculture	0.04	0.69	0.02						NA,NE,NO	NA,NE,NO	NO,NE,NA	NE
A. Enteric fermentation		0.58										
B. Manure management		0.11	0.01								NO	
C. Rice cultivation		NO									NO,NA	
D. Agricultural soils		NA,NO	0.02						NA,NE,NO	NA,NE,NO	NA,NE,NO	
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		NO,NA	NO,NA						NA,NO	NA,NO	NA,NO	
G. Liming	NO											
H. Urea application	0.04											
I. Other carbon-contining fertilizers	NE											
J. Other	NA	NA	NA						NA	NA	NA	NE
4. Land use, land-use change and forestry [4]	4.45	NO	0.00						NO,NE	NO,NE	NO,NE	NO
A. Forest land [4]	-7.81	NO	NO						NO,NE	NO,NE	NE	
B. Cropland [4]	4.22	NO	0.00						NO	NO	NO,NE	
C. Grassland [4]	3.51	NO	0.00						NO	NO,NE	NE	
D. Wetlands [4]	0.41	NO	0.00						NO	NO	NE	
E. Settlements [4]	3.13	NO	0.00						NO	NO	NO,NE	
F. Other land [4]	0.80	NO	0.00						NO	NO	NE	
G. Harvested wood products	0.18											
H. Other [4]	NO	NO	NO						NO	NO	NO	NO
5. Waste	0.01	0.04	0.00						NO,NA	NO,NA	NO,NA	NO
A. Solid waste disposal [5]	NO	0.00							NO	NO	NO	
B. Biological treatment of solid waste [5]		0.00	0.00									
C. Incineration and open burning of waste [5]	0.01	0.00	0.00						NO	NO	NO	NO
D. Wastewater treatment and discharge		0.03	0.00						NO,NA	NO,NA	NO,NA	
E. Other [5]	NO	NO	NO						NO	NO	NO	NO
6. Other ***(please specify)*** [6]	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given at the end of the table on sheet 3.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 3 of 3)

Inventory 2020
Submission 2022 v1
LIECHTENSTEIN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]	PFCs[1]	Unspecified mix of HFCs and PFCs[1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Memo items:[7]												
International bunkers	0.93	0.00	0.00						NE	NE	NE	NE
Aviation	0.93	0.00	0.00						NE	NE	NE	NE
Navigation	NO	NO	NO									
Multilateral operations	NO	NO	NO						NO	NO	NO	NO
CO_2 emissions from biomass	21.76											
CO_2 captured	NO,NA											
Long-term storage of C in waste disposal sites	NA											
Indirect N_2O			NO									
Indirect CO_2	NO											

(1) The emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), unspecified mix of HFCs and PFCs and other fluorinated gases are to be expressed as carbon dioxide (CO_2) equivalent emissions. Data on disaggregated emissions of

(2) For verification purposes, Parties are requested to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in the documentation box to table 1.A(c). For estimating national

(3) 2.H. Other includes pulp and paper and food and beverages industry.

(4) For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(5) CO_2 from categories solid waste disposal on land and waste incineration should only be included if it stems from non-biogenic or inorganic waste streams. Only emissions from waste incineration without energy recovery are to be reported in the waste sector, whereas emissions from incineration with energy recovery are to be reported in the energy sector.

(6) If reporting any country-specific category under sector "6. Other", detailed explanations should be provided in Chapter 8: Other (CRF sector 6) of the national inventory report (NIR).

(7) Parties are asked to report emissions from international aviation and international navigation and multilateral operations, as well as CO_2 emissions from biomass and CO_2 captured, under Memo Items. These emissions should not be included in the national total emissions from the energy sector. Amounts of biomass used as fuel are included in the national energy consumption but the corresponding CO_2 emissions are not included in the national total as it is assumed that the biomass is produced in a sustainable manner. If the biomass is harvested at an unsustainable rate, net CO_2 emissions are accounted for as a loss of biomass stocks in the Land Use, Land-use Change and Forestry sector.

Summary 2: Summary Report for CO_2 Equivalent Emissions (1990)

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1990
Submission 2022 v1
LIECHTENSTEIN

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)]	206.24	19.24	10.57	0.00	NO	NO	NO	NO	236.04
1. Energy	198.70	1.28	1.28						201.25
A. Fuel combustion (sectoral approach)	198.70	0.91	1.28						200.89
1. Energy industries	0.12	0.00	0.05						0.18
2. Manufacturing industries and construction	36.19	0.02	0.09						36.29
3. Transport	75.36	0.63	0.89						76.87
4. Other sectors	87.02	0.27	0.26						87.55
5. Other	NO	NO	NO						NO
B. Fugitive emissions from fuels	0.00	0.36	NO,NA						0.36
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	0.00	0.36	NO,NA						0.36
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	0.20	NO	0.46	0.00	NO	NO	NO	NO	0.66
A. Mineral industry	NO								NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	0.20	NO	NO						0.20
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				0.00	NO				0.00
G. Other product manufacture and use	NO	NO	0.46		NO	NO			0.46
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.06	16.85	7.99						24.90
A. Enteric fermentation		13.92							13.92
B. Manure management		2.93	1.37						4.30
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NA,NO	6.62						6.62
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NO								NO
H. Urea application	0.06								0.06
I. Other carbon-containing fertilizers	NE								NE
J. Other	NA	NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7.27	NO	0.30						7.57
A. Forest land	-0.14	NO	NO						-0.14
B. Cropland	4.49	NO	0.01						4.50
C. Grassland	1.97	NO	0.01						1.99
D. Wetlands	0.16	NO	0.00						0.16
E. Settlements	3.06	NO	0.19						3.24
F. Other land	0.42	NO	0.03						0.45
G. Harvested wood products	-2.69								-2.69
H. Other	NO	NO	NO						NO
5. Waste	0.01	1.11	0.54						1.66
A. Solid waste disposal	NO	0.48							0.48
B. Biological treatment of solid waste		0.03	0.02						0.05
C. Incineration and open burning of waste	0.01	0.01	0.00						0.02
D. Waste water treatment and discharge		0.59	0.52						1.10
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO

Memo items:[(2)]									
International bunkers	0.43	0.00	0.00						0.43
Aviation	0.43	0.00	0.00						0.43
Navigation	NO	NO	NO						NO
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	6.37								6.37
CO_2 captured	NO,NA								NO,NA
Long-term storage of C in waste disposal sites	NA								NA
Indirect N_2O			NO						
Indirect CO_2[(3)]	NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									228.47
Total CO_2 equivalent emissions with land use, land-use change and forestry									236.04
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

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive
(2) See footnote 7 to table Summary 1.A.
(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

Summary 2: Summary Report for CO_2 Equivalent Emissions (2020)

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2020
Submission 2022 v1
LIECHTENSTEIN

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]	146.44	19.31	9.58	9.11	0.00	0.05	NO	NO	184.50
1. Energy	141.82	1.19	0.94						143.96
A. Fuel combustion (sectoral approach)	141.82	0.41	0.94						143.17
1. Energy industries	2.41	0.03	0.00						2.44
2. Manufacturing industries and construction	22.77	0.01	0.08						22.86
3. Transport	52.21	0.07	0.48						52.77
4. Other sectors	64.43	0.30	0.38						65.11
5. Other	NO	NO	NO						NO
B. Fugitive emissions from fuels	0.00	0.78	NO,NA						0.78
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	0.00	0.78	NO,NA						0.78
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	0.12	NO	0.14	9.11	0.00	0.05	NO	NO	9.43
A. Mineral industry	NO								NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	0.12	NO	NO						0.12
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				9.11	0.00				9.11
G. Other product manufacture and use	NO	NO	0.14		NO	0.05			0.20
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.04	17.18	7.44						24.67
A. Enteric fermentation		14.42							14.42
B. Manure management		2.77	1.56						4.32
C. Rice cultivation		NO							NO
D. Agricultural soils		NA,NO	5.89						5.89
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NO								NO
H. Urea application	0.04								0.04
I. Other carbon-containing fertilizers	NE								NE
J. Other	NA	NA	NA						NA
4. Land use, land-use change and forestry[1]	4.45	NO	0.39						4.84
A. Forest land	-7.81	NO	NO						-7.81
B. Cropland	4.22	NO	0.02						4.25
C. Grassland	3.51	NO	0.05						3.57
D. Wetlands	0.41	NO	0.01						0.43
E. Settlements	3.13	NO	0.19						3.32
F. Other land	0.80	NO	0.05						0.85
G. Harvested wood products	0.18								0.18
H. Other	NO	NO	NO						NO
5. Waste	0.01	0.94	0.66						1.60
A. Solid waste disposal	NO	0.09							0.09
B. Biological treatment of solid waste		0.05	0.03						0.08
C. Incineration and open burning of waste	0.01	0.01	0.00						0.02
D. Waste water treatment and discharge		0.79	0.62						1.41
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***	NO	NO	NO	NO	NO	NO	NO	NO	NO

Memo items:[2]									
International bunkers	0.93	0.00	0.01						0.94
Aviation	0.93	0.00	0.01						0.94
Navigation	NO	NO	NO						NO
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	21.76								21.76
CO_2 captured	NO,NA								NO,NA
Long-term storage of C in waste disposal sites	NA								NA
Indirect N_2O			NO						
Indirect CO_2 [3]	NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									179.66
Total CO_2 equivalent emissions with land use, land-use change and forestry									184.50
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

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

Annex 2: Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol

Table 10-1 Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC8

Information reported under Article 7, paragraph 2	NC8 section
National systems in accordance with Article 5, paragraph 1	3.3.3
National registries	3.3.2
Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17	5.2.4
Policies and measures in accordance with Article 2	4.2
Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures	4.1
Information under Article 10	
Art. 10(a)	3.2.1
Art. 10(b)	4.2, 6.4, 6.6
Art. 10(c)	7.2, 7.3
Art .10(d)	8
Art .10(e)	9
Financial resources	7

Annex 3: Provision of public financial support in 2020 and 2019

2020

Provision of public financial support: summary information for 2020

										2020
Allocation channel	Domestic currency (CHF)					USD[50]				
	Core/general	Climate-specific				Core/general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
p										
Multilateral climate change funds				50’000					46’950	
Other multilateral climate change funds										
Multilateral financial institutions, including regional development banks				16’997					15’960	
Specialized United Nations bodies				117’703					110’524	
Total contributions through bilateral, regional and other channels			2’853’986	48’000	525’227			2’679’893	45’072	493’188
Total			**2’853’986**	**232’700**	**525’227**			**2’679’893**	**218’506**	**493’188**

[50] Conversion of national currency (Swiss Franc, CHF) according to OECD annual exchange rate data, available at: https://data.oecd.org/conversion/exchange-rates.htm (2020: CHF/USD: 0.939).

Provision of public financial support: contributions through multilateral channels in 2020

Donor funding	Total amount				Status	Funding source	Financial instrument	Type of support	Sector
	Core/general		Climate-specific						
	Domestic currency (CHF)	USD[51]	Domestic currency (CHF)	USD	Committed Disbursed	ODA OOF Other	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and sanitation Cross-cutting Other Not applicable
Multilateral climate change funds									
1. Global Environment Facility 2. Least Developed Countries Fund 3. Special Climate Change Fund 4. Adaptation Fund 5. Green Climate Fund 6. UNFCCC Trust Fund for Supplementary Activities 7. Other multilateral climate change funds	50'000	46'950			Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Subtotal	**50'000**	**46'950**							
Multilateral financial institutions, including regional development banks									
1. World Bank 2. International Finance Corporation 3. African Development Bank 4. Asian Development Bank 5. European Bank for Reconstruction and Development 6. Inter-American Development Bank 7. Other:									

[51] Conversion of national currency (Swiss Franc, CHF) according to OECD annual exchange rate data, available at: https://data.oecd.org/conversion/exchange-rates.htm (2020: CHF/USD: 0.939).

a. International Union for the Conservation of Nature (IUCN)	15’520	14’573	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
b. International Renewable Energy Agency (IRENA)	1’477	1’387	Disbursed	ODA OOF	Grant	Cross-cutting	Cross-cutting
Subtotal	**16’997**	**15’960**					
Specialized United Nations bodies							
1. United Nations Development Programme (UNDP) (specific programmes)	75’000	70’425	Disbursed	ODA OOF	Grant	Cross-cutting	Cross-cutting
2. United Nations Environment Programme (UNEP)	11’773	11’055	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
3. Other:							
a. United Nations Framework Convention on Climate Change (UNFCCC)	3’036	2’851	Disbursed	ODA OOF	Grant	Cross-cutting	Not applicable
b. United Nations Convention to Combat Desertification (UNCCD)	727	683	Disbursed	ODA	Grant	Cross-cutting	Not applicable
c. Multilateral Fund for the Implementation of the Montreal Protocol	17’167	16’120	Disbursed	ODA	Grant	Cross-cutting	Not applicable
d. Intergovernmental Panel on Climate Change (IPCC)	10’000	9’390	Disbursed	ODA	Grant	Other	Not applicable
Subtotal	**117’703**	**110’524**					
Total	**184’700**	**173’434**					

