Second, Third, Fourth and Fifth National Communication of Luxembourg

Under the United Nations Framework Convention on Climate Change

February 2010

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère du Développement durable
et des Infrastructures

Département de l'environnement

Second, Third, Fourth and Fifth National Communication of Luxembourg under the United Nations Framework Convention on Climate Change

Published by:

**Ministry of Sustainable Development and Infrastructures –
Department of the Environment**

Photographs and layout by:

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This Communication is presenting the situation in Luxembourg on the 1st January 2010.

Important comment – 1

The present National Communication acts as a consolidated National Communication covering the second, third, fourth and fifth National Communications of Luxembourg: NC2 was due 15 April 1997; NC3, 30 November 2001 & NC4, 1st January 2006. The report contains several historical developments that the reader can easily connect to the appropriate NC.

This fifth National Communication also acts as the Report on Demonstrable Progress that was due on the 1st January 2006, jointly with the fourth Communication. Of course, in this report, and in order to offer relevant and up-to-date information, demonstrable progress related items are dated 1st January 2010 and not 1st January 2006.

Important comment – 2

Following national general elections in June 2009, Luxembourg has a new Government. This led to some reorganization amongst ministries. As a consequence, since the 23rd July 2009, the Ministry of the Environment has been integrated as a Department into a new overarching Ministry of Sustainable Development and Infrastructures. This Department has, overall, the same attributions the Ministry of the Environment had before the reorganization. Hence, the appellation Department of the Environment that comes throughout this report sometimes as such and sometimes combined with the Ministry of the Environment. For this Communication, both terminologies are interchangeable and the acronym used is MDDI-DEV.

The new Ministry of Sustainable Development and Infrastructures assembles former Ministry of the Environment, Ministry of Transport, Ministry of Public Works and the Administration in charge of Land Planning. There are two Ministers: the Minister of Sustainable Development and Infrastructures and the Deputy-Minister of Sustainable Development and Infrastructures. The latter is also Minister of Housing.

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Chapter I

Executive Summary

It is now assumed that a large part of the observed global warming of the planet is attributable to human activities and that this warming will undoubtedly be one of the greatest threats for mankind during the course of the current century. Climate change has already, and will have, deep implications on the environment, the economy and the society as a whole (social cohesion, migrations, development policies).

I.1. CLIMATE CHANGE IN LUXEMBOURG

Annual mean temperatures for Luxembourg-City are now usually above the 30 years averages of the last century. Indeed, the 1951-1980, the 1961-1990 or the 1971-2000 mean yearly temperatures for the capital city – around 9°C – are nowadays regularly exceeded: since the turn of the 21st century, annual mean temperatures are comprised between 9.3°C (2001) and 11.3°C (2007). Yearly averages increase is mainly driven by higher air temperatures during winter seasons. Other meteorological stations disseminated throughout the country show similar results. With regard to other meteorological parameters – rainfalls, sunshine hours, relative humidity – no clear trends can be identified yet, probably because the very small size of the country (2 586 km²) limits the identification of such changes.

Climate change effects are also witnessed by increasing frost-free periods, earlier blooming seasons and higher flood frequencies over the last 20 years. For the future, higher average yearly temperatures are anticipated with consequences on public health (heat waves), floods (higher frequency and intensity), vegetation cycles (longer periods with frost risks after early blooming) and forests (degradation of its phytosanitary state).

I.2. GREENHOUSE GAS EMISSIONS: STATE, KEY DRIVERS AND PRESSURES

Luxembourg is a Party to the Kyoto Protocol. The related European Union Burden-Sharing Agreement limits Luxembourg's greenhouse gas (GHG) emissions for the Kyoto period 2008-2012 to an average of 28% below their 1990 level.

In 2007,[1] carbon dioxide (CO_2) was the main source of GHG in Luxembourg. This source counted for 91.7% of the total GHG emissions calculated in CO_2e (excl. LULUCF).[2] The second source of GHG was nitrous oxide (N_2O) with slightly more than 4% of the total emissions. Methane (CH_4) was the third source with 3.5%. Fluorinated gases only accounted for 0.7% of the total emissions.

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1 The latest official GHG inventory according to Decision 280/2004/EC as well as according to the UNFCCC requirements covers the period 1990-2007. First estimates for the year 2008 have however already been produced and, where relevant, results from this exercise are provided in the text.

2 CO_2e stands for CO_2 equivalents, i.e. other GHG gases are converted into CO_2 according to their 100-year global warming potential (GWP).
LULUCF stands for "Land Use, Land Use Change & Forestry". This covers carbon sinks (or sources) due to land cover and changes induced to it, whether through human activities (deforestation, reforestation, renaturation, conversion to agricultural land or settlements) or due to natural causes (fires, storms). In the rest of the executive summary, unless indicated, GHG total emissions are excluding emissions from LULUCF activities.

The very high share of carbon dioxide is the result of a GHG emissions structure that is vastly dominated by energy related releases in the atmosphere: in 2007, 88% of the total GHG emissions were generated by energy production, combustion or distribution. Industrial processes related emissions only represented 6% of that total and agriculture (rearing, farming, soils) only 5.5%. The other sources of GHG emissions (solvents, waste, waste water) were negligible.

One element explaining the predominance of CO_2 and of energy sources in the total GHG emissions is the very high share of road transportation related emissions: in 2007, this source category was responsible of almost 52% of the total emissions originating from Luxembourg. With its location at the heart of the main traffic axes for Western Europe, Luxembourg is a focal point for international road traffic and has, therefore, had traditionally a high volume of road transit traffic for both goods (freight transport) and passengers (tourists on their way to or back from southern Europe). The latter has increased even further by the high number of commuter journeys observed every working day: 146 000 persons, i.e. about 30% of the residential population, that mostly (around 90%) commute by car. In comparison with international traffic, domestic traffic plays only a relatively small role since it is responsible for only one quarter of the total road fuels sold in Luxembourg. Consequently, in 2007, "road fuel exports" (transit traffic, commuters and "fuel tourism") represented about 38% of the total GHG emissions.[3]

With 19.5% of the total emissions in 2007, industries (energy combustion and industrial processes) were the second main emitting sources of GHG, whereas energy combustion in buildings (houses, offices and commercial activities) represented 11% of that total. The fourth main source of emissions was public electricity and heat production with some 10% of the total. For this latter source category, the share was only 1.5% in 2001. In fact, the development of combined heat-power installations, but mainly the setting up, in 2002, of a gas and steam power station with an electrical output of 350 MWel, increased in a few years almost tenfold the weight of that source category in total GHG emitted. This is a perfect example on how, due to the small size of Luxembourg and of its economy, one individual project can have important effects on some key environmental parameters.

I.3. GREENHOUSE GAS EMISSIONS: PAST TRENDS AND PROJECTIONS

Total GHG emissions amounted to 12.914 Mio. tonnes of CO_2-equivalents (t CO_2e) in 2007, i.e. 1.56% below their 1990 level and 1.93% below the Kyoto commitment period base year value of 13.167 Mio. t CO_2e. Several phases can clearly be distinguished over the period 1990 to 2007:

[3] The highest percentage ever recorded was 41.5% in 2005. According to IPCC rules for GHG inventories, "road fuel exports" are to be considered in Luxembourg's GHG balance since these rules are based on the "origin" principle.

- firstly, from base year up to 1993, Luxembourg's emissions remained rather stable;
- then, between 1994 and 1998, they started to decrease significantly to reach their lowest value in 1998: 9 Mio. t CO2e;
- from 1999 up to 2004, emissions increased recurrently;
- from 2004 to 2006, a stabilisation around 13.3 Mio. t CO2e is observed;
- from 2006 to 2007, emissions experienced a decrease (-2.94%). This decline is confirmed by the first 2008 estimates that reports a further reduction of 4% compared to 2007, i.e. 5.5% below the base year level retained for the Kyoto commitment.

The evolution during those 18 years can essentially be explained by changes in production techniques, as well as by changes in the final "energy-mix" consumption: less solid fuels, more natural gas and ever increasing liquid fuels in line with increasing transport flows. Of course, increasing or decreasing activities for certain source categories also played a crucial role in Luxembourg's GHG emissions trend. As an example, the move from blast furnaces to electric arc furnaces in the steel industry between 1994 and 1998 explains the significant decrease observed for GHG emissions over that period.

Estimating GHG emissions for the coming year is a difficult exercise for Luxembourg. On the one side, the size of the country implies that emissions would be affected by a single plant which might start new activities, close them down or change its production processes. On the other side, the important weight of "road fuel exports" in the total emissions exerts a high uncertainty on the estimates. This weight is depending on many factors such as price differentials, pay tolls for motorways, economic cycles, development of alternatives to road freight, and so on; i.e. a set of parameters on which Luxembourg alone cannot act. Nevertheless, Luxembourg will have to take more actions to comply with the "Climate & Energy package" objective that it has been assigned by the European Commission (EC) at the 2020 horizon, i.e. a 20% reduction in the non EU-ETS sectors compared to 2005.

The challenge of bridging the gap

The actual level of GHG emissions, as well as the projected trends, would require important efforts for Luxembourg in order to respect both the Kyoto commitment and the "Climate & Energy package" objectives defined by the EC. But Luxembourg is facing a critical challenge in this respect since, at national level; it has only limited emissions reduction potentials. Indeed, with the move from blast to electric arc furnaces in the steel sector during the 1990s, Luxembourg very soon exhausted its only major technical potential for GHG emissions reduction. Other industrial activities present relatively small mitigation potentials and those installations which are emitting the most are part of the actual EU-ETS scheme and will more likely be part of the post-Kyoto EU-ETS scheme.

Looking at energy production, the picture is similar with no mitigation potentials, on the contrary. In fact, up to the end of the last century, Luxembourg did not have any significant fossil-fuel plants and most of its electricity needs were satisfied by imports.[4] Consequently, any investments in power plants – whether they are using fossil fuels or renewable energy sources – is not replacing electricity production from inefficient existing fossil-fuel plants. In other terms, investing in its own electricity production capacities does not offer any mitigation potentials for Luxembourg.

Thus, any energy-efficient fossil fuel-based electricity generating plant that Luxembourg might decide to construct will automatically lead to an increase of its national GHG emissions. This is clearly illustrated by growing emissions in the public electricity and heat production these last years after the starting up of highly efficient combined heat-power (CHP) installations and of the ultramodern gas and steam power station mentioned above: they have led to an additional amount of approx. 1.2 Mio. t CO_2e in Luxembourg's GHG balance, i.e. around 9 to 10% of the total emissions. This also implies that the implementation of the EU CHP installation guidelines, which in other countries may lead to CO_2 reductions thanks to increased efficiency, is counterproductive for Luxembourg. For this reason, the new Government, which started its activities during the summer of 2009, recalls in its Programme that it will primarily promote production units based on renewable energy sources, with a special focus on biomass, wood and solar energy. This will be achieved by adopting new instruments and reinforcing existing ones, such as special tariffs for electricity produced from renewable sources that are in place since 1994. However, no GHG reductions could be expected from these measures, since encouraging electricity generation from renewable energy sources, which is associated with major investments, will not substitute electricity generation from highly efficient national production plants, which have just been constructed. Such a support will mainly result in replacing imported electricity, which does not appear in Luxembourg's GHG balance according to IPCC rules for GHG inventories.

Consequently, considering the main emissions source categories, room for manoeuvres left for deploying mitigation policies are lying in the fields of road transportation and buildings. These are two sectors identified as those to focus on in the 2006 national "Action Plan for reducing CO_2 emissions" [Ministry of the Environment (2006b)]. Luxembourg has therefore implemented various policies and measures in these two domains.

[4] For which, according to IPCC rules, related emissions were counted in GHG balances of exporting countries, not in the one of Luxembourg.

I.3.1. Road transportation

- vehicle tax reform: since the 1st January 2007, the annual tax is based on CO_2 emissions;[5]
- promotion of CO_2-efficient vehicles: since the 1st January 2008 and up to mid or end 2010 according to the emissions in g CO_2/km, subsidies for the purchase of low emission vehicles or of vehicles running on natural gas, moved by fuel cells or "hybrid". This subsidy has been complemented by a so-called "*prime à la casse*" for new vehicles registered for the first time in 2009 that replace vehicles older than 10 years. All these financial supports will be regularly evaluated to adapt or amend them in due time;
- "Kyoto-cent": climate cents are levied on both gasoline and diesel sold since the 1st January 2007 (2 ct€/litre for gasoline, 2.25 ct€/litre for diesel);
- promoting the use of biofuels of the second generation according to EU legal texts;
- promoting public transports: Luxembourg has an ambitious modal-split target at the 2020 horizon: 25% of home-work journeys by public transport against 75% by private vehicles. Instruments for reaching this goal, amongst other objectives in the transport sector, consist of two Action Plans: one dealing with transport as a whole and another one focusing on non-motorized mobility.[6]

I.3.2. Buildings (residential, commercial, institutional)

Numerous policies, measures and incentives have been promulgated to increase energy-efficiency in buildings as well as for promoting the use of renewable energy sources. These measures concern old buildings (renovation) as well as new constructions that have to comply with more and more stringent energy constraints. Since 2001, e.g., the Government granted some 105 Mio. € to households that did invest in low-energy houses or in the production and use of renewable energy sources (photovoltaic cells, thermal solar energy, etc.).

I.4. BRIDGING THE GAP – TARGET ASSESSMENT 2008-2012

As a conclusion, due to limited mitigation potentials and to considerations linked to the size and the location of the country, as well as to the anticipated economic and demographic growths that might offset part of the energy-efficiency gains, there is a risk that national policies and measures might not be sufficient to bridge the gap between allocated emissions under the Kyoto Protocol and the estimated emissions for the Kyoto period. In fact, recent calculations anticipate that, including the expected effects of implemented and additional policies and measures, GHG emissions should reach an annual average of 13.19 Mio. t CO_2e over the Kyoto commitment period

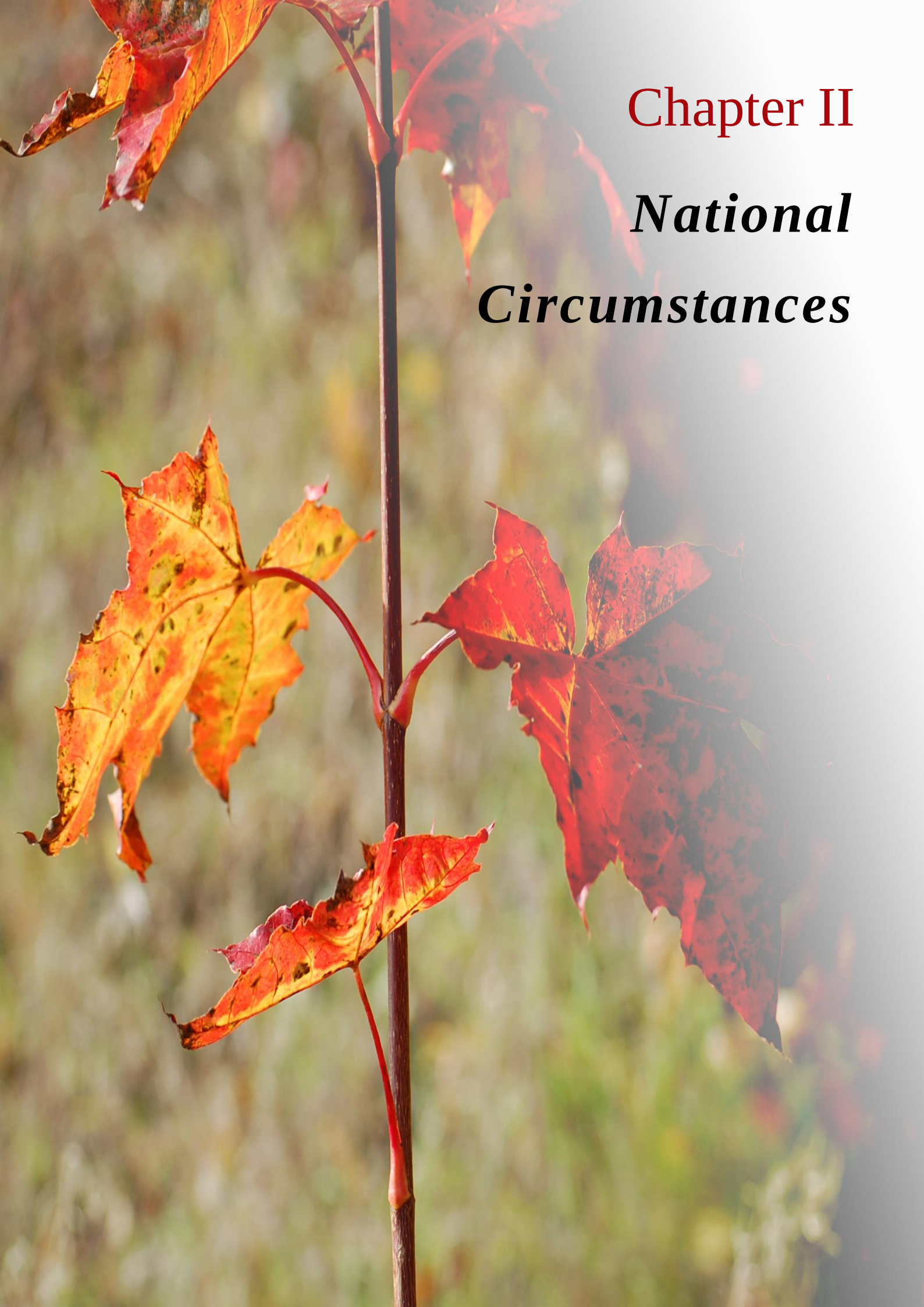
5 Other emissions are also considered: for instance, diesel vehicles – which emit less CO_2 than gasoline vehicles – must have a particle filter to benefit from a low tax.

6 *Mobilité Douce* in French.

2008-2012, i.e. some 3.7 Mio. t CO_2e per year above the annual amount Luxembourg is supposed to emit to respect its -28% Kyoto reduction target. As a consequence, and since no reductions from carbon sinks are expected, Luxembourg anticipates a use of project-based mechanisms and international emissions trading of about 19 Mio. t CO_2e over the commitment period. The "Clean Development Mechanism" (CDM) is expected to provide about half of the emission reductions, "Joint Implementation" (JI) and "International Emissions Trading" (IET) the remaining half.

I.5. FINANCING THE USE OF KYOTO FLEXIBLE MECHANISMS: THE "KYOTO FUND"

In order to finance the purchase of tonnes of CO_2 in the framework of project-based mechanisms and international emissions trading, a fund was created by a Law of 23rd December 2004: the "Kyoto Fund". Sources of revenue of the "Kyoto Fund" are annual budgetary grants, 40% of the CO_2-based vehicle tax and 100% of the "Kyoto-cent". Budgetary grants represents around 10% of the means of the "Kyoto Fund", the fraction of the vehicle tax around 30% and the "Kyoto-cent" some 60%.



Chapter II

National Circumstances

In line with paragraph 8 of the UNFCCC reporting guidelines, Chapter II provides a description of national circumstances and how they affect GHG emissions and removals, as well as how these circumstances and changes therein affected GHG emissions and removals over time.

Socio-economic developments and physical characteristics (geography and climate) are presented in the various sections of this chapter. They are complemented by a discussion of how both the UNFCCC and the Kyoto Protocol are challenging Luxembourg's action with regard to climate change *[→ Section II.12]*. The chapter concludes with an overview of the main developments of and drivers to GHG emissions in Luxembourg since 1990 *[→ Section II.13]*.

II.1. THE GRAND-DUCHY OF LUXEMBOURG[7]

The Grand Duchy of Luxembourg has been an independent sovereign state since the Treaty of London was signed on 19 April 1839. The country is a **parliamentary democracy** in the form of a **constitutional monarchy** and is the second smallest Member State of the EU-27, after Malta. For many years, it has been characterized by **high economic and demographic growth rates**. The country is **located in the heart of North-Western Europe** and has direct borders with Belgium, Germany and France *[→ Illustrations II.1-1 & 2]*. It is therefore a crossroad for international trade and related transport flows, the most dynamic source of its GHG emissions.

The organisation of the Grand Duchy starts from the principle that the responsibilities of the different powers should be given to diverse apparatus of the state. As in every parliamentary democracy, the separation of powers is flexible in Luxembourg: many links exist between the legislative and executive branches, and solely the judicial power remains completely independent.

Legislative power resides in the joint action of the Parliament (*Chambre des Députés*), the Government and the Council of State *(Conseil d'Etat*); each entity serving a wholly separate function.

Parliament is made up of 60 members of Parliament (hereafter, MPs) elected for a five-year term combining a one-person-one-vote suffrage and a system of proportional representation. Its primary function is to vote on bills submitted by the Government and to control the executive branch. The MPs also possess a right of parliamentary initiative which is exercised by bringing in bills *(propositions de Loi*).

The Government has a right of initiative in legislative matters known as governmental initiative, which allows it to bring in bills (*projets de Loi*). After being examined by the Council of State, bills are put to the vote before Parliament, where the government normally holds a majority. After the parliamentary vote, the Grand Duke promulgates the legislative text, i.e. he commands its

[7] Part of this section is based on texts from: the "political portal" (http://www.luxembourg.public.lu/fr/politique/index.html), as well as on the following documents: Information and Press Service of the Luxembourg Government (2006) and (2007).

publication in the compendium of legislation known as the *Mémorial*, whereupon the text acquires legal status.

The Council of State is composed of 21 councillors. State councillors are formally appointed and dismissed by the Grand Duke on proposal by the Government, Parliament or the Council of State. In Luxembourg's unicameral system, the Council of State exerts the moderating influence of a second legislative assembly. It is required to voice its opinion on all items of legislation; that is to say on all bills brought in before the Parliament prior to voting by the MPs. Its opinion must entail a thorough examination to ensure compliance of the draft texts with the Constitution, international conventions and the rule of law. The role of the Council of State is one of persuasion rather than enforcement and is therefore advisory in nature.

Executive power is the prerogative of the Grand Duke, together with the Government and its members, i.e. the Ministers and, eventually, Secretaries of State. In practice the Grand Duke chooses the Prime Minister on the basis of election results, which takes place every five years jointly with the election of the members of the European Parliament (the "European Elections"). Then, the Prime Minister himself proposes the members of the Government. The Government appointed by the Grand Duke presents its political programme to the Parliament which takes a vote of confidence, thereby giving the newly appointed Government a parliamentary majority on which it can rely. The actual Government, stemming from the general elections of the 7th of June 2009, has been appointed on the 23rd of July 2009 and should remain in place up to the next general elections, in June 2014. It is made up of the Prime Minister, one Vice Prime Minister and 13 members having the title of Ministers. It is worth noting that the number of ministerial departments generally exceeds the number of members of the Government called upon to serve in office; thus a single minister normally holds more than one portfolio.[8]

As a conclusion, a parliamentary democracy in the form of a constitutional monarchy suits perfectly well to a country such as Luxembourg where social consensus and dialogue are key words. Consensus and dialogue have been, and will continue to be, of particular relevance for the definition of climate change related policies and action plans, as well as for the designing of related legislative texts. Luxembourg's first Action Plan for mitigating CO_2 emissions [Ministry of the Environment (2006b)] and its revision planned for 2010 *[→ Section IV.1]* are good examples of bringing these two key words into play.

8 For more information on the Government in place in Luxembourg since July 2009, refer to http://www.gouvernement.lu/gouvernement/index.html. Its political program can be downloaded here: http://www.gouvernement.lu/gouvernement/programme-2009/programme-2009/programme-gouvernemental-2009.pdf. Climate change related actions are presented on pages 39 to 43.

Box II.1-1 – Legislative procedure in Luxembourg

Two types of legislative initiative are distinguishable:

> *Projet de Loi*: this preliminary draft of a law is drawn up by the relevant Ministry, approved by the Cabinet and then submitted to the Council of State for its opinion. It is then submitted to the Parliament.
>
> *Proposition de Loi*: one or more MPs may bring in a bill, which is submitted to the Conference of Presidents of the Parliament, which decides on its referral to a committee. The text of the proposal is submitted to the Council of State for its opinion and sent to the Government for its position.

Once the Council of State has given its opinion, the bill is sent to the relevant parliamentary committee which examines it and reports to the Parliament.

The debate in plenary session of the Parliament is conducted in two stages: a general discussion and a discussion article by article. Any deputy may propose amendments.

In Luxembourg's unicameral system, once the Parliament has voted on the draft, it must vote a second time on the whole text after a period of at least three months. It can however dispense with this vote if the Council of State accepts the waiver. If the latter does not give its consent, the Parliament must hold a second vote after a minimum period of three months.

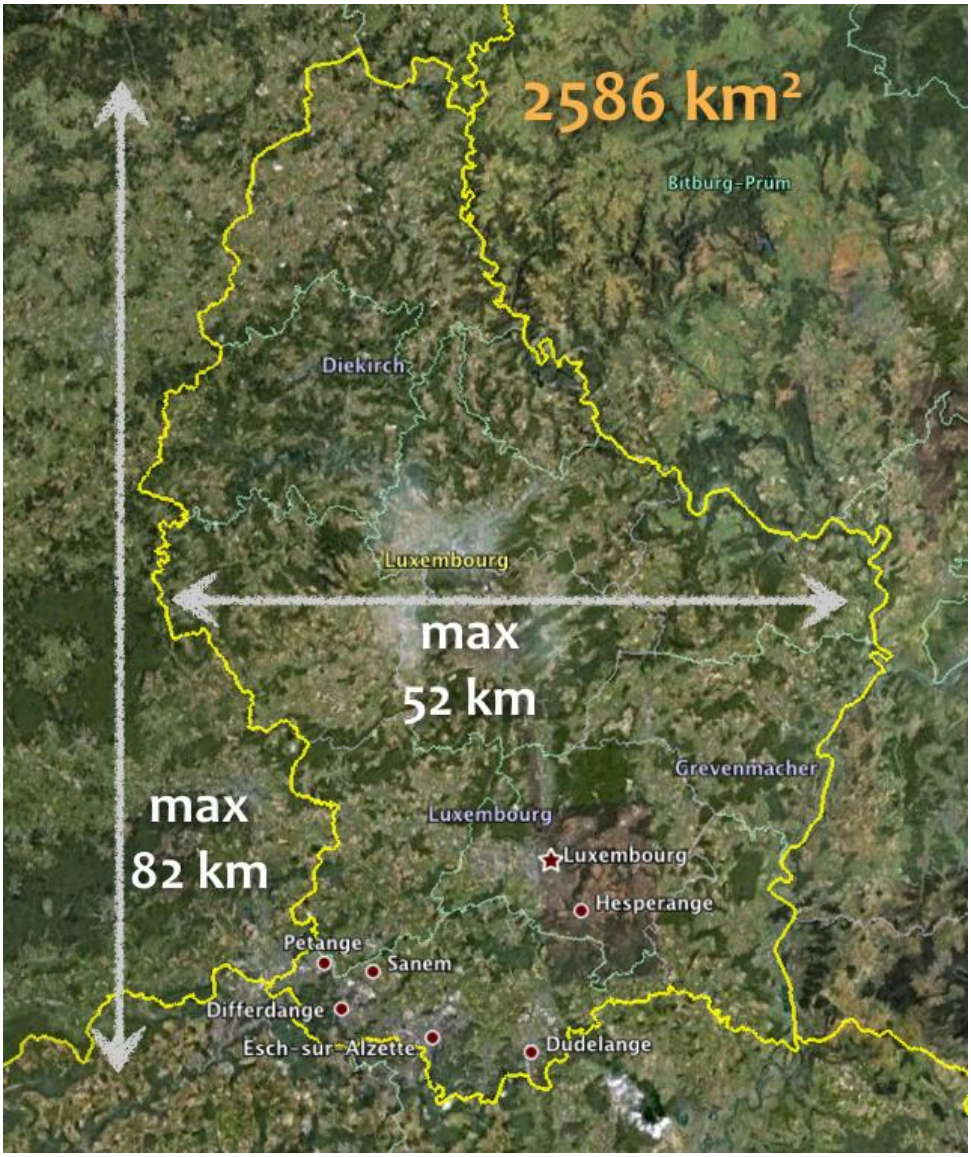
The law finally adopted by the Parliament enters into force only after it has been promulgated by the Grand Duke, i.e. published in the *Mémorial* (compendium of legislation).

TABLES, FIGURES & ILLUSTRATIONS

ILLUSTRATION II.1-1 – GEOGRAPHIC LOCATION OF LUXEMBOURG

Source: Google Earth.

ILLUSTRATION II.1-2 – LUXEMBOURG SIZE



Source: Google Earth.

II.2. POPULATION AND WORKFORCE

II.2.1. A strong population growth driven by immigration

End 2008, the population of Luxembourg amounted to 493 500 inhabitants. Within 48 years, the residential population has grown by some 179 000 inhabitants or about 57% – slightly more than 28% since 1990 *[→ Table II.2-1]*.

The average annual growth rate of the resident population of Luxembourg is high compared to the rates of its neighbouring regions: between 1990 and 2008, the average annual growth rate for

Luxembourg (1.4%) was more than 3.5 times higher than its equivalent for the *Grande Région*.[9] It even reached 1.5% p. a. since 2000 *[→ Figure II.2-1b]*.

Demographic growth in Luxembourg is actually dominated by immigration. Nationals themselves saw their number stagnating, and without immigrants taking the citizenship of Luxembourg they would even have fallen. End 2008, almost 44% of the residential population did not have the citizenship of Luxembourg. This percentage was only 30% in 1990 *[→ Figure II.2-1a]*. The main driver behind these demographic trends is the economic restructuring and development of the country towards the tertiary sector coupled with attractive wages *[→ Section II.5]*.

Population projections are based on scenarios derived from past statistical data. It therefore comes as no surprise that population forecasts a continuation of the demographic trend in Luxembourg. Projections calculated in the framework of the European Commission (EC) Ageing Working Group predict that 700 000 inhabitants could be living in Luxembourg by 2050 *[→ Figure II.2-1b]*. As it is the case for any forecasts, these predictions should be treated with caution because they cannot predict radical changes in the economic structure or demographics of a country, especially a small one whose economy relies heavily on a few economic sectors *[→ Section II.5]*. However, since population growth is one of the key drivers for domestic energy use, mainly in the housing and transportation sector, these forecasts illustrate the scale of one of the many challenges Luxembourg is facing in the definition of measures aiming at reducing its GHG emissions.

Box II.2-1 – The *Grande Région*

The *Grande Région* is the geographic unit that includes Luxembourg, the Region of Wallonia in Belgium, Lorraine in France and two German *Länder*: Saarland and Rheinland-Pfalz.

Today, this structure is more a cooperative space than an effective integrated region defining and modelling its own policies and development. This is the result of the diversity of the territories constituting the *Grande Région*, of its dimension and of the barriers created by institutional and administrative structures in each country. De facto, being a sovereign state amongst country regions, Luxembourg has a special status in this cooperative space: it is the main driving force behind the *Grande Région*, a position re-enforced by its demographic and economic development as shown by the figures in the table below.

Grande Région entity	population change *% 1990-2007*	population annual average growth rate *% 1990-2007*	GDP average growth rate *% 2000-2006*	paid workers in 2008 *1990=100*
BE-Wallonia	5.90%	0.34%	1.90%	115
DE-Rheinland-Pfalz	9.50%	0.58%	0.90%	114
DE-Saarland	-2.00%	-0.06%	1.70%	108
FR-Lorraine	1.70%	0.08%	1.60%	108
Luxembourg	**25.70%**	**1.32%**	**4.70%**	**193**

Wallonia: paid workers in 2006.

More information on the Grande Région can be found in STATEC (2009d), Section 1.1.3 and on line:
http://www.granderegion.net/fr/index.html
http://www.grande-region.lu/eportal/pages/HomeTemplate.aspx

9 Refer to Box II.2-1 for a presentation of the *Grande Région*.

II.2.2. Workforce: the importance of cross-border commuters

The economic restructuring and development of Luxembourg led to a doubling of the paid workers in almost 20 years (1990-2008). The resident population of Luxembourg nationality was unable to meet this increasing demand for labour. The number of Luxembourg nationals employed increased from some 85 700 units in 1990 to 94 100 in 2008, representing an average annual growth of only 0.5%. How, therefore, could this urgent economic need be satisfied? The initial response was to resort to immigration. The number of foreign employees living and working in Luxembourg rose from 51 000 in 1990 to about 92 100 in 2008 – an average annual growth rate of 3.3%. But, this was not enough. So the cross-border commuters came into play. Between 1990 and 2008, the number of cross-border workers increased from 33 700 to 146 000, at an average annual growth rate of 8.5% *[→ Table II.2-2]*.[10]

End 2008, among the paid workers, 49.2% of the commuters came from France, 25.8% from Belgium and 25% from Germany. In total, the commuters accounted for 43.8% of all paid workers in Luxembourg and for 29.5% (i.e. more than a quarter) of the residential population: *[→ Figure II.2-2]*.[11] The commuting flows amongst the various regions of the *Grande Région* clearly show the economic attraction of Luxembourg *[→ Illustration II.2-1]*.

A vast majority of workers from abroad commute by car.[12] However, in order to alter the current modal split of home-work journeys, Luxembourg invests predominantly and jointly with the neighbouring regions into the public transport offer *[→ Section IV.1-4]*.

Paid employment, as well as cross-border commuters, both peaked in October 2008 (339 000 and 150 000 units respectively). Since then, paid workers saw their number decreased by 0.7% and the commuters by 1.5% (up to June 2009). These evolutions are a turnaround initiated by the financial and economic crisis that started during the second semester of 2008. Industrial activity in Luxembourg was particularly hit by the crisis: -21% for the nine first months of 2009 compared to the same period for 2008 – and even -35.5% in the steel industry, the main industrial sector if the country.[13] This will undoubtedly have impacts on the total GHG emissions from Luxembourg for the year 2009 – though industry represented, in 2007, only 19.5% of the total: more on this in *Section III.1*. In the banking sector – the most important in the economy of Luxembourg *[→ Section II.5]* – employment was reduced by 2.8% in a year. Nevertheless, when reading the

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10 Figures indicated in this paragraph are annual cumulative averages.

11 Calculated from STATEC, *Indicateurs rapides*, Serie L: http://www.statistiques.public.lu/stat/tableviewer/document.aspx?ReportId=352.

12 In 2007 , 89% of the cross-border commuters were only using their car for their home-work journeys according to a recent study: http://www.ceps.lu/pdf/6/art1415.pdf?CFID=1253513&CFTOKEN=38691590&jsessionid=20303f926e506f584f4d.

13 STATEC, *Statnews* n°49/2009: http://www.statistiques.public.lu/fr/communiques/entreprises/industrie/2009/12/20091215/20091215.pdf.

pessimistic figures above, the fall in employment has been rather contained so far, notably through extended possibilities offered by the authorities to businesses to turn to partial unemployment.[14]

For more discussions on the role of cross-border commuters in Luxembourg's economy, refer to STATEC (2009d), pages 35-41.

II.2.3. Effects on GHG emissions: rising emissions due to road transport flows

Both demographic and employment strong increases in Luxembourg should have impacts on GHG emissions. The 3 CRF sub-categories that are the most likely influenced by the demographic and workforce developments are the residential sector (CRF 1A4b), the commercial & institutional sector (CRF 1A4a) and road transportation (CRF 1A3b). For the latter, a distinction has been made between emissions due to residents and those generated by non-residents – whether they are in transit or commuting for work or leisure – i.e. "road fuel exports" *[→ Figure II.2-3]*.[15]

Emissions from residential, commercial and institutional sectors did not vary significantly, what seems quite remarkable as both economic activity in the tertiary sector and population have gone up during the whole period, hence offices building and housing constructed surfaces too. Overall emissions in these two sectors – 1A4a and 1A4b – have ranged between a minimum of 1.4 Mio. t CO_2e in both 1990 and 2007, and a maximum of 1.7 Mio. t CO_2e in 2001 *[→ Figure II.2-3]*.[16] Gains in energy efficiency as well as the expansion in the use of natural gas as heating fuel in Luxembourg *[→ Section II.6]* are the main drivers behind this relatively flat evolution.

Concerning road transportation, both emissions generated by the national vehicles fleet – i.e. by vehicles owned by people living or business settled in Luxembourg – and by the non-residents – "road fuel exports" – showed dramatic increases over the period: +82% and +165% respectively *[→ Figure II.2-3]*. For the national fleet, the evolution is correlated with both the population and economic activity growth. It is also explained by an increasing rate for passenger cars per inhabitants (from 515 to 675 passenger cars per 1000 inhabitants between 1991 and 2007, i.e. the highest rate within the EU[17]). Regarding "road fuel exports", the rise is undoubtedly linked to the growing number of commuters crossing the borders every working day as well as to the general increase of road freight traffic in Europe – amongst which an important share transit through

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14 STATEC, *Conjoncture Flash*, November 2009: http://www.statistiques.public.lu/fr/publications/series/conjonctureFlash/2009/11_09_conjflash/11_09_conjflash.pdf and Section II.5.3 below.

15 The notion and the importance of "road fuel exports" in GHG emissions are discussed in Section II.8 below.

16 The two CRF 1A4 sub-categories (residential and commercial & institutional) represented 10.4% of the total GHG emissions, excluding LULUCF, in 1990 and 10.5% in 2007 (for 2008, provisional calculations give a share of 11.3% explained by a drop in energy combustion related emissions except for CRF 1A4a & b that increased following a harsh winter).
The two CRF 1A4 sub-categories also have a very similar level because national energy statistics does not allow for distinguishing these two sub-categories. So far a 50-50 distribution is carried out in the inventories [Ministry of the Environment (2009d), p. 155].

17 Data extracted from EUROSTAT databases (updated 18-06-2009) and from EUROSTAT, *Energy, transport and environment indicators*, 2009 edition, p.92-93.

Luxembourg because of its location and grasps the opportunity to fill up due to lower road fuel prices in Luxembourg compared to its neighbouring countries.[18]

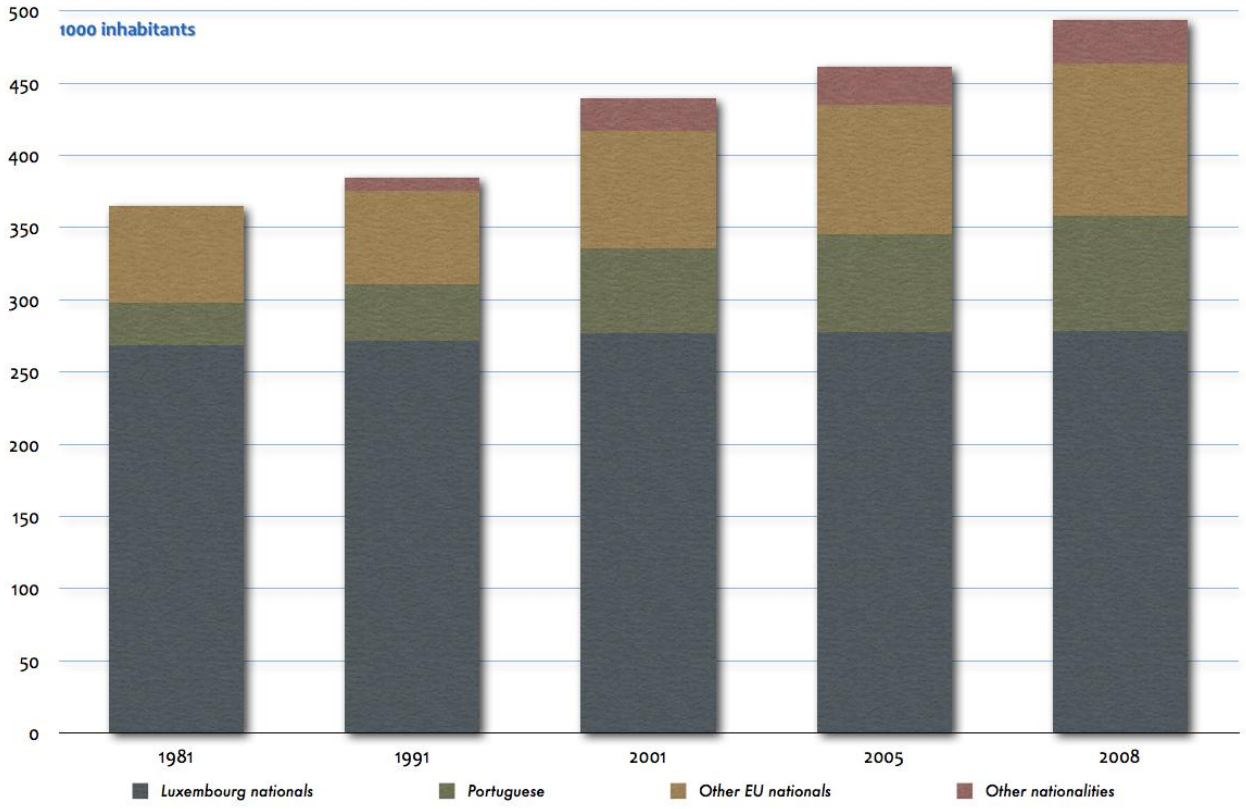
TABLES, FIGURES & ILLUSTRATIONS

TABLE II.2-1 – POPULATION: 1960-2008

calculated on 31st December	1960	1990	2000	2002	2003	2004	2005	2006	2007	2008
Resident population (x 1000)	314.9	384.4	439.0	448.3	455.0	461.2	469.1	476.2	483.8	493.5

Source: STATEC, *Statistical Yearbook*, Table B.1100:
http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=467&IF_Language=fra&MainTheme=2&FldrName=1

FIGURE II.2-1a – POPULATION STRUCTURE ON 31ST DECEMBER: 1981-2008

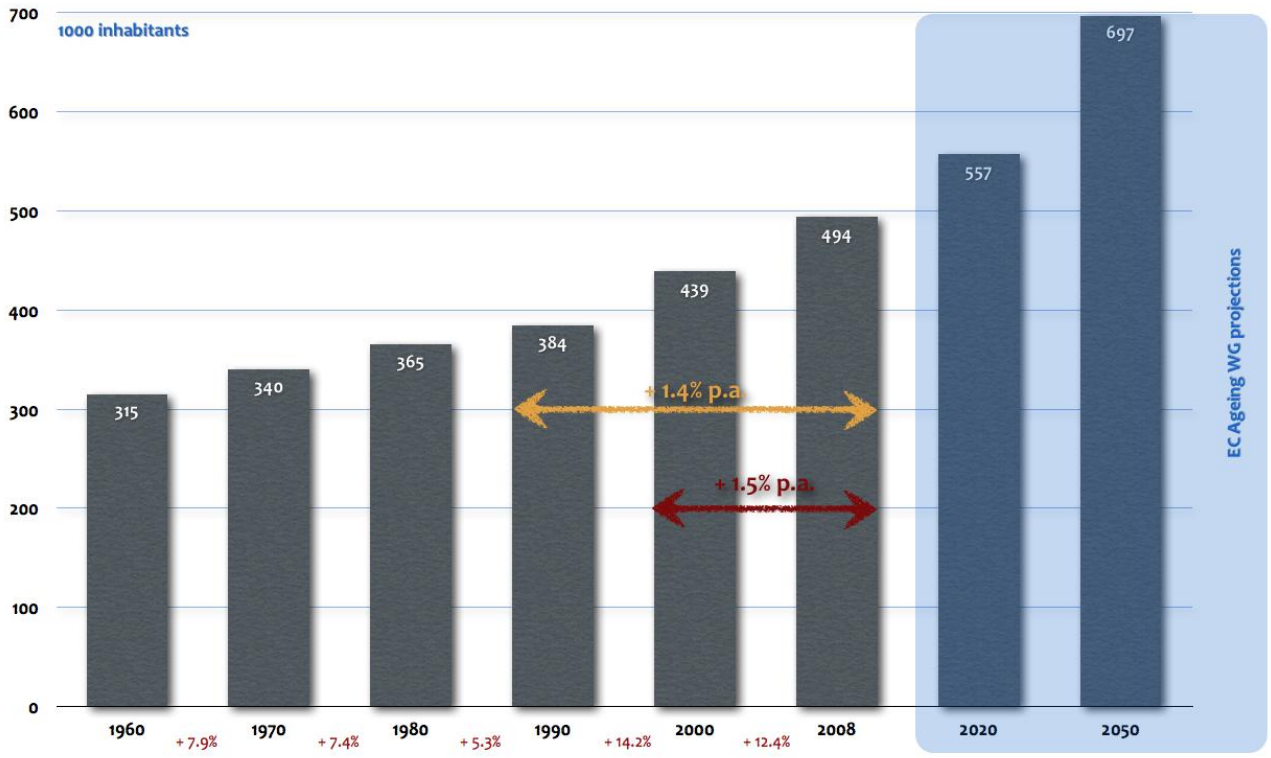


Source: STATEC, *Statistical Yearbook*, Table B.1000:
http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=463&IF_Language=fra&MainTheme=2&FldrName=1

Note: 1981, 1991 and 2001 data are coming from population censuses held every decade, other years are calculated by STATEC.

18 It is important to stress that price differentials for diesel have reduced these last years, especially with Belgium where a "professional" price has been implemented for diesel with low sulphur content since 2004 – via refunding of excises surpluses (cf http://www.uptr.be/common/pages.php?s_id=11_50 for instance) paid by EU licensed taxis, busses & coaches and road freight trucks over 7.5 tonnes. A similar arrangement exists in France too for road freight trucks over 7.5 tonnes (http://www.douane.gouv.fr/page.asp?id=171#0). Now, these last years, ¾ of the diesel sold in Luxembourg was bought by non-residents, against two-thirds for gasoline. The introduction of these measures could be one of the reasons behind the drop in "road fuel exports" observed since 2005.

FIGURE II.2-1b – POPULATION GROWTH ON 31ST DECEMBER: 1960-2050



Source: STATEC, *Statistical Yearbook*, Table B.1100: http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=467&IF_Language=fra&MainTheme=2&FldrName=1 and projections prepared for the EC Ageing Working Group.

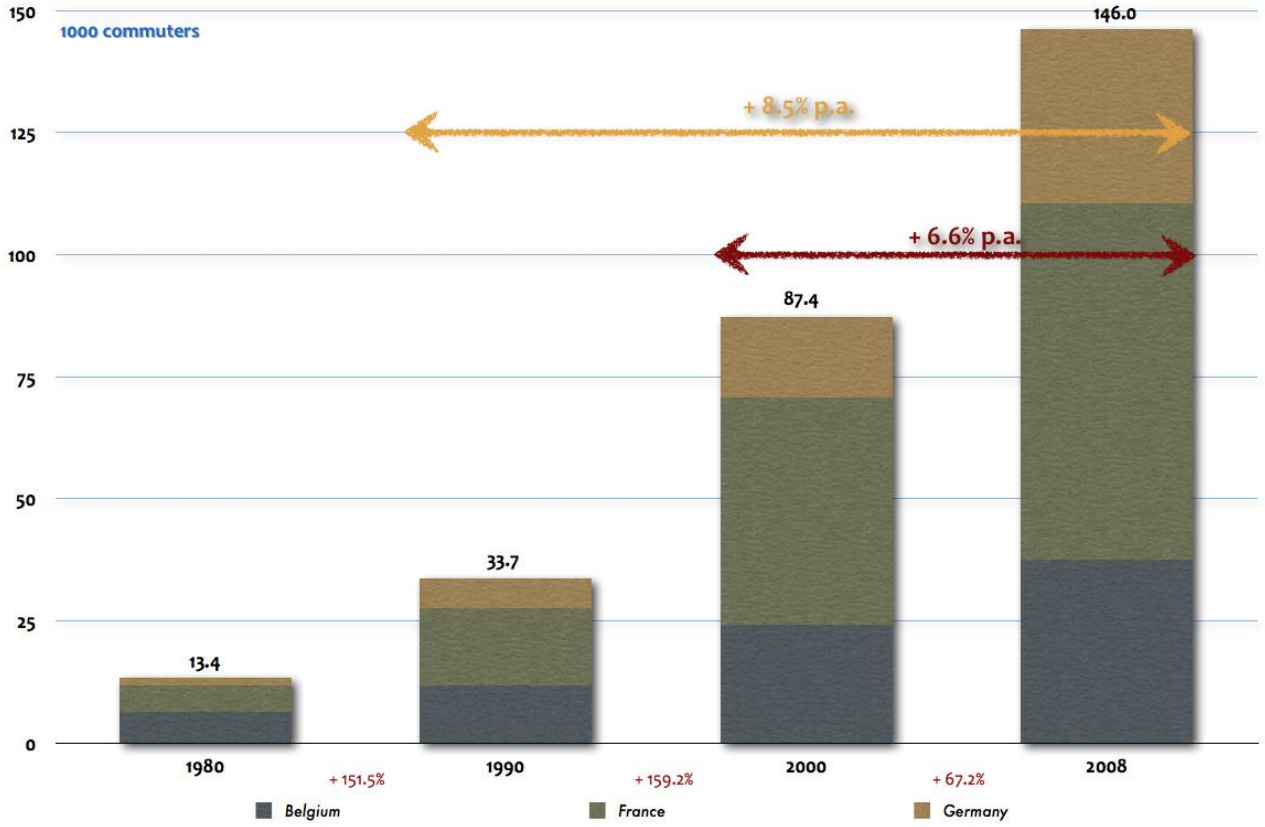
TABLE II.2-2 – PAID WORKERS: 1980-2008

annual cumulative averages x1000	1980	1990	2000	2001	2002	2003	2004	2005	2006	2007	2008
Resident workers – Lux. nationals	85.1	85.7	87.4	89.0	91.2	91.4	90.9	91.3	92.7	93.5	94.1
Resident workers – foreigners	38.5	51.0	70.1	73.4	74.6	75.9	78.5	80.8	83.5	86.8	92.1
Cross-border workers	13.4	33.7	87.4	97.3	103.0	106.9	111.9	118.3	126.2	136.2	146.0
Total paid workers	**137.0**	**170.4**	**244.9**	**259.7**	**268.8**	**274.2**	**281.3**	**290.4**	**302.4**	**316.5**	**332.2**

Sources: MDDI-DEV calculations on the basis of STATEC, *Statistical Yearbook*, Table B.5106 & B.5107:
http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=359&IF_Language=fra&MainTheme=2&FldrName=5&RFPath=37
http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=360&IF_Language=fra&MainTheme=2&FldrName=5&RFPath=37
and STATEC, *Indicateurs rapides*, Série L: http://www.statistiques.public.lu/stat/tableviewer/document.aspx?ReportId=352

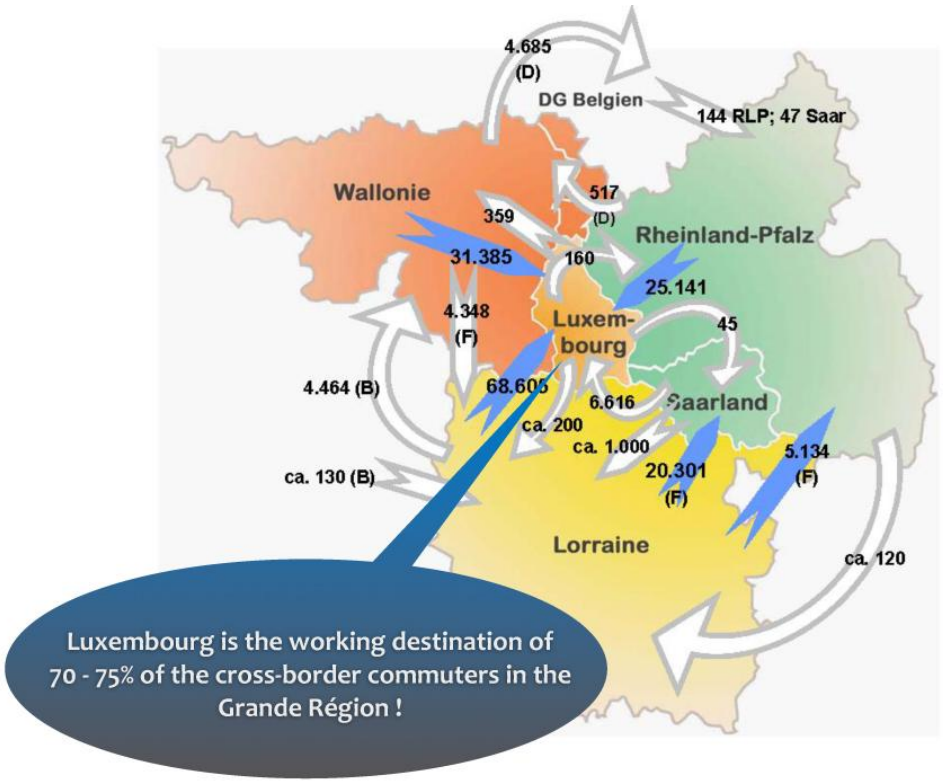
Note: annual cumulative averages are simply the sum of the workers at the end of each month divided by 12.

FIGURE II.2-2 – CROSS-BORDER COMMUTERS GROWTH: ANNUAL CUMULATIVE AVERAGES 1980-2008



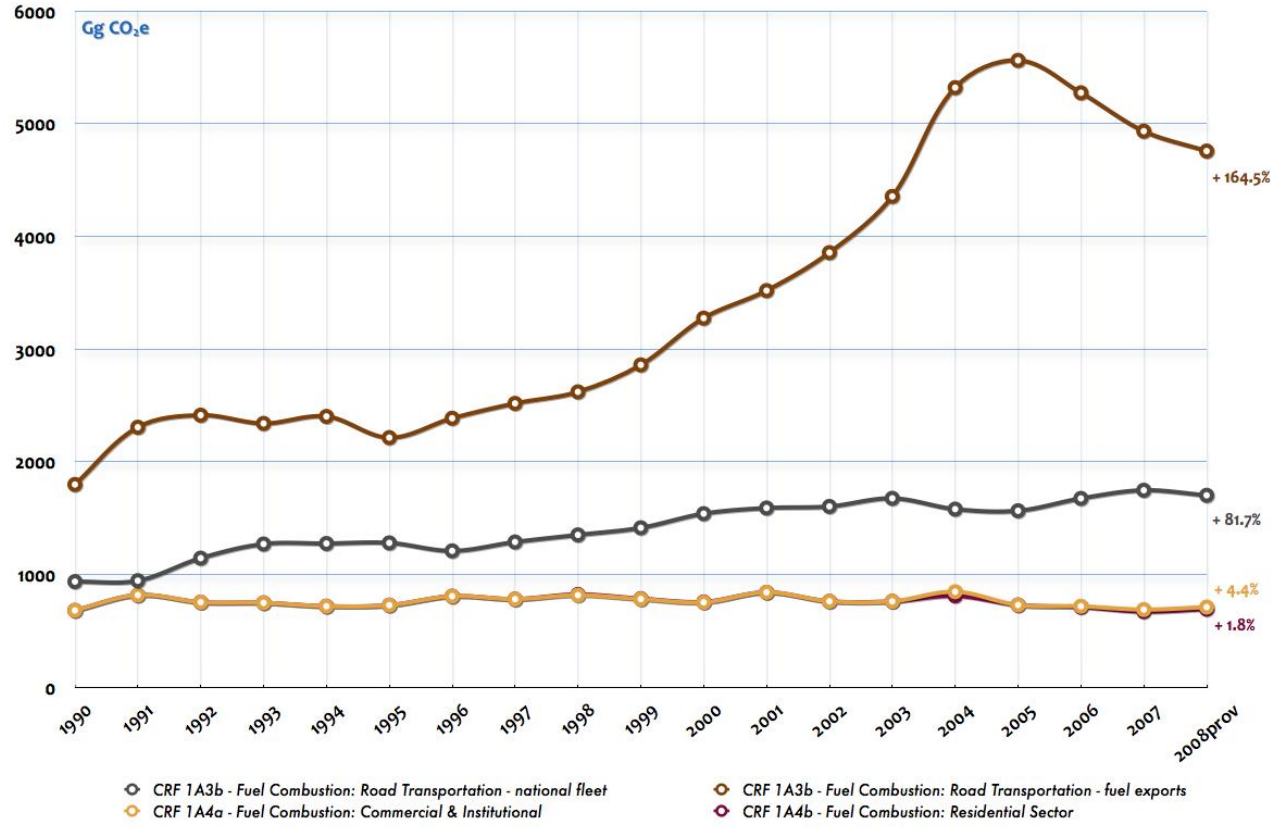
Source: STATEC, *Indicateurs rapides*, Série L: http://www.statistiques.public.lu/stat/tableviewer/document.aspx?ReportId=352

ILLUSTRATION II.2-1 – COMMUTING FLOWS 2007-2008



Source: 6th Report of the OIE (*Observatoire Interrégional de l'Emploi*), July 2009.

FIGURE II.2-3 – GHG EMISSIONS FOR SELECTED CRF FUEL COMBUSTION ACTIVITIES SUB-CATEGORIES: 1990-2008[19]



Sources: Environment Agency and MDDI-DEV.

II.3. GEOGRAPHY

Luxembourg is a territory of 2 586 km². The maximum distance from north to south is some 82 km, from west to east about 57 km. Of the total area of Luxembourg, in 2008, 86% was agricultural land and land under forest – with around 51% for agriculture *[→ Section II.9]* and 35% for forests *[→ Section II.10]*. The built-up areas occupied about 9% of the total surface and land covered by water and transport infrastructure about 5% *[→ Table II.3-1 & Figure II.3-1]*.

The north of Luxembourg is a part of the Ardennes and is called "Ösling". Its altitude is at an average of 400 to 500 meters above sea level. The "Ösling" landscape is affected by hills and deep river valleys, as for instance the Sure River (Sauer). With 560 m, the highest elevation is called the "Kneiff" in Wilwerdange. In the South of Luxembourg lies the rank "Gutland", which belongs to the "Lothringer Stufenland". This area has higher population and industrial densities than "Ösling". The lowest point in the country, called "Spatz" (129 m above sea-level), is located at the confluence of the Moselle and the Sure rivers in Wasserbillig. Most important rivers are the Moselle, the Sure, the Our – all three delimiting the border with Germany – and the Alzette.

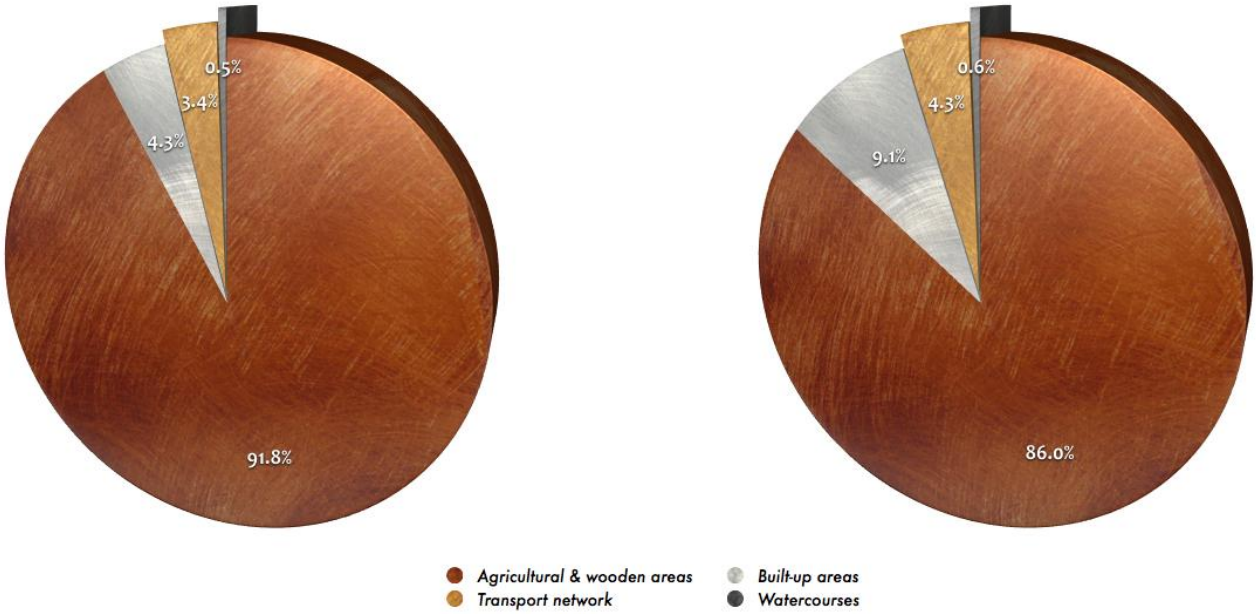
19 2008 data are provisional data estimated by the Department of the Environment during the summer of 2009 for the EC and the European Environment Agency: more on this in Section III.1 below.

TABLE II.3-1 – LAND USE IN LUXEMBOURG: 1972-2008

percentages	1972	1990	2000	2005	2008
Total land	100.0	100.0	100.0	100.0	100.0
Agricultural & wooden area	93.2	91.8	87.4	86.5	86.0
Built-up area	3.1	4.3	8.1	8.7	9.1
of which industrial area & other	…	…	2.7	*2.8*	*2.9*
Transport network & sheets of water	3.2	3.4	3.9	4.2	4.3
Watercourses	0.5	0.5	0.6	0.6	0.6

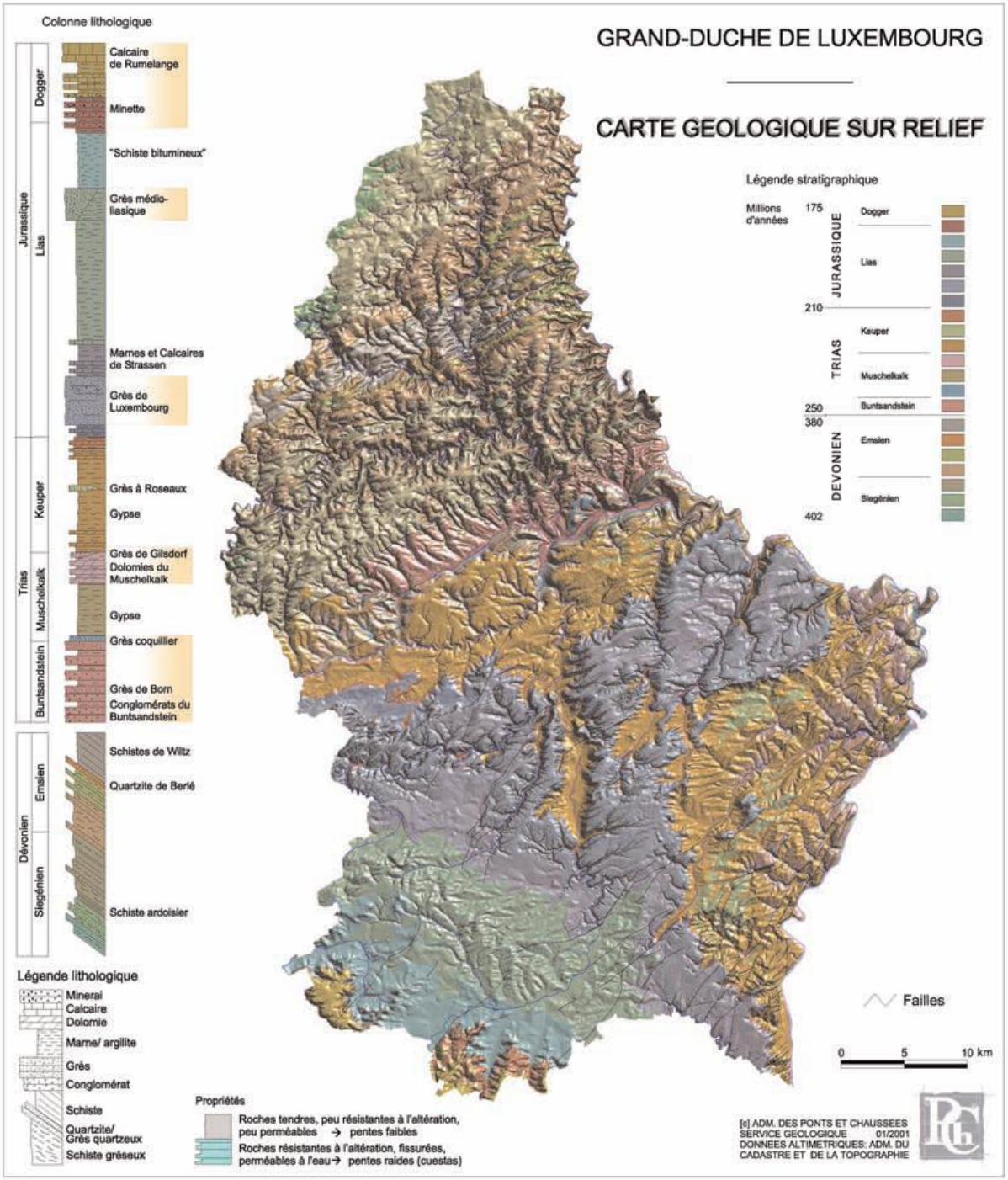
Source: STATEC, *Luxembourg in Figures 2009*, page 6: http://www.statistiques.public.lu/fr/publications/horizontales/luxChiffresEN/index.html

FIGURE II.3-1 – LAND USE: 1990 & 2008



Source: STATEC, *Luxembourg in Figures 2009*, page 6: http://www.statistiques.public.lu/fr/publications/horizontales/luxChiffresEN/index.html

ILLUSTRATION II.3-1 – GEOLOGICAL MAP OF LUXEMBOURG'S TERRITORY



Source: STATEC, *Annuaire statistique du Luxembourg 2008*, page 39: http://www.statistiques.public.lu/fr/publications/horizontales/annuaireStatLux/A.pdf

II.4. CLIMATE[20]

II.4.1. Situation: an increasing average air temperature during the last decades

The climate in Luxembourg can be characterized as a **moderate oceanic Western European climate** with mild winters and comfortable summers.

As shown by the long-term annual means (WMO reference period from 1961 to 1990) measured at the Findel-Airport meteorological station,[21] temperatures have an unimodal distribution, with the lowest long-term mean values occurring during January (0.0°C) and the highest air temperature in July (16.9°C) *[→ Table II.4-1]*.

Absolute minimum and maximum air temperatures in the reference period 1961-1990 reach from –17.8°C in January (1979) to 35.1°C in July (1964).[22] According to definitions for GHG reporting, with an annual average air temperature below 15°C, **Luxembourg is situated in a cool climate region**.

Climate conditions have significant impacts on energy use for heating or cooling purposes. An increase in average air temperature in the forthcoming years could have a positive impact on energy consumption, especially in the residential, commercial and institutional sectors. However, in case of a substantial increase of average air temperatures, an increase in energy consumption related to a more frequent use of air conditioning systems is to be expected.

As shown by measures at the Findel-Airport meteorological station, two conclusions can be drawn: firstly, an increase in average air temperature is observed over the last decades; secondly, other meteorological parameters do not show such clear trends *[→ Table II.4-2]*. Similar observations have been obtained in scientific studies on the climate in Luxembourg, notably in Ries (éditeur) (2005) and Pfister et al. (2005a). Concerning air temperatures, these studies show a clear positive trend from 1910 up to the 1950s, then about 3 decades of stabilisation, followed by several colder years. From 1990 onwards, annual mean air temperatures for the city of Luxembourg started to increase rather sharply to systematically be over the 1961-1990 mean value *[→ Illustration II.4-1]*. Luxemburg-City temperature highs have mostly been observed during the last 15-20 years *[→ Illustration II.4-2]*.

Further analysis of the data suggests that the average air temperature in Luxembourg has increased during the winter seasons, coupled with longer frost-free periods.

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20 This section has been prepared by Pfister, L., Junk, L. & Hoffmann, L. of the *Centre de Recherche Public-Gabriel Lippmann*.

21 http://www.aeroport.public.lu/fr/meteo/index.html.

22 Absolute minimum and maximum air temperatures ever recorded were -20.2°C (2 February 1956) and 37.9°C (8 & 12 August 2003).

With regard to annual precipitation, no clear changes can be detected from the direct measurements *[→ Table II.4-1]*. However, the seasonal distribution of precipitation totals has shown substantial variability through the past 130 years *[→ Illustration II.4-3]*. Most of this variability can be attributed to changes in the atmospheric circulation patterns. An increase in westerly atmospheric fluxes during winter months has reportedly been responsible over the past 30 years for significant redistributions of winter rainfall totals. In combination with higher air temperatures, this has led to higher flood frequencies in most national river basins [Pfister et al. (2000) and (2004)].

II.4.2. Projections: continuing rise in air temperature

Preliminarily results taken from an ongoing study of the Department "Environment and Agro-biotechnology" of the *Centre de Recherche Public-Gabriel Lippmann* suggest an increase in mean air temperature for the Grand-Duchy of Luxembourg. Based on selected results of the FP6 ENSEMBLES project climate change projections,[23] mean annual temperatures are expected to reach up to 11.6°C for the period 2071 till 2100. This value refers to the GHG emission scenario A1B *[→ Illustration II.4-4]*.

Preliminarily results concerning changes in precipitation suggest a relative stability in annual totals until 2100. However, a substantial redistribution of seasonal precipitation totals can be expected in the second half of the 21st century, with a decrease in summer rainfall and an increase in winter precipitation *[→ Illustration II.4-5]*.

TABLES, FIGURES & ILLUSTRATIONS

TABLE II.4-1 – LONG-TERM MEAN VALUES (1961-1990) OF AIR TEMPERATURE AND PRECIPITATION FOR FINDEL-AIRPORT STATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average air t° [°C]	0.0	1.1	4.0	7.5	11.8	14.9	16.9	16.4	13.4	9.1	3.8	1.0	**8.3**
Mean min. air t° [°C]	-2.3	-1.8	0.6	3.3	7.1	10.2	12.0	11.8	9.3	5.7	1.2	-1.3	**4.8**
Mean max. air t° [°C]	2.3	4.2	8.0	12.1	16.8	19.9	22.0	21.0	18.2	13.0	6.6	3.3	**12.3**
Mean annual precipitation sum [mm]	71.2	61.7	70.0	61.2	81.2	82.2	68.4	72.3	70.0	74.6	83.2	79.6	**875.5**

Source: ASTA, *Annuaire météorologique et hydrologique 1990*.

23 http://ensembles-eu.metoffice.com.

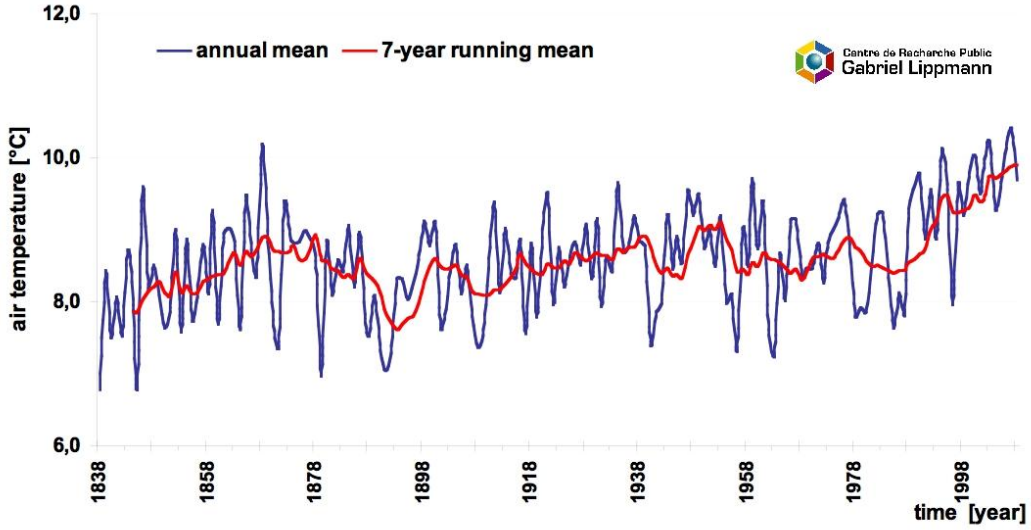
TABLE II.4-2 – MEAN VALUES OF AIR TEMPERATURE, PRECIPITATION, SUNSHINE DURATION AND RELATIVE HUMIDITY FOR FINDEL-AIRPORT STATION FOR DIFFERENT TIME SPANS

	1961-1990	1971-2000	1990	2000	2005	2007	2009
Mean air t° [°C]	8.3	8.7	9.8	10.0	9.6	10.4	9.9
Precipitation sums [mm]	875.5	862.4	1046..0	1036.4	718.2	1031.6	890.2
Accumulated sunshine duration [h]	1630.2	1648.5	1772.3	1643.9	1906.0	1887.0	1879.8
Mean relative humidity [%]	79	78	74	79	78	76	76

Sources: ASTA, *Annuaire météorologique et hydrologique 1990* and Findel-Airport station (SMA).

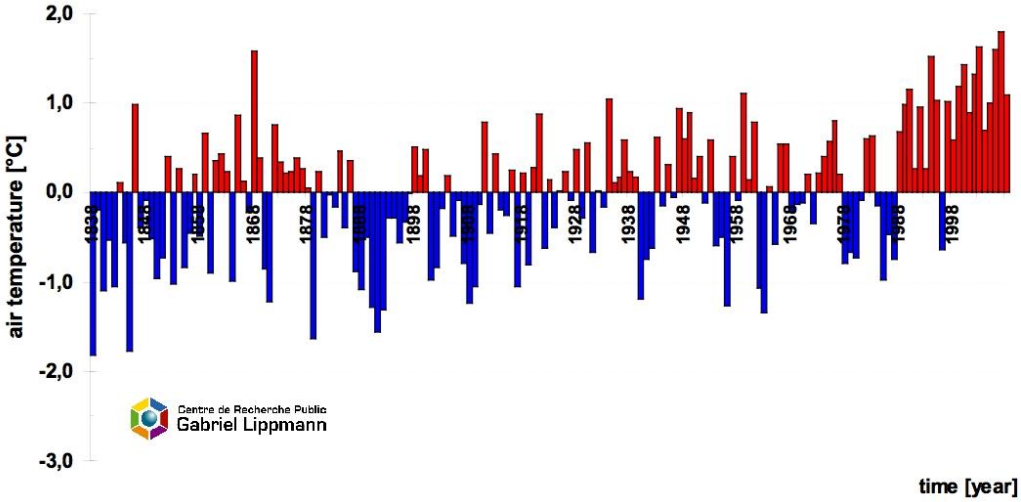
Note: the mean air t° for the reference period 1951-1980 was 8.2°C. From 2010 onwards, the reference period will be 1981-2010 with a mean t° around 9°C.

ILLUSTRATION II.4-1 – AVERAGE ANNUAL AIR TEMPERATURE (BLUE LINE) AND 7-YEAR RUNNING MEAN (RED LINE) FOR LUXEMBOURG-CITY: 1838-2007



Source: *Centre de Recherche Public-Gabriel Lippmann*, unpublished.

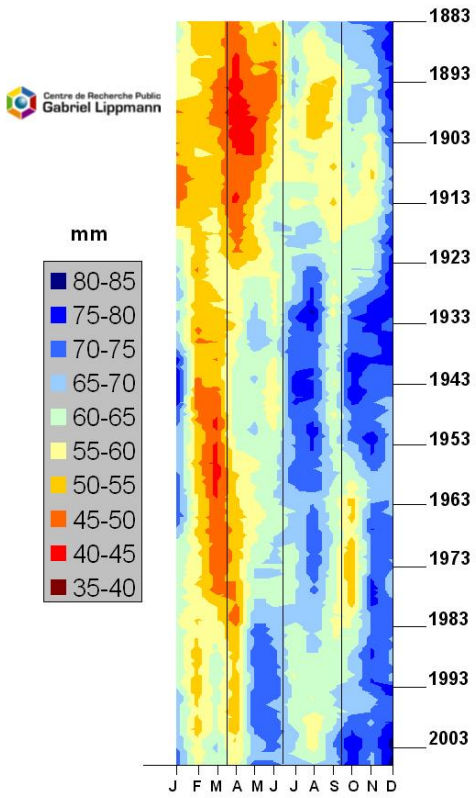
ILLUSTRATION II.4-2 – ANOMALIES OF ANNUAL AIR TEMPERATURE FROM THE REFERENCE PERIOD 1961-1990 FOR LUXEMBOURG-CITY



Source: *Centre de Recherche Public-Gabriel Lippmann*, unpublished.

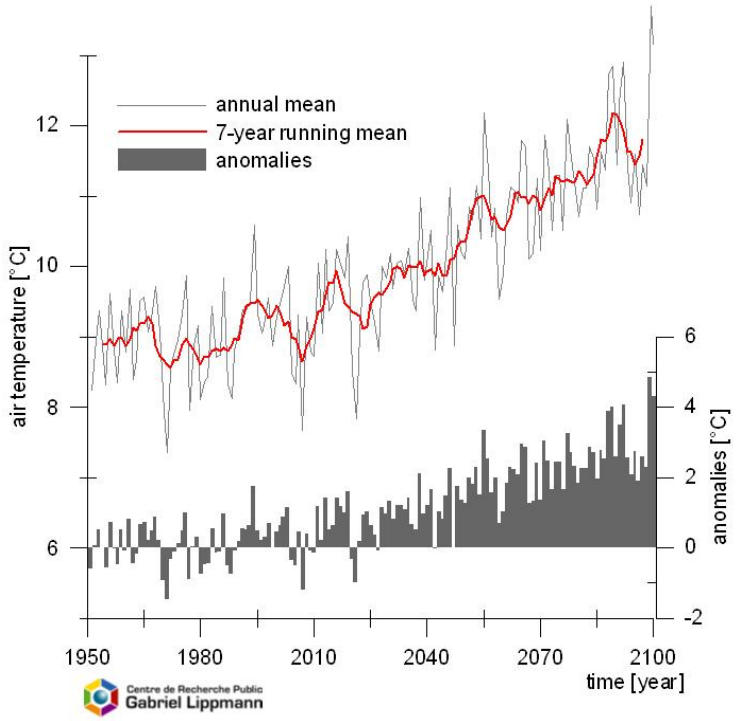
Note: anomalies from the reference period 1961 till 1990: long-term mean: 8.6°C.

ILLUSTRATION II.4-3 – RAINFALLS 1883-2006: 30 YEARS MOVING AVERAGES



Source: *Centre de Recherche Public-Gabriel Lippmann*, unpublished.

ILLUSTRATION II.4-4 – PROJECTIONS OF MEAN ANNUAL AIR TEMPERATURE



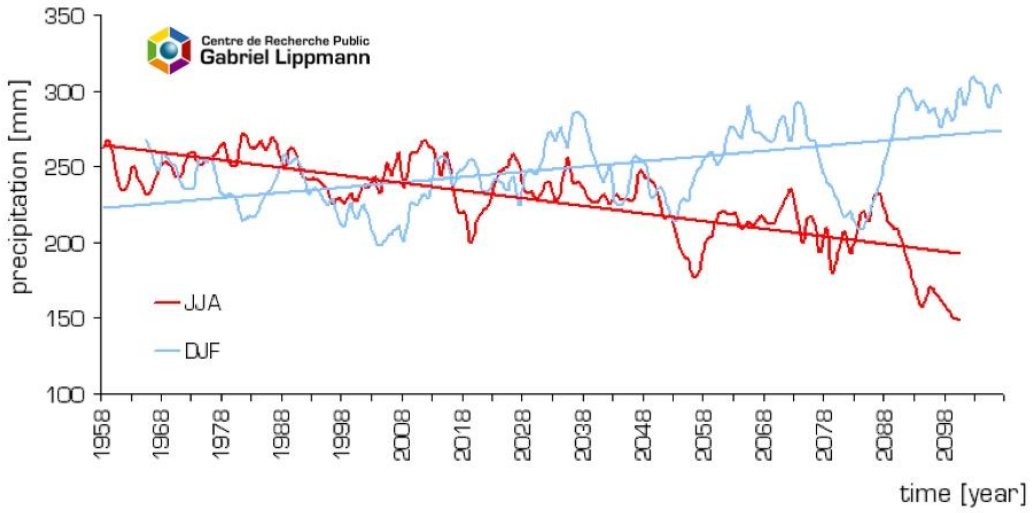
Source: *Centre de Recherche Public-Gabriel Lippmann*, unpublished.

Notes:

(1) based on selected ENSEMBLES data sets, A1B emission scenario.

(2) anomalies from the reference period 1961 till 1970: long-term mean: 8.9°C.

ILLUSTRATION II.4-5 – PROJECTIONS OF PRECIPITATION SUMS FOR THE METEOROLOGICAL SUMMER AND WINTER SEASONS



Source: *Centre de Recherche Public-Gabriel Lippmann*, unpublished.

Note: based on selected ENSEMBLES data sets, A1B emission scenario.

II.5. ECONOMIC PROFILE

One of the main characteristics of economic growth in Luxembourg is its volatility. Generally speaking, the economic cycle in Luxembourg follows that of other European countries, but the amplitude of the GDP variations is more pronounced. This is a common feature of small economies, open to the outside world, and therefore more vulnerable to external shocks. It would however appear that over the past ten years the amplitude of GDP variations in Luxembourg has diminished, as has the gap in relation to the European cycle.