Provision of public financial support: contributions through bilateral, regional and other channels in 2020

Recipient country/region/project/programme/activity	Total amount		Status	Funding source	Financial instrument	Type of support	Sector	Additional information
	Climate-specific		Committed Disbursed	ODA OOF Other	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and sanitation Cross-cutting Other	Partner
	Domestic currency (CHF)	USD[52]						
Project to establish a sustainability scholarship for Africa	48’000	45’072	Disbursed	ODA	Grant	Cross-cutting	Other	Liechtenstein Institute for Strategic Development (LISD)
Integration education-production at higher humanistic-technical schools	366’017	343’690	Disbursed	ODA	Grant	Other	Other	Fundación Educación para el Desarrollo (Fautapo)
Mountain Research Initiative	10’000	9’390	Disbursed	IDA	Grant	Other	Other	Mountain Research Initiative (MR)
Climate Ledger Initiative	20’000	18’780	Disbursed	ODA	Grant	Other	Cross-cutting	INFRAS
Forced Migration Review	10’000	9’390	Disbursed	ODA	Grant	Other	Other	Oxford University
Permanent Secretariat of the Alpine Convention	19’210	18’038	Disbursed	OOF	Grant	Other	Cross-cutting	Permanent Secretariat of the Alpine Convention
Long-term system comparison organic farming	800’000	751’200	Disbursed	ODA	Grant	Adaptation	Agriculture	FiBL
Pacific Climate Information Strengthening Project	50’000	46’950	Disbursed	ODA	Grant	Adaptation	Other	IFCR
Legal study on climate change and migration	100’000	93’900	Disbursed	ODA	Grant	Other	Other	Displacement Solutions
AMACE: Food security in Northern Mozambique	85’880	80’641	Disbursed	ODA	Grant	Adaptation	Agriculture	HELVETAS
Access to drinking water in rural communities of Mozambique	229’232	215’249	Disbursed	ODA	Grant	Adaptation	Water and sanitation	Inter Aide

[52] Conversion of national currency (Swiss Franc, CHF) according to OECD annual exchange rate data, available at: https://data.oecd.org/conversion/exchange-rates.htm (2020: CHF/USD: 0.939).

Farmer Communication Programme	500’000	469’500	Disbursed	ODA	Grant	Adaptation	Agriculture	BioVision
Food security of the rural population in six regions of Senegal	558’376	524’315	Disbursed	ODA	Grant	Adaptation	Agriculture	Horizont 3000
Participatory research in agroecology in the department of Nioro du Rip	53’871	50’585	Disbursed	ODA	Grant	Adaptation	Agriculture	Horizont 3000
Adapting to climate change through protecting and enriching local natural woodlands and forests in Malipati, Chiredzi District	86’099	80’847	Disbursed	ODA	Grant	Adaptation	Forestry	Southern Alliance For Indigenous Resources
Integrated Food Security Programme in Matabeleland South	175’285	164’593	Disbursed	ODA	Grant	Adaptation	Agriculture	Pro Africa Development
Programme for institutional development and food security	109’443	102’767	Disbursed	ODA	Grant	Adaptation	Agriculture	Organisation of Collective Co-Operations in Zimbabwe
SAFIRE – Shashe/Manijinji Irrigation Project	205’800	193’246	Disbursed	ODA	Grant	Adaptation	Water and sanitation	Liechtenstein Development Service (LED)
Total	**3’427’213**	**3’218’153**						

2019

Provision of public financial support: summary information for 2019

										2019
Allocation channel	Domestic currency (CHF)					USD[53]				
	Core/general	Climate-specific				Core/general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels:										
Multilateral climate change funds				50’000					49’700	
Other multilateral climate change funds										
Multilateral financial institutions, including regional development banks				17’115					17’012	
Specialized United Nations bodies				114’684					113’996	
Total contributions through bilateral, regional and other channels			3’662’366	80’000	262’128			3’640’391	79’520	260’005
Total			**3’662’366**	**261’799**	**262’128**			**364’391**	**260’228**	**260’005**

[53] Conversion of national currency (Swiss Franc, CHF) according to OECD annual exchange rate data, available at: https://data.oecd.org/conversion/exchange-rates.htm (2019: CHF/USD: 0.994).

Provision of public financial support: contributions through multilateral channels in 2019

Donor funding	Total amount				Status	Funding source	Financial instrument	Type of support	Sector
	Core/general		Climate-specific						
	Domestic currency (CHF)	USD[54]	Domestic currency (CHF)	USD	Committed Disbursed	ODA OOF Other	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and sanitation Cross-cutting Other Not applicable
Multilateral climate change funds									
1. Global Environment Facility 2. Least Developed Countries Fund 3. Special Climate Change Fund 4. Adaptation Fund 5. Green Climate Fund 6. UNFCCC Trust Fund for Supplementary Activities 7. Other multilateral climate change funds	50'000	49'700			Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
Subtotal	**50'000**	**49'700**							
Multilateral financial institutions, including regional development banks									
1. World Bank 2. International Finance Corporation 3. African Development Bank 4. Asian Development Bank 5. European Bank for Reconstruction and Development 6. Inter-American Development Bank 7. Other:									

[54] Conversion of national currency (Swiss Franc, CHF) according to OECD annual exchange rate data, available at: https://data.oecd.org/conversion/exchange-rates.htm (2019: CHF/USD: 0.994).

a. International Union for the Conservation of Nature (IUCN)	15’520	15’427	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
b. International Renewable Energy Agency (IRENA)	1’595	1’585	Disbursed	ODA OOF	Grant	Cross-cutting	Cross-cutting
Subtotal	**17’115**	**17’012**					
Specialized United Nations bodies							
1. United Nations Development Programme (UNDP)	74’000	73’556	Disbursed	ODA OOF	Grant	Cross-cutting	Cross-cutting
2. United Nations Environment Programme (UNEP) (specific programmes)	11’562	11’493	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting
3. Other:							
a. United Nations Framework Convention on Climate Change (UNFCCC)	1’782	1’771	Disbursed	ODA OOF	Grant	Cross-cutting	Not applicable
b. United Nations Convention to Combat Desertification (UNCCD)	590	586	Disbursed	ODA	Grant	Cross-cutting	Not applicable
c. Multilateral Fund for the Implementation of the Montreal Protocol	16’750	16’650	Disbursed	ODA	Grant	Cross-cutting	Not applicable
d. Intergovernmental Panel on Climate Change (IPCC)	10’000	9’940	Disbursed	ODA	Grant	Cross-cutting	Other
Subtotal	**114’684**	**113’996**					
Total	**181’799**	**180’708**					

Provision of public financial support: contributions through bilateral, regional and other channels in 2019

Recipient country/region/project/programme/activity	Total amount		Status	Funding source	Financial instrument	Type of support	Sector	Additional information
	Climate-specific		Committed Disbursed	ODA OOF Other	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and sanitation Cross-cutting Other	Partner
	Domestic currency (CHF)	USD[55]						
Project to establish a sustainability scholarship for Africa	38’000	37’772	Disbursed	ODA	Grant	Cross-cutting	Other	Liechtenstein Institute for Strategic Development (LISD)
Integration education-production at higher humanistic-technical schools	115’345	114’653	Disbursed	ODA	Grant	Other	Other	Fundación Educación para el Desarrollo (Fautapo)
Mountain Research Initiative	10’000	9’390	Disbursed	ODA	Grant	Other	Other	Mountain Research Initiative (MR)
Climate Ledger Initiative	20’000	19’880	Disbursed	ODA	Grant	Other	Cross-cutting	INFRAS
Permanent Secretariat of the Alpine Convention	24’354	24’208	Disbursed	OOF	Grant	Other	Cross-cutting	Secretariat of the Alpine Convention
Long-term comparison of organic agriculture systems	800’000	795’200	Disbursed	ODA	Grant	Adaptation	Agriculture	FiBL
Climate Change Stretegy Project - Nèmasso	42’000	41’748	Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	HELVETAS
AMACE: Food security in Northern Mozambique	395’500	393’127	Disbursed	ODA	Grant	Adaptation	Agriculture	HELVETAS
Access to drinking water in rural communities of Mozambique	232’717	231’321	Disbursed	ODA	Grant	Adaptation	Water and sanitation	Inter Aide

[55] Conversion of national currency (Swiss Franc, CHF) according to OECD annual exchange rate data, available at: https://data.oecd.org/conversion/exchange-rates.htm (2019: CHF/USD: 0.994).

Farmer Communication Programme	600’000	596’400	Disbursed	ODA	Grant	Adaptation	Agriculture	BioVision
Food security of the rural population in six regions of Senegal	758’424	753’873	Disbursed	ODA	Grant	Adaptation	Agriculture	Horizont 3000
Participatory research in agroecology in the department of Nioro du Rip	86’766	86’245	Disbursed	ODA	Grant	Adaptation	Agriculture	Horizont 3000
Adapting to climate change through protecting and enriching local natural woodlands and forests in Malipati, Chiredzi District	9’091	9’036	Disbursed	ODA	Grant	Adaptation	Forestry	Southern Alliance For Indigenous Resources
Integrated Food Security Programme in Matabeleland South	200’506	199’303	Disbursed	ODA	Grant	Adaptation	Agriculture	Pro Africa Development
Programme for institutional development and food security	133’151	132’352	Disbursed	ODA	Grant	Adaptation	Agriculture	Organisation of Collective Co-Operations in Zimbabwe
SAFIRE – Shashe/Manijinji Irrigation Project	246’211	244’734	Disbursed	ODA	Grant	Adaptation	Water and sanitation	Liechtenstein Development Service (LED)
Promoting climate-resilient and sustainable agriculture	200’000	198’800	Disbursed	ODA	Grant	Adaptation	Agriculture	Caritas Switzerland
Strengthening Livelihood Options for Women Phase I	92’429	91’874	Disbursed	ODA	Grant	Other	Other	Zimbabwe Women’s Bureau
Total	**4’004’494**	**3’979’916**						

Abbreviations

AD	Activity Data
AWNL	Amt für Wald, Natur und Landschaft (OFNLM)
AZV	Abwasserzweckverband der Gemeinden Liechtensteins (Liechtenstein's wastewater administration union)
BR	Biennial Report
CH_4	Methane
CHF	Swiss francs
CHP	Combined Heat and Power (Kraftwärmekopplung)
CIPRA	International Commission for the Protection of the Alps
CLRTAP	UNECE Convention on Long-range Transboundary Air Pollution
CO	Carbon monoxide
CO_2 (CO_2eq)	Carbon dioxide (equivalent)
CORINAIR	CORe Inventory of AIR emissions (under the European Topic Centre on Air Emissions and under the European Environment Agency)
CP	Commitment period
CRF	Common reporting format
ETH/ETHZ	Swiss Federal Institute of Technology, Zurich
EF	Emission factor
EMEP	European Monitoring and Evaluation Programme (under the Convention on Long-range Transboundary Air Pollution)
ERT	Expert Review Team
FL	Fürstentum Liechtenstein (Principality of Liechtenstein)
FOEN	Swiss Federal Office for the Environment
GCOS	Global Climate Observing System
GDP	Gross domestic product
g	Gramme
GHFL	Genossenschaft für Heizöllagerung im Fürstentum Liechtenstein (Cooperative society for the Storage of Gas Oil in the Principality of Liechtenstein)
GHG	Greenhouse gases
GJ	Giga Joule (10^9 Joule = 1,000 Mega Joule)
GWP	Global Warming Potential, factor for converting CH_4, N_2O, HFC, PFC, and SF_6 emissions into CO_2 equivalents
ha	hectare
HWP	Harvested Wood Products
HFC	Hydrofluorcarbons
IDP	Inventory Development Plan
IPCC	Intergovernmental Panel on Climate Change
HVF	Heavy Vehicle Fee
KC, KCA	Key Category, Key Category Analysis
kg	Kilogramme (1,000 g)

kha	Kilo hectare (1,000 ha)
KP	Kyoto Protocol
kt	Kilo tonne (1,000 tonnes)
LGV	Liechtensteinische Gasversorgung (Liechtenstein's gas utility)
LKW	Liechtensteinische Kraftwerke (Liechtenstein's electric power company)
LULUCF	Land Use, Land-Use Change and Forestry
MJ	Mega Joule (10^6 Joule = 1,000,000 Joule)
MSW	Municipal solid waste
MWh	Mega Watt hour (1 MWh = 3.6 MJ)
NA	Not applicable (notation key)
NC	National Communication
NF_3	Nitrogen trifluoride
NFR	Nomenclature for reporting (category codes)
NGO	Non-governmental organisation
NIC	National Inventory Compiler
NIR	National Inventory Report
NIS	National Inventory System
NMVOC	Non-methane volatile organic compounds
NO_X	Nitrogen oxides
N_2O	Nitrous oxide
OA	Office of Agriculture
OCP	Office of Civil Protection
OE	Office of Environment
OEA	Office of Economic Affairs
OEP	Office of Environmental Protection, former name of today's Office of Environment (OE) since 2012
OFIVA	Office of Food Inspection and Veterinary Affairs
OFNLM	Office of Forests, Nature and Land Management
OS	Office of Statistics
PFC	Perfluorinated carbon compounds (e.g. Tetrafluoromethane)
QA/QC	Quality assurance, quality control
SDC	Swiss Agency for Development and Cooperation
SF_6	Sulfur hexafluoride
SFOE	Swiss Federal Office of Energy
SLP	Office of Land Use Planning
SO_2	Sulphur dioxide
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

ANNEX
Liechtenstein's Biennial Report 5

December 2022

Table of contents

1. Introduction

The Government of Liechtenstein is pleased to present its Fifth Biennial Report (BR5). Liechtenstein's Fifth Biennial Report follows the UNFCCC biennial reporting guidelines for developed country Parties.

The Biennial Report complements the existing national reports "National Inventory Report (NIR)" and "National Communication (NC)". Liechtenstein's BR5 has been prepared as Annex to Liechtenstein's Eighth National Communication. Due to the fact that both reports have to be submitted by 31st of December 2022 and considering the overlap of some information to be reported according to the respective guidelines, Liechtenstein decided to refer to the respective sections of its Eighth National Communication in those cases, where such overlap would occur within the Biennial Report.

Liechtenstein's Fifth Biennial Report has been prepared by:

Office of Environment Liechtenstein

Environmental Protection Division

P.O. Box 684, 9490 Vaduz, Liechtenstein.

2. Information on GHG emissions and trends

Summary of Liechtenstein's latest greenhouse gas inventory

Liechtenstein's greenhouse gas emissions in the year 2020 amount to 179.7 kt CO_2 equivalent (CO2eq) excluding LULUCF sources or sinks (including LULUCF: 184.5 kt CO_2eq). This is equivalent to 4.60 t CO_2eq per capita. Total emissions in 2020 (excl. LULUCF) have declined by 21.4% compared to 1990. Compared to 2019, they decreased by 4.3%. When including LULUCF categories, total emissions decreased by 7.8% between 2019–2020 and by 21.8% between 1990–2020. [1]

Among the different greenhouse gases, CO_2 accounts for the largest share of total emissions. The most important emission sources are fuel combustion activities in the Energy sector. Emissions of CH_4 and N_2O mainly originate from the sector Agriculture and F-gas emissions stem from the sector 2 Industrial processes and product use (IPPU) by definition.

National Inventory Arrangements

The Government of the Principality of Liechtenstein bears the overall responsibility for Liechtenstein's National Inventory System (NIS). By Liechtenstein's Emission Trading Act (Emissionshandelsgesetz, Government 2012), the Office of Environment (OE) is in charge of establishing emission inventories and is therefore also responsible for all aspects concerning the establishing of the National Inventory System (NIS) under the Kyoto Protocol. The responsibility of the OE for establishing the NIS is also described in the report of the Government to the parliament for ratifying the Kyoto Protocol.

For further information please refer to chapter 3 of Liechtenstein's Eighth National Communication.

Notation key used:

- NO means no emissions occurring.
- NE means no estimated emissions.
- NA means not applicable.
- IE means implemented elsewhere.

[1] After the review of Liechtenstein's greenhouse gas inventory of the submission 2022, Liechtenstein resubmitted its CRF Tables in November 2022. In the resubmission, greenhouse gas emissions for the year 2020 were updated (correction of emissions from 1B2 and minor corrections in 1A). The emission data described here is based on the CRF Tables Liechtenstein submitted in April 2022. Therefore, the greenhouse gas emission data in the year 2020 differ from the emissions reported in the CTF Tables 1 and Tables 6, which are based on the CRF Tables submitted in November 2022.

Table 1 LIE_BR5_v0.1
Emission trends: summary
(Sheet 1 of 3)

GREENHOUSE GAS EMISSIONS	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998
	kt CO_2 eq									
CO_2 emissions without net CO_2 from LULUCF	198.97	198.97	206.33	206.95	215.03	201.11	204.20	205.96	218.38	229.24
CO_2 emissions with net CO_2 from LULUCF	206.24	206.24	197.97	209.42	214.26	219.46	209.24	202.75	226.50	229.69
CH_4 emissions without CH_4 from LULUCF	19.24	19.24	19.17	18.71	17.87	17.93	17.92	18.22	17.93	17.82
CH_4 emissions with CH_4 from LULUCF	19.24	19.24	19.17	18.71	17.87	17.93	17.92	18.22	17.93	17.82
N_2O emissions without N_2O from LULUCF	10.27	10.27	10.54	10.50	10.28	10.25	10.18	10.10	10.16	9.82
N_2O emissions with N_2O from LULUCF	10.57	10.57	10.83	10.79	10.58	10.54	10.47	10.39	10.47	10.14
HFCs	0.00	0.00	0.01	0.08	0.18	0.43	1.24	1.57	1.95	2.51
PFCs	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	228.47	228.47	236.04	236.24	243.37	229.72	233.54	235.85	248.42	259.38
Total (with LULUCF)	236.04	236.04	227.98	239.01	242.89	248.37	238.87	232.94	256.85	260.15
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998
	kt CO_2 eq									
1. Energy	201.25	201.25	208.88	209.68	217.85	203.86	207.06	208.90	221.46	232.34
2. Industrial processes and product use	0.66	0.66	0.64	0.69	0.76	0.98	1.77	2.08	2.45	2.98
3. Agriculture	24.90	24.90	24.91	24.23	23.14	23.25	23.10	23.27	22.92	22.46
4. Land Use, Land-Use Change and Forestry[b]	7.57	7.57	-8.06	2.77	-0.48	18.65	5.33	-2.91	8.43	0.77
5. Waste	1.66	1.66	1.61	1.64	1.61	1.62	1.62	1.60	1.59	1.61
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	236.04	236.04	227.98	239.01	242.89	248.37	238.87	232.94	256.85	260.15

Notes:

All footnotes for this table are given on sheet 3 of table 1.

Table 1 LIE_BR5_v0.1
Emission trends: summary
(Sheet 2 of 3)

GREENHOUSE GAS EMISSIONS	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO_2 emissions without net CO_2 from LULUCF	226.57	216.86	214.67	220.02	229.35	229.39	228.99	231.12	200.79	219.54	205.37
CO_2 emissions with net CO_2 from LULUCF	225.91	241.66	216.55	222.81	236.14	238.34	237.99	244.91	223.64	244.49	227.39
CH_4 emissions without CH_4 from LULUCF	17.13	16.69	17.56	17.74	17.91	18.00	18.49	19.27	19.51	19.70	19.59
CH_4 emissions with CH_4 from LULUCF	17.13	16.69	17.56	17.74	17.91	18.00	18.49	19.27	19.51	19.70	19.59
N_2O emissions without N_2O from LULUCF	9.58	9.48	9.49	9.58	9.57	9.00	9.12	9.32	9.38	9.57	9.50
N_2O emissions with N_2O from LULUCF	9.91	9.83	9.84	9.95	9.95	9.38	9.51	9.71	9.78	9.98	9.91
HFCs	3.10	3.87	4.67	5.28	5.89	6.53	6.73	7.42	8.19	8.61	8.45
PFCs	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.07	0.07	0.06
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	0.00	0.09	0.17	0.24	0.25	0.26	0.26	0.06	0.11	0.35	0.14
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	256.38	247.01	246.57	252.88	263.01	263.23	263.64	267.24	238.05	257.83	243.10
Total (with LULUCF)	256.06	272.15	248.80	256.04	270.17	272.56	273.03	281.43	261.30	283.19	265.53
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	229.68	220.06	217.74	222.99	232.26	231.83	231.45	233.62	203.24	222.13	207.99
2. Industrial processes and product use	3.57	4.41	5.25	5.93	6.61	7.28	7.49	7.95	8.79	9.41	8.98
3. Agriculture	21.52	20.91	21.95	22.33	22.48	22.46	23.07	24.09	24.45	24.65	24.54
4. Land Use, Land-Use Change and Forestry[b]	-0.33	25.14	2.23	3.16	7.16	9.33	9.39	14.18	23.24	25.36	22.43
5. Waste	1.61	1.62	1.63	1.64	1.65	1.66	1.63	1.59	1.58	1.63	1.59
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	256.06	272.15	248.80	256.04	270.17	272.56	273.03	281.43	261.30	283.19	265.53

Notes:

All footnotes for this table are given on sheet 3 of table 1.

Table 1 LIE_BR5_v0.1
Emission trends: summary
(Sheet 3 of 3)

GREENHOUSE GAS EMISSIONS	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
												(%)
CO_2 emissions without net CO_2 from LULUCF	190.83	176.78	185.33	192.54	161.26	159.77	149.84	155.77	142.95	149.03	141.94	-28.66
CO_2 emissions with net CO_2 from LULUCF	211.42	201.10	209.91	209.68	178.32	171.55	159.84	167.07	164.93	161.02	146.39	-29.02
CH_4 emissions without CH_4 from LULUCF	19.01	19.36	19.80	18.99	19.17	19.01	19.13	18.64	18.90	19.57	19.71	2.48
CH_4 emissions with CH_4 from LULUCF	19.01	19.36	19.80	18.99	19.17	19.01	19.13	18.64	18.90	19.57	19.71	2.48
N_2O emissions without N_2O from LULUCF	9.29	9.66	9.53	9.22	9.13	9.17	9.01	8.97	9.15	9.30	9.19	-10.53
N_2O emissions with N_2O from LULUCF	9.70	10.08	9.95	9.65	9.55	9.60	9.45	9.39	9.57	9.70	9.58	-9.38
HFCs	8.95	9.44	9.81	9.75	10.03	10.13	9.76	10.03	10.20	9.73	9.11	8,624,277.58
PFCs	0.05	0.06	0.04	0.04	0.03	0.01	0.01	0.00	0.00	0.00	0.00	100.00
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
SF_6	0.02	0.01	0.00	0.17	0.12	0.04	0.01	0.05	0.07	0.05	0.05	100.00
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (without LULUCF)	228.17	215.32	224.51	230.73	199.73	198.15	187.76	193.46	181.27	187.67	180.01	-21.21
Total (with LULUCF)	249.17	240.05	249.52	248.29	217.21	210.36	198.19	205.17	203.66	200.07	184.85	-21.69
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
												(%)
1. Energy	193.43	179.32	187.93	195.15	163.63	162.18	152.22	158.21	145.42	151.52	144.31	-28.30
2. Industrial processes and product use	9.39	9.86	10.18	10.28	10.48	10.48	10.06	10.35	10.53	10.05	9.43	1,321.01
3. Agriculture	23.73	24.50	24.77	23.65	24.03	23.87	23.88	23.29	23.74	24.50	24.67	-0.93
4. Land Use, Land-Use Change and Forestry[b]	21.01	24.73	25.01	17.56	17.48	12.21	10.43	11.72	22.39	12.40	4.84	-36.07
5. Waste	1.62	1.64	1.62	1.65	1.59	1.62	1.60	1.60	1.58	1.60	1.60	-3.18
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (including LULUCF)	249.17	240.05	249.52	248.29	217.21	210.36	198.19	205.17	203.66	200.07	184.85	-21.69

Notes:
Further detailed information could be found in the common reporting format tables of the Party's greenhouse gas inventory,
1 kt CO2 eq equals 1 Gg CO2 eq.

Abbreviation: LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different

[b] Includes net CO_2, CH_4 and N_2O from LULUCF.