II.5.1. A bit of history

The turn of the 20th century up to the First World War was characterized by a sustained growth in the steel industry that attracted new inhabitants, which induced a population concentration in the city of Luxembourg and the canton of Esch-sur-Alzette (mining region) while, up to then, Luxembourg was rather a rural country. Afterwards, up to the 1950s, economic development was mostly flat (annual average GDP growth of 1.6%) due to the crises associated with the two World Wars and the economic recession in the early 1930's.

Following the Second World War, during the "*Trente glorieuses*" (i.e. 1945-1975), GDP growth reached levels of almost 4% a year. The 1975-1985 world economic crisis brought a temporary end to these years of exceptional growth. The average annual GDP growth was "only" 2.3% during this period.

Nevertheless, during the 1960s, Luxembourg's economic growth had been beneath the percentages recorded for the, at that time, European Community Member States. This is one of the reasons that

encouraged authorities to diversify the economy, which gradually shift from an industry dominated structure to a services one. This led to an exceptional growth in Luxembourg as from the mid-eighties, largely due to a boom in the financial sector: the GDP level per inhabitant then exceeded those of the majority of industrialised countries in Europe at that time.

More precisely, when looking at labour productivity and employment respective contributions to economic growth in Luxembourg, a clear hiatus between the periods 1960-1985 and 1985-2009 appears. This reveals a real change of "economic regime" in the country.[24] Up until the 1980's, annual GDP variations were largely due to variations in productivity. The period between the end of the Second World War and the 1980's is marked by what could be called an "industrial regime". Steelmaking was at the core of the Luxembourg economy at that time and, consequently, the economic somersaults could be attributed to this sector. Then, starting in the 1980's, variations in GDP and in labour productivity started to diverge and employment became the main driver of economic growth. Moreover, productivity showed a tendency to subside. That is the period when the economy shifted towards a service economy boosted by the financial sector and that Luxembourg began, from the second half of the 1980's, to substantially outstrip growth in neighbouring countries. This period is also the one characterized by the beginnings of high population and cross-border commuters growths (as depicted in *Section II.2*).

II.5.2. Recent economic development: the industrial decline and the increasing weight of financial & corporate services

The economic restructuring and development of the country towards the tertiary sector described in the previous section led to the following economic cycles since 1990:

- up to 1992, the continuation of the exceptional growth initiated around 1985;
- the effects of the economic slowdown in Luxembourg during the period between 1992 and 1996 and the economic downturn in 2001 – as well as the less impressive growth in 2002-2004 – which is mirrored by a stagnation of the GDP level per inhabitant in Luxembourg in comparison with the EU-15;
- the good economic performance of Luxembourg between 2005 and 2008;
- the financial and economic crisis that started end 2008 and that has been particularly pronounced in the first semester of 2009 *[→ Section II.5-3]*.[25]

Nowadays, gross value added is mainly generated in the financial intermediation (banking and insurances), real estate and services to business sector. The share of total gross value added in this branch has increased from about 39% in 1995 to 49% in 2008.[26] While the commercial sector has

[24] This is clearly illustrated by graphic 1.1.15 in STATEC (2009d).

[25] For more details on the economic evolution and structure of Luxembourg, refer to STATEC (2009d), section 1.1.2.

[26] Data prior to 1995 are and will not be translated into the new European System of Accounts (ESA).

maintained a constant share at about 20 to 22.5%, the share of the industry sector has decreased significantly from 15% in 1995 to a bit less than 10% in 2008. Other service activities ranged between a share of 15 to 17.5% and construction kept a rather constant share in total gross value added at around 6%. The contribution of the agricultural sector is negligible with less than 1% *[→ Table II.5-1 & Figure II.5-1]*.

It is therefore obvious that the financial sector has been the principal engine driving the economy for more than two decades. Today, Luxembourg is the leading European financial centre, and the second in the world in terms of the amount of assets managed by undertakings for collective investment. However, the radical shift from an industrial economy based on steel to a service economy based on banking and finance initiated in the 1960s has led to an economy which is again dominated by a few activities. It is the case to such a point that there is, at the present, a high correlation between evolutions in banking activities and in GDP. The Government, therefore, initiated a new process of diversification via 3 Action Plans promoting new economic pillars in domains Luxembourg might have comparative advantages in: logistics, health technologies and, since February 2009, eco-technologies. The latter led to a "cluster" – *EcoDev* – which might have implications with regard to measures for reducing GHG emissions in Luxembourg.[27]

II.5.3. The financial and economic crisis of 2008-2009

With an economy heavily depending on the financial sector and related activities, as well as on a few large enterprises, some operating in the fields of steelworks and of the automotive industry (glass, tyres), the financial then economic crisis has important effects. According to the latest forecasts, GDP should contract by 4% in 2009 [STATEC (2009c)], so that the year 2009 is set to be the worst seen in Luxembourg since the iron and steel crisis in the mid-1970s.

Bit recovery signs are tangible. During the second quarter of 2009, the financial and manufacturing sectors again made a positive contribution to the creation of added value. The financial sector benefited from a more stable international environment and the recovery in the stock markets, even though there are still many uncertainties. However, cost control remains the order of the day, and this is having negative consequences on banking employment in particular.

The entire European manufacturing industry was faced with collapsing demand in the autumn of 2008. The decline in activity was halted at the end of the 1st quarter of 2009 but output remained well below that of 2007. Against this general trend, Luxembourg manufacturing suffered particularly badly, even though the negative effects on employment were offset by massive recourse to partial unemployment.

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27 The *EcoDev* cluster is one of the outcomes of the "Eco-technology Action Plan": http://www.innovation.public.lu/html/portal/FR/getset/42/.

In fact, in Luxembourg, the impact of falling activity took a while to affect employment and unemployment figures (refer also to comments in *Section II.2-2*). In terms of employment, temporary workers were some of the first affected. However, this had little impact on the unemployment rate given the high proportion of temporary cross-border workers. The adjustment in the labour factor also often initially led to an exceptionally sharp fall in working hours, delaying job losses. Partial unemployment is a case in hand and was used to minimise the damage. With the rapid collapse in output and almost non-existent short-term visibility for many companies, this measure was highly popular. Finally, the number of people in job schemes started to climb again from the 2nd quarter of 2009 on, damping down the rise in unemployment. However, general labour market trends were for ongoing but slowing decline. The unemployment rate is expected to reach 6.0% for 2009 as a whole.[28]

As in many other Western countries, in order to minimize the crisis effects, the Government injected money in the economy by maintaining public investments. The new Government, that started its work during the summer of 2009, also pledges to "greening" its economy by promoting "green growth",[29] ensuring a sustainable development[30] and supporting "green" and renewable energy sources.[31]

II.5.4. Effects on GHG emissions: it is not so much modifications in the economic structure than particular changes that affect the GHG emissions trend

Since the main structural changes affecting Luxembourg's economic profile took place before 1990 (→ *Section II.5-1*), they do not come out in the GHG emissions trends for some emblematic CRF sub-categories: total GHG excluding LULUCF, public electricity and heat production (CRF 1A1a), manufacturing industries and construction combustion and processes emissions (CRF 1A2+2A+2C1) and "road fuel exports" (CRF 1A3b, part) *[→ Figure II.5-2]*.

While the increasing shares in gross value added from less energy and carbon intensive sectors (as financial and services) has a positive effect on the carbon intensity of the Luxembourg economy, the overall GHG emissions trend is mostly determined by the developments of the 3 CRF (sub-) categories displayed in *Figure II.5-2*. The residential, commercial and institutional sectors do not influence the general trend, as we have seen in *Section II.2.3*.

Regarding electricity and heat production, the decline observed up to 1998 is linked to structural changes in the steel industry. Then, the jump in 2002 is the result of a new power plant that started its operation that year *[→ Section II.6]*.

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28 For a more detailed discussion on the impacts of the financial and economic crisis, refer to STATEC (2009c).

29 Government Programme: http://www.gouvernement.lu/gouvernement/programme-2009/programme-2009/programme-gouvernemental-2009.pdf, p. 61.

30 Ibid., p. 38-39.

31 Ibid., p. 40-43.

Manufacturing industries and construction sharp fall up to 1998 is linked to structural changes in one industrial sector, the steel industry: *[→ Section II.7]*.

With regard to "road fuel exports", the evolution has been briefly described in ***Section II.2.3*** and will be exposed in detail in ***Section II.8*** below.

Finally, the impacts of the financial and economic crisis do not yet show off obviously in the figure above: for electricity and heat production, the 2008 decrease is the result of a maintenance operation of the main power plant of the country; for "road fuel exports", the 2008 reduction in emissions compared to 2007 is lower than the decrease between 2006 and 2007, e.g., showing that other parameters *[→ Section II.2.3]* played a bigger role in 2008 than those relating to the crisis. Nevertheless, figures and data already collected for 2009; whether they concern industrial production (cf above) or fuel sales, indicate that the crisis effects should be clearly visible in the 2009 emission levels.

To conclude, GHG emissions trends in Luxembourg are not so much influenced by the economic profile of the country, but for the most part by:

- the energy-mix for both production and consumption of fuels (liquid, solid, gaseous, biomass) *[→ Section II.6]*;
- structural changes in the energy and industrial sector that could be initiated by a single entity *[→ Sections II.6 & II.7]*;
- road transportation related fuel sales *[→ Section II.8]*.

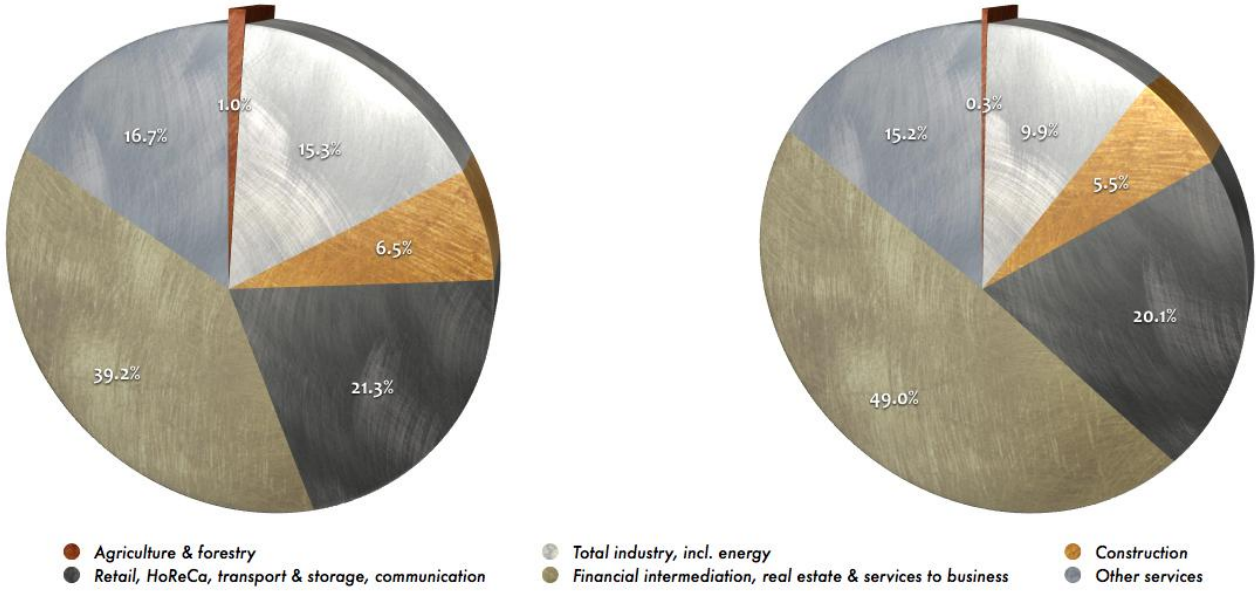
TABLES, FIGURES & ILLUSTRATIONS

TABLE II.5-1 – SECTORAL GROSS VALUE ADDED AT CURRENT PRICES: 1995-2008

mio. EUR		1995	2000	2002	2003	2004	2005	2006	2007	2008
Agriculture, hunting, forestry & fishing (A & B)		140.6	134.3	143.6	141.5	143.3	120.5	117.1	131.9	119.8
	%	*1.0%*	*0.7%*	*0.7%*	*0.6%*	*0.6%*	*0.4%*	*0.4%*	*0.4%*	*0.3%*
Total industry, including energy (C to E)		2088.6	2475.1	2523.9	2682.8	2790.0	2856.9	3068.2	3539.9	3507.8
	%	*15.3%*	*12.6%*	*11.7%*	*11.5%*	*11.4%*	*10.6%*	*10.0%*	*10.5%*	*9.9%*
Construction (F)		884.1	1126.4	1446.5	1497.1	1547.2	1640.4	1786.1	1845.2	1951.7
	%	*6.5%*	*5.7%*	*6.7%*	*6.4%*	*6.3%*	*6.1%*	*5.8%*	*5.5%*	*5.5%*
Wholesale & retail trade, repair of motor vehicles, motorcycles and personnal & households goods; hotels & restaurants; transport, storage & communication (G to I)		2915.7	4274.1	4848.8	5015.0	5266.2	5561.1	6066.9	6694.5	7149.2
	%	*21.3%*	*21.8%*	*22.5%*	*21.6%*	*21.5%*	*20.5%*	*19.7%*	*19.8%*	*20.1%*
Financial intermediation; real estate, renting & business activities (J & K)		5366.0	8587.2	8975.5	9968.7	10428.3	12311.1	14943.1	16421.6	17419.4
	%	*39.2%*	*43.8%*	*41.7%*	*42.9%*	*42.6%*	*45.5%*	*48.5%*	*48.6%*	*49.0%*
Other services (public administration & defence, compulsory social security; edication; health & social work; other community social & personal service activities; private households with employed persons (L to P)		2279.9	3026.3	3603.9	3930.3	4315.0	4583.1	4818.3	5135.4	5410.2
	%	*16.7%*	*15.4%*	*16.7%*	*16.9%*	*17.6%*	*16.9%*	*15.6%*	*15.2%*	*15.2%*
Total: all NACE rev1.1 branches		13675.1	19623.4	21542.2	23235.3	24490.0	27073.2	30799.7	33768.5	35558.0

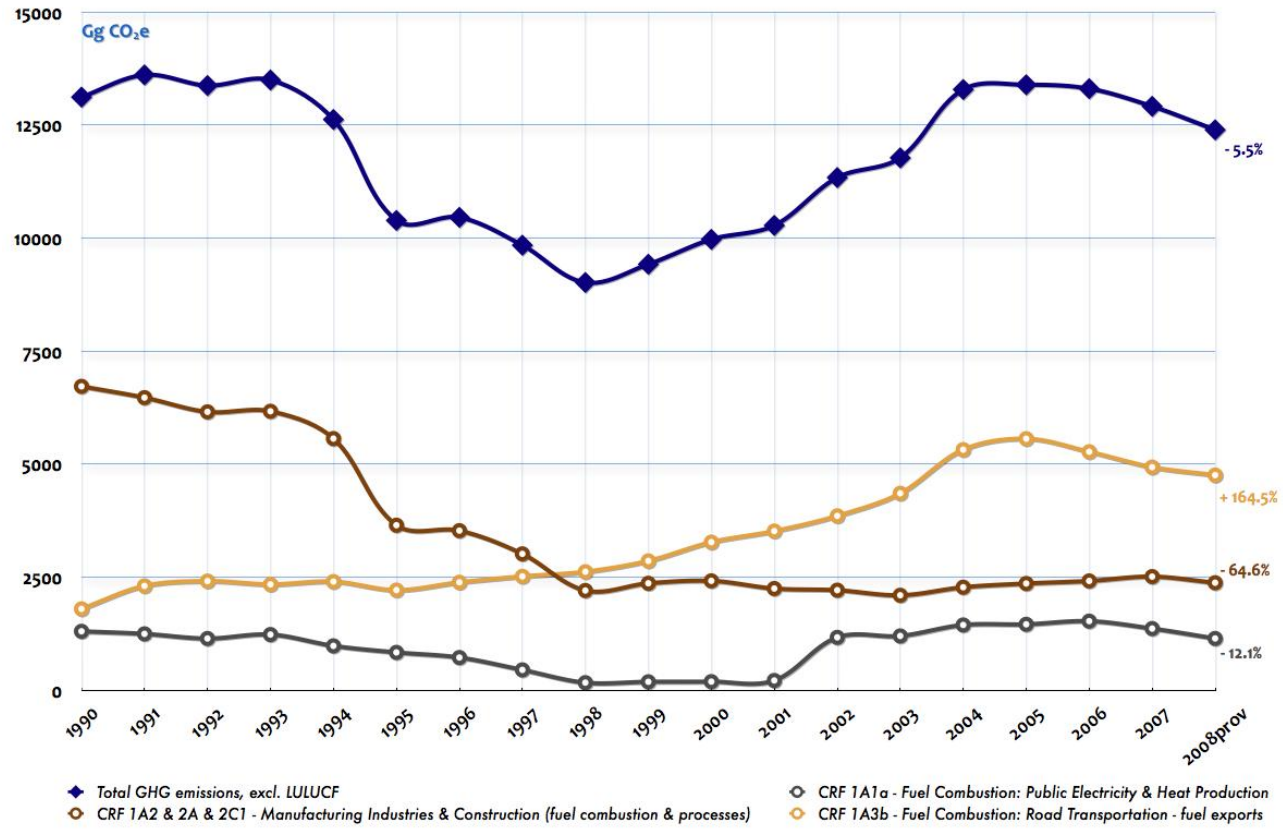
Source: STATEC, *Statistical Yearbook*, Table D.1304:
http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=216&IF_Language=fra&MainTheme=4&FldrName=2&RFPath=15

FIGURE II.5-1 – SECTORAL GROSS VALUE ADDED AT CURRENT PRICES: 1995 & 2008



Source: STATEC, *Statistical Yearbook*, Table D.1304:
http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=216&IF_Language=fra&MainTheme=4&FldrName=2&RFPath=15

FIGURE II.5-2 – GHG EMISSIONS FOR SELECTED CRF FUEL COMBUSTION ACTIVITIES SUB-CATEGORIES: 1990-2008[32]



Sources: Environment Agency and MDDI-DEV.

32 2008 data are provisional data estimated by the Department of the Environment during the summer of 2009 for the EC and the European Environment Agency: more on this in Section III.1 below.

II.6. ENERGY

CRF (sub-)categories covered	1A1a	
share in total GHG emissions, excl. LULUCF	***1990***	9.9% = 1301.82 Gg CO_2e
	2007	10.6% = 1362.66 Gg CO_2e
	2008prov	9.2% = 1144.02 Gg CO_2e

II.6.1. A total change in Luxembourg's energy-mix

Primary and final energy consumption in Luxembourg experienced dramatic changes since 1990. Overall primary energy consumption increased by 22.4% between 1990 and 2007.[33] Whereas solid fuels and coal declined by more than 93% over the period, liquid fuels (excl. kerosene) and natural gas consumptions increased by 69.4% and 179.9% respectively *[→ Table II.6-1 & Figure II.6-1]*.

Final energy consumption increased by 20.4% between 1990 and 2007. As for primary energy consumption, all the energy sources have seen their consumption increase over the period, except solid fuels and coal *[→ Table II.6-2 & Figure II.6-2]*.

However, over the period 1990-2007, the final energy-mix of Luxembourg changed considerably with a dropping share for solid fuels – for which the main part was used in the iron and steel industry – in favour of liquid fuels and natural gas and, to a lesser extent, to new energy sources such as cogeneration. Indeed, in 2007, 84% of the final energy consumption was covered by fossil fuels – 62% by liquid fuels including the important volume of road fuels,[34] 20% by natural gas and 2% by coal. The remaining 16% of the consumption were either electricity (14%) and energy produced using cogeneration techniques (1.4%) or wood and biofuels (0.4%). Going back to 1990, 31% of the final energy consumption was stemming from solid fuels and coal, 44% from liquid fuels, 14% from natural gas and 11% from electricity *[→ Table II.6-2 & Figure II.6-2]*. What did happen?

- regarding solid fuels and coal, the important decline (-92.1%) is the result of a change in production processes in the steel industry sector: the production process was moved from blast furnaces to electric arc furnaces between 1994 and 1998 and, therefore, solid fuels (mainly imported coke, but also imported anthracite) were replaced, to a very large extent, by electricity and natural gas;
- liquid fuels increase (+69.7%) was driven by road fuel sales, and especially "road fuel exports";

[33] 2008 energy balances have not yet been completed at the time this report has been finalized: major revision and re-organization of the energy data are currently on-going at STATEC.

[34] Diesel being the first liquid fuel in terms of volumes sold. The liquid fuel consumption in Luxembourg is much lower than the level of fuel sales, because large amounts of road fuels are bought by foreign commuters and transit traffic passing through Luxembourg: cf Section II.8.1 below.

- the 70.9% increase in natural gas final consumption followed the continuous extension of the natural gas network in Luxembourg so that this fuel ranked second after the consumption of liquid fuels in 2007 – and even first if "road fuel exports" are not considered.

Natural gas has also become the main energy source of Luxembourg's national electricity production capacity. In 1990, more than 90% of Luxembourg's electric energy consumption was imported and one medium size power plant of about 70 MW was run by the iron and steel company Arbed.[35] That power plant was mainly run on blast furnace gas – a side product of the blast furnaces in the steel industry – and was phased out in 1998 after the last blast furnace went out of service .In the early 1990s, small combined heat-power (CHP) installations (or cogeneration) plants appeared. Their installation was encouraged financially by the Government. This development was followed later by some industrial companies which installed gas turbines to produce electricity and heat simultaneously. In mid-2002, the ultra-modern TWINerg power plant started its commercial operation. Located in Esch-sur-Alzette, TWINerg is a gas and steam turbine power station running on natural gas, with an electrical output of 350 MWel (efficiency 57% new).[36] There are plans for decoupling heat at a later stage (28 MWth) for remote heating of the new Belval-Ouest district project.[37] If almost all of these cogeneration plants run on natural gas, gas oil remains the emergency fuel in case of a natural gas supply disruption.

The impact of TWINerg in the primary energy consumption mix is clearly visible in *Table II.6-1* and its associated *Figure II.6-1*: electricity imports dropped and natural gas primary consumption increased. To complement this analysis, an energy balance for electric power is provided *[→ Table II.6-3 & Figure II.6-3]*.

II.6.2. Effects on GHG emissions: a V-shaped form

GHG emissions of the public electricity and heat production (CRF 1A1a) are clearly reflecting the changes described above. Emissions are firstly declining from 1994 to 1998: this is the result of the move from blast furnaces to electric arc furnaces in the steel industry. Then, a sharp increase occurred in 2002 when the TWINerg power plant started to operate at full capacity. The rather important decrease observed between 2007 and 2008 is the result of a 3 months maintenance operation of TWINerg, hence 3 months with no substantial production *[→ Figure II.6-4]*.

35 Then Arcelor and now, Arcelor-Mittal.

36 http://www.twinerg.lu/data/fr/home.htm

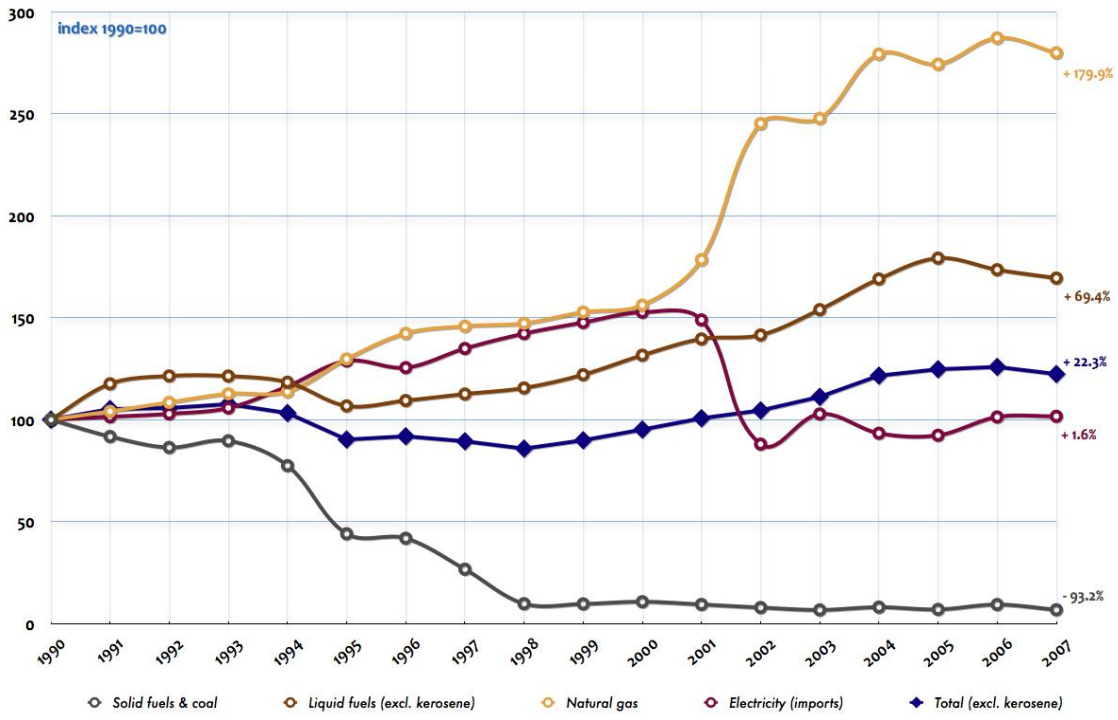
37 http://www.agora.lu.

TABLE II.6-1 – PRIMARY ENERGY CONSUMPTION (EXCL. AIR TRANSPORT): 1990-2007

1000 toe	1990 (base year)	1991	1992	1993	1994	1995	1996	1997	1998	1999
Solid fuels & coal	1198.61	1099.27	1034.88	1073.87	928.05	527.59	501.20	319.20	116.62	115.50
	34.32%	*29.92%*	*28.04%*	*28.58%*	*25.74%*	*16.74%*	*15.63%*	*10.23%*	*3.89%*	*3.68%*
Liquid fuels (excl. kerosene)	1456.42	1711.93	1768.12	1767.28	1723.27	1554.27	1592.53	1638.96	1682.32	1777.20
	41.70%	*46.60%*	*47.90%*	*47.03%*	*47.80%*	*49.32%*	*49.66%*	*52.50%*	*56.15%*	*56.62%*
Kerosene	127.60	132.97	128.79	127.72	162.15	183.86	199.82	229.35	289.80	326.99
Natural gas	477.55	496.86	517.89	537.96	542.83	619.38	679.47	696.24	703.01	729.21
	13.67%	*13.53%*	*14.03%*	*14.32%*	*15.06%*	*19.66%*	*21.19%*	*22.30%*	*23.47%*	*23.23%*
Electricity (imports)	318.22	322.65	327.21	336.34	370.05	409.85	399.29	429.16	452.41	469.72
	9.11%	*8.78%*	*8.86%*	*8.95%*	*10.26%*	*13.01%*	*12.45%*	*13.75%*	*15.10%*	*14.96%*
Waste incineration (with heat recovery)	26.84	27.92	28.16	26.94	26.34	25.15	19.40	23.14	26.41	31.62
	0.77%	*0.76%*	*0.76%*	*0.72%*	*0.73%*	*0.80%*	*0.60%*	*0.74%*	*0.88%*	*1.01%*
Biomass (1)	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.40
	0.43%	*0.41%*	*0.41%*	*0.40%*	*0.42%*	*0.48%*	*0.47%*	*0.48%*	*0.50%*	*0.49%*
Biogas	NO	NO	NO	NO	NO	NO	NO	NO	0.13	0.29
	NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00%*	*0.01%*
Total (excl. kerosene)	3492.64	3673.63	3691.26	3757.39	3605.54	3151.24	3206.89	3121.70	2995.90	3138.94

1000 toe	2000	2001	2002	2003	2004	2005	2006	2007
Solid fuels & coal	128.26	112.03	94.10	79.94	96.22	82.89	111.53	81.00
	3.86%	*3.19%*	*2.58%*	*2.06%*	*2.27%*	*1.90%*	*2.54%*	*1.90%*
Liquid fuels (excl. kerosene)	1916.19	2032.22	2060.74	2241.71	2460.46	2609.28	2526.84	2466.90
	57.68%	*57.81%*	*56.46%*	*57.74%*	*57.95%*	*59.92%*	*57.49%*	*57.73%*
Kerosene	311.64	337.06	365.19	380.44	407.36	420.60	393.62	422.10
Natural gas	745.47	852.06	1170.77	1183.02	1333.47	1309.80	1371.31	1336.54
	22.44%	*24.24%*	*32.08%*	*30.47%*	*31.41%*	*30.08%*	*31.20%*	*31.28%*
Electricity (imports)	485.74	473.73	279.92	327.01	296.91	293.72	322.28	323.37
	14.62%	*13.48%*	*7.67%*	*8.42%*	*6.99%*	*6.74%*	*7.33%*	*7.57%*
Waste incineration (with heat recovery)	30.77	28.15	26.72	31.42	38.19	35.79	38.17	38.91
	0.93%	*0.80%*	*0.73%*	*0.81%*	*0.90%*	*0.82%*	*0.87%*	*0.91%*
Biomass (1)	15.40	15.40	15.40	15.40	15.40	15.97	15.94	16.40
	0.46%	*0.44%*	*0.42%*	*0.40%*	*0.36%*	*0.37%*	*0.36%*	*0.38%*
Biogas	0.55	2.01	2.29	4.13	4.99	7.43	8.91	9.98
	0.02%	*0.06%*	*0.06%*	*0.11%*	*0.12%*	*0.17%*	*0.20%*	*0.23%*
Total (excl. kerosene)	3322.38	3515.60	3649.94	3882.63	4245.64	4354.88	4394.98	4273.10

FIGURE II.6-1 – PRIMARY ENERGY CONSUMPTION (EXCL. AIR TRANSPORT): 1990-2007



Sources: Ministry of Economic Affairs and External Trade-Energy Department and FiFo Köln.

Note:

(1) wood only up to 2004 included, wood and biofuels in 2005, 2006 and 2007.

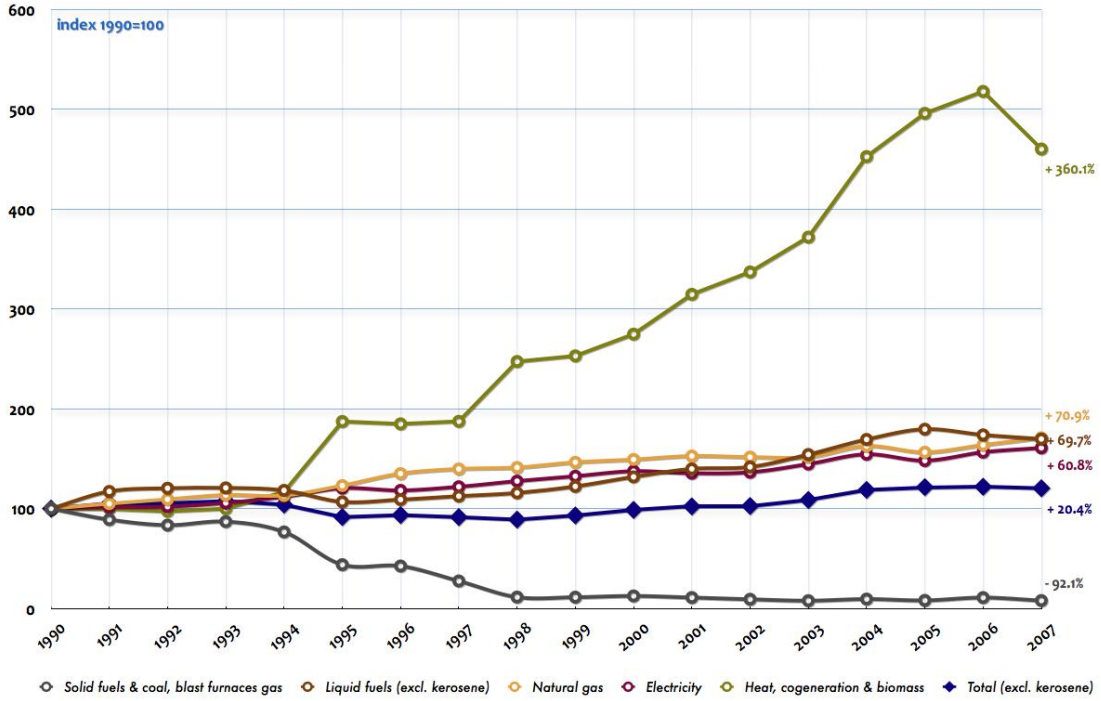
data prepared in March 2009 (subject to changes since that date)

TABLE II.6-2 – FINAL ENERGY CONSUMPTION (EXCL. AIR TRANSPORT): 1990-2007

1000 toe	1990 (base year)	1991	1992	1993	1994	1995	1996	1997	1998	1999
Solid fuels & coal, blast furnaces gas	**1021.28**	**909.03**	**852.52**	**888.65**	**782.74**	**448.24**	**434.28**	**281.20**	**116.62**	**115.50**
	30.84%	*26.13%*	*24.43%*	*24.93%*	*22.72%*	*14.79%*	*14.02%*	*9.28%*	*3.96%*	*3.74%*
solid fuels & coal	819.56	736.47	704.10	733.06	651.29	382.99	374.29	248.93	116.62	115.50
blast furnaces gas	201.72	172.56	148.42	155.59	131.45	65.25	59.99	32.27	NO	NO
Liquid fuels (excl. kerosene)	**1453.61**	**1703.86**	**1750.48**	**1755.69**	**1718.68**	**1552.32**	**1585.14**	**1634.81**	**1681.99**	**1776.83**
	43.89%	*48.98%*	*50.16%*	*49.24%*	*49.89%*	*51.21%*	*51.17%*	*53.96%*	*57.05%*	*57.61%*
Kerosene	**127.60**	**132.97**	**128.79**	**127.72**	**162.15**	**183.86**	**199.82**	**229.35**	**289.80**	**326.99**
Natural gas	**464.14**	**487.02**	**507.24**	**527.48**	**525.22**	**571.29**	**627.00**	**648.61**	**655.32**	**679.43**
	14.01%	*14.00%*	*14.53%*	*14.80%*	*15.25%*	*18.85%*	*20.24%*	*21.41%*	*22.23%*	*22.03%*
Electricity	**357.63**	**363.04**	**364.75**	**378.03**	**400.27**	**430.70**	**422.96**	**435.93**	**456.15**	**473.77**
	10.80%	*10.44%*	*10.45%*	*10.60%*	*11.62%*	*14.21%*	*13.65%*	*14.39%*	*15.47%*	*15.36%*
Heat, cogeneration & biomass	**15.40**	**15.40**	**15.00**	**15.40**	**18.00**	**28.84**	**28.47**	**28.86**	**38.09**	**38.96**
	0.46%	*0.44%*	*0.43%*	*0.43%*	*0.52%*	*0.95%*	*0.92%*	*0.95%*	*1.29%*	*1.26%*
heat & cogeneration	NO	NO	NO	NO	3.00	13.84	13.07	13.46	22.69	23.56
biomass (1)	15.40	15.40	15.00	15.40	15.00	15.00	15.40	15.40	15.40	15.40
Total (excl. kerosene)	**3312.06**	**3478.35**	**3489.99**	**3565.25**	**3444.91**	**3031.39**	**3097.85**	**3029.41**	**2948.17**	**3084.49**

1000 toe	2000	2001	2002	2003	2004	2005	2006	2007
Solid fuels & coal, blast furnaces gas	**128.26**	**112.03**	**94.10**	**79.94**	**96.22**	**82.89**	**111.53**	**81.00**
	3.92%	*3.31%*	*2.77%*	*2.22%*	*2.45%*	*2.06%*	*2.76%*	*2.03%*
solid fuels & coal	128.26	112.03	94.10	79.94	96.22	82.89	111.53	81.00
blast furnaces gas	NO	NO	NO	NO	NO	NO	NO	NO
Liquid fuels (excl. kerosene)	**1915.99**	**2031.88**	**2060.51**	**2241.59**	**2460.36**	**2609.28**	**2526.84**	**2466.90**
	58.58%	*60.02%*	*60.64%*	*62.26%*	*62.55%*	*64.84%*	*62.58%*	*61.87%*
Kerosene	**311.64**	**337.06**	**365.19**	**380.44**	**407.36**	**420.60**	**393.62**	**422.10**
Natural gas	**692.52**	**708.62**	**703.73**	**704.09**	**754.88**	**726.15**	**759.97**	**793.00**
	21.17%	*20.93%*	*20.71%*	*19.56%*	*19.19%*	*18.04%*	*18.82%*	*19.89%*
Electricity	**491.69**	**484.32**	**487.84**	**517.26**	**552.15**	**529.57**	**559.68**	**575.15**
	15.03%	*14.31%*	*14.36%*	*14.37%*	*14.04%*	*13.16%*	*13.86%*	*14.43%*
Heat, cogeneration & biomass	**42.31**	**48.45**	**51.90**	**57.27**	**69.69**	**76.36**	**79.74**	**70.86**
	1.29%	*1.43%*	*1.53%*	*1.59%*	*1.77%*	*1.90%*	*1.97%*	*1.78%*
heat & cogeneration	26.91	33.05	36.50	41.87	54.29	60.39	63.80	54.46
biomass (1)	15.40	15.40	15.40	15.40	15.40	15.97	15.94	16.40
Total (excl. kerosene)	**3270.77**	**3385.30**	**3398.08**	**3600.15**	**3933.30**	**4024.25**	**4037.76**	**3986.91**

FIGURE II.6-2 – FINAL ENERGY CONSUMPTION (EXCL. AIR TRANSPORT): 1990-2007



Sources: Ministry of Economic Affairs and External Trade-Energy Department and FiFo Köln.

Note:

(1) wood only up to 2004 included, wood and biofuels in 2005, 2006 and 2007.

data prepared in March 2009 (subject to changes since that date)

TABLE II.6-3 – ENERGY BALANCE FOR ELECTRIC POWER: 1990-2008

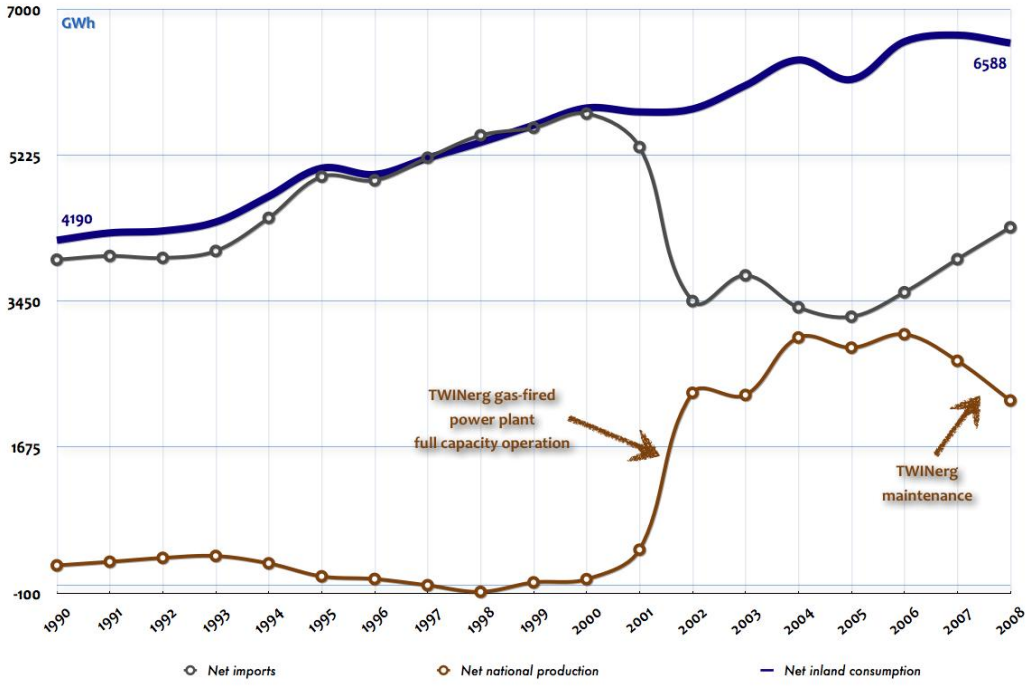
GWh		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Imports		**4708.28**	**4713.87**	**4517.87**	**4453.75**	**5026.76**	**5707.38**	**5725.89**	**6040.48**	**6388.99**	**6212.79**
National production		**626.24**	**676.37**	**662.49**	**669.79**	**626.80**	**537.67**	**503.77**	**414.77**	**343.23**	**371.12**
	cogeneration	NO	NO	NO	NO	30.00	99.84	122.35	124.83	198.03	205.15
	thermic power stations	558.72	622.11	594.14	607.83	505.96	346.53	307.87	205.38	45.38	52.29
	of which, TWINerg **(2)**	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*
	hydro-electricity	67.52	54.26	68.35	61.96	90.84	91.30	73.55	81.71	94.75	95.53
	wind	NO	NO	NO	NO	NO	NO	NO	2.74	4.61	17.14
	biomass	NO	NO	NO	NO	NO	NO	NO	0.12	0.46	1.01
	photovoltaic	NO	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00
Total		**5334.52**	**5390.24**	**5180.36**	**5123.54**	**5653.56**	**6245.06**	**6229.66**	**6455.25**	**6732.22**	**6583.91**
exports		**754.92**	**715.17**	**542.95**	**394.41**	**565.57**	**744.15**	**808.06**	**846.96**	**924.12**	**654.97**
conversion uses and losses		**389.32**	**395.43**	**334.28**	**318.06**	**364.83**	**434.15**	**431.95**	**418.98**	**428.05**	**340.97**
net inland consumption		**4190.27**	**4279.65**	**4303.13**	**4411.08**	**4723.16**	**5066.76**	**4989.66**	**5189.31**	**5380.05**	**5587.98**
Total		**5334.52**	**5390.24**	**5180.36**	**5123.54**	**5653.56**	**6245.06**	**6229.66**	**6455.25**	**6732.22**	**6583.91**

Summary in GWh	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Net imports	**3953.36**	**3998.70**	**3974.92**	**4059.35**	**4461.19**	**4963.24**	**4917.84**	**5193.52**	**5464.86**	**5557.82**
Net national production (1)	**236.91**	**280.95**	**328.21**	**351.73**	**261.97**	**103.52**	**71.82**	**-4.21**	**-84.81**	**30.15**
Net inland consumption	**4190.27**	**4279.65**	**4303.13**	**4411.08**	**4723.16**	**5066.76**	**4989.66**	**5189.31**	**5380.05**	**5587.98**
Net inland consumption in Mio. MJ	15072.91	15394.42	15478.88	15867.20	16989.80	18225.75	17948.41	18666.59	19352.70	20100.64
Net inland consumption in 1000 toe **(2)**	360.01	367.69	369.71	378.98	405.79	435.31	428.69	445.84	462.23	480.10

GWh		2000	2001	2002	2003	2004	2005	2006	2007	2008
Imports		**6465.87**	**6389.20**	**6390.70**	**6562.18**	**6506.31**	**6391.61**	**6823.54**	**6846.58**	**6829.87**
National production		**428.47**	**842.18**	**2785.42**	**2784.39**	**3373.52**	**3336.72**	**3518.95**	**3190.23**	**2707.96**
	cogeneration	227.96	321.41	341.50	382.28	421.57	417.92	438.09	362.39	378.35
	thermic power stations	51.74	374.43	2312.42	2285.48	2787.37	2736.60	2866.49	2598.86	2089.25
	of which, TWINerg **(2)**	*NO*	*323.03*	*2275.65*	*2237.29*	*2731.06*	*2646.00*	*2774.01*	*2511.69*	*2047.16*
	hydro-electricity	119.46	114.39	97.38	73.94	95.64	85.03	102.67	107.19	121.23
	wind	24.74	23.70	24.73	26.17	39.40	52.25	57.99	64.29	60.59
	biomass	4.54	8.20	9.30	15.13	20.34	27.22	32.60	36.59	38.51
	photovoltaic	0.04	0.05	0.08	1.40	9.20	17.70	21.11	20.90	20.03
Total		**6894.34**	**7231.39**	**9176.12**	**9346.57**	**9879.83**	**9728.33**	**10342.49**	**10036.81**	**9537.83**
exports		**736.85**	**1066.79**	**2939.92**	**2799.41**	**3131.58**	**3131.31**	**3266.55**	**2886.84**	**2483.53**
conversion uses and losses		**359.49**	**414.82**	**450.53**	**475.68**	**366.33**	**452.92**	**472.35**	**466.47**	**466.16**
net inland consumption		**5798.00**	**5749.79**	**5785.67**	**6071.48**	**6381.92**	**6144.11**	**6603.59**	**6683.49**	**6588.14**
Total		**6894.34**	**7231.39**	**9176.12**	**9346.57**	**9879.83**	**9728.33**	**10342.49**	**10036.81**	**9537.83**

Summary in GWh	2000	2001	2002	2003	2004	2005	2006	2007	2008
Net imports	**5729.01**	**5322.42**	**3450.78**	**3762.77**	**3374.73**	**3260.30**	**3556.99**	**3959.74**	**4346.34**
Net national production (1)	**68.99**	**427.37**	**2334.89**	**2308.71**	**3007.19**	**2883.81**	**3046.60**	**2723.76**	**2241.79**
Net inland consumption	**5798.00**	**5749.79**	**5785.67**	**6071.48**	**6381.92**	**6144.11**	**6603.59**	**6683.49**	**6588.14**
Net inland consumption in Mio. MJ	20856.11	20682.68	20811.76	21839.86	22956.54	22101.11	23753.92	24041.34	23698.33
Net inland consumption in 1000 toe **(3)**	498.14	494.00	497.08	521.64	548.31	527.88	567.35	574.22	566.02

FIGURE II.6-3 – ENERGY BALANCE FOR ELECTRIC POWER: 1990-2008



Sources: Ministry of Economic Affairs and External Trade-Energy Department, *Institut Luxembourgeois de Régulation* and FiFo Köln.

Note:

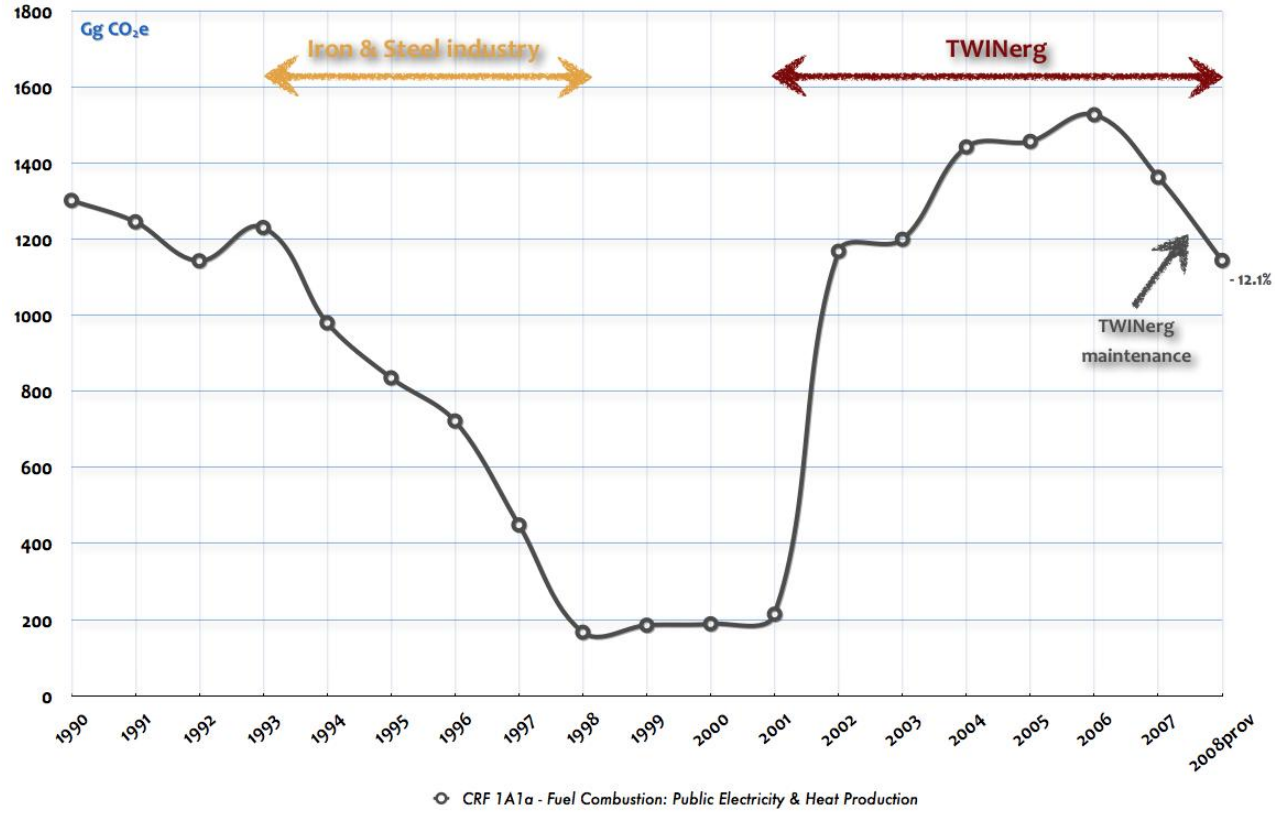
(1) the net national production is the difference between the national production and the conversion process uses and losses.

(2) as indicated in the main text, the TWINerg power plant started its commercial operation in 2002. The recorded value for 2001 corresponds to a testing phase in production.

(3) net inland consumption expressed in 1000 toe differs slightly from the corresponding figures in Table II.6-2 – less than 2% – because data sources, units and calculations are not exactly the same. The on-going work at STATEC on energy statistics aims, among other things, at avoiding these minor discrepancies.

data prepared in August 2009 (subject to changes since that date)

FIGURE II.6-4 – GHG EMISSIONS FOR PUBLIC ELECTRICITY & HEAT PRODUCTION (CRF SUB-CATEGORY 1A1A): 1990-2008[38]



Sources: Environment Agency and MDDI-DEV.

II.7. INDUSTRY

CRF (sub-)categories covered		1A2 & 2		
share in total GHG emissions, excl. LULUCF		***1990***	51.4% =	6736.96 Gg CO_2e
		2007	20.2% =	2603.00 Gg CO_2e
		2008prov	20.0% =	2477.36 Gg CO_2e
	1A2	***1990***	39.1% =	5124.28 Gg CO_2e
		2007	14.1% =	1819.34 Gg CO_2e
		2008prov	14.0% =	1738.86 Gg CO_2e
	2	***1990***	12.3% =	1612.68 Gg CO_2e
		2007	6.1% =	783.66 Gg CO_2e
		2008prov	6.0% =	738.49 Gg CO_2e

38 2008 data are provisional data estimated by the Department of the Environment during the summer of 2009 for the EC and the European Environment Agency: more on this in Section III.1 below.

II.7.1. An activity branch dominated by the metallurgy

These last years, metallurgy – steel and aluminium in Luxembourg – represented between one quarter and one third of the manufacturing industry total gross value added. Consequently, GHG it would be expected that emissions trends in the industrial sector were driven by the activities and changes that occurred in these two branches. But, aluminium production in Luxembourg is a secondary production using aluminium scraps. Since there are no transformation activities from bauxite, this branch only records emissions related to combustion activities, i.e. there are no emissions stemming from industrial processes. Then, as underlined in the previous section, the iron and steel industry has been characterized by a move from blast furnaces to electric arc furnaces between 1994 and 1998. Consequently, industrial emissions are nowadays depending on changes in activities or processes in a various number of manufacturing branches as illustrated in the section below.

Industrial process emissions include emissions from industrial installations pertaining to 3 sectors only: clinker, flat glass, iron and steel. They also cover consumption of halocarbons and SF_6 (the fluorinated gases or F-gases).[39]

II.7.2. Effects on GHG emissions: iron & steel used to set the pace

Overall emissions related to fuel combustion and processes in the manufacturing industry and construction sector were dominated by emissions generated by the iron and steel production plants up to 1998: from 1990 to 1998, GHG emissions in Luxembourg were reduced by one third due to the move from blast furnaces to electric arc furnaces. 1998 is also the year with the lowest GHG emissions, excluding LULUCF, ever recorded for Luxembourg since 1990 *[→ Figure II.7-1]*.

When the move from blast furnaces to electric arc furnaces was completed, iron and steel was no longer the main emitter of GHG and the overall emissions trend started to fluctuate according to changes in the various manufacturing and construction sub-categories. Excluding iron and steel from the picture shows that, in some cases, emissions produced by the other manufacturing industries and construction activities did evolve in an erratic way. This is particularly the case for CRF sub-category 1A2f *[→ Figure II.7-2]*. Though such irregular developments are explained by the small size of Luxembourg's industrial activities,[40] for sub-category 1A2f, the reason also lies in the way the emissions have been estimated. This is a sector where improvements in GHG calculations are requested.[41]

The striking increase of F-gases emissions *[→ Figure II.7-1]* is the consequence of supposedly growing use in the country, notably due to an increasing use of air conditioning, but also of the

39 No PFC application and emissions have been identified in Luxembourg so far.

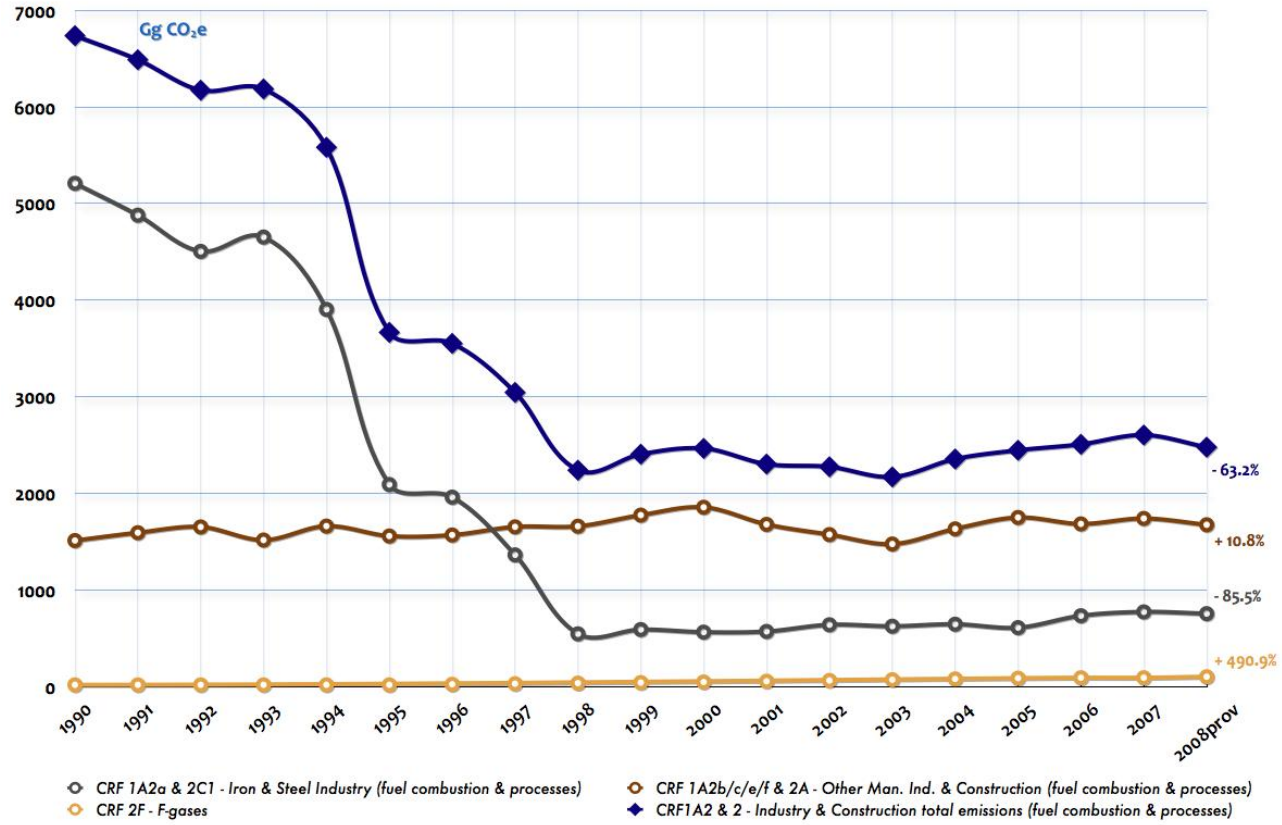
40 A change in one unit might have important impact on an aggregated trend: cf discussion in Section II.12.2 below.

41 Ministry of the Environment (2009d), table 3-33, p. 142.

hypothesis made for their estimation. Here too, as it is the case for fuel combustion in manufacturing industry, improvements in GHG calculations are requested.[42]

TABLES, FIGURES & ILLUSTRATIONS

FIGURE II.7-1 – GHG EMISSIONS FOR SELECTED CRF INDUSTRIAL SUB-CATEGORIES: 1990-2008[43]

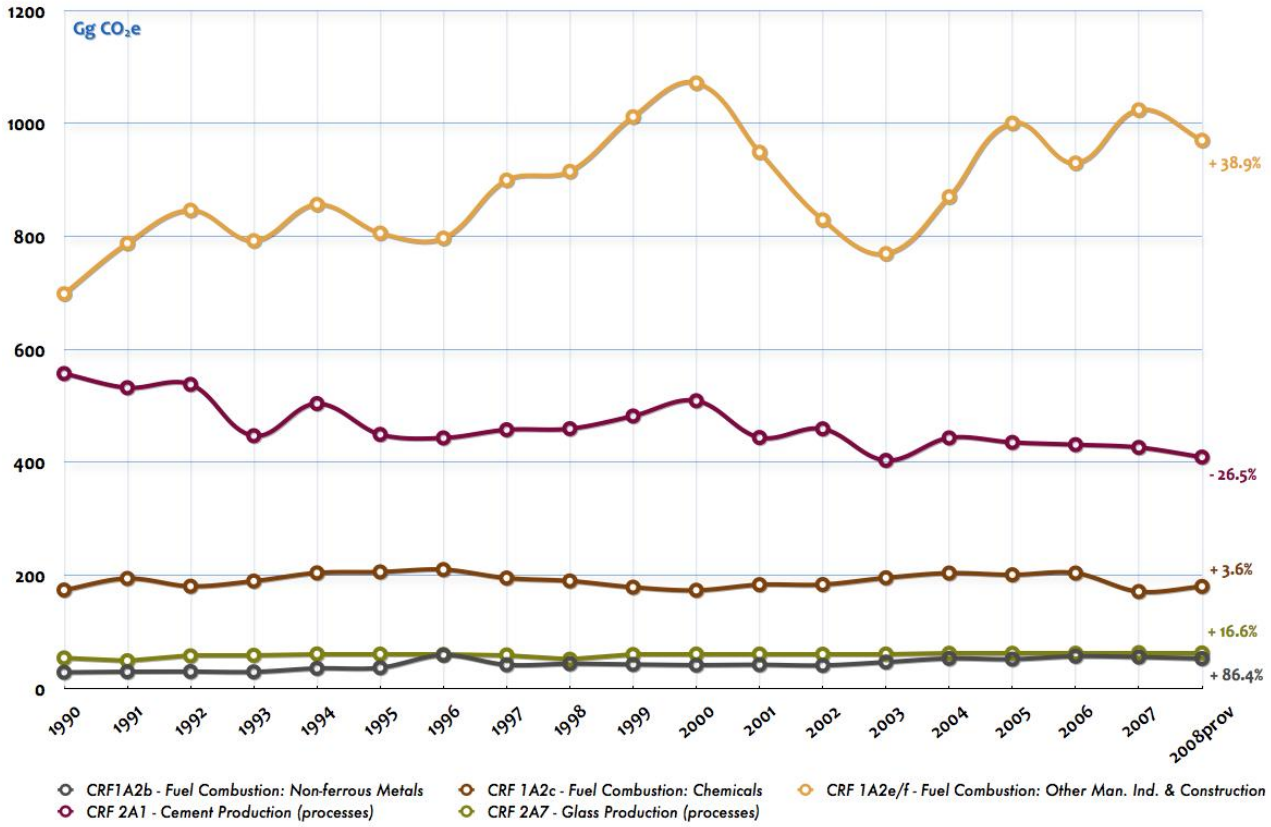


Sources: Environment Agency and MDDI-DEV.

[42] Ministry of the Environment (2009d), table 4-23, p. 200.

[43] 2008 data are provisional data estimated by the Department of the Environment during the summer of 2009 for the EC and the European Environment Agency: more on this in Section III.1 below.

FIGURE II.7-2 – GHG EMISSIONS FOR SELECTED CRF INDUSTRIAL SUB-CATEGORIES EXCL. IRON & STEEL: 1990-2008[44]



Sources: Environment Agency and MDDI-DEV.

II.8. ROAD TRANSPORTATION

CRF (sub-)categories covered		1A3b		
share in total GHG emissions, excl. LULUCF		***1990***	20.9% =	2734.93 Gg CO_2e
		2007	51.7% =	6680.50 Gg CO_2e
		2008prov	52.1% =	6459.31 Gg CO_2e
	national fleet	***1990***	6.9% =	900.46 Gg CO_2e
		2007	13.8% =	1783.92 Gg CO_2e
		2008prov	13.7% =	1702.34 Gg CO_2e
	"road fuel exports"	***1990***	14.0% =	1834.47 Gg CO_2e
		2007	37.9% =	4896.58 Gg CO_2e
		2008prov	38.4% =	4756.97 Gg CO_2e

II.8.1. Diverse inland and cross-border road transport flows

Luxembourg's location and its economic development have made it a focal point for international road traffic. Luxembourg is located at the heart of the main traffic axes for Western Europe [→

44 2008 data are provisional data estimated by the Department of the Environment during the summer of 2009 for the EC and the European Environment Agency: more on this in Section III.1 below.

Illustration II.8-1] and, therefore, has traditionally had a high volume of road transit traffic for both goods (freight transport) and passengers (tourists on their way to or back from southern Europe). The latter has increased even further by the high number of commuter journeys observed every working day. In comparison with international traffic, domestic traffic plays only a relatively small role since it responsible for only one quarter of the total road fuels sold in Luxembourg.

Road traffic is also the largest source of emissions in Luxembourg's GHG balance. Fuel quantities sold at Luxembourg's petrol stations, after having been converted into GHG volumes, are, according to IPCC reporting rules, totally included in the GHG balance, although around 75% of the emissions cannot be assigned to vehicles registered in Luxembourg and are actually emitted mostly abroad. This phenomenon is referred to as "**road fuel exports**", i.e. fuel sold to non-residents – whether they are in transit or commuting for work or leisure. Indeed, due to a policy of low taxed fuel (gasoline and diesel), Luxembourg is an attractive "fuelling station" for daily commuters from neighbouring countries and cross-border shoppers, but, in first instance, for international road transit traffic crossing its territory (mainly freight transport). "Road fuel exports" is discussed extensively in Ministry of the Environment (2006a) – i.e. the 2nd National Allocation Plan (NAP) – and Thöne (2008) and is briefly defined in Box II.8-1.

With numerous trucks transiting through Luxembourg, as well as a passenger cars market dominated by diesel vehicles in at least two of its neighbouring countries – namely Belgium and France – it is not surprising that diesel oil is the first liquid fuel in terms of volumes sold *[→ Figure II.8-1]*.

The allocation of fuel sales between residents ("domestic") and non-residents ("exports") is not made on the basis of statistics or counting, but well using the COPERT model. Box II.8-2 describes the methodology that has been applied for the GHG inventory.

Box II.8-1 – "Road fuel exports"

"Road fuel exports" cover fuel sales to non-residents, i.e.:

1. road vehicles in transit: freight trucks, buses & coaches, passenger cars, whose an important share fills up in Luxembourg because of lower fuel prices;
2. cross-border commuters who are also benefiting of the cheaper fuel prices;
3. "fuel tourism", known as "*Tanktourismus*" in Luxembourg: people driving especially to Luxembourg for benefiting of lower fuel prices, as well as lower prices on other commodities such as non-alcoholic & alcoholic drinks, tobacco, etc. (Luxembourg usually applies the lower taxation rates adopted at EU levels, i.e. 15%).

Box II.8-2 – The COPERT model

For estimating GHG emissions of the road transport sector, Luxembourg uses, such as many EU countries, the COPERT model, version IV, developed by the National Technical University of Athens [Kouridis et al (2000)] – COPERT IV uses the same approach as COPERT III, but some parameters have been revised between the two versions.

Input data are based on car fleet statistics of registered vehicles in Luxembourg as well as on various parameters, such as annual average distance covered by each vehicle category. Emission factors are defaults from COPERT IV. With this information it is thus possible to estimate annual fuel consumptions for the domestic or national vehicle fleet, i.e.

vehicles owned by people living or business settled in Luxembourg. However, this fuel consumption estimate is much lower than the total road fuel sales in Luxembourg, the difference being "road fuel exports". Lacking data on the vehicles commuting or transiting to or through Luxembourg, it is quite difficult to use the COPERT model to estimate their respective emissions on the basis of fuel sold.

Therefore, Luxembourg uses a five steps calculation procedure to calculate road transportation GHG emissions, assuming that the domestic fleet resembles the vehicle fleet of commuters, cross-border shoppers and transit vehicles:

1. fuel consumption and GHG emissions of the domestic vehicle fleet are estimated for each fossil fuel type using COPERT IV;
2. implied emission factors are calculated from the above mentioned data, by dividing the emissions relative to each gas and fuel type by the corresponding calculated fuel consumption;
3. biofuel quantities were subtracted from the quantities of fuel sold, to differentiate between fossil and biogenic emissions;
4. national emissions per fuel type were calculated by multiplying the implied emissions factors with the corresponding quantities of fuel calculated in step 3.
5. national emissions per GHG are obtained by adding the corresponding national emissions per fuel type.

II.8.2. Effects on GHG emissions: an untypical situation

Combining the size of the country and of its economy, on the one side, and lower road fuel prices that implies a disproportionate volume of road fuel sales compared to its resident population, on the other side, Luxembourg presents a completely untypical and unique structural feature in its GHG emissions balance. In 2007, some 6.68 Mio. t CO_2e were produced by the road transportation sector and out of these, almost 4.9 Mio. t CO_2e, or 73.8%, was the result of road fuels bought by non-residents and were, consequently, merely emitted abroad – provisional figures for 2008 are 6.46 Mio. t CO_2e, 4.8 Mio. t CO_2e and 73.6% respectively. That amount represented around 38.2% of the total 2007 GHG emissions for Luxembourg (excluding LULUCF) – 38.4% for 2008 – which makes of CRF sub-category 1A3b the first contributor to total GHG emissions *[→ Figure II.8-2 & Table III.1-4]*. According to the baseline scenario used by Luxembourg for its 2nd NAP [Ministry of the Environment (2006a)], this proportion may increase up to 46% by 2012.[45]

Both emissions generated by the national vehicles fleet and by the non-residents – "road fuel exports" – showed dramatic increases over the period: +82% and +165% respectively *[→ Figure II.2-3]*.[46] For the national fleet, the evolution is correlated with both the population and economic activity growth as depicted in *Section II.2*. It is also explained by an increasing rate for passenger cars per inhabitants (from 515 to 675 passenger cars per 1000 inhabitants between 1991 and 2007, i.e. the highest rate within the EU[47]). Regarding "road fuel exports", the rise is undoubtedly

45 Nevertheless, "road fuel exports" have reached a maximum in 2005 with 5.7 Mio. t CO_2e, which represented 78% of road transportation GHG emissions and 41.5% of the total GHG emissions (excluding LULUCF). Consequently, the upward trend that was characterizing "road fuel exports" since 1995 is slightly reversing these last years. Moreover, the 2012 estimate has been made a few years ago and did not, of course, anticipate the financial and economic crisis.

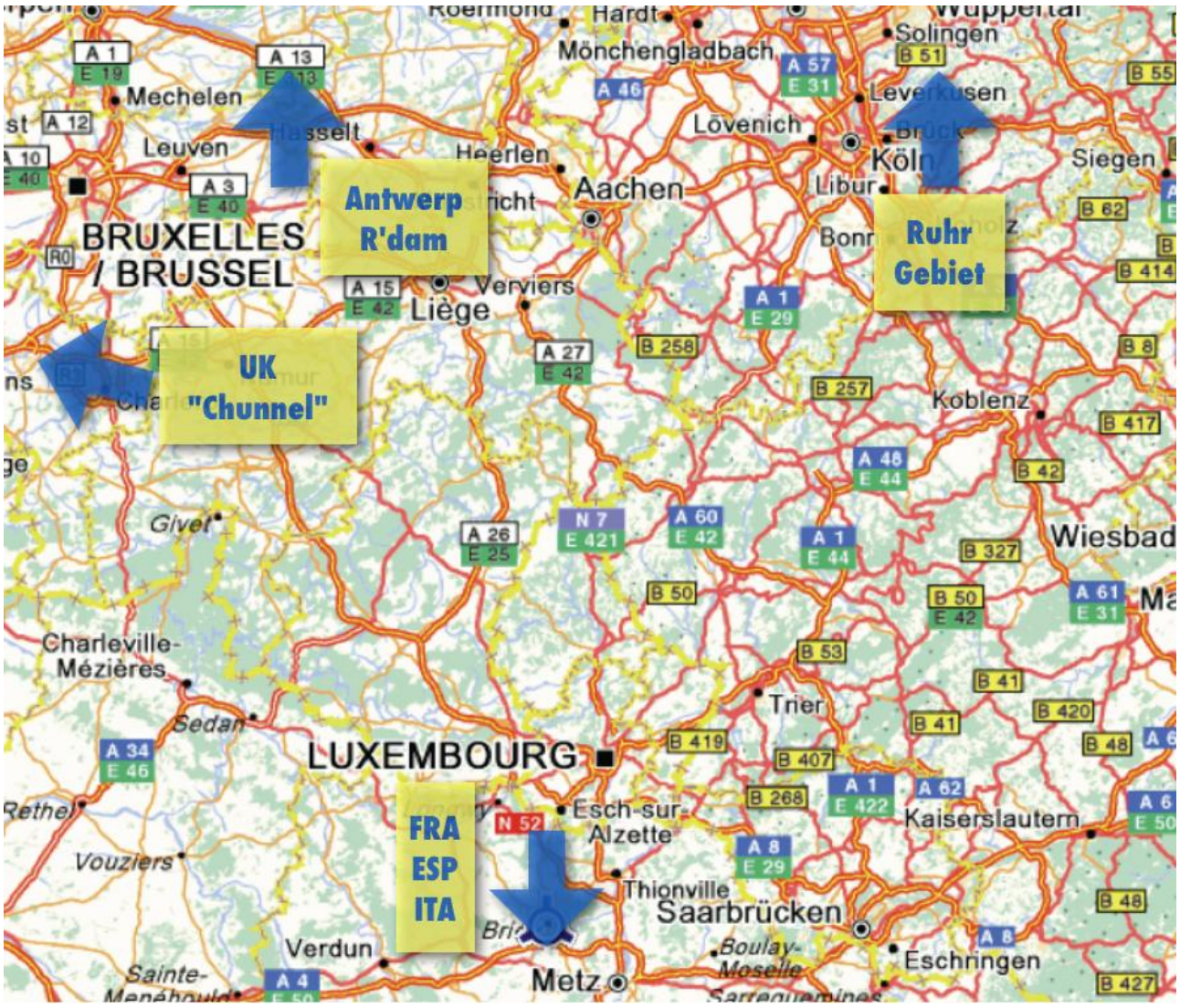
46 Corresponding percentages were +67% and +209% in 2005, the peak year with regard to road transportation related emissions.

47 Data extracted from EUROSTAT databases (updated 18-06-2009) and from EUROSTAT, *Energy, transport and environment indicators*, 2009 edition, p.92-93.

linked to the growing number of commuters crossing the borders every working day as well as to the general increase of road freight traffic in Europe.[48]

TABLES, FIGURES & ILLUSTRATIONS

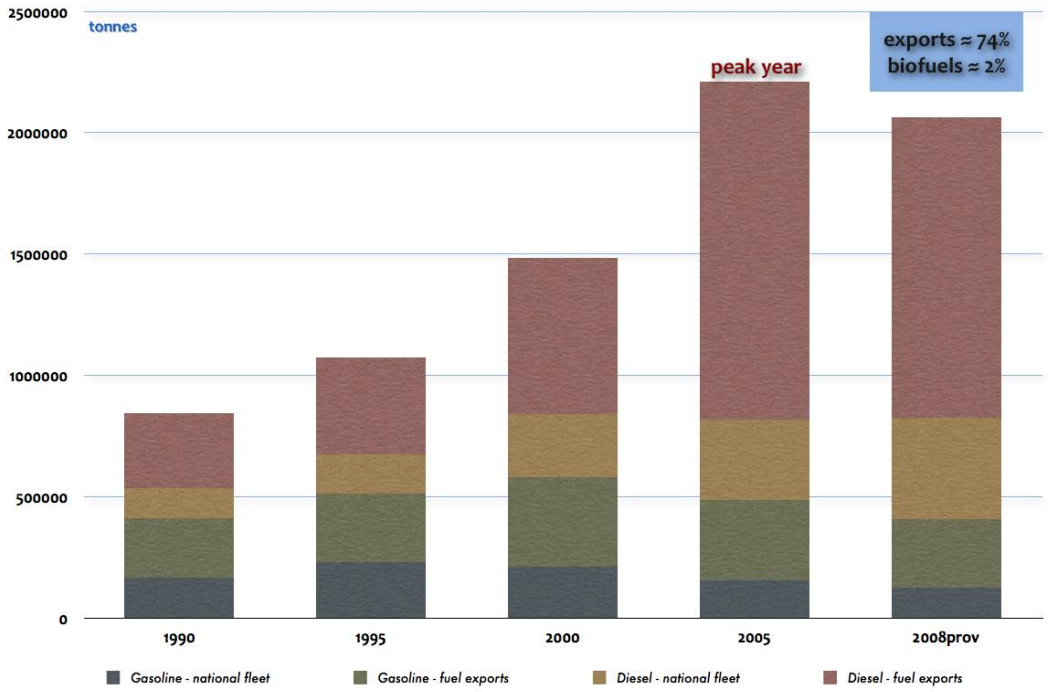
ILLUSTRATION II.8-1 – MAIN ROAD FREIGHT AXES CROSSING LUXEMBOURG



Source: ViaMichelin.

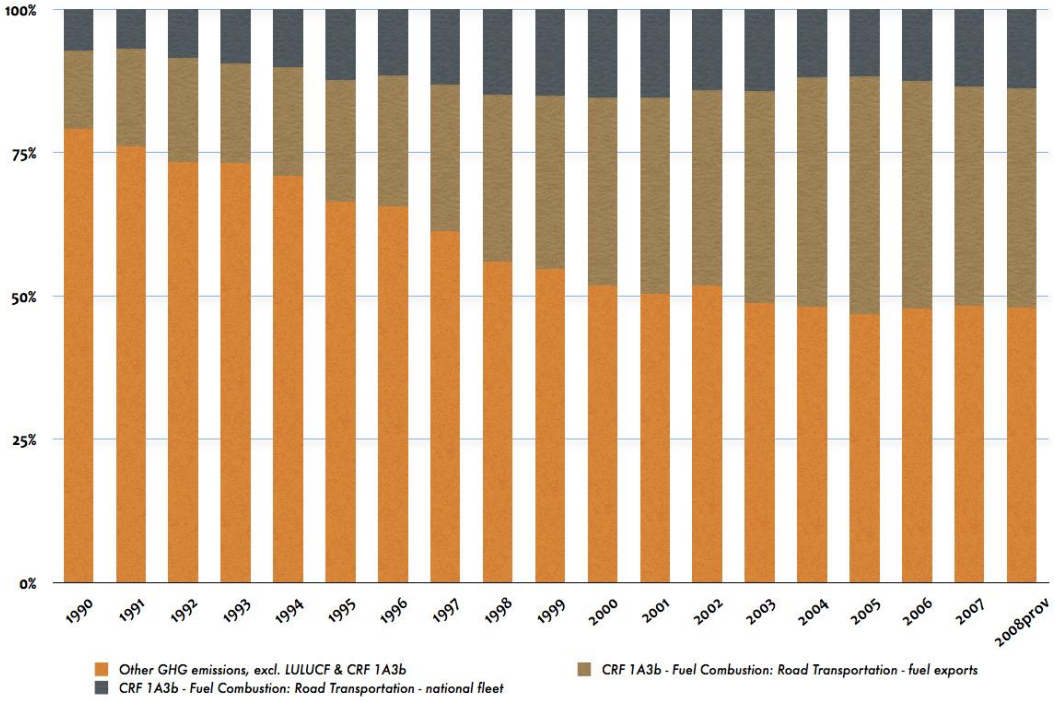
[48] It is important to stress that price differentials for diesel have reduced these last years, especially with Belgium where a "professional" price has been implemented for diesel with low sulphur content since 2004 – via refunding of excises surpluses (cf http://www.uptr.be/common/pages.php?s_id=11_50 for instance) paid by EU licensed taxis, busses & coaches and road freight trucks over 7.5 tonnes. A similar arrangement exists in France too for road freight trucks over 7.5 tonnes (http://www.douane.gouv.fr/page.asp?id=171#0). Now, these last years, ¾ of the diesel sold in Luxembourg was bought by non-residents, against two-thirds for gasoline. The introduction of these measures could be one of the reasons behind the drop in "road fuel exports" observed since 2005.

FIGURES II.8-1 – ROAD FUEL SALES: 1990-2008 IN TONNES[49]



Sources: Environment Agency and MDDI-DEV.

FIGURE II.8-2 – GHG EMISSIONS FOR ROAD TRANSPORTATION (CRF SUB-CATEGORY 1A3b): 1990-2008[50]



Sources: Environment Agency and MDDI-DEV.

Note: excluding CO_2 emissions from biofuels, which are reported as "memo item".

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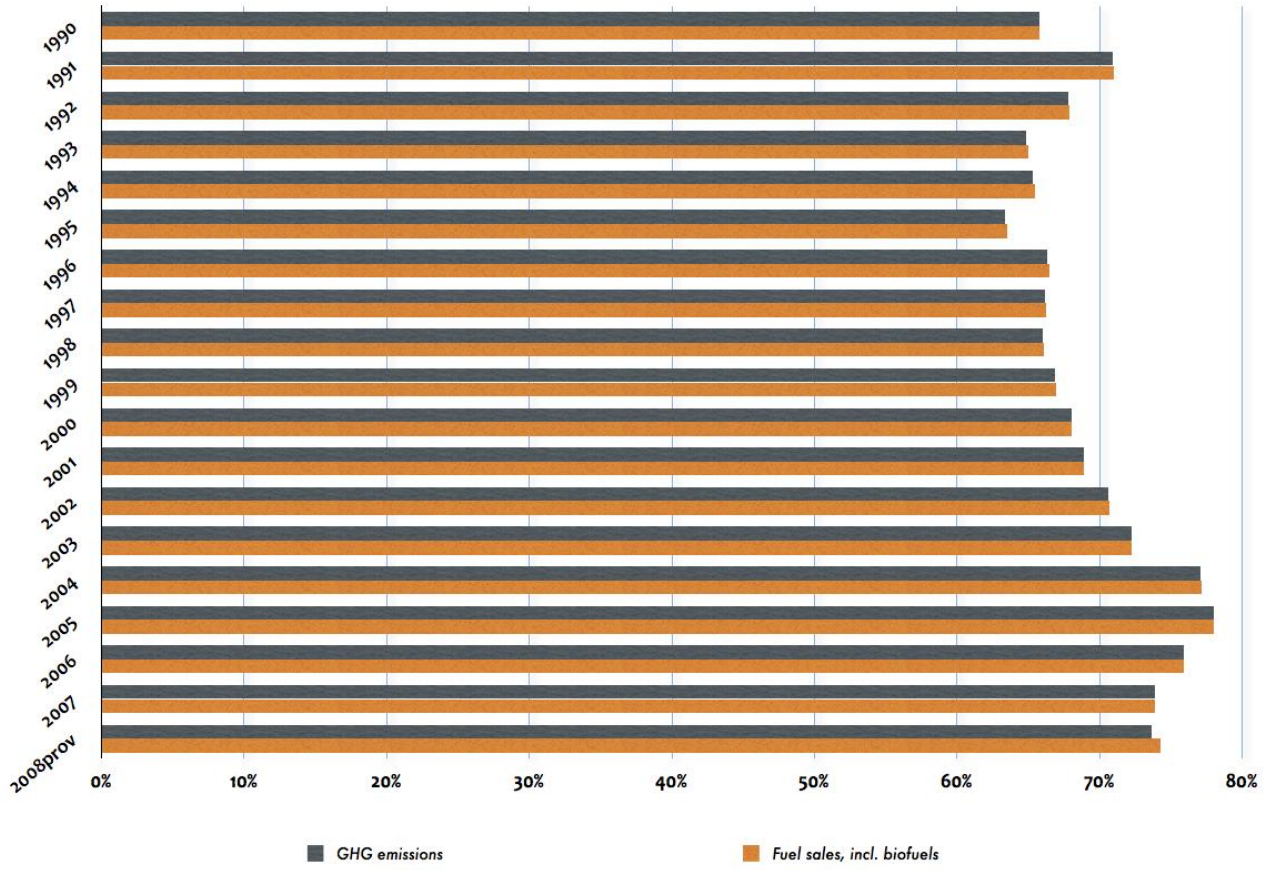
[49] 2008 data are provisional data estimated by the Environment Agency and the Department of the Environment on the basis preliminary data prepared by the Energy Directorate of the Ministry of Economic Affairs and External Trade.

[50] 2008 data are provisional data estimated by the Department of the Environment during the summer of 2009 for the EC and the European Environment Agency: more on this in Section III.1 below.

FIGURE II.8-3 – SHARE OF "ROAD FUEL EXPORTS" IN FUEL SALES AND IN CRF SUB-CATEGORY 1A3b GHG EMISSIONS: 1990-2008



Sources: Environment Agency and MDDI-DEV.

Note: biofuels are included in fuel sales from 2004 onwards. They are not included in GHG emissions for CO_2 as they are reported as "memo item".

II.9. AGRICULTURE

CRF (sub-)categories covered	4		
share in total GHG emissions, excl. LULUCF	***1990***	5.9% =	775.27 Gg CO_2e
	2007	5.5% =	710.64 Gg CO_2e
	2008prov	5.8% =	725.00 Gg CO_2e

II.9.1. A sector that concentrates in fewer units but shows stability in land consumption

In 2008,[51] 2 268 farms were counted. They were managing a utilized agricultural area (UAA) of 130 421 ha, i.e. a bit more than 50% of the territory of Luxembourg. The UUA was divided almost equally between arable land (60 656 ha) and permanent pasture and meadows (67 173 ha). With

[51] Agriculture yearly censuses are reflecting the situation on the 15th of May. The latest census is available here: http://www.ser.public.lu/statistik/agrarstrukturen/statec_15_mai_pluriannuel.pdf .

1 544 ha, permanent crops represented only 1.2% of the total UUA. The remaining surfaces were dedicated to horticulture and family gardens.

About a half of the arable land was covered by cereals in 2008 (mostly wheat and barley and, to a lesser extent, triticale). Permanent pasture and meadows were mainly grazing land (58 359 ha) and permanent crops related to vineyards for their most part *[→ Table II.9-1]*.

Since 1990, the UAA did not change a lot: a 3.3% increase. However, arable land surfaces climbed by 10%, whereas permanent pastures & meadows stepped back by about 2.5%. Permanent crops increased by 7.2%.

Since the 1950s, agriculture has undergone profound structural changes, with the number of farms falling by 92% between 1950 and 2008 (i.e., 0.3% annually on average). Since 1990, 1 535 farms closed down, which corresponds to more than 85 farms on average per year. In percentage, the reduction reached -40% (i.e., 2.8% annually on average). This reduction in the number of units touches all the size classes. Only those farms with more than 50 ha stabilized between 1990 and 2008: -3%. These bigger farms are the only one seeing their numbers increased since 1950.[52]

In 2008, 3 535 ha were classified under organic farming – i.e. 2.7% of the total UAA – and 85 farms were active in this field – i.e. 3.7% of all the farms.[53] In 2000 (first data collected on organic farming), the corresponding percentages were 0.8% of the UUA and 1.1% of all the farms. The surfaced dedicated to organic farming are peaking since 2006 (2006: 3 516 ha & 2007: 3 733 ha). It has to be stressed that the latest rural development plan do not offer incentives and grants for organic farming; solely the preservation and the development of natural zones in the rural landscapes is supported via the agri-environment support scheme.[54] The most important agri-environmental measure is the "premium for the upkeep of the landscape and the countryside", designed to maintain agricultural activity on lands suitable for farming, vineyards and horticulture, using forms of exploitation that are adapted to the natural setting and landscape and respectful of the environment. This premium was introduced in 1997 in the context of Regulation (EC) 2078/1992.

Livestock population in Luxembourg has also undergone some changes since 1990. With regard to cattle, its total population size declined throughout the period 1990-2008. However, a shift did occur within the cattle population with a reduction for dairy cattle (-32%) and an increase for female mature non-dairy cattle (+64.2%) *[→ Table II.9-2]*. In fact, cattle population and its evolution are strongly influenced by changes in the agricultural policy and, more precisely, in the

52 Data mentioned in this paragraph are extracted from STATEC, *Statistical Yearbook*, Table C.2101: http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=142&IF_Language=fra&MainTheme=3&FldrName=2&RFPath=6.

53 Farms that are converted or in course of being converted and recognized by the authorities in the scope of Council Regulation (EC) 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) 2092/91.

54 Rural Development Plan 2007-2013: http://www.ma.public.lu/aides_financieres/aides_communautaires/aides_rural/brochure.pdf, p. 20-21.

Common Agricultural Policy of the EU (CAP). This is the case for dairy cows, whose declining population results from the combination of increasing milk yields and the introduction of a milk production cap (administrative quota system for milk production). Furthermore, several reductions in the milk quota were decided in the framework of the CAP. Another factor influencing cattle population is, of course, prices (which, themselves are affected by agricultural policy changes and targets). As an example, the peak in the non-dairy cattle population observed in 1991 can be explained by a sharp price fall of the bovine meat price that year. This price fall led farmers to postpone slaughtering until early 1992.

Table II.9-2 presents the population for a selection of livestock categories, those which are the main sources of methane and nitrous oxide emissions. Actually, in 2008, cattle accounted for 97% of methane emissions due to enteric fermentation and for 63% of the emissions of the same gas stemming from manures. Cattle were also responsible of 87% of the nitrous oxide emissions due to manure management schemes.

More detailed data on agricultural activities are compiled in a booklet - *the agriculture of Luxembourg in figures* published in September 2009 by the *Service d'Economie Rurale* (SER)[55] – and are also available on the SER website[56] and in STATEC's *Statistical Yearbook*.[57]

II.9.2. Effects on GHG emissions: slow decrease in emissions

In Luxembourg, emissions are recorded for 3 CRF categories: enteric fermentation (CRF 4A), manure management (CRF 4B) and agricultural soils (CRF 4D). GHG emissions for 2008 are final data that will be included in the next submission to the UNFCCC Secretariat in spring 2010.[58] They could already be calculated because, as indicated in footnote 51, for animal and crop productions, the years covered in the GHG inventory run from the 15th of May of year T-1 to the 15th of May of year T.

Total GHG emissions related to agricultural activities slowly decline by about 10.3% since 1990, i.e. at an annual average rate of -0.8%. Enteric fermentation saw its emissions falling by 6.6%, whereas agricultural soils, the decrease reaches almost 16%. For manure management, emissions remained quite stable between 1990 and 2008 (-1.9%), though opposite variations are observed for the two GHG emitted by this activity: methane increased by almost 17% and nitrous oxide declined by 38% *[→ Figure II.9-1]*.

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55 http://www.ser.public.lu/publikationen/Landwirtschaft_in_Luxbg/lux_landw_zahl_en.pdf.

56 http://www.ser.public.lu/statistik/index.html.

57 Tables C series: http://www.statistiques.public.lu/stat/ReportFolders/ReportFolder.aspx?IF_Language=fra&MainTheme=3&FldrName=2&RFPath=6.

58 These emissions do not correspond to the data in the box above which are extracted from submission 2009v1.4. The revision for submission 2010v1.1 reduces agriculture related emissions by 3.5% to 7.5% according to the years. Revised data have not been included in the box and in subsequent tables in this NC so to keep comparability with the 2009v1.4 submission totals.

Agricultural soils emissions present an erratic evolution towards the end of the period *[→ Figure II.9-1]*. This is explained mainly by important changes in crops, as well as in N-fertilizer use, which showed a slack in 2003 and a peak in 2004. The lower N-fertilizer use in 2003 was the result of the drought that characterized that year's summer. The evolution of that CRF category also shapes the overall agriculture emission pattern since it is the biggest contributor to agriculture related emissions (45-50% over the whole period). It is also worth noting that the shares in the total agricultural emissions of each category for which emissions have been reported have not changed much over the period.

TABLES, FIGURES & ILLUSTRATIONS

TABLE II.9-1 – AGRICULTURAL UTILIZED AREA: 1950-2008

ha	1950	1970	1990	1995	2000	2005	2006	2007	2008
Agricultural utilized area (UAA)	**144053**	**135143**	**126298**	**126865**	**127643**	**129128**	**128875**	**130884**	**130421**
Arable land	79628	64228	55891	57841	60927	60017	59665	61022	61656
cereals	*52699*	*45341*	*32980*	*28774*	*28639*	*28497*	*28846*	*28513*	*31068*
dried pulses	*407*	*423*	*537*	*474*	*431*	*467*	*372*	*367*	*222*
tubers & roots	*13083*	*3302*	*1057*	*1023*	*906*	*659*	*631*	*667*	*634*
industrial plants (colza, …)	*14*	*62*	*1999*	*2247*	*3344*	*4687*	*5563*	*6112*	*5764*
forage plants	*11070*	*13528*	*19024*	*23543*	*26079*	*22869*	*22063*	*23196*	*22938*
other	*146*	*13*	*22*	*7*	*2*	*978*	*828*	*821*	*889*
fallow land	*2209*	*1559*	*272*	*1773*	*1527*	*1861*	*1363*	*1347*	*140*
Permanent pastures & meadows	60893	69094	68827	67515	65277	67504	67659	68290	67172
pastures (grazing land)	*32276*	*39509*	*41070*	*40450*	*44407*	*57747*	*56946*	*59290*	*58359*
Kitchen gardens	1483	317	121	73	53	27	25	12	12
Horticulture	145	63	19	18	21	34	31	49	37
Permanent crops	1904	1441	1440	1418	1365	1546	1494	1512	1544
vineyards	*1188*	*1180*	*1326*	*1297*	*1249*	*1275*	*1275*	*1294*	*1294*

Sources: SER: http://www.ser.public.lu/statistik/agrarstrukturen/statec_15_mai_pluriannuel.pdf

STATEC, *Statistical Yearbook*, Table C.2100:
http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=141&IF_Language=fra&MainTheme=3&FldrName=2&RFPath=6

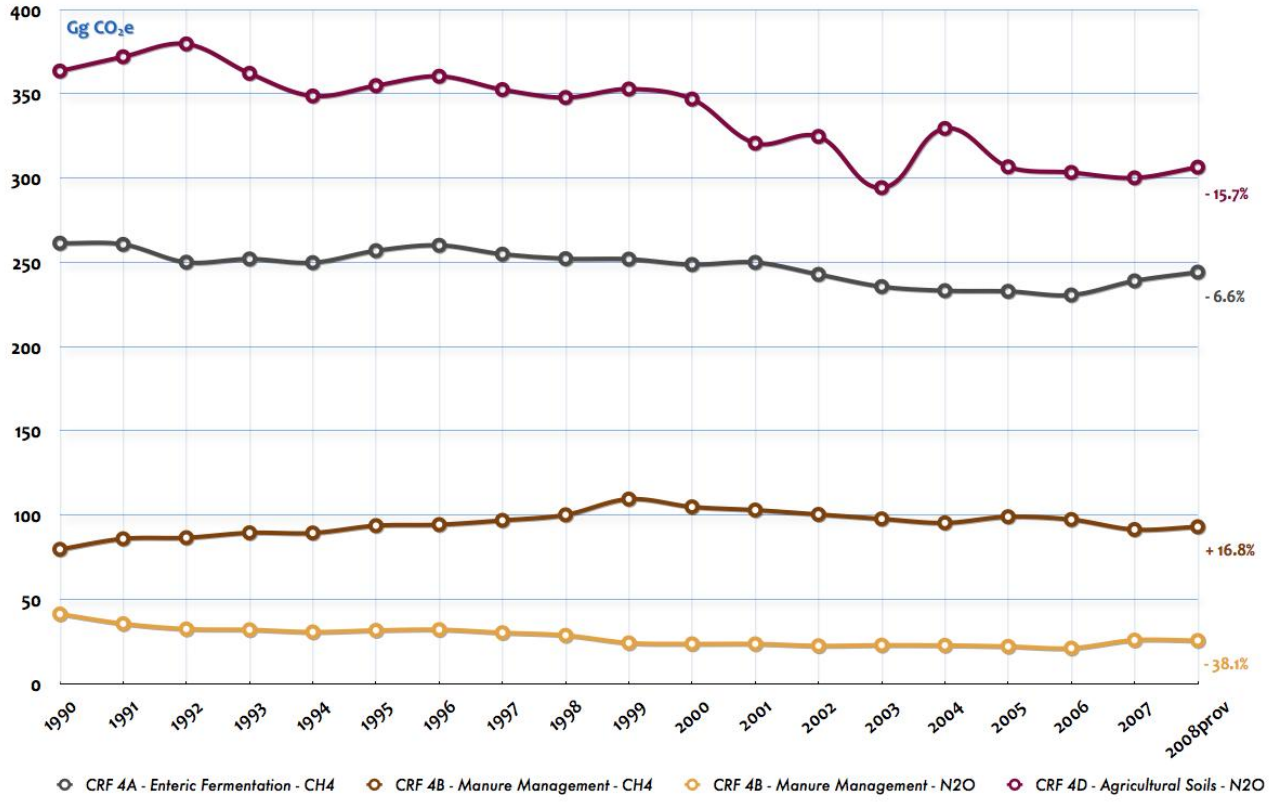
TABLE II.9-2 – LIVESTOCK POPULATION FOR SELECTED ANIMALS' CATEGORIES: 1990-2008

heads	1990	1995	2000	2005	2006	2007	2008
Dairy cattle	58840	48599	43346	39340	38617	38983	39968
Non-dairy cattle	158611	165288	161726	145895	145023	152945	155693
Sheep	7281	7552	7971	10277	9644	9339	8477
Horses, mules & asses	1722	2164	3154	4193	4336	4334	4536
Swine	75463	72640	80141	90147	84151	83255	81374

Sources: SER: http://www.ser.public.lu/statistik/agrarstrukturen/statec_15_mai_pluriannuel.pdf

STATEC, *Statistical Yearbook*, Table C.2107:
http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=148&IF_Language=fra&MainTheme=3&FldrName=2&RFPath=6

FIGURE II.9-1 – GHG EMISSIONS FOR AGRICULTURE (CRF SECTOR 4): 1990-2008



Source: MDDI-DEV.

II.10. FORESTRY

CRF (sub-)categories covered	5A1		
share in total GHG emissions, incl. LULUCF	***1990***	1.5% =	205.39 Gg CO_2e
	2007	|3.2%| =	-396.18 Gg CO_2e
	2008prov	NA =	NE

II.10.1. Forests in Luxembourg: an old asset under a shared responsibility[59]

With the retreat of farming over the last century, the forest area has increased to reach nowadays some 89 000 ha, covering a bit less than 35% of the national territory as a whole (ranging from 42% in Ösling to 31% in Gutland). The Ardennes region is the most heavily wooded.

Forests are managed by the public authorities – the Nature and Forests Administration (NFA) – and an association of private owners - *Lëtzebuerger Privatbësch – Family Forestry Luxembourg*.[60] NFA administers municipal woods (some 33% of the forests of Luxembourg), woods owned by the state (11%) and those belonging to public administration (1%). Public forests are managed according to

[59] Some texts of this section have been extracted from OECD (2010).

[60] http://www.privatbesch.lu/.

Resolution H1 of the Second Ministerial Conference on the Protection of Forests in Europe held in 1993 in Helsinki[61] and which is part of the PEFC system ("Program for Endorsement of the Forest Certification scheme").

The remaining 55% are private forests, which are extremely fragmented[62] and generally neglected. However, professional foresters have been assigned to *Lëtzebuerger Privatbësch* to help private owners promote sustainable forestry. This is notably done under the "Luxembourg Certification Scheme for Sustainable Forest Management".[63]

The different forests types are:

- broadleaved forests – mostly beech & oak – for 47% of the total (¾ of these trees are located in public forests);
- mixed forests – lobed-leaved trees and conifers such as spruces & pines – for 35% of the total (two thirds being located in private forests);
- coppices and bark hedges for 15% of the total (almost 90% being placed in private forests);
- non forested areas – shrubs, forest roads, quarries, clear cuttings, etc. – for a bit more than 3%.

The Luxembourg forest contains no natural forest and has been strongly stamped by human activity.[64] Old-growth forests (over 100 years) cover 16 800 ha, or 61% of the broadleaved forest. Conifer groves are younger, because their production cycle is shorter. Total reforestation between 1985 and 2005 covered 8 250 ha, versus 12 800 ha during the previous period, despite the massive tree planting campaign after the storms of 1984 and 1989-90. As a whole, the Luxembourg forest is relatively old.

Observations on the phytosanitary state of Luxembourg forest show sharp degradation of the forest, which appears today to have stabilised.[65] The declining health of these forests results from complex factors that include air pollution (causing acidification and eutrophication), climate change, diseases due to insect infestations, impoverishment of forest soils, and deficiencies in magnesium and calcium. The situation has been aggravated by replanting with a poor choice of species and inappropriate forestry activities.

The ageing of the forest also increases the risk of infestation by insects and other parasites. Insect attacks have affected 8 800 m³ of beech stands in Ösling and 3 750 m³ in Gutland, adding to the

61 http://www.mcpfe.org/filestore/mcpfe/Conferences/Helsinki/helsinki_resolution_h1.pdf.

62 In particular, because of the pattern of transmission through successive generations.

63 http://www.privatbesch.lu/index.php?id=9 and http://www.pefc.lu/. The latter is a joint web portal of and for the public authorities and the private owners.

64 The beech stands of Gutland, for instance, have been overexploited to produce charcoal for the iron industry.

65 http://www.environnement.public.lu/forets/dossiers/pfn/index.html.

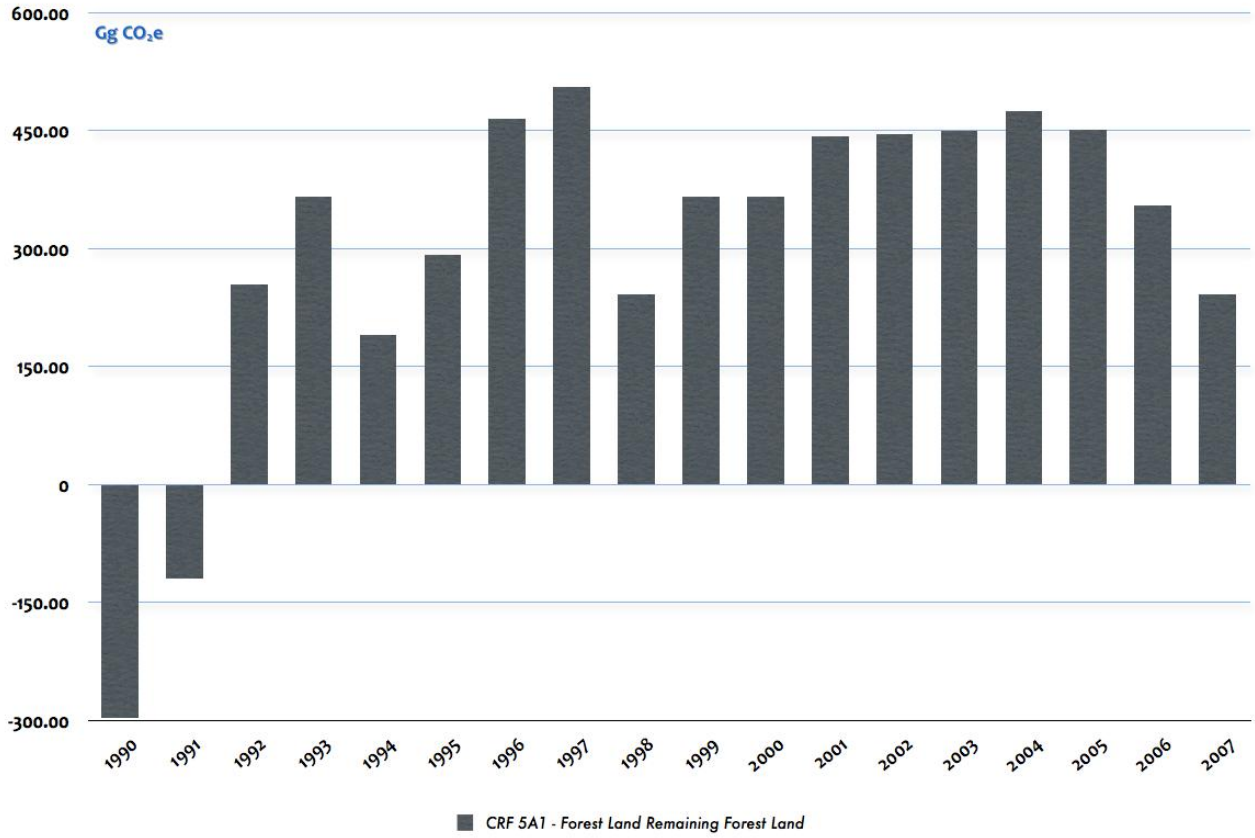
damage caused by overabundant populations of game, whose browsing has affected 5% of mature trees and 66% of replanting.

II.10.2. GHG emissions: forests act as a sink in Luxembourg

Submission 2009v1.4 to the UNFCCC[66] was the first to contain an elaborated estimation of GHG emissions or removals for CRF sub-category 5A1 – forest land remaining forest land.[67] From these calculations there have been net emissions in both 1990 and 1991 *[→ Figure II.10-1]*. This is the consequence of the important storms that touched the country in early 1989-90 and severely hit Luxembourg's forests, for which two-thirds consists of single-story stands, which are more unstable than multi-storied forests in the face of storms.

TABLES, FIGURES & ILLUSTRATIONS

FIGURE II.10-1 – GHG EMISSIONS & REMOVALS FOR FOREST LAND REMAINING FOREST LAND (CRF SUB-CATEGORY 5A1): 1990-2007



Source: Nature and Forests Administration.

Note: negative values correspond to net emissions and positive values to net removals.

66 Available at http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/lux_2009_crf_19may.zip.

67 For details, refer to the NIR of submission 2009v1.4 [Ministry of the Environment (2009d), section 7.2, p. 282-285].

II.11. WASTE

CRF (sub-)categories covered		1A1a part & 6		
share in total GHG emissions, excl. LULUCF		***1990***	0.7% =	97.25 Gg CO_2e
		2007	0.9% =	122.08 Gg CO_2e
		2008prov	1.0% =	124.24 Gg CO_2e
	1A1a pt	***1990***	0.3% =	33.92 Gg CO_2e
		2007	0.5% =	66.94 Gg CO_2e
		2008prov	0.6% =	68.38 Gg CO_2e
	2	***1990***	0.5% =	63.34 Gg CO_2e
		2007	0.4% =	55.14 Gg CO_2e
		2008prov	0.5% =	55.86 Gg CO_2e

II.11.1. Managed waste streams bearing concrete results[68]

Luxembourg has for many years been pursuing an active policy of waste management based on prevention and recovery with a view to minimising environmental impact and supplying high-quality secondary raw materials. It gives priority to recovering materials for reintroduction into the economic circuit.

The legislative and regulatory framework is based on the amended "Waste Prevention and Management Act"(*Plan Général de Gestion des Déchets*, PGD),[69] which calls for full-cost pricing at every stage of waste management and sets the following goals:

- preventing and reducing waste production and pollution from waste;
- recovery through reuse, recycling or any other environmentally appropriate method;
- disposal of final waste in environmentally and economically appropriate ways.

Other laws and grand-ducal regulations concerning specific waste flows supplement the PGD Act and transpose European legislation into national law (movements of hazardous waste, packaging waste, waste oils, PCBs, waste incineration, sewage sludge, waste electrical and electronic equipment (WEEE), batteries etc.). European legislation plays an increasing role in determining policies and establishing objectives. Luxembourg must also comply with other international commitments relating to cross-border waste movements and to the ecological management of waste and resource productivity.

II.11.1.1. Municipal waste: high generation but also high recovery rate

Under the impact of separate collection and recovery measures, there has been a continuous decoupling between municipal waste, residual waste for disposal and GDP these last 10 to 15

68 Some texts of this section have been extracted from OECD (2010).

69 http://www.environnement.public.lu/dechets/dossiers/pggd/index.html.

years. The volume of waste that must be dealt with has been growing less quickly than GDP, although at a rate close to growth in private consumption, while both population and cross-border employment have been rising (→ *Section II.2*). Waste generation per capita (at 690 kg) is among the highest in Western Europe. It is, however, including waste generated by cross-border commuters and by (small) services businesses whose numbers increased considerably since 1990.

But, collection and recovery rates of municipal waste are among the best in Europe. With separate collection, some 44% of total municipal waste can now be recovered. Recovery volumes are rising, reflecting the growing network of recycling centres and active public awareness about trash sorting. Municipal waste collection amounts to more than 300 kg per capita every year, making Luxembourg's performance among the best in Western Europe. Most of the waste collected is exported for recycling (primarily to Germany, Belgium, France and the Netherlands). Organic waste is also recovered but, with a rate of 45%, it remains insufficient.

There has been a decrease of municipal waste being incinerated or stored in landfill sites during the last decade: -15%. More than two-thirds of this waste is incinerated with energy recovery (72%), while the remainder goes to landfills (28%). The objective of reducing landfill-destined biodegradable waste to 35% of the 1995 level by 2016 has already been achieved.

II.11.1.2. Industrial, commercial and service waste: important volumes but declining

Industrial, commercial and service waste was estimated at 389 000 tonnes in 2007, of which respectively 296 000 tonnes and 93 000 tonnes of waste are generally exported to Germany, France, Belgium and the Netherlands for treatment. Indeed, Luxembourg does not have recycling or recovery installations on its small territory. The same holds for municipal waste collected through recycling centres or schemes, which are, therefore, mostly sent abroad for valorisation or other treatments.

Final industrial waste declined during the period under review, reflecting the combined impact of the closure of a mill and of the implementation of "Waste Prevention and Management Plans" (*Plan de Prévention et de Gestion des Déchets*, PPGDs) by businesses, which have diverted many types of waste from disposal to recovery. In fact, companies are to appoint a "waste management officer" and prepare a PPGD that requires firms to evaluate their prevention and recycling potential and to institute ecological management of their waste. More than 3 000 firms have established such a plan since 1995.

II.11.1.3. Other waste streams are also subject to valorisation

There are about 13 000 tonnes of sewage sludge generated each year, most of which is used in agriculture (50 to 55%) as fertilizer (sludge spreading) or composted (around 40%). There are also 10.5 Mio. t of inert waste, consisting primarily of construction materials (76% excavated earth),

demolition waste and road maintenance waste that have to go to dedicated disposal sites where they are recovered, notably via grinding operations. The volume of inert waste generated, which is closely linked to construction activity, has risen in recent years.

II.11.1.4. Waste reduction and materials recovery: the solution for Luxembourg waste management policy

Luxembourg has few levers available for influencing the design or composition of products. It can however act on consumer habits and on household and business participation in selective sorting and in waste prevention and ecological management programmes. Its policy is to introduce separate collection and appropriate management systems, together with information targeted at households and consumers, as well as advisory services, training and assistance to businesses.

For 20 years now, separate collection of **municipal waste** has been based on both mobile and fixed collection, a network of 24 recycling centres and a programme of regular public information. Separate collection applies to all recoverable items and "problem waste". The volumes collected by voluntary delivery to recycling centres have more than doubled since 1999.

To prevent the **generation of consumer waste**, the emphasis is on informing the public about the products that generate waste, components that are hazardous to the environment and health, and available substitutes. These efforts rely on joint public- and private-sector initiatives and on economic instruments.

With regard to **industrial, commercial and service waste**, the main instruments for achieving waste prevention targets and reintroducing materials into the economic circuit are the PPGDs and the advice provided to businesses by the *SuperDrecksKëscht® fir Betriber* programme (cf Box II.11-1).

II.11.1.5. Treatment and disposal of final waste

Municipal waste treatment, as well as separate collection and recycling centres, is under the responsibility of three inter-communal syndicates operating, respectively, two controlled landfills and an incineration plant with energy recovery.

Regarding **industrial, commercial and service waste**, thanks to the PPGDs, remaining quantities to be eliminated are such that domestic facilities are less justified than in the past. Non-household waste for disposal is exported to specialised facilities in neighbouring countries, primarily in Germany. Due to the size of the country and of its economy, total quantities exported may vary sharply from one year to the next.

Box II.11-1 – The *SuperDrecksKëscht*® (SDK): a success story in managing hazardous waste (1)

SDK is a programme for managing problem waste sponsored by the Environment Administration in co-operation with the communes – household component – and the *Chambre des Métiers* (Trades Council) – business component. The programme is based on the principles of prevention, reduction and recovery of waste:

i) all recyclable materials are processed to recover a maximum of secondary materials, and all problem substances are treated to minimise their impact on the environment; and

ii) substance flows, from generation to transformation into new raw materials or until their disposal in an environmentally friendly manner, must be clearly presented so that they can be audited at any time.

The SDK programme is ISO 14001 certified and has had a legal basis since 2005.

The household component (*SuperDrecksKëscht® fir Birger*) has been handling household waste since 1985. It includes:

- collection by mobile containers, collection at fixed recycling centres, and home pickup on request;
- actions targeting particular flows of waste, organised in co-operation with private partners (e.g. for batteries, medications and syringes);
- numerous information and awareness campaigns, in the schools and elsewhere.

The business component (*SuperDrecksKëscht® fir Betriber*), in place since 1992, concerns non-household waste generated by businesses and by public and private establishments. Participation is voluntary and is done by contract. It includes:

- assistance and advice for certifying ecological management of waste, with i) a situation report on waste management in the firm, and help in preparing the waste balance sheets; ii) assistance in preparing the firm's Waste Prevention and Management Plan (PPGD); iii) assistance in implementing the PPGD (separate collection, storage, treatment, finding of licensed enterprises, prevention of waste generation through use of durable materials or introduction of environmentally friendly production methods); and iv) information, training and awareness activities for employees;
- collection of small quantities of waste on request;
- collection of particular flows in co-operation with public and private sector partners.

A quality label is awarded service firms and waste transport companies that manage their waste in an environmentally responsible manner consistent with the SDK concept. Compliance with management criteria is audited once a year. Firms that have had the label for five consecutive years are audited only every two years. The list of certified firms is published on the Internet.

The cost of the household component is fully covered by the government through the Environment Protection Fund. The cost of the business component is shared: assistance, advisory and training services are financed by the government, while waste collection and treatment is covered by the firms.

Since 2007, the SDK concept has been exported in the form of franchise contracts that are available to public authorities and to public and private establishments in other countries seeking to institute a waste management system along the lines of the Luxembourg model.

(1) this box is an extract from OECD (2010). More information available at http://www.sdk.lu/.

II.11.2. Effects on GHG emissions: a yearly increase of 1.4% on average since 1990

In Luxembourg's GHG inventory, emissions are recorded for 4 CRF categories: waste incineration (CRF 6C but part of CRF 1A1a since energy is recovered), solid managed waste disposal on land (CRF 6A1), waste water treatment (CRF 6B) and composting (CRF 6D) *[→ Figure II.11-1]*.

Waste GHG related emissions recorded under CRF sector 6 in the inventory decreased by 12% since 1990. But, if waste incineration is included, they increased by almost 28%, i.e. 1.4% per year on average. This result is rather surprising since, as indicated above, there has been a decrease of municipal waste being incinerated or stored in landfill sites during the last decade. This decline is clearly visible for **solid waste disposal on land**, where methane related emissions have been reduced by 47% between 1990 and 2008 due to a decrease in the quantity of waste being stored in authorised landfill sites, notably through the development of recycling schemes and the expansion of both the numbers of and the various waste categories collected by recycling centres, as described in the previous section. The aerobic pre-treatment before storage in one of the two landfill sites, as well as the recent installation of methane recovery systems at waste dumping sites, also contribute to reducing methane emissions.

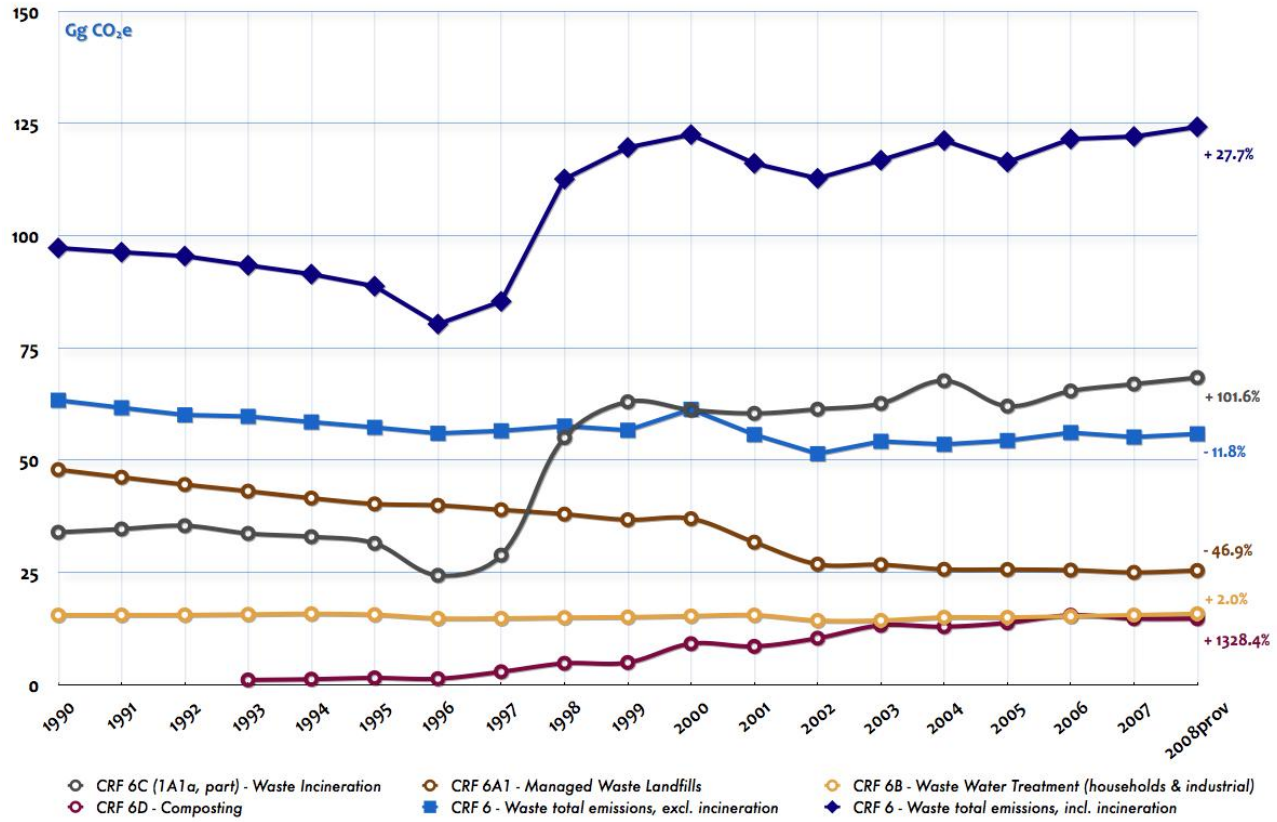
However, **waste incineration** related emissions[70] – that are presented under CRF sub-category 1A1a – public electricity and heat production – in the inventory because energy from waste burning is recovered in the sole incinerator of the country and injected in the electric public network – did increase a lot, setting the upward trend for the overall waste emissions. The big jump in the series between 1997 and 1998 *[→ Figure II.11-1]*, which is responsible of the increasing waste incineration emissions, is due to methodological reasons and to the fact that incinerated waste composition data are only available for some years, requesting interpolations. This problem is part of the planned improvements of the GHG inventory. Therefore, the overall trend presented in this section for waste, including incineration, should be looked at with caution. In the inventory, it is hidden since waste incineration represents less than 5% of the total public electricity and heat production category emissions (CRF 1A1a) and 0.5% of the total GHG emitted in Luxembourg, excluding LULUCF.

Wastewater treatment plant (WWTP) capacities expressed in population-equivalents have steadily grown since 1990. However, methane and nitrous oxide emissions only increased by 2% since 1990. Therefore, technical changes, with regard to wastewater treatment, have had an unquestionable role too.

Concerning **compost production**, this activity started on an "industrial scale" only in the early 1990s. It experienced a steady growth from 1993 to 2003 and then stabilizes.

[70] For CO_2, emissions reported cover only the "non biogenic" fraction of waste to be incinerated – the "biogenic" fraction is reported under memo items.

FIGURE II.11-1 – GHG EMISSIONS FOR WASTE (CRF SECTOR 6): 1990-2008[71]



Sources: Environment Agency, Water Agency and MDDI-DEV.

II.12. UNFCCC AND KYOTO PROTOCOL: A DEMANDING CHALLENGE FOR LUXEMBOURG

II.12.1. The road transportation dilemma

Since Luxembourg's public finances have to rely on overall lower specific rates of taxation and excises, only marginal variations in the price differentials for petrol and diesel can be initiated by the authorities. Indeed, if Luxembourg's rates of taxation and prices are higher than those in the surrounding countries, it is rather easy for any citizen of Luxembourg to avoid domestic taxation and to practise arbitrage: no location in Luxembourg is further than a maximum of 25-30 km away from a border with a neighbouring country. Lower taxation rates for certain goods – such as fuels, e.g. – have therefore always been part of Luxembourg fiscal policy and will remain crucial in the future, because of the country's geographical location and its small area. Whereas in larger neighbouring states, increasing certain tax rates would result in a slight shift in demand and in arbitrage deals at the outer fringes of their national territory – with a corresponding relatively

71 2008 data are provisional data estimated by the Department of the Environment during the summer of 2009 for the EC and the European Environment Agency: more on this in Section III.1 below.

slight reduction in tax revenues – this would not be the case for Luxembourg where such a policy may result in big losses in tax incomes. However, since road transportation, and more precisely "road fuel exports", is the main contributor to GHG emissions in Luxembourg, as underlined in the new Government programme,[72] Luxembourg will aim at progressively reducing road transport related emissions, though a complete phasing-out of "road fuel exports" is not foreseen. To do so, the Government intends to progressively increase the excise duties on road fuels via the so-called "Kyoto-cent" climatic contribution (cf P&M TR03 in *Section IV.3.3*), taking into account the market prices of crude and refined petroleum products.

II.12.2. Country and economy sizes

Special attention must also be made for the small size of the country's economy in a different context: it is a contributory factor to the fact that, in spite of the healthy economic situation, the courses of the overall development of the country, of the demand for energy and of the emissions balance are often affected by a single plant which is starting its activities, closing them down or changing its production processes. This became particularly clear when the steel industry switch from blast furnaces to electric arc furnaces was completed during the 1990s: from 1990 to 1998, GHG emissions in Luxembourg were reduced by one third *[→ Section II.7]*.

These last years, the construction of a single power station, the TWINerg gas and steam plant, represents a further illustrative example as depicted in *Section II.6*. When TWINerg started its operation in mid-2002, Luxembourg, which did not have so far any substantial electricity generating capacity, saw, at once, its GHG emissions increasing by 0.9 to 1 Mio. t CO_2e per year. To give another illustration on how this project affected the GHG emissions pattern in Luxembourg, one can underline that it represents 35% of the allocated emissions volume of the whole GHG EU Emissions Trading Scheme sector (EU-ETS) for the commitment period under the Kyoto Protocol.

The impact that single industrial projects might have, plays also the other way round when a production unit or a plant is closed down. Also, a sufficiently long breakdown in one of the main industrial unit of the country could have impacts on the total GHG emissions, such as the long maintenance operation of the TWINerg power plant in 2008 demonstrates *[→ Section II.6-2]*.

If these issues might not be a major concern for large economies, it is for Luxembourg, as shown by the examples discussed above.

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72 A new Government has started its work after the general elections of June 2009 (cf Section II.1). Its program can be read here: http://www.gouvernement.lu/gouvernement/programme-2009/index.html. For the climate change policy, go to *Programme gouvernemental* > *Ministère du Développement durable et des Infrastructures* > section II. 3.

II.12.3. Limited GHG emissions reduction potentials

As of today, Luxembourg does not have those significant technical potentials which exist in other countries where residual "old-technology" industrial and power plants still operate. In Luxembourg, there were almost none, and there still is none of those GHG reduction potentials stemming from the modernisation or the replacement of existing national industrial or power plants. In fact, with the move from blast to electric arc furnaces in the steel sector during the 1990s, Luxembourg very soon exhausted its only major technical potential for GHG emissions reduction. With the process change in the steel industry – an activity which accounted for almost 40% of Luxembourg's total GHG emissions in 1990 (excluding LULUCF) – total emissions from industry and electricity generation – i.e. largely the sectors covered by the EU-ETS – decreased to just 2.4 Mio. t CO_2e in 1998 – or about 26% of total GHG emissions (excluding LULUCF) – coming from slightly more than 8 Mio. t CO_2e in 1990 - or about 61% of total GHG emissions (excluding LULUCF) *[→ Table III.1-4]*.[73]

Also, any ultramodern fossil fuel-based electricity generating plant that Luxembourg might decide to construct will automatically lead to an increase of its national GHG emissions, since there are no existing power plants which can be stopped in return. Thus, those highly efficient CHP installations and the ultramodern gas and steam power station (TWINerg) that have been promoted and are operating in Luxembourg since 1998, and that use natural gas and, sometimes, gas oil as inputs, have led to an additional amount of approx. 1.2 Mio. t CO_2e in the GHG balance.[74] It is therefore clear that any new fossil-fuel power generating installation that might be constructed will inevitably lead to a deterioration of Luxembourg's GHG balance. This also implies that the implementation of the EU CHP installation guidelines, which in other countries may lead to CO_2 reductions thanks to increased efficiency, is counterproductive for Luxembourg. For this reason, the new Government recalls in its Programme that it will only promote heat production from renewable energy sources, focusing mainly on biomass, wood and solar energy.[75] More precisely, CHP installations using renewable energies, biogas addition in distribution networks and the mobilization of wood resources will be favoured.

II.12.4. The "origin" principle of the IPCC reporting Guidelines vs. the "polluter pays" principle

The "origin" or "territorial" principle applied for reporting GHG emissions under the IPCC Guidelines generates a GHG balance for Luxembourg that looks significantly less favourable than would a "consumer" approach produce. The "origin" principle is in favour of Luxembourg in that

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73 In 2007, the values are about 3.9 Mio. t CO_2e and 30% respectively. The lowest share was obtained in 2001, the year prior to the one TWINerg started its production.

74 1 Mio. t CO_2e for the TWINerg and 0.2 Mio. t CO_2e for CHP installations.

75 Refer to footnote 72 for references.

its imports of electricity are excluded from its GHG emission balance: those emissions are attributed to the electricity producing countries. But, as indicated above, "road fuel exports" emissions are recorded in Luxembourg's GHG balance.

Now, if the "polluter pays" principle is used as a yardstick, Luxembourg's assessment is that, for 2007, GHG emissions according to the IPCC Guidelines are some 0.9 Mio. t CO_2e "too high" *[→ Figure II.12-1]*.[76] The same correction for the year 2012 has been evaluated in the framework of the second NAP for Luxembourg. For the baseline scenario, it gave a difference of approximately 4.8 Mio. t CO_2e between the "origin" and the "polluter pays" principles with the former higher than the latter.[77]

Thus, Luxembourg's efforts to develop efficient, low-carbon electricity production are not rewarded in the actual reporting system for GHG emissions. Luxembourg has, for many years, promoted the construction and the development of highly efficient CHP installations and of a modern gas and steam power plant. Luxembourg has also actively supported power generation and uses based upon renewable energies and, for all these policies, further developments are still in the offing. The impact of these policies has been evaluated using GEMIS 4.2:[78] it has been estimated that electricity imports – with, nowadays, an average emission factors of 0.78 (kt CO_2 per GWh) – have fallen by more than 1 500 GWh since 1998 and have been replaced by national electricity generation with a current average emission factor of 0.41 (kt CO_2 per GWh).

So, in terms of the GHG balance, the promotion of renewable energies in the electricity sector, which is associated with major investments, is of little interest. Moreover, additional capacities based upon renewable energies cannot actually be used to replace any electricity from inefficient existing fossil-fuel plants in Luxembourg. Nor will they substitute the highly efficient national production plants which have just been constructed. In reality, they will replace the imported electricity which does not appear in Luxembourg's GHG balance. In this sense, the existing system provides Luxembourg with the incentive not to earmark the generally scant subsidies for Europe's priority investments in renewable energies but, instead, to invest these in measures which might improve its GHG balance.

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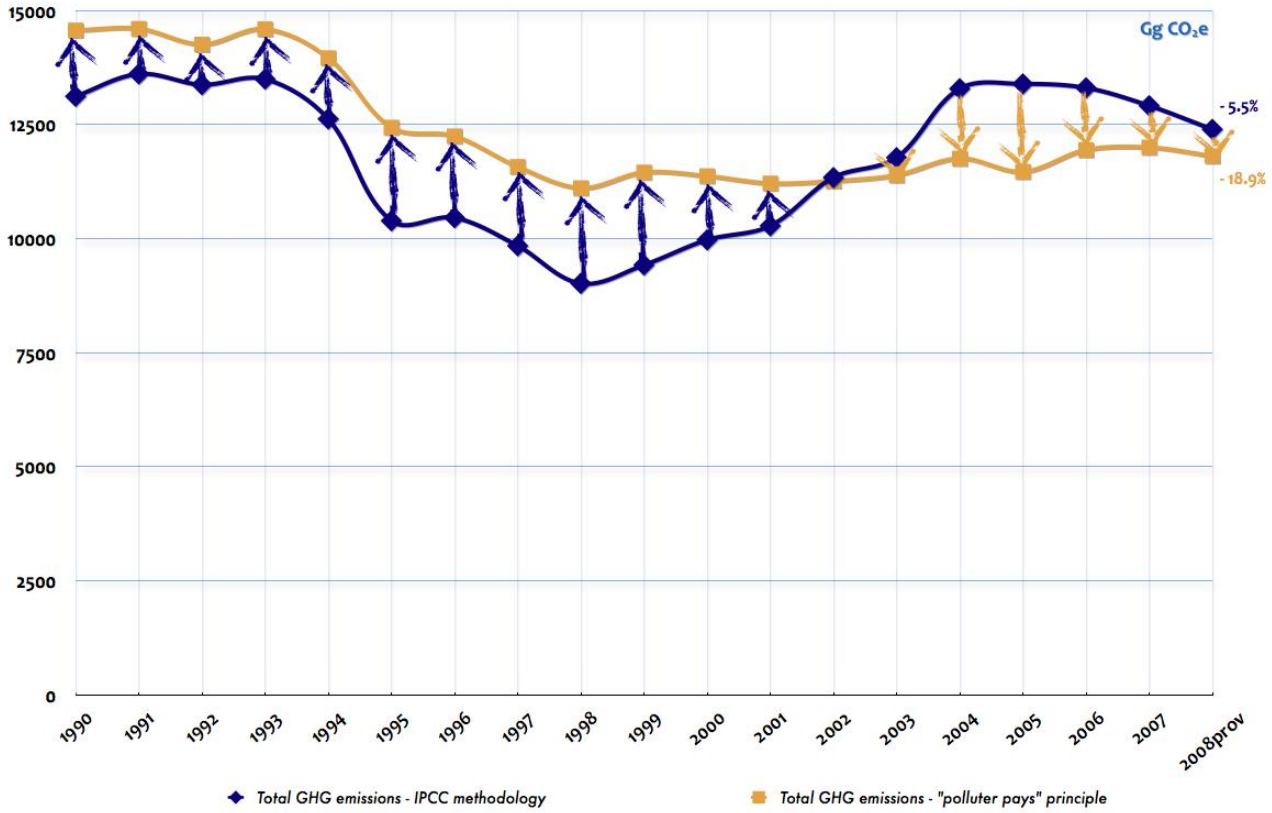
76 After having reached a "surplus" of almost 2 Mio. t CO_2e in 2005.

77 However, the latest developments of GHG trends and composition in Luxembourg, combined with the actual financial and economic crisis effects, tend to indicate that this "surplus" of 4.8 Mio. t CO_2e by 2012 is probably overestimated.

78 GEMIS stands for *Global Emission Model for Integrated Systems*: http://www.oeko.de/service/gemis.

FIGURE II.12-1 – TOTAL GHG EMISSIONS, EXCLUDING LULUCF – TWO APPROACHES: 1990-2008



Sources: Environment Agency and MDDI-DEV.

Note: the "polluter pays" principle figures have been obtained from the total GHG emission according to the IPCC methodology by excluding emissions from "road fuel exports" and for electricity generated that is exported, and by adding an estimate for electricity production emissions generated abroad for satisfying Luxembourg consumption (i.e. emissions relating to electricity imports):

emissions "polluter pays" principle = emissions IPCC methodology – emissions "road fuel exports" + emissions electricity net imports

II.13. NATIONAL CIRCUMSTANCES: OVERVIEW

Key points that plays a role on GHG emissions trends in the past and in the future are:

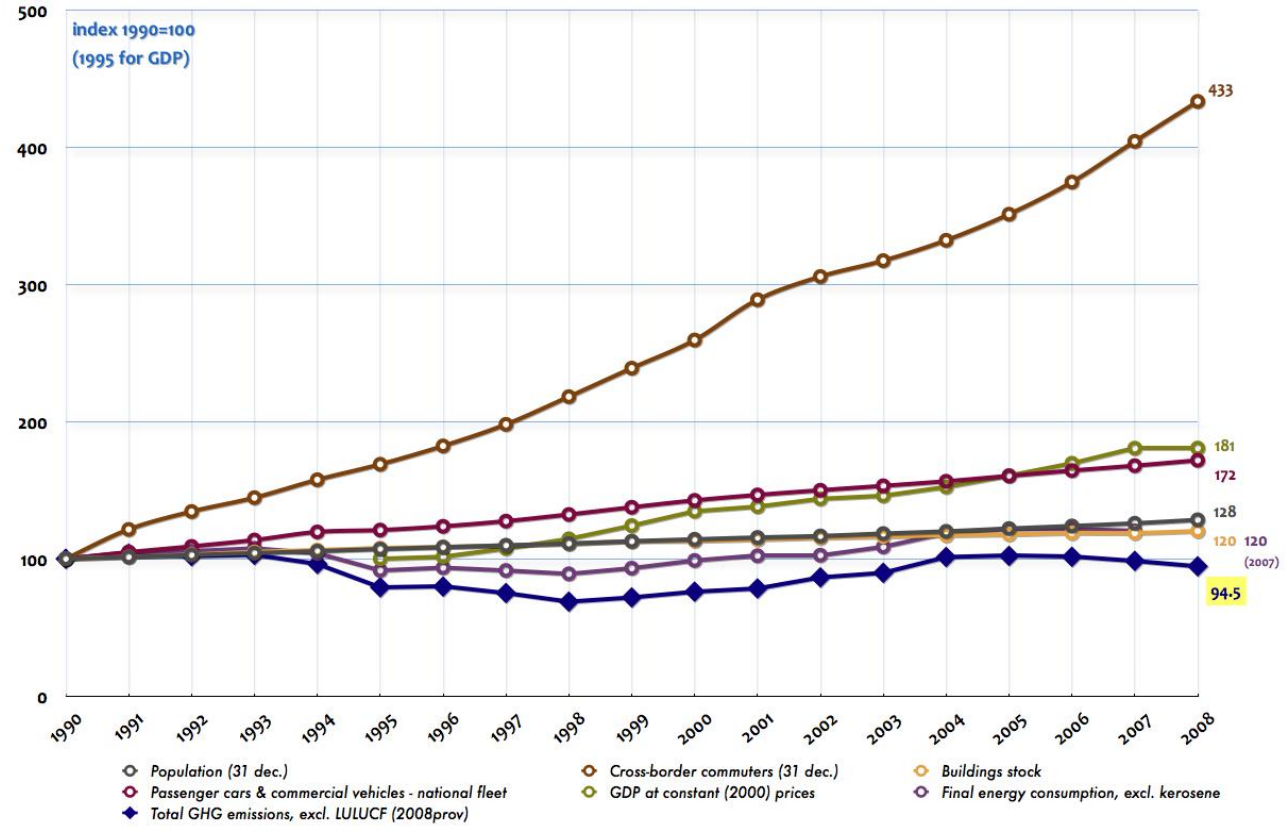
- a country characterized by both **high demographic** and **high economic growth** in a stagnating region, hence an **attractive economic destination**;
- **strong population growth** due to immigration and that is expected to go on;
- **even stronger cross-border commuters growth** that is expected as well to go on once the financial and economic crisis will be over;
- **increase of built-up areas** (housing, offices, services, infrastructures) as a consequence of the previous statements;
- location at the **heart** of the main Western Europe **transit routes** for both **goods and passengers**;
- **increase of transport flows** as a consequence of the previous statements;

- **small** size and open economy: a new industrial project, a technological change, a closure or a breakdown of a production unit might have significant impacts on the GHG emissions and increase the overall uncertainty of GHG projections;
- **limitations in taxation policies** due to short distances to neighbouring countries;
- a country that **needs to co-operate and to interact with its neighbours** since environmental issues become quickly cross-border issues;
- **limited national** GHG emissions reduction potential.

Figures II.13-1a & b & II.13.2 provide a quick overview of the trends of some key variables since 1990.

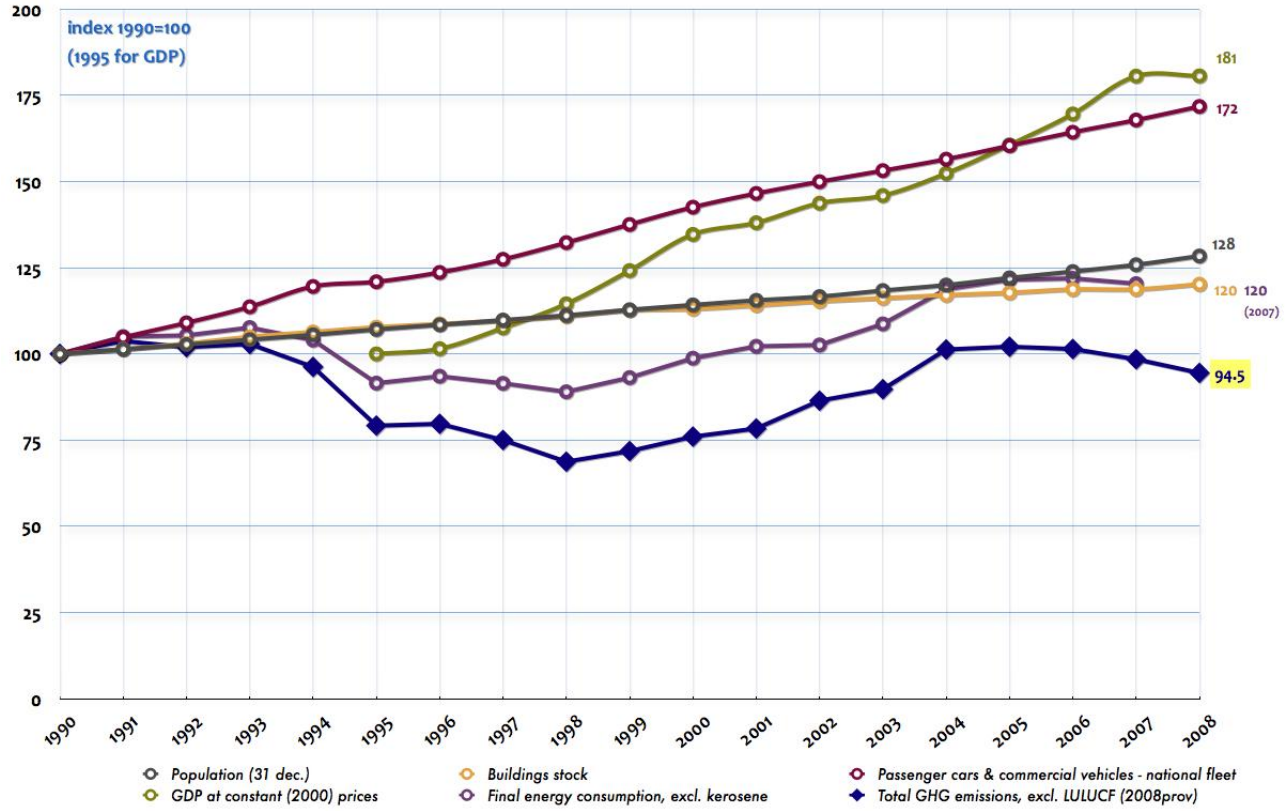
TABLES, FIGURES & ILLUSTRATIONS

FIGURES II.13-1a – KEY VARIABLES TRENDS – 1: 1990-2008



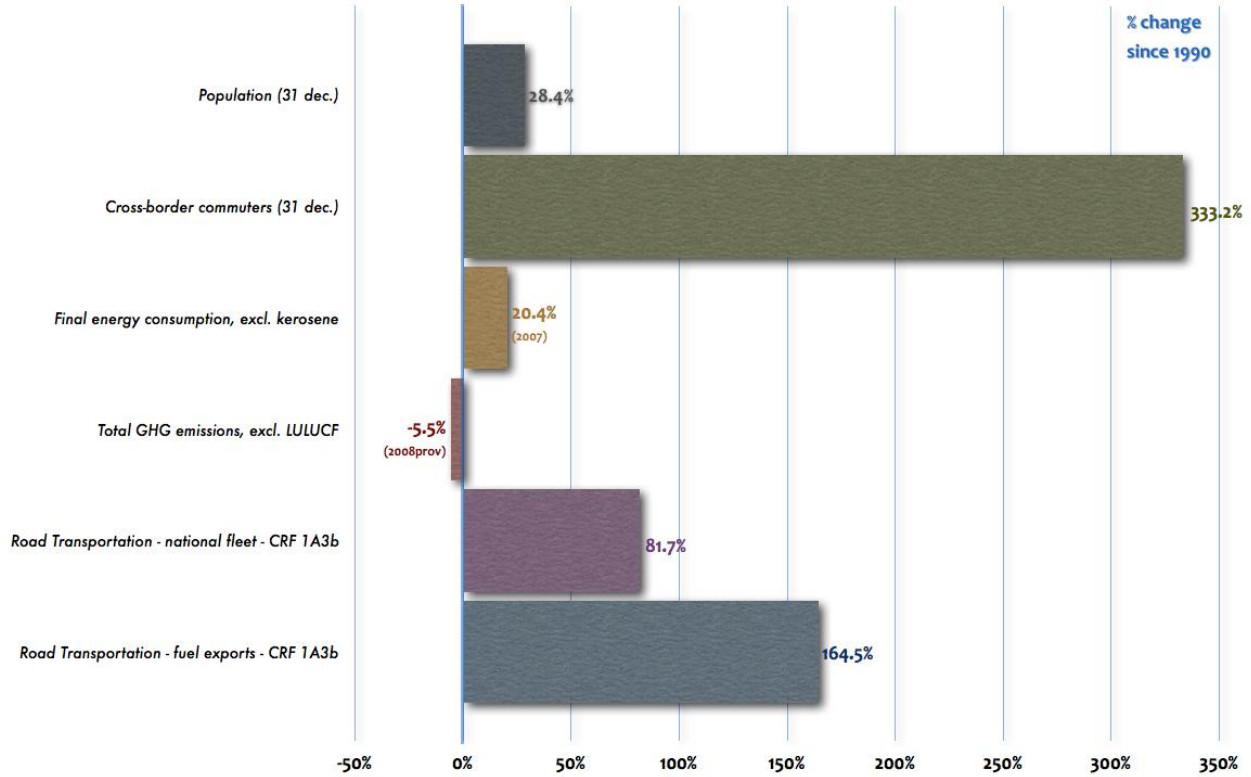
Sources: STATEC, Ministry of Economic Affairs and External Trade-Energy Department and FiFo Köln.

FIGURES II.13-1b – KEY VARIABLES TRENDS – 1: 1990-2008 (EXCL. CROSS-BORDER COMMUTERS)



Sources: STATEC, Ministry of Economic Affairs and External Trade-Energy Department, Environment Agency, MDDI-DEV and FiFo Köln.

FIGURE II.13-2 – KEY VARIABLES TRENDS – 2: 1990 & 2008



Sources: STATEC, Ministry of Economic Affairs and External Trade-Energy Department, Environment Agency, MDDI-DEV and FiFo Köln.

Chapter III

GHG Inventory Information, including National System and the National Registry

Chapter III comprises three main sections. Firstly, GHG emissions as reported in the latest inventory submission to the UNFCCC Secretariat is analyzed in details, as suggested in UNFCCC reporting guidelines, paragraphs 10 to 12. The years covered are 1990 to 2007, complemented by first estimates for the year 2008 – 2008 being both the year characterized by the premises of the financial and economic crisis as well as the first year under the commitments of the Kyoto Protocol *[→ Section III.1]*. Then, in line with paragraphs 30 and 31 of the Kyoto Protocol reporting guidelines, a general description of the National System under Article 5, paragraph 1 of the Protocol is provided *[→ Section III.2]*. This section is complemented by some additional information relating to requests formulated in Article 10, paragraph (f), of the Kyoto Protocol *[→ Section III.2.8]*. Finally, this chapter concludes by a description of the National Registry as demanded by paragraph 32 of the Kyoto Protocol reporting guidelines *[→ Section III.3]*.

III.1. MAIN TRENDS IN GHG EMISSIONS[79]

This section presents Luxembourg's GHG emissions trends between the base year (1990) and the latest year covered by **submission 2009v1.4**, i.e. 2007. Submission 2009v1.4 is the latest submission officially submitted to the UNFCCC Secretariat;[80] the next one (2010v1.1) has to be delivered to the UNFCCC before the 15th of April 2010 and will cover the years 1990 to 2008.

Nevertheless, during the 2009 summer, the Department of the Environment undertook the calculation of first estimates for 2008, or "nowcasts" – some of these having been already presented and discussed in *Chapter II*. This work was initiated at the same time as the EC, together with the European Environment Agency (EEA), did a similar exercise.[81] These "nowcasts" are included in the analysis of the main trends since 2008 is the year the financial and economic crisis started and the first year under the commitments of the Kyoto Protocol. Box III.1-1 described briefly how the 2008 first estimates have been calculated. In this section, 2008 data, results and comments are identified by the use of a dark orange colour.

Luxembourg being a small country, its GHG inventory is characterized by a rather high number of CRF (sub-)categories which do not occur or are not applicable. *Table III.1-1a* gives an overview of those CRF (sub-)categories for which emissions or removals are recorded and those for which emissions or removals are either not occurring or not applicable or not (yet) estimated. Completeness and transparency indexes are presented in *Table III.1-1b*: for the inventory year

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79 This section of the NC5 covers sections III.A and III.B of the Outline and General Structure of the NC5 according to IPCC reporting guidelines (para. 5).

80 Available on: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/lux_2009_crf_19may.zip.

81 For instance: http://www.eea.europa.eu/highlights/new-estimates-confirm-the-declining-trend-in-eu-greenhouse-gas-emissions.These EC/EEA "nowcasts", together with national "nowcasts" for those countries which calculated them, such as Luxembourg, have been used for the EU GHG emissions trends and projections 2009 report (http://www.eea.europa.eu/publications/eea_report_2009_9).

2007, the transparency index (cells reported as "included elsewhere" – IE – compared to the number of estimates to be reported) was 98% and the completeness index (cells reported as "not estimated" – NE – compared to the number of estimates to be reported) reached 89%. A more complete picture – including activity data and emission factors sources as well as estimations' tier levels – is provided in Annex A.I as additional information to an excerpt of summary tables of submission 2009v1.4.

Box III.1-1 – 2008 GHG emissions "nowcasts"

During the 2009 summer, the Department of the Environment calculated, for the first time, emissions estimates for the year 2008. This was made possible with an anticipated good level of confidence because of the structure of GHG emissions in Luxembourg and of data used to perform the "nowcasts". **However, due to some changes in calculation methods and for some background data, first results already available for the 2010 submission to the UNFCCC – to be delivered by the 15th of April 2010 – depart from the "nowcasts". The NC5 might be updated later this year to reflect these changes and to present final 2008 GHG estimates together with 2009 "nowcasts".**

In Luxembourg, GHG emissions, excluding LULUCF, reported in the inventory are mainly made of CO_2 (92% in 2007). The energy sector (CRF 1) is the main contributor to emissions (88% in 2007). Consequently, other gases, which are sometimes less straightforward to estimate than CO_2, as well as the other GHG sources – industrial processes, solvents & other product use, agriculture and waste – represent only a small fraction of the total emissions, excluding LULUCF.

However, EU-ETS data of a definite year being available during the first trimester of the following year, they could be used for the estimation of industrial processes related emissions so that this sector could also be "nowcasted" with a good level of confidence: in Luxembourg, only 3 enterprises are included in CRF sector 2 and they are all three taking part to this system. Of course, EU-ETS data also helped in the calculations of CRF sub-category 1A2 (manufacturing industries & construction).

For CRF category 1A (fuel combustion), together with EU-ETS data, yearly energy statistics could be used to perform the "nowcasts", even if all the breakdowns by sectors were not yet totally on hand in the data sets that are usually available, for most of the fuels, at the end of the first semester of the next year.

Consequently, CRF sectors 1A and 2 (more than 90% of the total emissions, excluding LULUCF, in 2007) could be estimated for 2008 using rather precise data, whereas for the other sectors or (sub-)categories simple methods have been used, e.g. an average of the 5 last years or a simple reproduction of the 2007 value (i.e. a zero-growth hypothesis). In some case, however, population could be used: that was the case for solid waste disposal on land, waste incineration and domestic waste water treatment, for which ratios based on inhabitants could be applied to 2008 population figures.

More details can be provided, if requested: the result of this exercise have not been disseminated within the country but used internally and provided to the EC and the EEA. EEA used the results of this "nowcasting" exercise in the EU GHG emissions trends and projections 2009 report (http://www.eea.europa.eu/publications/eea_report_2009_9).

III.1.1. GHG trend: the supremacy of CO_2 and of the energy sector

Luxembourg ratified the United Nations Framework Convention on Climate Change in 1994, and the Kyoto Protocol in 2002. Pursuant to that Protocol and the terms of the European agreement distributing the burden among, at that time, the EU-15 Member States, Luxembourg undertook **to reduce its GHG emissions by 28% below their 1990 level over the period 2008-12**. This is the deepest cut of any agreed by the 15 Member States. When the Act approving the Kyoto Protocol was adopted in Luxembourg (2001), its GHG emissions were down by more than 30% between 1990 and 1998 *[→ Tables III.1-2, III.1-3 or III.1-4]*.

In 2007, carbon dioxide was the main source of GHG in Luxembourg. This source counted for 91.7% of the total GHG emissions calculated in CO_2e – total excluding LULUCF.[82] The second source of GHG was nitrous oxide with slightly more than 4% of the total emissions. Methane was the third source with 3.5%. Fluorinated gases only accounted for 0.7% of the total emissions, with hydrofluorocarbons representing 0.67% of the total and sulphur hexafluoride representing 0.03% of the total *[→ Table III.1-2]*. As indicated in ***Table III.1-1a***, there were no known sources of perfluorocarbons in Luxembourg. For 2008, first estimates – "nowcasts" – lead to the following percentages: CO_2 = 91.2%, N_2O = 4.3%, CH_4 = 3.7% and F-gases = 0.8% *[→ Table III.1-2]*.

In 2007, total GHG emissions amounted to 12.914 Mio. t CO_2e, 1.56% below their level for the base year.[83] Several phases can clearly be distinguished over the period 1990 to 2007 *[→ Figures III.1-1a & III.1-1b]*:

- firstly, from base year up to 1993, Luxembourg's emissions remained rather stable;
- then, between 1994 and 1998, they started to decrease significantly to reach their lowest value in 1998 when they were down by more than 30%;
- from 1999 up to 2004, emissions augmented recurrently;
- from 2004 to 2006, a stabilisation around 13.3 Mio. t CO_2e is observed;
- from 2006 to 2007, emissions experienced a relatively important decrease (-2.94%).

In 2008, first estimates for total GHG emissions reach the value of 12.394 Mio. t CO_2e, 5.5% below the base year level. Hence, the decreasing trend started in 2006 went on that year and will most probably be reinforced in 2009, concomitantly with the financial and economic crisis aftermaths.

According to data validated during the peer-review of Luxembourg's initial report facilitating the calculation of the assigned amount pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol, Luxembourg obtained an assigned amount of 47 402 996 t CO_2e for the commitment period 2008-2012 under the Kyoto Protocol.[84] This represents, therefore, **annual maximum emissions of 9 480.60 Gg CO2e**. In 2007, total GHG emissions were 26.6% above this annual target (+23.5% in 2008) *[→ Figures III.1-1a & III.1-1b]*.

As portrayed in *Chapter II* presenting Luxembourg's national circumstances, the evolution during those about 20 years can essentially be explained by changes in production techniques, as well as by changes in the final "energy-mix" consumption. Of course, increasing or decreasing activities for certain source categories also played a crucial role in Luxembourg's GHG emissions trend.

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82 In Section III.1, when it is referred to "total (GHG) emissions" it is meant "total GHG emissions excluding LULUCF". Reference is made to total emissions excluding LULUCF since this is the one that counts for the reduction target under the Kyoto Protocol.

83 The base year for CO_2, CH_4 and N_2O is 1990. For the F-gases, the base year is 1995. However, due to lack of data on F-gases for the first half of the 1990s, 1995 emission estimates are equalled to 1990 emission estimates (cf Table III.1-2).

84 http://unfccc.int/resource/docs/2007/irr/lux.pdf, p. 4.

A major example for a technological change in production took place in the iron and steel industry, where the steel production process was moved from blast furnaces to electric arc furnaces between 1994 and 1998 and, therefore, solid fuels (coke) were replaced, to a very large extent, by electricity and natural gas. Due to that technological change, the total energy consumption in steel industry was significantly reduced and the "energy-mix" greatly modified *[→ Section II.6.1]*. This process change was the main driver for the reduction in GHG emissions observed between 1994 and 1998 *[→ Figure III.1-1b]*. Changes also occurred in the industrial and the residential, commercial and institutional sectors, where the consumption of liquid fuels (residual oil, gasoline) was reduced in favour of natural gas in conjunction with the extension of the natural gas network in Luxembourg.

The road transport sector, on the other hand, is a clear example on how activity levels of a source category can influence the overall GHG emission trend. Indeed, the upward trend for GHG emissions recorded from 1999 to 2004 was merely justified by increasing energy consumption and fuel sales in the transport sector. The stabilization spotted for the inventory years 2004 to 2006 was largely the result of steady sales of gasoline for road transportation together with a lower use of energy in the residential, commercial and institutional sectors *[→ Figure III.1-1b]*. Finally, the decrease in total emissions from 2006 to 2008 was driven by a "road fuel exports" related emissions reduction combined with a diminution of GHG emissions from the power generation sector, the latter being exceptionally important in 2008 because, as stressed in *Section II.6.2*, the 3 months maintenance of the TWINerg installations resulted in 3 months without substantial production *→ Figures II.2-4 & III.1-1b*.

More detailed explanations are provided in *Sections III.1.3* (dealing with gases) *& III.1.4* (dealing with CRF sectors).

A fundamental point worth mentioning when analysing Luxembourg's GHG emission trends and their composition over time, is the small size of Luxembourg, and therefore, the special nature of its economy. Indeed, the structure of the economy, the related energy demand and the energy and emission balances may vary significantly, whether a new economic activity starts its operations or an existing one ceases them or, even, is stroked by a breakdown. This characteristic explains, for instance, the reduction of emissions pertaining to the industrial sector: with 6.7 Mio. t in 1990, CO_2e emissions from industrial processes and fuel combustion in industry accounted for 51% of total GHG emissions. They could eventually be reduced to 2.2 Mio. t in 1998 – i.e. 24.5% of total GHG emissions – mainly after the reorganization of the steel industry took place in the mid-nineties (move from blast furnaces to electric arc furnaces indicated above). At that time, GHG emissions of Luxembourg were almost one third below the base year level. Another illustrative example is the building of the TWINerg power plant *[→ Section II.6]*. This plant started its operation in mid-2002 and, by 2007, was responsible of about 0.9 Mio. t CO_2, i.e. around 7% of the

total GHG emissions.[85] However, due to the long maintenance in 2008, anticipated emissions for 2008 felt to 0.75 Mio. t CO_2.

These considerations can easily be identified in *Table III.1-4*, and its associated figures, which assemble CRF source categories in such a way that GHG emission sources are distributed between main emitters – such as energy production, industry, road transportation – and other categories.

III.1.2. GHG emissions for Luxembourg remain very high per capita but are decoupling from GDP growth

Indicators on GHG intensity are commonly found in publications analyzing GHG emissions. Intensity can be measured either with regard to population – GHG emissions per capita – or per unit of GDP – GHG intensity of GDP.

For Luxembourg, these calculations are suggested for GHG emissions levels obtained using either the IPCC methodology – i.e. the emissions reported in GHG inventories – or corrected to reflect the "polluter pays" principle *[→ Section II.12.4]*. The two GHG intensities indicators – GHG emissions per capita and GHG emissions per unit of GDP – clearly went down over the period 1990-2008, whether the IPCC methodology or the "polluter pays" principle is chosen for total emissions → *Figures III.1-5*.[86]

Whilst Luxembourg's population increased by 28.4% between 1990 and end 2008 *[→ Section II.2.1]*, total GHG emissions declined by 5.5% using the IPCC methodology and by almost 19% according to the "polluter pays" principle. It is therefore not surprising to see a reduction of -26.4% or -36.8% for GHG emissions per capita since 1990, respectively *[→ Figures III.1-5]*. Nevertheless, emissions level per capita – though they decrease from 34.1 (IPCC) and 37.9 ("polluter pays") tonnes per person in 1990 to 25.1 and 23.9 tonnes per person in 2008 – remains much higher than those in the other European countries. Countries with the highest emissions per capita after Luxembourg are (2007 data) Estonia (with around 16.5 tonnes per person) and Ireland (with some 16 tonnes per person). The EU-15 average was, in 2007, 10.3 tonnes per person.[87] Correcting the resident population for the important workforce coming every working day from abroad to work in Luxembourg – the cross-border commuters – does not change radically the picture. If the yearly population is increased – by hypothesis – by half of the yearly average number of cross-border commuters,[88] the per capita ratio would drop to 22 in 2008 (but 25 in 2005), i.e. to about 90% of the IPCC methodology per capita ratio. It is only if "road fuel exports" related emissions are

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85 The highest emissions recorded for the TWINerg plant were 1.02 Mio. t CO_2 in 2006, i.e. 7.6% of the total GHG emissions reported for that year.

86 The series including GDP start in 1995 since data prior to 1995 are (and will not be) translated into the new European System of Accounts (ESA).

87 Calculations made using EEA's data viewer: http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475.

88 The hypothesis is therefore than one cross-border commuter = 0.5 resident, which is a sensible assumption that is also made when calculating waste water treatment plants related emissions [Ministry of the Environment (2009d), p. 317-318].

subtracted from the IPCC totals – i.e. without taking into account emissions generated abroad for the electricity consumption in Luxembourg – that Luxembourg's emissions per capita ranged between 15 and 17 tonnes since the turn of the 21st century, i.e. still at a rank that places the country amongst those, in Europe, with the highest emissions per person.

However, the main drivers behind emissions per capita have changed through time in Luxembourg: in the early 1990s, the steel industry activities were responsible for the high ratios recorded; nowadays it is rather road transportation fuel related consumption together with electricity and heating fuels needs that push the per capita emissions amongst the highest. The latter have sharply increased during the last years *[→ Figure II.6-2 & Table II.6-3]*.

Turning to emissions per unit of GDP (at constant price), in 2008, a reduction of -34.0% or -47.4% is observed since 1995 when using the IPCC methodology and the "polluter pays" principle in that order *[→ Figures III.1-5]*. More precisely, GHG intensity of GDP decreased from 636 or 761 tonnes/Mio. € to 420 or 400 tonnes/Mio. € for the IPCC or the "polluter pays" approaches respectively. Both figures also show that an absolute decoupling happened since 1995, though less noticeably when the IPCC methodology calculation is considered.

This decoupling, or efficiency gains, is the conjunction of two elements: firstly the increasing share of "road fuel exports" in total GHG emissions *[→ Figure II.8-3 & Table III.1-4]* – which is more correlated to the overall GDP growth in (Western) Europe than to the national GDP growth, the latter being higher *[→ Section II.5]* – and, secondly, as described in *Section II.5.2*, the expansion of the tertiary sector at the expense of the industrial sector *[→ Table III.1-4]*. These observations should be analyzed together with the conclusions drawn out in *Section II.5.4*, that is to say that GHG emissions trends in Luxembourg are not so much influenced by the economic profile of the country but for the most part by the energy-mix, individual changes in the economic activity that could lead to structural changes and road transportation related fuel sales.

Figure III.1-6 wraps up the main variables discussed in this section by presenting their evolution **since 1995**.

III.1.3. GHG trends by gas: reduction for CO_2 and CH_4 emissions, rise for N_2O and F-gases

For the different GHG, trends over the period 1990-2007 (2008) were as follows:

- CO_2: ..... -2.41% (-6.82%)
- CH_4: ..... -2.68% (-1.80%)
- N_2O: ..... +5.28% (+5.78%)
- F-gases: ..... +431,59% (+490.87%)

For carbon dioxide, the relatively close values estimated in 1990 and 2007 respectively hide a V-shape evolution over the period as well as important changes in the sources of CO_2 emissions: declining emissions in industrial and thermal power plant combustion, increasing emissions from transport and for natural gas fired power plants – CHP installations, TWINerg. The 2008 decline is explained by the continuation of the "road fuel exports" related emissions reduction started between 2006 and 2007, as well as by the 3 months maintenance operations of the TWINerg.

The methane emissions decline over the period 1990-2007 (2008) is the conjunction of reduced methane emissions in agriculture – -3.2% (-1.8%) – and in waste management – -33.5% (-32.8%) – with growing emissions in energy use – +30.7% (+25.5%) – the latter being due to an upward trend for fugitive emissions from natural gas distribution and use.

Nitrous oxide emissions development is closely linked to an increase of liquid fuels related emissions in both other manufacturing industries and road transportation (gasoline and diesel oil) that could not be balanced by declining emissions from the agriculture sector.

Finally, with regard to F-gases, HFCs emissions were more than 5 times higher in 2007 than in the base year (6 times higher in 2008), whereas SF_6 emissions showed a 35.4% increase between 1990 and 2007 (+37.5% between 1990 and 2008).

These evolutions can be visualized in ***Table III.1-3***, which distributes, for each GHG, emissions amongst the main source categories, as well as in the associated ***Figures III.1-3a to III.1-3d***. These table and figures offer the opportunity to further analyze emission trends for each of the gases.

III.1.3.1. Carbon dioxide – CO_2

CRF (sub-)categories covered	1A1a, 1A2, 1A3, 1A4, 1A5, 1B2b, 2A1, 2A7, 2C1, 3A, 3B, 3C & 3D	
share in total GHG emissions, excl. LULUCF	***1990***	92.5% =12 136.02 Gg CO_2e
	2007	91.7% =11 844.04 Gg CO_2e
	2008prov	91.2% =11 308.02 Gg CO_2e

Throughout the period 1990-2007 (as well as 1990-2008), the main GHG has remained carbon dioxide, which accounted between 88% and 93% of the total GHG emissions. However, the structure of CO_2 emissions has evolved with an increase in fuel combustion, which accounted for 80.2% of total GHG emissions for the base year (1990) and climbed up to 86.3% in 2007 (86% in 2008), after having reach a maximum of 87.1% in 2005.

Road transport, and more precisely "road fuel exports", is, with electricity production, one of the culprits for this development. Indeed, in 1990, fuel combustion from the transport sector accounted for 20.6% of total GHG emissions. Then, with 6.57 Mio. t CO_2, this percentage reached 50.9% in 2007 (51.3% in 2008).[89] CO_2 emissions due solely to "road fuel exports" amounted to about

[89] The highest percentage was recorded for the year 2005: 7 Mio. t CO_2 and 52.4% of total GHG emissions.

1.80 Mio. t in 1990 and reached 4.85 Mio. t in 2007 (4.73 Mio. t in 2008),[90] i.e. roughly a threefold increase (the same comparison shows only a twofold increase for road fuel consumed by the national vehicle fleet). In 2007, "road fuel exports" represented 73.8% of CO_2 emissions of the transport sector and 37.6% of the total GHG emissions (74.5% and 38.2% respectively in 2008).[91] In 1990, these percentages were, respectively, 66.5% and 13.7%.