Custom Footnotes

Table 1(a) LIE_BR5_v0.1

Emission trends (CO_2)

(Sheet 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year* [a]	1990	1991	1992	1993	1994	1995	1996	1997	1998
	kt									
1. Energy	198.70	198.70	206.07	206.70	214.79	200.89	203.98	205.74	218.14	229.03
A. Fuel combustion (sectoral approach)	198.70	198.70	206.07	206.70	214.79	200.89	203.98	205.74	218.14	229.03
1. Energy industries	0.12	0.12	0.79	1.82	1.88	1.76	2.00	2.50	2.44	2.83
2. Manufacturing industries and construction	36.19	36.19	35.83	36.21	37.47	35.52	35.60	35.66	37.50	40.24
3. Transport	75.36	75.36	88.52	87.75	85.64	78.36	80.30	81.57	85.15	84.89
4. Other sectors	87.02	87.02	80.93	80.92	89.80	85.25	86.09	86.00	93.05	101.08
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. CO2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	0.20	0.20	0.19	0.18	0.17	0.16	0.16	0.17	0.18	0.16
A. Mineral industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	0.20	0.20	0.19	0.18	0.17	0.16	0.16	0.17	0.18	0.16
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.04
A. Enteric fermentation										
B. Manure management										
C. Rice cultivation										
D. Agricultural soils										
E. Prescribed burning of savannas										
F. Field burning of agricultural residues										
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Urea application	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.04
I. Other carbon-containing fertilizers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land Use, Land-Use Change and Forestry	7.27	7.27	-8.36	2.47	-0.77	18.35	5.04	-3.21	8.12	0.45
A. Forest land	-0.14	-0.14	-15.96	-5.32	-8.75	10.19	-3.30	-11.72	-0.94	-9.15
B. Cropland	4.49	4.49	4.48	4.47	4.46	4.45	4.44	4.44	4.43	4.43
C. Grassland	1.97	1.97	1.96	1.96	1.95	1.94	1.93	1.92	2.15	2.37
D. Wetlands	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.18	0.20
E. Settlements	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.09	3.13
F. Other land	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.50	0.58
G. Harvested wood products	-2.69	-2.69	-2.48	-2.27	-2.07	-1.87	-1.67	-1.48	-1.29	-1.11
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Biological treatment of solid waste										
C. Incineration and open burning of waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Waste water treatment and discharge										
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:										
International bunkers	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.44	0.45	0.46
Aviation	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.44	0.45	0.46
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass	6.37	6.37	4.97	6.53	6.09	7.38	5.76	5.58	6.45	7.14
CO2 captured	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indirect N2O										
Indirect CO2 (3)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CO2 equivalent emissions without land use, land-use change and forestry	198.97	198.97	206.33	206.95	215.03	201.11	204.20	205.96	218.38	229.24
Total CO2 equivalent emissions with land use, land-use change and forestry	206.24	206.24	197.97	209.42	214.26	219.46	209.24	202.75	226.50	229.69
Total CO2 equivalent emissions, including indirect CO2, without land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

All footnotes for this table are given on sheet 3 of table 1(a).

Table 1(a) LIE_BR5_v0.1

Emission trends (CO_2)

(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	226.35	216.63	214.46	219.81	229.10	229.13	228.73	230.88	200.54	219.30	205.18
A. Fuel combustion (sectoral approach)	226.35	216.63	214.46	219.81	229.10	229.13	228.73	230.88	200.54	219.30	205.18
1. Energy industries	2.83	2.67	2.83	2.42	2.73	2.85	3.03	2.75	2.48	2.81	2.87
2. Manufacturing industries and construction	39.70	36.31	36.30	37.76	41.06	39.70	39.03	40.40	33.79	36.24	27.45
3. Transport	89.03	89.84	86.51	82.62	82.51	81.45	81.08	78.56	82.68	87.09	81.21
4. Other sectors	94.79	87.82	88.82	97.00	102.80	105.12	105.58	109.17	81.59	93.16	93.65
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. CO2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	0.17	0.17	0.15	0.15	0.20	0.20	0.20	0.19	0.20	0.18	0.14
A. Mineral industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	0.17	0.17	0.15	0.15	0.20	0.20	0.20	0.19	0.20	0.18	0.14
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.04
A. Enteric fermentation											
B. Manure management											
C. Rice cultivation											
D. Agricultural soils											
E. Prescribed burning of savannas											
F. Field burning of agricultural residues											
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Urea application	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.04
I. Other carbon-containing fertilizers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
J. Other	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land Use, Land-Use Change and Forestry	-0.66	24.80	1.88	2.79	6.78	8.95	9.00	13.78	22.84	24.95	22.02
A. Forest land	-10.80	14.12	-9.27	-8.82	-5.08	-3.16	-3.36	1.17	9.98	11.86	8.78
B. Cropland	4.43	4.43	4.43	4.43	4.41	4.38	4.36	4.34	4.32	4.30	4.30
C. Grassland	2.59	2.81	3.04	3.25	3.38	3.51	3.63	3.76	3.88	4.01	4.04
D. Wetlands	0.22	0.24	0.26	0.28	0.29	0.29	0.30	0.30	0.31	0.31	0.33
E. Settlements	3.17	3.20	3.24	3.28	3.29	3.29	3.30	3.31	3.32	3.32	3.32
F. Other land	0.67	0.75	0.83	0.91	0.94	0.98	1.02	1.05	1.09	1.12	1.12
G. Harvested wood products	-0.93	-0.75	-0.65	-0.54	-0.44	-0.34	-0.25	-0.15	-0.06	0.04	0.13
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Biological treatment of solid waste											
C. Incineration and open burning of waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D. Waste water treatment and discharge											
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:											
International bunkers	0.48	0.49	0.50	0.45	0.50	0.34	0.48	0.83	0.82	0.80	0.97
Aviation	0.48	0.49	0.50	0.45	0.50	0.34	0.48	0.83	0.82	0.80	0.97
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass	7.79	12.05	8.14	8.33	10.44	11.33	12.25	13.89	18.00	18.19	21.52
CO2 captured	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA		NO, NA	NO, NA	NO, NA	NO, NA
Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indirect N2O											
Indirect CO2 (3)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CO2 equivalent emissions without land use, land-use change and forestry	226.57	216.86	214.67	220.02	229.35	229.39	228.99	231.12	200.79	219.54	205.37
Total CO2 equivalent emissions with land use, land-use change and forestry	225.91	241.66	216.55	222.81	236.14	238.34	237.99	244.91	223.64	244.49	227.39
Total CO2 equivalent emissions, including indirect CO2, without land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

All footnotes for this table are given on sheet 3 of table 1(a).

Table 1(a) LIE_BR5_v0.1

Emission trends (CO_2)

(Sheet 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
												%
1. Energy	190.63	176.58	185.13	192.35	161.06	159.58	149.65	155.58	142.77	148.85	141.77	-28.65
A. Fuel combustion (sectoral approach)	190.63	176.58	185.13	192.35	161.06	159.58	149.65	155.58	142.77	148.85	141.77	-28.65
1. Energy industries	3.15	2.95	2.71	2.92	2.48	2.02	2.14	2.09	2.15	3.38	2.41	1,886.16
2. Manufacturing industries and construction	25.98	23.47	25.62	26.29	27.23	27.49	25.86	27.59	24.51	24.03	22.76	-37.11
3. Transport	77.08	76.24	79.27	78.98	73.18	61.31	59.91	60.26	58.23	56.78	52.21	-30.72
4. Other sectors	84.41	73.91	77.54	84.16	58.17	68.76	61.74	65.64	57.88	64.66	64.39	-26.01
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	225.08
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	225.08
C. CO2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Industrial processes	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.13	0.12	0.12	0.12	-39.99
A. Mineral industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.13	0.12	0.12	0.12	-39.99
E. Electronic industry												
F. Product uses as ODS substitutes												
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	0.04	0.05	0.04	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.04	-31.01
A. Enteric fermentation												
B. Manure management												
C. Rice cultivation												
D. Agricultural soils												
E. Prescribed burning of savannas												
F. Field burning of agricultural residues												
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Urea application	0.04	0.05	0.04	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.04	-31.01
I. Other carbon-containing fertilizers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
J. Other	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	0.00
4. Land Use, Land-Use Change and Forestry	20.59	24.31	24.59	17.14	17.06	11.78	10.00	11.30	21.98	12.00	4.45	-38.80
A. Forest land	7.22	10.89	11.13	3.63	3.51	-1.80	-3.62	-1.98	9.04	-0.60	-7.81	5,541.49
B. Cropland	4.30	4.30	4.31	4.31	4.31	4.30	4.29	4.27	4.26	4.24	4.22	-5.89
C. Grassland	4.08	4.11	4.14	4.18	4.21	4.25	4.28	4.09	3.90	3.71	3.51	78.03
D. Wetlands	0.34	0.36	0.38	0.39	0.41	0.42	0.44	0.43	0.42	0.42	0.41	165.61
E. Settlements	3.32	3.31	3.31	3.30	3.30	3.30	3.29	3.25	3.21	3.17	3.13	2.42
F. Other land	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.04	0.96	0.88	0.80	89.50
G. Harvested wood products	0.21	0.21	0.21	0.20	0.20	0.19	0.19	0.19	0.18	0.18	0.18	-106.53
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-26.23
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Biological treatment of solid waste												
C. Incineration and open burning of waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-26.23
D. Waste water treatment and discharge												
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Memo items:												
International bunkers	0.84	0.91	1.11	1.05	1.18	1.19	0.92	0.86	1.09	1.12	0.93	118.74
Aviation	0.84	0.91	1.11	1.05	1.18	1.19	0.92	0.86	1.09	1.12	0.93	118.74
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO2 emissions from biomass	22.83	24.69	25.19	22.01	22.51	25.34	24.98	24.26	28.81	26.77	21.76	241.48
CO2 captured	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NE, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	0.00
Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Indirect N2O												
Indirect CO2 (3)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total CO2 equivalent emissions without land use, land-use change and forestry	190.83	176.78	185.33	192.54	161.26	159.77	149.84	155.77	142.95	149.03	141.94	-28.66
Total CO2 equivalent emissions with land use, land-use change and forestry	211.42	201.10	209.91	209.68	178.32	171.55	159.84	167.07	164.93	161.02	146.39	-29.02
Total CO2 equivalent emissions, including indirect CO2, without land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total CO2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

Abbreviations : CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[b] Fill in net emissions/removals as reported in CRF table Summary 1.A of the latest reported inventory year. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

Custom Footnotes

Table 1(b) LIE_BR5_v0.1

Emission trends (CH_4)

(Sheet 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year*[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998
	kt									
1. Energy	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06
A. Fuel combustion (sectoral approach)	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01
4. Other sectors	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
C. CO2 transport and storage										
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Mineral industry										
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.67	0.67	0.67	0.65	0.62	0.62	0.62	0.63	0.62	0.61
A. Enteric fermentation	0.56	0.56	0.55	0.54	0.51	0.51	0.52	0.53	0.52	0.51
B. Manure management	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.10	0.10
C. Rice cultivation	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
D. Agricultural soils	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
G. Liming										
H. Urea application										
I. Other carbon-containing fertilizers										
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
A. Solid waste disposal	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH4 emissions without CH4 from LULUCF	0.77	0.77	0.77	0.75	0.71	0.72	0.72	0.73	0.72	0.71
Total CH4 emissions with CH4 from LULUCF	0.77	0.77	0.77	0.75	0.71	0.72	0.72	0.73	0.72	0.71
Memo items:										
International bunkers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass										
CO2 captured										
Long-term storage of C in waste disposal sites										
Indirect N2O										
Indirect CO2 (3)										

Notes:

All footnotes for this table are given on sheet 3 of table 1(b).

Table 1(b) LIE_BR5_v0.1

Emission trends (CH_4)

(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07
A. Fuel combustion (sectoral approach)	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4. Other sectors	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04
C. CO2 transport and storage											
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Mineral industry											
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.58	0.57	0.60	0.61	0.61	0.61	0.63	0.66	0.67	0.68	0.68
A. Enteric fermentation	0.49	0.47	0.50	0.51	0.51	0.52	0.53	0.56	0.57	0.57	0.57
B. Manure management	0.10	0.09	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.11	0.11
C. Rice cultivation	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
D. Agricultural soils	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
G. Liming											
H. Urea application											
I. Other carbon-containing fertilizers											
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products											
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
A. Solid waste disposal	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH4 emissions without CH4 from LULUCF	0.69	0.67	0.70	0.71	0.72	0.72	0.74	0.77	0.78	0.79	0.78
Total CH4 emissions with CH4 from LULUCF	0.69	0.67	0.70	0.71	0.72	0.72	0.74	0.77	0.78	0.79	0.78
Memo items:											
International bunkers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass											
CO2 captured											
Long-term storage of C in waste disposal sites											
Indirect N2O											
Indirect CO2 (3)											

Notes:

All footnotes for this table are given on sheet 3 of table 1(b).

Table 1(b) LIE_BR5_v0.1

Emission trends (CH_4)

(Sheet 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
												%
1. Energy	0.07	0.07	0.07	0.07	0.06	0.07	0.06	0.07	0.07	0.07	0.06	24.65
A. Fuel combustion (sectoral approach)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-55.24
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	650.50
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-46.77
3. Transport	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-88.57
4. Other sectors	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	12.59
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Fugitive emissions from fuels	0.05	0.04	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	225.08
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	0.05	0.04	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	225.08
C. CO2 transport and storage												
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
A. Mineral industry												
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Electronic industry												
F. Product uses as ODS substitutes												
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	0.65	0.67	0.69	0.65	0.67	0.66	0.66	0.64	0.65	0.68	0.69	1.97
A. Enteric fermentation	0.55	0.56	0.58	0.55	0.56	0.55	0.56	0.54	0.55	0.57	0.58	3.54
B. Manure management	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	-5.50
C. Rice cultivation	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NO, NA	NO, NA	NO, NA	NO	NO	NO	0.00
D. Agricultural soils	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	0.00
G. Liming												
H. Urea application												
I. Other carbon-containing fertilizers												
J. Other	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	0.00
4. Land use, land-use change and forestry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Harvested wood products												
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	-15.40
A. Solid waste disposal	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-80.97
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.42
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-22.94
D. Waste water treatment and discharge	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	33.87
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total CH4 emissions without CH4 from LULUCF	0.76	0.77	0.79	0.76	0.77	0.76	0.77	0.75	0.76	0.78	0.79	2.48
Total CH4 emissions with CH4 from LULUCF	0.76	0.77	0.79	0.76	0.77	0.76	0.77	0.75	0.76	0.78	0.79	2.48
Memo items:												
International bunkers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	119.95
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	119.95
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO2 emissions from biomass												
CO2 captured												
Long-term storage of C in waste disposal sites												
Indirect N2O												
Indirect CO2 (3)												

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

Custom Footnotes

Table 1(c) LIE_BR5_v0.1

Emission trends (N_2O)

(Sheet 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year*[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998
	kt									
1. Energy	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A. Fuel combustion (sectoral approach)	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
4. Other sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
C. CO2 transport and storage										
2. Industrial processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Mineral industry										
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
A. Enteric fermentation										
B. Manure management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Rice cultivation										
D. Agricultural soils	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
G. Liming										
H. Urea application										
I. Other carbon containing fertlizers										
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F. Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Solid waste disposal										
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N2O emissions without N2O from LULUCF	0.03	0.03	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Total direct N2O emissions with N2O from LULUCF	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.03
Memo items:										
International bunkers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass										
CO2 captured										
Long-term storage of C in waste disposal sites										
Indirect N2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Indirect CO2 (3)										

Notes:

All footnotes for this table are given on sheet 3 of table 1(c).

Custom Footnotes

Table 1(c) LIE_BR5_v0.1

Emission trends (N_2O)

(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
A. Fuel combustion (sectoral approach)	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Other sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
C. CO2 transport and storage											
2. Industrial processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Mineral industry											
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
A. Enteric fermentation											
B. Manure management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
C. Rice cultivation											
D. Agricultural soils	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
G. Liming											
H. Urea application											
I. Other carbon containing fertlizers											
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F. Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Harvested wood products											
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Solid waste disposal											
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N2O emissions without N2O from LULUCF	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total direct N2O emissions with N2O from LULUCF	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Memo items:											
International bunkers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass											
CO2 captured											
Long-term storage of C in waste disposal sites											
Indirect N2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Indirect CO2 (3)											

Notes:

All footnotes for this table are given on sheet 3 of table 1(c).

Custom Footnotes

Table 1(c) LIE_BR5_v0.1

Emission trends (N_2O)

(Sheet 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
												%
1. Energy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-26.49
A. Fuel combustion (sectoral approach)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-26.49
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-94.06
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-4.20
3. Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-45.57
4. Other sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.60
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Fugitive emissions from fuels	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	NO, NA	NO, NA	NO	NO, NA	NO, NA	0.00
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	NO, NA	NO, NA	NO	NO, NA	NO, NA	0.00
C. CO2 transport and storage												
2. Industrial processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-68.96
A. Mineral industry												
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Electronic industry												
F. Product uses as ODS substitutes												
G. Other product manufacture and use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-68.96
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	-6.84
A. Enteric fermentation												
B. Manure management	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	13.52
C. Rice cultivation												
D. Agricultural soils	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-11.05
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	0.00
G. Liming												
H. Urea application												
I. Other carbon containing fertlizers												
J. Other	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	0.00
4. Land use, land-use change and forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.33
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	109.84
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	341.03
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	262.79
E. Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.07
F. Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	87.51
G. Harvested wood products												
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.64
A. Solid waste disposal												
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.42
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-22.94
D. Waste water treatment and discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.07
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total direct N2O emissions without N2O from LULUCF	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	-10.53
Total direct N2O emissions with N2O from LULUCF	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	-9.38
Memo items:												
International bunkers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	119.95
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	119.95
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO2 emissions from biomass												
CO2 captured												
Long-term storage of C in waste disposal sites												
Indirect N2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Indirect CO2 (3)												

Abbreviations : CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

Custom Footnotes

Table 1(d) LIE_BR5_v0.1

Emission trends (HFCs, PFCs and SF_6)

(Sheet 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year*[a] *kt*	1990	1991	1992	1993	1994	1995	1996	1997	1998
Emissions of HFCs and PFCs - (kt CO2 equivalent)	0.00	0.00	0.01	0.08	0.18	0.43	1.24	1.57	1.95	2.51
Emissions of HFCs - (kt CO2 equivalent)	0.00	0.00	0.01	0.08	0.18	0.43	1.24	1.57	1.95	2.51
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of PFCs - (kt CO2 equivalent)	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_3F_8	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of SF6 - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of NF3 - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Notes:

All footnotes for this table are given on sheet 3 of table 1(d).

Table 1(d) LIE_BR5_v0.1

Emission trends (HFCs, PFCs and SF_6)

(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Emissions of HFCs and PFCs - (kt CO2 equivalent)	3.11	3.88	4.68	5.30	5.92	6.57	6.79	7.48	8.26	8.68	8.50
Emissions of HFCs - (kt CO2 equivalent)	3.10	3.87	4.67	5.28	5.89	6.53	6.73	7.42	8.19	8.61	8.45
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unspecified mix of HFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of PFCs - (kt CO2 equivalent)	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.07	0.07	0.06
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_3F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of SF6 - (kt CO2 equivalent)	0.00	0.09	0.17	0.24	0.25	0.26	0.26	0.06	0.11	0.35	0.14
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions of NF3 - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Notes:

All footnotes for this table are given on sheet 3 of table 1(d).

Table 1(d) LIE_BR5_v0.1

Emission trends (HFCs, PFCs and SF_6)

(Sheet 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
												%
Emissions of HFCs and PFCs - (kt CO2 equivalent)	9.01	9.50	9.85	9.80	10.06	10.15	9.76	10.03	10.20	9.74	9.11	8,625,373.57
Emissions of HFCs - (kt CO2 equivalent)	8.95	9.44	9.81	9.75	10.03	10.13	9.76	10.03	10.20	9.73	9.11	8,624,277.58
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-134a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,674,886.78
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-143a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-365mfc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Unspecified mix of HFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of PFCs - (kt CO2 equivalent)	0.05	0.06	0.04	0.04	0.03	0.01	0.01	0.00	0.00	0.00	0.00	100.00
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_3F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of PFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of SF6 - (kt CO2 equivalent)	0.02	0.01	0.00	0.17	0.12	0.04	0.01	0.05	0.07	0.05	0.05	100.00
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Emissions of NF3 - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00

Abbreviations : CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[c]Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO2 equivalent emissions.

[d]In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories", HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is kt of CO2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.)

Custom Footnotes

For further information please refer to chapter 3 of Liechtenstein's Eighth National Communication.

3. Quantified Economy-wide Emission Reduction Target (QEWER)

Liechtenstein's quantified economy-wide emission reduction target

Liechtenstein's quantified economy-wide emission reduction target is -20% of its 1990 total GHG emissions by 2020.

Table 2(a) LIE_BR5_v0.1

Description of quantified economy-wide emission reduction target: base year[a]

Party	*Liechtenstein*	
Base year /base period	1990	
Emission reduction target	% of base year/base period 20.00	% of 1990 [b]
Period for reaching target	BY-2020	

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Optional.

Table 2(b) LIE_BR5_v0.1

Description of quantified economy-wide emission reduction target: gases and sectors covered[a]

Gases covered		*Base year for each gas (year):*
CO_2		1990
CH_4		1990
N_2O		1990
HFCs		1990
PFCs		1990
SF_6		1990
NF_3		
Other Gases (specify)		
Sectors covered[b]	Energy	Yes
	Transport[f]	Yes
	Industrial processes[g]	Yes
	Agriculture	Yes
	LULUCF	Yes
	Waste	Yes
	Other Sectors (specify)	

Abbreviations : LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] More than one selection will be allowed. If Parties use sectors other than those indicated above, the explanation of how these sectors relate to the sectors defined by the IPCC should be provided.

[f] Transport is reported as a subsector of the energy sector.

[g] Industrial processes refer to the industrial processes and solvent and other product use sectors.

Table 2(c) LIE_BR5_v0.1

Description of quantified economy-wide emission reduction target: global warming potential values (GWP)[a]

Gases	*GWP values* [b]
CO_2	4th AR
CH_4	4th AR
N_2O	4th AR
HFCs	4th AR
PFCs	4th AR
SF_6	4th AR
NF_3	
Other Gases (specify)	

Abbreviations : GWP = global warming potential

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Please specify the reference for the GWP: Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) or the Fourth Assessment Report of the IPCC.

Table 2(d) LIE_BR5_v0.1

Description of quantified economy-wide emission reduction target: approach to counting emissions and removals from the LULUCF sector[a]

Role of LULUCF	LULUCF in base year level and target	Included
	Contribution of LULUCF is calculated using	Land-based approach

Abbreviation : LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

First commitment period 2008-2012 of Kyoto Protocol

For the first commitment period of the Kyoto Protocol (2008-2012) Liechtenstein made a quantified emission limitation and reduction commitment of 92 per cent of the base year level (1990).

The True-Up Period report submitted by Liechtenstein on 2. January 2016[2] contains the information required to be reported upon the expiration of the additional period for fulfilling the commitments for the first commitment period of the Kyoto Protocol in accordance with the relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol.

Second commitment period 2013-2020 of Kyoto Protocol

Liechtenstein's quantified emission limitation and reduction commitment in the second commitment period (2013-2020) is 84 per cent of the base year (1990). This is in line with Liechtenstein's quantified economy wide target of 20% below 1990 levels in 2020.

Regarding the achievement of the abovementioned target, the priority remains on implementing domestic measures. The legal framework ensuring the focus on domestic reduction measures has been transferred into the new Emissions Trading Act in September 2012. Liechtenstein's focus lies on domestic emission reductions, international carbon credits will play a subsidiary role.

Article 4 paragraph 1 states:

"The emissions of GHG have to be reduced by 20 % compared to the year 1990 until 2020. In accordance with international obligations the Government may increase its reduction target by 40%. The Government informs the Parliament about any increase of the target.

Article 4 paragraph 2 states:

"The reduction of GHG emissions shall be achieved through respective domestic measures, in particular through policy measures within the field of energy, transportation, environment, forestry, agriculture, economy and finance."

Article 4 paragraph 3 states:

"Only these GHG emissions which cannot be reduced by domestic measures, in order to fulfil the reduction obligation according to paragraph 1, may be reduced by using project based mechanisms abroad or international emissions trading."

Use of international market based mechanisms

Liechtenstein will continue the use of carbon credits generated from international market mechanisms to ensure the achievement of the national reduction target. However, Liechtenstein's climate policy generally aims to achieve the reduction target through domestic reductions.

A revision of the Emissions Trading Act is expected to be adopted in spring 2023, in which the domestic reduction target will be defined alongside the reduction target cap to be achieved through measures defined under Article 6 of the Paris agreement.

Liechtenstein will decide on the final modalities pertaining to the use of carbon credits when issuing the true-up report for the second commitment period of the Kyoto Protocol.

During COP 18 in 2012 in Doha, Qatar, Liechtenstein declared not to acquire AAUs for compliance purposes under the second commitment period of the Kyoto Protocol (FCCC/KP/CMP/2012/L.9).

[2] True-up period report Liechtenstein (OE, 2016): https://www.llv.li/files/au/true-up-period-report-by-liechtenstein.pdf

Liechtenstein may, however, use a limited amount of its own AAUs to be carried over in the second commitment period (see Table 2 (e)I).

Table 2(e)I LIE_BR5_v0.1

Description of quantified economy-wide emission reduction target: market-based mechanisms under the Convention[a]

Market-based mechanisms under the Convention	*Possible scale of contributions (estimated kt CO_2 eq)*
CERs	314.00
ERUs	
AAUs[i]	
Carry-over units[j]	42.98
Other mechanism units under the Convention (specify)[d]	

Abbreviations: AAU = assigned amount unit, CER = certified emission reduction, ERU = emission reduction unit.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[d] As indicated in paragraph 5(e) of the guidelines contained in annex I of decision 2/CP.17 .

[i] AAUs issued to or purchased by a Party.

[j] Units carried over from the first to the second commitment periods of the Kyoto Protocol, as described in decision 13/CMP.1 and consistent with decision 1/CMP.8.

Table 2(e)II LIE_BR5_v0.1

Description of quantified economy-wide emission reduction target: other market-based mechanisms[a]

Other market-based mechanisms (Specify)	*Possible scale of contributions (estimated kt CO_2 eq)*

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

Table 2(f) LIE_BR5_v0.1

Description of quantified economy-wide emission reduction target: any other information[a,b]

No source of NF3 in Liechtenstein

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] This information could include information on the domestic legal status of the target or the total assigned amount of emission units for the period for reaching a target. Some of this information is presented in the narrative part of the biennial report.