Another important source of CO_2 is industrial processes, i.e., in the case of Luxembourg, mainly carbon oxidizing of pig iron from steel industry (basic oxygen furnace steel production) and decarbonisation of mineral input in clinker and glass industry. The steel production process change described above was the main driver behind declining emissions for this sector.

III.1.3.2. Methane – CH_4

CRF (sub-)categories covered	1A1a, 1A2, 1A3, 1A4, 1A5, 1B2b, 4A, 4B, 6A, 6B & 6D		
share in total GHG emissions, excl. LULUCF	***1990***	3.6% =	466.01 Gg CO_2e
	2007	3.5% =	453.54 Gg CO_2e
	2008prov	3.7% =	457.63 Gg CO_2e

Methane emissions originate above all from the agricultural sector, and more precisely from enteric fermentation and from manure production and management. As these emissions have been rather stable over the period 1990-2007,[92] total methane emissions have not varied very much.

For the other methane emitting source categories, the increase observed for fuel combustion is mainly due to fugitive emissions from natural gas distribution and use. The decrease noted for waste is the result of reduced methane emissions from waste landfill sites.

III.1.3.3. Nitrous oxide – N_2O

CRF (sub-)categories covered	1A1a, 1A2, 1A3, 1A4, 1A5, 3D, 4B, 4D, 6B & 6D		
share in total GHG emissions, excl. LULUCF	***1990***	3.8% =	498.65 Gg CO_2e
	2007	4.1% =	524.96 Gg CO_2e
	2008prov	4.3% =	527.47 Gg CO_2e

A large part of nitrous oxide emissions is caused by agricultural soils. Another important source, which has generated increasing N_2O emissions since 1990, is road transport, where incomplete NO_X reduction in catalytic converters of diesel oil motor vehicles leads to N_2O emissions that were multiplied by almost 3 over the period following the increasing share of diesel vehicles on the roads.

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90 5.47 Mio. t CO_2 in 2005.

91 For 2005, these percentages were respectively 78% and 40.9%.

92 And, consequently, 1990-2008 since 2008 estimates are an average of the emissions reported for the last five years.

III.1.3.4. Hydrofluorocarbons – HFCs and sulphur hexafluoride – SF_6

CRF (sub-)categories covered	2F		
share in total GHG emissions, excl. LULUCF	***1990***	0.1% =	17.12 Gg CO_2e
	2007	0.7% =	90.98 Gg CO_2e
	2008prov	0.8% =	101.13 Gg CO_2e

A first estimation of the emissions of fluorinated GHG types (HFCs, PFCs and SF_6) was done at the end of 1999 by the Environment Agency and Luxembourg's *Centre de Ressources des Technologies pour l'Environnement* (CRTE). It indicated that there are some HFCs and SF_6 emissions in Luxembourg, but no emissions of PFCs.

The increase in HFC emissions between 1990 and 2007 (2008) is explained by a more wide spread use of mobile and stationary cooling equipments as well as of aerosols.[93]

SF_6 emissions increased from 1990 onwards following a raising use of high voltage electrical devices and a higher amount of gas emitted from noise reduction windows.[94]

Nevertheless, methodological improvements are needed to better estimate F-gases related emissions.[95]

III.1.4. GHG trends by sector: reductions in all sectors but one, energy

This section should be read together with *Chapter II*, where changes and developments that occurred since 1990 in the various sectors and the socio-economic profile of Luxembourg have been described and analyzed with regard to their impacts on GHG emissions.

In 2007, the energy sector accounted for almost 88% of the total CO_2e GHG emissions. Two sectors represent between 5.5% and 6% of the total emissions: industrial processes (6.1%) and agriculture (5.5%). The remaining sectors[96] (solvent and other product use, waste[97]) were not even reaching 1% of the total GHG emitted in Luxembourg in 2007 For 2008, first estimates – "nowcasts" – lead to almost identical percentages *[→ Table III.1-2 & Figure III.1-2c]*.

93 2008 "nowcast" is based on the 2005-2010 yearly average growth rate in the CRTE study.

94 Cf previous note.

95 Ministry of the Environment (2009d), table 4-23, p. 200.

96 The sector "other" is not reported for Luxembourg.

97 The waste sector covers only waste disposed off in landfills, wastewater handling and composting activities. Waste incineration, which is the main treatment method for municipal waste in Luxembourg, is carried out in the sole incinerator of the country where energy is recovered. Consequently, waste incineration related emissions are accounted for in CRF sector 1 – Energy.

For the different sectors, trends over the period 1990-2007 (2008) were as follows:

- Energy: .....+6.60% (+2.01%)
- Industrial Processes: .....-51.41% (-54.21%)
- Solvent and Other Product Use: .....-21.29% (-21.64%)
- Agriculture: .....-8.34% (-6.48%)
- Waste:.....-12.94% (-11.80%)
- ***Total GHG emissions:..... -1.56% (-5.52%)***

Emission reductions observed in all sectors but could just balance the growth of energy use and production related emissions whose contribution to total GHG emissions ranged from 81% to 92% over the period 1990 to 2007 (2008).

III.1.4.1. CRF 1 – Energy

GHG covered	CO_2, CH_4 & N_2O	
share in total GHG emissions, excl. LULUCF	***1990***	81.1% =10 642.61 Gg CO_2e
	2007	87.9% =11 345.27 Gg CO_2e
	2008prov	87.6% =10 856.18 Gg CO_2e

Energy production and consumption related GHG emissions have increased by 6.6% between 1990 and 2007 (2% between 1990 and 2008) from 10.64 Mio. t CO_2e in 1990 to 11.34 Mio. t CO_2e in 2007 (10.86 Mio. t CO_2e in 2008). For carbon dioxide, methane and nitrous oxide, the growth over the period 1990-2007 was 5.8%, 30.7% and 119.2% respectively (1.3%, 28.5% and 107.1% in that order).

However, the overall trends at sector level hide very different developments at the CRF sub-category level. Within the energy sector, the fastest growing sub-sector was transport (1A3): +142% between 1990 and 2007 (+134%) with, as a result, a share in the total energy related GHG emissions rising from 25.7% to 58.9% (59.5%) *[→ Figure III.1-7]*. For the other sub-sectors, the observed trends between 1990 and 2007 are: +4.7% for energy industries (1A1), -64.5% for manufacturing industries (1A2), +2.7% for the other sectors (1A4) and +175.5% for fugitive emissions from fuels (1B).[98] For 2008, first estimates lead to the following percentages: 1A1 = -12.1%,[99] 1A2 = -66.1%, 1A4 = +5.9%[100] and 1B = +179.7%.

In fact, over the period, GHG emissions have been strongly influenced by varying fuel consumption levels in industry, in particular in the iron and steel industry, as well as in the road transport sector as percentage growths recorded for CRF sub-categories 1A2 and 1A3 demonstrate. There are several industrial sites which had relatively high levels of GHG emissions, and which,

98 Fugitive emission growth is closely linked to natural gas use in Luxembourg.

99 TWINerg maintenance effect.

100 Harsh winter season.

therefore, have had a large impact on the national total of GHG emissions. In the transport sector, road fuel consumption, and even more so road fuel sales, have a very important weight in the national energy balance, and, consequently, have also a very important impact on the total GHG emissions.

In the iron and steel industry, the passage from blast furnaces to electric arc furnaces allowed to significantly reducing GHG emissions between 1993 and 1998. Due to the importance of iron and steel industry in Luxembourg, this evolution hid many other emission trends between 1990 and 1998. After 1998, the increase of road fuel sales and, to a lesser extent, of electric energy production has led to a rather steep increase of GHG emissions in these sectors and, by extension, of the national total for GHG emissions.

All these changes briefly presented in the previous paragraphs – as well as in *Sections II.6, II.7 & II.8* – completely modified the pattern of the energy related GHG emissions with regard to CRF sub-categories share *[→ Figure III.1-7]* and to the "energy-mix" or fuel usage for energy production and consumption *[→ Tables & Figures II.6-1 & II.6-2]*.

III.1.4.2. CRF 2 – Industrial Processes

GHG covered	CO_2 & F-gases	
share in total GHG emissions, excl. LULUCF	***1990***	12.3% = 1 612.68 Gg CO_2e
	2007	6.1% = 783.66 Gg CO_2e
	2008prov	6.0% = 738.49 Gg CO_2e

Industrial processes are the second largest sector in Luxembourg with regard to GHG emissions. It includes emissions from industrial installations and from consumption of halocarbons and SF_6 (the fluorinated gases or F-gases).[101] Leaving F-gases out, in Luxembourg, only 3 companies and their various production installations are part of CRF sector 2:

- CRF sub-categories 2A1 & 2A7: one cement works unit and one flat glass manufacturing company;
- CRF sub-category 2C1: the iron and steel manufacturing company Arcelor-Mittal.

Industrial processes emissions show a declining trend between 1990 and 1998, then a relative stabilisation. This evolution was mainly driven by process changes that occurred in the steel industry. As indicated above, this industry moved from blast to electric arc furnaces between 1994 and 1998. As a consequence, steel industry emissions in CO_2e decreased by 79.3% over the period 1990-2007 (-83.2%). Overall sector emissions in CO_2e felt by about 51% between 1990 and 2007 (about 54%) reducing the weight of this sector in total GHG emissions from 12.3% to 6% over the period *[→ Figure III.1-2c]*. By gas, however, the picture is different. For carbon dioxide, the

101 No PFC application and emissions have been identified in Luxembourg so far.

decrease over the period 1990-2007 was -56.6% (-60%): 2A1 = -23.5% (-26.5%), 2A7 = +17.5% (+16.6%) and 2C1 = -79.3% (-83.2%). F-gases emissions, on the contrary, increased regularly: +432% over the period 1990-2007 (+491%) but they are minor in the total emissions *[→ Figure III.1-3b]*.

The striking increase of F-gases emissions is the consequence of supposedly growing use in the country, notably due to an increasing use of air conditioning *[→ Section III.1.3.4]* but also of the hypothesis made for their estimation. Nevertheless, methodological improvements are needed to better estimate F-gases related emissions.[102]

The emission trends briefly described in the previous paragraphs led to a significant change in the composition of industrial processes' GHG emissions *[→ Figure III.1-8]*.

III.1.4.3. CRF 3 – Solvent and Other Product Use

GHG covered	CO_2 & N_2O		
share in total GHG emissions, excl. LULUCF	***1990***	0.2% =	23.90 Gg CO_2e
	2007	0.1% =	18.81 Gg CO_2e
	2008prov	0.2% =	18.73 Gg CO_2e

Carbon dioxide emissions from solvent use have been estimated from related NMVOC emissions. These NMVOC emanations have been calculated using both a bottom-up and a top-down approach. This is detailed in Ministry of the Environment (2009d), section 5.2, p. 205-223. Nitrous oxide emissions reported for this sector are exclusively stemming from anaesthesia usage that have been estimated by combining reported emissions per capita in Germany with the relative population in Luxembourg.

Emissions decreased by 21% between 1990 and 2007,[103] due to decreasing solvent and N_2O emissions, as well as due to the positive impact of diverse enforced laws and regulations in Luxembourg.[104] The cut in emissions was sharper for anaesthesia (-37%) than for solvent (-11%) leading to a reduced share of nitrous oxide emissions in the total emissions of CRF sector 3 *[→ Figure III.1-9]*.

III.1.4.4. CRF 4 – Agriculture

GHG covered	CH_4 & N_2O		
share in total GHG emissions, excl. LULUCF	***1990***	5.9% =	775.27 Gg CO_2e
	2007	5.5% =	710.64 Gg CO_2e
	2008prov	5.8% =	725.00 Gg CO_2e

[102] Ministry of the Environment (2009d), table 4-23, p. 200.

[103] For the period 1990-2008, the decrease reaches 21.6%. However, the various categories of this sector having been "nowcasted" using very simple methods, this reduction percentage does not make much sense.

[104] These legal texts are listed in Ministry of the Environment (2009d), section 5.1, p. 203-204.

Trends in agriculture were also favourable between 1990 and 2007: GHG related to agricultural activities have decreased by about 8.3% (-3.2% for methane and -12.7% for nitrous oxide). Enteric Fermentation (4A) saw its emissions falling by some 9%, whereas for agricultural soils (4D), the decrease reaches a bit more than 10%. For manure management (4B), emissions remained quite stable between 1990 and 2007 (-1.8%), though opposite variations are observed for the two GHG emitted by this activity: methane increased by 14.8% and nitrous oxide declined by 36.8%.[105] [106]

However, the evolution of nitrous oxide emissions stemming from agricultural soils (4D) shapes the overall agriculture emission pattern. Indeed, for both the years 1990 and 2007, CRF category 4D is the biggest contributor to agriculture related emissions *[→ Figure III.1-10]*, though it is also, as for other Annex I Parties, the agriculture category that shows the highest uncertainty in the inventory. It is also worth noting that the shares of each CRF category under CRF sector 4 for which GHG emissions are reported have barely changed over the period *[→ Figure III.1-10]*.

Looking at each CRF category in more detail, the decrease in **enteric fermentation** related **methane** emanations over the period is mainly the result from declining emissions generated by the main contributor to these emissions – with more than 95% – i.e. cattle: -18.4% for dairy cattle and -1.5% for non-dairy cattle. With regard to cattle, its total population size declined throughout the period 1990-2007. However, a shift did occur within the cattle population with a reduction for dairy cattle (-32%) and an increase for female mature non-dairy cattle (+48.9%). In fact, cattle population and its evolution are strongly influenced by changes in the agricultural policy and, more precisely, in the Common Agricultural Policy of the EU (CAP). Another factor influencing cattle population is, of course, meat and milk prices (which, themselves are affected by agricultural policy changes and targets).[107] Finally, when the dairy cattle population decreased by 32% between 1990 and 2007, related methane emissions only declined by 18.4%. This is explained by increasing milk yield over the period which, in turn, led to an augmentation of the gross energy intake for dairy cattle and, consequently, of the methane IEF.[108]

Looking at **methane** emissions from **manure management**, an increase by a bit less than 15% can be observed for the period 1990-2007. Animals who did contribute the most to these emissions were cattle, swine and, to a lesser extent, chicken. As far as **nitrous oxide** emissions from **manure management** are concerned, a decrease of almost 37% is observed for the period 1990-2007. These emissions are mainly due to cattle. However, if cattle were responsible for more than 95% of

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105 As for the other CRF sectors, data presented in this section are those from submission 2009v1.4. Note that in Section II.9 however, estimates are those from submission 2010v1.1, which are not comparable since important revisions (re-allocations, new values for some parameters entering in the IEFs calculations) took place between the two submissions.

106 If 2008 is chosen as ending year, percentages are -9.6%, +3.0% & -7.4% respectively for 4A, 4B & 4D. Nevertheless, CRF categories 4A, 4B & 4D having been "nowcasted" using an average of the emissions reported for the last five years, these percentages do not make much sense.

107 As an example, the peak in the non-dairy cattle population observed in 1991 can be explained by a sharp price fall of the bovine meat price that year. This price fall led farmers to postpone slaughtering until early 1992.

108 Cf footnote 105.

manure related N_2O emissions in 1990, this share dropped to 87% in 2007. This evolution is the result of a declining cattle population at the same time as other farm animal categories saw their number grow and as liquid system share in the animal waste management systems (AWMS) doubled at the expense of solid storage systems.[109]

Finally, **nitrous oxide** emissions from **agricultural soils** are mainly driven by:

- nitrogen input to soils (such as application of synthetic fertilizers and manure) as well as nitrogen fixed by crops or crop residues (about 50% of category 4D emissions);
- nitrogen excretion on pasture, range and paddock (around 15%);
- by indirect soil emissions due to atmospheric deposition as well as to nitrogen from fertilizers and animals that is lost through leaching and run-off (about 35%).

III.1.4.5. CRF 6 – Waste

GHG covered	CH_4 & N_2O		
share in total GHG emissions, excl. LULUCF	***1990***	0.5% =	63.34 Gg CO_2e
	2007	0.4% =	55.14 Gg CO_2e
	2008prov	0.5% =	55.86 Gg CO_2e

In the waste sector, the main source of GHG was solid waste disposal on land (6A), but its weight decreased over the period 1990-2007 due to the combination of reduced amounts of waste disposed off in landfills and of increased emissions arising from composting activities (6D). However, GHG emission reduction for solid waste disposal on land between 1990 and 2007 (-48%) (-47%) still drove a reduction for the overall waste sector despite composting rising emissions. Wastewater handling emissions (6B) experienced an 8.3% rise in emissions between 1990 and 2007 (+10.4%). This increase was driven by domestic and commercial wastewater treatment since industrial wastewater management remained fairly stable throughout the period.

For **solid waste disposal on land**, methane emissions have been reduced due to:

- a decrease in the quantity of waste being stored in authorised landfill sites (two as of today, three in the early 1990s), notably through the development of recycling schemes and the expansion of both the numbers of and the various waste categories collected by recycling centres;
- the aerobic pre-treatment before storage in one of the two landfill sites;
- the recent installation of methane recovery systems at waste dumping sites.

Wastewater treatment plant (WWTP) capacities expressed in population-equivalents have steadily grown since 1990. However, methane and nitrous oxide emissions only increased by 2% since

109 Cf footnote 105.

1990. Therefore, technical changes, with regard to wastewater treatment, have had an unquestionable role too.

Concerning **compost production**, this activity started on an "industrial scale" only in the early 1990s. It experienced a steady growth from 1993 to 2003 and then stabilizes. Nowadays, 7 composting installations operate in Luxembourg, plus one that co-compost sewage sludge. The latter uses active ventilation and operates fully aerobic – without methane formation. The other plants operate in part under anaerobic conditions, with a residence time in the "composter" of a few weeks.

It is recalled that waste incineration related emissions are part of CRF sub-category 1A1a (public electricity and heat production) since energy is recovered in the sole incinerator of the country and injected in the network.

The emission trends briefly described in the previous paragraphs led to a significant change in the composition of waste related GHG emissions *[→ Figure III.1-11]*.

III.1.4.6. CRF sectors – overview

The fact that the iron and steel industry has abandoned blast furnaces between 1994 and 1998, and that fossil fuel consumption as well as road fuel sales have continued to increase after 1998, hide many other emission trends and, due to their importance in the national total GHG emissions, they shape the overall pattern of Luxembourg's GHG emissions trend. However, *Figure III.1-2d* summarized analyzes presented in the previous sub-sections.

More details for each CRF sector are available in Ministry of the Environment (2009d).

III.1.5. LULUCF

Submission 2009v1.4 to the UNFCCC was the first to contain an elaborated estimation of GHG emissions or removals for some of the CRF sub-categories under LULUCF: refer to *Table III.1-1a* for the sub-categories estimated so far.

In Luxembourg, LULUCF was a net sink every year, except in 1990 and 1991.[110] An important sub-category is forest land, in particular its sub-source forest land remaining forest land (5A1). This sub-category, as well as the category grassland (5C), are net sinks for CO_2, whereas category cropland (5B) is a source of emissions (both CO_2 and N_2O). For categories wetlands (5D), settlements (5E) and other land (5F), areas of "land use" and "land use change" could have been calculated, but emissions and removals have not yet been estimated due to a lack of data on biomass.

[110] Net emissions these two years are the consequence of the important storms that touched the country in early 1989-90 severely hitting Luxembourg's forests.

Luxembourg has chosen **to account for the activities under Article 3.3** of the Kyoto Protocol for the whole commitment period but **does not plan to account for net emissions and removals from activities under Article 3.4** of the same Protocol since, for the moment, there is a lack of reliable data allowing to produce realistic estimates of the activities covered under Article 3.4. Nevertheless, it is anticipated – expert judgment by the Nature and Forest Administration - that land or, at least, forestry would not contribute to Luxembourg's means of meeting its Kyoto commitment. The latter would, therefore, be reached **only via national policies and measures and the use of "Kyoto flexible mechanisms"** and not via carbon sinks *[→ Section V.5.1]*.

Consequently, LULUCF will not be discussed intensively in this National Communication and for more details on the emission trends and their calculation, reference is made to the NIR [Ministry of the Environment (2009d), chapter 7, p. 276-298].

III.1.6. Additional information

III.1.6.1. Uncertainty analysis

Uncertainty estimates are an essential element of a complete inventory of GHG emissions and removals and requires a detailed understanding of the uncertainties of the respective input parameters. They should be derived for both the national level and the trend estimate, as well as for the component parts such as emission factors, activity data and other estimation parameters for each category.[111] Principally, two different Tiers for the estimation of combined uncertainties are presented in the *2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*: Tier 1 uses simple error propagation equations, while Tier 2 uses Monte Carlo.

In December 2007, the Environment Agency contracted *Austrian Research Centers GmbH – ARC*[112] for performing a detailed uncertainty analysis of Luxembourg's GHG inventory, using both Tiers approaches [Winiwarter et al (2008)].[113] Due to limited resources and assigned priority within the inventory preparation, only a Tier 1 uncertainty analysis could be performed on submission 2009v1.4. In fact, it is planed to update the Tier 2 analysis periodically but not every year, unless important methodological changes and/or revisions of activity data and/or EFs happened between two inventories.

For submission 2009v1.4, Tier 1 uncertainty analysis resulted in an overall combined uncertainty of total national emissions in 2007 of 2.82%, excluding LULUCF, and 2.91%, including LULUCF. Respective percentages for the uncertainty introduced into the trend in total national emissions

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111 *2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, Chapter 6 ("Quantifying Uncertainties in Practice").

112 Now "AIT Austrian Institute of Technology GmbH": http://www.ait.ac.at/.

113 This report is reproduced in Ministry of the Environment (2008b), Annex III, p.257.

were 1.83%, excluding LULUCF, and 1.79%, including LULUCF. For more details, refer to the latest NIR [Ministry of the Environment (2009d), section 1.6, p. 55-70].

III.1.6.2. Indirect GHG and SO_2

No indirect GHG – NOx, CO, NMVOCs – and SO_2 emissions are recorded in the inventory so far. In fact, they need to be re-evaluated in the light of the revision of the inventories Luxembourg is compiling for the UNECE CLRTAP. Consequently, these emissions will not be discussed in this National Communication and generating better emission estimates for these gases are part of Luxembourg's planned improvements for its GHG inventory.

TABLES, FIGURES & ILLUSTRATIONS

TABLE III.1-1a – LIST OF GHG SOURCES OR SINKS WITH RELATED GHG EMISSIONS OR REMOVALS

GHG source & sink categories *(CRF nomenclature)*	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
1. ENERGY	✓	✓	✓			
A. Fuel Combustion	✓	✓	✓			
1. Energy Industries	✓	✓	✓			
a. Public Electricity and Heat Production	✓	✓	✓			
b. Petroleum Refining	NO	NO	NO			
c. Manufacture of Solid Fuels and Other Energy Industries	NO	NO	NO			
2. Manufacturing Industries and Construction	✓	✓	✓			
a. Iron and Steel	✓	✓	✓			
b. Non-Ferrous Metals	✓	✓	✓			
c. Chemicals	✓	✓	✓			
d. Pulp, Paper and Print	NO	NO	NO			
e. Food Processing, Beverages and Tobacco	✓	✓	✓			
f. Other	✓	✓	✓			
3. Transport	✓	✓	✓			
a. Civil Aviation	✓	✓	✓			
b. Road Transportation	✓	✓	✓			
c. Railways	✓	✓	✓			
d. Navigation	✓	✓	✓			
e. Other Transportation	NA	NA	NA			
4. Other Sectors	✓	✓	✓			
a. Commercial/Institutional	✓	✓	✓			
b. Residential	✓	✓	✓			
c. Agriculture/Forestry/Fisheries	✓	✓	✓			
5. Other	✓	✓	✓			
a. Stationary	✓	✓	✓			
b. Mobile	✓	✓	✓			
B. Fugitive Emissions from Fuels	✓	✓	NO			
1. Solid Fuels	NO	NO	NO			
a. Coal Mining	NO	NO	NO			
b. Solid Fuel Transformation	NO	NO	NO			
c. Other	NO	NO	NO			
2. Oil and Natural Gas	✓	✓	NO			
a. Oil	NE	NE	NO			
b. Natural Gas	✓	✓				
c. Venting and Flaring	NO	NO	NO			
d. Other	NA	NA	NA			

GHG source & sink categories *(CRF nomenclature)*	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
2. INDUSTRIAL PROCESSES	✓	NO	NO			
A. Mineral Products	✓	NO	NO			
1. Cement Production	✓					
2. Lime Production	NO					
3. Limestone and Dolomite Use	IE					
4. Soda Ash Production and Use	IE					
5. Asphalt Roofing	NO					
6. Road Paving with Asphalt	NO					
7. Other: Glass Production	✓	NO	NO			
B. Chemical Industry	NO	NO	NO	NO	NO	NO
1. Ammonia Production	NO	NO	NO	NO	NO	NO
2. Nitric Acid Production			NO	NO	NO	NO
3. Adipic Acid Production	NO		NO	NO	NO	NO
4. Carbide Production	NO	NO		NO	NO	NO
5. Other	NO	NO	NO	NO	NO	NO
C. Metal Production	✓	NO			NO	NO
1. Iron and Steel Production	✓	NO			NO	NO
2. Ferroalloys Production	NO	NO			NO	NO
3. Aluminium Production	NO	NO			NO	NO
4. SF_6 Used in Aluminium and Magnesium Foundries						NO
5. Other	NA	NA	NA	NA	NA	NA
D. Other Production	NO					
1. Pulp and Paper						
2. Food and Drink	NO					
E. Production of Halocarbons and SF_6				NO	NO	NO
1. By-product Emissions				NO	NO	NO
2. Fugitive Emissions				NO	NO	NO
3. Other				NA	NA	NA
F. Consumption of Halocarbons and SF_6				✓	NO	✓
1. Refrigeration and Air Conditioning Equipment				✓	NO	NO
2. Foam Blowing				✓	NO	NO
3. Fire Extinguishers				NO	NO	NO
4. Aerosols/ Metered Dose Inhalers				✓	NO	NO
5. Solvents				NO	NO	NO
6. Other applications using ODS substitutes				NO	NO	NO
7. Semiconductor Manufacture				NO	NO	NO
8. Electrical Equipment				NO	NO	✓
9. Other: Noise Reduction Windows				NO	NO	✓
G. Other	NA	NA	NA	NA	NA	NA
3. SOLVENT AND OTHER PRODUCT USE	✓		✓			
A. Paint Application	✓					
B. Degreasing and Dry Cleaning	✓		NE			
C. Chemical Products, Manufacture and Processing	✓					
D. Other	✓		✓			
4. AGRICULTURE		✓	✓			
A. Enteric Fermentation		✓				
1. Cattle		✓				
2. Buffalo		NO				
3. Sheep		✓				
4-10. Other: Horses, Goats, Swine, Poultry, Rabbits, Cervidae		✓				
B. Manure Management		✓	✓			
1. Cattle		✓	✓			
2. Buffalo		NO	NO			
3. Sheep		✓	✓			
4-10. Other: Horses, Goats, Poultry, Rabbits, Cervidae		✓	✓			
8. Swine		✓	✓			
11-14. AWMS			✓			
C. Rice Cultivation		NO				
D. Agricultural Soils			✓			
1. Direct Soil Emissions			✓			
2. Pasture, range and paddock manure			✓			
3. Indirect Emissions			✓			
4. Other			NA			
E. Prescribed Burning of Savannas		NO	NO			
F. Field Burning of Agricultural Residues		NO	NO			
G. Other		NA	NA			

GHG source & sink categories *(CRF nomenclature)*	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
5. LULUCF	✓	NE	✓			
A. Forest Land	✓	NE	NE			
1. Forest Land remaining Forest Land	✓	NE	NE			
2. Land converted to Forest Land	✓	NO	NE			
B. Cropland	✓	NO	✓			
1. Cropland remaining Cropland	✓	NO	NO			
2. Land converted to Cropland	✓	NO	✓			
C. Grassland	✓	NO	NO			
1. Grassland remaining Grassland	NO	NO	NO			
2. Land converted to Grassland	✓	NO	NO			
D. Wetlands	NE	NO	NO			
1. Wetlands remaining Wetlands	NE	NO	NO			
2. Land converted to Wetlands	NO	NO	NO			
E. Settlements	NE	NE	NE			
1. Settlements remaining Settlements	NE	NE	NE			
2. Land converted to Settlements	NE	NE	NE			
F. Other Land	NE	NE	NE			
1. Other Land remaining Other Land		NE	NE			
2. Land converted to Other Land	NE	NE	NE			
G. Other (please specify)	NE	NE	NE			
Harvested Wood Products	NE	NE	NE			
6. WASTE	NO	✓	✓			
A. Solid Waste Disposal on Land	NO	✓				
1. Managed Waste Disposal on Land	NO	✓				
2. Unmanaged Waste Disposal Sites	NO	NO				
3. Other	NA	NA				
B. Wastewater Handling		✓	✓			
1. Industrial Wastewater		NE	✓			
2. Domestic and Commercial Wastewater		✓	✓			
3. Other		NA	NA			
C. Waste Incineration	IE	IE	IE			
D. Other	NO	✓	✓			
7. OTHER	NA	NA	NA	NA	NA	NA
MEMO ITEMS	✓	✓	✓			
International Bunkers	✓	✓	✓			
Aviation	✓	✓	✓			
Marine	✓	✓	✓			
CO_2 Emissions from Biomass	✓					

Sources: Environment Agency and MDDI-DEV.

Legend:

✓ - emissions reported at least once over the period 1990-2007

IE - included elsewhere

NA - not applicable

NE - not estimated

NO - not occuring

CRF (sub-)categories & sectors for which emissions existed at least once over the period 1990-2007.

Covers ✓ , IE & NE.

TABLE III.1-1b – TRANSPARENCY AND COMPLETENESS: 2007

CRF sector	Submission 2009v1.4			
	IE	*NE*	*TR*	*CP*
Energy (sectoral approach) – CRF 1 (1)	3	2	97%	98%
Industrial Processes – CRF 2	2	13	98%	87%
Solvent and Other Product Use – CRF 3	0	3	100%	70%
Agriculture – CRF 4	0	1	100%	98%
LULUCF – CRF 5	0	13	100%	61%
Waste – CRF 6	3	1	83%	94%
Total	6	33	98%	89%

Sources: Environment Agency and MDDI-DEV.

Notes:

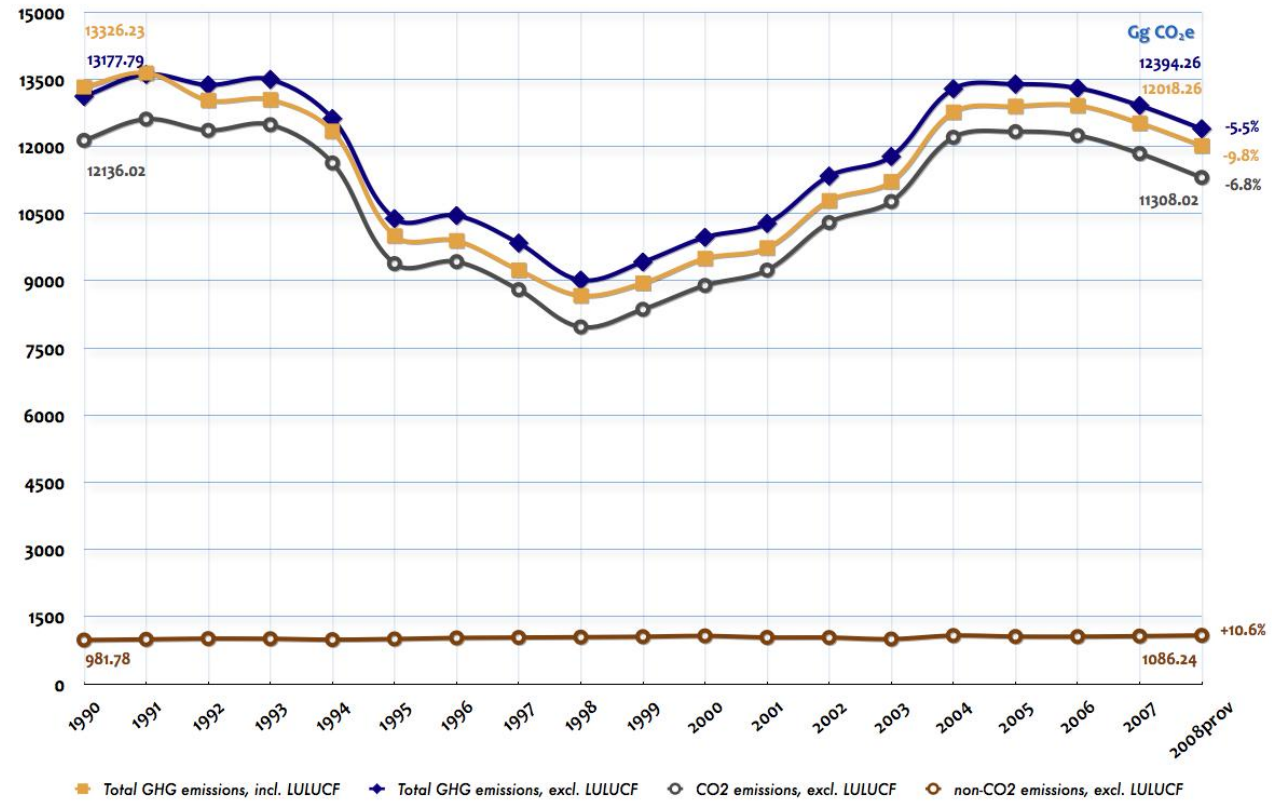
(1) includes waste incineration that is reported under CRF sub-category 1A1a since the energy produced while burning waste is recovered.

Transparency (TR) [%] = [1 – (number of IE/number of estimates)]*100

Completeness (CP) [%] = [1 – (number of NE/number of estimates)]*100

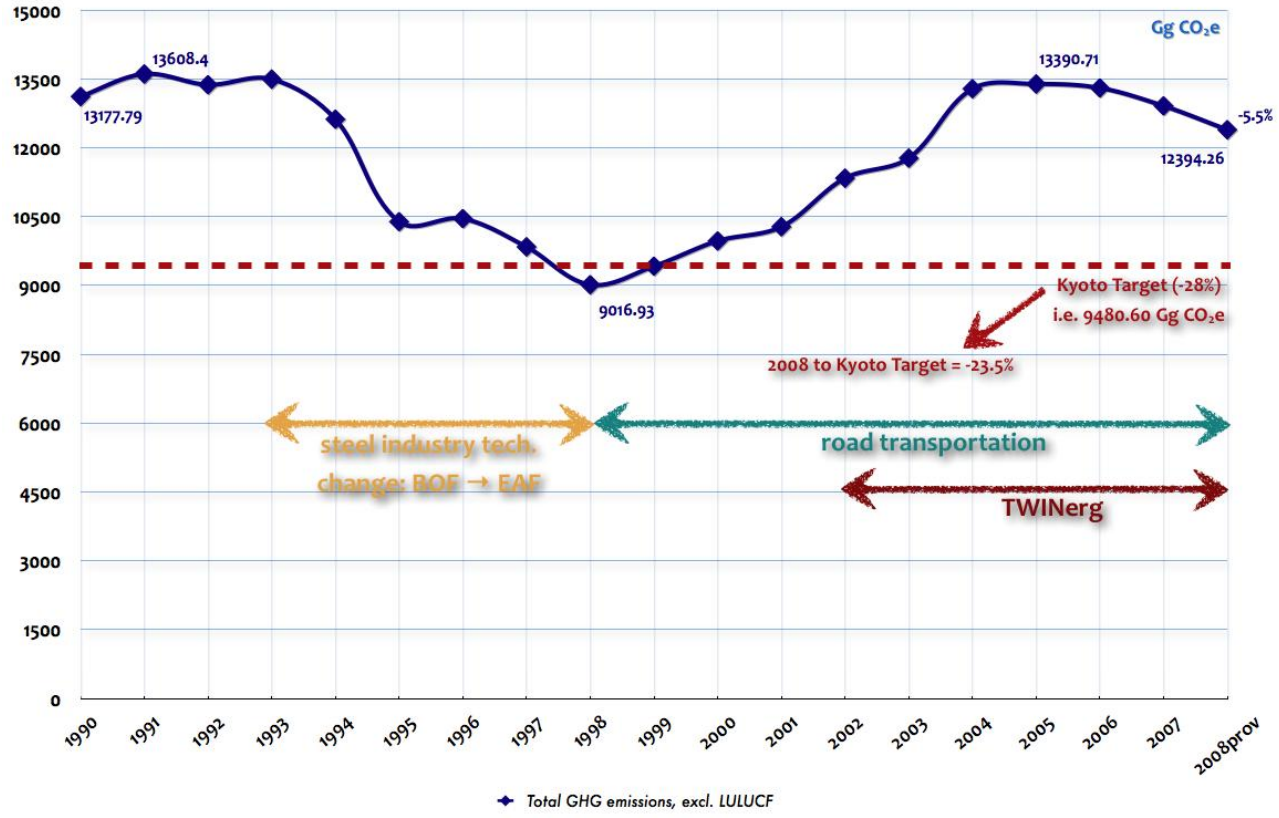
The exercise focuses on sectoral report tables only. The level of detail for CRF sources and categories is up to 4 digits for the energy sector (e.g. CRF sub-category 1A1a) and 3 digits for the other sectors (e.g. CRF sub-category 4D3). Finally, only the 6 GHG are covered by this counting exercise. Under these conditions, 307 cells have been scrutinized: 87 for CRF sector 1, 104 for CRF sector 2, 10 for CRF sector 3, 55 for CRF sector 4, 33 for CRF sector 5 and 18 for CRF sector 6.

FIGURE III.1-1a – GHG EMISSIONS AND REMOVALS – OVERVIEW CO_2 vs. NON-CO_2: 1990-2008



Sources: Environment Agency and MDDI-DEV.

FIGURE III.1-1b – GHG EMISSIONS (EXCL. LULUCF): 1990-2008



Sources: Environment Agency and MDDI-DEV.

TABLE III.1-2 – GHG EMISSIONS AND REMOVALS – OVERVIEW BY MAIN GASES AND CRF SECTORS: 1990-2008

Gg (1000 t.) CO_2 equivalent	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 emissions, incl. net CO_2	12344,32	12642,34	12020,72	12035,13	11350,77	8999,53	8869,46	8202,85	7625,60	7894,13
from LULUCF (1)	*92,63%*	*92,69%*	*92,22%*	*92,26%*	*91,97%*	*89,95%*	*89,60%*	*88,76%*	*87,94%*	*88,20%*
CO_2 emissions, excl. net CO_2	12136,02	12611,07	12360,09	12486,04	11632,18	9384,52	9428,70	8803,73	7970,95	8364,31
from LULUCF	*92,52%*	*92,67%*	*92,42%*	*92,52%*	*92,15%*	*90,32%*	*90,16%*	*89,45%*	*88,40%*	*88,79%*
CH_4 (2) emissions, incl. net CH_4	466,01	475,88	463,74	465,70	460,77	470,12	476,75	471,99	472,24	481,39
from LULUCF (1)	*3,50%*	*3,49%*	*3,56%*	*3,57%*	*3,73%*	*4,70%*	*4,82%*	*5,11%*	*5,45%*	*5,38%*
CH_4 (2) emissions, excl. net CH_4	466,01	475,88	463,74	465,70	460,77	470,12	476,75	471,99	472,24	481,39
from LULUCF	*3,55%*	*3,50%*	*3,47%*	*3,45%*	*3,65%*	*4,52%*	*4,56%*	*4,80%*	*5,24%*	*5,11%*
N_2O (3) emissions, incl. net N_2O	498,78	504,46	532,63	527,39	512,58	518,34	529,26	537,37	539,11	534,45
from LULUCF (1)	*3,74%*	*3,70%*	*4,09%*	*4,04%*	*4,15%*	*5,18%*	*5,35%*	*5,81%*	*6,22%*	*5,97%*
N_2O (3) emissions, excl. net N_2O	498,65	504,33	532,50	527,26	512,45	518,20	529,12	537,23	538,97	534,31
from LULUCF	*3,80%*	*3,71%*	*3,98%*	*3,91%*	*4,06%*	*4,99%*	*5,06%*	*5,46%*	*5,98%*	*5,67%*
HFCs (4)	14,21	14,21	14,21	14,21	14,21	14,21	19,97	25,73	31,49	37,25
	0,11%	*0,10%*	*0,11%*	*0,11%*	*0,11%*	*0,14%*	*0,19%*	*0,26%*	*0,35%*	*0,40%*
PFCs (4)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
SF_6 (4)	2,91	2,91	2,91	2,91	2,91	2,91	3,03	3,15	3,28	3,40
	0,02%	*0,02%*	*0,02%*	*0,02%*	*0,02%*	*0,03%*	*0,03%*	*0,03%*	*0,04%*	*0,04%*
1. Energy	10642,61	11206,87	11040,68	11193,10	10437,03	8542,38	8650,90	8140,36	7471,07	7831,63
	81,13%	*82,35%*	*82,56%*	*82,94%*	*82,69%*	*82,22%*	*82,72%*	*82,71%*	*82,86%*	*83,13%*
2. Industrial Processes	1612,68	1535,59	1465,61	1445,58	1352,51	992,16	942,47	839,46	686,29	729,84
	12,29%	*11,28%*	*10,96%*	*10,71%*	*10,72%*	*9,55%*	*9,01%*	*8,53%*	*7,61%*	*7,75%*
3. Solvent and Other Product Use	23,90	22,98	21,88	20,85	19,57	19,74	19,42	19,00	17,88	17,30
	0,18%	*0,17%*	*0,16%*	*0,15%*	*0,16%*	*0,19%*	*0,19%*	*0,19%*	*0,20%*	*0,18%*
4. Agriculture	775,27	781,29	785,20	776,84	754,92	778,38	788,82	786,47	784,10	785,24
	5,91%	*5,74%*	*5,87%*	*5,76%*	*5,98%*	*7,49%*	*7,54%*	*7,99%*	*8,70%*	*8,34%*
5. LULUCF (5)	208,44	31,41	-339,23	-450,77	-281,28	-384,86	-559,10	-600,74	-345,22	-470,04
	NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
6. Waste	63,34	61,67	60,07	59,74	58,49	57,30	55,97	56,53	57,60	56,66
	0,48%	*0,45%*	*0,45%*	*0,44%*	*0,46%*	*0,55%*	*0,54%*	*0,57%*	*0,64%*	*0,60%*
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Total GHG including LULUCF	13326,23	13639,81	13034,21	13045,34	12341,23	10005,10	9898,47	9241,09	8671,71	8950,63
	100,00%	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*
Total GHG excluding LULUCF	13117,79	13608,40	13373,44	13496,11	12622,52	10389,96	10457,57	9841,83	9016,93	9420,67
	100,00%	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*

Gg (1000 t.) CO_2 equivalent	2000	2001	2002	2003	2004	2005	2006	2007	2008prov (6)
CO_2 emissions, incl. net CO_2	8425,80	8697,64	9754,49	10211,74	11686,26	11837,33	11856,93	11453,26	10932,02
from LULUCF (1)	*88,69%*	*89,32%*	*90,39%*	*91,05%*	*91,53%*	*91,78%*	*91,81%*	*91,46%*	*90,96%*
CO_2 emissions, excl. net CO_2	8897,31	9239,90	10300,82	10770,93	12204,39	12330,88	12245,75	11844,04	11308,02
from LULUCF	*89,23%*	*89,88%*	*90,85%*	*91,48%*	*91,86%*	*92,09%*	*92,05%*	*91,72%*	*91,24%*
CH_4 (2) emissions, incl. net CH_4	476,10	470,18	468,92	459,22	458,41	458,63	456,11	453,54	457,63
from LULUCF (1)	*5,01%*	*4,83%*	*4,35%*	*4,09%*	*3,59%*	*3,56%*	*3,53%*	*3,62%*	*3,81%*
CH_4 (2) emissions, excl. net CH_4	476,10	470,18	468,92	459,22	458,41	458,63	456,11	453,54	457,63
from LULUCF	*4,77%*	*4,57%*	*4,14%*	*3,90%*	*3,45%*	*3,42%*	*3,43%*	*3,51%*	*3,69%*
N_2O (3) emissions, incl. net N_2O	551,33	515,68	505,96	473,95	544,92	515,02	511,39	525,10	527,47
from LULUCF (1)	*5,80%*	*5,30%*	*4,69%*	*4,23%*	*4,27%*	*3,99%*	*3,96%*	*4,19%*	*4,39%*
N_2O (3) emissions, excl. net N_2O	551,20	515,54	505,83	473,82	544,79	514,88	511,26	524,96	527,47
from LULUCF	*5,53%*	*5,01%*	*4,46%*	*4,02%*	*4,10%*	*3,85%*	*3,84%*	*4,07%*	*4,26%*
HFCs (4)	43,01	50,92	58,82	66,73	74,63	82,54	87,04	87,04	101,13
	0,43%	*0,50%*	*0,52%*	*0,57%*	*0,56%*	*0,62%*	*0,65%*	*0,67%*	*0,82%*
PFCs (4)	NO	NO	NO	NO	NO	NO	NO	NO	NO
	NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
SF_6 (4)	3,52	3,57	3,62	3,68	3,73	3,78	3,86	3,94	IE
	0,04%	*0,03%*	*0,03%*	*0,03%*	*0,03%*	*0,03%*	*0,03%*	*0,03%*	*NA*
1. Energy	8349,84	8744,46	9795,25	10330,46	11745,22	11882,12	11740,68	11345,27	10856,18
	83,74%	*85,06%*	*86,39%*	*87,74%*	*88,40%*	*88,73%*	*88,25%*	*87,86%*	*87,59%*
2. Industrial Processes	761,99	713,53	737,19	686,27	735,85	736,22	793,78	783,66	738,49
	7,64%	*6,94%*	*6,50%*	*5,83%*	*5,54%*	*5,50%*	*5,97%*	*6,07%*	*5,96%*
3. Solvent and Other Product Use	15,81	16,54	16,76	16,80	18,80	18,47	17,88	18,81	18,73
	0,16%	*0,16%*	*0,15%*	*0,14%*	*0,14%*	*0,14%*	*0,13%*	*0,15%*	*0,15%*
4. Agriculture	782,18	749,90	737,40	686,65	732,56	699,54	695,54	710,64	725,00
	7,84%	*7,29%*	*6,50%*	*5,83%*	*5,51%*	*5,22%*	*5,23%*	*5,50%*	*5,85%*
5. LULUCF (5)	-471,37	-542,13	-546,19	-559,06	-518,00	-493,42	-388,69	-390,64	-376,00
	NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
6. Waste	61,32	55,69	51,42	54,19	53,52	54,36	56,14	55,14	55,86
	0,62%	*0,54%*	*0,45%*	*0,46%*	*0,40%*	*0,41%*	*0,42%*	*0,43%*	*0,45%*
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
	NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Total GHG including LULUCF	**9499,77**	**9737,98**	**10791,82**	**11215,31**	**12767,95**	**12897,29**	**12915,33**	**12522,88**	**12018,26**
	100,00%	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*
Total GHG excluding LULUCF	**9971,14**	**10280,11**	**11338,01**	**11774,37**	**13285,95**	**13390,71**	**13304,02**	**12913,52**	**12394,26**
	100,00%	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*	*100,00%*

Sources: Environment Agency and MDDI-DEV.

Notes:

(1) these percentages are relative to the total GHG emissions, including LULUCF.

(2) the methane emissions are converted in CO_2 equivalents by multiplying the emissions by 21, i.e. the global warming potential (GWP) value for methane based on the effects of GHG over a 100-year time horizon.

(3) the nitrous oxide emissions are converted in CO_2 equivalents by multiplying the emissions by 310, i.e. the global warming potential (GWP) value for nitrous oxide based on the effects of GHG over a 100-year time horizon.

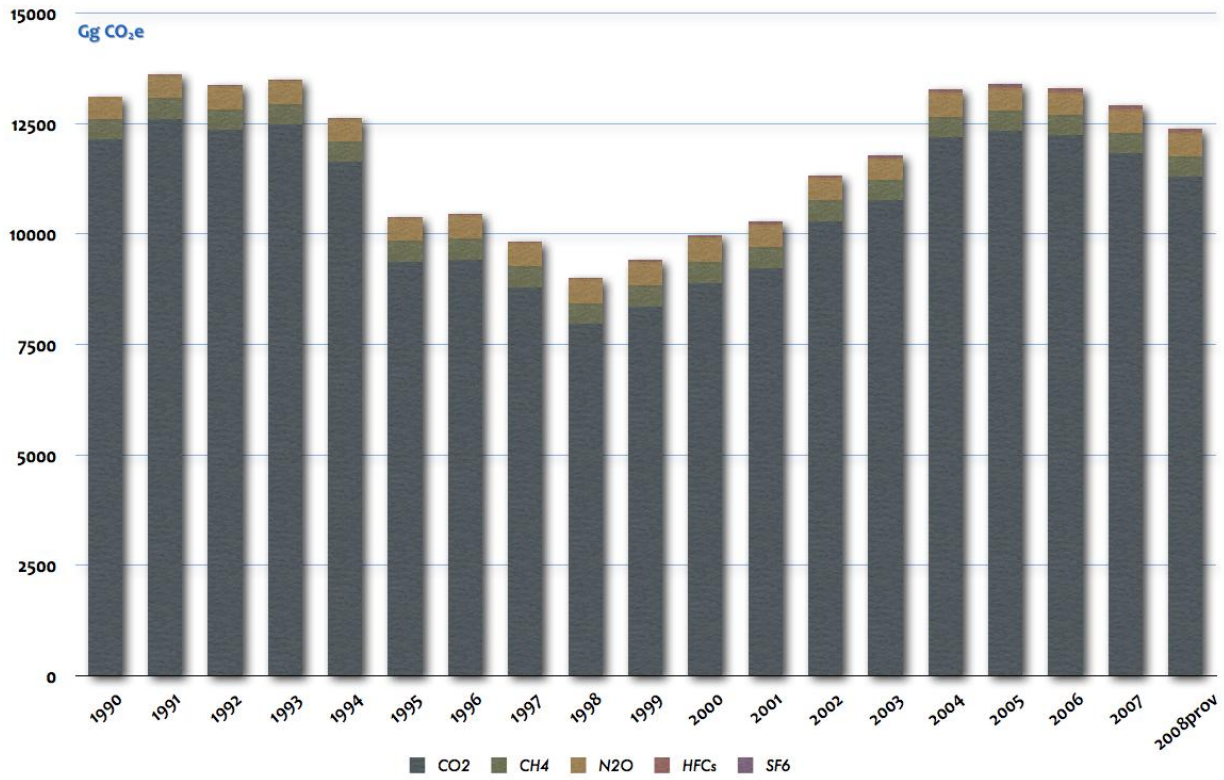
(4) the F-gases are those not covered by the Montreal Protocol, i.e. the HFCs, PFCs and SF_6 expressed in CO_2 equivalents using the global warming potential (GWP) values based on the effects of GHG over a 100-year time horizon.

(5) LULUCF emissions are covering CRF categories 5A, 5B & 5C only.

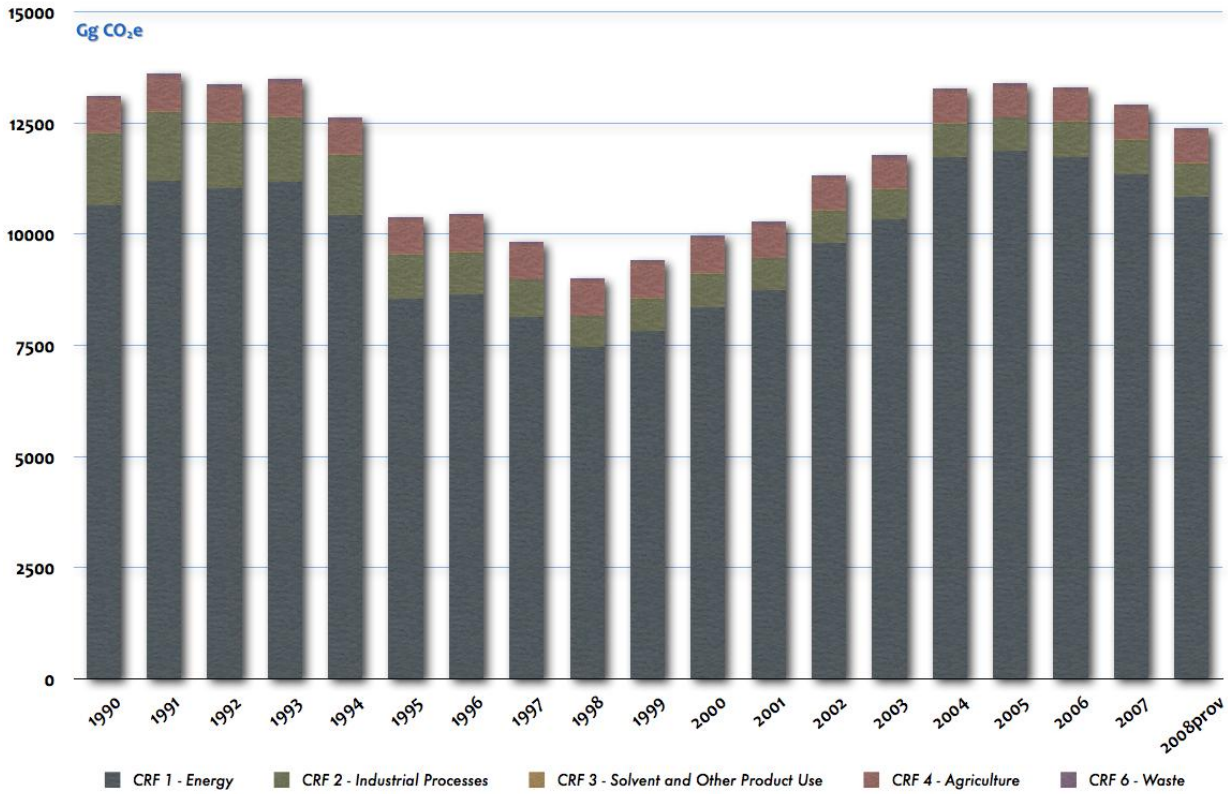
(6) for F-gases and LULUCF, 2008 “nowcasts” have been done at an aggregated level. For LULUCF, it has been recorded under CO_2, this gas being the most important in this sector. The "nowcast" also relates to an average for 2008-2012.

FIGURES III.1-2a – GHG EMISSIONS (EXCL. LULUCF) – MAIN GASES & SECTORS: ABSOLUTE VALUES 1990-2008

GHG



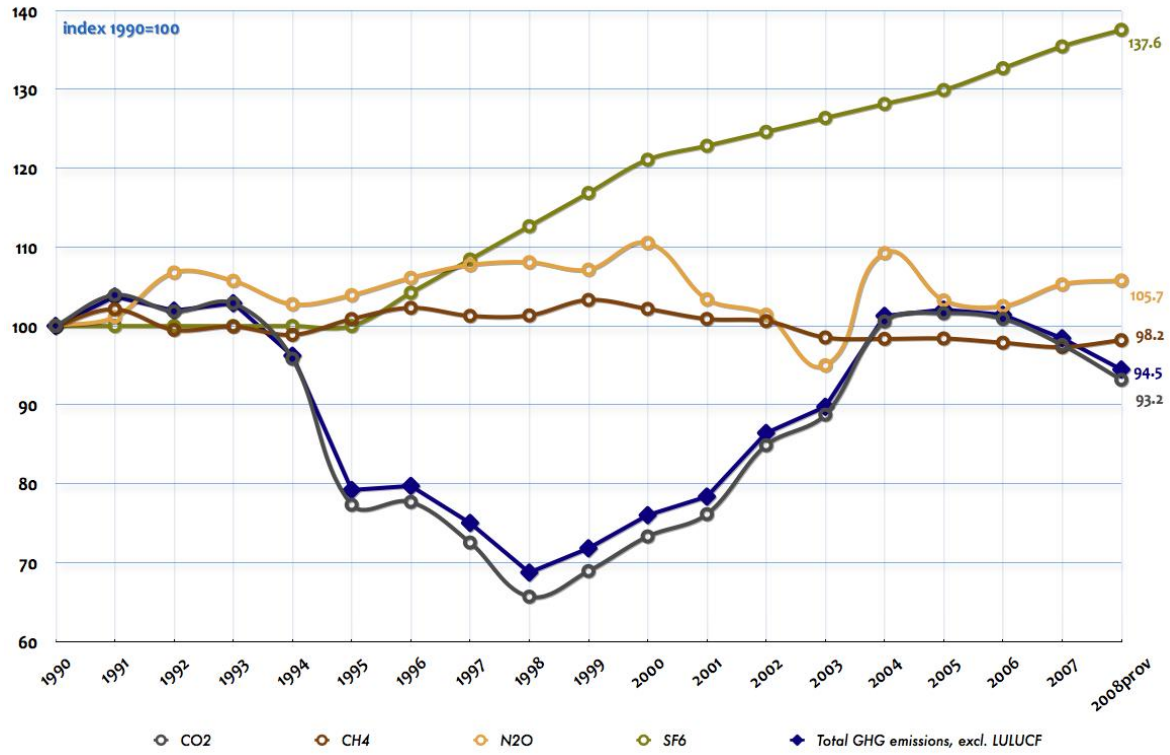
CRF sectors



Sources: Environment Agency and MDDI-DEV.

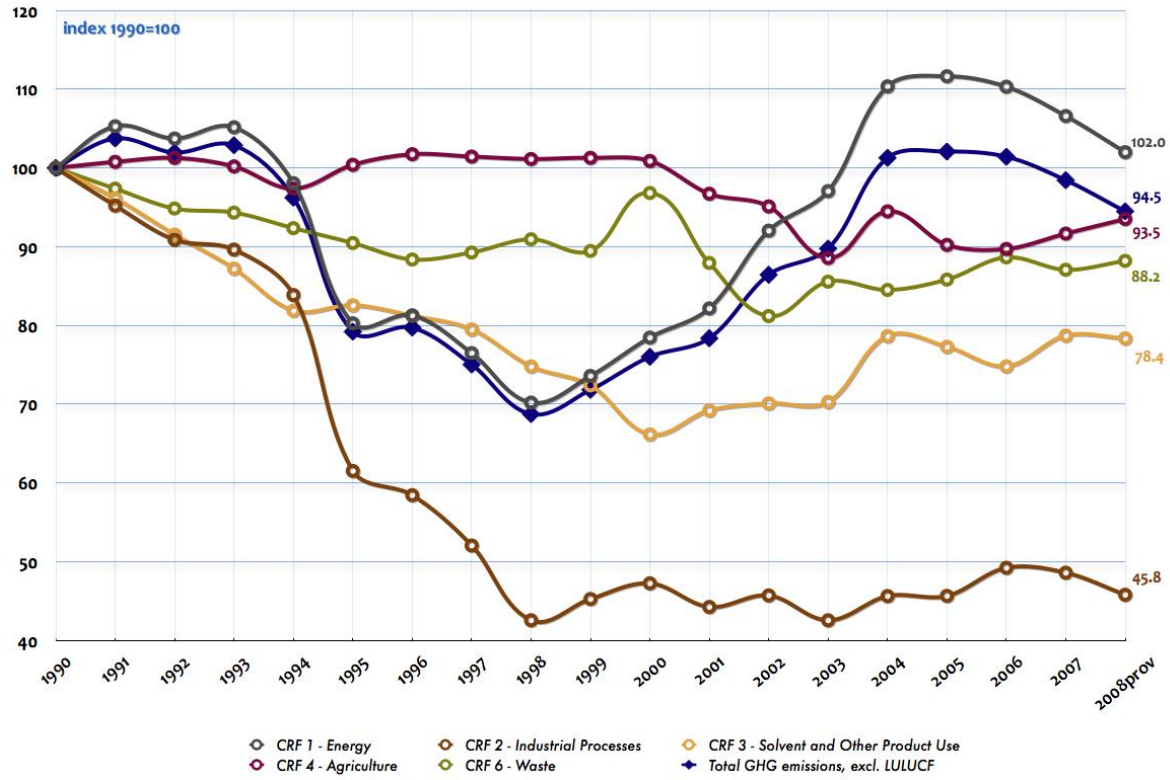
FIGURES III.1-2b – GHG EMISSIONS (EXCL. LULUCF) – MAIN GASES & SECTORS: INDEXES 1990-2008

GHG



Note: HFCs are not included in this figure for readability reasons (+583.7% between 1990 and 2008).

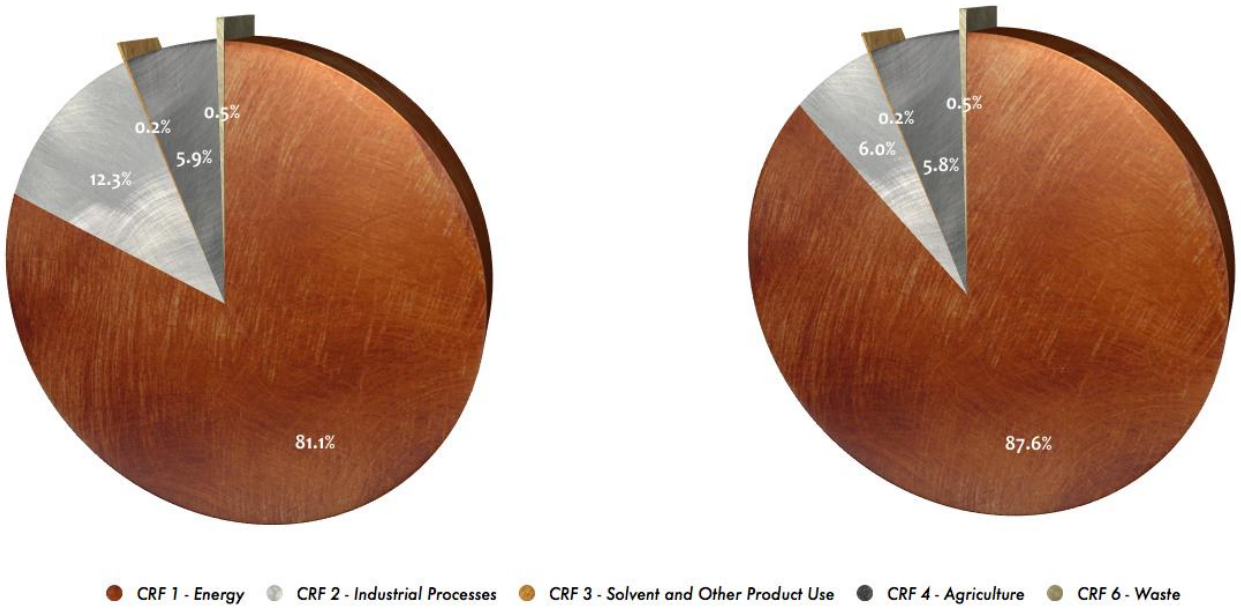
CRF sectors



Sources: Environment Agency and MDDI-DEV.

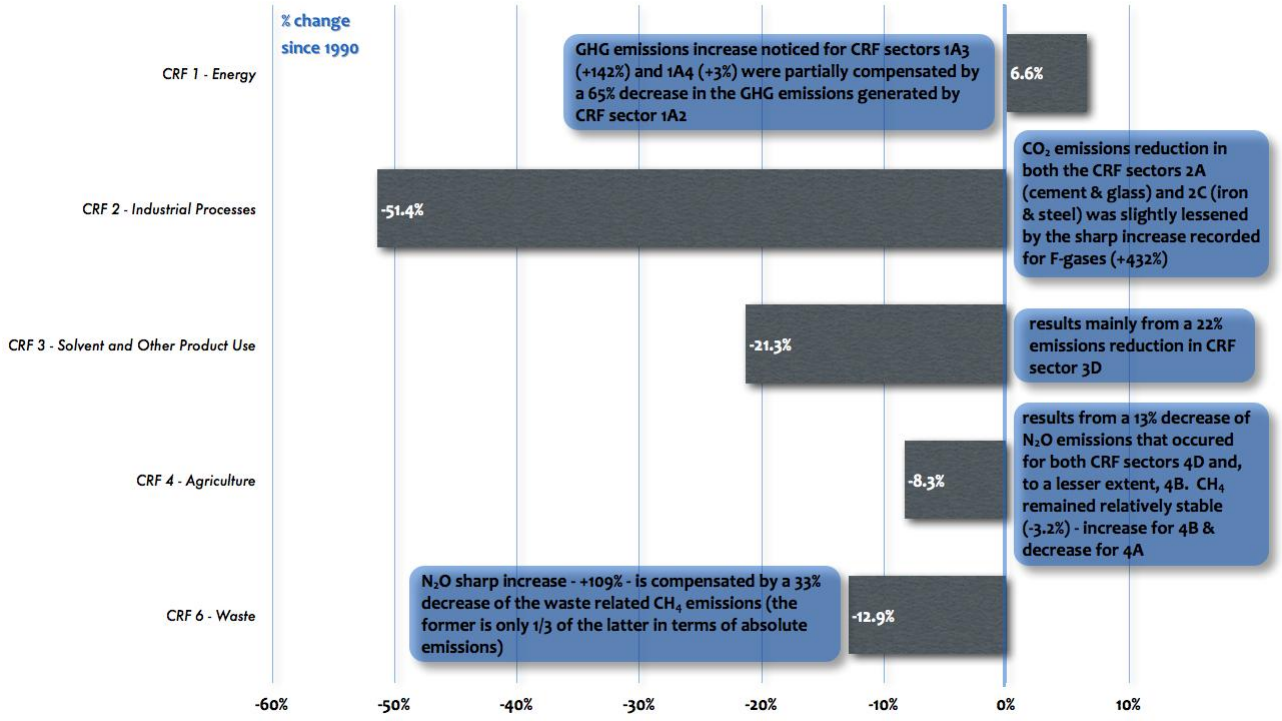
FIGURE III.1-2c – GHG EMISSIONS (EXCL. LULUCF) – CONTRIBUTION OF EACH CRF SECTOR TO TOTAL EMISSIONS: 1990 & 2007

1990 *2007*



Sources: Environment Agency and MDDI-DEV.

FIGURE III.1-2d – GHG EMISSIONS (EXCL. LULUCF) – OVERVIEW BY CRF SECTOR: % CHANGE 1990-2007



Sources: Environment Agency and MDDI-DEV.

TABLE III.1-3 – GHG EMISSIONS AND REMOVALS – DETAILS BY MAIN GASES: 1990-2008

Gg (1000 t.) CO_2 equivalent	1990 (base year)	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	**12136.02**	**12611.07**	**12360.09**	**12486.04**	**11632.18**	**9384.52**	**9428.70**	**8803.73**	**7970.95**	**8364.31**
	92.52%	*92.67%*	*92.42%*	*92.52%*	*92.15%*	*90.32%*	*90.16%*	*89.45%*	*88.40%*	*88.79%*
of which										
CRF 1 - Energy	10525.81	11078.54	10898.28	11044.95	10285.13	8397.32	8497.05	7981.04	7308.09	7664.02
	80.24%	*81.41%*	*81.49%*	*81.84%*	*81.48%*	*80.82%*	*81.25%*	*81.09%*	*81.05%*	*81.35%*
CRF 1A1 - Fuel Combustion from Energy Industries	1299.25	1242.90	1140.24	1227.91	977.54	833.07	720.17	446.75	164.20	182.38
	9.90%	*9.13%*	*8.53%*	*9.10%*	*7.74%*	*8.02%*	*6.89%*	*4.54%*	*1.82%*	*1.94%*
CRF 1A2 - Fuel Combustion from Manuf. Industries & Construction	5107.88	4937.32	4691.07	4725.24	4214.86	2662.70	2597.58	2192.20	1539.43	1657.23
	38.94%	*36.28%*	*35.08%*	*35.01%*	*33.39%*	*25.63%*	*24.84%*	*22.27%*	*17.07%*	*17.59%*
CRF 1A3 - Fuel Combustion from Transport	2701.49	3207.13	3501.26	3546.66	3607.58	3423.22	3523.36	3729.88	3895.85	4196.24
	20.59%	*23.57%*	*26.18%*	*26.28%*	*28.58%*	*32.95%*	*33.69%*	*37.90%*	*43.21%*	*44.54%*
of which, "road fuel export" (1)	1797.57	2297.95	2394.33	2321.56	2378.96	2161.54	2326.45	2457.42	2559.75	2795.61
	13.70%	*16.89%*	*17.90%*	*17.20%*	*18.85%*	*20.80%*	*22.25%*	*24.97%*	*28.39%*	*29.68%*
CRF 1A4 - Fuel Combustion from Other Sectors	1366.41	1640.41	1514.92	1500.71	1443.91	1459.62	1621.46	1573.21	1648.91	1583.93
	10.42%	*12.05%*	*11.33%*	*11.12%*	*11.44%*	*14.05%*	*15.51%*	*15.98%*	*18.29%*	*16.81%*
CRF 1A5 & 1B2b - Other Energy Sources	50.78	50.78	50.78	44.43	41.24	18.71	34.47	39.00	59.72	44.23
	0.39%	*0.37%*	*0.38%*	*0.33%*	*0.33%*	*0.18%*	*0.33%*	*0.40%*	*0.66%*	*0.47%*
CRF 2 - Industrial Processes	1595.57	1518.48	1448.49	1428.47	1335.39	975.05	919.47	810.58	651.52	689.19
	12.16%	*11.16%*	*10.83%*	*10.58%*	*10.58%*	*9.38%*	*8.79%*	*8.24%*	*7.23%*	*7.32%*
Other Sources (2)	14.64	14.06	13.32	12.62	11.66	12.16	12.18	12.11	11.33	11.11
	0.11%	*0.10%*	*0.10%*	*0.09%*	*0.09%*	*0.12%*	*0.12%*	*0.12%*	*0.13%*	*0.12%*
CH_4 (3)	**466.01**	**475.88**	**463.74**	**465.70**	**460.77**	**470.12**	**476.75**	**471.99**	**472.24**	**481.39**
	3.55%	*3.50%*	*3.47%*	*3.45%*	*3.65%*	*4.52%*	*4.56%*	*4.80%*	*5.24%*	*5.11%*
of which										
CRF 1 - Energy	55.49	61.25	61.33	59.31	58.50	57.44	61.06	59.34	59.03	59.70
	0.42%	*0.45%*	*0.46%*	*0.44%*	*0.46%*	*0.55%*	*0.58%*	*0.60%*	*0.65%*	*0.63%*
CRF 4A+4B - Enteric Fermentation and Manure Management	356.52	362.47	352.02	357.15	354.65	366.37	369.98	367.37	368.21	378.04
	2.72%	*2.66%*	*2.63%*	*2.65%*	*2.81%*	*3.53%*	*3.54%*	*3.73%*	*4.08%*	*4.01%*
Other Sources (4)	54.00	52.16	50.38	49.24	47.62	46.31	45.71	45.28	45.00	43.66
	0.41%	*0.38%*	*0.38%*	*0.36%*	*0.38%*	*0.45%*	*0.44%*	*0.46%*	*0.50%*	*0.46%*
N_2O (5)	**498.65**	**504.33**	**532.50**	**527.26**	**512.45**	**518.20**	**529.12**	**537.23**	**538.97**	**534.31**
	3.80%	*3.71%*	*3.98%*	*3.91%*	*4.06%*	*4.99%*	*5.06%*	*5.46%*	*5.98%*	*5.67%*
of which										
CRF 1 - Energy	61.30	67.07	81.07	88.84	93.40	87.62	92.80	99.99	103.94	107.92
	0.47%	*0.49%*	*0.61%*	*0.66%*	*0.74%*	*0.84%*	*0.89%*	*1.02%*	*1.15%*	*1.15%*
CRF 4D - Agricultural Soils	378.14	383.95	401.44	388.40	370.30	381.07	387.48	388.98	387.36	383.18
	2.88%	*2.82%*	*3.00%*	*2.88%*	*2.93%*	*3.67%*	*3.71%*	*3.95%*	*4.30%*	*4.07%*
Other Sources (6)	59.21	53.31	49.99	50.02	48.75	49.51	48.85	48.27	47.68	43.21
	0.45%	*0.39%*	*0.37%*	*0.37%*	*0.39%*	*0.48%*	*0.47%*	*0.49%*	*0.53%*	*0.46%*
F-gases (7)	**17.12**	**17.12**	**17.12**	**17.12**	**17.12**	**17.12**	**23.00**	**28.88**	**34.77**	**40.65**
	0.13%	*0.13%*	*0.13%*	*0.13%*	*0.14%*	*0.16%*	*0.22%*	*0.29%*	*0.39%*	*0.43%*
Total GHG excluding LULUCF	**13117.79**	**13608.40**	**13373.44**	**13496.11**	**12622.52**	**10389.96**	**10457.57**	**9841.83**	**9016.93**	**9420.67**
	100.00%	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*
LULUCF (8)	**208.44**	**31.41**	**-339.23**	**-450.77**	**-281.28**	**-384.86**	**-559.10**	**-600.74**	**-345.22**	**-470.04**

Gg (1000 t.) CO_2 equivalent	2000	2001	2002	2003	2004	2005	2006	2007	2008prov (9)
CO_2	**8897.31**	**9239.90**	**10300.82**	**10770.93**	**12204.39**	**12330.88**	**12245.75**	**11844.04**	**11308.03**
	89.23%	*89.88%*	*90.85%*	*91.48%*	*91.86%*	*92.09%*	*92.05%*	*91.72%*	*91.24%*
of which									
CRF 1 - Energy	8171.86	8569.75	9614.79	10143.78	11533.66	11668.12	11530.73	11138.38	10657.88
	81.96%	*83.36%*	*84.80%*	*86.15%*	*86.81%*	*87.14%*	*86.67%*	*86.25%*	*85.99%*
CRF 1A1 - Fuel Combustion from Energy Industries	186.10	211.59	1164.36	1195.78	1438.08	1452.84	1522.69	1358.55	1140.05
	1.87%	*2.06%*	*10.27%*	*10.16%*	*10.82%*	*10.85%*	*11.45%*	*10.52%*	*9.20%*
CRF 1A2 - Fuel Combustion from Manuf. Industries & Construction	1682.39	1573.82	1524.34	1471.03	1603.89	1687.48	1691.46	1797.60	1717.39
	16.87%	*15.31%*	*13.44%*	*12.49%*	*12.07%*	*12.60%*	*12.71%*	*13.92%*	*13.86%*
CRF 1A3 - Fuel Combustion from Transport	4730.44	5026.57	5375.56	5937.34	6794.48	7016.55	6842.18	6571.27	6358.31
	47.44%	*48.90%*	*47.41%*	*50.43%*	*51.14%*	*52.40%*	*51.43%*	*50.89%*	*51.30%*
of which, "road fuel export" (1)	3205.38	3448.57	3784.27	4276.44	5230.51	5470.97	5189.64	4851.60	4734.76
	32.15%	*33.55%*	*33.38%*	*36.32%*	*39.37%*	*40.86%*	*39.01%*	*37.57%*	*38.20%*
CRF 1A4 - Fuel Combustion from Other Sectors	1519.60	1692.66	1531.06	1530.20	1684.13	1495.25	1464.73	1398.13	1442.05
	15.24%	*16.47%*	*13.50%*	*13.00%*	*12.68%*	*11.17%*	*11.01%*	*10.83%*	*11.63%*
CRF 1A5 & 1B2b - Other Energy Sources	53.33	65.11	19.47	9.44	13.08	16.00	9.67	12.83	0.08
	0.53%	*0.63%*	*0.17%*	*0.08%*	*0.10%*	*0.12%*	*0.07%*	*0.10%*	*0.00%*
CRF 2 - Industrial Processes	715.45	659.03	674.75	615.86	657.49	649.90	702.87	692.67	637.36
	7.18%	*6.41%*	*5.95%*	*5.23%*	*4.95%*	*4.85%*	*5.28%*	*5.36%*	*5.14%*
Other Sources (2)	9.99	11.12	11.28	11.29	13.24	12.86	12.14	12.98	12.78
	0.10%	*0.11%*	*0.10%*	*0.10%*	*0.10%*	*0.10%*	*0.09%*	*0.10%*	*0.10%*
CH_4 (3)	**476.10**	**470.18**	**468.92**	**459.22**	**458.41**	**458.63**	**456.11**	**453.54**	**457.63**
	4.77%	*4.57%*	*4.14%*	*3.90%*	*3.45%*	*3.42%*	*3.43%*	*3.51%*	*3.69%*
of which									
CRF 1 - Energy	60.60	61.07	73.81	73.43	78.99	75.45	76.18	72.51	71.32
	0.61%	*0.59%*	*0.65%*	*0.62%*	*0.59%*	*0.56%*	*0.57%*	*0.56%*	*0.58%*
CRF 4A+4B - Enteric Fermentation and Manure Management	369.67	368.91	359.02	348.56	343.51	347.03	343.10	345.13	350.00
	3.71%	*3.59%*	*3.17%*	*2.96%*	*2.59%*	*2.59%*	*2.58%*	*2.67%*	*2.82%*
Other Sources (4)	45.84	40.19	36.09	37.23	35.91	36.15	36.84	35.89	36.31
	0.46%	*0.39%*	*0.32%*	*0.32%*	*0.27%*	*0.27%*	*0.28%*	*0.28%*	*0.29%*
N_2O (5)	**551.20**	**515.54**	**505.83**	**473.82**	**544.79**	**514.88**	**511.26**	**524.96**	**527.47**
	5.53%	*5.01%*	*4.46%*	*4.02%*	*4.10%*	*3.85%*	*3.84%*	*4.07%*	*4.26%*
of which									
CRF 1 - Energy	117.38	113.63	106.65	113.25	132.57	138.55	133.77	134.38	126.98
	1.18%	*1.11%*	*0.94%*	*0.96%*	*1.00%*	*1.03%*	*1.01%*	*1.04%*	*1.02%*
CRF 4D - Agricultural Soils	389.07	357.56	356.09	315.45	366.52	330.62	331.61	339.85	350.00
	3.90%	*3.48%*	*3.14%*	*2.68%*	*2.76%*	*2.47%*	*2.49%*	*2.63%*	*2.82%*
Other Sources (6)	44.75	44.35	43.09	45.12	45.69	45.72	45.88	50.73	50.49
	0.45%	*0.43%*	*0.38%*	*0.38%*	*0.34%*	*0.34%*	*0.34%*	*0.39%*	*0.41%*
F-gases (7)	**46.53**	**54.49**	**62.45**	**70.40**	**78.36**	**86.32**	**90.90**	**90.98**	**101.13**
	0.47%	*0.53%*	*0.55%*	*0.60%*	*0.59%*	*0.64%*	*0.68%*	*0.70%*	*0.82%*
Total GHG excluding LULUCF	**9971.14**	**10280.11**	**11338.01**	**11774.37**	**13285.95**	**13390.71**	**13304.02**	**12913.52**	**12394.26**
	100.00%	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*
LULUCF (8)	**-471.37**	**-542.13**	**-546.19**	**-559.06**	**-518.00**	**-493.42**	**-388.69**	**-390.64**	**-376.00**

Sources: Environment Agency and MDDI-DEV.

Notes:

(1) estimation done using COPERT IV and the quantities of road fuels sold in Luxembourg [cf Section II.8.1].

(2) the other CO_2 sources are emissions from solvent and other product use (CRF 3).

(3) the methane emissions are converted in CO_2 equivalents by multiplying the emissions by 21, i.e. the global warming potential (GWP) value for methane based on the effects of GHG over a 100-year time horizon.

(4) the other CH_4 sources are emissions from solid waste disposal on land (CRF 6A), waste water handling (CRF 6B) and composting (CRF 6D).

(5) the nitrous oxide emissions are converted in CO_2 equivalents by multiplying the emissions by 310, i.e. the global warming potential (GWP) value for nitrous oxide based on the effects of GHG over a 100-year time horizon.

(6) the other N_2O sources are emissions from anaesthesia (CRF 3D), manure management (CRF 4B), waste water handling (CRF 6B) and composting (CRF 6D).

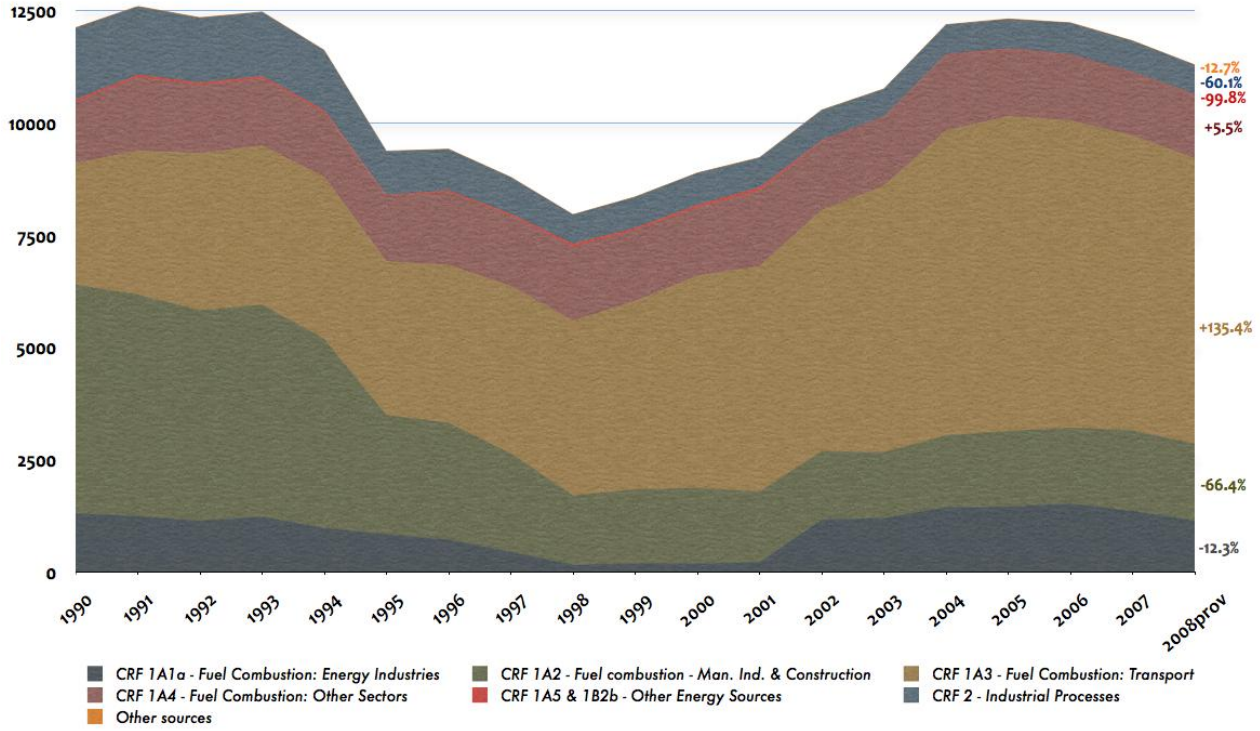
(7) the F-gases are those not covered by the Montreal Protocol, i.e. the HFCs, PFCs and SF_6 expressed in CO_2 equivalents using the global warming potential (GWP) values based on the effects of GHG over a 100-year time horizon.

(8) LULUCF emissions are covering CRF categories 5A, 5B & 5C only.

(9) for LULUCF, 2008 the "nowcast" relates to an average for 2008-2012 and for CRF 1A5 & 1B2b, it relates to CRF 1B2b only.

FIGURES III.1-3a – GHG EMISSIONS (EXCL. F-GASES & LULUCF) – DETAILS BY MAIN GASES: ABSOLUTE VALUES 1990-2008

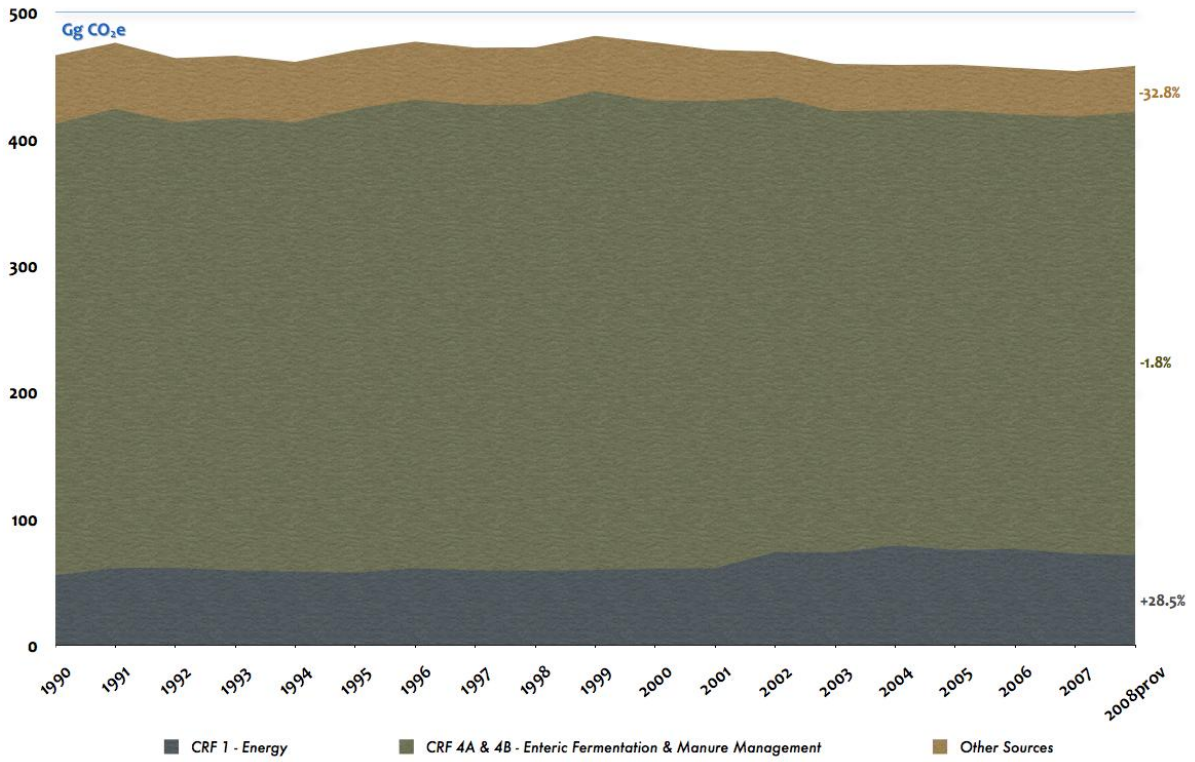
CO_2



Sources: Environment Agency and MDDI-DEV.

Note: the other CO_2 sources are emissions from solvent and other product use (CRF 3).

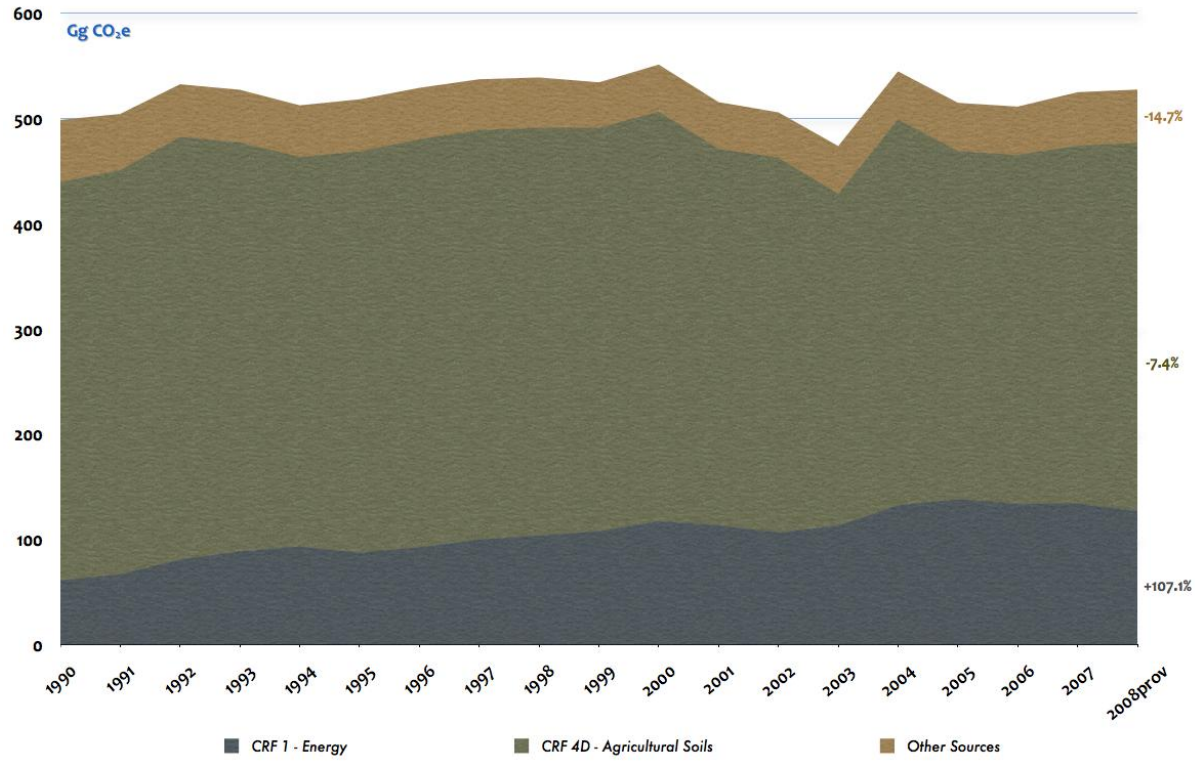
CH_4



Sources: Environment Agency and MDDI-DEV.

Note: the other CH_4 sources are emissions from solid waste disposal on land (CRF 6A), waste water handling (CRF 6B) and composting (CRF 6D).

N_2O

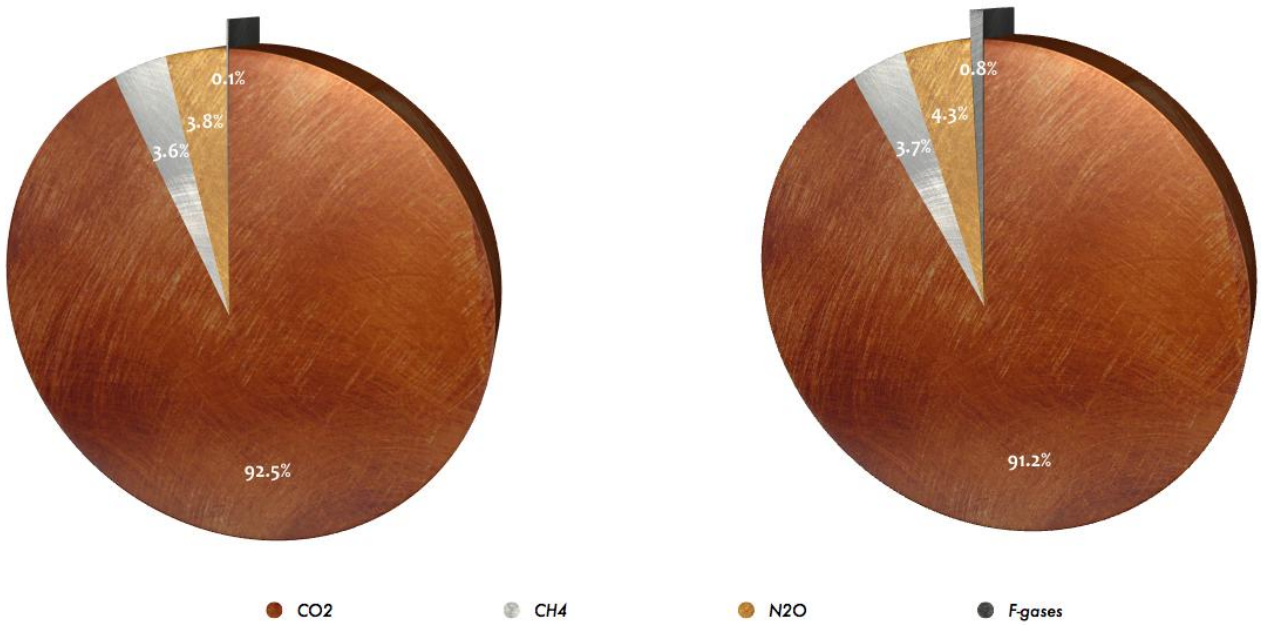


Sources: Environment Agency and MDDI-DEV.

Note: the other N_2O sources are emissions from anaesthesia (CRF 3D), manure management (CRF 4B), waste water handling (CRF 6B) and composting (CRF 6D).

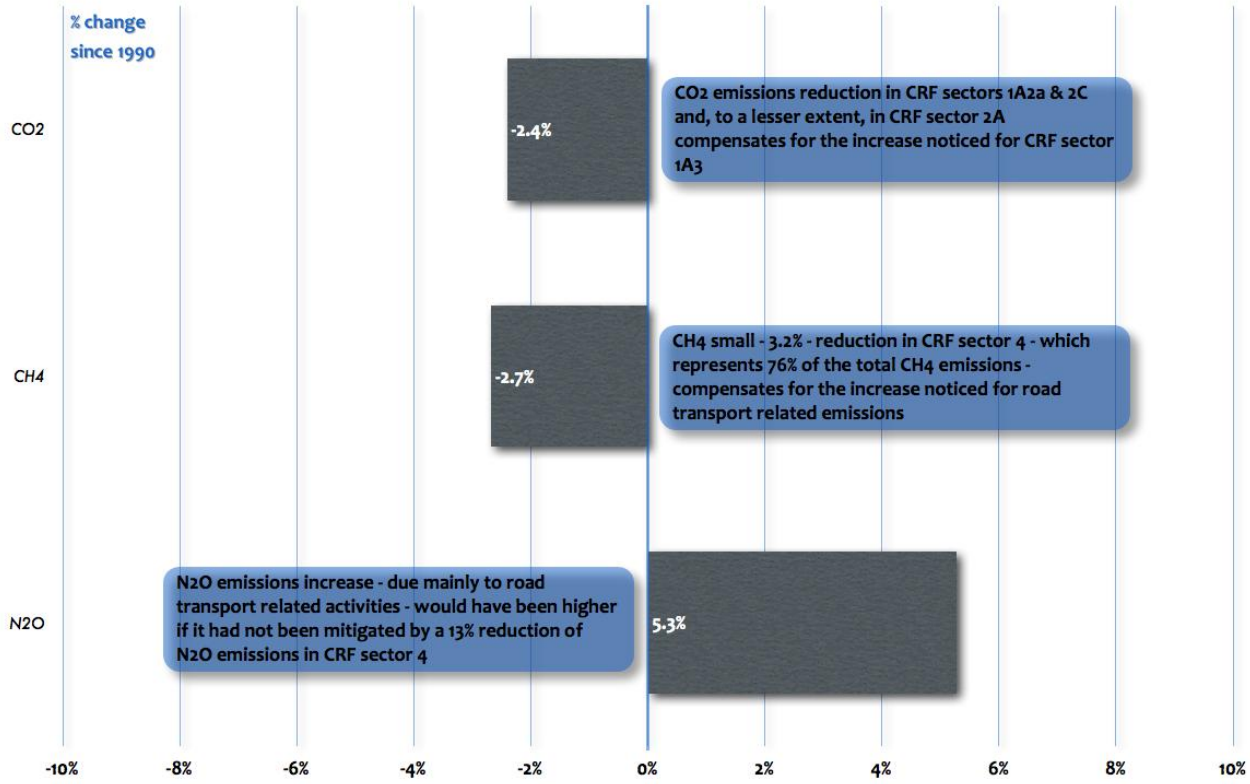
FIGURES III.1-3b – GHG EMISSIONS (EXCL. LULUCF) – CONTRIBUTION OF EACH GAS TO TOTAL EMISSIONS: 1990 & 2007

1990 *2007*



Sources: Environment Agency and MDDI-DEV.

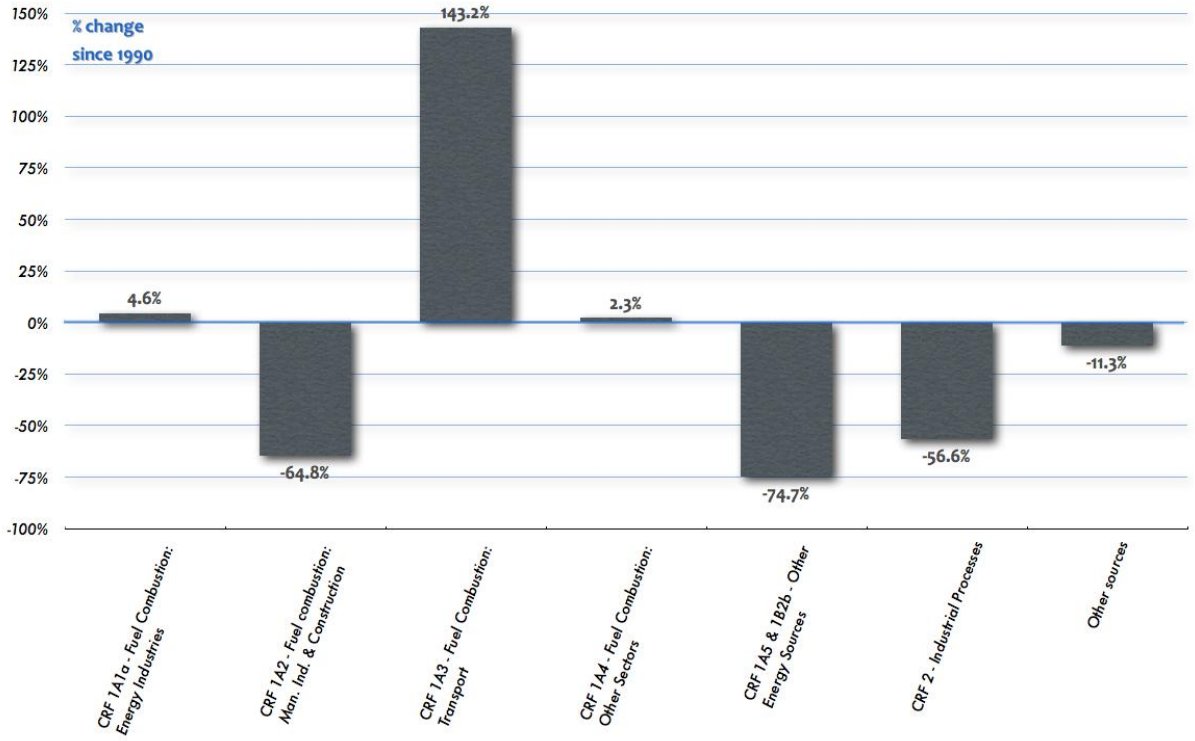
FIGURE III.1-3c – GHG EMISSIONS (EXCL. LULUCF) – OVERVIEW BY GAS: % CHANGE 1990-2007



Sources: Environment Agency and MDDI-DEV.

FIGURE III.1-3d – GHG EMISSIONS TRENDS (EXCL. LULUCF) – MAIN GASES' TRENDS: 1990-2007

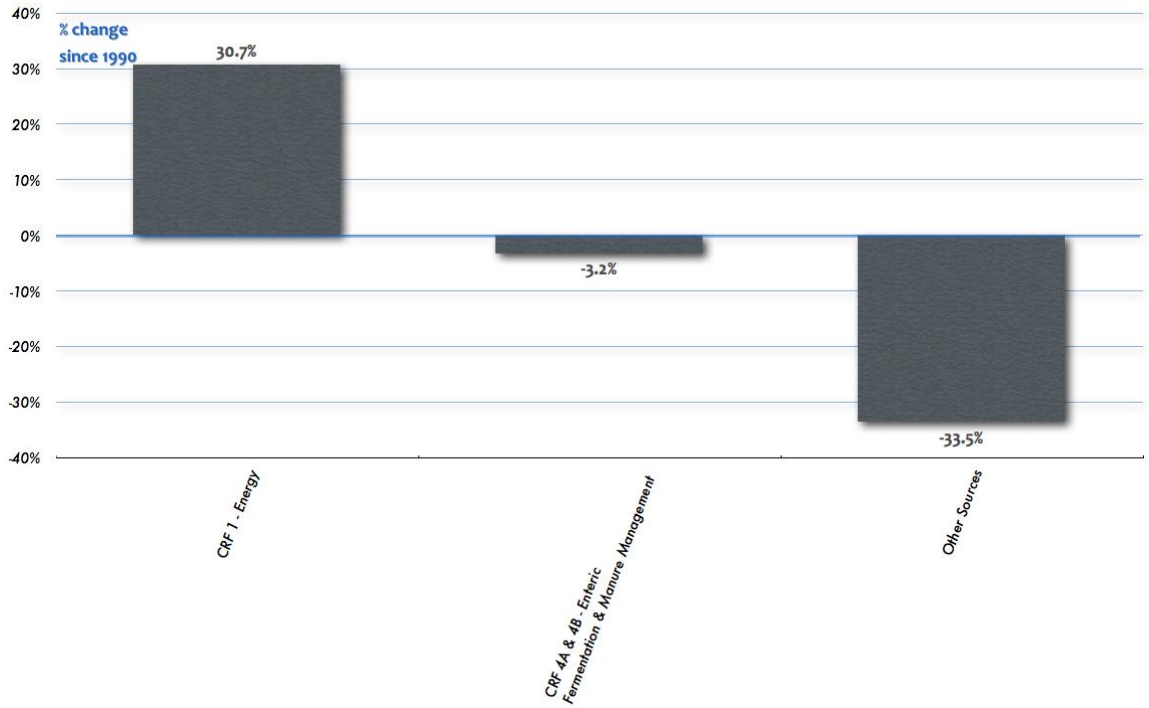
CO_2



Sources: Environment Agency and MDDI-DEV.

Note: the other CO_2 sources are emissions from solvent and other product use (CRF 3).

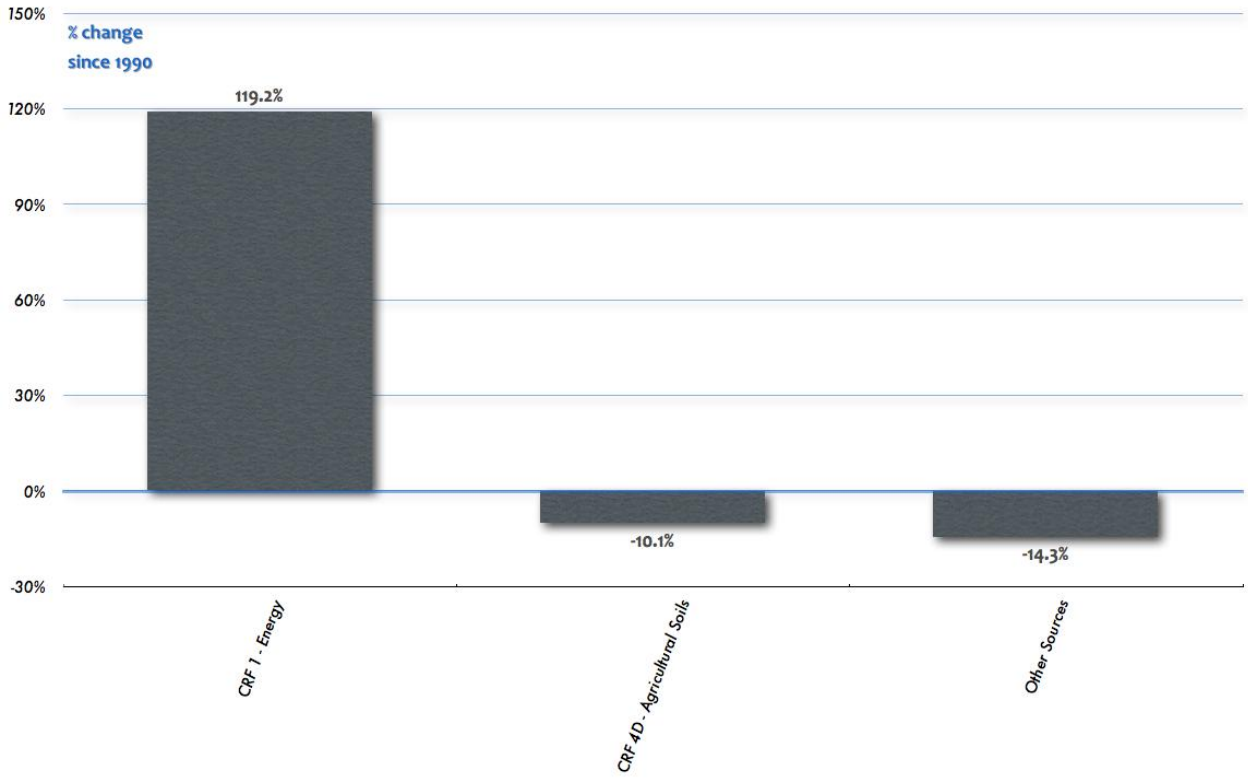
CH_4



Sources: Environment Agency and MDDI-DEV.

Note: the other CH_4 sources are emissions from solid waste disposal on land (CRF 6A), waste water handling (CRF 6B) and composting (CRF 6D).

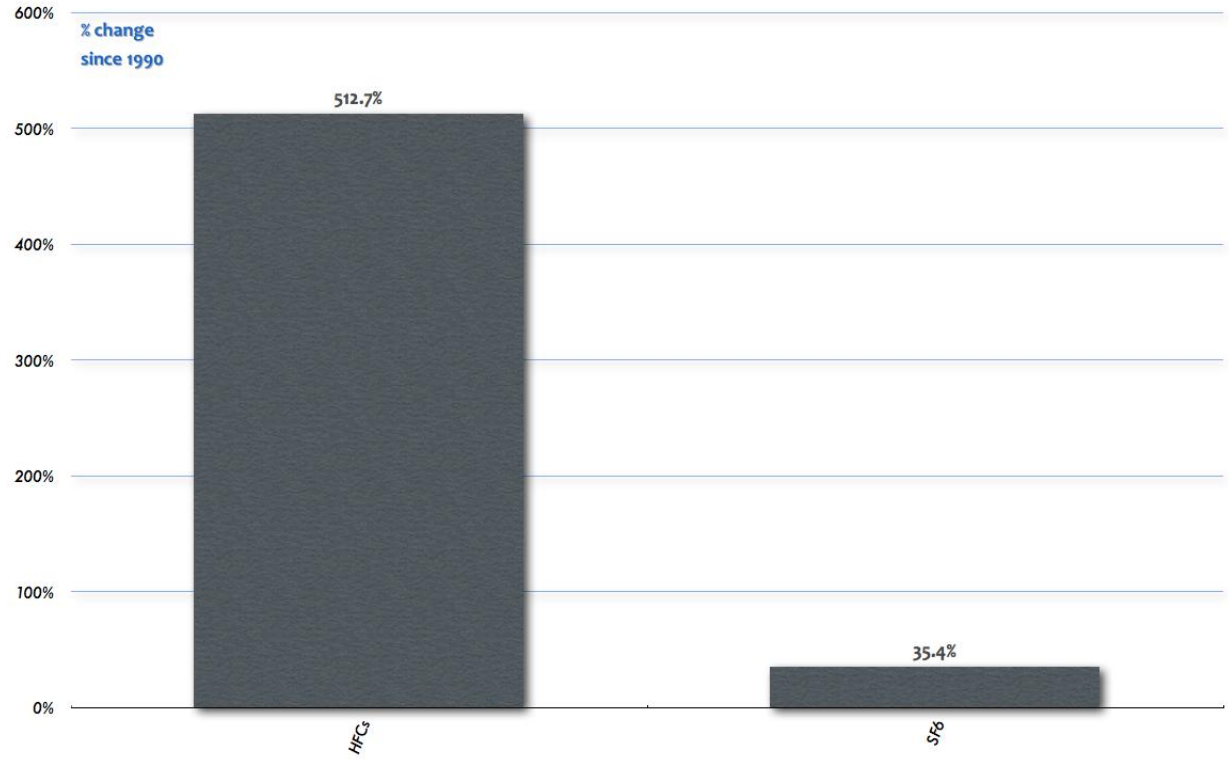
N_2O



Sources: Environment Agency and MDDI-DEV.

Note: the other N_2O sources are emissions from anaesthesia (CRF 3D), manure management (CRF 4B), waste water handling (CRF 6B) and composting (CRF 6D).

F-gases



Sources: Environment Agency and MDDI-DEV.

TABLE III.1-4 – GHG EMISSIONS (EXCL. LULUCF) – SECTOR-BASED BREAKDOWN: 1990-2008

Gg (1000 t.) CO_2 equivalent	CRF Categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Main Emitting Source Categories											
Public Electricity & Heat Production (excl. waste incineration)	*1A1a*	1267.90	1210.89	1107.56	1196.82	947.05	803.98	697.70	420.03	111.65	122.22
		9.67%	*8.90%*	*8.28%*	*8.87%*	*7.50%*	*7.74%*	*6.67%*	*4.27%*	*1.24%*	*1.30%*
Iron & Steel (fuel combustion & processes)	*1A2a + 2C1*	5208.86	4878.94	4504.29	4652.61	3904.20	2091.20	1960.27	1362.64	545.24	589.77
		39.71%	*35.85%*	*33.68%*	*34.47%*	*30.93%*	*20.13%*	*18.74%*	*13.85%*	*6.05%*	*6.26%*
Other Manufacturing Industries & Construction (fuel combustion & processes)	*1A2b/c/e/f + 2A*	1510.99	1591.99	1651.46	1516.16	1660.36	1557.73	1568.30	1652.66	1659.12	1774.21
		11.52%	*11.70%*	*12.35%*	*11.23%*	*13.15%*	*14.99%*	*15.00%*	*16.79%*	*18.40%*	*18.83%*
Road Transportation - national fleet	*1A3b*	936.71	944.74	1144.57	1270.10	1274.81	1280.04	1209.39	1288.15	1351.10	1413.98
		7.14%	*6.94%*	*8.56%*	*9.41%*	*10.10%*	*12.32%*	*11.56%*	*13.09%*	*14.98%*	*15.01%*
Road Transportation - fuel export	*1A3b*	1798.21	2306.25	2413.30	2340.20	2402.17	2214.18	2386.10	2517.75	2620.15	2859.46
		13.71%	*16.95%*	*18.05%*	*17.34%*	*19.03%*	*21.31%*	*22.82%*	*25.58%*	*29.06%*	*30.35%*
Residential Fuel Combustion (4)	*1A4b*	680.66	816.73	753.65	748.07	717.93	727.37	807.02	781.22	822.64	785.08
		5.19%	*6.00%*	*5.64%*	*5.54%*	*5.69%*	*7.00%*	*7.72%*	*7.94%*	*9.12%*	*8.33%*
Commercial & Institutional Fuel Combustion (4)	*1A4a*	680.66	816.73	753.65	748.07	717.93	727.37	807.02	781.22	816.09	781.80
		5.19%	*6.00%*	*5.64%*	*5.54%*	*5.69%*	*7.00%*	*7.72%*	*7.94%*	*9.05%*	*8.30%*
Agriculture (fuel combustion, livestock, crops, soils)	*1A4c+4*	792.05	801.31	805.19	793.58	774.91	795.12	808.80	809.76	807.38	814.98
		6.04%	*5.89%*	*6.02%*	*5.88%*	*6.14%*	*7.65%*	*7.73%*	*8.23%*	*8.95%*	*8.65%*
Other Source Categories											
Municipal Waste Incineration (with energy & heat recovery)	*1A1a (6C)*	33.92	34.65	35.38	33.66	32.93	31.45	24.33	28.83	55.01	62.98
		0.26%	*0.25%*	*0.26%*	*0.25%*	*0.26%*	*0.30%*	*0.23%*	*0.29%*	*0.61%*	*0.67%*
Other Transport	*1A3a/c/d*	28.60	28.71	28.84	29.09	28.35	23.21	25.84	25.49	25.37	25.45
		0.22%	*0.21%*	*0.22%*	*0.22%*	*0.22%*	*0.22%*	*0.25%*	*0.26%*	*0.28%*	*0.27%*
Other Energy Sources (5)	*1A5 + 1B2b*	74.89	75.68	76.49	70.04	66.71	44.16	64.42	69.66	92.93	76.12
		0.57%	*0.56%*	*0.57%*	*0.52%*	*0.53%*	*0.43%*	*0.62%*	*0.71%*	*1.03%*	*0.81%*
F-gases	*2F*	17.12	17.12	17.12	17.12	17.12	17.12	23.00	28.88	34.77	40.65
		0.13%	*0.13%*	*0.13%*	*0.13%*	*0.14%*	*0.16%*	*0.22%*	*0.29%*	*0.39%*	*0.43%*
Solvent & Other Product Use	*3*	23.90	22.98	21.88	20.85	19.57	19.74	19.42	19.00	17.88	17.30
		0.18%	*0.17%*	*0.16%*	*0.15%*	*0.16%*	*0.19%*	*0.19%*	*0.19%*	*0.20%*	*0.18%*
Municipal Waste Disposal on Land	*6A*	47.87	46.18	44.56	43.08	41.53	40.24	39.92	38.94	37.96	36.71
		0.36%	*0.34%*	*0.33%*	*0.32%*	*0.33%*	*0.39%*	*0.38%*	*0.40%*	*0.42%*	*0.39%*
Waste Water Handling	*6B*	15.47	15.49	15.51	15.64	15.77	15.57	14.75	14.75	14.92	15.04
		0.12%	*0.11%*	*0.12%*	*0.12%*	*0.12%*	*0.15%*	*0.14%*	*0.15%*	*0.17%*	*0.16%*
Composting	*6D*	NO	NO	NO	1.03	1.19	1.49	1.30	2.85	4.72	4.91
		NA	*NA*	*NA*	*0.01%*	*0.01%*	*0.01%*	*0.01%*	*0.03%*	*0.05%*	*0.05%*
Total GHG excluding LULUCF		13117.79	13608.40	13373.44	13496.11	12622.52	10389.96	10457.57	9841.83	9016.93	9420.67
		100.00%	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*
Memo Items											
International Bunkers - Aviation		401.98	417.69	405.15	402.02	508.80	577.90	628.15	766.32	863.66	1014.39
		NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
International Bunkers - Marine		0.07	0.07	0.07	0.10	0.08	0.08	0.08	0.08	0.08	0.09
		NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
CO_2 Emissions from Biomass		166.27	168.15	170.95	166.54	164.68	161.00	143.40	154.68	143.30	152.27
		NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*

Gg (1000 t.) CO_2 equivalent	CRF Categories	2000	2001	2002	2003	2004	2005	2006	2007	2008prov
Main Emitting Source Categories										
Public Electricity & Heat Production (excl. waste incineration)	*1A1a*	127.66	153.92	1106.67	1136.93	1374.61	1394.79	1461.48	1295.72	1075.65
		1.28%	*1.50%*	*9.76%*	*9.66%*	*10.35%*	*10.42%*	*10.99%*	*10.03%*	*8.68%*
Iron & Steel (fuel combustion & processes)	*1A2a + 2C1*	562.79	569.99	639.14	624.14	644.98	609.65	732.83	772.50	701.84
		5.64%	*5.54%*	*5.64%*	*5.30%*	*4.85%*	*4.55%*	*5.51%*	*5.98%*	*5.66%*
Other Manufacturing Industries & Construction (fuel combustion & processes)	*1A2b/c/e/f + 2A*	1855.38	1678.21	1572.64	1475.08	1631.74	1749.60	1683.34	1739.51	1674.38
		18.61%	*16.32%*	*13.87%*	*12.53%*	*12.28%*	*13.07%*	*12.65%*	*13.47%*	*13.51%*
Road Transportation - national fleet	*1A3b*	1539.65	1589.71	1603.56	1675.43	1579.78	1565.25	1674.67	1747.04	1702.34
		15.44%	*15.46%*	*14.14%*	*14.23%*	*11.89%*	*11.69%*	*12.59%*	*13.53%*	*13.73%*
Road Transportation - fuel export	*1A3b*	3274.28	3518.94	3855.82	4354.52	5319.73	5561.87	5273.97	4933.45	4756.97
		32.84%	*34.23%*	*34.01%*	*36.98%*	*40.04%*	*41.54%*	*39.64%*	*38.20%*	*38.38%*
Residential Fuel Combustion (4)	*1A4b*	756.06	841.25	761.56	761.17	810.43	729.11	710.44	670.67	692.72
		7.58%	*8.18%*	*6.72%*	*6.46%*	*6.10%*	*5.44%*	*5.34%*	*5.19%*	*5.59%*
Commercial & Institutional Fuel Combustion (4)	*1A4a*	752.78	841.25	761.56	761.17	846.85	729.11	717.60	688.54	710.48
		7.55%	*8.18%*	*6.72%*	*6.46%*	*6.37%*	*5.44%*	*5.39%*	*5.33%*	*5.73%*
Agriculture (fuel combustion, livestock, crops, soils)	*1A4c+4*	805.50	772.85	757.13	706.25	777.81	751.77	748.32	767.24	781.60
		8.08%	*7.52%*	*6.68%*	*6.00%*	*5.85%*	*5.61%*	*5.62%*	*5.94%*	*6.31%*
Other Source Categories										
Municipal Waste Incineration (with energy & heat recovery)	*1A1a (6C)*	61.19	60.41	61.35	62.62	67.68	62.03	65.39	66.94	68.38
		0.61%	*0.59%*	*0.54%*	*0.53%*	*0.51%*	*0.46%*	*0.49%*	*0.52%*	*0.55%*
Other Transport	*1A3a/c/d*	25.03	26.88	23.83	21.03	16.88	11.20	8.53	2.83	2.83
		0.25%	*0.26%*	*0.21%*	*0.18%*	*0.13%*	*0.08%*	*0.06%*	*0.02%*	*0.02%*
Other Energy Sources (5)	*1A5 + 1B2b*	87.15	99.96	64.12	54.63	64.79	67.17	62.51	64.14	51.36
		0.87%	*0.97%*	*0.57%*	*0.46%*	*0.49%*	*0.50%*	*0.47%*	*0.50%*	*0.41%*
F-gases	*2F*	46.53	54.49	62.45	70.40	78.36	86.32	90.90	90.98	101.13
		0.47%	*0.53%*	*0.55%*	*0.60%*	*0.59%*	*0.64%*	*0.68%*	*0.70%*	*0.82%*
Solvent & Other Product Use	*3*	15.81	16.54	16.76	16.80	18.80	18.47	17.88	18.81	18.73
		0.16%	*0.16%*	*0.15%*	*0.14%*	*0.14%*	*0.14%*	*0.13%*	*0.15%*	*0.15%*
Municipal Waste Disposal on Land	*6A*	36.95	31.71	26.82	26.71	25.67	25.63	25.50	24.98	25.41
		0.37%	*0.31%*	*0.24%*	*0.23%*	*0.19%*	*0.19%*	*0.19%*	*0.19%*	*0.21%*
Waste Water Handling	*6B*	15.27	15.48	14.28	14.29	14.97	14.97	15.20	15.48	15.77
		0.15%	*0.15%*	*0.13%*	*0.12%*	*0.11%*	*0.11%*	*0.11%*	*0.12%*	*0.13%*
Composting	*6D*	9.11	8.50	10.32	13.19	12.88	13.75	15.44	14.68	14.68
		0.09%	*0.08%*	*0.09%*	*0.11%*	*0.10%*	*0.10%*	*0.12%*	*0.11%*	*0.12%*
Total GHG excluding LULUCF		9971.14	10280.11	11338.01	11774.37	13285.95	13390.71	13304.02	12913.52	12394.26
		100.00%	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*	*100.00%*
Memo Items										
International Bunkers - Aviation		979.84	1058.35	1146.27	1193.39	1300.15	1318.99	1237.33	1328.40	NE
		NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
International Bunkers - Marine		0.10	0.10	0.11	0.11	0.11	0.14	0.15	0.13	NE
		NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
CO_2 Emissions from Biomass		153.41	155.86	156.38	174.09	188.58	183.84	194.93	357.10	NE
		NA	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*

Sources: Environment Agency and MDDI-DEV.

Notes:

(1) the methane emissions are converted in CO2 equivalents by multiplying the emissions by 21, i.e. the global warming potential (GWP) value for methane based on the effects of GHG over a 100-year time horizon.

(2) the nitrous oxide emissions are converted in CO2 equivalents by multiplying the emissions by 310, i.e. the global warming potential (GWP) value for nitrous oxide based on the effects of GHG over a 100-year time horizon.

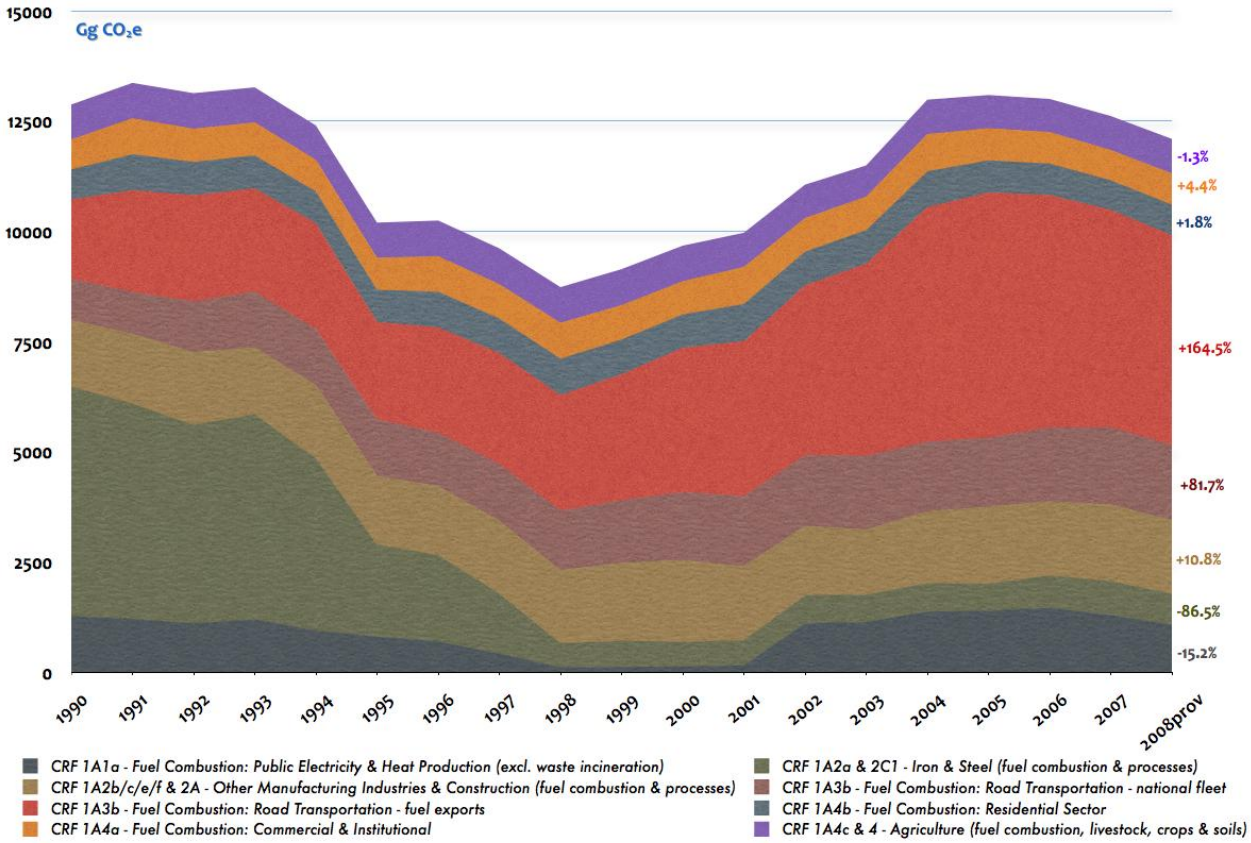
(3) the F-gases are those not covered by the Montreal Protocol, i.e. the HFCs, PFCs and SF6 expressed in CO2 equivalents using the global warming potential (GWP) values based on the effects of GHG over a 100-year time horizon.

(4) The two CRF 1A4 sub-categories (residential and commercial & institutional) have a very similar level because national energy statistics does not allow for distinguishing these two sub-categories. So far a 50-50 distribution is carried out in the inventories: cf Ministry of the Environment (2009d), page 155.

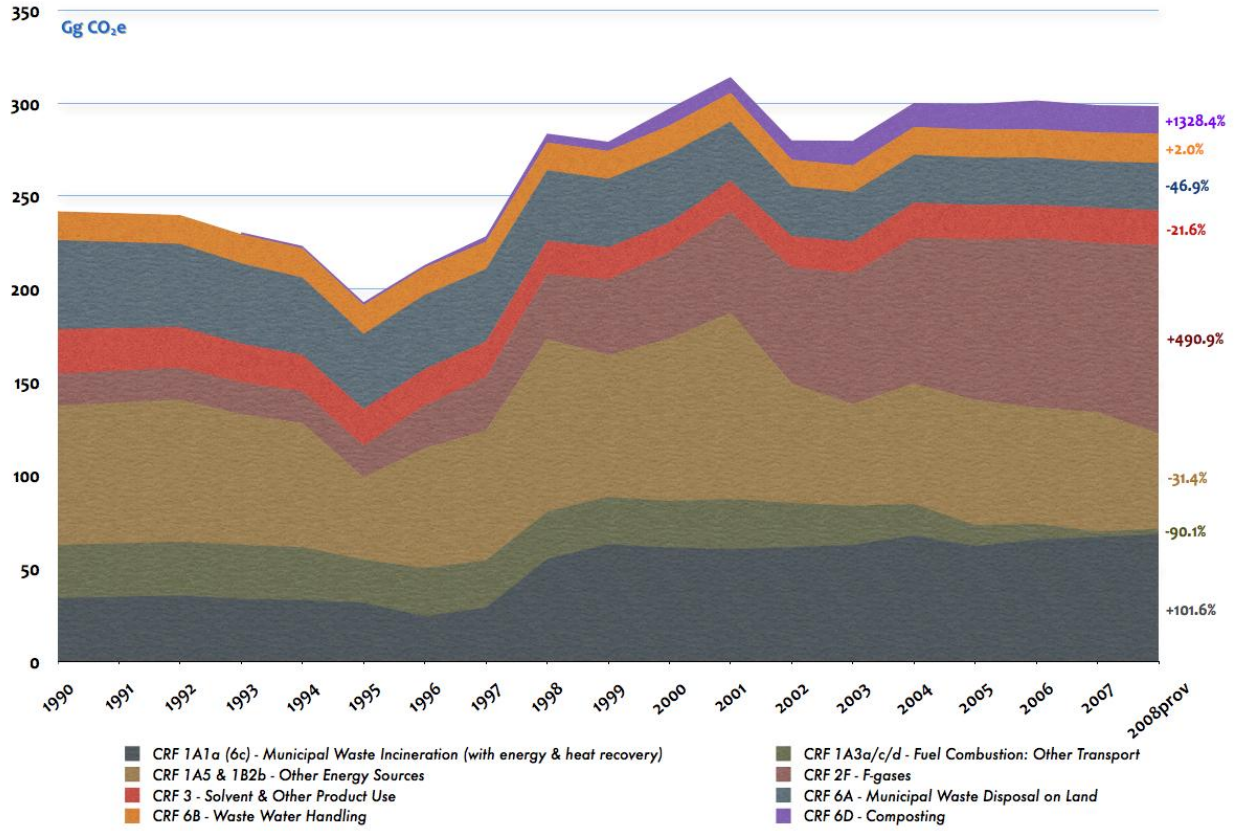
(5) for the category "other energy sources", the 2008 "nowcast" relates to CRF 1B2b only.

FIGURES III.1-4a –GHG EMISSIONS (EXCL. LULUCF) – SECTOR-BASED BREAKDOWN: ABSOLUTE VALUES 1990-2008 (2007 for memo items)

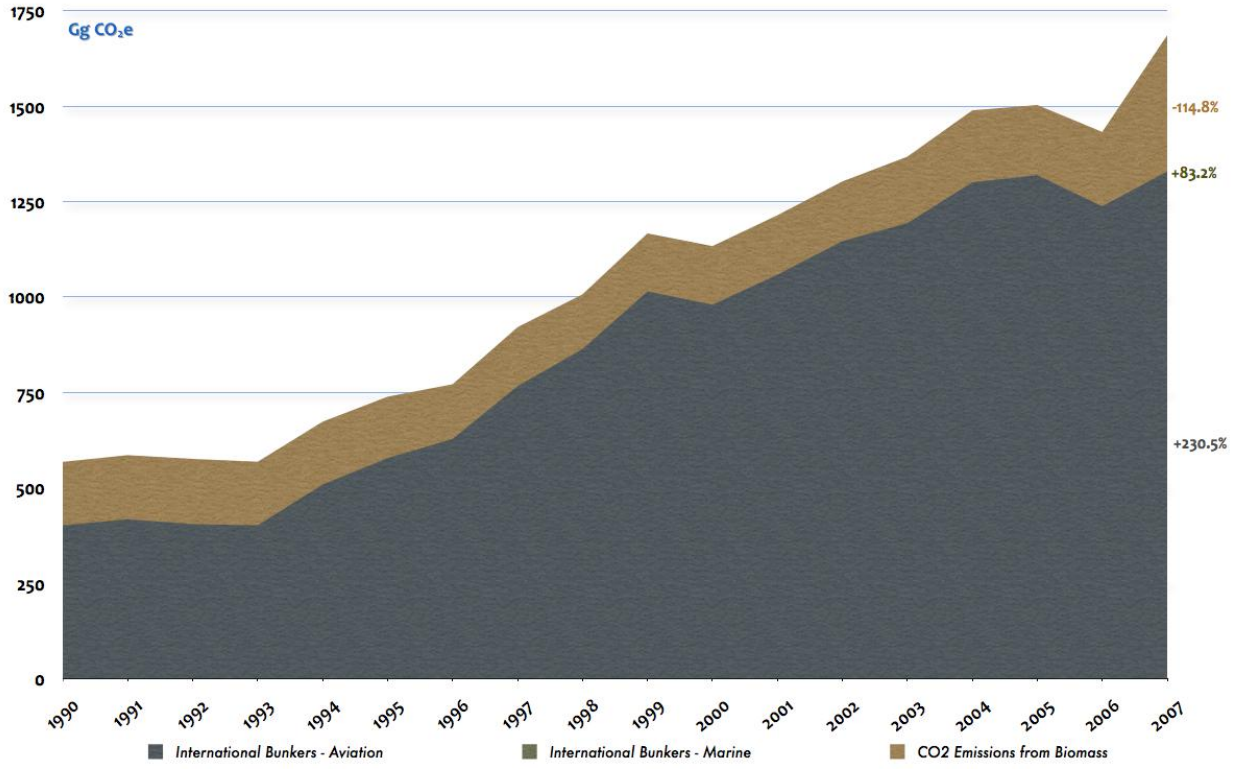
Main emitting source categories



Other source categories



Memo Items

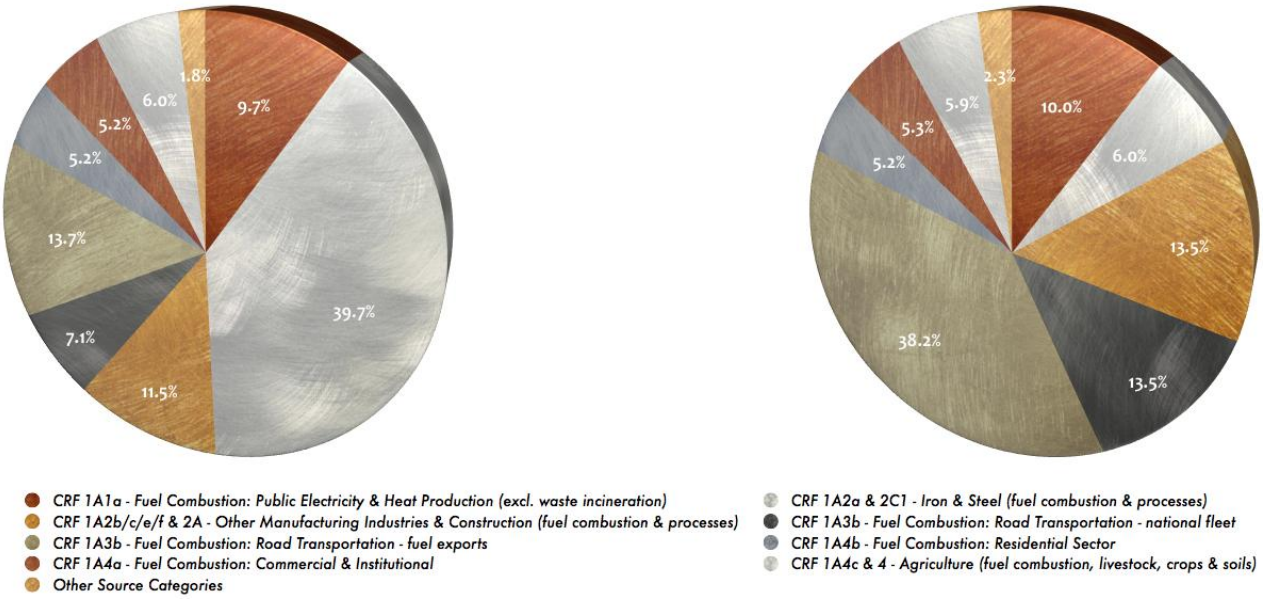


Sources: Environment Agency and MDDI-DEV.

Note: 2008 has not been estimated.

FIGURES III.1-4b – SECTOR-BASED BREAKDOWN: CONTRIBUTION TO TOTAL EMISSIONS 1990 & 2007

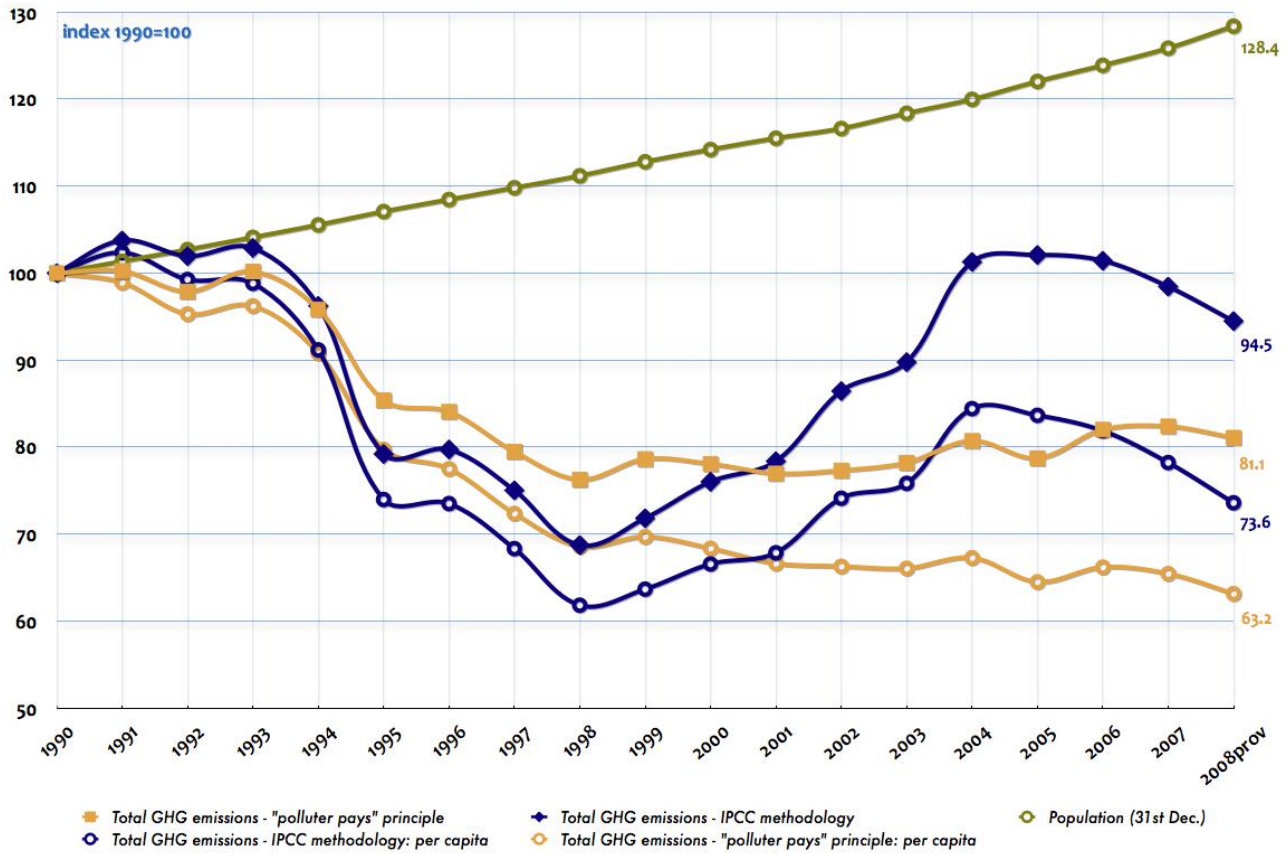
1990 *2007*



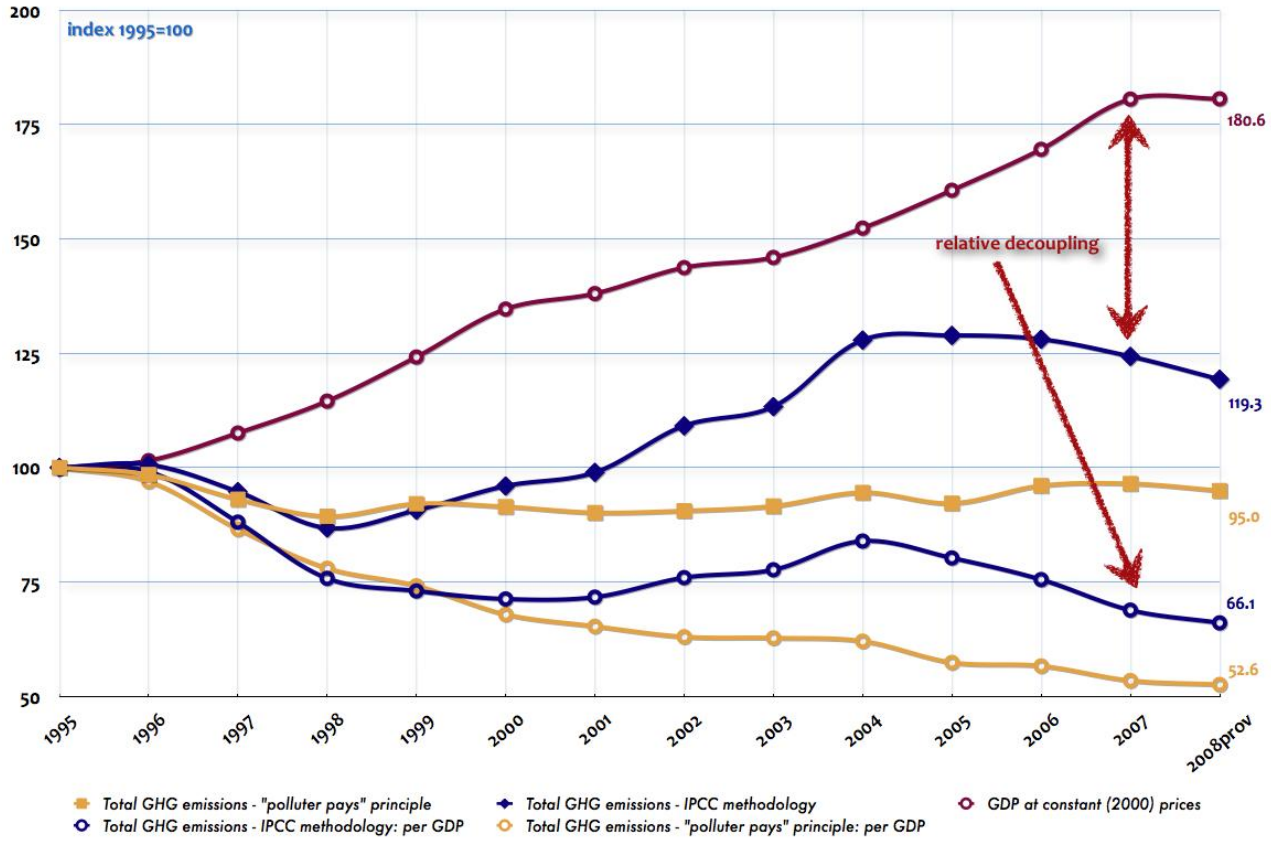
Sources: Environment Agency and MDDI-DEV.

FIGURES III.1-5 – GHG INTENSITIES (EXCL. LULUCF): 1990-2008

Population



GDP at constant (2000) prices

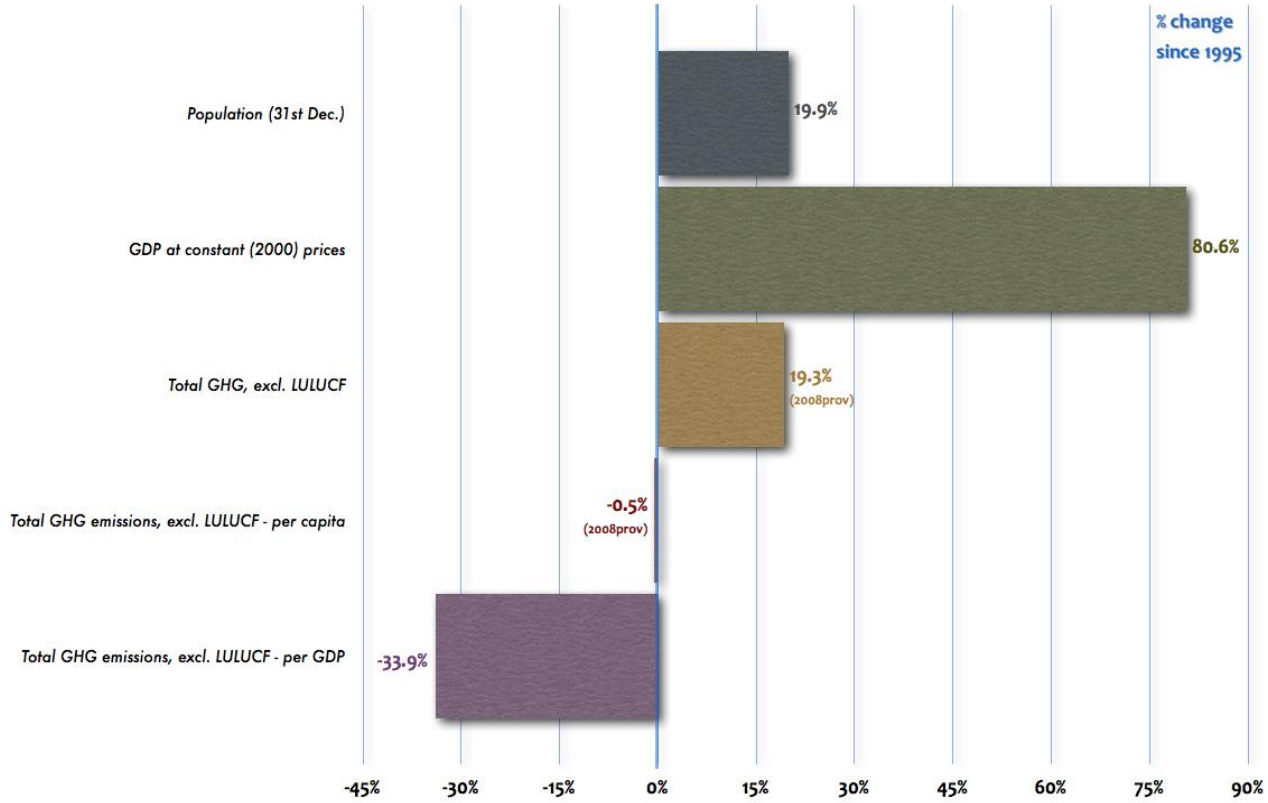


Sources: Environment Agency, MDDI-DEV and STATEC, *Statistical Yearbook*, Table B.1100: http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=467&IF_Language=fra&MainTheme=2&FldrName=1 and Table D.1101: http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=228&IF_Language=fra&MainTheme=4&FldrName=2&RFPath=16

Note: the "polluter pays" principle figures have been obtained from the total GHG emission according to the IPCC methodology by excluding emissions from "road fuel exports" and for electricity generated that is exported, and by adding an estimate for electricity production emissions generated abroad for satisfying Luxembourg consumption (i.e. emissions relating to electricity imports):

emissions "polluter pays" principle = emissions IPCC methodology – emissions "road fuel exports" + emissions electricity net imports

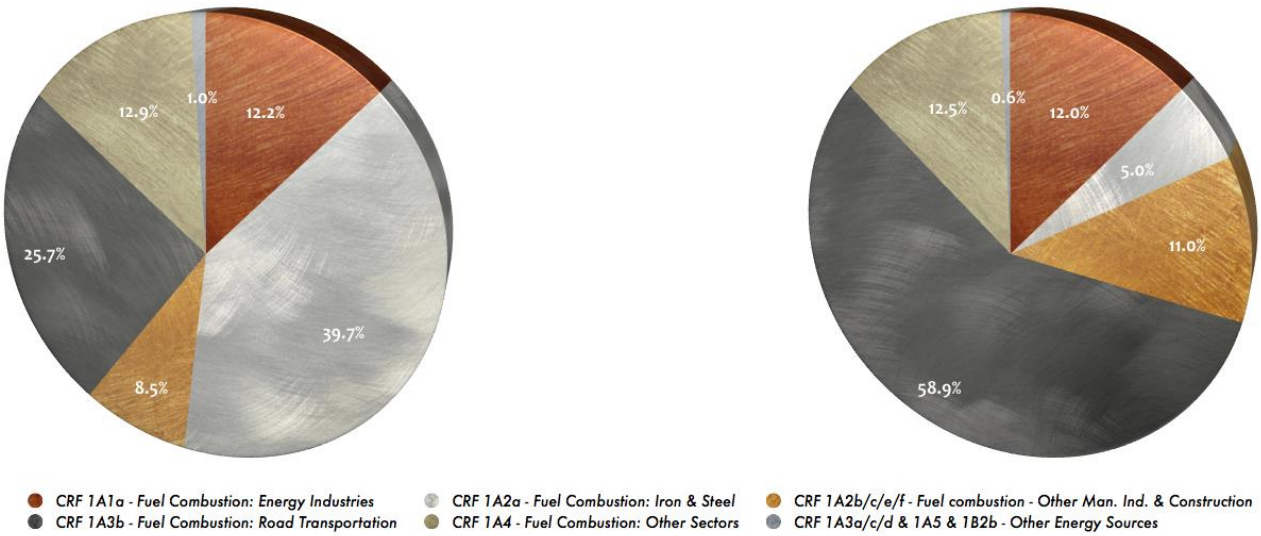
FIGURE III.1-6 – POPULATION, GDP & GHG EMISSIONS (IPCC METHODOLOGY): 1995 & 2008



Sources: Environment Agency, MDDI-DEV and STATEC, *Statistical Yearbook*, Table B.1100: http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=467&IF_Language=fra&MainTheme=2&FldrName=1 and Table D.1101: http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=228&IF_Language=fra&MainTheme=4&FldrName=2&RFPath=16

FIGURE III.1-7 – CRF SUB-CATEGORIES SHARE IN GHG EMISSIONS FOR CRF 1 – ENERGY: 1990 & 2007

1990 *2007*



Sources: Environment Agency and MDDI-DEV.

FIGURE III.1-8 – CRF SUB-CATEGORIES SHARE IN GHG EMISSIONS FOR CRF 2 – INDUSTRIAL PROCESSES: 1990 & 2007

1990 *2007*

Source: Environment Agency.

FIGURE III.1-9 – CRF SUB-CATEGORIES SHARE IN GHG EMISSIONS FOR CRF 3 – SOLVENT AND OTHER PRODUCT USE: 1990 & 2007

1990 *2007*

Source: Environment Agency.

FIGURE III.1-10 – CRF SUB-CATEGORIES SHARE IN GHG EMISSIONS FOR CRF 4 – AGRICULTURE: 1990 & 2007

1990 *2007*

Source: MDDI-DEV.

FIGURE III.1-11 – CRF SUB-CATEGORIES SHARE IN GHG EMISSIONS FOR CRF 6 – WASTE: 1990 & 2007

1990 *2007*

Sources: Environment Agency, Water Agency and MDDI-DEV.

III.2. NATIONAL SYSTEM

III.2.1. Institutional arrangement for inventory preparation

III.2.1.1. Applicable international legal requirements

GHG inventories are depending on and regulated by various obligations, to which Luxembourg has to comply with:

- obligations under the UNFCCC. Relevant COP Decisions and Guidelines are:
  - Decision 3/CP.5 – Guidelines for the preparation of National Communications by Parties included in Annex I to the Convention, Part I: UNFCCC Reporting Guidelines on Annual Inventories (referring to Document FCCC/CP/1999/7) revised with Decision 18/CP.8 (referring to Document FCCC/CP/2002/8);
  - Decision 4/CP.5 – Guidelines for the preparation of National Communications by Parties included in Annex I to the Convention, Part II: UNFCCC Reporting Guidelines on National Communications (referring to Document FCCC/CP/1999/7) revised with Decision 19/CP.8 (referring to Document FCCC/CP/2002/8);
  - Document FCCC/CP/1999/7 – Review of the Implementation of Commitments and of other Provisions of the Convention – UNFCCC Guidelines on Reporting and Review revised with Document FCCC/CP/2002/8;
  - Decision 11/CP.4 – National communications from Parties included in Annex I to the Convention;
  - Document FCCC/CP/2001/13/Add.3 – Report of the Conference of the Parties on its seventh session, held at Marrakech from 29 October to 10 November 2001, Addendum, Part two: Action taken by the Conference of the Parties, Volume III (Decision 20/CP.7: Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol; Decision 21/CP.7: Good practice guidance and adjustments under Article 5, paragraph 2, of the Kyoto Protocol; Decision 22/C.7: Guidance for the preparation of the information required under Article 7 of the Kyoto Protocol; Decision 23/CP.7: Guidelines for review under Article 8 of the Kyoto Protocol).
- annual obligations under Decision 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol (known as the "Monitoring Decision") and Commission Decision 2005/166/EC of 10 February 2005 laying down rules implementing Decision 280/2004/EC.

Some obligations provide, indirectly, information that can be used to produce GHG inventories:

- annual obligations under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) and its Protocols (1979) comprising the annual reporting of national emission data on SO_2, NOx, NMVOCs, NH_3, CO, TSP, PM_{10} and $PM_{2.5}$ as well as on the heavy metals Pb, Cd and Hg and persistent organic hydrocarbons (PAHs), dioxins and furans and hexachlorobenzene (HCB);
- annual obligations under Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, (known as the "NEC Directive") comprising the annual reporting of national emission data on SO_2, NOx, NMVOCs and NH_3;
- obligations under Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe covering, notably, SO_2, benzene and particulate matters (PM_{10} and $PM_{2.5}$);
- obligation according to Article 15 of the European IPPC Directive 1996/61/EC to implement a European Pollutant Emission Register (EPER). EPER was displaced and up-graded by Regulation (EC) 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register (E-PRTR). EPER and E-PRTR are associated with Article 6 of the Aarhus Convention (United Nations: Aarhus, 1998) which refers to the right of the public to access environmental information and to participate in the decision-making process of environmental issues;
- obligations under the framework of the European Union Emission Trading Scheme (EU-ETS) established by Directive 2003/87/EC of the European Parliament and complemented by Commission Decision 2006/780/EC.

III.2.1.2. National Inventory System

A Grand-Ducal Regulation[114] - hereafter the "Regulation" – designates a **Single National Entity**, the **National Inventory Compiler** and the **National GHG Inventory Focal Point**. It also defines and allocates specific responsibilities for the realization of the GHG Inventories both within the Single National Entity and within the other administrations and/or services that will be involved in the inventory preparation in the future.

Single National Entity and other cross-cutting roles

The previously cited regulation designates the **Environment Agency** (*Administration de l'Environnement*)[115] as the "**Single National Entity with overall responsibility for the GHG**

[114] *Règlement grand-ducal du 1er août 2007 relatif à la mise en place d'un Système d'Inventaire National des émissions de gaz à effet de serre dans le cadre de la Convention-cadre des Nations Unies sur le Changement Climatique* (http://www.legilux.public.lu/leg/a/archives/2007/1300708/1300708.pdf, p. 2318-2320).

[115] The Environment Agency is directly linked to the Department of the Environment and works under its supervision: http://www.environnement.public.lu/functions/apropos_du_site/mev/mev_attributions/index.html and the assignments of the Environment Agency: http://www.environnement.public.lu/functions/apropos_du_site/aev/aev_missions.html.

Inventory". Overall management of the Single National Entity (SNE) is assigned to one staff member of the Environment Agency that is nominated **GHG Inventory Focal Point**. The Agency also acts as **National Inventory Compiler** (NIC) compiling and checking the information and GHG emission estimates coming from sector experts working in other administrations or services *[→ Table III.2-1]*. The GHG Inventory Focal Point and the NIC are actually the same person.[116]

The Environment Agency has therefore the "technical" knowledge and responsibility for the GHG Inventories, but the "political" responsibility is staying with the **Department of the Environment** acting as UNFCCC **National Focal Point** (NFP). Thus, it is the Department that officially submits the inventories and their related reports to the UNFCCC Secretariat and to the EC (cf Article 8 of the Regulation).

Specific responsibilities for the GHG Inventory compilation and development process

Article 3 of the Regulation presents the tasks of the SNE. In a few words, the SNE – i.e. the Environment Agency – provides sector experts for all the CRF sectors except Agriculture, LULUCF and Wastewater Handling *[→ Table III.2-1]*. It is also the Agency that:

- manages the NIS and coordinates the work on GHG Inventories by informing the experts of any changes and evolutions in the Guidelines;
- as National Inventory Compiler, compiles the GHG emissions estimates produced by sector experts;
- prepares the NIR (notably on the basis of chapters received from the sector experts), including the Key Source Analysis (KSA) and the calculation of the uncertainties;
- prepares and defines work plans to secure timely data supply;
- assists sector experts in their assignments and their training;
- defines and approves, together with sector experts, activity/background data (AD), emission factors (EF), methods to estimate GHG emissions;
- archives the relevant information on the inventories and the NIS;
- implements recommendations from the quality assurance/quality control (QA/QC) annual exercise *[→ Section III.2.6]*.

Article 4 describes the tasks that fall to sector experts:

- choice of the best methods to evaluate GHG emissions, using IPCC Guidelines (these methods have to be approved by the SNE as indicated above);
- collection of the necessary AD and EFs;
- calculation of emission estimates;

[116] Luxembourg being a small country, its administrations and public services are small too. Hence, it is frequent that its staff members wear different hats. Nevertheless, this conjunction of responsibilities makes sense.

- recalculation of emission estimates when possible and desirable: new AD sources, new parameters, new methods, etc.;
- proceeding with first quality checks (using, inter alia, tools embedded in CRF Reporter that allow to verify completeness and consistency);
- preparation of the NIR relevant chapters.

Finally, Article 5 indicates that activity/background data providers have to transmit quality AD using formats, and respecting the deadlines, defined by the SNE.

TABLE III.2-1 – CRF SECTOR RESPONSIBILITIES WITHIN THE NIS

CRF sector	AD	Choice of EFs	Emissions estimation methods
Energy, excl. road transportation – CRF 1 except 1A3b	AEV – DEN – STATEC	AEV	AEV
Road Transportation – CRF 1A3b	AEV – ADA – DEN – SNCT	AEV	AEV
Industrial Processes – CRF 2	AEV	AEV	AEV
Solvent and Other Product Use – CRF 3	AEV	AEV	AEV
Agriculture – CRF 4	ASTA – SER	ASTA – SER	ASTA – SER
LULUCF – CRF 5	ANF – MDDI-DEV – SER – ASTA - AEV	ANF – SER – ASTA	ANF – SER – ASTA – AEV
Waste – CRF 6A, 6B & 6D	AEV (Waste Division)	AEV (Waste Division)	AEV (Waste Division)
Wastewater Handling – CRF 6B	AGE	AGE	AGE

Abbreviations used in Table III.2-1:

Ministry of Agriculture, Viticulture and Rural Development:

ASTA = Agriculture Technical Services Administration (*Administration des Services Techniques de l'Agriculture*): http://www.asta.etat.lu/

SER = Agriculture Economic Service (*Service d'Economie Rurale*): http://www.ser.public.lu/

Ministry of Economic Affairs and External Trade:

DEN = Energy Directorate (*Direction de l'Energie*): http://www.eco.public.lu/index.html

STATEC = National Statistical Institute: http://www.statec.public.lu/fr/index.html

Ministry of Finance:

ADA: Customs & Excises Administration (*Administration des Douanes et Accises*): http://www.do.etat.lu/

Ministry of Internal Affairs and of the *Grande Région*:

AGE = Water Agency (*Administration de la Gestion de l'Eau*): http://www.eau.public.lu/

Ministry of Sustainable Development and Infrastructures – Department of the Environment (MDDI-DEV): http://www.emwelt.lu/:

ANF = Nature & Forestry Administration (*Administration de la Nature et des Forêts*)

AEV = Environment Agency (*Administration de l'Environnement*)

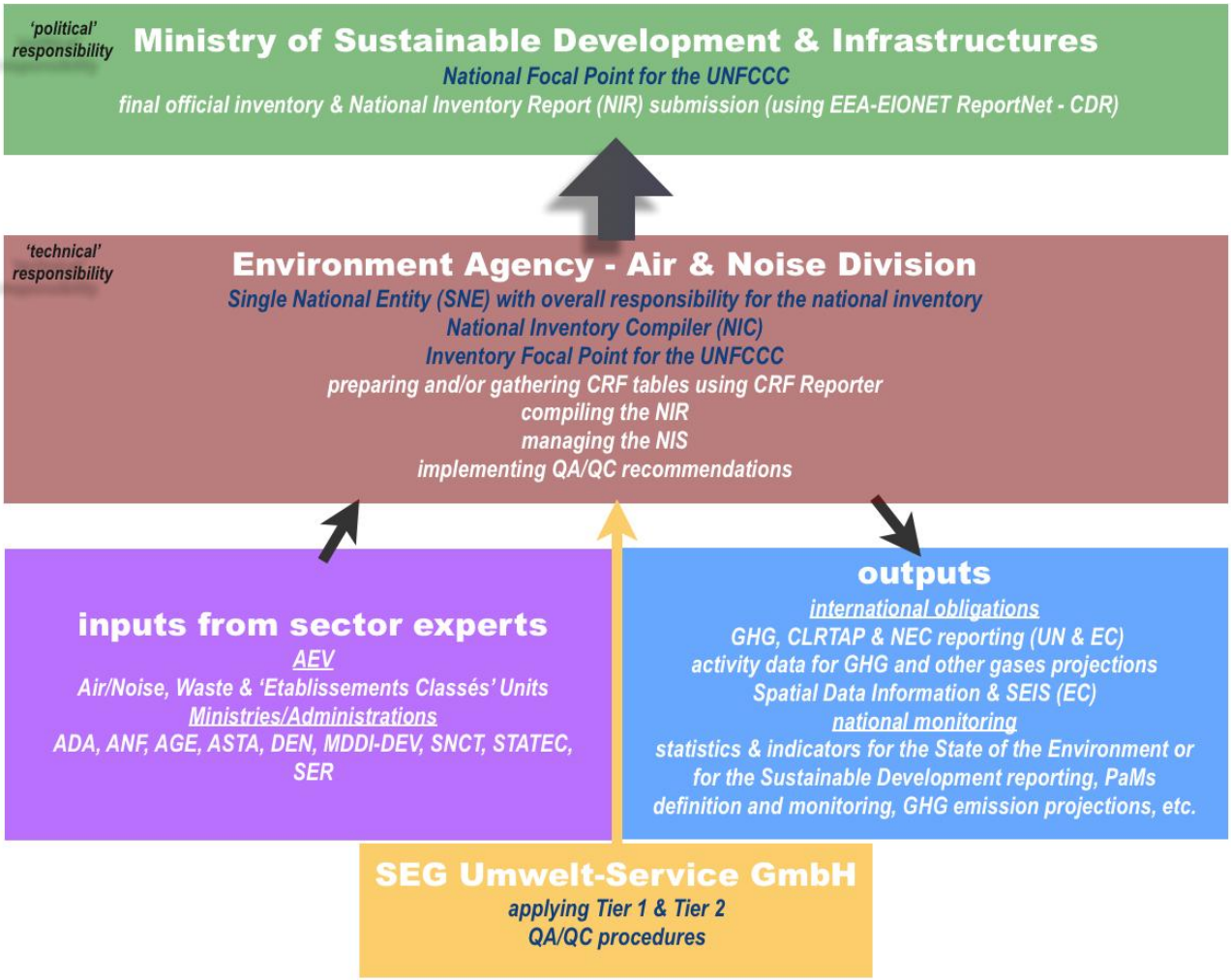
Ministry of Sustainable Development and Infrastructures – Department of Transport:

SNCT = Vehicles Check Administration (*Société Nationale de Contrôle Technique*): http://www.snct.lu/snct/home.nsf

GHG reporting

Illustration III.2-1 summarizes the organization of the GHG reporting in Luxembourg in accordance with the national Regulation for the setting-up of a National Inventory System (NIS).

ILLUSTRATION III.2-1 – LUXEMBOURG'S NIS ACCORDING TO THE REGULATION OF 1ST AUGUST 2007



It is worth noting that the Inventories Division of the Environment Agency, a Division part of the Air/Noise Unit of this Agency, is not only dealing with GHG reporting but also with reporting under the UNECE CLRTAP and under the "NEC Directive".