Custom Footnotes

4. Progress in achievement of QEWER target

Mitigation actions and their effects in Liechtenstein

Liechtenstein has implemented its climate related policies and measures strongly into individual sectorial policies. The responsibility of monitoring the effects of individual measures or policies is therefore beard by the respective administration offices that are in charge of the execution of the individual measure. These authorities provide an annual report of their activities (not only climate change related) which will be forwarded to the Liechtenstein Parliament. The reports are publicly available.

Liechtenstein's legislative and administrative main arrangements to meet its commitments under the Kyoto Protocol are to be found in the Emissions Trading Act and the CO_2 Act.

The third measure in the CO_2 Act obliges entities which import (motor) fuels ("Treibstoffe") to compensate a share of up to 40% of the domestic emissions of these fuels.

In alignment with the planned comprehensive revision of the Swiss CO_2 Act, Liechtenstein planned to revise its CO_2 Act entering into force in 2022, in order to achieve the set climate targets for 2030 and 2050 (see Emissions Trading Act). However, since the revised Swiss CO_2 Act was rejected in the Swiss popular referendum, the revision of the Liechtenstein CO_2 Act was put on hold as well. The existing measures have been prolonged until 2025, when the new revision is expected to be adopted.

The CO_2 Act corresponds with the CO_2 Act of Switzerland (in force since 2008) and introduces a levy on the consumption of fossil fuel (oil and natural gas). In 2013 the CO2 Act has been revised. Besides the levy on fossil fuel an obligation to compensate CO_2 emissions from the use of motor fuels (gasoline and diesel) as well as emission regulations for passenger cars has been introduced.

The CO_2 Act is part of "The bilateral Agreement between the Principality of Liechtenstein and the Swiss Confederation on Environmental Levies within the Principality of Liechtenstein".

The Emissions Trading Act provides the basis for the coordination of different sectors on climate measures, the framework for the purchase of emission reduction units abroad, etc. The CO_2 Act is coordinated on the basis of the bilateral treaty on environmental levies between Liechtenstein and Switzerland through the relevant Swiss authorities.

The revised draft of the Emissions Trading Act (EHG) foresees to reduce emissions by 50% by 2030. In addition, it states that emission reductions are first and foremost to be achieved by domestic measures and sets the minimum domestic reduction target with 40%. If the reduction obligations cannot be fulfilled through domestic measures the Government may participate in project activities abroad or in international emissions trading. Liechtenstein is currently assessing the establishment of bilateral agreements as stipulated under Article 6.2 of the Paris agreement. Liechtenstein is associated to the emission trading directive of the European Commission and will join the discussion of the EC around operationalising Article 6.4 of the Paris agreement. However, it is unlikely that significant progress on the latter will be made prior to 2024.

The Energy Efficiency Act and the Energy Strategy 2030 serve as central drivers for the achievement of Liechtenstein's GHG reduction targets until 2030:

The **Energy Efficiency Act** (2008) and the relevant Ordinance (2008) as well as the Energy Ordinance (2007) on the Construction Act constitute the legal framework for the implementation of measures relating to buildings. In terms of measurable mitigation action, the most relevant measures are to be found in the energy sector, since over 80 % of Liechtenstein's CO_2 emissions are energy related. Measured against the reference year 1990, the emissions in this sector must be eliminated reduced by around 50% by 2030 reaching net zero by 2050. An ambitious goal that requires comprehensive measures, high investments and the support from all sectors: politics, the economy and individuals. The increase of energy efficiency and in particular the increased use of renewable energies are of central importance for the reduction of greenhouse gas emissions and accordingly for a long-term climate policy.

The Government adopted the "**Energy Strategy 2030**". The strategy provides future-oriented impulses for the national energy policy. The focus areas of the concept are the promotion of efficient energy use, the use of renewable energies, and energy conservation. The main measures outlined in the energy strategy are subsidy for renovation of old buildings, residential heating installations, solar collectors and photovoltaic installations.

The annual publication of Liechtenstein's energy statistics by the Office of Statistics serves as a monitoring tool to evaluate the effect of the respective policies. The Bureau of Energy Consumption and Conservation ('Energiefachstelle') was responsible for the implementation and monitoring of measures set out in the Energy Strategy 2020 and maintains this responsibility for the Energy Strategy 2030. The Bureau uses the energy statistics and its data on approved subsidies to provide annual monitoring reports to Parliament.

For further information please refer to chapter 4 of Liechtenstein's Eighth National Communication.

Table 3 LIE_BR5_v0.1

Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects

Name of mitigation action [a]	*Sector(s) affected* [b]	*GHG(s) affected*	*Objective and/or activity affected*	*Type of instrument* [c]	*Status of implementation* [d]	*Brief description* [e]	*Start year of implementation*	*Implementing entity or entities*	*Estimate of mitigation impact (not cumulative, in kt CO_2 eq)*	
									2020	*2025* [f]
Liechtenstein Energy Strategy 2030 (Energiestrategie 2030)*	Energy, Transport	CO_2	Governmental Strategy that targets a sustainable energy supply, energy efficiency and net zero emissions	Other (Planning measure)	Implemented	Including policies on: Building standards, support for Minergie buildings, district heating network	2020	Government of Liechtenstein / Office of Economic Affairs	2.56	3.49
Climate Strategy 2050	Cross-cutting	CH_4, CO_2, HFCs, N_2O, PFCs, SF_6	Definition of the increase in the emission reduction target for 2030 from 40% to 50% below 1990 and concrete measures to achieve this target and the target of climate neutrality by 2050.	Other (Planning Measure)	Planned		2023	Government of Liechtenstein	NA	22.77

Note: The two final columns specify the year identified by the Party for estimating impacts (based on the status of the measure and whether an ex post or ex ante estimation is available).

Abbreviations: GHG = greenhouse gas; LULUCF = land use, land-use change and forestry.

[a] Parties should use an asterisk (*) to indicate that a mitigation action is included in the 'with measures' projection.

[b] To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors, cross-cutting, as appropriate.

[c] To the extent possible, the following types of instrument should be used: economic, fiscal, voluntary agreement, regulatory, information, education, research, other.

[d] To the extent possible, the following descriptive terms should be used to report on the status of implementation: implemented, adopted, planned.

[e] Additional information may be provided on the cost of the mitigation actions and the relevant timescale.

[f] Optional year or years deemed relevant by the Party.

Custom Footnotes

Estimates of emission reductions and removals and the use of units from the market-based mechanisms and LULUCF

Information on progress in the achievement of the quantified economy-wide emission reduction targets is provided in BR CTF Table4.

Liechtenstein's base year (1990) emissions and the Kyoto Target 2020 (assigned amount units) are defined in the report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of Liechtenstein[3]. Due to recalculations the base year emissions may differ from the values Liechtenstein reported for the year 1990 in its latest greenhouse gas inventory.

Information on the effective quantity of units from market based mechanisms under the Convention is provided in Table 4(b).

With the transition from Kyoto to Paris mechanisms Liechtenstein is not using the mechanisms described under 6.4 of the Paris agreement prior to 2024. However, Liechtenstein is currently assessing the use of bilateral agreements under Article 6.2 to achieve its emission reduction target until 2030.

Table 4 LIE_BR5_v0.1

Reporting on progress[a, b]

	Total emissions excluding LULUCF (1)	*Contribution from LULUCF*[d] *(2)*	*Quantity of units from market based mechanisms under the Convention*		*Quantity of units from other market based mechanisms*	
Year[c]	*(kt CO_2 eq)*	*(kt CO_2 eq)*	*(number of units)*	*(kt CO_2 eq)*	*(number of units)*	*(kt CO_2 eq)*
Base year/period (1990)	231.55		NA	NA	NA	
2010	228.17		NA		NA	
2011	215.32		NA		NA	
2012	224.51		NA		NA	
2013	230.73		0.00		NA	
2014	199.73		0.00		NA	
2015	198.15		0.00		NA	
2016	187.76		0.00		NA	
2017	193.46		209,603.00		NA	
2018	181.27		50,938.00		NA	
2019	187.67		53,463.00		NA	
2020	180.01		0.00		NA	

Abbreviation: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] For the base year, information reported on the emission reduction target shall include the following: (a) total GHG emissions, excluding emissions and removals from the LULUCF sector; (b) emissions and/or removals from the LULUCF sector based on the accounting approach applied taking into consideration any relevant decisions of the Conference of the Parties and the activities and/or land that will be accounted for; (c) total GHG emissions, including emissions and removals from the LULUCF sector. For each reported year, information reported on progress made towards the emission reduction targets shall include, in addition to the information noted in paragraphs 9(a–c) of the UNFCCC biennial reporting guidelines for developed country Parties, information on the use of units from market-based mechanisms.

[c] Parties may add additional rows for years other than those specified below.

[d] Information in this column should be consistent with the information reported in table 4(a)I or 4(a)II, as appropriate. The Parties for which all relevant information on the LULUCF contribution is reported in table 1 of this common tabular format can refer to table 1.

Custom Footnotes

(1) Liechtenstein's base year (1990) emissions are defined in the report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of Liechtenstein. Due to recalculations the base year emissions may differ from the values Liechtenstein reported for the year 1990 in its latest greenhouse gas inventory.

(2) Refer to Table 1

[3] Liechtenstein. Report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of Liechtenstein. Note by the expert review team. https://unfccc.int/documents/28242

Table 4(a)I LIE_BR5_v0.1

Progress in achieving the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector in 2019 [a,b]

	Net GHG emissions/removals from LULUCF categories [c]	*Base year/period or reference level value* [d]	*Contribution from LULUCF for reported year*	*Cumulative contribution from LULUCF* [e]	*Accounting approach* [f]
	(kt CO_2 eq)				
Total LULUCF					Land-based approach
A. Forest land					Land-based approach
1. Forest land remaining forest land					Land-based approach
2. Land converted to forest land					Land-based approach
3. Other [g]					Land-based approach
B. Cropland					Land-based approach
1. Cropland remaining cropland					Land-based approach
2. Land converted to cropland					Land-based approach
3. Other [g]					Land-based approach
C. Grassland					Land-based approach
1. Grassland remaining grassland					Land-based approach
2. Land converted to grassland					Land-based approach
3. Other [g]					Land-based approach
D. Wetlands					Land-based approach
1. Wetland remaining wetland					Land-based approach
2. Land converted to wetland					Land-based approach
3. Other [g]					Land-based approach
E. Settlements					Land-based approach
1. Settlements remaining settlements					Land-based approach
2. Land converted to settlements					Land-based approach
3. Other [g]					Land-based approach
F. Other land					Land-based approach
1. Other land remaining other land					Land-based approach
2. Land converted to other land					Land-based approach
3. Other [g]					Land-based approach
G. Other					Land-based approach
Harvested wood products					Land-based approach

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Parties that use the LULUCF approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[c] For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its Kyoto Protocol, explain in the biennial report how the value was derived.

[d] Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.

[e] If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.

[f] Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).

[g] Specify what was used for the category "other". Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its Kyoto Protocol.

Custom Footnotes

Table 4(a)I LIE_BR5_v0.1

Progress in achieving the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector in 2020 [a, b]

	Net GHG emissions/removals from LULUCF categories [c]	*Base year/period or reference level value* [d]	*Contribution from LULUCF for reported year*	*Cumulative contribution from LULUCF* [e]	*Accounting approach* [f]
	(kt CO_2 eq)				
Total LULUCF					Land-based approach
A. Forest land					Land-based approach
1. Forest land remaining forest land					Land-based approach
2. Land converted to forest land					Land-based approach
3. Other [g]					Land-based approach
B. Cropland					Land-based approach
1. Cropland remaining cropland					Land-based approach
2. Land converted to cropland					Land-based approach
3. Other [g]					Land-based approach
C. Grassland					Land-based approach
1. Grassland remaining grassland					Land-based approach
2. Land converted to grassland					Land-based approach
3. Other [g]					Land-based approach
D. Wetlands					Land-based approach
1. Wetland remaining wetland					Land-based approach
2. Land converted to wetland					Land-based approach
3. Other [g]					Land-based approach
E. Settlements					Land-based approach
1. Settlements remaining settlements					Land-based approach
2. Land converted to settlements					Land-based approach
3. Other [g]					Land-based approach
F. Other land					Land-based approach
1. Other land remaining other land					Land-based approach
2. Land converted to other land					Land-based approach
3. Other [g]					Land-based approach
G. Other					Land-based approach
Harvested wood products					Land-based approach

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Parties that use the LULUCF approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[c] For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its Kyoto Protocol, explain in the biennial report how the value was derived.

[d] Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.

[e] If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.

[f] Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).

[g] Specify what was used for the category "other". Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its Kyoto Protocol.

Custom Footnotes

Table 4(a)II

LIE_BR5_v0.1
Source: Submission 2022 v3, LIECHTENSTEIN

Progress in achievement of the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land-use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol[a,b,c]

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	*Base year*[d]	*Net emissions/removals*[e]									*Accounting parameters*[h]	*Accounting quantity*[i]
		2013	2014	*2015*	*2016*	2017	2018	2019	2020	Total[g]		
	(kt CO_2 eq)											
A. Article 3.3 activities												
A.1. Afforestation/reforestation		-0.32	-0.32	-0.33	-0.33	-0.34	-0.34	-0.35	-0.35	-2.67		-2.67
Excluded emissions from natural disturbances(5)			NO	NO	NO	NO	NO	NO		NO		NO
Excluded subsequent removals from land subject to natural disturbances(6)			NO	NO	NO	NO		NO	NO	NO		NO
A.2. Deforestation		4.68	4.77	4.87	4.96	4.80	4.63	4.46	4.29	37.47		37.47
B. Article 3.4 activities												
B.1. Forest management										16.15		13.27
Net emissions/removalse		5.67	5.58	0.14	-1.72	-0.04	11.33	1.34	-6.15	16.15		
Excluded emissions from natural disturbances(5)			NO		NO	NO	NO	NO		NO		NO
Excluded subsequent removals from land subject to natural disturbances(6)			NO		NO	NO	NO	NO	NO	NO		NO
Any debits from newly established forest (CEF-ne)(7),(8)												
Forest management reference level (FMRL)(9)											0.10	
Technical corrections to FMRL(10)											0.26	
Forest management capl											66.09	13.27
B.2. Cropland management (if elected)			NO		NO	NO	NO	NO	NO	NO		NO
B.3. Grazing land management (if elected)			NO		NO	NO	NO	NO	NO	NO		NO
B.4. Revegetation (if elected)			NO		NO	NO	NO	NO	NO	NO		NO
B.5. Wetland drainage and rewetting (if elected)			NO		NO	NO	NO	NO	NO	NO		NO

Note: 1 kt CO_2 eq equals 1 Gg CO_2 eq.

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Developed country Parties with a quantified economy-wide emission reduction target as communicated to the secretariat and contained in document FCCC/SB/2011/INF.1/Rev.1 or any update to that document, that are Parties to the Kyoto Protocol, may use table 4(a)II for reporting of accounting quantities if LULUCF is contributing to the attainment of that target.

[c] Parties can include references to the relevant parts of the national inventory report, where accounting methodologies regarding LULUCF are further described in the documentation box or in the biennial reports.

[d] Net emissions and removals in the Party's base year, as established by decision 9/CP.2.

[e] All values are reported in the information table on accounting for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.

[f] Additional columns for relevant years should be added, if applicable.

[g] Cumulative net emissions and removals for all years of the commitment period reported in the current submission.

[h] The values in the cells "3.3 offset" and "Forest management cap" are absolute values.

[i] The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7, paragraph 4, of the Kyoto Protocol.

[j] In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following afforestation and reforestation since 1990 shall not be greater than the credits accounted for on that unit of land.

[k] In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3 paragraph 3, may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3, paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.

[l] In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period of the Kyoto Protocol only, additions to and subtractions from the assigned amount of a Party resulting from Forest management under Article 3, paragraph 4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.

Custom Footnotes

Table 4(b) LIE_BR5_v0.1

Reporting on progress[a, b, c]

Units of market based mechanisms			*Year*	
			2019	*2020*
Kyoto Protocol units[d]	*Kyoto Protocol units*	*(number of units)*	53463	0
		(kt CO_2 eq)		
	AAUs	*(number of units)*		
		(kt CO2 eq)		
	ERUs	*(number of units)*		
		(kt CO2 eq)		
	CERs	*(number of units)*	53463	0
		(kt CO2 eq)		
	tCERs	*(number of units)*		
		(kt CO2 eq)		
	lCERs	*(number of units)*		
		(kt CO2 eq)		
Other units[d,e]	*Units from market-based mechanisms under the Convention*	*(number of units)*		
		(kt CO_2 eq)		
	Units from other market-based mechanisms	*(number of units)*		
		(kt CO_2 eq)		
Total		*(number of units)*	53463	0
		(kt CO_2 eq)		

Abbreviations : AAUs = assigned amount units, CERs = certified emission reductions, ERUs = emission reduction units, lCERs = long-term certified emission reductions, tCERs = temporary certified emission reductions.
Note: 2011 is the latest reporting year.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] For each reported year, information reported on progress made towards the emission reduction target shall include, in addition to the information noted in paragraphs 9(a-c) of the reporting guidelines, on the use of units from market-based mechanisms.

[c] Parties may include this information, as appropriate and if relevant to their target.

[d] Units surrendered by that Party for that year that have not been previously surrendered by that or any other Party.

[e] Additional rows for each market-based mechanism should be added, if applicable.

Custom Footnotes

For further information please refer to chapter 4 of Liechtenstein's Eighth National Communication.

5. Projections

This section covers Liechtenstein's greenhouse gas emissions under the three scenarios 'without measures' (WOM), 'with measures' (WM) and 'with additional measures' (WAM) according to the guidelines for the preparation of national communications (UNFCCC 2019):

- The 'without measures' (WOM) scenario projection excludes all policies and measures implemented, adopted or planned after the year chosen as the starting point for that projection. For Liechtenstein's NC8, this starting year is 2008. 2008 was the year when the Energy Efficiency Act was adopted in Liechtenstein, and no other (quantifiable) measures were implemented earlier than 2008 in Liechtenstein.
- The 'with measures' (WM) scenario projection encompasses currently implemented and adopted policies and measures. In Liechtenstein, projections based on specific measures are only available for the sector Energy (1A Fuel combustion). For the waste sector projections were calculated based on past emissions and the expected growth in population. Projections for the sectors Energy (1B Fugitive emissions from fuels) as well as for IPPU (2) and Agriculture (3) were adopted from Switzerland's WM projection in its NC8 (FOEN 2022). The projections for LULUCF were assumed to be constant (mean of the latest five inventory years). The projection of international bunkers is also assumed to be constant (mean of last 10 years; note that within the last 10 years, only minor fluctuations occurred in reported emissions).
- The 'with additional measures' (WAM) scenario projection also encompasses planned policies and measures. The Climate Strategy 2050 (Government 2022) defines additional measures for the sectors Energy, IPPU, Agriculture and Waste. Projections under the WAM scenario are therefore adopted from the Climate Strategy 2050.

The energy sector dominates Liechtenstein's greenhouse gas emissions. In the year 2020, emissions from this sector amounted 80.1% of Liechtenstein's total emissions. Therefore, the focus for the elaboration of Liechtenstein's projections in its NC8 lies on the Energy sector.

The aggregated projections in CO_2 equivalents under the WM and WAM scenario are depicted in the following tables. The actual GHG emission reduction for the years 1990–2020 amounts 21.4%. From then, further reductions by 30.5% (WM scenario) and by 46.30% (WAM scenario) are projected in the years 2020–2035. The total reduction from 1990–2035 under the WM scenario is anticipated to be 45.4%, for the WAM scenario 57.8%. As CTF Tables 6a-c only show projections up to the year 2030, the projections for the year 2035 are shown in a separate Table below.

Table 5 LIE_BR5_v0.1

Summary of key variables and assumptions used in the projections analysis[a]

Key underlying assumptions		*Historical*[b]											Projected		
Assumption	*Unit*	*1990*	*1995*	2000	2005	2010	2015	2016	2017	2018	2019	2020	2025	2030	2035
Population	*thousands*	29.03	30.92	32.86	34.91	36.15	37.62	37.81	38.11	38.38	38.75	39.06	40.35	41.42	42.55

[a] Parties should include key underlying assumptions as appropriate.

[b] Parties should include historical data used to develop the greenhouse gas projections reported.

Custom Footnotes

Table 6(a) LIE_BR5_v0.1

Information on updated greenhouse gas projections under a 'with measures' scenario[a]

	GHG emissions and removals[b] *(kt CO_2 eq)*								GHG emission projections ($kt CO_2$ eq)	
	Base year (1990)	1990	1995	2000	2005	2010	2015	2019	2020	2030
Sector[d,e]										
Energy	124.38	124.38	124.96	128.44	149.64	115.67	100.33	94.16	91.54	69.79
Transport	76.87	76.87	82.10	91.62	81.81	77.76	61.85	57.36	52.77	44.54
Industry/industrial processes	0.66	0.66	1.77	4.41	7.49	9.39	10.48	10.05	9.43	4.95
Agriculture	24.90	24.90	23.10	20.91	23.07	23.73	23.87	24.50	24.67	24.49
Forestry/LULUCF	7.57	7.57	5.33	25.14	9.39	21.01	12.21	12.40	4.84	12.35
Waste management/waste	1.66	1.66	1.62	1.62	1.63	1.62	1.62	1.60	1.60	1.81
Other (specify)										
Gas										
CO_2 emissions including net CO_2 from LULUCF	206.24	206.24	209.24	241.66	237.99	211.42	171.55	161.02	146.39	123.53
CO_2 emissions excluding net CO_2 from LULUCF	198.97	198.97	204.20	216.86	228.99	190.83	159.77	149.03	141.94	112.17
CH_4 emissions including CH_4 from LULUCF	19.24	19.24	17.92	16.69	18.49	19.01	19.01	19.57	19.71	19.62
CH_4 emissions excluding CH_4 from LULUCF	19.24	19.24	17.92	16.69	18.49	19.01	19.01	19.57	19.71	19.62
N_2O emissions including N_2O from LULUCF	10.57	10.57	10.47	9.83	9.51	9.70	9.60	9.70	9.58	9.96
N_2O emissions excluding N_2O from LULUCF	10.27	10.27	10.18	9.48	9.12	9.29	9.17	9.30	9.19	8.96
HFCs	0.00	0.00	1.24	3.87	6.73	8.95	10.13	9.73	9.11	4.78
PFCs	NO	NO	0.00	0.01	0.05	0.05	0.01	0.00	0.00	0.00
SF_6	NO	NO	NO	0.09	0.26	0.02	0.04	0.05	0.05	0.03
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other (specify)										
Total with LULUCF[f]	236.05	236.05	238.87	272.15	273.03	249.15	210.34	200.07	184.84	157.92
Total without LULUCF	228.48	228.48	233.54	247.00	263.64	228.15	198.13	187.68	180.00	145.56

Abbreviations : GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", at a minimum Parties shall report a 'with measures' scenario, and may report 'without measures' and 'with additional measures' scenarios. If a Party chooses to report 'without measures' and/or 'with additional measures' scenarios they are to use tables 6(b) and/or 6(c), respectively. If a Party does not choose to report 'without measures' or 'with additional measures' scenarios then it should not include tables 6(b) or 6(c) in the biennial report.

[b] Emissions and removals reported in these columns should be as reported in the latest GHG inventory and consistent with the emissions and removals reported in the table on GHG emissions and trends provided in this biennial report. Where the sectoral breakdown differs from that reported in the GHG inventory Parties should explain in their biennial report how the inventory sectors relate to the sectors reported in this table.

[c] 20XX is the reporting due-date year (i.e. 2014 for the first biennial report).

[d] In accordance with paragraph 34 of the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", projections shall be presented on a sectoral basis, to the extent possible, using the same sectoral categories used in the policies and measures section. This table should follow, to the extent possible, the same sectoral categories as those listed in paragraph 17 of those guidelines, namely, to the extent appropriate, the following sectors should be considered: energy, transport, industry, agriculture, forestry and waste management.

[e] To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors (i.e. cross-cutting), as appropriate.

[f] Parties may choose to report total emissions with or without LULUCF, as appropriate.