Luxembourg has, thus, adopted an **integrated approach** to avoid redundant and overlapping activities in different administrative services. This concentration of air emissions reporting in one department also allows an improved consistency between different reporting schemes. As an example, indirect GHG and SO_2 emissions that are to be recorded in the GHG inventory – and that, as indicated previously, need to be re-evaluated in the light of the revision of the inventories Luxembourg is compiling for the UNECE CLRTAP and under the "NEC Directive" – will be extracted and adapted from the CLRTAP/NEC reporting schemes.

With regard to inputs for the monitoring of GHG emissions, having E-PRTR and EU-ETS managed by the Air/Noise Unit of the Environment Agency ensures easy access to facilities' reported fuel and/or emissions that are subsequently integrated in GHG emissions calculations. The Environment Agency also gathers information from establishments and installations subordinated

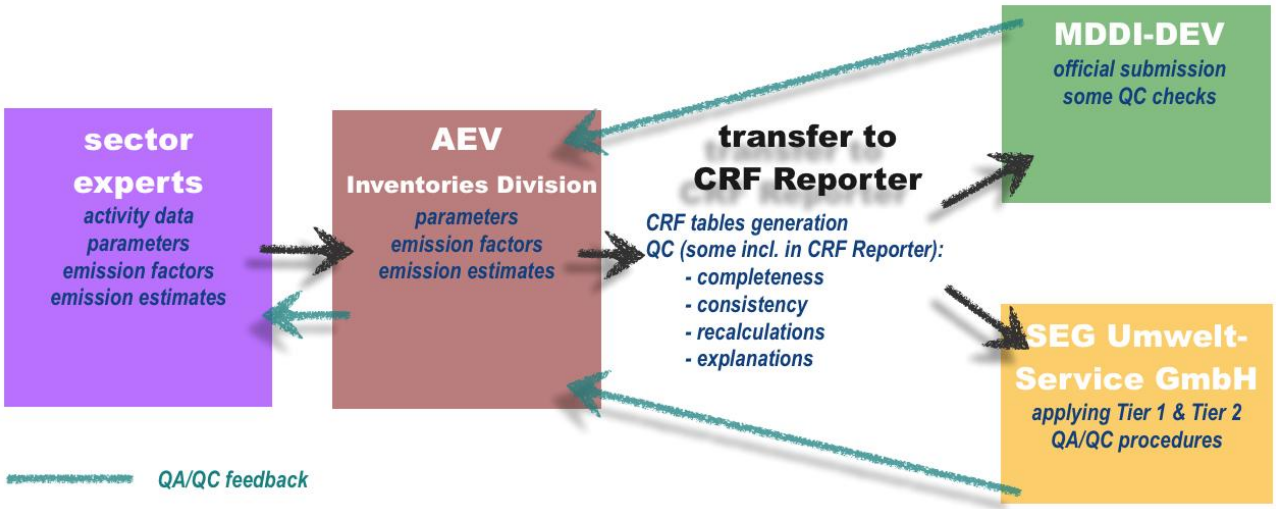
to operational permits to carry out certain activities, the so-called "*établissements classés*". There, too, valuable information for the inventories is found. More details on these AD and, sometimes, EF sources are presented in *Section III.2.3*.

With regards to outputs from the Inventory Division, not only are they used for the various inventory reporting obligations (GHG, CLRTAP, NEC), but also for other reporting activities, such as those linked to Spatial Data Information (such as the EC INSPIRE Directive[117]) and under the Shared Environmental Information System.[118] Of course, these are also used for various national publications, as well as, for defining policies and measures (PaMs).

Finally, although the national regulation, setting up the NIS, only indicates that an agent, belonging to the Environment Agency, should develop, implement and maintain a QA/QC plan, it has been decided that QA/QC activities should be performed by an external company so to guarantee an independent review process *[→ Section III.2.6]*.

Illustration III.2-2 goes over the data flow process that is implied by the setting-up of the NIS. The Inventories Division of the Environment Agency not only collects and validates AD, EFs, parameters and emission estimates from sector experts – to whom the Environment Agency belongs too *[→ Table III.2-1]* – but also produces emission estimates. This flexibility is introduced in Luxembourg's system to ensure a better quality for the reporting of GHG emissions.

ILLUSTRATION III.2-2 – THEORETICAL DATA FLOW ACCORDING TO LUXEMBOURG'S NIS



117 http://inspire.jrc.it/.

118 http://ec.europa.eu/environment/seis/index.htm.

III.2.2. Inventory preparation process

III.2.2.1. Overview

Submission 2009v1.4 was the first submission to be produced under the provisions of the National Regulation for the setting-up of a NIS in Luxembourg. That means, that the 3 usual stages for a GHG inventory preparation – i.e. (i) inventory planning, (ii) inventory preparation and (iii) inventory management – were tested for the first time during the preparation of this submission.

An inventory timeline has been worked out to ensure submission in time *[→ Illustration III.2-3]*.

A centralised data management and archiving system (based on the European Data Exchange and Storage System CIRCA) has been implemented: **CIRCALUX** *[→ Illustration III.2-4]*. This system is hosted by the National IT Administration, and access is password protected. This system enables sector experts to exchange and store data quickly and easily between administrations, which are not connected through a single network.

An official approval process has been established between the SNE – i.e. the Environment Agency – and the UNFCCC NFP – i.e. the Department of the Environment.[119] Thus, the SNE notifies the NFP, in writing, that the inventory has been compiled according to the rules established by the UNFCCC and uploads the submission onto the CIRCALUX data archive. The NFP informs the Minister of Sustainable Development and Infrastructures accordingly. Upon acceptance, the NFP uploads the submission from the CIRCALUX archive onto the UNFCCC submission portal.[120]

However, some cross-cutting issues have been identified, and are being dealt with in the course of the 2010 submission preparation:[121]

- establishment of a decision making body for relevant decisions;
- improvement of the QA/QC system *[→ Section II.2.6]*;
- prioritization of inventory improvements.

[119] Implementation of a recommendation from the 2008 in-country review [UNFCCC (2009), § 31(b)].

[120] Refer also to article 8 of the Grand-Ducal Regulation of August 1st, 2007 relative to the implementation of the NIS.

[121] Recommendation from the 2008 in-country review [UNFCCC (2009), §24].

ILLUSTRATION III.2-3 – INVENTORY PREPARATION TIMELINE

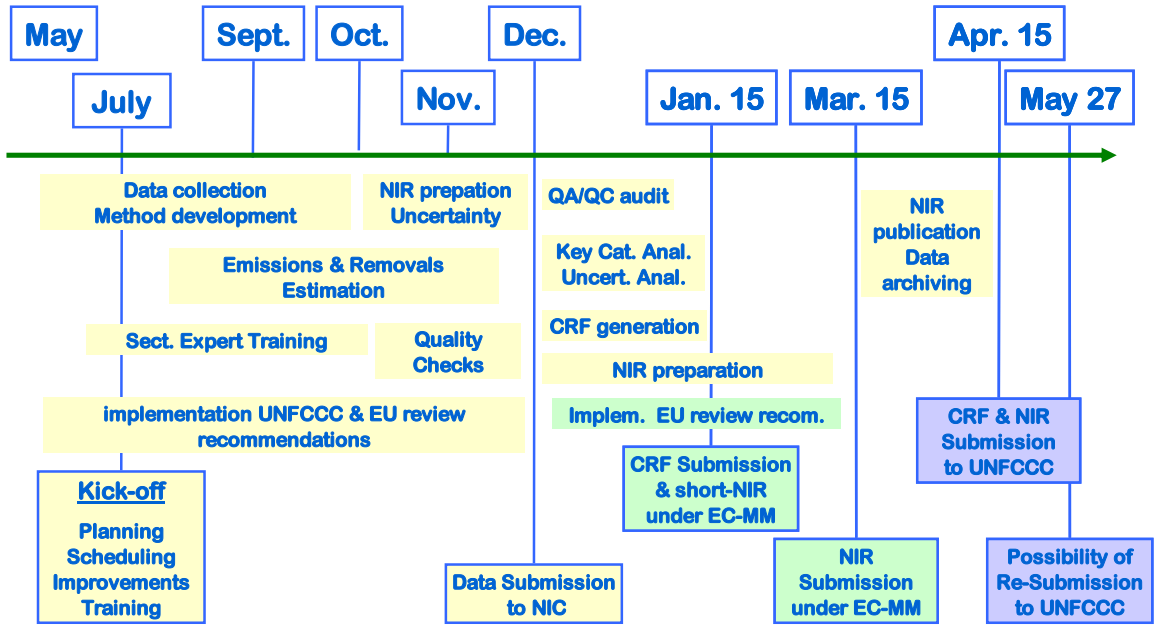
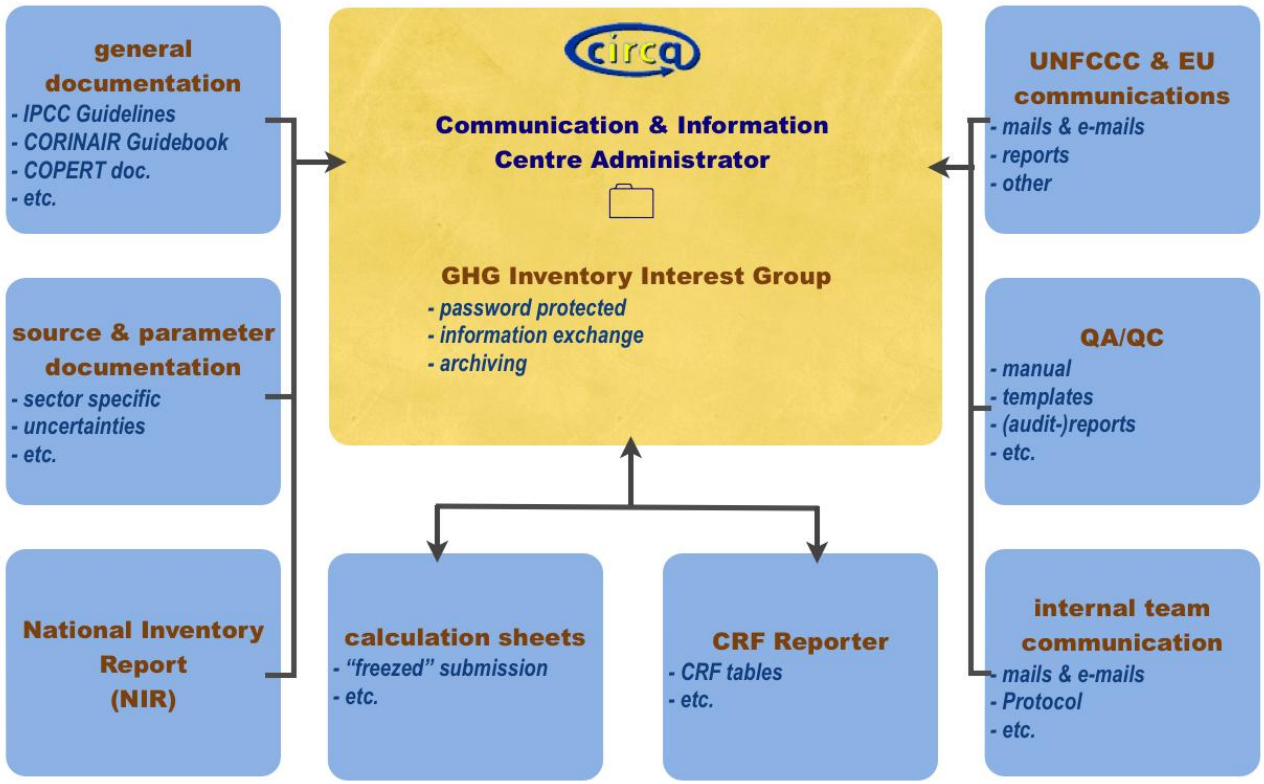


ILLUSTRATION III.2-4 – DATA MANAGEMENT AND ARCHIVING SYSTEM (CIRCALUX)



III.2.2.2. Preparation process for submission 2009v1.4

Submission 2009v1.4 has been prepared using version 3.2.3 of CRF Reporter.

A large number of GHG source categories are not occurring in Luxembourg *[→ Table III.1-1]*. Consequently, for one inventory year, emission values – other than notation keys – to be included in CRF Reporter amount to around 150. This is why, so far, CRF Reporter has been "manually" populated by having recourse to "copy-paste" from Microsoft Excel™ inventory work files. This task is performed **by a single individual** – the NIC – so that one, and only one, person works on the "compiler" version of CRF Reporter, i.e. the version used for preparing an official submission.

However, with the increasing number of LULUCF data, which needs to be transferred to the CRF Reporter, this manual data transfer becomes prone to errors. Therefore, it is foreseen to use some specific software tools for the preparation and the compilation of air emission inventories and estimates (GHG, emissions in the framework of the CLRTAP) from which it might be envisaged to develop automated routines for transferring emission estimates directly to CRF Reporter for the next submission (in 2010).[122] Nevertheless, this is not an absolute "must do" for Luxembourg since, as underlined above, yearly data to be included in CRF Reporter are not numerous. Furthermore, "manually" populating CRF Reporter offers concrete advantages compared to automated operations: mistakes and missing values can be directly identified, recalculations cross-checked, explanations for notation keys or recalculations not forgotten and documentation boxes filled accordingly when needed.

For preparing submission 2009v1.4, Luxembourg did refer to the note by the Secretariat FCCC/SBSTA/2006/9 of 18 August 2006 on updated UNFCCC Reporting Guidelines on Annual Inventories following incorporation of the Provisions of Decision 14/CP.11. IPCC Guidelines have been applied as much as possible. These Guidelines are:

- the *Revised 1996 IPCC Guidelines for National GHG Inventories* (1996 IPCC-GL);
- the *2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (2000 IPCC-GPG);
- the *2006 IPCC Guidelines for National GHG Inventories* (2006 IPCC-GL);
- the *2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (2003 IPCC-GPG-LULUCF).

Information on the methods and sources used for preparing the inventory are presented in details in Ministry of the Environment (2009d). They are also summarized in *Section III.2.3*.

[122] Recommendation from the 2008 in-country review [UNFCCC (2009), §27].

For estimating GHG emissions reported in submission 2009v1.4, Luxembourg mostly used Microsoft Excel™ spreadsheets *[→ Table III.2-2]*. This way of proceeding is offering a very flexible system that can be easily adjusted to new requirements. It is only for the estimation of road transportation emissions, where a dedicated computer program developed for the EEA is employed: COPERT. COPERT IV v6.1 is a Microsoft Windows™ software tool for the calculation of emissions from road transport [Kouridis et al (2000)]. The emissions calculated include all major pollutants (CO_2, CO, CH_4, NOx, VOC, PM) and several more (N_2O, NH_3, SO_2, ...). Data produced is then transformed, using Microsoft Excel™ spreadsheets, into the UNFCCC CRF, according to the IPCC Guidelines, to comply with the reporting obligations under the UNFCCC.

TABLE III.2-2 – PROGRAMS AND SOFTWARE USED FOR GENERATING SUBMISSION 2009V1.4

CRF sector	Emissions calculated using …
Energy, excl. road transportation – CRF 1 except 1A3b	MS Excel 2000
Road Transportation – CRF 1A3b	COPERT IV 6v1 and MS Excel 2000
Industrial Processes – CRF 2	MS Excel 2000
Solvent and Other Product Use – CRF 3	MS Excel 2000
Agriculture – CRF 4	MS Excel 2000
LULUCF – CRF 5	MS Excel 2000
Waste – CRF 6	MS Excel 2000

More precisely, with the help of our partner – the *Umweltbundesamt* of Austria –, emissions have been calculated by the institutions indicated in *Table III.2-3*.

TABLE III.2-3 – CRF SECTOR RESPONSIBILITIES FOR SUBMISSION 2009V1.4

CRF sector	AD	Choice of EFs	Emissions estimation methods
Energy, excl. road transportation – CRF 1 except 1A3b	AEV, DEN, STATEC	AEV	AEV
Road Transportation – CRF 1A3b	DEN, ADA, SNCT	AEV	AEV
Industrial Processes – CRF 2	AEV	AEV	AEV
Solvent and Other Product Use – CRF 3	AEV	AEV	AEV
Agriculture – CRF 4	ASTA, SER	MEV	MEV
LULUCF – CRF 5	MEV, ASTA, SER, ANF	ASTA, SER, ANF	ASTA, SER, ANF, AEV
Waste – CRF 6A, 6B & 6D	AEV, STATEC	AEV	AEV
Wastewater Handling – CRF 6B	AGE	AGE	AGE

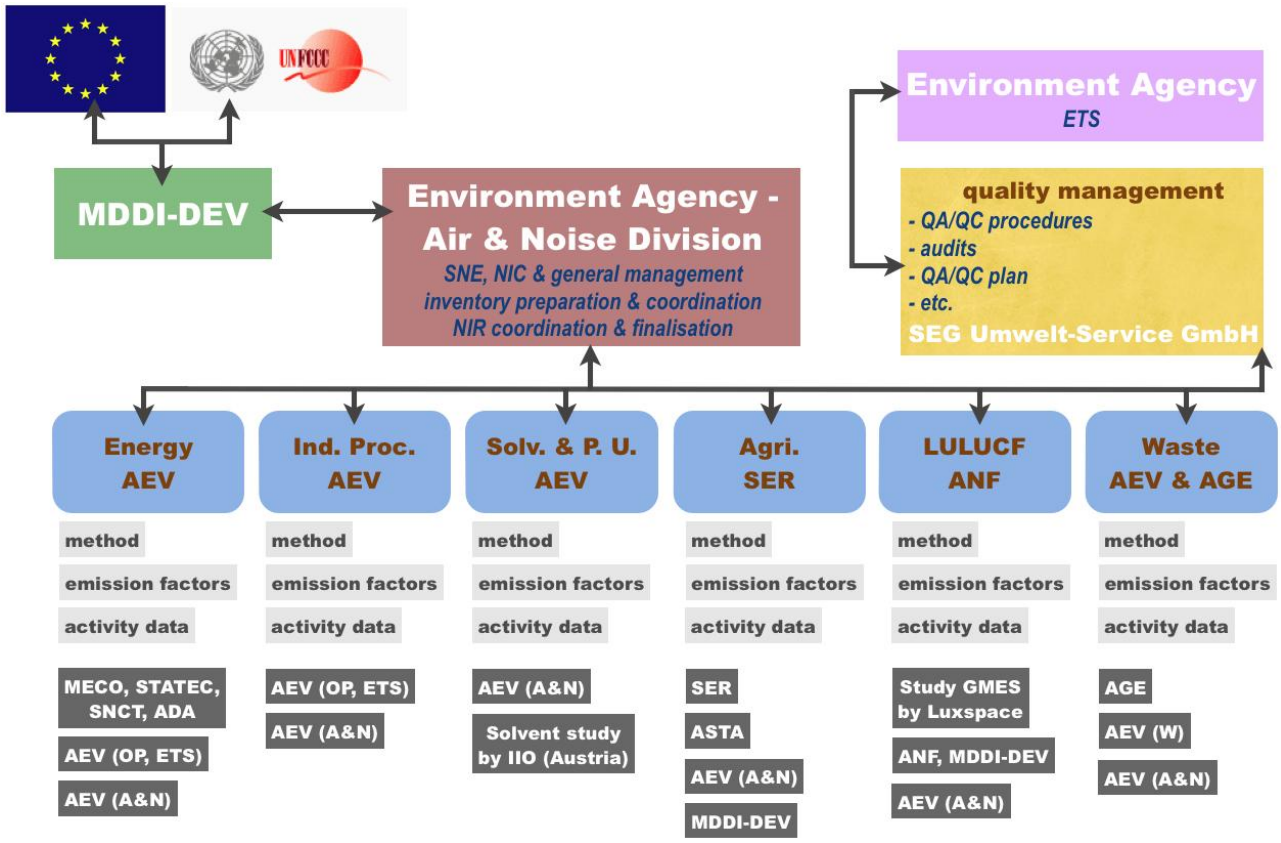
Note: for the abbreviations used, cf Table III.2-1 above.

GHG estimates produced by those different contributors have been centralized and verified by the SNE (Environment Agency). The data have then been "manually" transferred to CRF Reporter, by the SNE. Consequently, for submission 2009v1.4, it is the SNE that acted as the National Inventory Compiler.

Quality assurance, control and plausibility assessments of the estimates have been performed through an internal audit covering all sectors, by the SNE[123] in collaboration with its external QA/QC manager. In addition, various checking procedures, included in CRF Reporter, were undertaken. It is worth noting that all the checks included in CRF Reporter have been passed successfully by submission 2009v1.4. In other words, submission 2009v1.4 is consistent through time[124] and is complete: all the cells/entries have been filled; all the notation keys and recalculations are fully documented.

An overview of submission 2009v1.4 process is presented in *Illustration III.2-5*.

ILLUSTRATION III.2-5 – SUBMISSION 2009V1.4 INVENTORY PRODUCTION PROCESS



III.2.3. Methodologies and data sources used for submission 2009v1.4

Table III.2-4 briefly presents the AD sources, the types of EFs used, as well as the methods applied for estimating GHG emissions reported in submission 2009v1.4. A much more detailed table – based on the table in Annex I of Commission Decision 2005/166/EC, which itself is an expansion of CRF table Summary 3 – is provided in Annex A.I as additional information to an excerpt of summary tables of submission 2009v1.4.

123 And its partner, the *Umweltbundesamt* in Austria.

124 That means that Luxembourg can provide an explanation for each of the important yearly changes (in %) that were identified as outliers by CRF Reporter procedures.

TABLE III.2-4 – METHODOLOGIES, DATA SOURCES AND EFS USED BY LUXEMBOURG FOR SUBMISSION 2009V1.4 – MAIN CRF SECTORS

CRF sector	CO_2			CH_4			N_2O		
	method applied	*AD*	*EF*	*method applied*	*AD*	*EF*	*method applied*	*AD*	*EF*
Energy, excl. road transportation – CRF 1 except 1A3b	Tier 1 Tier 2	NS PS Q TÜV	D CS PS	Tier 1	NS PS Q TÜV	D	Tier 1	NS PS Q TÜV	D
Road Transportation – CRF 1A3b	CIV	NS ADA	D OTH	CIV	NS ADA	D OTH	CIV	NS ADA	D OTH
Industrial Processes – CRF 2	Tier 2 CS	NS PS	CS PS	NA	NO	NA	NA	NO	NA
Solvent and Other Product Use – CRF 3	CS	NS PS	CS	NA	NA	NA	CS	NS PS	CS
Agriculture – CRF 4	NA	NA	NA	Tier 1 Tier 2	EJ NS	CS D OTH	Tier 1	EJ NS	D
LULUCF – CRF 5	Tier 1 Tier 2	NS EJ	CS D	NA	NA	NA	Tier 1	NS EJ	D
Waste – CRF 6	NA	NA	NA	Tier 1 Tier 2	NS Q PS	CS D	Tier 1	NS Q PS	PS D

Note: for F-gases (CRF category 2F) methods applied = CS; AD = NS & Q; EF = CS.

Abbreviations:

C = CORINAIR CS = Country Specific CIV = COPERT IV D = IPCC Default

EJ = Expert Judgement NS = National Statistics OTH = Other PS = Plant Specific Data

Q = Specific Questionnaire/Survey TÜV = TÜV Rheinland (1990), *Emissionskataster für das Großherzogtum Luxemburg*, Köln.

Detailed information on data sources for activity and emission data, as well as for EFs used by sector, can be found in Ministry of the Environment (2009d). A few general comments are, however, presented in the next two sub-sections.

III.2.3.1. Activity and background data

Data used to produce the annual air emission (including GHG) inventories are mainly:

- taken from official statistics published by the National Statistical Institute (STATEC);
- coming from information supplied directly by facilities;
- extracted from statistical information received from other ministries (Ministry of Economic Affairs and External Trade for energy (IEA Joint Questionnaires), Administrations under the authority of the Ministry of Agriculture for agriculture, etc.);
- on occasion, from specific surveys or questionnaire and from expert judgements.

For large point sources – and after careful assessment of data plausibility – activity data that are reported by facilities are preferably used. Indeed, these data usually reflect the actual consumptions better than aggregated national statistics data, because the facility is supposed

having the best information about its own emissions. Such plant specific data have been used for CRF sectors 1 and 2. Luxembourg's planned improvement for the future foresees to considerably extent the use of consumption and emission data provided by facilities either in the framework of the EU-ETS and of the E-PRTR in its inventories.

Besides plant specific data collected under EU legal requirements, national obligations are also a source of activity and emission data for single facilities. This is the case under the law for "*établissements classés*" [125] that imposes regular reporting obligations to those units – the "*établissements classés*" – which, by their activities, could represent a risk with regards to security, public health and convenience for both the citizens and the workers occupied in these units, as well as regards the environment.[126] These "*établissements classés*" could be public or private industrial or commercial establishments and craft industries, as well as single specific equipments or processes within an installation.

Most of the plant specific data, whether they are collected for EU or national obligations, are actually transmitted and managed by the Environment Agency which eases a more systematic use of data provided directly by facilities. Thus, a more systematic use of facilities' data is currently being implemented. In particular, it is investigated whether it will be feasible, both technically and legally, that facilities would report only once for various purposes – such as EU-ETS, E-PRTR, permitting activities, etc. – in order to avoid extra and unnecessary burden for them.

III.2.3.2. Emission factors

For EFs, besides plant specific factors derived from emission data transmitted by facilities (cf above), it is mainly made use of default IPCC values published in the Revised 1996 or the 2006 IPCC Guidelines, as well as in the 2000 IPCC-GPG. Other sources for EFs are the EMEP/CORINAIR Guidebook and national studies or calculations leading to country specific EFs.

III.2.4. Key Category Analysis for submission 2009v1.4

The identification of key categories is described in the 2000 IPCC-GPG, Chapter 7 and in the 2003 IPCC-GPG-LULUCF, Chapter 5.4. It stipulates that a key category is one that is prioritised within the National System because its estimate has a significant influence on a country's total inventory of GHG in terms of the absolute level of emissions or removals, the trend in emissions or removals, or both. Actually, any category meeting the 95% threshold in any year of the Level Assessment (LA) or in the Trend Assessment (TA) is considered a key category. Then, whenever a method used for the estimation of emissions/removals of a key category is not consistent with the

125 http://www.environnement.public.lu/etablissements_classes/index.html.

126 "Permitting activities", i.e. activities subordinated to a permit.

requirements of the 2000 IPCC-GPG, the method will have to be improved in order to reduce uncertainty, which is considered in the emission inventory improvement programme.

All notations, descriptions of identification and results for key categories included in this section are based on the 2000 IPCC-GPG and the 2003 IPCC-GPG-LULUCF. The identification includes all reported GHG CO_2, CH_4, N_2O, HFC, PFC and SF_6, and all CRF categories.

The key category analysis was performed by the Department of the Environment on the basis of submission 2009v1.4 to the UNFCCC. It comprises a level assessment for all years between 1990 and 2007, as well as a trend assessment for the trend of the year 2007 with respect to base year emissions, i.e. 1990. Key source categories have been first identified excluding LULUCF categories and then repeated for the full inventory including LULUCF categories, since submission 2009v1.4 includes for the first time more detailed, yet not complete, emissions/removals estimates for the LULUCF sector.

III.2.4.1. Key categories for Luxembourg

This sub-section presents the results of Luxembourg's key category analysis, once excluding LULUCF categories, once including them.

Key categories analysis – excluding LULUCF

The key source categories comprise 12 517.49 Gg CO_2e in the year 2007, which is a share of 96.9% of Luxembourg's 2007 total GHG emissions, excluding LULUCF *[→ Table III.2-5]*.

TABLE III.2-5 – KEY CATEGORIES EXCLUDING LULUCF BASED ON EMISSION DATA RECORDED IN SUBMISSION 2009V1.4

CRF	CRF source category	Fuel	Gas	2007 emissions Gg CO_2e	Share in 2007 national total GHG emissions (excl. LULUCF)
1A1a	Public Electricity and Heat Production	*gaseous*	CO_2	1291.59	10.00%
1A1a	Public Electricity and Heat Production	*other*	CO_2	65.68	0.51%
1A1a	Public Electricity and Heat Production	*solid*	CO_2	NO	NO
1A2a	Iron and Steel	*gaseous*	CO_2	562.10	4.35%
1A2a	Iron and Steel	*liquid*	CO_2	6.38	0.05%
1A2a	Iron and Steel	*solid*	CO_2	NO	NO
1A2c	Chemicals	*gaseous*	CO_2	167.77	1.30%
1A2c	Chemicals	*liquid*	CO_2	3.19	0.02%
1A2f	Other	*gaseous*	CO_2	467.05	3.62%
1A2f	Other	*liquid*	CO_2	247.85	1.92%
1A2f	Other	*other*	CO_2	49.69	0.38%
1A2f	Other	*solid*	CO_2	214.13	1.66%
1A3b	Road Transportation	*diesel oil*	CO_2	5201.88	40.28%
1A3b	Road Transportation	*gasoline*	CO_2	1362.02	10.55%
1A3b	Road Transportation	*diesel oil*	N_2O	70.94	0.55%
1A3b	Road Transportation	*gasoline*	N_2O	27.95	0.22%
1A4a	Commercial/Institutional	*gaseous*	CO_2	312.73	2.42%

CRF	CRF source category	Fuel	Gas	2007 emissions Gg CO_2e	Share in 2007 national total GHG emissions (excl. LULUCF)
1A4a	Commercial/Institutional	*liquid*	CO_2	368.31	2.85%
1A4b	Residential	*gaseous*	CO_2	312.73	2.42%
1A4b	Residential	*liquid*	CO_2	352.37	2.73%
1A5b	Other – Mobile	*liquid*	CO_2	6.38	0.05%
2A1	Cement Production	-	CO_2	426.27	3.30%
2A7	Other – Glass Production	-	CO_2	62.92	0.49%
2C1	Iron and Steel Production	-	CO_2	203.49	1.58%
2F	Emissions of F-gases	-	*F-gases*	90.98	0.70%
4A1	Enteric Fermentation – Cattle	-	CH_4	240.69	1.86%
4B1	Manure Management – Cattle	-	CH_4	62.55	0.48%
4D1	Agricultural Soils – Direct Soil Emissions	-	N_2O	166.38	1.29%
4D2	Agricultural Soils – Pasture, Range & Paddock Manure	-	N_2O	55.12	0.43%
4D3	Agricultural Soils – Indirect Emissions	-	N_2O	118.36	0.92%

Sources: Environment Agency and MDDI-DEV.

Table III.2-6 indicates which source categories have been identified as key categories for every reported year from 1990 to 2007.

TABLE III.2-6 – KEY CATEGORIES EXCLUDING LULUCF (QUALITATIVE) OF SUBMISSION 2009V1.4: 1990-2007

CRF	CRF source category	Fuel	Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007
				LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	TA
1A1a	Public Electricity and Heat Production	*gaseous*	CO_2						X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A1a	Public Electricity and Heat Production	*other*	CO_2									X	X	X	X	X	X	X			X	
1A1a	Public Electricity and Heat Production	*solid*	CO_2	X	X	X	X	X	X	X	X											
1A2a	Iron and Steel	*gaseous*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A2a	Iron and Steel	*liquid*	CO_2		X	X	X	X	X		X	X	X									X
1A2a	Iron and Steel	*solid*	CO_2	X	X	X	X	X	X	X	X											
1A2b	Non-Ferrous Metals	*gaseous*	CO_2																			X
1A2c	Chemicals	*gaseous*	CO_2	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A2c	Chemicals	*liquid*	CO_2	X	X	X	X	X	X	X	X											X
1A2f	Other	*gaseous*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A2f	Other	*liquid*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A2f	Other	*other*	CO_2																X	X		
1A2f	Other	*solid*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A3b	Road Transportation	*diesel oil*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A3b	Road Transportation	*gasoline*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A3b	Road	*diesel oil*	N_2O																X	X	X	X

CRF	CRF source category	Fuel	Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007
				LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	TA
	Transportation																					
1A3b	**Road Transportation**	*gasoline*	N_2O							X	X	X	X	X	X	X						
1A4a	**Commercial/ Institutional**	*gaseous*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A4a	**Commercial/ Institutional**	*liquid*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A4b	**Residential**	*gaseous*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A4b	**Residential**	*liquid*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A5b	**Other – Mobile**	*liquid*	CO_2									X										
2A1	**Cement Production**	-	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2A7	**Other – Glass Production**	-	CO_2	X		X	X	X	X	X	X	X	X	X	X		X	X			X	
2C1	**Iron and Steel Production**	-	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2F	**Emissions of F-gases**	-	*F-gases*										X	X	X	X	X	X	X	X	X	X
4A1	**Enteric Fermentation – Cattle**	-	CH_4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
4B1	**Manure Management – Cattle**	-	CH_4		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
4D1	**Agricultural Soils – Direct Soil Emissions**	-	N_2O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
4D2	**Agricultural Soils – Pasture, Range & Paddock Manure**	-	N_2O	X	X				X	X	X	X	X	X	X							
4D3	**Agricultural Soils – Indirect Emissions**	-	N_2O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Sources: Environment Agency and MDDI-DEV.

Key categories analysis – including LULUCF

The key source categories comprise 11 803.32 Gg CO_2e in the year 2007, which is a share of 94.3% of Luxembourg's 2007 total GHG emissions, including LULUCF*[→ Table III.2-7]*.

TABLE III.2-7 – KEY CATEGORIES INCLUDING LULUCF BASED ON EMISSION DATA RECORDED IN SUBMISSION 2009V1.4

CRF	CRF source category	Fuel	Gas	2007 emissions Gg CO_2e	Share in 2007 national total GHG emissions (excl. LULUCF)
1A1a	**Public Electricity and Heat Production**	*gaseous*	CO_2	1291.59	10.31%
1A1a	**Public Electricity and Heat Production**	*solid*	CO_2	NO	NO
1A2a	**Iron and Steel**	*gaseous*	CO_2	562.10	4.49%
1A2a	**Iron and Steel**	*liquid*	CO_2	0.01	0.00%
1A2a	**Iron and Steel**	*solid*	CO_2	NO	NO
1A2c	**Chemicals**	*gaseous*	CO_2	167.77	1.34%

CRF	CRF source category	Fuel	Gas	2007 emissions Gg CO_2e	Share in 2007 national total GHG emissions (excl. LULUCF)
1A2c	Chemicals	*liquid*	CO_2	3.19	0.03%
1A2f	Other	*gaseous*	CO_2	467.05	3.73%
1A2f	Other	*liquid*	CO_2	247.85	1.98%
1A2f	Other	*solid*	CO_2	214.13	1.71%
1A3b	Road Transportation	*diesel oil*	CO_2	5201.88	41.54%
1A3b	Road Transportation	*gasoline*	CO_2	1362.02	10.88%
1A4a	Commercial/Institutional	*gaseous*	CO_2	312.73	2.50%
1A4a	Commercial/Institutional	*liquid*	CO_2	368.31	2.94%
1A4b	Residential	*gaseous*	CO_2	312.73	2.50%
1A4b	Residential	*liquid*	CO_2	352.37	2.81%
2A1	Cement Production	-	CO_2	426.27	3.40%
2A7	Other – Glass Production	-	CO_2	62.92	0.50%
2C1	Iron and Steel Production	-	CO_2	203.49	1.62%
4A1	Enteric Fermentation – Cattle	-	CH_4	240.69	1.92%
4B1	Manure Management – Cattle	-	CH_4	62.55	0.50%
4D1	Agricultural Soils – Direct Soil Emissions	-	N_2O	166.38	1.33%
4D2	Agricultural Soils – Pasture, Range & Paddock Manure	-	N_2O	55.12	0.44%
4D3	Agricultural Soils – Indirect Emissions	-	N_2O	118.36	0.95%
5A1	Forest Land Remaining Forest Land	-	CO_2	|396.18|	|3.16%|

Sources: Environment Agency and MDDI-DEV.

Table III.2-8 indicates which source categories have been identified as key categories for every reported year from 1990 to 2007.

TABLE III.2-8 – KEY CATEGORIES INCLUDING LULUCF (QUALITATIVE) OF SUBMISSION 2009V1.4: 1990-2007

CRF	CRF source category	Fuel	Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007
				LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	TA
1A1a	Public Electricity and Heat Production	*gaseous*	CO_2													X	X	X	X	X	X	X
1A1a	Public Electricity and Heat Production	*solid*	CO_2	X	X	X	X	X	X	X	X											
1A2a	Iron and Steel	*gaseous*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A2a	Iron and Steel	*liquid*	CO_2		X																	
1A2a	Iron and Steel	*solid*	CO_2	X	X	X	X	X	X	X	X											
1A2b	Non-Ferrous Metals	*gaseous*	CO_2																			X
1A2c	Chemicals	*gaseous*	CO_2									X	X	X				X		X		X
1A2c	Chemicals	*liquid*	CO_2	X	X																	X
1A2f	Other	*gaseous*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A2f	Other	*liquid*	CO_2	X	X							X	X	X	X				X	X	X	X
1A2f	Other	*solid*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
1A3b	Road Transportation	*diesel oil*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

CRF	CRF source category	Fuel	Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007
				LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	LA	TA
1A3b	Road Transportation	*gasoline*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A3b	Road Transportation	*diesel oil*	N_2O																			X
1A4a	Commercial/ Institutional	*gaseous*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A4a	Commercial/ Institutional	*liquid*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A4b	Residential	*gaseous*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1A4b	Residential	*liquid*	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2A1	Cement Production	-	CO_2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2A7	Other – Glass Production	-	CO_2	X																		
2C1	Iron and Steel Production	-	CO_2	X	X	X	X	X	X	X	X	X								X	X	X
2F	Emissions of F-gases	-	*F-gases*																			X
4A1	Enteric Fermentation – Cattle	-	CH_4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
4B1	Manure Management – Cattle	-	CH_4		X																	
4D1	Agricultural Soils – Direct Soil Emissions	-	N_2O	X	X	X		X	X			X	X	X	X							
4D2	Agricultural Soils – Pasture, Range & Paddock Manure	-	N_2O	X	X																	
4D3	Agricultural Soils – Indirect Emissions	-	N_2O	X	X			X	X													
5A1	Forest Land Remaining Forest Land	-	CO_2	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Sources: Environment Agency and MDDI-DEV.

III.2.4.2. Description of methodology

The identification of key source categories follows the Tier 1 method - quantitative approach described in the 2000 IPCC-GPG, Chapter 7 ("Methodological Choice and Recalculation") and in the 2003 IPCC-GPG-LULUCF, Chapter 5.4 ("Methodological Choice – Identification of key categories").

The analysis includes all GHG reported under UNFCCC: CO_2, CH_4, N_2O, HFC, PFC and SF_6. All IPCC categories are included.

As indicated above, key categories were identified for the inventory excluding LULUCF and, then, including LULUCF. Therefore, the identification of key categories consisted of four steps:

a) identifying categories;
b) Level Assessment excluding/including LULUCF;
c) Trend Assessment excluding/including LULUCF;
d) qualitative considerations.

The qualitative criteria considered were: mitigation techniques, high expected growth of emissions/removals and unexpected low or high emissions/removals. No additional key source categories were identified with those qualitative criteria.

III.2.5. Recalculation of data

Compiling an emission inventory includes data collection, data transfer and data processing. For Luxembourg's GHG inventory, data are collected from different sources, for instance national statistics, plant operators, studies, personal information or other publications. The provided data must be transferred from different data formats and units into a unique electronic format to be processed further. The calculation of emissions, by applying methodologies on the collected data, and the final computing of time series into a predefined format (CRF) are further steps in the preparation of the final submission. Finally, the submission must be delivered in due time. Even though the implemented QA/QC system should prevent or at least minimize potential errors *[→ Section III.2.6]*, it will remain necessary to make some revisions (called "recalculations") under the following circumstances:

- an emission source was not considered in the previous inventory;
- a source/data supplier has delivered new data. The causes might be that previous data were preliminary data or that methodology has been improved/modified;
- occurrence of errors in data transfer or processing: wrong data, unit-conversion, software errors, etc;
- methodological changes: a new methodology must be applied to fulfil the reporting obligations because of one of the following reasons:
  - to decrease uncertainties;
  - an emission source becomes a key source;
  - consistent input data needed for applying the methodology is no longer accessible;
  - input data for more detailed methodology is now available;
  - the methodology is no longer appropriate.

In Luxembourg, recalculations of previously submitted inventory data are performed following the 2000 IPCC-GPG, Chapter 7 ("Methodological Choice and Recalculation") with, as the list above shows, the **unique purpose to improve the GHG inventory**. They are made **on an ad-hoc basis** by each sector experts and should be documented so that the NIC can cross-check and assess the rationale for any recalculation.[127] The procedures put in place for the QA/QC – such as checklists, e.g. – provides also a mean to present, justify and validate recalculations.

III.2.6. Quality Assurance and Quality Control (QA/QC)[128]

The overall responsibility for the establishment and existence of a Quality Management System (QMS), in order to prepare the national inventory of GHG and air pollutants, lies with the SNE – i.e. the Environment Agency. Within the Agency, the inventories Division supervises the inventory preparation process for various obligations as outlined in *Section III.2.1.1* and acts as both the NIC and the national inventory focal point *[→ Section III.2.1.2]*.

III.2.6.1. Quality Policy

The quality policy is the central aspect of a QMS. It defines the under-standing of quality in relation to all topics of inventory preparation and specifies its basic principles.

The SNE has:

- to establish and maintain the quality policy and quality objectives regarding GHG inventories;
- to promote the quality policy and quality objectives regarding GHG inventories through-out the organisation to increase awareness, motivation and involvement;
- to ensure focus on the fulfilment of the Kyoto Protocol and the requirements of the IPCC GPG Chapter 8 QA/QC;
- to ensure that appropriate processes are implemented to enable requirements of the IPCC GPG Chapter 8 QA/QC (and other interested parties) to be fulfilled and quality objectives to be achieved;
- to ensure that an effective and efficient QMS is established, implemented and maintained in order to achieve these quality objectives;
- to ensure the availability of necessary resources;
- to review the QMS periodically;

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127 As underlines in Section III.2.2.2, the NIC is the only person who will populate, i.e. insert, delete, document data, in the "compiler" version of CRF Reporter.

128 This section has been prepared by the Environment Agency and *SEG Umwelt-Service GmbH*.

- to decide on actions regarding the quality policy and quality objectives regarding GHG inventories;
- to decide on actions for the improvement of the QMS;
- to decide on actions for the improvement of national GHG inventories.

III.2.6.2. QMS build-up

The build-up of the QMS of the GHG emission reporting is currently outsourced and supervised by *SEG Umwelt-Service GmbH*.[129]

Luxembourg's QMS follows a "Plan-Do-Check-Act-Cycle" (PDCA-cycle)[130], which is an accepted model for pursuing a continual improvement of performance according to international standards and is in line with procedures described in decision 19/CMP.1 and in the IPCC Good Practice Guidance.

Due to Luxembourg's clear extent, its QMS deals with a manageable quantity of documents. Following are the specifications of Luxembourg's QMS:

- firm build-up with a quality manual consisting of a chart with all relevant documents, handling instructions and deadlines for check *[→ Illustration III.2-6]*;
- good manageability (instead of a complex system);
- usable and effective quality control procedures (user-friendly, clearly arranged).

Since the QMS has been implemented in the year 2008, it needs further development and improvements. The QMS framework exists and needs to proof its efficiency during the following years.

The QMS shall ensure and continuously improve the quality (measured by transparency, accuracy consistency, comparability, completeness (TACCC) and timeliness) of Luxembourg's GHG Inventory in order to fulfil the party's obligations according to articles 3, 5 and 7 of the Kyoto Protocol. The QMS therefore supplies procedures to:

- check integrity, correctness and completeness of data;
- identify errors and omissions;
- reduce uncertainties of emission estimates;
- document and archive inventory calculation sheets and background data.

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129 SEG Umwelt-Service GmbH, Auf der Haardt 2, D – 66693 Mettlach, http://www.seg-online.de.

130 http://www.asq.org/learn-about-quality/project-planning-tools/overview/pdsa-cycle.html.

III.2.6.3. QMS Structure

Luxembourg's QMS is organised in three layers *[→ Illustration III.2-6]*:

Performance processes

Performance processes directly concern the compilation of the GHG inventory. They comprise input data, data acquisition, calculations, and generation of CRF tables and NIR as well as quality control checks and the outcomes of the NIR and CRF tables.

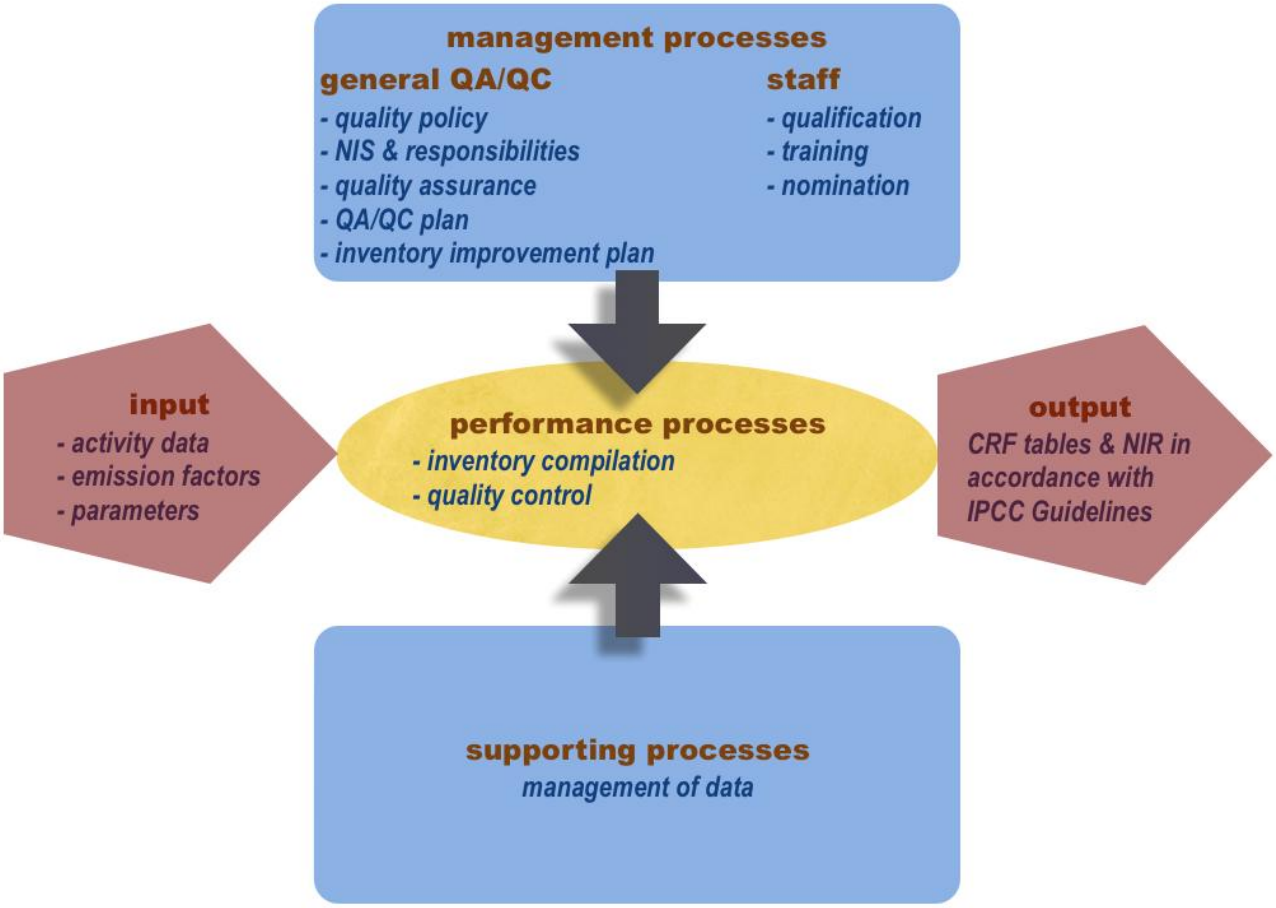
Management processes

Management processes control the system's performance by defining quality objectives, responsibilities, quality assurance procedures, improvement plans and the personnel's qualifications and obligations.

Supporting processes

Supporting processes assist the system's performance by providing technical requirements and standards.

ILLUSTRATION III.2-6 – QMS STRUCTURE



III.2.6.4. Quality Manual

The applied quality manual adopts the structure of the QMS and is divided in management, performance and supporting processes *[→ Illustration III.2-7]*. For each process, a list of related documents exists with information on content, handling, interval of document check and planned improvement.

III.2.6.5. Inventory Timetable

The inventory timetable gives several schedules to control the performance of inventory compilation, quality control and quality assurance procedures, implementation of inventory improvements and inventory publication *[→ Illustration III.2-3]*.

In addition, there are summaries of deadlines regarding EU and UNFCCC submissions.

Timetable for inventory planning and preparation

This schedule refers to general inventory work:

- yearly meetings of the inventory work group and the decision making body;
- Key category analysis;
- uncertainty analysis;
- generation of CRF tables;
- NIR preparation and finalisation;
- NIR and CRF submission;
- publication and archiving of NIR;
- consideration and implementation of EU review recommendations;
- consideration and implementation of UNFCCC review recommendations;
- internal and external training;
- documentation and archiving.

Sector specific timetable for inventory planning and preparation

This schedule refers to sector specific compilation work and quality control checks:

- collection of activity data, emission factors and other parameters;
- calculation of emissions and removals;
- quality check of data, comparison with previous years, documentation of calculations and assumptions;

ILLUSTRATION III.2-7 – EXTRACT OF THE QA/QC MANUAL

	QA/QC procedure	purpose	document	content	handling	interval of document check
management processes	**quality policy**	basis of the implemented quality management system	quality policy	obligation to prepare and improve a GHG inventory according the demands resulting from UNFCCC, Kyoto protocol and other obligations	the head of administration, NIC and quality manager check validity of quality policy -> adjustment if necessary -> announcement	yearly before kick-off meeting
	general QA/QC	organisation of inventory work	definitions and list of abbreviations	explanation of important terms and abbreviations that are used	NIC and quality manager check validity -> adjustment if necessary	yearly before kick-off meeting
			Luxembourg's National Inventory System	organisation of Luxembourg's National System, organigram, position of QA/QC within the organisation, handling of submission	"Règlement grand-ducal du 1er août 2007 relatif à la mise en place d'un Système d'Inventaire national des émissions de gaz à effet de serre dans le cadre de la Convention-cadre des Nations Unies sur le Changement Climatique" (RGD) dictates handling of submission (AEV -> EIONET, MEV -> UNFCCC); NIC and quality manager check validity -> adjustment if necessary -> announcement	yearly before kick-off meeting
			responsibilities	personnel involved in inventory work (collection of activity data, selection of emission factors and methods, calculation of emissions, data compilation, uncertainties, recalculations, identification of key categories, etc.)	nomination of sector experts and data suppliers according RGD; NIC and quality manager check validity -> adjustment if necessary -> announcement	yearly before kick-off meeting
	personnel		nominations	nominations of sector experts and data suppliers according RGD	nomination by minister of environment; NIC and quality manager check validity -> information of ministry if necessary	yearly before kick-off meeting
			job specification and obligation for secrecy	description of job and tasks, request of data secrecy	NIC and quality manager check validity -> adjustment if necessary; announcement per mail	yearly before kick-off meeting
			personal file	proof of sector expert's qualification	sector experts complete their personal file	current
	quality assurance	to support and complete quality control measures check of formal aspects check of applicability & comparisons	internal audit programm	checklist for performance of internal reviews (conformity with IPCCC Guidelines, target-performance comparison)	internal audit of general aspects by quality manager, of sector specific aspects by NIC -> internal audit report -> QA/QC plan	yearly before kick-off meeting
			internal audit report	audited sectors, observations, proposed improvements	report prepared by quality manager and NIC -> generation of QA/QC plan	current
			external audit report	audited sectors, observations, proposed improvements	report prepared by external persons or organisations -> generation of QA/QC plan	current
			audit list	date, audit character, audited sectors, auditors, hence prepared audit reports and QA/QC plans	auditlist completed by NIC and quality manager	current
			inconsistencies	procedure for handling of inconsistencies (that are detected during compilation of inventory, in internal or external audits)	documenting and archiving of indication of inconsistency (audit report, annotation) -> informing of NIC and quality manager -> entry of proposals for improvement in QA/QC plan	yearly before kick-off meeting
	QA/QC plan	list of objectives and proposed actions in order to improve inventory's quality	QA/QC plan	general and sector specific improvement plan	result of internal and external audits; documenting of detected inconsistencies or possibilities for improvement in QA/QC plan by NIC and quality manager -> definition of deadlines -> check if objectives have been achieved during the following audits	current
performance processes	**inventory**		inventory timetable	general timetable with dates of submission; sector specific timetables; deadlines; timetable QA/QC	NIC, quality manager and sector experts check validity -> adjustment if necessary -> announcement per mail	yearly before kick-off meeting
			calculation sheets	calculated emissions; information on activity data, data suppliers (QA/QC), emission factors, calculation methods and special events; information on completeness, revisions and planned improvements of emission data	sector experts complete their calculation sheets -> transfer to NIC before deadline; check of document by NIC and quality manager; check of data content by sector expert	yearly before kick-off meeting
			documentation standard operating procedure	calculated emissions; information on activity data, data suppliers (QA/QC), emission factors, calculation methods and special events; documentation shall be replaced by calculation sheets as soon as possible	sector experts describe calculation of emissions -> transfer to NIC before deadline; check of document by NIC and quality manager; check of data content by sector expert;	yearly before kick-off meeting
			NIR and crf-tables	national greenhouse gas inventory	sector experts submit calculation sheets to NIC before deadline -> NIC generates crf-tables and compiles NIR -> submission of crf-tables and NIR to EU and UNFCCC	current according the deadlines
	quality control	activities to assess and maintain the quality of the inventory being compiled	data validation	Accuracy checks on data acquisition and calculations	performance by sector experts before submission; completion of checklists; archiving of checks; transmission of completed checklists in common with NIR data to NIC	yearly before kick-off meeting
supporting processes	**data management**	definition of data naming and archiving	data flow	cooperation between the competent authorities and organisations; exchange and archiving of data and information	sector experts calculate emissions and perform data validation checks -> submission of calculations to NIC -> NIC validates methods, activity data and emission factors, generates crf-tables and compiles NIR; NIC and quality manager perform internal audit on NIR compilation -> generation of a QA/QC plan including proposed improvements -> information of sector experts and implementation of improvements	yearly before kick-off meeting
			management of input data for multiple use	procedure for handling of input data that serve several sectors		yearly before kick-off meeting
			data management on CIRCA	instruction for data naming and archiving	NIC designates access authorisation	yearly before kick-off meeting

Sources: SEG Umwelt-Service GmbH and Environment Agency.

- uncertainty analysis;
- completion of checklists and other QC activities;
- documentation and archiving.

QA/QC timetable

This schedule especially refers to QA procedures:

- internal audit;
- implementation of internal review recommendations;
- yearly meetings of the inventory work group and the decision making body;
- QA/QC training for the NIC and the sector experts.

III.2.6.6. Quality Control and Quality Assurance procedures

The first steps to implement quality control and quality assurance procedures *[→ Illustration III.2-8]* have already been undertaken but need further improvement. The current status and planned improvements are described in the following sub-sections.

ILLUSTRATION III.2-8 – QA/QC PROCEDURES

does NOT require knowledge of the emission source category	requires knowledge of the emission source category
general	source specific
QC procedures sector experts (1st party) performed throughout preparation of inventory	
TIER 1	**TIER 2**
data validation, calculation sheet (check of formal aspects)	preparation of NIR, comparison with Guidelines (check of applicability, comparisons)
QA procedures quality manager (2nd or 3rd party; staff not directly involved, preferably independent) performed after inventory work has finished	
TIER 1 basic, before submission	
	Internal audit / EU 'Initial check' **(Expert Peer Review)**
	evaluate if TIER2 QC is effectively performed (check if methodologies are applicable)
TIER 2 extensive	
System audit by Umweltbundesamt (Audit)	**ICR by UNFCCC (Expert Peer Review)**
evaluate if TIER 2 QC is effectively performed	evaluate if TIER 2 QC is effectively performed (Check if methodologies are applicable)

Sources: *Umweltbundesamt* Austria, *SEG Umwelt-Service GmbH* and Environment Agency.

Quality Control procedures

The following Quality Control procedures are conducted:

- meeting of the inventory group twice a year (the inventory group consists of the head of the Environment Agency, the NIC, the sector experts and the quality manager) in order to appoint responsibilities, priorities and schedules of inventory work;
- checklists for validation of data that have to be completed by sector experts until data are transmitted to the NIC. An example of a data validation checklist is given in ***Illustration III.2-9***.

Checks for validation of data include:

- checks of activity data (trend checks, time series consistency, completeness, check of assumptions and criteria for activity data, check for transcription errors in data input and reference);
- checks of EFs (trend checks, time series consistency, completeness, check of correct recording of units and the use of appropriate conversion factors, check of documentation of assumptions and criteria for the selection of emission factors, check for transcription errors in data input and reference);
- checks of emissions (trend checks, time series consistency, completeness, check of documentation of assumptions and criteria for emissions, check for transcription errors in data input and reference, check of correct recording of units and the use of appropriate conversion factors);
- check of uncertainties (check of correct calculation and estimation of uncertainties in emissions and removals).

Quality Assurance procedures

The following Quality Assurance procedures are conducted:

- internal audit during NIR preparation time performed by the quality manager, the NIC and a consultant from *Umweltbundesamt* Austria. The internal review analyses every sector as well as the QMS system and checks:
  - whether inventory work and the inventory comply with Revised 1996 IPCC Guidelines, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and Good Practice Guidance for Land Use, Land Use Change and Forestry;
  - whether data acquisition, calculation, referencing and archiving is handled according to the defined methods;
  - whether there are enough resources for inventory work;
  - whether relevant data are available and if the reliability of external data is guaranteed;

ILLUSTRATION III.2-9 – DATA VALIDATION CHECKLIST

checklist validation sector expert

Data:	1990 - 2xxx																	
Source:	**CRF**	**XXX**		**Snap**	**XX XX**													
	Activity data			**check done**			**Emission factor**			**check done**			**Emissions**			**check done**		
Greenhouse gas	**CO2**	**CH4**	**N2O**	Remarks	Date	Person	**CO2**	**CH4**	**N2O**	Remarks	Date	Person	**CO2**	**CH4**	**N2O**	Remarks	Date	Person
Content check																		
Trend checks																		
For each category, current inventory estimates should be compared to previous estimates, if available. If there are significant changes or departures from expected trends, re-check estimates and explain any differences																		
Data plausible in comparison to other references																		
Check time series consistency																		
For each category check input data for temporal consistency in time series																		
Check methodological and data changes resulting in recalculations																		
Check that the effects of mitigation activities have been appropriately reflected in time series calculations																		
Check completeness																		
Confirm that estimates are reported for all categories and for all years from the appropriate base year to the period of the current inventory																		
For subcategories, confirm that entire category is being covered																		
Provide clear definition of "Other" type categories																		
Check that known data gaps that result in incomplete estimates are documented, including a qualitative evaluation of the importance of the estimate in relation to total emissions																		
Uncertainty estimation of data existent																		
data relying on a legal reporting commitment																		
Formal check																		
Collection of data is understandable																		
Check that assumptions and criteria for the selection of data are documented																		
Assumptions and criteria for the selection of data are documented																		
Cross-check descriptions of activity data, emission factors and other estimation parameters with information on categories and ensure that these are properly recorded and archived																		
Check for transcription errors in data input and reference																		
data correctly entered and transcribed																		
Confirm that bibliographical data references are properly cited in the internal documentation																		
Cross-check a sample of data from each source category (either measurements or parameters used in calculations) for transcription errors																		
Accurate data aggregation and correctness of calculations																		
Parameters and units are correctly recorded																		
Data fields are properly labelled																		
Data transmission of intermediate result is correct																		
Check that parameters and units are correctly recordedand that appropriate conversion factors are used																		
Units are properly labelled and correctly carried through from beginning to end of calculations																		
Conversion factors respectively temporal and spatial adjustment factors are correct																		
Data path and data coherence are understandable																		
Consistency given for the multiple use of data																		
Archiving of data and records ensured																		
Emissions complete																		
Uncertainty estimation of emissions existent																		
emission measurements in compliance with international accredited standards																		

	Uncertainties			**check done**		
Greenhouse gas	**CO2**	**CH4**	**N2O**	Remarks	Date	Person
Content check						
Check that uncertainties in emissions and removals are estimated and calculated correctly						
Check that qualifications of individuals providing expert judgement for uncertainty estimates are appropriate						
Check that qualifications, assumptions and expert judgements are recorded						
Formal check						
Designation of uncertainties is understandable						
Uncertainties complete						
documentation of fundamental assumption concerning expert judgement						
Archiving of data and records ensured						

Sources: *Umweltbundesamt* Austria, *SEG Umwelt-Service GmbH* and Environment Agency.

- whether the QMS system needs improvement;
- whether recommendations of EU reviews, UNFCCC reviews and previous internal audits have been considered and implemented.

- QA/QC training for the sector experts and the NIC during execution of the internal audit;
- support by inventory experts from *Umweltbundesamt* Austria;
- external audits conducted by experts who provide support for inventory work, EU or UNFCCC.

QA/QC plan

The results from internal and external audits are merged in the QA/QC plan. This plan lists the relevant sector, recommendations for improvement, responsibilities, deadlines and gives opportunity for attest.

Since the current QA/QC plan contains recommendations for the improvement of the QMS as well as for inventory improvement, it will be segmented in a QA/QC plan and an inventory improvement plan in 2009.

In addition, there will be a decision making body that will be able to prioritise the recommended improvements and at the same time be able to care for associated resources.

Planned improvements

The following QMS improvements should be implemented in 2009-2010 whilst preparing the 2010 submissions to the EC and the UNFCCC:

- definition and implementation of quality objectives (revision of the quality policy draft);
- establishment of a decision making body for relevant decisions such as adopting the QA/QC and the inventory improvement plan, prioritisation of possible inventory improvements and the set of deadlines;
- segmentation of the current QA/QC plan in a QA/QC and an inventory improvement plan;
- definition of roles of experts in the QMS;
- preparation of checklist procedures according to the role and process step in inventory work;
- establishment of an official approval procedure for the GHG Inventory before submission.

III.2.6.7. Archiving and documentation

Within the inventory system, a system for transparent documentation of inventory data and related information (special circumstances, assumptions etc.) is implemented. Archiving takes

place on the CIRCALUX server within the folder "*Inventaires gaz à effet de serre*".[131] The data is secure for at least fifteen years.

As a principle, every file shall be named clearly, shall be write/delete protected and supply relevant information concerning validity in the footer.

III.2.7. Procedures for official consideration and approval of the inventory

The process for the official consideration of the GHG inventory has been presented in *Section III.2.1.2* and *Illustration III.2-1* where it is explained that the Environment Agency has the "technical" knowledge and responsibility for the GHG Inventories, and that the Department of the Environment acting as UNFCCC National Focal Point (NFP) has the "political" responsibility. Thus, it is the Department that officially submits the inventories and their related reports to the UNFCCC Secretariat and to the EC (cf Article 8 of the Grand-Ducal Regulation[132] setting-up a National Inventory System in Luxembourg).

III.2.8. Additional information

According to Article 10, paragraph (f), of the Kyoto Protocol, Annex I Parties should include in their national communications information on programmes and activities undertaken pursuant to this Article. It is suggested, in the framework of the National System, to report on paragraph a of Article 10 dealing with "(…) **cost-effective** national and, where appropriate, regional **programmes to improve the quality of local EFs, activity data and/or models** which reflect the socio-economic conditions of each Party for the preparation and periodic updating of national GHG inventories (…)".

In this context, on-going activities in three domains are worth to be briefly described.

III.2.8.1. "Road fuel exports"

As discussed in *Section II.8*, an unequivocal imbalance exists in Luxembourg between road fuel consumption by the resident population and the total road fuel sales. Due to its location and the, usually, cheaper prices as in its neighbouring countries, a large part of road fuel sold in Luxembourg is burnt beyond its borders. This is the concept of "road fuel exports".

Due to the commitments within the framework of the Kyoto objectives in terms of climate gases or of the "NEC Directive" with regard to the nitrogen oxide emissions, it is necessary to determine **precisely** the domestic and foreign consumptions, respectively the emissions resulting from these

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131 https://circalux.etat.lu/Members/irc/public/invges/home (only for members).

132 *Règlement grand-ducal du 1er août 2007 relatif à la mise en place d'un Système d'Inventaire National des émissions de gaz à effet de serre dans le cadre de la Convention-cadre des Nations Unies sur le Changement Climatique* (http://www.legilux.public.lu/leg/a/archives/2007/1300708/1300708.pdf, p. 2318-2320).

consumptions. This is particularly important while, as underlined in ***Section III.1.3.1***, and according to the COPERT model approach, "road fuel exports" are estimated amounting to almost 38% of the total GHG emissions in 2007.

The commissioned study on the determination of the "road fuel exports" and the appertained emissions from climate relevant gases and air pollutant emissions in Luxembourg aims at:

- determining emissions resulting from fuel consumption from national vehicle fleet vs. non-resident fleet;
- developing a measure-sensitive model in order to profile "road fuel exports" and the resident consumption.

The study will be divided into four phases:

1. determination of data needed in order to calculate or to model the home consumption and the fuel export in vehicles, as well as to collect the available data in the different administrations and statutory corporations. Should it turn out that detailed data which could decisively improve the quality of the results is missing, the necessary data collection design will be outlined and the collection carried out;
2. determination of emissions, broken up according to climate gases and air pollutants;
3. emission prediction until 2020. Therefore the basic principles relative to the "drivers" will be developed and the EFs determined;
4. procedure scenarios to be developed for the reduction of "road fuel exports".

III.2.8.2. Energy balances

Energy statistics in Luxembourg only make the distinction between three sectors: industry, transport and "others".[133] Industry is covering manufacturing industry as well as power supply and distribution. Transport is compiling energy use in the transport sector, i.e. mainly the road transportation. Finally, the sector "others" includes all the remaining energy uses or production in Luxembourg: households, services, retail, institutions, agriculture, etc. These limitations make it difficult to determine accurately emissions from the households, on the one hand, and from the commercial and institutional sectors, on the other hand.[134]

Nevertheless, this situation is currently changing with the progressive establishment of detailed energy balances by STATEC in the framework of an EC energy statistics Regulation adopted in

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133 For instance, STATEC, *Statistical Yearbook*, Table C.3503: http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=532&IF_Language=fra&MainTheme=3&FldrName=3&RFPath=61.

134 Hence, the two CRF 1A4 sub-categories have a very similar emission level through time. So far a 50-50 distribution is carried out in the inventories [Ministry of the Environment (2009d), page 155].

October 2008 and that entered into force on 1st January 2009.[135] During the course of 2009, preliminary balances have been established for the most recent years (2007 and 2008). They have been constructed mixing existing statistics and various administrative sources. The latter includes information transmitted by facilities *[→ Section III.2.3.1]*, either in the context of the EU-ETS or under the law for "*établissements classes*". Consequently, the Environment Agency – i.e. the SNE to which the NIC or GHG inventory focal point belongs to – is deeply involved in this revision and improvement of energy statistics. Results of this collaborative process did already partially arise in submission 2009v1.4 where energy related activity data consisted in a mix of top-down and bottom-up approaches – i.e. of more detailed national statistics and individual/plant statistics. This approach will be pursued – notably for submission 2010v1.1 – but with a higher convergence.

In a word, forthcoming advanced energy balances will undoubtedly **increase the accuracy and the completeness** of energy combustion and production activity data, hence the overall quality of the inventory.

III.2.8.3. LULUCF

As stressed in *Section III.1.5*, and illustrated in *Tables III.1-1 & b*, LULUCF is the sector in Luxembourg's inventory for which the completeness criteria is the lowest.

Two on-going projects should help improving the reporting under LULUCF, and more importantly, the specific and complex reporting of emissions under Article 3.3 and 3.4 of the Kyoto Protocol – the so-called "KP LULUCF" sector.

Firstly, regarding **land use and land use change monitoring**, Luxembourg has developed a CORINE Landcover (CLC) compliant database: OBS for "*occupation biophysique du sol*". OBS dataset is based on aerial imagery and some field survey. It is available at the reference scale of 1/20000 which is much more detailed than CLC. It also extends the hierarchical nomenclature of CLC by two more levels and many more categories. At this point of time, however, OBS is only available for the year 1999. Nevertheless, an update of OBS is carried out at the moment, based on IKONOS Satellite imagery from the year 2008. The final version of this update should be available during the first semester of 2010. And for the extrapolation and the assessment of the land uses and land use changes into the years before 1999, a survey of 1962 using the same land use categories as OBS and based on aerial photographs for 25 % of Luxemburg could be exploited. All this should allow a much more detailed and accurate land use and land use change monitoring in the next submissions.

Secondly, a study for a comprehensive revision of the activity data and methodology for estimating emissions and removals in **forestland** is commissioned and first results are due in the

[135] Regulation (EC) 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:304:0001:0062:EN:PDF.

coming months. This study includes data from the GSE Forest Monitoring study[136] and it covers the following tasks:

- support to National UNFCCC and Kyoto Protocol reporting on LULUCF activities by providing statistics on land use and land use change, forest area and forest area change (afforestation, reforestation and deforestation) based on relevant maps coming from earth observation data and auxiliary information for the reference years 1990, 2000 and 2007;
- the updating of the forest information data and basic forest typologies (provision of forest type maps and forest type change maps) especially important for areas where forest management information is not available (e.g. private forests) for the reference years 1990, 2000 and 2007;
- support to environmental monitoring towards nature conservation policy by provision of fragmentation indices based on relevant maps coming from earth observation data for the reference years 1990, 2000 & 2007; and
- detecting and monitoring of forest operations and disturbances: monitoring of management operations, i.e. clear cutting, by provision of a clear cut map based on land cover maps of 2004 & 2007.

III.3. NATIONAL REGISTRY[137]

III.3.1. The Registry administrator

The **Environment Agency** acts as **Registry administrator** designated to maintain Luxembourg's National Registry.[138]

Contact information

Administration de l'Environnement (Environment Agency)
Registre des quotas de gaz à effet de serre
Martine Kemmer & Georges Blasen – authorised representatives of the Registry administrator
16, rue Eugène Ruppert
L-2453 Luxembourg
e-mail: martine.kemmer@aev.etat.lu
georges.blasen@aev.etat.lu

136 Ministry of the Environment (2008b), Annex IV. GSE stands for "GMES Service Element": http://www.gmes-luxembourg.lu/gseforest/gseforest_scope.htm.

137 This section has been prepared by the Environment Agency.

138 *Loi du 23 décembre 2004 1) établissant un système d'échange de quotas d'émission de gaz à effet de serre; 2) créant un fonds de financement des mécanismes de Kyoto; 3) modifiant l'article 13bis de la loi modifiée du 10 juin 1999 relative aux établissements classes*, Article 18 (http://www.legilux.public.lu/leg/a/archives/2004/0210/a210.pdf, p. 3792-3799)

III.3.2. A kind of consolidated system

Luxembourg and Belgium maintain a sort of consolidated registry system with both Registries operating independently but sharing the same hardware environment.[139] Belgium manages the technical side of Luxembourg's National Registry: hosting, development, testing and maintenance.

The following project partners are involved in the registry activities:

- software development: .....Dr. Lippke & Dr. Wagner GmbH, Berlin
- software maintenance:.....Dr. Lippke & Dr. Wagner GmbH, Berlin
- hardware and network hosting:.....Colt Telecom GmbH
- technical support and adaptive maintenance:.....Colt Telecom GmbH

The different tasks of the partners are summarised in *Table III.3-1*.

TABLE III.3-1 – NATIONAL REGISTRY – PARTNERS' TASKS

Partners	Tasks
Registry administrators Belgium-Luxembourg	- project coordination, planning, development - coordination with software provider, support/hosting company, other Registries, ITL/CITL - incident solving
Support/hosting company	- adapting interface - keep the Registry running - Internet/server security - incident solving - back-up/disaster recovery - 2nd level helpdesk
Database manager	- 1st level user helpdesk - daily administration - test of new software versions
Software provider	- version development - incident solving - 3rd level helpdesk

Source: Environment Agency.

The Data Centre in Berlin is equipped with a redundant power supply, with UPS systems as well as with emergency power supplies for longer outages. Air-conditioning is maintained by separate systems at 20-25 °C and 40-60% RH.

Access to the Data Centre is very limited and strictly controlled.

A redundant fire detection system is in place and communication is ensured by 2 Internet Service Providers trough multiple access points.

[139] Since Luxembourg's Registry just share the same server as the Belgian one but is totally independent from the Belgian Registry, it is not certain that it could be called a "consolidated system".

III.3.3. Database structure and capacity

The software application is based on the *European Community registry software* (CR software) provided under a free license by the EC. It has been originally developed by *Trasys*,[140] and the adapted version has been developed by *Dr. Lippke & Dr. Wagner GmbH*.[141] Transactions are executed within seconds, even under heavy load.

The adapted version of CR software used by Luxembourg was accredited both by the ITL administrator (in October 2007) and the CITL administrator (in June 2008) so to fully operate under the European and Kyoto rules. The SEF reporting was accredited in January 2009.

III.3.4. Conformity with the DES standards

The database structure and capacity correspond to the requirements of the Data Exchange Standards (DES) between registry systems for the purpose of ensuring the accurate, transparent and efficient exchange of data between national registries, the clean development mechanism registry and the transaction log.[142]

III.3.5. Minimizing discrepancies in the Registry

In the case of discrepancies,[143] the incident/problem management procedures of the UNFCCC are followed.

Yearly the SEF report checks if there are no discrepancies between the records of Kyoto units in the various registry systems of Luxembourg, the UN and the EU. The 2009 SEF report from Luxembourg[144] – concerning the year 2008 – has been judged complete by the UNFCCC and showed no discrepancies.

III.3.6. Security measures in the Registry

Prior to opening an account in the Registry, an ID-Check (= passport copy, paper signature) is performed before granting access trough a Username/Password combination. An automatic logoff ensures that no unauthorised person may have access to an account in absence of the holder.

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140 Trasys, Rozendal Park, Terhulpsesteenweg 6 C, B-1560 Hoeilaart, http://www.trasys.be/.

141 Dr. Lippke und Dr. Wagner GmbH, Nassauische Strasse 25, D-10717 Berlin, http://www.liwa.de/.

142 Cf the IAR report: http://unfccc.int/kyoto_protocol/registry_systems/independent_assessment_reports/items/4061.php as well as paragraph 127 of the Report of the review of the initial report of Luxembourg (doc. FCCC/IRR/2007/LUX of 14 December 2007): http://unfccc.int/national_reports/initial_reports_under_the_kyoto_protocol/items/3765.php.

143 Discrepancies in the issuance, transfer, acquisition, cancellation and retirement of emission reduction units (ERUs), certified emission reductions (CERs), temporary certified emissions reductions (tCERs), long-term certified emission recutions (lCERs), assigned amount units (AAUs) and/or removal units (RMUs), and replacement of tCERS and lCERs.

144 http://unfccc.int/files/kyoto_protocol/registry_systems/registry_status/application/pdf/2008_lu.pdf.

The Registry System is secured by a SSL/VPN secure login whereas data integrity is checked during reconciliation every night. In order to re-establish coherent databases, manual interventions are performed by the Registry administrator in case of a negative result from reconciliation.

Updating of software is only performed after thorough tests in a test environment in order to minimise the risk that updates and patches might destabilising the system.

Internet/server hardware is monitored 24/7 year round. At the hosting company level, the registry software is running on dedicated servers which are backed-up according to procedures detailed in *Section III.3.8*.

Finally, the software has been improved so as to deter or forbid certain unwanted transactions, such as performing a transfer instead of a surrendering, by inserting confirmation steps with informative warning messages.

III.3.7. National Registry accesses and Internet addresses

A public access to the Registry is possible from the environment web portal of Luxembourg: http://www.environnement.public.lu/air_bruit/dossiers/CC-registre_national_quotas_GES/index.html. The information available to the public on this web page consists of:

- international policy context;
- general presentation of the National Registry;
- the second National Allocation Plan for GHG emission allowances (NAP);
- access to the secured site for the National Registry: https://www.climateregistry.lu;
- detailed public reports on (i) all accounts, participants and contacts, (ii) operators holding accounts (including compliance status), (iii) holding and transactions information , (iv) Joint Implementation (JI) projects in Luxembourg and issued Emission Reduction Units (ERUs), and (v) information about the commitment period reserve according to Decision 18/CP.7: https://www.climateregistry.lu/crweb/report/public/publicReportList.do;
- FAQ;
- helpdesk.

Detailed reports on accounts, operators, etc. have only recently been fully implemented jointly with the implementation of the latest Luxembourg CR software release. This information is provided according to Annex XVI of Regulation (EC) 2216/2004 changed by Regulation (EC) 916/2007, and in accordance with Decision 13/CMP.1, Annex II, paragraph 45 and 46.

The Government of Luxembourg did not allocate specific authorizations as regards the various Kyoto units. In fact, if one person or a moral person opens an account in the Registry, it is automatically authorized to hold any type of Kyoto units (refer to

https://www.climateregistry.lu/crweb/report/public/publicReportList.do mentioned above). This list is compliant with Article 6 of Decision 2005/166/EC.[145]

However, Directive 2003/87/EC[146] requires confidentiality of all transaction data during 5 year. This prohibits Luxembourg's Registry from disclosing any transaction information.

III.3.8. Safeguarding, maintaining, recovering

Adequate backup procedures are in place and backups are safely stored.

Luxembourg's National Registry has a very detailed Disaster Recovery procedure that was tested and proved in the production environment in June 2008 (before the ITL Go-Live) and on 4-5 June 2009 with the full ITL/CITL connection. This means that, in the case of a disastrous failure of the hosting site, the Registry will be backed-up and running on the Disaster Recovery site within hours.

More detailed descriptions of security measures are provided in Annex A.II. Refer also to the elements indicated in *Section III.3.2*.

III.3.9. Results of test procedures

Luxembourg's National Registry was tested according to the ITL administrator accreditation test plan (in October 2007) and to the CITL administrator accreditation test plan (in June 2008) so to fully operate under the European and Kyoto rules *[→ Section III.3.3]*.

Apart from this legally required testing, the registry software is extensively tested by the Belgian registry team. Very detailed and partially automated testing scenarios are run before every new release of a registry upgrade and any inconsistencies or bugs found are fed into the bug-tracking system *Bugzilla*; where they are constantly classified, labelled and solved. Every solved bug is again tested by the registry team before release.

Constant monitoring of hard- and software parameters is in place. The monitoring is performed in several ways:

- COLT internal monitoring of solution components (agent-based);
- COLT external monitoring of solution components (probe-based, e.g. ping and port probes);
- transactional monitoring of the solution (automated monitoring with "dummy end user");

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145 Commission Decision 2005/166/EC of 10 February 2005 laying down rules implementing Decision 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

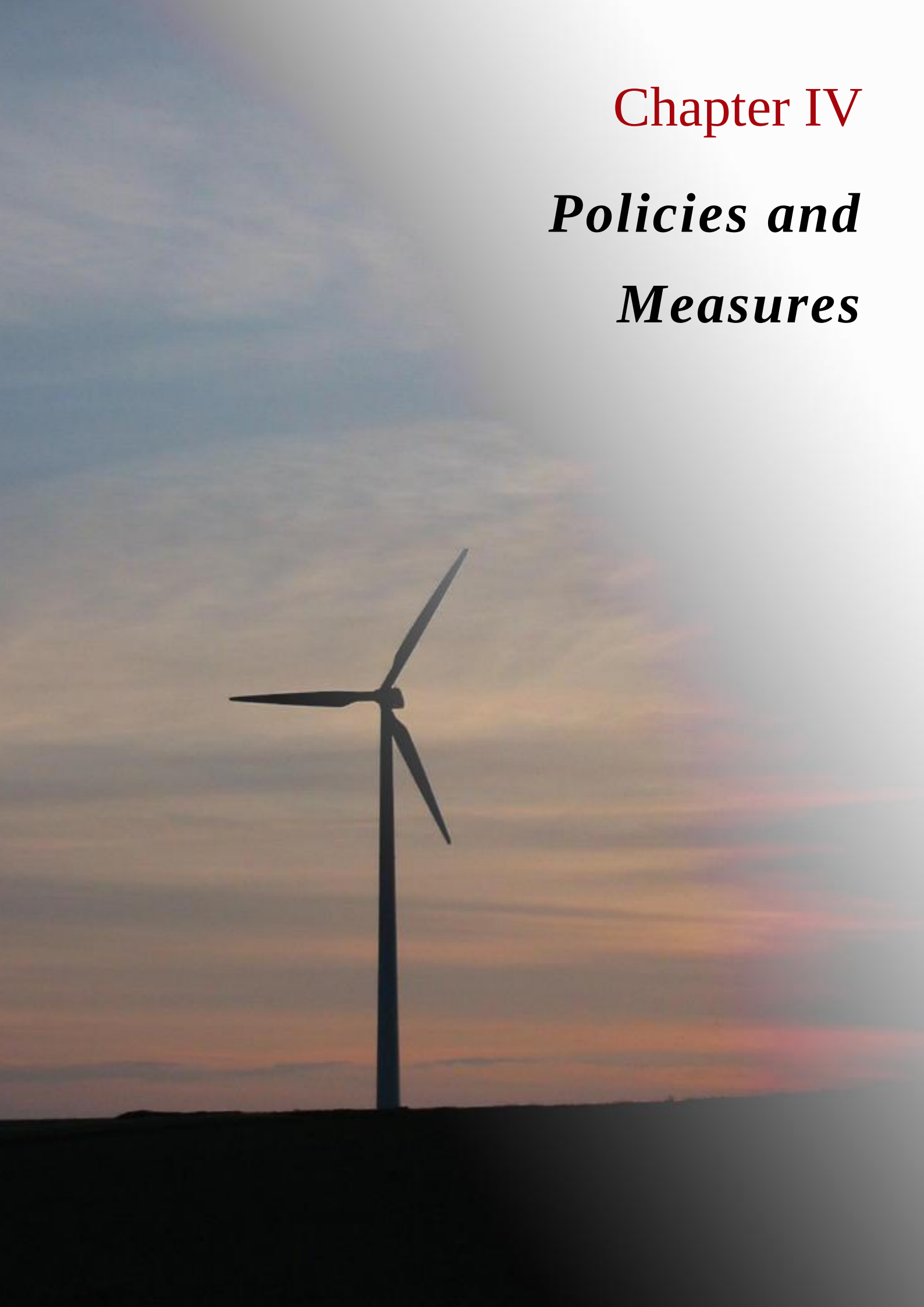
146 Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC.