Custom Footnotes

GHG emissions projections in kt CO2eq	2035
Sector	
Energy	61.89
Transport	35.10
Industry/industrial processes	4.26
Agriculture	24.49
Forestry/LULUCF	12.35
Waste management/waste	1.90
Other (specify)	
Gases	
CO_2 emissions including net CO_2 from LULUCF	106.36
CO_2 emissions excluding net CO_2 from LULUCF	95.00
CH_4 emissions including CH_4 from LULUCF	19.63
CH_4 emissions excluding CH_4 from LULUCF	19.63
N_2O emissions including N_2O from LULUCF	9.85
N_2O emissions excluding N_2O from LULUCF	8.86
HFCs	4.11
PFCs	0.00
SF_6	0.02
NF_3	NO
Other (specify)	
Total with LULUCF [f]	139.98
Total without LULUCF	127.63

Table 6(b) LIE_BR5_v0.1

Information on updated greenhouse gas projections under a 'without measures' scenario [a]

	GHG emissions and removals [b] (*kt CO_2 eq*)								GHG emission projections ($kt CO_2$ eq)	
	Base year (1990)	1990	1995	2000	2005	2010	2015	2019	2020	2030
Sector [d,e]										
Energy	124.38	124.38	124.96	128.44	149.64	133.30	138.19	141.58	142.42	142.88
Transport	76.87	76.87	82.10	91.62	81.81	84.09	80.60	80.93	81.02	81.58
Industry/industrial processes	0.66	0.66	1.77	4.41	7.49	9.97	12.25	12.50	12.82	13.65
Agriculture	24.90	24.90	23.10	20.91	23.07	23.73	23.87	24.50	24.67	24.55
Forestry/LULUCF	7.57	7.57	5.33	25.14	9.39	21.01	12.21	12.40	4.84	12.35
Waste management/waste	1.66	1.66	1.62	1.62	1.63	1.67	1.79	1.88	1.90	2.10
Other (specify)										
Gas										
CO_2 emissions including net CO_2 from LULUCF	206.24	206.24	209.24	241.66	237.99	235.09	227.30	230.84	224.28	231.75
CO_2 emissions excluding net CO_2 from LULUCF	198.97	198.97	204.20	216.86	228.99	214.50	215.52	218.84	219.83	220.39
CH_4 emissions including CH_4 from LULUCF	19.24	19.24	17.92	16.69	18.49	19.25	19.66	20.46	20.66	21.16
CH_4 emissions excluding CH_4 from LULUCF	19.24	19.24	17.92	16.69	18.49	19.25	19.66	20.46	20.66	21.16
N_2O emissions including N_2O from LULUCF	10.57	10.57	10.47	9.83	9.51	9.84	10.04	10.32	10.26	10.94
N_2O emissions excluding N_2O from LULUCF	10.27	10.27	10.18	9.48	9.12	9.42	9.61	9.92	9.87	9.94
HFCs	0.00	0.00	1.24	3.87	6.73	9.51	11.85	12.11	12.38	13.19
PFCs	NO	NO	0.00	0.01	0.05	0.06	0.02	0.00	0.00	0.00
SF_6	NO	NO	NO	0.09	0.26	0.02	0.04	0.06	0.07	0.08
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other (specify)										
Total with LULUCF [f]	236.05	236.05	238.87	272.15	273.03	273.77	268.91	273.79	267.65	277.12
Total without LULUCF	228.48	228.48	233.54	247.00	263.64	252.76	256.70	261.39	262.81	264.76

Abbreviations : GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", at

[b] Emissions and removals reported in these columns should be as reported in the latest GHG inventory and consistent with the emissions and removals reported in the table on GHG emissions and trends provided in this biennial report. Where the sectoral breakdown differs from that reported in the GHG inventory Parties should explain in their biennial report how the inventory sectors relate to the sectors reported in this table.

[c] 20XX is the reporting due-date year (i.e. 2014 for the first biennial report).

[d] In accordance with paragraph 34 of the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", projections shall be presented on a sectoral basis, to the extent possible, using the same sectoral categories used in the policies and measures section. This table should follow, to the extent possible, the same sectoral categories as those listed in paragraph 17 of those guidelines, namely, to the extent appropriate, the following sectors should be considered: energy, transport, industry, agriculture, forestry and waste management.

[e] To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors (i.e. cross-cutting), as appropriate.

[f] Parties may choose to report total emissions with or without LULUCF, as appropriate.

Custom Footnotes

GHG emissions projections in kt CO2eq	2035
Sector	
Energy	143.11
Transport	81.58
Industry/industrial processes	14.31
Agriculture	24.55
Forestry/LULUCF	12.35
Waste management/waste	2.21
Other (specify)	
Gases	
CO_2 emissions including net CO_2 from LULUCF	231.76
CO_2 emissions excluding net CO_2 from LULUCF	220.40
CH_4 emissions including CH_4 from LULUCF	21.45
CH_4 emissions excluding CH_4 from LULUCF	21.45
N_2O emissions including N_2O from LULUCF	10.99
N_2O emissions excluding N_2O from LULUCF	9.99
HFCs	13.83
PFCs	0.00
SF_6	0.08
NF_3	NO
Other (specify)	
Total with LULUCF [f]	278.11
Total without LULUCF	265.75

Table 6(c) LIE_BR5_v0.1

Information on updated greenhouse gas projections under a 'with additional measures' scenario[a]

	GHG emissions and removals[b] (*kt CO_2 eq*)								GHG emission projections (kt CO_2 eq)	
	Base year (1990)	1990	1995	2000	2005	2010	2015	2019	2020	2030
Sector [d,e]										
Energy	124.38	124.38	124.96	128.44	149.64	115.67	100.33	94.16	91.54	60.20
Transport	76.87	76.87	82.10	91.62	81.81	77.76	61.85	57.36	52.77	42.55
Industry/industrial processes	0.66	0.66	1.77	4.41	7.49	9.39	10.48	10.05	9.43	4.53
Agriculture	24.90	24.90	23.10	20.91	23.07	23.73	23.87	24.50	24.67	20.07
Forestry/LULUCF	7.57	7.57	5.33	25.14	9.39	21.01	12.21	12.40	4.84	12.35
Waste management/waste	1.66	1.66	1.62	1.62	1.63	1.62	1.62	1.60	1.60	1.76
Other (specify)										
Gas										
CO_2 emissions including net CO_2 from LULUCF	206.24	206.24	209.24	241.66	237.99	211.42	171.55	161.02	146.39	112.04
CO_2 emissions excluding net CO_2 from LULUCF	198.97	198.97	204.20	216.86	228.99	190.83	159.77	149.03	141.94	100.69
CH_4 emissions including CH_4 from LULUCF	19.24	19.24	17.92	16.69	18.49	19.01	19.01	19.57	19.71	16.48
CH_4 emissions excluding CH_4 from LULUCF	19.24	19.24	17.92	16.69	18.49	19.01	19.01	19.57	19.71	16.48
N_2O emissions including N_2O from LULUCF	10.57	10.57	10.47	9.83	9.51	9.70	9.60	9.70	9.58	8.53
N_2O emissions excluding N_2O from LULUCF	10.27	10.27	10.18	9.48	9.12	9.29	9.17	9.30	9.19	7.53
HFCs	0.00	0.00	1.24	3.87	6.73	8.95	10.13	9.73	9.11	4.37
PFCs	NO	NO	0.00	0.01	0.05	0.05	0.01	0.00	0.00	0.00
SF_6	NO	NO	NO	0.09	0.26	0.02	0.04	0.05	0.05	0.03
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other (specify)										
Total with LULUCF[f]	236.05	236.05	238.87	272.15	273.03	249.15	210.34	200.07	184.84	141.45
Total without LULUCF	228.48	228.48	233.54	247.00	263.64	228.15	198.13	187.68	180.00	129.10

Abbreviations : GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", at a minimum Parties shall report a 'with measures' scenario, and may report 'without measures' and 'with additional measures' scenarios. If a Party chooses to report 'without measures' and/or 'with additional measures' scenarios they are to use tables 6(b) and/or 6(c), respectively. If a Party does not choose to report 'without measures' or 'with additional measures' scenarios then it should not include tables 6(b) or 6(c) in the biennial report.

[b] Emissions and removals reported in these columns should be as reported in the latest GHG inventory and consistent with the emissions and removals reported in the table on GHG emissions and trends provided in this biennial report. Where the sectoral breakdown differs from that reported in the GHG inventory Parties should explain in their biennial report how the inventory sectors relate to the sectors reported in this table.

[c] 20XX is the reporting due-date year (i.e. 2014 for the first biennial report).

[d] In accordance with paragraph 34 of the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", projections shall be presented on a sectoral basis, to the extent possible, using the same sectoral categories used in the policies and measures section. This table should follow, to the extent possible, the same sectoral categories as those listed in paragraph 17 of those guidelines, namely, to the extent appropriate, the following sectors should be considered: energy, transport, industry, agriculture, forestry and waste management.

[e] To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors (i.e. cross-cutting), as appropriate.

[f] Parties may choose to report total emissions with or without LULUCF, as appropriate.

Custom Footnotes

GHG emissions projections in kt CO2eq	2035
Sector	
Energy	49.72
Transport	29.11
Industry/industrial processes	2.02
Agriculture	18.05
Forestry/LULUCF	12.35
Waste management/waste	1.82
Other (specify)	
Gases	
CO_2 emissions including net CO_2 from LULUCF	88.34
CO_2 emissions excluding net CO_2 from LULUCF	76.98
CH_4 emissions including CH_4 from LULUCF	15.05
CH_4 emissions excluding CH_4 from LULUCF	15.05
N_2O emissions including N_2O from LULUCF	7.73
N_2O emissions excluding N_2O from LULUCF	6.73
HFCs	1.95
PFCs	0.00
SF_6	0.01
NF_3	NO
Other (specify)	
Total with LULUCF [f]	113.07
Total without LULUCF	100.72

For further information please refer to chapter 5 of Liechtenstein's Eighth National Communication.

6. Provision of financial, technological and capacity-building support to developing country Parties

According to the biennial reporting guidelines the reporting obligations concerning financial, technological and capacity-building support to developing country parties only apply to Annex II Parties to the Convention (see FCCC/CP/2011/9/Add.1, Annex I, Chapter VI). Since Liechtenstein is not listed in Annex II to the Convention the Government does not consider itself to be bound by the respective provisions.

However, due to Liechtenstein's activities within the Fast Start Finance Period 2010 to 2012 as well as with regard to the Government decision of 2012 to continue its engagement within the framework of international climate finance Liechtenstein has chosen to report these activities under paragraph 25, Chapter 7 "Other Reporting matters".

With respect to future submissions Liechtenstein aims at using that reporting format and opportunity to also address the request by Parties made in conjunction with the work program on long term finance at COP 19 in Warsaw[4].

[4] see paragraph 10 http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf

7. Other reporting elements

Liechtenstein's emissions measurements, reporting and verification and emission projections

Liechtenstein accounts yearly for the national greenhouse gas inventory (NIR).

The annual publication of Liechtenstein's energy statistics by the Office of Statistics serves as a monitoring tool to evaluate the effect of the respective policies. The Bureau of Energy Consumption and Conservation ('Energiefachstelle') was responsible for the implementation and monitoring of measures set out in the Energy Strategy 2020 and maintains this responsibility for the Energy Strategy 2030. The Bureau uses the energy statistics and its data on approved subsidies to provide annual monitoring reports to Parliament.

Liechtenstein's activities within international climate finance

Liechtenstein's climate finance priorities are elaborated upon in detail in its Eighth National Communication chapter 7.

As an Annex 1 country, Liechtenstein does not have any obligation to participate in the mandatory funding arrangements. Nevertheless, Liechtenstein is in per capita calculations amongst top donors in climate financing. In 2021, Liechtenstein's IHCD had resources of about 22.9 million Swiss francs, i.e. about 580 Swiss francs per capita. The total Official Development Assistance (ODA) amount was 25.5 million Swiss francs. The average exchange rate for USD was 0.914 in 2021.

In 2015, the Parliament decided to give permanence to the climate finance commitment and integrated climate finance into the regular budget of the International Humanitarian Cooperation and Development IHCD.

In general, support is given to development country partners to help them both adapt to and mitigate the effects of climate change. For the sake of performance and efficiency, Liechtenstein prefers a bilateral allocation of climate finance projects. Therefore, the realisation of projects is focused on traditional cooperation partners under the umbrella of the Mountain Partnership or partners of the Liechtenstein Development Service (LED).

Liechtenstein's **adaptation** assistance focuses on improving resilience to extreme weather conditions and other hazards, by investing in infrastructure which can better withstand climate change impacts, and through other practical measures to help local communities be more prepared.

To assist in **mitigating** climate change, Liechtenstein is placing emphasis on supporting energy efficiency programmes and renewable energy systems in the Caucasus, Central Asia and African countries. Liechtenstein strives to allocate these official funds in a balanced manner by supporting climate projects, which are reflecting recipient needs as regards sustainable development and which are politically supported by respective authorities.

The Office of Environment is also represented in the Life climate fund as well as the Swiss climate fund, which are both supporting innovative projects in the areas of adaption and mitigating climate change, mainly at national level but with selected projects of international outreach.

Liechtenstein will also join further discussions on the Loss & Damage Fund, which was widely discussed the COP27 in Sharm El Sheik. While it is unclear yet, if it comes with mandatory obligations for Annex 1 countries, Liechtenstein may anyway consider contributing to the Loss & Damage Fund in the future.

Liechtenstein is also a strong supporter of broadening the donor base in climate finance.
With regard to the implementation of efficient and effective development policies, both partnerships and networks are indispensable: partnerships, which for their mutual benefit are embracing governments, institutions and civil society. Such Public Private Partnerships (PPP) with their potential for mobilizing private funds and knowledge in order to carry out governmental obligations and at the same time making best use of each partners strengths must much more determine successful environment and development policies in future as they do today.

For further information please refer to chapter 7 of Liechtenstein's Eighth National Communication.