- out-of-band script monitoring with "dummy end user" performing basic actions with the Registry.

Cumulated monthly reporting done by the Service Manager – i.e. COLT – monitors the COLT Data Centre infrastructure, network elements and managed service components 24 hours a day , 7 days a week for each days of the year ("24x7x365"). COLT uses a mix of agent based and agent-less tools to monitor all managed devices. Systems are tested every five minutes and the customer is notified if any degradation of service occurs.

Chapter IV

Policies and Measures



Chapter IV deals with policies and measures (P&Ms). It starts with the description of the overall policy context and of the policy-making process according to paragraphs 20 and 21 of the UNFCCC reporting guidelines *[→ Section IV.1]*. The domestic programmes pursuant to the implementation of the Kyoto Protocol, as required by paragraph 37 of the Kyoto Protocol reporting guidelines, are presented in the subsequent section *[→ Section IV.2]*, where information on Article 3.3 and 3.4 of the Kyoto Protocol and their relation with the conservation of biodiversity and the sustainable use of resources could be found (paragraph 38). Finally, P&Ms and their effects, as well as those which have expired or have been repealed, are extensively discussed in the last section, which responds to UNFCCC reporting guidelines, paragraphs 13 to 17 and 23 to 26, as well as to Kyoto Protocol reporting guidelines, paragraphs 34 to 36 *[→ Section IV.3]*.

IV.1. POLICY-MAKING PROCESS

IV.1.1. International context: Kyoto and post-Kyoto

Luxembourg signed the **UNFCCC** on June 9, 1992 and ratified it on May 9, 1994 so that the Convention **entered into force on the 7th of August 1994**. As for the **Kyoto Protocol**, it has been signed by Luxembourg on April 29, 1998, ratified on May 31, 2002 and **entered into force**, concomitantly with other EU Annex I Member States, **on February 16, 2005**.[147] Pursuant to that Protocol and the terms of the European agreement distributing the burden among the, at the time, 15 Member States of the EU, Luxembourg undertook **to reduce its GHG emissions by 28% below their 1990 levels over the period 2008-2012**. This is the deepest cut of any agreed by the 15 Member States. In 2004, the government made a commitment that the bulk of its emission reductions under the Kyoto agreement would be achieved in Luxembourg itself, with limited resort to the Protocol's "flexible mechanisms". However this commitment has to cope with very peculiar national circumstances – amongst which size and "road fuel exports" are the main driving forces – and the limited GHG reduction potentials within the country *[→ Section II.12]*.

At EU level, a post-Kyoto strategy has already been decided. The "Climate & Energy package" adopted in 2008 is intended to contribute to a common energy policy and to combat climate change after 2012. Covering the period 2013-2020, this package intends to reduce GHG emissions of EU Member States by 20% below their 1990 levels,[148] which corresponds to a 14% reduction compared to 2005 emissions level – 2005 is the key year for the post-Kyoto engagements at EU level. The package also defines objectives in the energy field for 2020: reach 20% of clean, renewable energy sources in the final energy consumption, increase energy efficiency by 20% and,

147 Source: http://maindb.unfccc.int/public/country.pl?country=LU.

148 The -20% target was proposed to be upgraded to -30% in case of a binding agreement at global level at COP-15 in Copenhagen. It might however be reviewed, though there was no such agreement in Copenhagen, following discussions and decisions at EU level early 2010. Reminder: under the Kyoto Protocol, the EU countries have the objective of reducing their emissions by 8% compared to 1990.

as part of the renewable energy effort, reach, in each Member State, a 10% share for sustainable produced biofuels and other renewable fuels in transport.[149]

The "Climate & Energy package" defines differentiated commitments and targets for each EU countries. For Luxembourg, it calls to:

- reduce GHG emissions by 20% below their 2005 for sectors outside EU-ETS;[150]
- achieve an 11% share of renewable energy in total energy consumption by 2020; and
- achieve a 10% share of biofuels in total transport by 2020.[151]

Regarding energy efficiency, Decision 406/2009/EC indicates, in its Article 4, that "if appropriate, in particular in order to assist Member States in their contributions towards meeting the Community's GHG emission reduction commitments, the Commission shall, by 31 December 2012, propose strengthened or new measures to accelerate energy efficiency improvements". However, in the context of the "National Energy Efficiency Action Plan" (NEEAP), [152] Luxembourg has to improve energy efficiency by 9% (1 582 GWh) by 2016.

Here too, the goals set for Luxembourg will be particularly challenging, for the same reasons as those for the Kyoto Protocol, especially since the sectors outside EU-ETS covers mainly emissions stemming from residential, commercial and institutional buildings and from road transportation.[153]

IV.1.2. National approach to climate change mitigation and adaptation: an historical overview since 1990 …

Climate change has been a policy issue of the highest importance in Luxembourg for many years.

The first climate policy objectives for Luxembourg were adopted in 1990 when the Government decided on a stabilization target for CO_2 emissions by 2000 at their level in 1990, and a 20%

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149 For more details and other measures – such as the extension of the EU-ETS sectors – http://ec.europa.eu/environment/climat/pdf/brochures/post_2012_en.pdf.

150 That is to say, the highest reduction target amongst Member States, together with Denmark and Ireland: the criteria for defining targets having been GDP per capita. The targets regarding emissions are set in Decision 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0136:0148:EN:PDF).

151 The targets regarding renewable energy are set in Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF).

152 Plan developed pursuant to Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC [Ministry of Economic Affairs and External Trade (2008)].

153 Sectors outside EU ETS are road transport, buildings, services, agriculture, solvents, waste, and small industrial plants. In 2007, agriculture represented 5.5% of total emissions, waste and solvents, not even 1% (cf Section III.1.4).

reduction target for CO_2 emissions by 2005.[154] The climate strategy has been gradually developed since then, primarily within the framework of policy decisions on the environment, energy and transport.

Many of the policy instruments in Luxembourg's climate policy have been introduced and gradually tightened up since the 1990's. A "**National Strategy for reducing GHG emissions**" was adopted in **May 2000** and outlined how Luxembourg intends to meet its reduction potentials. The strategy identified six areas for action: renewable energies, energy production efficiency, energy savings, "green taxation", transportation, and co-operation with developing countries and countries in transition. This was followed by regulations instituting subsidies for the rational use of energy and the promotion of renewable energy sources. A ministerial working group, headed by the Ministry of the Environment, was set up to evaluate progress of measures implemented at national and Community level.

The Ministry/Department of the Environment engaged, and still engages, consultants with expert skills to conduct some of the GHG inventory related tasks, reporting and other requirements in the area of climate change. During autumn 2005 till spring 2006, with the help of these consultants, workshops were organized by the Ministry of the Environment, with stakeholders' involvement, in order to evaluate Luxembourg's national GHG emissions reduction potentials and with the view to develop a new Action Plan.

This first national "**Action Plan for reducing CO_2 emissions**" was adopted by the Government in **April 2006**, and presented to the public in May 2006 [Ministry of the Environment (2006b)]. It outlines how Luxembourg intends to meet its emission reduction commitments under the Kyoto Protocol and identifies two major goals: (i) limiting dependence on fossil fuels, especially by accelerating their replacement through renewable energy sources (in particular, for thermal energy generation), and (ii) seeking energy savings by enhancing the energy efficiency of transportation, industry and buildings. It called for regulatory measures and also voluntary economic instruments, public awareness campaigns, training and counselling, as well as the use of the "flexible mechanisms": details in Box IV.1-1. To resort to "flexible mechanisms" cannot be avoided in Luxembourg – even at a rather large scale – since preparatory workshops concluded on the fact that the country presents limited national GHG reduction potentials: no power plants running old technologies or using carbon-intensive fuels that could be replaced, "road fuel exports", etc. *[→ Section II.12]*.

The Action Plan provides for evaluation of progress at regular intervals: a first evaluation took place in May 2007 and resulted in the adoption of a further package of reserve measures. The Action Plan also established a governmental taskforce chaired by the Minister of the Environment.

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154 If the intermediary target for 2000 was encountered and even exceeded, the 2005 goal was not reached, mainly because of road fuel sales and power generation (cf Section III.1.1 for instance).

The taskforce includes the Ministers of Agriculture, the Economy, Finance, the Interior, Housing, Transport and Public works. Nowadays, due to the new Government structure, the taskforce includes the Minister of Sustainable Development and Infrastructures, the Minister of Housing - which is also Deputy-Minister of Sustainable Development and Infrastructures – and the Ministers of Agriculture, the Economy, Finance, and the Interior. The role of the taskforce is to present progress reports of implementation, based on updated emissions data, to the Government at regular intervals. A preparatory inter-ministerial committee has been set up at the same time.

Alongside the "Action Plan for reducing CO_2 emissions", and in the wake of an initial **National Allocation Plan for GHG emission allowances** (NAP) covering the period 2005-07 [Ministry of the Environment (2004)], a second NAP was adopted for the period 2008-12, pursuant to Directive 2003/87/EC, and was notified to the European Commission in 2006 [Ministry of the Environment (2006a)]. It proposed allocating 3.95 Mio. t CO_2e per year to the sectors covered by the emissions trading scheme (manufacturing and energy generation), but the Commission accepted a revised version of the plan in which the annual allocation for Luxembourg was set at 2.5 Mio. t CO_2e (or 20% of total GHG emissions in 2006); with the consequence than there are no reserve left for "new entrants" to the scheme. Allowances are allocated free of charge; and operators' use of credits resulting from projects (clean development mechanism and joint implementation) is limited to 10% of the allocated ceiling.

Finally, if the overall coordination and implementation of the national climate change strategy, of the Action Plan and of the NAP are the responsibility of the Department of the Environment, the implementation of measures at the sector level is, in general, the responsibility of the relevant Government departments and agencies.

IV.1.3. … and plans ahead

The new Government that came out from the general elections in June 2009 has clearly indicated that climate change mitigation and adaptation remains a central issue. Two main activities are foreseen in the next two years:

- as for other EU Member States, and further to the EC white paper on adaptation to climate change,[155] Luxembourg will have to prepare a **national climate change adaptation plan** that should be adopted by the Government by end 2011 *[→ Section VI.3]*;
- a **second** "**Action Plan for reducing CO_2 emissions**" will be prepared by end 2010 in order to cope with the ambitious Kyoto and post-Kyoto targets and commitments decided for Luxembourg in the EU context *[→ Section IV.1.1]*.

[155] *Adapting to climate change: towards a European framework for action* (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF).

Box IV.1-1 – Action Plan for reducing CO_2 emissions

The Action Plan and its 2 major goals articulate round 5 major axes:

1. transportation sector: (i) fiscal and regulatory measures (green taxation, biofuels, natural gas), (ii) improving public transport infrastructures (modal split), (iii) reducing professional road transport nuisances ("Eurovignette", road-rail transfers), (iv) changing behaviours ("eco-driving", promoting cycling & walking);

2. buildings and construction: (i) fiscal and regulatory measures (insulation standards, subsidies & grants), (ii) improving energy efficiency of public buildings, (iii) embedding the energy consumption and use in territorial development plans;

3. renewable energy sources: (i) fiscal measures (subsidies & grants for renewable energy production, for injection of biogas in natural gas network, for CHP installations), (ii) promoting the "biomass" industry, (iii) promoting research and development (biogas, biomass, solar energy, sewage sludge valorisation, …);

4. industry and power generation: (i) second "National Allocation Plan for GHG emission allowances", (ii) research on and promotion of best available technologies in energy (for SMEs, the food industry, …); (iii) promoting and revising voluntary agreements;

5. information, consciousness-raising campaigns, advices and training in energy management and efficiency, notably via a centralized counter (*My Energy* EIG: http://www.myenergy.lu/).

Lots of the measures presented above have been implemented and are regularly revised or updated. The 2007 evaluation led to the redirecting and the reinforcement of the measures of the first Action Plan – no new axis was introduced however: http://www.gouvernement.lu/publications/informations_gouvernementales/rapports_activite/rapport-activite-2007/09environnement/rapport.pdf, section 1.1.5, p. 6-8. In 2008 and 2009, refinement of measures and the introduction of new measures went on. Section IV.3 describes those P&Ms – situation on 1st January 2010 – that are part of and were instigated by the Action Plan.

These two main actions will be co-ordinated by the Department of the Environment in conjunction with a **governmental task-force** gathering the competent Ministries and Administrations.

The elaboration of the second "Action Plan for reducing CO_2 emission" will focus on the continuation of the P&Ms already put into place or planned in the context of the Kyoto commitment and on P&Ms that will let Luxembourg complying with the EU "Climate & Energy package". The new Government Programme[156] indicates some actions and measures that would be part of the second Action Plan (they are presented in detail as additional measures – references between square brackets – in ***Section IV.3.4***):[157]

- further excise duties on road fuels whose receipts will help financing several national mitigation and adaptation P&Ms, as well as the use of "flexible mechanisms" and the potential buying of emission permits from other countries *[P&M TR03 & TR11]*;
- further use of biofuels in road transport *[P&M TR12]*;
- revise subsidies allocation for the promotion of CO_2-efficient vehicles – decided end 2009 *[P&M TR02]*;
- examine fiscal arrangements in place for company cars *[P&M TR13]*;

156 http://www.gouvernement.lu/gouvernement/programme-2009/programme-2009/programme-gouvernemental-2009.pdf, go to *Ministère du Développement durable et des Infrastructures* > section II. 3, p. 38-45.

157 Most of these actions and measures were already considered before the new Government started its activities. The new Programme inscribes and confirms them.

- increase the modal split share for public transport and promote cycling and walking ("*mobilité douce*") *[P&M TR14]*;
- further promote and expand subsidies for the buying and the use of low-energy electrical households appliances *[P&M EC16]*;
- analyze the feasibility and the interest of introducing a "*bonus-malus*" on other products than vehicles according to their energy use and related (embedded) carbon emissions;[158]
- revise and expand the package of measures for increasing energy efficiency and the use of renewable energy sources in the residential, commercial & institutional sectors *[P&M EC11 to EC15]*;
- mobilize renewable energy sources potentials identified in Luxembourg in order to reach the targets set for Luxembourg with regard to renewable energies, eventually by defining an action plan *[TR ES11]*;
- amplify research and development efforts in green technologies and energy – principally solar energy industry, intelligent networks, biomass and biofuels – by supporting national research centres with the aim of positioning Luxembourg as an eco-technology hub.[159]

As shown by the list above, Government future actions are mainly driven by increasing energy efficiency in all sectors as well as by promoting the use of renewable energy sources – in Luxembourg: biomass, solar energy, windmills, hydro-electricity, geothermic installations. These actions also take their place in the context of "green economy" and "green growth" that the new Government advocates in its Programme.[160]

It is also expected that a systematic analysis of all Government decisions will be done in the light of their potential effects with regard to the climate change issues.

Finally, in its Programme, the Government also reiterates that its intention is to reduce the post-2012 GHG emissions by using national P&Ms but, due to its national circumstances, also "flexible mechanisms" and the exchange of emission permits between countries. With regard to "flexible mechanisms", Luxembourg would like to accelerate the procedures of purchasing emission credits from the Clean Development Mechanism (CDM) and the Joint Implementation (JI) so to effectively meet its Kyoto and post-Kyoto targets ***[→ Section V.5.2]***. The projects under CDM and JI should comply with the ecological and social criteria established in the framework of the approval procedures of the UNFCCC and to the specific criteria defined by the committee in charge of managing the Kyoto Mechanisms Fund – the "Kyoto Fund" ***[→ Section V.5.2]***. In order to facilitate

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158 This proposal cannot be considered as a planned measure yet, hence no reference to the list of additional P&Ms.

159 This proposal is not considered as an additional measure since it is rather general and might only have co-benefits/indirect impacts with regard to climate change mitigation. This objective also responds to the willingness of Luxembourg's authorities to diversify the economy (cf Section II.5.2).

160 Government Programme: http://www.gouvernement.lu/gouvernement/programme-2009/programme-2009/programme-gouvernemental-2009.pdf, p. 61.

emission rights transfers, Luxembourg also envisages concluding deals with other EU countries ready to sell a part of their post-Kyoto emission rights and with host-countries of CDM and JI projects.

All these issues will be intensively discussed in 2010 in Luxembourg. On the basis of the consensus and dialogue approach favoured in Luxembourg *[→ Section II.1]*, the Minister for Sustainable Development and Infrastructures announced, end 2009, that it has planned to consult a vast number of stakeholders – Ministries, Administrations, local authorities, workers and businesses associations, NGOs – for discussing climate change and sustainable development in Luxembourg. The idea is to create various thematic working groups by the spring of 2010 and to issue first synthesis documents by the summer of 2010 with the aim of having a "Climate Change & Sustainable Development " package of P&Ms that could be accepted, hence implemented, by all stakeholders and citizens. Besides subjects listed above and extracted from the Government Programme, other issues could be dealt with in this vast consultation and series of workshops, such as mobility, urban sustainable development, biodiversity, "green jobs", research, public awareness, and fiscal measures. Consequently, a broad discussion will be initiated that will look at and encompass all the aspects of the climate change issue without moving apart some of these.

IV.1.4. Other plans & programmes

In addition to the actions and P&Ms presented in the two previous sections, there are also various public action plans, programmes or schemes which could have positive effects on GHG emissions reduction, though their primary aim is not GHG mitigation or adaptation. These are listed below (non exhaustive):

- the "National Energy Efficiency Action Plan" (NEEAP) [Ministry of Economic Affairs and External Trade (2008)] already mentioned above, and whose measures will be presented when describing national P&Ms *[→ Section IV.3]*. An update of the NEEAP is foreseen, after having monitored the results of the actual NEEAP. This update will be completed by the elaboration a National Renewable Energy Action Plan.
  (http://www.eco.public.lu/documentation/rapports/Erster_Nationaler_Energieeffizienzaktionsplan_Luxemburg_-_Final.pdf);
- the "National Programme aiming at reducing air pollutants" – "*Programme National de Réduction Progressive des Emissions de Polluants Atmosphériques (SO_2, NOx, COV, NH_3)* " – that could have some co-benefits with regard to GHG mitigation.
  (http://www.environnement.public.lu/air_bruit/dossiers/PA-PN_reduction_polluants_atmospheriques/index.html)
- the coming 2nd "National Sustainable Development Plan" that as identified climate change as one out of 14 unsustainable trends in Luxembourg and, consequently, as one of the 18 main objectives of the Plan. More details in Box IV.1-2.
  (http://www.environnement.public.lu/developpement_durable/dossiers/avant_projet_pndd_2009/index.html)

- the "Transport Sector Plan" – "*Plan Sectoriel Transports – PST*" – which is one of the sector plans linked to the general long term planning concept of integrated spatial development and transports – the IVL for *Integratives Verkehrs-und Landesentwicklungskonzept* – that fixes objectives for the 2020 horizon. More details in Box IV.1-3.
  (http://www.mt.public.lu/planification/plan_sectoriel/index.html)
  (http://www.ivl.public.lu/de/index.html)
- the "Waste Prevention and Management Act" – "*Plan Général de Gestion des Déchets*" – which should lead to emission reductions from waste management activities by reducing waste generation, increasing waste recovery and reducing the negative impacts of waste disposal ***[→ Section II.11]***.
  (http://www.environnement.public.lu/dechets/dossiers/pggd/index.html)
- the "Landscapes and Forests Sector Plan" – "*Plan Sectoriel Grands Ensembles Paysagers et Massifs Forestiers – PSP*" – which is one of the sector plans linked to the general concept of IVL and that could contribute to climate change policies by preventing urban sprawling, for instance.
  (http://www.environnement.public.lu/conserv_nature/dossiers/PSP/index.html)
- the "Rural Development Programme" – "*Programme de Développement Rural*" – whose one of the four strategic axes is the improvement of the environmental conditions and of the rural space.
  (http://www.ma.public.lu/aides_financieres/aides_communautaires/aides_rural/index.html)
- the "National Forests Programme" – "*Programme Forestier National*" – which should aim at restoring good quality forests in Luxembourg: nowadays, forests are characterized by high fragmentation, old species and trees and, sometimes, carelessness ***[→ Section II.10]***.
  (http://www.environnement.public.lu/forets/dossiers/pfn/index.html)
- the "Eco-technology Action Plan" – *Plan d'Action Eco-technologies – PAET* – and its "*EcoDev*" cluster. Through synergies with research centres and through logistic and financial support by the authorities, it is aiming at positioning Luxembourg in the "green economy". These activities could have spill-over effects that would be beneficial to climate change adaptation and mitigation.
  (http://www.innovation.public.lu/html/portal/FR/getset/42/)

Box IV.1-2 – The second National Sustainable Development Plan – NSDP2

Luxembourg's NSDP2 has been agreed by the Government Council on the 6th of March 2009 (http://www.gouvernement.lu/salle_presse/conseils_de_gouvernement/2009/03-mars/06-conseil/index.html#10). The new NSDP is still a preliminary version ("*avant-projet*" – http://www.environnement.public.lu/developpement_durable/dossiers/avant_projet_pndd_2009/index.html) that is currently being submitted for comments to various stakeholders: citizens; NGOs; social, business and environmental organizations; High Council for Sustainable Development (*Conseil Supérieur pour le Développement Durable – CSDD*); Chamber of Deputies). The latest comments are expected by end January 2010.

The second NSDP has been constructed on the basis of 14 non-sustainable trends identified by an inter-departmental body – the CIDD for *Commission Interdépartementale du Développement Durable* – and on 18 quality objectives to be achieved by 2050. These objectives are intended to be responses to the non-sustainable trends and they come with 89 actions, which are break downed into 155 measures. NSDP2 is expected to be conclusively adopted by the Government by June 2010.

Amongst the 14 non-sustainable trends, one relates to climate change – "GHG emissions that does not slow down due to an increasing energy use"**(1)** – and one to transport – "continuous growth of transport flows with adverse consequences on energy consumption, land use and road safety". Another non-sustainable trend that could be linked to climate change related issues is the "important land consumption leading to landscapes fragmentation (...)", which reduces GHG potential sinks. Responses to these trends – the quality objectives – are (i) climate protection by limiting the effects of climate change and its costs through mitigation and adaptation actions; (ii) decoupling between economic growth and transport flows, and (iii) a sustainable land planning.

Turning to actions and measures, NSDP2 makes Luxembourg's post-Kyoto objectives its own – reduce by 2020 GHG emissions by 20% below their 2005 for sectors outside EU-ETS; achieve an 11% share of renewable energy in total energy consumption by 2020 – and indicates the NEEAP objective of improving energy efficiency by 9% by 2016. However, NSDP2 adds a few specific measures not listed in the actual and planned "Action Plan for reducing CO_2 emissions" **(2)**. It also insists on the warning role that the State of Luxembourg could play in the domains of energy efficiency and of renewable energy sources: energetic improvement of state buildings, use of renewable energies in state buildings, new constructions following the "low-energy" and "passive" construction standards.

For economy-transport decoupling; NSDP2 lists various measures, some of them being included in the PST. Specific NSDP2 measures are, for instance, the setting-up of a transboundary mobility action plan or the reduction of cross-border commuters flows by encouraging moving in Luxembourg.

(1) nevertheless, GHG emissions recorded in the inventory are declining since 2006 (cf Section III.1).

(2) however, it remains to be seen if these extra measures will be kept after the on-going consultation by various stakeholders.

Box IV.1-3 – Transport Sector Plan - PST

The planning approach developed in the framework of the PST is directed to an optimal co-ordination between spatial development, environmental constraints and the future organisation of transport networks. The approach aims at reducing potential conflicts between transport planning and the environment, and seeks for synergies between a sustainable land planning and the development of transport infrastructures and offer. It is anticipated that, together with actions on road fuel sales, the PST will grant the biggest GHG reduction potential in the coming years through a likely reduction of cars journeys within the country and from cross-border commuters. Actually, the modal split objective of 25/75 by 2020 – i.e. 25% of the journeys by public transport and 75% by private vehicles – is one of the cornerstones of the PST, which proposes substantial investments in national and cross-border public transport infrastructures (the actual modal split is estimated at 14/86). More precisely, the PST lists the following measures and actions:

1. promote and favour urban development around the main railways axes;
2. reduce congested roads and bottlenecks that create vehicles lines, hence unnecessary emissions of various pollutants;
3. realisation of large railway projects at national, regional and cross-border levels (new stations; new lines, improving existing lines);
4. develop "multimodal" platforms for both private journeys (park & ride sites next to train stations, e.g.) and for fret (such as the Bettembourg-Perpignan rail speedway for trailers – the "*autoroute ferroviaire*");

5. create a maximum of bus reserved lanes and putting strong emphasis on the extension of the bus network for cross-border commuters;

6. promote cycling and walking ("*mobilité douce*").

For prioritizing the projects, 3 criteria are used:

1. the potential complementarity between transport means;

2. practical impacts at local, regional, national and transnational levels;

3. potential damaging effects on the environment and contribution to climate change mitigation.

In the context of the PST, it is worth mentioning a recent project, which is also a very good example of collaboration between partners of the *Grande Région*: the strategic scheme SMOT - *schéma stratégique de mobilité transfrontalière Lorraine-Luxembourg* (http://www.gouvernement.lu/salle_presse/actualite/2009/01-janvier/08-lux-smot/index.html). Due to its size and the important workforce that comes from abroad every working day, these types of cross-border and transnational projects are vital for Luxembourg's policies aiming at reducing environmental nuisances and their driving forces.

Next to public national action plans and programmes, there also exist local projects as well as private/corporate initiatives. Some of these are presented in Box IV.1-4 and IV.1-5.

Box IV.1-4 – Initiatives at local level

The *Climate Alliance of European Cities with the Indigenous Rainforest Peoples / Alianza del Clima e. V.* is Europe's largest city network for climate protection. It aims at reducing GHG emissions in the industrialised countries of the North, and conserving the rainforests in the South of the planet. For achieving this goal, local climate strategies are developed and implemented, especially in the energy and transport sectors. Furthermore there are measures to raise the public's awareness for the protection of the rainforest and to abstain in municipal procurement from tropical timber derived from destructive logging (http://www.klimabuendnis.org/).

Luxembourg's branch of the Climate Alliance is *Klimabündnis Lëtzebuerg* (http://mouvement.oeko.lu/klimabundnis_Oeko.289-3.html). It comprises 35 municipalities, out of 116 in Luxembourg (http://mouvement.oeko.lu/klimabundnis_Mitgliedsgemeinden.228-3.html). These 35 municipalities represent around 75% of the population of the country.

Recently; *Klimabündnis Lëtzebuerg* launched a project for helping its members to monitor their commitments towards reducing their CO_2 emissions. Indeed, cities and municipalities members of the alliance commit themselves to reduce CO_2 emissions by 10% every 5 years. This project consists of using the ECORegion software tool developed by the Swiss company *Ecospeed*. The tool allows monitoring as well as to simulate the impact of policy measures on regional energy consumption and related CO_2 emissions (http://www.ecospeed.ch/). When the tool will be implemented, Luxembourg will become the fourth country, after Germany, Italy and Switzerland, and before Austria and France during the course of 2010-2011, where municipalities and/or regions strive to monitor their own mitigation actions and to build P&Ms scenarios.

Though the ECORegion tool certainly suffer from its limitation to energy related CO_2 emissions only and from some methodological drawbacks in the eyes of GHG inventory specialists and compilers, it might be a very useful way to further mobilize municipalities in their actions for limiting GHG emissions, as well as for informing and involving their inhabitants and local businesses.

Box IV.1-5 – Initiatives at corporate and business level

One of the actions retains in the list of existing P&Ms is the Voluntary Agreement of the Business Federation of Luxembourg – *FEDIL*: cf P&M IN02 in Section IV.3.3. This Agreement concerns mainly industrial private companies.

But they are also initiatives in other economic domains. For instance, the national railway company *Chemins de Fer Luxembourgeois* – CFL, took a series of environmental commitments (http://www.cfl.lu/CFLInternet/Espaces/01EspaceVoyageurs/07AproposdesCFL/NosEngagements/PreserverlEnvironnementpourlesgenerationsfutures.htm). One of the most important decisions is that now trains are moved by "green electricity" only (all the network is electrified in Luxembourg): http://www.gouvernement.lu/salle_presse/actualite/2007/11/15-lux-cfl/index.html.

Another example is the energy efficiency and energy reduction actions led by the postal and telephone company *P&T Luxembourg*. The enterprise took the commitment to only buy "green electricity", to promote sustainable low-energy buildings, to reduce fossil fuel consumption of the vehicle fleet ("eco-driving" guides for the staff, natural gas driven vehicles, etc.): http://www.pt.lu/portal/Entreprise/pid/2448.

These two cases covers public owned companies. However, they set an example and are in line with the Government views expressed in its Programme and in the "Action Plan for reducing CO_2 emissions".

Note:
Individuals as well as businesses or institutions could decide which electricity they would like to buy:

Luxstroum: a mix of locally produced electricity from renewable energy sources (around 17% in 2008) – windmills, solar energy; hydro-electricity, biomass & biogas – and from CHP installations in Luxembourg;

Nova Naturstroum: with an extra cost of 0.45 ct€/kWh, it is possible to consume only "green electricity", whose mix in 2009, was 95% hydro-electricity and 5% windmills.

Most of the electricity produced from renewable sources is imported, i.e. bought abroad since the capacities – especially in hydro-electricity – are limited in Luxembourg.

Source: Enovos (http://www.enovos.eu/index.php?id=371&L=2).

IV.1.5. Inter-ministerial decision making process/bodies

As underlined in *Section IV.1.2*, the overall coordination and implementation of the national climate change strategy and, then, the "Action Plan for reducing CO_2 emissions" and the NAP is the responsibility of the Department of the Environment. Refer also to the discussion on the "Kyoto Fund" in *Section V.5.2*.

IV.1.6. Monitoring and evaluating P&Ms

Achieving reduced emissions of GHG requires the implementation of a number of different measures, both technical measures and behavioural changes. Various policy instruments can be used to achieve this. The strategy followed by Luxembourg includes taxes, grants, regulations, information and a market-based system that mainly influence emissions within the energy and transport sectors *[→ Sections IV.1.2 & IV.1.3]*. Policy instruments introduced in the waste and agricultural sectors also influence developments *[→ Section IV.1.4]*. There are also linkages between national P&Ms and the "Common and Coordinated Policies and Measures" (CCPM's) of the EU *[→ Tables IV.3-2 & IV.3-3]*. CCPM's have different kind of impacts in Luxembourg, some reducing emissions beyond what is achieved by or possible with purely national policies (such as the agreement with car manufacturers at EU level and the biofuels Directive), others that do not lead to additional emission reductions beyond those generated by national policies.

At the moment, it is difficult to distinguish the effects of individual policy instruments from each other and from other driving forces in society, which makes it difficult to evaluate individual policy instruments – although a first evaluation is provided, when appropriate and possible, for some P&Ms presented in *Section IV.3*. For this reason, the Department of the Environment envisages to work with a consultant in 2010-2011 for (i) developing GHG scenarios tools and (ii) determining how to better evaluate the mitigation potential of some P&Ms and how to assess their concrete results.

Other research projects might also help to produce better projections and evaluations of P&Ms, such as the use of an economic general equilibrium model (CGE) or the CRTE-LEAQ and CRTE-LUXEN projects *[→ Section V.4]*.

IV.2. DOMESTIC PROGRAMMES PURSUANT TO THE IMPLEMENTATION OF THE KYOTO PROTOCOL[161]

In previous chapters and sections, the various institutions playing a role in climate change reporting and management in the context of the UNFCCC and the Kyoto Protocol have been pointed out. *Table IV.1-1* recapitulates the situation.

[161] Due to its size, there are no regional programmes or legislative arrangements and enforcement in Luxembourg.

TABLE IV.2-1 – UNFCCC AND KYOTO PROTOCOL – RESPONSIBLE AUTHORITIES

Topic	Responsible or co-ordinating authority(ies)	Corresponding legal act or decision
UNFCCC National Focal Point	MDDI-DEV (responsibility)	Officially notified to the Convention Secretariat. Not defined as such in a national act, only mentioned in Art. 8, Regulation of 1st August 2007 *[→ Section III.2.1.2]*.
National Registry	AEV (responsibility)	Law of 23 December 2004 *[→ Section III.3]*
National Strategy and Action Plans, incl. NAP and coming Adaptation Plan	MDDI-DEV (responsibility + co-ordination)	Government Programme & declaration.
Kyoto Protocol "flexible mechanisms"	MDDI-DEV (responsibility + co-ordination)	Law of 23 December 2004 *[→ Section IV.5.2]*
"Kyoto Fund"	MDDI-DEV (responsibility + authority)	Law of 23 December 2004 *[→ Section IV.5.2]*
GHG inventories ***Single National Entity*** ***National GHG Inventory Focal Point*** ***National Inventory Compiler*** ***official submission***	 AEV (responsibility + co-ordination) AEV (responsibility + co-ordination) AEV (responsibility + co-ordination) MDDI-DEV ("political" responsibility)	Regulation of 1st August 2007 *[→ Section III.2.1.2]*.
GHG projections	MDDI-DEV (responsibility + co-ordination)	Government internal decision.
Definitions of P&Ms	Diverse Ministries & Administrations but in a co-ordinated framework by the MDDI-DEV since most of them are linked to the National Strategy and Action Plans.	Government Programme & declaration.
Kyoto Protocol, Art. 3.3 (& 3.4)	ANF ("technical" responsibility)	Government internal decision.
Awareness raising, information	MDDI-DEV (responsibility)	Government internal decision.

Abbreviations used in Table IV.1-1:

Ministry of Sustainable Development and Infrastructures – Department of the Environment (MDDI-DEV): http://www.emwelt.lu/:

ANF = Nature & Forestry Administration (*Administration de la Nature et des Forêts*)

AEV = Environment Agency (*Administration de l'Environnement*)

The description of any institutional arrangements and decision-making procedures that are in place in Luxembourg to coordinate activities relating to participation in the mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol, including the participation of legal entities, are provided in ***Section V.5.2***, where the "Kyoto Fund" is presented in detail. This **Fund is a key element in the strategy** put in place by Luxembourg to achieve its Kyoto emission reduction objective since "flexible mechanisms" are representing the primary way for meeting it ***[→ Section V.5.1]***.

The information on Article 3.3 of the Kyoto Protocol is under preparation, with a view to report it in 2010, so no official figure can be delivered for the time being. Nevertheless, first indications conclude that no reductions from carbon sinks could be expected in the coming years so that Luxembourg's commitment within the framework of the Kyoto Protocol would only be reached by national P&Ms and "flexible mechanisms". It has to be noted that Luxembourg did not elect any activity under Article 3.4 of the Protocol ***[→ Section V.5.1]***.

IV.3. SECTORAL AND CROSS-SECTORAL P&Ms[162]

This section is made of several sub-sections. It described P&Ms which primary aim is GHG mitigation, i.e. which might have a significant impact on GHG emissions and removals as emphasized in section IV.C of the Outline and General Structure of the NC5 according to IPCC reporting guidelines (para. 5).

Section IV.3.2 gives an overview of the measures which are implicitly included in the "Business As Usual" (BAU) projection and for which their impact on GHG emissions development is already included in the "without measures" scenario (WOM), whose results are presented in *Section V.3*.

Section IV.3.3 includes a detailed overview of P&Ms which were adopted and **implemented between end 2006 and end 2009** and which are, therefore, considered as **existing measures**. The quantitative impacts of these measures are key input for the construction of the "with measures" scenario (WEM), which is presented in *Section V.3*.

Measures which were **planned but not yet implemented or adopted end 2009** are treated as **additional measures**. They are summarised in *Section IV.3.4*. The relevant "with additional measures" scenario (WAM) results are presented in *Section V.3*.

Those P&Ms which expired or were repealed during the reporting period between the 4th and the fifth National Communications are discussed in *Section IV.3.5*.

Finally, actions undertaken so as to minimize adverse effects of P&Ms – both national and according to Articles 6, 12 and 17 of the Kyoto Protocol – are briefly described in *Section IV.3.6*.

This section starts however with some preliminary general comments.

IV.3.1. Preliminary remarks to P&Ms and GHG projections

IV.3.1.1. Energy: the keyword in Luxembourg's P&Ms set

As *Sections IV.1.3 & IV.1.4* show, and *Section IV.1.6* deduces, national P&Ms implemented or planned cover a goes over a rather large number of domains, from the overall policy regarding mobility to very specific grant schemes. However, actions are **mainly driven by increasing energy efficiency in all sectors as well as by promoting the use of renewable energy sources**. They take the form of **direct allowances and payments** for the installation of devices that offer the possibility to use renewable energy sources – such as solar energy equipments – or for the construction of low-energy ("passive") houses. The direct subsidies also cover cash-back schemes, or financial incentives, such as refunding partially the purchase of a low-energy electrical appliance *[→ P&M*

[162] This section of the NC5 covers sections IV.C and II.D of the Outline and General Structure of the NC5 according to IPCC reporting guidelines (para. 5).

EC06 in the WEM scenario] or of low-CO_2 emitting vehicle *[→ P&M TR02 in the WEM scenario]*. Actions also correspond to **subsidy schemes** for the production of "ecological" energy, such as a bonus – feed-in tariffs – offered for electricity production from windmills, hydraulic installations, biomass or biogas *[→ NEEAP A5 in the baseline scenario]*.

Most of the P&Ms were actually announced or derived from the "Action Plan for reducing CO_2 emission" and a majority of them are taken out from the NEEAP. There are, therefore, **close links between the NEEAP** objectives and those taken for mitigating climate change within Luxembourg, hence between NEEAP measures **and climate change related P&Ms** *[→ Tables IV.3-2 & IV.3-3]*.

IV.3.1.2. Road transportation: "road fuel exports" share complicates the projection exercise

As underlined in *Section II.12.1*, the impact from "road fuel exports" can hardly be controlled by unilateral adaptations in national tax-policy: as fuel sales attributed to "road fuel exports" are mainly triggered by fuel price differentials (which are predominantly determined by differentials in national excise rates), Luxembourg would need to permanently coordinate its tax policy with the policy of all neighbouring states (Belgium, France and Germany). This would mean to accept a limitation of the scope of national tax design options. However, the Government intends to progressively, though not completely, reduce price differentials with the neighbouring countries so that Luxembourg could meet its 2020 GHG emissions target outside the EU-ETS sectors as determined in the framework of the EU "Climate & Energy package" *[→ P&M TR11 in the WAM scenario]*.[163]

Nevertheless, the dominant influence of tax policy, but also other factors, as the expansion of road networks in neighbouring countries, which would allow a by-pass of the territory of Luxembourg, or the institution or increase of road use taxes in these same countries,[164] makes projection of fuel sales – and corresponding GHG emissions – a hard task. Technological developments also complicate the exercise: for instance, what would be the impact of higher energy efficient engines in 5 to 10 years? – though EU regulations and planned EURO norms could help in this respect. Sometimes it is even impossible to predict now the influence of technological changes on road fuel sales since it depends on numerous indeterminate parameters such as the launch date of new types of vehicles driven by electricity, fuel cells or compressed air or the speed at which new concepts will be deployed, and adopted by the public: the electric car and the associated recharging/reloading network that some countries (France e.g.) are planning is a good example.

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163 Government Programme: http://www.gouvernement.lu/gouvernement/programme-2009/programme-2009/programme-gouvernemental-2009.pdf, p. 41.

164 Road use taxes could be tolls to be paids on certain sections of motorways or other infrastructures, such as it is the case in France or specific taxes levied on specific vehicles categories, such as the "Eurovignette".
Like its neighbours Germany and Belgium, and as well as the Netherlands, Luxembourg has, since 2001, been charging the "Eurovignette" on trucks using its highways following the so-called "Eurovignette Directive": http://europa.eu/legislation_summaries/internal_market/single_market_for_goods/motor_vehicles/interactions_industry_policies/l24045b_en.htm#Amendingacts. In Luxembourg this tax (or user fee) is based on pollutant emissions (EURO standards) and the truck's number of axles. It can be paid on a yearly, monthly, weekly or daily basis.

These projections are, therefore, **associated with a high uncertainty that falls upon the overall GHG projections**.

IV.3.1.3. Promoting electricity generation from renewable energy source is not a P&M

Only a relatively small fraction of overall electricity consumption in Luxembourg was generated by installations in Luxembourg – especially since the generation from blast furnace gas was stopped. The natural gas fired TWINerg power plant, which was set into service in 2002, led to an increase of the share of domestically produced electricity, as did the numerous small CHP installations. Despite the increase in generation capacity, since 2002 the import dependency remains on a high level of about 50 to 65%, compared to 94.5% in 1990 *[→ Section II.6]*. The import dependency – mainly from the German network – has one major impact on the quantitative assessment of effects of P&Ms in the field of electricity generation from renewable energy sources: while most EU Member States – and by extension, most countries – own a "double dividend" from the encouragement of electricity generation from renewable ("carbon neutral") sources – by increasing the share of renewable energy in accordance with Directive 2001/77/EC and, in addition, by lowering GHG emissions from electricity generation in the context of the Burden Sharing Agreement – Luxembourg only benefits from the increase in the share of renewable energy. As stressed in *Section II.12.3*, electricity generated in Luxembourg from renewable sources does not substitute generation from fossil fuels, as it is the case in most other Member States, but replaces electricity imports, which are "carbon neutral" according to IPCC allocation rule of GHG emissions based on the territorial principle. Therefore the **promotion of electricity generation from renewable energy sources or from CHP does not have an impact on the GHG emissions** and are consequently **not considered as measures in this report** and are, **de facto**, **included in the baseline – or BAU - scenario**. Other renewable energy sources, which **substitute fossil fuel consumption** within Luxembourg (e.g. biomass or biogas for heating purposes or solar thermal installations), **do have**, instead, **a lowering effect on the GHG balance and are, therefore, considered as P&Ms**.

IV.3.1.4. Economy size increase uncertainty of GHG projections

The power generation and the iron and steel sectors give good examples of the difficulty to provide reliable long-run projections for the Luxembourg energy system. Single decisions at company level have a dominant impact on the structure of the overall national emissions development *[→ Section II.12.2]*. **As decisions at company level can hardly be anticipated appropriately**, **emissions projections** for both the power generation and the industrial sectors **need to be evaluated with care**.

IV.3.1.5. Slight discrepancies between activity data used for GHG inventories and the NEEAP

Before discussing the P&Ms in detail, it is important to stress that background activity data used for the GHG inventory and for the NEEAP are not always matching. Indeed, one of the key-source for the NEEAP was the ad-hoc energy balance produced in 2005 for Luxembourg's second NAP by the Ministry of Economic Affairs and External Trade and FiFo-Köln, in close cooperation with the Ministry of the Environment. Consequently, GHG reduction potentials derived from the NEEAP cannot be – in principle – directly transposed into GHG emissions and (sub-)categories of the inventory. As a result, some compromises had to be made.

IV.3.2. Measures considered in the baseline projection

These measures are those supposedly included in the BAU scenario. They are national measures adopted and implemented **before end 2006** as well as all the measures embedded in the EU legislation **up to end 2006** and, therefore, normally transposed at national level. Measures included in the EU legislation are part of the "European Climate Change Programme" (ECCP).

2006 as cutting date for the P&Ms is the logical consequence of the choice of 2006 as the reference year in ECONOTEC's study;[165] a choice justified in *Section V.2*. Therefore, it is also obvious that the baseline projection is not a WOM scenario stricto sensu, i.e. as defined in UNFCCC Decisions or supporting documents. It is not possible to evaluate the actual effects of P&Ms implemented since a certain year.[166] In other words, it is not possible to quantify ex-post effects of P&Ms put into place.

IV.3.2.1. Measures from the NEEAP

Measures from the NEEAP, regarded as "early action" measures in the sense of Directive 2006/32/EC should theoretically be included in the BAU scenario *[→ Table IV.1-3]*.

165 ECONOTEC Consultants (2009a).

166 UNFCCC defines that "certain" year in their documents as being 1995. The EC usually refer to the year 2000.

TABLE IV.3-1 – MEASURES ASSESSED IN THE NEEAP THAT ARE ASSUMED TO BE TREATED IN THE BASELINE PROJECTION

Measure *NEEAP code*	Sector	Measure
A1	Residential sector	Heat insulation of new buildings and building stocks
A2	Residential sector	Subsidies for an efficient use of energy and to resort to renewable energy sources
A3	Commercial sector	Heat insulation of new buildings and building stocks
A4	Residential, commercial and institutional sectors	Subsidies to resort to renewable energy sources
A5	Electricity and heat generation	Subsidies to produce electricity from renewable energy sources (installations not covered by the ETS)

A1 & A3: *Règlement grand-ducal du 22 novembre 1995 concernant l'isolation thermique des immeubles* (http://www.legilux.public.lu/leg/a/archives/1995/0099/a099.pdf, p. 2530-2538).

A2: *Règlement grand-ducal du 17 juillet 2001 instituant un régime d'aides pour la promotion de l'utilisation rationnelle de l'énergie et la mise en valeur des sources d'énergie renouvelables* (http://www.legilux.public.lu/leg/a/archives/2001/0852307/0852307.pdf, pages 1767-1774) modified by another *Règlement grand-ducal* in July 2004. The latter is part of a set of legal texts on renewable energies published in July 2004 (http://www.legilux.public.lu/leg/a/archives/2004/1352807/1352807.pdf, p. 1935-1946).

A2 & A4: *Règlement grand-ducal du 3 août 2005 instituant un régime d'aides pour des personnes physiques en ce qui concerne la promotion de l'utilisation rationnelle de l'énergie et la mise en valeur des sources d'énergie renouvelables* and *Règlement grand-ducal du 3 août 2005 instituant une prime d'encouragement écologique pour l'électricité produite à partir de l'énergie éolienne, hydraulique, de la biomasse et du biogaz* (http://www.legilux.public.lu/leg/a/archives/2005/1362308/1362308.pdf, p. 2434-2448).

A4 & A5: *Règlement grand-ducal du 14 octobre 2005 1) concernant la fourniture d'énergie électrique basée sur les énergies renouvelables et 2) modifiant le règlement grand-ducal du 30 mai 1994 concernant la production d'énergie électrique basée sur les énergies renouvelables ou sur la cogénération ainsi que le règlement grand-ducal du 22 mai 2001 concernant l'introduction d'un fonds de compensation dans le cadre de l'organisation du marché de l'électricité* (http://www.legilux.public.lu/leg/a/archives/2005/0181/a181.pdf#page=2, p. 2948-2951).

A5: *Règlement grand-ducal du 30 mai 1994 concernant la production d'énergie électrique basée sur les énergies renouvelables ou sur la cogénération* (http://www.legilux.public.lu/leg/a/archives/1994/0062/a062.pdf, p. 1139-1154).

IV.3.2.2. Other measures

Besides those reported in the NEEAP, 4 other measures are considered in the baseline projection.

Promotion of energy efficiency and use of renewable energy sources – households

NEEAP actions A1 and A2 are targeted towards the residential sector. Another measure is the one promoting a "*carnet de l'habitat*",[167] i.e. a booklet providing information on households buildings and based on experts visits and analyzes that are partially refunded by the Government.

Financial incentives for the promotion of renewable energy sources and energy efficiency – enterprises

In the industrial sector, besides NEEAP actions A4 and A5 aiming at promoting electricity production using renewable sources that is introduced in the public network, financial incentives

[167] *Règlement grand-ducal du 25 mai 2005 fixant les conditions et modalités d'octroi et de calcul de la participation étatique aux frais d'experts exposés par le propriétaire d'un logement pour l'établissement d'un carnet de l'habitat de son logement* (http://www.legilux.public.lu/leg/a/archives/2005/1122807/1122807.pdf, p. 1919-1922).

such as investment subsidies are granted for certain projects in favour of renewable energy use and improvement of energy efficiency.[168]

Some subsidies and grants have also been especially defined for the small & medium sized enterprises (manufacturing industries, retail and services). These financial aids are covering measures taken in favour of environment protection and a more reasonable use of natural resources, including investments relating to energy use.[169]

Production of electricity from renewable energy sources

In 2001, a Compensation Fund was created, which aims at buying back, at an attractive price, electricity produced from renewable sources of from CHP installations and to promote its injection in the network by electricity suppliers.[170] It is financed by electricity users – households and enterprises – via a contribution per kWh consume that is decided every year by a public authority on the basis of the market price for conventional electricity production.[171]

IV.3.3. Existing measures included in the WEM scenario

Measures which were **adopted and implemented between end 2006 and end 2009** are considered as existing measures.

P&Ms are organized by main sectors according to paragraph 17 of the UNFCCC guidelines for the preparation of National Communications by Parties included in Annex I to the Convention, part II.[172] For each P&M, besides a textual description, a recapitulative table covering the requested information by paragraph 17 of the UNFCCC guidelines is filled in.

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168 *Loi du 22 février 2004 instaurant un régime d'aide à la protection de l'environnement, à l'utilisation rationnelle de l'énergie et à la production d'énergie de sources renouvelables* (http://www.legilux.public.lu/leg/a/archives/2004/0240403/0240403.pdf, p. 360-362).

169 *Loi du 30 juin 2004 portant création d'un cadre général des régimes d'aides en faveur du secteur des classes moyennes* (http://www.legilux.public.lu/leg/a/archives/2004/1420608/1420608.pdf, p. 2013-2017). More precisely, it is Article 4 of this law that is of relevance here and its practical modalities as defined in the *Règlement grand-ducal du 24 novembre 2005 portant exécution de l'article 4 de la loi du 30 juin 2004 portant création d'un cadre général des régimes d'aides en faveur du secteur des classes moyennes et instituant un régime d'aides en vue d'encourager et de soutenir les entreprises luxembourgeoises en matière de protection de l'environnement et d'utilisation rationnelle des ressources naturelles* (http://www.legilux.public.lu/leg/a/archives/2005/2021512/2021512.pdf, p. 3249-3251).

170 *Règlement grand-ducal du 22 mai 2001 concernant l'introduction d'un fonds de compensation dans le cadre de l'organisation du marché de l'électricité* (http://www.legilux.public.lu/leg/a/archives/2001/0070/a070.pdf#page=3, p. 1407-1410).

171 For instance, for the year 2010: http://www.ilr.public.lu/electricite/decisions/2009/E0937_Communication_tx_FdC_10_pdf.pdf.

172 Doc. FCCC/CP/1999/7.

IV.3.3.1. Transport

P&M TR01 – Vehicle tax reform

P&M ID	TR01 (P&M No 1 in the MMRT)
Name of the P&M	vehicle tax reform
Main targeted sector(s)	transport
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency of the vehicle fleet
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	fiscal
Status	implemented
P&M came into force	01-01-2007
P&M duration	not determined
Implementing entity(ies)	Customs & Excises Administration of the Ministry of Finance
Mitigation potential	2010 – 7.50
(kt CO_2e p.a.)	2015 – 20.00
	2020 – 23.70

In December 2006, a Regulation introduced a vehicle tax reform based on CO_2 emissions. It entered into force on the 1st of January 2007.[173] As the impact of the law is limited to the vehicle fleet registered in Luxembourg, only the fraction of GHG emissions from domestic fuel combustion in the transport sector is affected by this P&M, which is referred to as measure B8 in the NEEAP.

According to the NEEAP, annual energy savings potential from the vehicle tax reform is expected to reach 86 GWh in the year 2016 of which about 40% would come from the reduction of gasoline consumption and 60% from the reduction of diesel consumption. Thus, the vehicle tax reform would trigger a total GHG saving of 22 400 t CO_2 in 2016. According to the assumptions made in the NEEAP, for 2020, a reduction potential of roughly 23 700 t CO_2 could be reached. For the years 2010 and 2015, saving values have been estimated by linear interpolation.

For diesel, the interpolation yields savings of 4 500 t CO_2 in 2010 and of 12 000 t CO_2 in 2015. For gasoline, saving estimates are 3 000 t CO_2 in 2010 and 8 000 t CO_2 in 2015. The reduction potential, which is based on the NEEAP assumptions, can be viewed as being relatively small and need to be treated with care as it strongly depends on the assumed baseline energy consumption in future years.

The vehicle tax reform also has minor impacts on N_2O and CH_4 emissions in the transport sector, which were not calculated explicitly for this report.

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173 NEEAP B8 : *Règlement grand-ducal du 22 décembre 2006 portant exécution des mesures d'application de la loi du 22 décembre 2006 promouvant le maintien dans l'emploi et définissant des mesures spéciales en matière de sécurité sociale et de politique de l'environnement* (http://www.legilux.public.lu/leg/a/archives/2006/0244/a244.pdf#page=2, p. 4862-4877). A description of the law and underlying assumptions is included in the NEEAP, p. 67. The tax reform concerns passenger cars, motorcycles, scooters, buses and coaches, vans, trucks and towing trucks. The 2006 Regulation has been slightly amended since it came into force for certain categories (large families, disables persons, etc.).

P&M TR02 – Promotion of CO_2-efficient vehicles

P&M ID	TR02 (P&M No 2 in the MMRT)
Name of the P&M	promotion of CO_2-efficient vehicles
Main targeted sector(s)	transport
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency of the vehicle fleet
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	economic
Status	implemented
P&M came into force	01-01-2008
P&M duration	01-06-2007 to 31-12-2007 (31-07-2010 for the scrapping premium)
Implementing entity(ies)	Department of the Environment
Mitigation potential (kt CO_2e p.a.)	2010 – 6.00 2015 – 17.50 2020 – 27.50

In December 2007, a Regulation introduced a financial incentive for the purchase of energy efficient cars by individuals. It came into force on the 1st of January 2008 and is applicable to eligible vehicles registered from the 1st of June 2007 on.[174] In the NEEAP, this Regulation is referred to as measure B9. The law provides a financial incentive of 750 € for the purchase of passenger cars with specific CO_2 emissions not exceeding 120g/km. For passenger vehicles with more than six passengers and that are owned by families of at least 6 persons, a maximum specific emissions factor of 160g CO_2/km has been fixed. The same limit of 160g CO_2/km is also applicable to passenger vehicles running on natural gas, moved by fuel cells or "hybrid". Vehicles should be kept at least 7 months and for diesel cars, they should be equipped with a high performance particles filter.

In December 2008, the Regulation has been amended to qualify as well passenger cars owned by legal entities or in leasing and to vehicles running on LPG.[175] For vehicles owned by legal entities, the financial incentive of 750 € is applicable to passenger cars registered from the 1st of June 2008 on and that are kept at least 12 months.

A specific web site (http://www.car-e.lu/) has been launched to present the financial incentive that is labelled "CAR-e".

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174 NEEAP B9 : *Règlement grand-ducal du 5 décembre 2007 concernant l'octroi d'une aide financière aux personnes physiques pour la promotion des voitures à personnes à faibles émissions de CO_2* (http://www.legilux.public.lu/leg/a/archives/2007/0222/a222.pdf#page=2, p. 3838-3841). A description of the law and underlying assumptions is included in the NEEAP, p. 68.

175 *Règlement grand-ducal 19 décembre 2008 a.) modifiant le règlement grand-ducal du 5 décembre 2007 concernant l'octroi d'une aide financière aux personnes physiques pour la promotion des voitures à personnes à faibles émissions de CO_2* (…) that is renamed *Règlement grand-ducal du 5 décembre 2007 concernant l'octroi d'une aide financière aux personnes physiques et aux personnes morales de droit privé pour la promotion des voitures à personnes à faibles émissions de CO_2* (http://www.legilux.public.lu/leg/a/archives/2008/0219/a219.pdf#page=11, p. 3265-3271).

On the 22nd of January 2009, the December 2007 Regulation has been once again modified to introduce financial incentives for passenger vehicles taken off-road and replaced by energy efficient ones – the so-called "*prime à la casse*".[176] Two scraping premiums are foreseen for new passenger cars registered between the 1st January 2009 and the 31st December 2009 that replace vehicles which were first registered more than 10 years ago: 1 750 € (including the "CAR-e" premium of 750 €) if the new vehicle emits 120g CO_2/km or less (160g CO_2/km for categories identified above) and 1 500 € if it emits 150g CO_2/km or less. This addition to the previous Regulations is labelled "CAR-e plus" and is promoted on the web as part of the "CAR-e" initiative (http://www.car-e.lu/prime-car-e-plus.html).

End 2009, the new Government decided to prolong the financial incentive during the year 2010,[177] in accordance with the following conditions:

CAR-e

- 120g CO_2/km.....750 € - 01.01.2010 – 31.07.2010
- 110g CO_2/km.....750 € - 01.08.2010 – 31.12.2010
- 100g CO_2/km.....1 500 € - 01.01.2010 – 31.12.2010

CAR-e plus (incl. CAR-e premium)

- 150g CO_2/km.....1 500 € - 01.01.2010 – 31.07.2010
- 120g CO_2/km.....2 500 € - 01.01.2010 – 31.07.2010
- 100g CO_2/km.....3 250 € - 01.01.2010 – 31.07.2010

Notes

(1) time intervals correspond to the first date the vehicle is put into circulation.

(2) for the 120g category, the 160g CO_2/km limit still applies for elected vehicles identified above.

A financial incentive has also been offered for heavy utility vehicles, coaches and buses. Trucks and towing trucks with an authorized mass higher than 12 tonnes, coaches and buses that have been registered between the 1st January 2007 and the 30 June 2009 did benefit of a subsidy of 2 500 €.[178]

These financial incentives clearly target CO_2 emissions and other traffic related GHG emissions. However, their impacts are limited to the domestic consumption of fuel in Luxembourg, which

176 *Règlement grand-ducal du 22 janvier 2009 a.) modifiant le règlement grand-ducal modifié du 5 décembre 2007 concernant l'octroi d'une aide financière aux personnes physiques et aux personnes morales de droit privé pour la promotion des voitures à personnes à faibles émissions de CO_2 b.) portant introduction d'une «prime à la casse» pour la promotion du remplacement d'anciennes voitures à personnes par des voitures à faibles émissions de CO_2* (http://www.legilux.public.lu/leg/a/archives/2009/0015/a015.pdf#page=2, p. 160-166).

177 *Règlement grand-ducal du 11 décembre 2009 modifiant 1) le règlement grand-ducal modifié du 5 décembre 2007 concernant l'octroi d'une aide financière et d'une prime à la casse aux personnes physiques et aux personnes morales de droit privé pour la promotion des voitures à personnes à faibles émissions de CO_2 2) le règlement grand-ducal du 19 décembre 2008 a) modifiant le règlement grand-ducal du 5 décembre 2007 concernant l'octroi d'une aide financière aux personnes physiques pour la promotion des voitures à personnes à faibles émissions de CO_2 b) portant introduction d'une aide financière pour la promotion des appareils électroménagers réfrigérants à basse consommation d'énergie (A++)* (http://www.legilux.public.lu/leg/a/archives/2009/0245/a245.pdf#page=2, p. 4370-4375).

178 *Règlement grand-ducal du 24 octobre 2008 concernant l'octroi d'une aide financière aux entreprises pour la promotion des véhicules utilitaires lourds et des autobus à faibles émissions* (http://www.legilux.public.lu/leg/a/archives/2008/0162/a162.pdf#page=6, p. 2262-2263).

represents only around a quarter of the total road fuel sales in the country *[→ Section II.8.2] [→ Figures II.8-1 & II.8-3]*.

The mitigation potential of this P&M has been evaluated in the NEEAP. However, t**he potential only refers to the first Regulation of December 2007**; hence, **subsequent revisions are not included** in NEEAP measure B9. More generally, in the NEEAP, mitigation potential calculations are made on the basis of price elasticities and technological progress.[179] So, an implicit hypothesis is that the financial incentive will be prolonged beyond the 31st of December 2010 or that passenger cars which benefited from the measure are still "replacing" more polluting vehicles up to 2020. This explains why mitigation potentials are provided for the years 2010, 2015 and 2020.

According to the NEEAP, annual energy savings potential from the financial incentive is expected to reach 75 GWh in the year 2016. This forecast assumes an increase in the share of efficient vehicles by 50%, i.e. from 10% to 15% of the total national vehicle fleet. NEEAP energy saving estimates can be converted to CO_2 by applying fuel specific emission factors that are taken from the GHG inventory. The conversion leads to a CO_2 reduction of 12 000 t CO_2 for diesel and 8 000 t CO_2 for gasoline in 2016. Under the assumption that from 2008 on, about 8.3% of the overall vehicle fleet will be replaced by new vehicles – of which, without the measure, 10% would be energy efficient and with the incentives, 15% would be energy efficient – the measure would reduce CO_2 emissions in the transport sector by roughly 6 000 t CO_2 in 2010 and by 27 500 t CO_2 in 2020. For the year 2015, using a linear interpolation, a quantitative impact of 17 500 t CO_2 has been estimated.

P&M TR03 – Raising excise duties on fuel for transport purposes

P&M ID	TR03 (P&M No 3 in the MMRT)
Name of the P&M	raising excise duties on gasoline and diesel: "Kyoto-cent"
Main targeted sector(s)	transport
Main targeted GHG	CO_2, CH_4 & N_2O
Objective(s)	reduction of road fuels consumption
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	fiscal
Status	implemented
P&M came into force	01-01-2007
P&M duration	not determined: the excise duties are fixed every year via a Regulation
Implementing entity(ies)	Department of the Environment for the "Kyoto Fund" related activities and financing Customs & Excises Administration of the Ministry of Finance for the excise duties
Mitigation potential (kt CO_2e p.a.)	2010 –309.00 2015 –309.00 2020 –309.00

179 Cf NEEAP, p. 38-39.

Increasing excise rates on road fuels lead to increases of the retail price of these fuels. Higher prices set an incentive for consumers to lower demand. By the 1st of January 2007, the excise rate on gasoline was increased by 2 ct€/litre. For diesel, the excise rate was increased in two stages: 1.25 ct€/litre on the 1st of January 2007 and another 1.25 ct€/litre on the 1st of January 2008. Actually, this autonomous addition to the existing excise rates was introduced to finance the "Kyoto Fund" set up in Luxembourg to deal with the Kyoto "flexible mechanisms" *[→ Section V.5.2]* and it is labelled "climate change contribution" or "Kyoto-cent".[180] In the NEEAP, the "Kyoto-cent" is referred to as measure B7.

Whereas a major impact could be expected from a reduction of GHG emissions stemming from "road fuel exports", the NEEAP only considers the effect of the increase of excise rates on the domestic consumption. Fuel savings are estimated to reach 61 GWh in the year 2016. These fuel savings translate into a corresponding CO_2 amount of 16 000 t CO_2 taking into account the respective shares of gasoline and diesel. In 2020, the CO_2 reduction potential is expected to reach about 17 000 t CO_2. For 2010, the reduction should be around 6 000 t CO_2 and takes into account the relative low price elasticity of demand that was assumed in the NEEAP.

According to Thöne (2008), a 2 ct€/litre increase in gasoline excise rates would cause a reduction of 13 000 t CO_2, based on the amounts of fuel consumed in 2006. A 2.5 ct€/litre increase in diesel excise rates would trigger a comparable higher reduction potential of 222 000 to 370 000 t CO_2.[181] The reduction potentials derived from Thöne's study are limited to a reaction in the short run. The results do not allow for a projection of future impacts of the measure taken. Thus, it is assumed for simplicity, that the reduction potential remains constant over the time period considered in this report. Hence, a reduction potential of 309 000 t CO_2 is assumed, although in the long run larger reduction potentials could be anticipated due to a higher price elasticity of fuel demand. The estimation, thus, almost certainly leads to an underestimation of the impact of the measure.

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180 NEEAP B7: *Loi du 22 décembre 2006 promouvant le maintien dans l'emploi et définissant des mesures spéciales en matière de sécurité sociale et de politique de l'environnement et portant (…) 9. introduction d'une contribution changement climatique sur les carburants et modifiant la loi modifiée du 23 décembre 2004 établissant un système d'échange de quotas d'émission de gaz à effet de serre; créant un fonds de financement des mécanismes de Kyoto; et modifiant l'article 13bis de la loi modifiée du 10 juin 1999 relative aux établissements classés* (http://www.legilux.public.lu/leg/a/archives/2006/0239/a239.pdf, *Chapitre 2*, p. 4728-4729). The climate change contribution is defined each year in a Regulation determining excise rates applicable in Luxembourg. These texts are: for the year 2007, the *Règlement grand-ducal du 22 décembre 2006 fixant les taux applicables en matière de droits d'accises autonomes sur les produits énergétiques* (http://www.legilux.public.lu/leg/a/archives/2006/0244/a244.pdf#page=27, Article 3, p. 4887), for the year 2008, the *Règlement grand-ducal du 21 décembre 2007 portant fixation du droit d'accise autonome et dispositions diverses sur les tabacs manufacturés et les produits énergétiques* (http://www.legilux.public.lu/leg/a/archives/2007/0245/a245.pdf#page=10, Article 4, p. 4546) and for the year 2009, the *Règlement grand-ducal du 19 décembre 2008 fixant les taux applicables en matière de droits d'accises autonomes sur les produits énergétiques* (http://www.legilux.public.lu/leg/a/archives/2008/0221/a221.pdf#page=3).
A description of the law and underlying assumptions is included in the NEEAP, p. 66.

181 Thöne (2008), page 49.

P&M TR04 – Biofuels

P&M ID	TR04 (P&M No 4 in the MMRT)
Name of the P&M	use of biofuels in road transport
Main targeted sector(s)	transport
Main targeted GHG	CO_2
Objective(s)	promoting renewable road fuels
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	regulatory
Status	implemented
P&M came into force	Budget Law of 23-12-2005
P&M duration	not determined: extended or revised every year via the annual Budget Law
Implementing entity(ies)	Customs & Excises Administration of the Ministry of Finance
Mitigation potential	2010 –141.00
(kt CO_2e p.a.)	2015 –150.00
	2020 –158.00

The Directive 2003/30/EC on the promotion of biofuels or other renewable fuels use for transport purposes has been adopted in May 2003.[182] According to the Directive, Member States should ensure a minimum proportion of biofuels in road fuel sales. By 2006, this minimum proportion should reach 2% and by 2011, 5.75% (as indicative targets). Since Luxembourg's Law referring to biofuels only clearly indicates the 2% minimum target, it is assumed a 2% proportion of biofuels for the quantitative estimation of the mitigation potential of this P&M.[183] It is, therefore, a conservative hypothesis that could lead to an underestimation of the impact of the measure.

The expected mitigation potentials of the 2% inclusion of biofuels are calculated on the basis of the anticipated road fuel sales determined by ECONOTEC using the specific transport module attached to the EPM *[→ Section V.2.4]*.

Box IV.3-1: Impacts of P&Ms in the field of transport – passenger cars

The Department of the Environment regularly monitors the passenger cars market to assess its evolution, notably towards the incentives and measures put in place.

The latest evaluation was made in November 2009, including vehicles sales up to October 2009. For the first ten months of 2009, new registrations for passenger cars showed a 25% share for vehicles emitting less than 120g CO_2/km. This is more than twice the share in 2007 (11.9%), the year before the "CAR-e" scheme was launched. For 2008, the share reached 17.9% and it was around 10% in 2005-2006 and barely 1.7% in 2001.

Taking a threshold of 140g CO_2/km, shares were 46.1%, 39.2%, 30.8%, 24.1%, and 16% for 2009 (10 months), 2008, 2007, 2006, and 2001 respectively. Consequently, high-emitting passenger cars (more than 200g CO_2/km) have seen

182 Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport.

183 Luxembourg has implemented the Directive since end 2005 in its yearly Budget Law which recalls the compulsory mimimum of 2%. The Law implemented a tax reduction for gasoline and diesel with a minimum fraction of biofuels content: tax reductions of 12.90 €/1000 litres for gasoline and of 6.00 €/1000 litres for diesel are granted: *Règlement Grand-Ducal du 23 décembre 2005 fixant les taux applicables en matière de droits d'accises autonomes sur les produits énergétiques* (http://www.legilux.public.lu/leg/a/archives/2005/2223012/2223012.pdf#page=6, p. 3730). This tax reduction has been granted in 2006 only. Subsequent Regulations determining excise rates do not indicate reductions for biofuels fractions any longer.

their importance declining in the total number of cars in Luxembourg. Their share decreased by 38% since 2007 (23% since 2008) to represent only 9.3% of the vehicles in 2009 (10 months).

The threshold lowering for the "CAR-e" premium from the 1st of August 2010 onwards is justified by the increasing share of passenger cars emitting less than 110g CO_2/km. They now reach almost 7% of the total cars registered. However, the share of very low-emitting vehicles – less than 100g CO_2/km – does not reach 1% yet.

Of course, these results are not only the consequence of the P&Ms put into place – "CAR-e", "CAR-e plus", vehicles' annual tax based on CO_2 emissions, public campaigns such as *OekoTopten [→ P&M EC07]*. The trends could also be explained by various other factors, amongst which, the high fuel prices in the first semester of 2008, the ever increasing share of diesel vehicles, and the continuous technological improvements implemented by car manufacturers. No decomposition analysis has been produced yet in Luxembourg for isolating the role of each factor on the trend of passenger cars sales by CO_2 emissions categories.

It must also be stressed than the rapid changes in shares are perhaps the outcome of the main characteristic of Luxembourg's passenger cars market, i.e. its relatively young vehicles fleet. This is the consequence of the high standard of living of the population, of the population increase, of the employees' turnover in the tertiary sector, and of company owned cars for their employees (leasing).

As of today, it is estimated than the passenger cars registered in Luxembourg have a mean CO_2 emission per km of 168.5, i.e. 7.1% less than 5 years ago (end 2004). Nonetheless, Luxembourg will have to go on with its efforts and its P&Ms so to reach the EU objectives of 130g CO_2/km for the overall cars fleet by 2015.

Additional information is available here: http://www.environnement.public.lu/energies_renouvelables/dossiers/ampoules/diapositives_cp.pdf.

IV.3.3.2. Residential, commercial and institutional sectors

The NEEAP includes a bottom-up analysis of energy consumption in the building sector and, therefore, allows addressing impacts of related P&Ms on GHG emissions.

P&Ms EC01a & EC01b – Promotion of energy efficiency and use of renewable energy sources

P&M ID	EC01a (P&M No 5 in the MMRT) EC01b (P&M No 6 in the MMRT)
Name of the P&M	EC01a – energy efficiency and use of renewable energy sources in the residential building sector: solar heaters & heat pumps (non biomass) EC01b – energy efficiency and use of renewable energy sources in the residential building sector: biomass boilers & wood stoves (biomass)
Main targeted sector(s)	residential sector
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency and the use of renewable energy sources in the residential sector
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	economic
Status	implemented
P&M came into force	01-01-2008
P&M duration	01-01-2008 to 31-12-2012
Implementing entity(ies)	Department of the Environment Public Revenue Office of the Ministry of Finance
Mitigation potential (kt CO_2e p.a.)	2010 – 0.90 (EC01a) & 6.00 (EC01b) 2015 – 1.60 (EC01a) & 10.50 (EC01b) 2020 – 1.60 (EC01a) & 10.50 (EC01b)

A Regulation to promote energy savings and the use of renewable energy sources by individuals came into force on the 1st of January 2008 and is due to be terminated by 2012.[184] It introduced financial incentives for the promotion of renewable energy use in the residential sector. In the NEEAP, the assessment of the law is split between measure B5, which concentrates on energy savings potential from solar energy and heat pumps and measure B6, which is focussed on the energy that could be substituted by biomass heating systems in the residential building sector.

P&M EC01a – NEEAP B5

Measure B5 that includes solar-thermal energy, heat pumps and solar power energy would, according to the NEEAP, substitute 12 GWh of (mainly) fossil energy and electric power consumption in 2016. For the purpose of the projection exercise, savings of electric energy need to be considered as "carbon neutral" and are for that reason excluded from the energy savings potential *[→ Section IV.3.1.3]*. Turning to the substitution of heating fossil fuels by renewable energy sources, for solar-thermal installations, an annual increase of the capacity by roughly 3 500 m² until 2012 could be expected according to the NEEAP. Form then on, the installed capacity would remain constant (per a conservative assumption that the programme will not be prolonged). Thus, starting from an annual production potential of about 1.1 GWh, solar-thermal installations and heat-pumps would contribute to about 7 GWh of the total 12 GWh reduction potential in 2016. Assuming, for simplicity, that solar energy and energy savings from heat pumps substitute the average fuel mix used for heating purposes for an amount of about 230 t CO_2 per GWh, the energy saving/substitution of 7 GWh can be converted into an emissions saving of roughly 1 600 t CO_2 in 2016. For 2015 and 2020 the reduction would remain at the same level, as the maximum annual reduction potential would already be reached in 2012, when the programme is due to be terminated. In 2008, with an estimated production of 1.1 GWh, the reduction of CO_2 could reach a rather small potential of 250 t CO_2. By linear interpolation between 2008 and 2012, the value for 2010 could be evaluated at a level of about 900 t CO_2.

P&M EC01b – NEEAP B6

Substitution of fossil energy by biomass in the residential sector (e.g. by wood-pellet heating equipment, etc.) is included in the NEEAP under code B6. For the year 2016, a substitution potential of 45 GWh is estimated. In contrast to measure B5, the overall potential needs not to be corrected for electric power savings. For a starting energy generation from biomass in residential heating systems of 8 GWh of energy, an increase in capacity by annually 150 installations with a specific capacity of 20 kW is assumed. Again, as in measure B5, the maximum substitution potential would be reached in 2012 with 45 GWh or 10 500 t CO_2 and, thus, would remain constant

184 NEEAP B5 & B6: *Règlement grand-ducal du 21 décembre 2007 instituant un régime d'aides pour des personnes physiques en ce qui concerne la promotion de l'utilisation rationnelle de l'énergie et la mise en valeur des énergies renouvelables* (http://www.legilux.public.lu/leg/a/archives/2007/0247/a247.pdf, p. 4560-4577). This Regulation has been repealed in 2009 by the *Règlement grand-ducal du 20 avril 2009 instituant un régime d'aides pour la promotion de l'utilisation rationnelle de l'énergie et la mise en valeur des énergies renouvelables* that is also due to be terminated by end 2012 (http://www.legilux.public.lu/leg/a/archives/2009/0083/a083.pdf, p. 980-997).
A description of the law and underlying assumptions is included in the NEEAP, p. 72-73.

throughout the rest of the period 2012-2020. The reduction in 2008 could be converted into an emissions saving of roughly 2 000 t CO_2. For 2010, the reduction has then been estimated by linear interpolation at a value of about 6 000 t CO_2.

P&M EC02 – Program encouraging refurbishment of old residential buildings

P&M ID	EC02 (P&M No 9 in the MMRT)
Name of the P&M	higher energy efficiency in existing residential buildings
Main targeted sector(s)	residential sector
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency in the residential sector
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	economic
Status	implemented
P&M came into force	01-01-2008
P&M duration	01-01-2008 to 31-12-2012
Implementing entity(ies)	Department of the Environment Public Revenue Office of the Ministry of Finance
Mitigation potential (kt CO_2e p.a.)	2010 – 2.50 2015 – 4.60 2020 – 5.00

Financial incentives for the renovation of existing residential buildings older than 10 years have been introduced by the Regulation that came into force on the 1st of January 2008.[185] This measure is referred to as B2 in the NEEAP. Financial aid can be claimed for improvements of building insulation and heating equipment. The measure aims to accelerate the renovation rate and to set incentives for more demanding efficiency standards.

According to the NEEAP, the program is supposed to trigger an energy saving of 25 GWh in 2016, mainly natural gas and mineral oil. This reduction of final energy consumption corresponds to a saving of CO_2 of 5 000 t CO_2 (eliminating the savings of electric power and "carbon neutral" fuels). As the program is limited to the year 2012, no additional reductions could be assessed afterwards and the reduction would remain constant until 2020. In 2010 2 500 t CO_2 could be assigned to the measure. By interpolation for the year 2015, a reduction of about 4 600 t CO_2 has been calculated.

185 NEEAP B2: *Règlement grand-ducal du 21 décembre 2007 instituant un régime d'aides pour des personnes physiques en ce qui concerne la promotion de l'utilisation rationnelle de l'énergie et la mise en valeur des énergies renouvelables* (http://www.legilux.public.lu/leg/a/archives/2007/0247/a247.pdf, p. 4560-4577). This Regulation has been repealed in 2009 by the *Règlement grand-ducal du 20 avril 2009 instituant un régime d'aides pour la promotion de l'utilisation rationnelle de l'énergie et la mise en valeur des énergies renouvelables* that is also due to be terminated by end 2012 (http://www.legilux.public.lu/leg/a/archives/2009/0083/a083.pdf, p. 980-997).
A description of the law and underlying assumptions is included in the NEEAP, p. 52.

P&M EC03 – Improvement of overall energy efficiency of residential buildings

P&M ID	EC03 (P&M No 8 in the MMRT)
Name of the P&M	new energy efficiency standards for new & existing residential buildings
Main targeted sector(s)	residential sector
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency in the residential sector
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	regulatory
Status	implemented
P&M came into force	01-01-2008
P&M duration	not determined
Implementing entity(ies)	Ministry of Economic Affairs and External Trade Ministry of Housing Ministry of Justice Ministry of SMEs and Tourism Land Planning Department of the Ministry of Sustainable Development and Infrastructures
Mitigation potential (kt CO_2e p.a.)	2010 – 17.00 2015 – 62.30 2020 –110.00

A Regulation introducing more restrictive energy efficiency standards in new residential buildings or, in case of major restructuring projects, for existing residential buildings came into force on the 1st of January 2008.[186] This Regulation is referred to as measure B1 in the NEEAP. Three minimum standards are defined in the text and have to be met: U-value, specific heating energy consumption (kWh/m²a) and minimum standards for primary energy efficiency. The Regulation actually implements the requirements set out in Directive 2002/91/EC.

The impact of the measure on overall final energy consumption, including electric power consumption, is considered in the NEEAP. As stated in ***Section IV.3.1.3***, the reduction of electric power consumption has no impact on CO_2 emissions attributed to Luxembourg's GHG balance and are, therefore, not considered in the quantitative assessment of P&Ms. An overall energy saving of 372 GWh in 2016 is estimated in the NEEAP, of which 96% are coming from natural gas and mineral oil use. The calculation is based on the assumption of an annual growth in the building stock of 1.3%. Rebound effects and non-compliance of the standards set out in the Regulation are captured by a "non-compliance rate" of 15%.

The Regulation of 30 November 2007 replaced the former Regulation of 22 November 1995 that is already included in the baseline projection – cf NEEAP measures A1 & A3 in ***Table IV.3-1***. Hence,

186 NEEAP B1: *Règlement grand-ducal du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation* (http://www.legilux.public.lu/leg/a/archives/2007/0221/a221.pdf, p. 3762-3836). This Regulation has been slightly amended on 19 August 2008. However, these amendments did not modify the principal objectives and measures of the 2007 Regulation: http://www.legilux.public.lu/leg/a/archives/2008/0124/a124.pdf#page=2, p. 1862-1863.
A description of the law and underlying assumptions is included in the NEEAP, p. 51.

the overall reduction of 372 GWh that is attributed to the November 2007 Regulation has to be corrected for the impact that could be assigned to the November 1995 Regulation. Unfortunately, that could not be done for this exercise and, consequently, double counting most likely occurs.

Energy savings of 372 GWh by 2016 could be converted into a CO_2 cutback of roughly 71 000 t CO_2. Savings of electric power, biomass and other fuels (which are considered as renewable energy sources) are not included as they have no impact on the CO_2 development: they are considered as "carbon neutral". The reduction compared to the baseline development would reach 17 000 t CO_2 in 2010 and 110 000 t CO_2 in 2020. By linear interpolation between the values for 2010 and 2016, a reduction of 62 300 t CO_2 has been assumed for the year 2015.

P&M EC04 – Program encouraging the construction of highly efficient residential buildings

P&M ID	EC04 (P&M No 10 in the MMRT)
Name of the P&M	new "low energy" ("*Niedrigenergiehaus*") and "passive" ("*Passivhaus*") residential buildings
Main targeted sector(s)	residential sector
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency in the residential sector
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	economic
Status	implemented
P&M came into force	01-01-2008
P&M duration	01-01-2008 to 31-12-2012
Implementing entity(ies)	Department of the Environment Public Revenue Office of the Ministry of Finance
Mitigation potential (kt CO_2e p.a.)	2010 – 0.35 2015 – 1.90 2020 – 3.50

The Regulation of 21 December 2007 also grants financial support for the construction of residential buildings with low energy consumption ("*Niedrigenergiehaus*") or "passive-house" standards ("*Passivhaus*"). In the NEEAP this measure is referred to as B3.[187]

According to the NEEAP, the program is supposed to generate an energy saving of 12 GWh in 2016. Energy savings, which were already counted for measure B1, are not considered for this measure. Thus, the reduction potential discussed in this section is an additional net effect caused by NEEAP B3 measure. The predominant share of energy reduction stems from reduced

[187] NEEAP B3: *Règlement grand-ducal du 21 décembre 2007 instituant un régime d'aides pour des personnes physiques en ce qui concerne la promotion de l'utilisation rationnelle de l'énergie et la mise en valeur des énergies renouvelables* (http://www.legilux.public.lu/leg/a/archives/2007/0247/a247.pdf, p. 4560-4577). This Regulation has been repealed in 2009 by the *Règlement grand-ducal du 20 avril 2009 instituant un régime d'aides pour la promotion de l'utilisation rationnelle de l'énergie et la mise en valeur des énergies renouvelables* that is also due to be terminated by end 2012 (http://www.legilux.public.lu/leg/a/archives/2009/0083/a083.pdf, p. 980-997).
A description of the law and underlying assumptions is included in the NEEAP, p. 53.

consumption of mineral oil and natural gas. Assuming that electric power and other fuels can be considered as "carbon neutral" from the perspective of the IPCC approach, the energy saving could be converted into a CO_2 reduction of about 2 300 t CO_2 in 2016. In 2010, a very limited potential of 350 t CO_2 could be achieved. In 2020 the reduction could reached 3 500 t CO_2.

Box IV.3-2: PRIMe House

P&Ms EC01a, EC01b, EC02 and EC04 are promoted by the Ministry/Department of the Environment under the label "PRIMe House" and through various brochures. This information is put forward on the environment internet public portal Emwelt.lu: http://www.environnement.public.lu/energies_renouvelables/dossiers/primehouse/index.html.

The Regulation of 21 December 2007 has been repealed in April 2009. Changes mainly concerned:

1. an extension of the Regulation that was previously directed to private individuals and is now also applicable to non-profit associations and to builders, whether they are private or public other than state owned;
2. an increase of certain grants for existing building insulation improvements *[→ P&M EC02]*: insulation works, double or triple window glasses;
3. a simplification of several technical criteria;
4. an extension of the eligibility deadlines for construction or refurbishment works started prior to 2008;
5. an extension of the grants dedicated to heat networks: previously only joining the network, nowadays installation of the network is eligible too.

Details on these changes are available here: http://www.environnement.public.lu/energies_renouvelables/dossiers/primehouse2/index.html and a brochure prepared for the public in January 2008 is downloadable here: http://www.environnement.public.lu/energies_renouvelables/publications/regime_aides_financieres_tc/index.html.

P&M EC05 – Improvement of U-value for non-residential buildings

P&M ID	EC05 (P&M No 11 in the MMRT)
Name of the P&M	higher U-values for non-residential buildings
Main targeted sector(s)	commercial & institutional sectors
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency in the commercial & institutional sectors
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	regulatory
Status	implemented
P&M came into force	01-01-2008
P&M duration	not determined
Implementing entity(ies)	Ministry of Economic Affairs and External Trade Ministry of Housing Ministry of Justice Ministry of SMEs and Tourism Land Planning Department of the Ministry of Sustainable Development and Infrastructures
Mitigation potential (kt CO_2e p.a.)	2010 – 0.00 2015 – 0.00 2020 – 6.80

The Regulation of 30 November 2007 presented above (P&M EC03 – NEEAP B1) also aims at the improvement of the energetic performance of non-residential buildings, mainly by fixing more

stringent U-values[188] and, thus, to improve overall energy efficiency of buildings in the "tertiary" sector (commercial, institutional and offices buildings).[189] This measure is referred to as B4 in the NEEAP.

The NEEAP calculates an energy saving of 40GWh for the year 2016 assuming an annual renovation rate of 2% with a savings potential of 50% compared to the status-quo in the year 1996. Considering savings of (district-heating) heat as "carbon neutral", the energy saving corresponds to an emissions saving of 6 800 t CO_2 in 2016. This saving estimate is used for the whole 2010-2020 cycle since not enough information is available to calculate reduction potentials all over the period.

In this context, some measures directed to public buildings are worth to be mentioned. Instructions are given for new state-owned buildings that should be "low-energy" and energy efficient. There is also a state building refurbishment Fund – funded up to 200 Mio. € – for improving energy efficiency of existing offices and buildings. Nevertheless, these "internal" measures are not strict sensu taken into account in the WEM scenario.

Box IV.3-3: *Passeport énergétique/Energiepass*

The Regulation of 30 November 2007 *[→ P&Ms EC03 & EC05]* introduced the energy performance certificate or "energy passport" – *passeport énergétique* in French, *Energiepass* in German. This certificate is compulsory from the 1st January 2008 on for all new residential buildings and for refurbishment, renovation or extension work requiring a construction permit. Since the 1st January 2010, such a document should also be prepared for houses or apartments that are sold to a new homeowner or when a new tenant moves in.

On 5 pages, the certificate informs clearly and precisely on the energy performance of the residential building – house or apartment. It uses the colour pictograms common to electrical appliances with 9 energy-efficiency classes A to I. For new residential constructions, the class should be at least D *[→ P&M EC03]*. The certificate also notifies other elements such as yearly energy needs and CO_2 emissions of the construction (taking into account the type of fuel used and how it reaches the construction), the type of heating and hot water systems installed as well as their consumption, proposals for improving energy efficiency (for existing buildings), etc.

The certificate can only be established by persons registered by the Ministry of Economic Affairs and External Trade and by architects and engineers member of the OAI (*Ordre des Architectes et des Ingénieurs-conseils du Grand-Duché de Luxembourg*). The certificate is not free and costs should be supported by the vendor or is included in the construction price for new buildings: according to the size of the construction, the cost may vary between 500 and 2 500 €.

Details are available on the following web pages:
http://www.energyefficient.lu/;
http://www.eco.public.lu/attributions/dg3/d_energie/energyefficient/depliant_passeport_energetique.pdf;
http://www.oai.lu/index2.php?lkf=http://forum.oai.lu/forum/ACA-OAI/dispatch.cgi/public_actualite/showFile/100130/d20090921081155/No/OAI_oekofoire_depliant%2009.pdf;
http://www.myenergy.lu/conseil/achat_vente/passeport_energetique;
http://www.myenergy.lu/fr/conseil/achat_vente/passeport_energetique/FAQ.

188 The U-value (or U-factor), more correctly called the overall heat transfer coefficient, describes how well a building element conducts heat. It measures the rate of heat transfer through a building element over a given area, under standardized conditions (Source: Wikipedia).

189 NEEAP B4: *Règlement grand-ducal du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation* (http://www.legilux.public.lu/leg/a/archives/2007/0221/a221.pdf, p. 3762-3836). This Regulation has been slightly amended on 19 August 2008. However, these amendments did not modify the principal objectives and measures of the 2007 Regulation: http://www.legilux.public.lu/leg/a/archives/2008/0124/a124.pdf#page=2, p. 1862-1863.
A description of the law and underlying assumptions is included in the NEEAP, p. 60.

P&M EC06 – Promoting low energy electrical appliances

P&M ID	EC06 (P&M No 26 in the MMRT)
Name of the P&M	low energy electrical appliances
Main targeted sector(s)	residential, commercial & institutional sectors
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency of electrical appliances sold
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	economic
Status	implemented
P&M came into force	30-12-2008
P&M duration	01-10-2008 to 31-12-2010
Implementing entity(ies)	Department of the Environment
Mitigation potential (kt CO_2e p.a.)	2010 – NE 2015 – NE 2020 – NE

In December 2008, a Regulation came into force that proposes financial incentives to households and enterprises for the buying of fridges, freezers or a combination of these two equipments.[190] It has been extended for the year 2010 in December 2009.[191] A financial subsidy of 150 € is offered for devices whose capacity is higher than 175 litres. This amount is reduced to 100 € if the capacity is lower than 175 litres. This financial incentive is labelled "PRIMe Cool" and is described both on the web pages of the Department of the Environment and on a web site promoting low energy electrical appliances and low emissions vehicles (cf P&M EC07 below).[192]

This P&M has not yet been evaluated with regard to its mitigation potential.

190 *Règlement grand-ducal 19 décembre 2008 (…) b) portant introduction d'une aide financière pour la promotion des appareils électroménagers réfrigérants à basse consommation d'énergie (A++)* (http://www.legilux.public.lu/leg/a/archives/2008/0219/a219.pdf#page=11, p. 3267-3268).

191 *Règlement grand-ducal du 11 décembre 2009 modifiant 1) le règlement grand-ducal modifié du 5 décembre 2007 concernant l'octroi d'une aide financière et d'une prime à la casse aux personnes physiques et aux personnes morales de droit privé pour la promotion des voitures à personnes à faibles émissions de CO_2 2) le règlement grand-ducal du 19 décembre 2008 a) modifiant le règlement grand-ducal du 5 décembre 2007 concernant l'octroi d'une aide financière aux personnes physiques pour la promotion des voitures à personnes à faibles émissions de CO_2 b) portant introduction d'une aide financière pour la promotion des appareils électroménagers réfrigérants à basse consommation d'énergie (A++)* (http://www.legilux.public.lu/leg/a/archives/2009/0245/a245.pdf#page=2, p. 4370-4375).

192 http://www.oekotopten.lu/index.php?page=primecool_fr.

P&M EC07 – Information and training campaigns

P&M ID	EC07 (P&M No 7 in the MMRT)
Name of the P&M	information and training campaigns for citizens
Main targeted sector(s)	residential, commercial & institutional sectors
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency and the use of RES
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	information & education
Status	adopted
P&M came into force	not applicable: regular campaigns
P&M duration	not applicable: regular campaigns
Implementing entity(ies)	Department of the Environment Ministry of Economic Affairs and External Trade, Energy Directorate
Mitigation potential (kt CO_2e p.a.)	2010 – NE 2015 – NE 2020 – NE

The Ministry/Department of the Environment regularly launches campaigns to raise awareness about climate change, such as the "Think Climate, Act Clever" 2007 campaign *[→ Section IX.1]*.[193]

In 1991, the Energy Agency was created to promote renewable energy projects and to inform citizens, the economic sector as well as municipalities on a better use of energy, renewable energy sources and financial public support. During the course of 2008, this Agency was reformed and renamed *Energieagence*.[194] This Agency is a partnership grouping the Department of the Environment, the Ministry of Economic Affairs and External Trade, the electricity and natural gas distributing company *Enovos* (previously *Cegedel*) and the *SEO* (*Société Electrique de l'Our*). An Economic Interest Group (*EIG*) has been established in 2008 to serve as principal contact point for information and advices on energy consumption reduction and on the use or the domestic production of renewable energy sources. This EIG is named *My Energy* whose partners are the Department of the Environment, the Ministry of Economic Affairs and External Trade and the *Energieagence [→ Section IX.1.1]*.[195] My Energy is also authorized to develop national or European projects in the fields of energy efficiency and of renewable energy sources.

Another tool proposed to the citizens is the *OekoTopten* project.[196] This web site offers a purchase guide and information on low energy electrical appliances, lightning bulbs, TVs and low emissions vehicles – the latter in conjunction with the "CAR-e" initiative. It is a partnership between the Department of the Environment, the NGO *Mouvement Ecologique* and the non-profit organization *OekoZenter Lëtzebuerg*. The Department of the Environment ensures financial resources for that

193 http://www.environnement.public.lu/energies_renouvelables/dossiers/think_climate/brochure_think_climate_2007.pdf.
194 http://www.energieagence.lu/fr.
195 http://www.myenergy.lu/fr.
196 http://www.oekotopten.lu/index.php?page=francais.

project and participates to its steering committee together with the two organizations *[→ Section IX.1.1]*.

In March 2009, the EU decided on a gradual withdrawal of incandescent bulbs. The Department of the Environment took this opportunity to launch a vast information campaign for raising awareness in the country *[→ Section IX.1.1]*.[197]

For this report, no assessment has been undertaken for estimating the impact on GHG emissions of the information and training campaigns.

IV.3.3.3. Main industries and power generation[198]

P&M IN01 – Emissions Trading Directive – trading period 2008 – 2012

P&M ID	IN01 (P&M No 13 in the MMRT)
Name of the P&M	EU-ETS 2008-2012
Main targeted sector(s)	manufacturing industry & power generation
Main targeted GHG	CO_2
Objective(s)	control of CO_2 industrial emissions by a cap-and-trade system
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	economic
Status	implemented
P&M came into force	25-10-2003
P&M duration	01-01-2008 to 31-12-2012
Implementing entity(ies)	Department of the Environment
Mitigation potential (kt CO_2e p.a.)	2010 – 0.00 2015 – 0.00 included in the BAU scenario 2020 – 0.00

The 2nd NAP in the framework of the EU-ETS[199] was submitted to the Commission on July 2006.[200] The EU-ETS is one of the cornerstones of the ECCP and concerns the regulation of CO_2 emissions among certain installations – mainly energy intensive industries and power generation – by a cap-and-trade emissions permit system. In the NAP, the government sets out rules regulating the allocation of emission permits to the installations covered by the EU-ETS.

The EU-ETS represents the main P&M implemented by national authorities in Luxembourg since the main large industrial emitters of GHG are all covered by this scheme.

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197 http://www.environnement.public.lu/energies_renouvelables/dossiers/ampoules/index.html. EU Regulation (EC) 244/2009 is available here: http://www.environnement.public.lu/energies_renouvelables/dossiers/ampoules/reg_eur.pdf.

198 SMEs are actually treated in the previous section.

199 Directive 2003/87/EC in OJ L 275, 25.10.2003, p. 32-46 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:275:0032:0046:EN:PDF).

200 http://ec.europa.eu/environment/climat/pdf/lux_nap_final.pdf.

For current EU-ETS installations, the 2nd NAP projected an emissions growth from about 2.6 Mio. t CO_2 (basic period of the allocation) to an average annual emissions volume of 3.2 Mio. t CO_2 in the period between 2008 and 2012. Strong emissions growth was expected for certain installations, especially in the steel industry and power plants, which had not reached full capacity in the reference period. By application of a compliance factor the "grandfathering" of emission permits to current installations was restricted to 3.17 Mio. t CO_2 per year (from 2008-2012). For newcomers, a set aside of 0.59 Mio. t CO_2 was reserved. 0.19 Mio. t CO_2 were planned to be auctioned in order to raise funds to cover the operational costs of the trading scheme. The overall annual allocation of the 2nd NAP amounted therefore to 3.95 Mio. t CO_2 per year.[201]

However, in its Decision of 29 November 2006, the Commission decided to limit the allocation to 2.69 Mio. t CO_2 per year with regard to the installations listed in the 2nd NAP.[202] This would be equivalent to a reduction of 1.26 Mio. t CO_2, taking the overall allocation, or 0.48 Mio. t CO_2, taking the projected emissions of 3.17 Mio. t CO_2 for Luxembourg's EU-ETS installations as reference case. Subsequently, the Decision of the Commission of 13 July 2007 concerning the amendment of the Decision on the NAP[203] once more reduced allowances to 2.49 Mio. t CO_2 per year.

Nevertheless, the mitigation potential of the EU-ETS **has been included in the BAU projection scenario**.[204]

P&M IN02 – Voluntary Agreement of the FEDIL (Business Federation Luxembourg)

P&M ID	IN02 (P&M No 12 in the MMRT)
Name of the P&M	voluntary agreement on energy efficiency between the Business Federation Luxembourg FEDIL and the Government
Main targeted sector(s)	manufacturing industry
Main targeted GHG	CO_2
Objective(s)	increasing efficient energy use
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	voluntary/ negotiated agreement
Status	adopted
P&M came into force	01-03-1996
P&M duration	regularly renewed: presently in force up to 2010
Implementing entity(ies)	FEDIL and its members Government

201 Cf 2nd NAP, p. 7.

202 Commission Decision of 29 November 2006 concerning the national allocation plan for the allocation of greenhouse gas emission allowances notified by Luxembourg in accordance with Directive 2003/87/EC of the European Parliament and of the Council, (http://ec.europa.eu/environment/climat/pdf/nap2006/20061128_lu_nap_en.pdf).

203 Commission Decision of 13 July 2007 concerning the amendment to the national allocation plan for the allocation of greenhouse gas emission allowances notified by Luxembourg in accordance with Article 3(3) of Commission Decision C/2006/5614 final of 29 November 2006 concerning the national allocation plan for the allocation of greenhouse gas emission allowances notified by Luxembourg in accordance with Directive 2003/87/EC of the European Parliament and of the Council (http://ec.europa.eu/environment/climat/pdf/nap2006/lx_nap_amendment_en.pdf).

204 ECONOTEC Consultants (2009a), Section 4.2.1, p. 13, as well as Table V.1-1 of this Communication.

Mitigation potential	2010 –	NE
(kt CO_2e p.a.)	2015 –	0.00
	2020 –	0.00

On the 1st March 1996, the members of the FEDIL agreed upon a voluntary agreement promoting the improvement of energy efficiency in the industrial sector that was substantially revised in April 2002.[205] The agreement includes the establishment of energy management systems in order to enable companies to monitor their energetic performance. For this purpose, companies are committed to collect data on energy consumption and corresponding output figures in order to generate "energy efficiency indicators". Moreover, energy audits shall be introduced to disclose energy efficiency potentials in the production processes. In cooperation with the, at that time, Energy Agency (now *Energieagence*), the FEDIL agreed to conduct information campaigns to raise its members' awareness of the issue of energy efficiency and renewable energy use.

In April 2005, a target for the improvement of energy efficiency in the industrial sector was introduced into the voluntary agreement. The FEDIL and the Ministry of Economic Affairs and External Trade as well as the Ministry of the Environment finally agreed upon the adoption of a minimum improvement of energy efficiency of 15% in the time period between 1990 and 2005. In February 2007, the voluntary agreement was amended again and new efficiency targets were introduced. According to the amended agreement FEDIL members accept an energy improvement target of 16% in the time period between 1990 and 2006 and 17% between 1990 and 2007. End 2008, the agreement was renewed again and comprises now a minimum improvement of energy efficiency of 20% in the time period between 1990 and 2010.

Nowadays, the voluntary agreement encompasses 80 enterprises responsible of about 90% of the total manufacturing industry energy consumption.

So far, the 2010 mitigation potential of the agreement could not be estimated.[206] For the years 2015 and 2020, the mitigation potential is set to zero since it is not decided whether the voluntary agreement will be extended or not.

[205] http://www.gouvernement.lu/salle_presse/conseils_de_gouvernement/2002/03/22conseil/index.html#8 and http://www.paperjam.lu/presse/2003/07/6847/index.html.

[206] ECONOTEC Consultants (2009a), Section 4.2.3.1, p. 14.

P&M IN03 – Information and training campaigns

P&M ID	IN03 (P&M No 14 in the MMRT)
Name of the P&M	information and training campaigns for industries
Main targeted sector(s)	manufacturing industry, construction & power generation
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency and the use of RES
Projections scenario	WEM (WEM+WAM in the MMRT)
Type of instrument(s)	information & education
Status	adopted
P&M came into force	not applicable: regular campaigns
P&M duration	not applicable: regular campaigns
Implementing entity(ies)	Department of the Environment Ministry of Economic Affairs and External Trade, Energy Directorate
Mitigation potential (kt CO_2e p.a.)	2010 – NE 2015 – NE 2020 – NE

Refer to explanations provided under P&M EC06 above for the *Energieagence* and *My Energy* EIG roles and activities.

IV.3.3.4. Overview: existing measures

Existing P&Ms and corresponding savings are summarised in ***Table IV.3-2***. The design of the table is closely linked to the Monitoring Mechanism Reporting Template (MMRT) provided by DG ENV of the EC and the Topic Centre on Air and Climate Change (ETC/ACC) of the European Environment Agency (EEA).[207] It contains all the headings of the climate change P&Ms table put online by the EEA[208] and covers all the information that is requested to be presented in a summary table by the UNFCCC Guidelines for the 5th National Communication.

The column "P&M – ID" presents the two identification keys used in the Communication: the one used in this report and the key used in both the MMRT submitted in June 2009 and in the 2009 report by ECONOTEC.[209] The penultimate column indicates which related Common and Coordinated Policies and Measures (CCPM) are linked to the domestic P&M considered. The last column specifies which source of information was used for determining the mitigation potentials of each P&M. The other columns repeat the information provided for each P&M in the individual tables above.

[207] The MMRT file could be provided on request.

[208] http://www.eea.europa.eu/themes/climate/pam/.

[209] ECONOTEC Consultants (2009a).

TABLE IV.3-2 – SUMMARY – QUANTITATIVE ASSESSMENT OF THE IMPACT OF MEASURES – WEM

P&M ID		Targeted sector	GHG	Name	Objective(s)	Type	Implementing entity(ies)	Status	Duration	Mitigation potential (kt CO_2e)			CCPM addressed	Source of information
report	MMRT									2010	2015	2020		
TR01	1	transport	CO_2	vehicle tax reform	increasing energy efficiency of the vehicle fleet	fiscal	ADA	implemented	01-01-2007 ↓ nd	7.50	20.00	23.70	none	NEEAP B8
TR02	2	transport	CO_2	promotion of CO_2-efficient vehicles	increasing energy efficiency of the vehicle fleet	economic	MDDI-DEV	implemented	01-06-2007 ↓ *31-07-2010* 31-12-2010	6.00	17.50	27.50	none	NEEAP B9
TR03	3	transport	CO_2 CH_4 N_2O	raising excise duties on gasoline & diesel	reduction of road fuels consumption	fiscal	MDDI-DEV ADA	implemented	01-01-2007 ↓ nd	309.00	309.00	309.00	none	Thöne (2008)
TR04	4	transport	CO_2	use of biofuels in road transport	promoting renewable road fuels	regulatory	ADA	implemented	23.12.2005 ↓ nd	141.00	150.00	158.00	Directive 2003/30/EC	EPM transport module
EC01a	5	residential	CO_2	energy efficiency and use of RES in the residential building sector: non biomass	increasing energy efficiency and use of RES in the residential sector	economic	MDDI-DEV PRO	implemented	01-01-2008 ↓ 31-12-2012	0.90	1.60	1.60	none	NEEAP B5
EC01b	6	residential	CO_2	energy efficiency and use of RES in the residential building sector: biomass	increasing energy efficiency and use of RES in the residential sector	economic	MDDI-DEV PRO	implemented	01-01-2008 ↓ 31-12-2012	6.00	10.50	10.50	none	NEEAP B6
EC02	9	residential	CO_2	higher energy efficiency in existing residential buildings	increasing energy efficiency in the residential sector	economic	MDDI-DEV PRO	implemented	01-01-2008 ↓ 31-12-2012	2.50	4.60	5.00	none	NEEAP B2
EC03	8	residential	CO_2	new energy efficiency standards for new & existing residential buildings	increasing energy efficiency in the residential sector	regulatory	MECO Min. of Housing Min. of Justice MSME MDDI-DoLP	implemented	01-01-2008 ↓ nd	17.00	62.30	110.00	Directive 2002/91/EC	NEEAP B1
EC04	10	residential	CO_2	new "low energy" and "passive" residential buildings	increasing energy efficiency in the residential sector	economic	MDDI-DEV PRO	implemented	01-01-2008 ↓ 31-12-2012	0.35	1.90	3.50	none	NEEAP B3

EC05	11	commercial institutional	CO_2	higher U-values for non-residential buildings	increasing energy efficiency in the commercial & institutional sectors	regulatory	MECO Min. of Housing Min. of Justice MSME MDDI-DoLP	implemented	01-01-2008 ↓ nd	0.00	0.00	6.80	none	NEEAP B4
EC06	26	residential commercial institutional	CO_2	low energy electrical appliances	increasing energy efficiency of electrical appliances sold	economic	MDDI-DEV	implemented	01-10-2008 ↓ 31-12-2010	NE	NE	NE	none	NA
EC07	7	residential commercial institutional	CO_2	information & training campaigns for citizens	increasing energy efficiency and the use of RES	information education	MDDI-DEV MECO-DEN	adopted	NA	NE	NE	NE	none	NA
IN01	13	man. Ind. Power gen.	CO_2	EU-ETS 2008-2012	control of CO_2 industrial emissions by a cap-and-trade system	economic	MDDI-DEV	implemented	01-01-2008 ↓ 31-12-2012	0.00	0.00	0.00	Directive 2003/87/EC	NA since included in the BAU scenario
IN02	12	man. Ind.	CO_2	voluntary agreement on energy efficiency FEDIL-Government	increasing efficient energy use	voluntary / negotiated agreement	FEDIL Government	adopted	01-03-1996 ↓ nd	NE	0.00	0.00	none	NA
IN03	14	man. Ind. Power gen. construction	CO_2	information & training campaigns for industries	increasing energy efficiency and the use of RES	information education	MDDI-DEV MECO-DEN	adopted	NA	NE	NE	NE	none	NA
TOTAL										**490.25**	**577.40**	**655.60**		

Legend

ADA – Customs & Excises Administration of the Ministry of Finance

MDDI-DEV – Department of the Environment of the Ministry of Sustainable Development & Infrastructures

MDDI-DoLP – Department of Land Planning of the Ministry of Sustainable Development & Infrastructures

MECO – Ministry of Economic Affairs & External Trade

MECO-DEN – Energy Directorate of the Ministry of Economic Affairs & External Trade

MSME – Ministry of SMEs & Tourism

PRO – Public Revenue Office (Treasury) of the Ministry of Finance

nd – not determined

RES – renewable energy sources

IV.3.4. Additional measures included in the WAM scenario

Measures considered as "additional measures" are planned P&Ms that were not yet implemented or adopted by end 2009. As for existing P&Ms, a range of additional measures considered in this Communication could also be taken from the NEEAP.

It is worth noting that the additional measures do not yet reflect in its entirety Directive 2009/28/EC on renewable energy sources[210] that requests from EU Member States to reach, by 2020, a share of 10% of renewable sources in the transport sector and of 11% – objective for Luxembourg – in final energy consumption. Solely the transport section of this Directive has been taken partially on board via P&M TR12.

IV.3.4.1. Transport

P&M TR11 – Further increase of excise duties on gasoline and diesel

P&M ID	TR11 (P&M No 22 in the MMRT)
Name of the P&M	further excise duties on gasoline and diesel
Main targeted sector(s)	transport
Main targeted GHG	CO_2, CH_4 & N_2O
Objective(s)	reduction of road fuels consumption
Projections scenario	WAM
Expected type of instrument(s)	fiscal
Status	planned
Expected P&M entry into force	gradual approach
Expected P&M duration	up to objectives are encountered
Expected implementing entity(ies)	Customs & Excises Administration of the Ministry of Finance
Mitigation potential (kt CO_2e p.a.)	2010 – NE 2015 – NE 2020 – NE

In 2007, excises rates on diesel and gasoline were increased in order to contribute to the "Kyoto Fund" *[→ P&M TR03]*. Further increases are anticipated since, in the context of the EU "Climate & Energy package", Luxembourg will have to reduce its GHG emissions outside the EU-ETS sectors by 20% by 2020 compared to 2005. In Luxembourg, the non EU-ETS sectors are predominately dominated by road transport related emissions – around 52% of total GHG emissions, excluding LULUCF, in 2008 *[→ Sections II.8 & IV.1.1]* *[→ Table III.1-4]*.

In its Programme, the new Government that came out from the general elections in June 2009 has indicated the willingness to gradually reduce emissions from road transportation, dominated by "road fuel exports". It is said that it is not planned to opt for a drastic phasing out of these exports,

[210] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF).

but to progressively increase the "Kyoto-cent" taking into account the evolution of the market prices and the possible repercussions on the public revenue.

The calculation of additional emissions savings from ongoing excise increases strongly depends on a range of conditions:

- most importantly, the level of excise rates levied in neighbouring countries;
- the increase in fuel prices;
- the development of transport flows crossing Luxembourg;
- the development of road infrastructure in Luxembourg and in neighbouring countries;
- the impact of measures influencing modal split in the *Grande Région*.

It can be assumed that the minimum effect of the P&M would be of the same size as the impact of NEEAP measure B7 (ca. 296 000 t CO_2). The maximum effect might reach more than 0.8 Mio. t CO_2, assuming stronger reactions of customers and comparable rigid prices in the neighbouring countries. However, these estimates come with a very high uncertainty since assessing the impact of an increase in excise rates similar to measure B7 is a difficult task. Therefore, no reduction potentials have been taken into account for P&M TR11 in this report.

P&M TR12 – Further use of biofuels

P&M ID	TR12 (P&M No 23 in the MMRT)
Name of the P&M	further use of biofuels in road transport
Main targeted sector(s)	transport
Main targeted GHG	CO_2
Objective(s)	promoting renewable road fuels
Projections scenario	WAM
Expected type of instrument(s)	regulatory
Status	planned
Expected P&M entry into force	not determined yet but probably via yearly Budget Laws
Expected P&M duration	not determined yet but most likely up to 2020 as a minimum
Expected implementing entity(ies)	Customs & Excises Administration of the Ministry of Finance
Mitigation potential (kt CO_2e p.a.)	2010 – 0.00 2015 –374.00 2020 –631.00

Directive 2009/28/EC on renewable energy sources requests, amongst other things, that by 2020 EU Member States reach a threshold of 10% of renewable energy in the transport sector. For Luxembourg, to comply with this demand, one of the most probable solutions would be to increase the share of so-called "second generation" biofuels in road fuels. In its Programme, the Government stresses this option but added conditions to it, such as the potential impacts of this choice on the biodiversity and on foodstuffs.

For the WAM scenario, ECONOTEC has assumed a biofuels fraction in both gasoline and diesel of 4% in 2010, 7% in 2015 and 10% in 2020 [ECONOTEC Consultants (2009a), p. 10]. For 2010 there are no anticipated additional gains, since the Budget Law clearly states the 2% compulsory target whilst not imposing or even suggesting a higher minimum for the biofuels fraction. These values have been computed in the projection model *[→ Section V.2]* to obtain the mitigation potentials for these 3 years.

P&M TR13 – Fiscal arrangements in place for company cars

P&M ID	TR13 (P&M No 28 in the MMRT)
Name of the P&M	assessment of the fiscal arrangements in place for company cars
Main targeted sector(s)	transport
Main targeted GHG	CO_2, CH_4 & N_2O
Objective(s)	increasing energy efficiency of the vehicle fleet
Projections scenario	WAM
Expected type of instrument(s)	fiscal
Status	planned
Expected P&M entry into force	not before 2011
Expected P&M duration	not determined yet
Expected implementing entity(ies)	Customs & Excises Administration of the Ministry of Finance
Mitigation potential (kt CO_2e p.a.)	2010 – NA 2015 – NE 2020 – NE

It is envisaged – but not as a priority action – to re-assess the fiscal measures in place for company cars.

The mitigation potential of this measure could not be evaluated since its conditions are not defined yet.

P&M TR14 – Measures to improve modal split in Luxembourg

P&M ID	TR13 (P&M No 21 in the MMRT)
Name of the P&M	increasing modal split share for public transports
Main targeted sector(s)	transport
Main targeted GHG	CO_2, CH_4 & N_2O
Objective(s)	promoting public transports
Projections scenario	WAM
Expected type of instrument(s)	information, education & planning
Status	planned
Expected P&M entry into force	not applicable: different measures have already been taken and others are planned. The PST aims at framing these actions.
Expected P&M duration	not determined yet but most likely up to 2020
Expected implementing entity(ies)	Land Planning & Transport Departments of the Ministry of Sustainable Development and Infrastructures

Mitigation potential (kt CO_2e p.a.)	2010 –	NE
	2015 –	NE
	2020 –	NE

In 2005, Luxembourg planned to implement measures that should increase the share of public transport up to 25% in 2020.

The agenda is made of the following elements:

- expansion of the international railway network: link to the *TGV-Est* and the *EUROCAP RAIL* to better and faster connect Brussels, Luxembourg and Strasbourg;
- expansion of national railway network: new railway connections from Luxembourg to Bettembourg and Luxembourg to Esch-sur-Alzette;
- construction of suburban train stations to enhance the opportunity to use park & ride more extensively;
- creation of a "*Centrale de Mobilité*", which serves as an integrated public transport service platform to promote the use of public transport in Luxembourg. This tool is already in place: cf http://www.mobiliteit.lu/.

These measures are mainly under the authority of Department of Transport and have been confirmed in the pilot study of the PST, which suggests a wider range of actions *[→ Section IV.1.4]*. Yet there is no detailed assessment of the mitigation potential of all these measures and actions. In particular, an allocation of the impacts of the specific policies and regulations listed in the PST on GHG emission seems hardly feasible.

IV.3.4.2. Residential, commercial and institutional sectors

P&M EC11a & EC11b – Further promotion of energy efficiency and use of renewable energy sources

P&M ID	EC11a (P&M No 19 in the MMRT) EC11b (P&M No 20 in the MMRT)
Name of the P&M	EC11a – further energy efficiency and use of renewable energy sources in the residential building sector: solar heaters & heat pumps (non biomass) EC11a – further energy efficiency and use of renewable energy sources in the residential building sector: biomass boilers & wood stoves (biomass)
Main targeted sector(s)	residential sector
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency and the use of renewable energy sources in the residential sector
Projections scenario	WAM
Expected type of instrument(s)	economic
Status	planned
Expected P&M entry into force	01-01-2010

Expected P&M duration	not determined yet
Expected implementing entity(ies)	Department of the Environment Public Revenue Office of the Ministry of Finance
Mitigation potential (kt CO_2e p.a.)	2010 – 0.00 (EC11a) & 1.00 (EC11b) 2015 – 0.70 (EC11a) & 2.60 (EC11b) 2020 – 2.30 (EC11a) & 25.00 (EC11b)

Luxembourg plans to intensify the promotion of renewable energy use in the residential building sector from 2010 on by encouraging decentralised renewable energy generation potentials. This additional P&M is split between measures C8 and C9 in the NEEAP.[211]

For NEEAP measure C8, emission reductions from substitution of fossil fuels by renewable sources have been calculated. Nevertheless, as already underscored several times above, savings in electric power cannot be counted as an emissions reduction, since Luxembourg is a net electricity importer. The NEEAP estimates an energy saving of 23 GWh in 2016 for this measure, of which only 4.3 GWh can be attributed to GHG-relevant heating purposes. Therefore, by weighting the energy reduction with the average specific CO_2 factor of heating purposes in the residential buildings sector, about 1 000 t CO_2 could be saved in 2016. Considering the assumptions made in the NEEAP, the reduction could be expanded to about 2 300 t CO_2 in 2020. The value for 2015 is interpolated and calculated at a level of about 700 t CO_2. Of course, these estimations are further savings compared to P&M EC01a – NEEAP B5.

NEEAP measure C9, in contrast to C8, is focused on the promotion of the utilisation of biomass in the residential building sector and, thus, on the substitution of fossil energy sources by renewable ones. The NEEAP estimates that energy substitution resulting from the measure would reach 11 GWh in 2016. As fossil fuels for heating purposes are substituted, the whole energy savings can be converted into emission savings, what would – assuming the average specific CO_2 intensity per GWh – result in emission savings of about 2 600 t CO_2. In accordance with the 2007 study on renewable energy source potentials [Fraunhofer ISI (2007)], probable reductions might increase up to 25 000 t CO_2 in the long run (2020).[212] In the short run, a potential of about 1 000 t CO_2 seems realistic. Here too, these estimations are further savings compared to P&M EC01b – NEEAP B6.

[211] For a more detailed description of underlying assumptions and the policy refer to the NEEAP, p. 74 for measure C8 and p. 75 for measure C9.

[212] Fraunhofer ISI (2007), Tab. 5.11.

P&M EC12 – Expand the program encouraging refurbishment of old residential buildings

P&M ID	EC12 (P&M No 15 in the MMRT)
Name of the P&M	further higher energy efficiency in existing residential buildings
Main targeted sector(s)	residential sector
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency in the residential sector
Projections scenario	WAM
Expected type of instrument(s)	economic
Status	planned
Expected P&M entry into force	01-01-2010
Expected P&M duration	not determined yet
Expected implementing entity(ies)	Department of the Environment Public Revenue Office of the Ministry of Finance
Mitigation potential **(kt CO_2e p.a.)**	2010 – 0.00 2015 – 6.20 2020 – 13.00

Luxembourg aims at prolonging and intensifying the promotion of (energetic) renovations of existing residential buildings that is part of the Regulation of 21 December 2007. This additional P&M is recorded as measure C1 in the NEEAP and is expected to start from 2010 on.

The general mechanism is similar to P&M EC02 – NEEAP B2, but is expected to trigger a higher renovation rate in the residential building stock. In 2016, the measure would release an energetic reduction potential of 32 GWh, i.e. an emission reduction – valid for Luxembourg's emissions balance, excluding electric power – of roughly 6 200 t CO_2. With an annual renovation rate of 0.5%, the saving would amount to 13 000 t CO_2 in 2020.[213]

P&M EC13 – Encouraging the modernisation of heating systems

P&M ID	EC13 (P&M No 17 in the MMRT)
Name of the P&M	further modernisation of heating systems
Main targeted sector(s)	residential sector
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency in the residential sector
Projections scenario	WAM
Expected type of instrument(s)	regulatory & economic
Status	planned
Expected P&M entry into force	01-01-2010
Expected P&M duration	not determined yet
Expected implementing entity(ies)	not determined yet
Mitigation potential **(kt CO_2e p.a.)**	2010 – 2.00 2015 – 10.30 2020 – 17.00

[213] For a more detailed description of underlying assumptions and the policy refer to the NEEAP, p. 54.

A major energy reduction potential of about 53 GWh by 2016 could, according to measure C2 of the NEEAP, be released from setting more stringent minimum efficiency standards for heating equipment in residential buildings. The NEEAP assumes a rate of substitution between old and new equipment of 5% per year. 85% of all heating equipments are expected to be covered and the reduction in energy consumption is estimated to reach 10% compared to the baseline. Assuming that average specific CO_2 emissions per GWh of heating energy in the sector would be saved by the measure, the energy saving would correspond to 12 000 t CO_2 in 2016. In 2010, a saving of roughly 2 000 t CO_2 could be expected. In 2020, it would be 17 000 t CO_2. For 2015, a linear interpolation between the values of 2010 and 2016 yields an estimate of 10 300 t CO_2.[214]

P&M EC14 – Expand the program encouraging the construction of highly efficient residential buildings

P&M ID	EC14 (P&M No 16 in the MMRT)
Name of the P&M	further promote "low energy" ("*Niedrigenergiehaus*") and "passive" ("*Passivhaus*") residential buildings
Main targeted sector(s)	residential sector
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency in the residential sector
Projections scenario	WAM
Expected type of instrument(s)	economic
Status	planned
Expected P&M entry into force	01-01-2010
Expected P&M duration	not determined yet
Expected implementing entity(ies)	Department of the Environment Public Revenue Office of the Ministry of Finance
Mitigation potential (kt CO_2e p.a.)	2010 – 0.50 2015 – 5.40 2020 – 14.30

Luxembourg aims at prolonging and intensifying the measure for the promotion of low and passive energy standard buildings that is part of the Regulation of 21 December 2007. This additional P&M is recorded as measure C3 in the NEEAP and is expected to start from 2010 on.

NEEAP measure C3 assumes that the renovation rate would reach 0.5% per year and that energy savings would be of the order of magnitude of 70% compared to the pre-1995 building standards. Compared to P&M EC04 – NEEAP B3, an additional saving of 25 GWh is foreseen for 2016. The predominant fraction of energy savings is generated by reduced consumption of mineral oil and natural gas and these savings could eventually be converted into an emissions reduction of about 6 300 t CO_2 in 2016. Under the assumptions laid down in the NEEAP, for 2020 the measure would trigger a reduction potential of 14 300 t CO_2. In 2010 the reduction would be limited to about 500 t CO_2. An approximation for the reduction achieved in 2015 could be calculated undertaking a

[214] For a more detailed description of underlying assumptions and the policy refer to the NEEAP, p. 55.

linear interpolation between 2010 and 2016. The approximation yields a reduction of 5 400 t CO_2 for 2015.[215]

P&M EC15 – Improvement of overall energy efficiency of non-residential buildings

P&M ID	EC15 (P&M No 18 in the MMRT)
Name of the P&M	further energy efficiency standards for new & existing non-residential buildings
Main targeted sector(s)	commercial & institutional sectors
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency in the commercial & institutional sectors
Projections scenario	WAM
Expected type of instrument(s)	regulatory
Status	planned
Expected P&M entry into force	01-01-2010
Expected P&M duration	not determined yet
Expected implementing entity(ies)	not determined yet
Mitigation potential (kt CO_2e p.a.)	2010 – 0.00 2015 – 15.00 2020 – 30.70

The inclusion from 2010 on of non residential buildings in the regulatory standards for energy efficiency set out in the Regulation of 30 November 2007 for residential buildings[216] is envisaged by the NEEAP as measure C5.[217] However, there are no details on the revised or expanded regulation available yet.

For the quantitative assessment of the impact of this additional measure, it is assumed that 50% of energy could be saved in buildings constructed with pre-1996 standards and 25% in buildings constructed in line with the standard set out in 1996. For 2016, an energy saving of 79 GWh stemming entirely from heating devices is estimated. This is equivalent to a carbon emissions reduction of 18 000 t CO_2, assuming the substitution of the average fuel mix. According to the assumptions set out in the NEEAP, for 2020 a reduction of slightly more than 30 700 t CO_2 could be estimated. By linear interpolation, for 2015 a reduction of about 15 000 t CO_2 could be achieved.

With regard to public buildings, the new Government's Programme indicates the following P&Ms:

- the refurbishment of public buildings towards low-energy consumption. The work will be arranged via annual energy improvement plans;
- from 2010 onwards, each new building, which is state-owned or subsidised by the state, will be constructed according to the "low energy consumption" standards;

215 For a more detailed description of underlying assumptions and the policy refer to the NEEAP, p. 56.

216 Cf P&M EC03 & EC05 – NEEAP B1 & B4.

217 For a more detailed description of underlying assumptions and the policy refer to the NEEAP, p. 61.

- from 2010 onwards too, demonstrations of "positive energy" buildings – i.e. buildings producing more energy than they consume – will be started.

These measures and actions are not taken into account in the mitigation potentials estimated above, though the first one could well be part of the C5 measure of the NEEAP.

P&M EC16 – Further promoting low energy electrical appliances

P&M ID	EC16 (P&M No 27 in the MMRT)
Name of the P&M	further promote low energy electrical appliances
Main targeted sector(s)	residential, commercial & institutional sectors
Main targeted GHG	CO_2
Objective(s)	increasing energy efficiency of electrical appliances sold
Projections scenario	WAM
Expected type of instrument(s)	economic
Status	planned
Expected P&M entry into force	2010
Expected P&M duration	not determined yet
Expected implementing entity(ies)	Department of the Environment
Mitigation potential (kt CO_2e p.a.)	2010 – NE 2015 – NE 2020 – NE

It is envisaged to expand the range of appliances that could benefit from the "PRIMe Cool" scheme *[→ P&M EC06]* as well as to continue financing the *OekoTopten* information site and the EIG *My Energy [→ P&M EC07]*.

The mitigation potential of this measure could not be evaluated since its conditions are not defined yet.

IV.3.4.3. Main industries and power generation[218]

P&M ES11 – Promotion of renewable energy projects

P&M ID	ES11 (P&M No 25 in the MMRT)
Name of the P&M	promoting energy production from renewable sources having positive impacts on the GHG balance
Main targeted sector(s)	energy supply
Main targeted GHG	CO_2
Objective(s)	increasing the supply of renewable energy sources
Projections scenario	WAM
Expected type of instrument(s)	fiscal & regulatory
Status	planned
Expected P&M entry into force	not determined yet
Expected P&M duration	not determined yet
Expected implementing entity(ies)	Department of the Environment Ministry of Economic Affairs and External Trade which has the energy in its attributions
Mitigation potential (kt CO_2e p.a.)	2010 – NE 2015 – NE 2020 – NE

As seen with other P&Ms, Luxembourg did set out and will further develop financial incentives for the promotion of energy efficiency and renewable energy projects. However, the promotion of power generation capacities will not have a positive impact on national GHG emissions according to IPCC rules *[→ Section IV.3.1.3]*. Therefore, as an example, one priority area could be the injection of biogas in the natural gas network. The substitution of natural gas by biogas reduces CO_2 emissions assigned to the GHG balance of Luxembourg, especially for power generation and for building heating systems. A GHG reduction, in contrast, would not occur if biogas would burn in additional power generation capacities. In this case, the electricity generated would only substitute "carbon neutral" electricity imports.

This is the reason why, relying on the 2007 study on renewable energy source potentials [Fraunhofer ISI (2007)], the Government intends to elaborate an action plan for promoting the production of energy that could have a clear positive impact on Luxembourg's GHG balance. In this context, it is planned to take advantage of (i) the production of heat from renewable sources (wood, biomass, geothermic and solar energy), (ii) CHP with heat networks using renewable sources, (iii) the injection of biogas in the natural gas network, and (iv) the use of forestry resources for energy purposes.

The idea of elaborating, by end 2011, a wind energy sector plan is also on the table, as well as increasing R&D efforts for "green energy" projects – primarily solar energy industry, intelligent networks, biomass and biofuels.

218 SMEs are actually treated in the previous section.

The mitigation potential of these measures and plans could not be evaluated since their conditions are not defined yet.

P&M IN11 – Emission Trading Scheme – post-2012 trading period

P&M ID	IN11 (P&M No 24 in the MMRT)
Name of the P&M	post-2012 ETS
Main targeted sector(s)	manufacturing industry & power generation
Main targeted GHG	CO_2
Objective(s)	control of CO_2 emissions by a cap-and-trade system
Projections scenario	WAM
Expected type of instrument(s)	economic
Status	planned
Expected P&M entry into force	01-01-2013
Expected P&M duration	at least up to 2020
Expected implementing entity(ies)	Department of the Environment
Mitigation potential (kt CO_2e p.a.)	2010 – NE 2015 – NE 2020 – NE

The post-Kyoto regime is of course one of the main anticipated additional measure. However, it is too early now to determine the mitigation potential of this regime at national level. The targets defined alongside the EU "Climate & Energy package" will of course decide on this potential.

IV.3.4.4. Overview: additional measures

Planned policies and measures that are considered as "additional measures" are summarised in *Table IV.3-3* on the next page. For the design and the content of this table, refer to *Section IV.3.3.4*.

TABLE IV.3-3 – SUMMARY QUANTITATIVE ASSESSMENT OF THE IMPACT OF ADDITIONAL MEASURES – WAM

P&M ID		Targeted sector	GHG	Name	Objective(s)	Type *(expected)*	Implementing entity(ies) *(expected)*	Status	Duration *(expected)*	Mitigation potential (kt CO_2e)			CCPM addressed	Source of information
report	MMRT									2010	2015	2020		
TR11	22	transport	CO_2 CH_4 N_2O	further excise duties on gasoline and diesel	reduction of road fuels consumption	fiscal	ADA	planned	gradual approach	NE	NE	NE	none	NA
TR12	23	transport	CO_2	further use of biofuels in road transport	promoting renewable road fuels	regulatory	ADA	planned	nd ↓ 31-12-2020	0.00	374.00	631.00	none	EPM transport module
TR13	28	transport	CO_2 CH_4 N_2O	fiscal arrangements for of company cars	increasing energy efficiency of the vehicle fleet	fiscal	ADA	planned	not before 2011	NE	NE	NE	none	NA
TR14	21	transport	CO_2 CH_4 N_2O	increasing modal split share for public transports	promoting public transports	information education planning	MDDI-DoLP MDDI-DoT	planned	gradually ↓ 31-12-2020	NE	NE	NE	none	NA
EC11a	19	residential	CO_2	further energy efficiency and use of RES in the residential building sector: non biomass	increasing energy efficiency and use of RES in the residential sector	economic	MDDI-DEV PRO	planned	01-01-2010 ↓ nd	0.00	0.70	2.30	none	NEEAP C8
EC11b	20	residential	CO_2	further energy efficiency and use of RES in the residential building sector: biomass	increasing energy efficiency and use of RES in the residential sector	economic	MDDI-DEV PRO	planned	01-01-2010 ↓ nd	1.00	2.60	25.00	none	NEEAP C9
EC12	15	residential	CO_2	further higher energy efficiency in existing residential buildings	increasing energy efficiency in the residential sector	economic	MDDI-DEV PRO	planned	01-01-2010 ↓ nd	0.00	6.20	13.00	none	NEEAP C1
EC13	17	residential	CO_2	further modernisation of heating systems	increasing energy efficiency in the residential sector	regulatory economic	nd	planned	01-01-2010 ↓ nd	2.00	10.30	17.00	none	NEEAP C2
EC14	16	residential	CO_2	further promote "low energy" and "passive" residential	increasing energy efficiency in the residential sector	economic	MDDI-DEV PRO	planned	01-01-2010 ↓ nd	0.50	5.40	14.30	none	NEEAP C3

				buildings										
EC15	18	commercial institutional	CO_2	further energy efficiency standards for new & existing non-residential buildings	increasing energy efficiency in the commercial & institutional sectors	regulatory	nd	planned	01-01-2010 ↓ nd	0.00	15.00	30.70	none	NEEAP C5
EC16	27	residential commercial institutional	CO_2	further promoting low energy electrical appliances	increasing energy efficiency of electrical appliances sold	economic	MDDI-DEV	planned	2010 ↓ nd	NE	NE	NE	none	NA
ES11	25	energy supply	CO_2	promoting energy production from RES having positive impacts on the GHG balance	increasing the supply of renewable energy sources	fiscal regulatory	MECO-DEN (most likely)	planned	nd	NE	NE	NE	none	NA
IN11	24	man. ind. power gen.	CO_2	post-2012 ETS	control of CO_2 industrial emissions by a cap-and-trade system	economic	MDDI-DEV	planned	01-01-2013 ↓ 31-12-2020	NE	NE	NE	none	NA
TOTAL										**3.50**	**414.20**	**733.30**		

Legend

CEA - Customs & Excises Administration of the Ministry of Finance

MDDI-DEV - Department of the Environment of the Ministry of Sustainable Development & Infrastructures

MDDI-DoLP – Department of Land Planning of the Ministry of Sustainable Development & Infrastructures

MDDI-DoT – Department of Transport the Ministry of Sustainable Development & Infrastructures

MECO-DEN – Energy Directorate of the Ministry of Economic Affairs & External Trade

PRO – Public Revenue Office (Treasury) of the Ministry of Finance

nd – not determined

RES – renewable energy sources

IV.3.5. P&Ms expired or repealed

Some of the measures that have been developed over the past years and that are well established have been adapted over time, in order to better achieve their definite goals – this is the case for the P&Ms dealing with energy use in buildings e.g. - whereas some others are rather new: for instance, vehicles CO_2 related taxes and premiums for the buying of new energy efficient cars.

In fact, with regard to previous National Communications, P&M TR04 would have been reported in the fourth Communication and P&M IN02 already in the second Communication. Otherwise, previous Communications would have mainly reported those P&Ms in the field of energy efficiency and the promotion of the use or renewable energy sources.

Consequently, for Luxembourg, between the fourth and the fifth Communication, i.e. January 2006 and end December 2009, **no P&Ms have expired** and only the one dealing with excise duties on fuels for road transport could be mentioned [P&M TR03]. In fact, each year, the Regulation determining the excise rates, and notably the extra excises for an employment fund and for the "Kyoto Fund", is repealed and replaced by a new one fixing the various rates for the next period. However, strictly speaking, one cannot consider these revisions as a repeal of the measure.

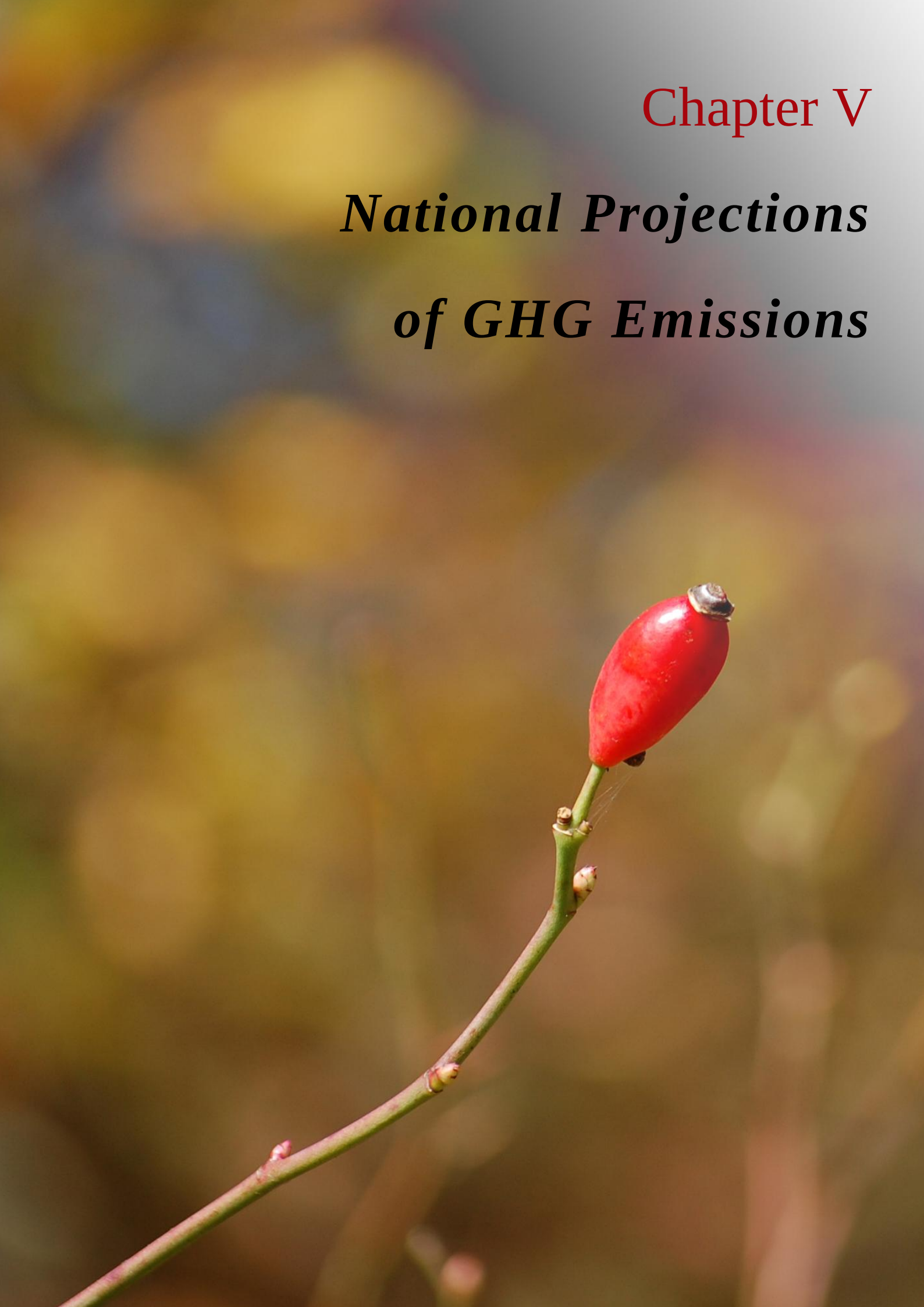
IV.3.6. Minimizing adverse effects of response measures

The following decisions take into account the minimization of adverse effects of P&Ms:

- the projects under CDM and JI should comply with the ecological and social criteria established in the framework of the approval procedures of the UNFCCC;
- promotion and tax exemption for biofuels is limited to fuels that meet ecological and social criteria. The conditions are set out in such a way that biofuels do not compete with food production and are not causing degradation of valuable ecosystems. In other terms, Luxembourg favours "second generation" biofuels;
- environmentally harmful subsidies and adverse incentives in the tax system are partially identified. The objective is a gradual elimination of such negative incentives. Fiscal deductions for commuting to work and the fiscal arrangements for company cars are two of such negative incentives. Tax exemptions for some "occupational" fuels, such as in agriculture, are another example of potential field of action.

Chapter V

National Projections of GHG Emissions



Chapter V discusses GHG projections up to 2020 for the 3 scenarios: without measures (BAU scenario), with existing measures (WEM scenario), and with additional measures (WAM scenario). After short preliminary comments *[→ Section V.1]*, as requested by paragraphs 42, 43 and 48 of the UNFCCC reporting guidelines, this chapter touches on the methodology underpinning the projections *[→ Section V.2]*. Then, results of the projection exercise are presented for a collection of sectors *[→ Section V.3]*. The projections are in line with most of the recommendations of the UNFCCC reporting guidelines, paragraphs 27 to 32 and 34 to 41, with the exception of paragraphs 32 – 2006 is the starting year rather than 2007 – and 36. Finally, after a brief discussion of possible improvements in the GHG projections methodology *[→ Section V.4]*, supplementarity relating to "flexible mechanisms" under Article 6, 12 and 17 of the Kyoto Protocol is discussed as required by paragraph 33 of the UNFCCC reporting guidelines *[→ Section V.5]*.

V.1. PRELIMINARY REMARKS: PROJECTIONS ASSOCIATED TO HIGH UNCERTAINTY

This Communication has already emphasizes specific national circumstances of Luxembourg on several occasions. In introduction to *Section IV.3* on the implemented, adopted and planned P&Ms, a few key remarks were formulated *[→ Section IV.1]*, which were setting the limits of a GHG projections exercise for Luxembourg. The two main points are:

- with more than 50% of total GHG emissions (excl. LULUCF), stemming from road transport, and almost 40% allocated to "road fuel exports", emissions structure is dominated by one sub-category – namely CRF 1A3b – for which the future evolution will not only depend on national P&Ms, but also (i) on the international context, such as road fuel prices and taxation in the neighbouring countries, (ii) on options chosen with regard to mobility at EU level and, especially, in the neighbouring countries or regions (limitation of trucks circulation, introduction of road use fees or changes in the toll policy, etc.) or (iii) on technological developments (electric or hybrid cars, fuel cells vehicles, higher energy efficient engines, etc.). There is, therefore, a **high uncertainty** for the projected emissions due to road transport for both the WEM and WAM scenarios.[219] These projections **take into account national P&Ms implemented, adopted or planned but do not include any hypothesis on the international context**;
- Luxembourg's and its economy sizes yield uncertainties in the projection since the opening, the closure or the breakdown of an industrial installation could have significant impacts on the total emissions, as the iron & steel move from blast furnaces to electric arc furnaces between 1994 and 1998 or the TWINerg power plant that started its operation in 2002 and faced technical problems in 2008 both demonstrate *[→ Section III.1]*.

[219] The WOM scenario includes general hypothesis on fuel prices and on the evolution of the average vehicles emissions per km in the coming years.

V.2. MODEL AND METHODOLOGY[220]

V.2.1. Overall approach

GHG projections for the year 2010, 2015 and 2020 have been performed at CRF category or sub-category levels so that it has been possible to fill in the *EmissionProjections* sheet of version 4.3 of the MMRT.[221] The only sector that has not been estimated is CRF 5 – LULUCF. Indeed, though Luxembourg has chosen to account for the activities under Article 3.3 of the Kyoto Protocol (afforestation, reforestation and deforestation) for the whole commitment period, so far, this option is not expected to contribute to the achievement of the burden sharing target of -28% that Luxembourg did commit itself to. This target would therefore be reached only by a combination of domestic P&Ms and the use of "flexible mechanisms" *[→ Section V.5]*.

Beginning 2009, the Department of the Environment financed the Belgian energy and environmental consultants' office ECONOTEC for preparing GHG projections to be reported under Article 3, paragraph 2, of Decision 280/2004/EC. Due to financial and time constraints, but also with the view of further developing an advanced modelling and scenario tool for GHG projections,[222] the contract with ECONOTEC was **limited to CO_2 projections in CRF sectors 1 and 2** [ECONOTEC Consultants (2009a)]. In the 2009 autumn, for the preparation of the fifth National Communication, these **projections have been revised**, mainly to **take into account the effects of the 2008-2009 financial and economic crises** [ECONOTEC Consultants (2009b)]. The two studies by ECONOTEC – written in French – are available upon request.

For the remaining emission sources (CO_2 emissions in CRF sectors 3, 4 and 6; CH_4, N_2O and F-gases emissions in all sectors), assumptions were made by the Department of the Environment. A colour coding has been used in the *EmissionsProjections* sheet of the MMRT in order to distinguish between the two "sets" of projections:

- **RED** – ECONOTEC's study projections (incl. correction for the correspondence between ECONOTEC's and 2009v1.4 submission 2006 emission estimates: cf *Section V.2.2*);
- **BLUE** – Department of the Environment assumptions.

Though the latest GHG inventory – submission 2009v1.4[223] – includes data on emissions for the year 2007, **the starting historical year for the projections is 2006**. This stems from two reasons:

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220 This section of the NC5 covers section V.D of the Outline and General Structure of the NC5 according to IPCC reporting guidelines (para. 5).

221 It is recalled that the MMRT file is available on request.

222 These developments are planned for the 2010-2011 period.

223 Available at: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/lux_2009_crf_19may.zip.

- ECONOTEC prepared the projections on the basis of the scenario developed in the second half of 2008 to fulfil reporting obligations associated with Directive 2001/81/EC on National Emission Ceilings for certain atmospheric pollutants [ECONOTEC Consultants (2008)]. As base year, this scenario was using the historical reported year 2006;
- most of the estimated GHG reduction potentials are based on Luxembourg's NEEAP, which was developed according to Directive 2006/32/EC and issued end February 2008 [Ministry of Economic Affairs and External Trade (2008)]. In the NEEAP, 2006 is the starting year for energy reduction potentials up to 2016.

In 2006, CO_2 emissions represented 92.05% of the total GHG emissions (excl. LULUCF). Energy related CO_2 emissions accounted for 86.67% of the total GHG emissions (excl. LULUCF). This percentage was 5.28% for industrial processes *[→ Tables III.1-2 & III.1-3]*. Hence, **ECONOTEC's projections cover almost 92% of the total 2006 GHG emissions** (excl. LULUCF).

Finally, the projections **for the year 2010 are annual projections and not an average** for the Kyoto commitment period 2008-2012.

V.2.2. Baseline scenario (WOM): CO_2 emission projections in CRF sectors 1 & 2

Source: ECONOTEC's final reports for the Department of the Environment of 20 May 2009 and 18 December 2009 [ECONOTEC Consultants (2009a) & (2009b)].

Coverage: CO_2 emissions in CRF categories and sub-categories 1A1 to 1A4, 2A-D.

Historical data used: submission 2009v1.4 of 15 May 2009 to both the EC and the UNFCCC.[224] For CRF sub-categories 1A4a & 1A4b, the data reported in the MMRT differ from those in the CRF tables. Indeed, in the latter, due to limitations in the energy balance for Luxembourg, energy consumption is broken down around 50-50 between these two sub-categories. However, for the projections, use was made of a study [Goblet Lavandier & Associés (2006)], which shows that almost ¾ of that consumption could be attributed to the residential sector (CRF 1A4b). Consequently, to stay consistent with the inventory, the remaining 25% go to the commercial/institutional sector.

Reference/starting year for the projections: 2006 *[→ Section V.2.1]*.

Adjustments: the Department of the Environment performed an adjustment to ECONOTEC's study projections so that emission estimates for 2006 correspond to those of submission 2009v1.4: historical emission levels in ECONOTEC's tables have been replaced by submission 2009v1.4 corresponding amounts where relevant, and projections have been adjusted so to allow

[224] The reported has been acknowledged on 19 May 2009 by UNFCCC Secretariat: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/lux_2009_crf_19may.zip.

consistency and comparability. The correction factor applied to projections is a simple rule of three:

$$corrected\ projection = 2009v1.4\ value_{2006}\ x\ [projected\ value_i / historical\ value_{2006}].$$

with i= 2010, 2015 or 2020 and values into brackets = CO_2 projections from the ECONOTEC study

Modelling tool: ECONOTEC used its own model – called EPM[225] – to carry out the projections. This model is presented in detail in ***Section V.2.4***.

Detailed assumptions for CO_2 emissions projections

The method for estimating GHG emission levels up to 2020 is making use of information on demographic, transport and housing developments in Luxembourg. Assumptions on future physical production in the various energy and industrial sectors are another input for the EPM. But, **neither GDP growth nor carbon or energy prices have been taken into account while preparing the projections**. For the latter, this is the result of the financial and time constraints indicated above. For GDP, there are obvious reasons for not considering it implicitly in the projection exercise: firstly, a great share of the industrial production in Luxembourg is exported (small internal market, most of the big industrial installations are subsidiaries of foreign business concerns) and, secondly, road freight transport, that is definitively correlated to GDP, is actually more correlated to an aggregated GDP for various EU Member States than to the GDP of Luxembourg since its emissions are principally due to traffic in transit. Consequently, without explicit use of either GDP or energy and carbon prices, no sensitivity analysis stricto sensu could have been performed so far on the projections *[→ Section V.3.8]*.

As presented in ***Sections IV.3.2 to IV.3.4***, P&Ms reduction potentials with regard to CO_2 are mainly coming from FiFo-Köln, which derived them from the NEEAP.[226] Exceptions are *[→ Tables IV.3-2 & IV.3-3]*:

a) P&M TR03: estimation by the *Finanzwissenschaftliches Forschungsinstitut an der Universität zu Köln – FiFo-Köln* – on the basis of a study of Thöne (2008);
b) P&M TR04: estimation made by ECONOTEC (2% biofuels in road fuels in 2010, 2015, 2020);
c) P&M TR12: estimation made by ECONOTEC (7% biofuels in road fuels in 2015 and 10% in 2020).

Table V.2-1 summarizes the specific assumptions for each of the CRF (sub-)categories included in ECONOTEC's study. Details are provided in ECONOTEC (2009a) and (2009b).

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225 EPM stands for "Energy/Emissions Projection Model". Some explanations are available on ECONOTEC's website: http://www.econotec.be/prod_index.htm and in Section V.2.4.

226 FiFo-Köln produced these CO_2 reduction potentials on the basis of the NEEAP while preparing Luxembourg's 2007 projection report [Ministry of the Environment (2009a)].

TABLE V.2-1 – MAIN ASSUMPTIONS FOR CO_2 PROJECTIONS IN CRF SECTORS 1 AND 2 IN THE ECONOTEC STUDY FOR THE BASELINE SCENARIO (WOM)

CRF (sub-)category	Projection assumptions
1A1a	**TWINerg power plant** - 2010: emission permits allocation presented in the 2008-2012 NAP [Ministry of the Environment (2006a)], other years = 2010 emissions level; **CHP installations** - 2010: EPM estimate, other years = 2010 emissions level; **municipal solid waste incinerator with energy recovery** - no estimation: 2010/15/20 = 2006 emissions level.
1A2a	2010: emission permits allocation presented in the 2008-2012 NAP, other years = 2010 emissions level multiplied by an annual factor of 1.005 (i.e. 0.5% production yearly growth & unchanged EFs).
1A2b	**aluminium plants** - 2010: EPM estimate, other years = 2010 emissions level; **secondary copper production** - no estimation: 2010/15/20 = 2006 emissions level.
1A2c	**ETS installations** - 2010: emission permits allocation presented in the 2008-2012 NAP, other years = 2010 emissions level; **non-ETS installations** - 2010: EPM estimate, other years = 2010 emissions level.
1A2f	**cement** - 2010 estimate based on discussions with the company on its expected future development (ad hoc data – expert judgment), other years = 2011 emissions level – 12.5% higher than the 2010 level – multiplied by an annual factor of 1.005 (i.e. 0.5% production yearly growth & unchanged EFs); **flat glass production** - 2010: emission permits allocation presented in the 2008-2012 NAP, other years = 2010 emissions level multiplied by an annual factor of 1.005 (i.e. 0.5% production yearly growth & unchanged EFs); **wood & plywood panels** - 2010: EPM estimate, other years = 2010 emissions level; **non-ETS installations** - EPM estimates based on a yearly activity growth rate of 3.5% combined with an energy combustion reduction per unit produced of 0.5% per year.[227]
1A3a	no estimation: 2010/15/20 = 2006 emission level.
1A3b	EPM combining (i) hypothesis on future demand of road fuels according to fuel prices (price-elasticities), (ii) mobility developments, and (iii) expected changes in vehicles CO_2 emissions (technologies) and 'fuel mix' shares (diesel vs. gasoline).
1A3c	no estimation: 2010/15/20 = 2006 emission level.
1A3d	no estimation: 2010/15/20 = 2006 emission level.
1A4a	EPM combining (i) estimates based on an energy consumption growth rate of 6.5% over the period 2006-2020, and (ii) on constant market shares for the different fuels all over the period 2006-2020.
1A4b	EPM combining (i) estimates based on an energy consumption growth of 4.5% over the period 2006-2020, corrected for an increasing penetration of natural gas as heating fuel (hypothesis of a 10% market share increase between 2006 and 2020), which limits the emissions growth over the same time span at 1.4%, and (ii) on hypothesis on the number of available accommodations up to 2020.
1A4c	no estimation: 2010/15/20 = 2006 emissions level.
2A1	2010 estimate based on discussions with the company on its expected future development (ad hoc data – expert judgment), other years = 2011 emissions level – 12.5% higher than the 2010 level – multiplied by an annual factor of 1.005 (i.e. 0.5% production yearly growth & unchanged EFs).
2A7	2010: emission permits allocation presented in the 2008-2012 NAP, other years = 2010 emissions level multiplied by an annual factor of 1.005 (i.e. 0.5% production yearly growth & unchanged EFs).
2C1	2010: emission permits allocation presented in the 2008-2012 NAP, other years = 2010 emissions level multiplied by an annual factor of 1.005 (i.e. 0.5% production yearly growth & unchanged EFs).

[227] For some small production units, the 2010/15/20 emission projections = 2006 emission level.

V.2.3. Baseline scenario (WOM): CO_2 emissions projections in CRF sectors 3, 4 & 6 and projections for non-CO_2 GHG

Source: Department of the Environment.

Coverage: CO_2 emissions in CRF categories & sub-categories 1A1 to 1A4, 2A-D, other GHG emissions in all CRF sectors but 5 - LULUCF.

Historical data used: submission 2009v1.4 of 15 May 2009 to both the EC and the UNFCCC.[228]

Reference/starting year for the projections: 2006 to keep consistency with the ECONOTEC study.

Adjustments: not applicable.

Modelling tool: not applicable.

Detailed assumptions for non-CO_2 emissions and CRF sectors 3 to 6 projections

For those CRF (sub-)categories for which CO_2 emissions have been estimated in the ECONOTEC study, use was made of simple ratios for completing the projections with non-CO_2 GHG.

For CRF sectors 3 to 6 very simple methods have been used, since they represented less than 8% of the total GHG emissions in 2006 (excl. LULUCF).

Table V.2-2 summarizes the specific assumptions made by the MDDI-DEV in order to complete ECONOTEC's results.

TABLE V.2-2 – MAIN ASSUMPTIONS FOR GASES AND EMISSION SOURCES NOT COVERED BY THE ECONOTEC STUDY FOR THE BASELINE SCENARIO (WOM)

CRF (sub-)category	2006 share in total GHG emissions, excl. LULUCF	Projection assumptions
1A1a	NA (ECONOTEC)	average ratio CH_4 or N_2O/CO_2 for the last 6 historical years (2002-2007), i.e. since the TWINerg power plant started its operations.
1A2a	NA (ECONOTEC)	ratios CH_4 or N_2O/CO_2 for the last 5 historical years (2003-2007), which are constant.
1A2b	NA (ECONOTEC)	ratios CH_4 or N_2O/CO_2 for the last 5 historical years (2003-2007), which are constant.
1A2c	NA (ECONOTEC)	ratios CH_4 or N_2O/CO_2 for the last 5 historical years (2003-2007), which are constant.
1A2f	NA (ECONOTEC)	average ratio CH_4 or N_2O/CO_2 for the last 5 historical years (2003-2007).
1A3a	NA (ECONOTEC)	no estimation for CH_4 and N_2O: 2010/15/20 = 2006 level.
1A3b	NA (ECONOTEC)	CH_4: the CH_4/CO_2 ratio shows a decreasing trend between 1990 and 2007. If this trend is continued, it would reach 0.05% by 2010 and 0% by 2015 (standard regression with OLS). As working hypothesis, ratio values of 0.1% in 2010 and 0.005% for the subsequent years have been used to project CH_4

[228] The reported has been acknowledged on 19 May 2009 by UNFCCC Secretariat: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/lux_2009_crf_19may.zip..

		emissions; N_2O: during the last year, the N_2O/CO_2 ratio stabilizes around 1.5%. As working hypothesis, we used this % for the projections.
1A3c	NA (ECONOTEC)	no estimation for CH_4 and N_2O: 2010/15/20 = 2006 level.
1A3d	NA (ECONOTEC)	no estimation for CH_4 and N_2O: 2010/15/20 = 2006 level.
1A4a	NA (ECONOTEC)	average ratio CH_4 or N_2O/CO_2 for the last 5 historical years (2003-2007).
1A4b	NA (ECONOTEC)	average ratio CH_4 or N_2O/CO_2 for the last 5 historical years (2003-2007).
1A4c	NA (ECONOTEC)	no estimation for CH_4 & N_2O: 2010/15/20 = 2006 level.
1A5	-	this sub-category is more a "statistical error" entry in the inventory than a proper GHG source: amounts are the result of statistical discrepancies obtained when combining bottom-up and top-down energy data. Hence, it has not been attempted to produce GHG projections for that sub-category.
1B2b	0.39%	no estimation for CO_2 & CH_4: 2010/15/20 = 2006 level.
2A1	NA (ECONOTEC)	CH_4 & N_2O are not occurring.
2A7	NA (ECONOTEC)	CH_4 & N_2O are not occurring.
2C1	NA (ECONOTEC)	CH_4 & N_2O are not occurring or are not applicable.
2F	0.70%	2F1/2/4: use of population estimates in 2010/15/20: $emissions_i = (emissions_{2006} / Pop_{2006}) \times Pop_i$ with i = 2010, 2015 or 2020 2F7/8: use of the average annual growth rate over the last 5 historical years (2003-2007), i.e. 1.395% per year.
3A	0.02%	CO_2: historical emissions stabilized around 3 Gg during the last years: this value of 3 Gg has been used for the projections.
3B	0.03%	CO_2: historical emissions stabilized around 3.5 Gg during the last years: this value of 3.5 Gg has been used for the projections.
3C	0.01%	CO_2: historical emissions stabilized around 1.7 Gg during the last years: this value of 1.7 Gg has been used for the projections.
3D	0.08%	CO_2 – 3D5: historical emissions show an increasing trend. If this trend is continued, it would reach 4.5 Gg by 2010, 4.6 Gg by 2015 and 4.7 Gg (standard regression with OLS); N_2O – 3D1: use of population estimates in 2010/15/20: $emissions_i = (emissions_{2006} / Pop_{2006}) \times Pop_i$ with i = 2010, 2015 or 2020
4A	1.91%	CH_4: the average mean over 5 periods (5 years) is around 245 Gg: this value of 245 Gg CH_4 has been used for the projections.
4B	0.96%	CH_4: the average mean over 5 periods (5 years) is around 105 Gg: this value of 105 Gg CH_4 has been used for the projections; N_2O: the average mean over 5 periods (5 years) is around 25 Gg: this value of 25 Gg N_2O has been used for the projections.
4D	2.63%	N_2O: emissions from this source category were around 400Gg in the early 90s and eventually dropped to about 340Gg around 2005. As working hypothesis, a value of 350 Gg N_2O has been used for the projections.
6A	0.19%	CH_4: use of population estimates in 2010/15/20: $emissions_i = (emissions_{2006} / Pop_{2006}) \times Pop_i$ with i = 2010, 2015 or 2020
6B	0.12%	**industrial wastewater handling** - no estimation for CO_2 & CH_4: 2010/15/20 = 2006 level; **domestic & commercial wastewater handling** - CH_4& N_2O: use of population estimates in 2010/15/20: $emissions_i = (emissions_{2006} / Pop_{2006}) \times Pop_i$ with i = 2010, 2015 or 2020

6D	0.11%	CH_4: emissions caped around 7 Gg during the last historical years: this value of 7 Gg CH_4 has been used for the projections; N_2O: emissions caped around 8 Gg during the last historical years: this value of 8 Gg N_2O has been used for the projections.

V.2.4. The EPM model - a "bottom-up" simulation model[229]

EPM (Energy/Emissions Projection Model) is a projection model for energy demand and atmospheric emissions – CO_2, CH_4, N_2O, SO_2, NOx, and VOCs – that covers all relevant emission sectors (energy sector, industry, residential, commercial, transport). It has been developed progressively by ECONOTEC since 1993 in the framework of a number of studies carried out for public authorities, whether at regional or at national level.

Given the heterogeneity of some industrial sectors or of the residential sector, in order to realize a good prediction, it is necessary to take into account internal structural effects within these sectors. Therefore, EPM is capable to count for differences in sub-sectors or production processes developments over time when these sub-sectors have different levels of specific consumptions.

EPM is a **techno-economic simulation model**, of the "**bottom-up**" type, i.e. explaining energy consumptions and GHG emissions from activity variables expressed as far as possible in physical units, and containing a detailed representation of a range of emission sources and of the main determining factors that influence the evolution of energy demand and of the various types of emissions.

This methodological option is based on the observation that there are no simple and homogeneous relationships between aggregated macroeconomic variables expressed in monetary value and actual energy consumption.

EPM also includes a techno-economic database on measures aiming at reducing energy use and emissions – i.e. PaMs in the context of GHG mitigation actions. It is used in particular for:

- the construction of a reference or BAU scenario, representing the probable future developments in the absence of any new emission reduction policy;
- evaluating economic potentials for emissions reduction;
- constructing emission reduction scenarios taking into account a set of reduction measures with a marginal cost below a given threshold;
- constructing cost curves, providing either the marginal or the total cost as a function of the level of emission or energy consumption reduction;

[229] The description of the EPM model comes from various reports published by ECONOTEC, and principally from ECONOTEC Consultants & VITO (2005).

- assessing the impact of existing or draft legislations on energy consumptions, emission levels and costs.

The BAU scenario is defined on the basis of energy consumption levels for a reference year (corrected for yearly climatic variations) as well as on a set of hypothesis on the evolution of activity variables, on the development of specific consumption and market shares of various energy sources and on emission factors. Two emission categories are considered: emissions linked to energy consumption and "process" emissions.

In the context of the study ECONOTEC made for the Department of the Environment, the reference year is 2006 *[→ Section V.2.1]* and, due to financial and time constraints, with the exception of the transport sector (cf below), solely the construction of a reference or BAU scenario has been undertaken. Regarding the P&Ms, reduction potentials with regard to CO_2 are mainly coming from FiFo-Köln, which derived them from the NEEAP *[→ Section V.2.2]*.

In the EPM, **industry** is usually represented by about a hundred activity variables (pig iron production, oxygen steel production, ethylene production, clinker production, flat glass production…). The large energy consumption branches are modelled in a more detailed way than the others. For example, iron & steel production is analyzed per installation type (agglomeration, blast furnace, oxygen steel production, etc.) and for the chemical industry, about twenty basic products are distinguished. Such details, however, are not necessary for Luxembourg where the industrial sector comprises only 25 to 30 main emitting installations (or "large point sources") and where, in the steel industry, e.g., a limited number of processes – in this case, electric arc furnaces – are present.

For the **residential sector**, EPM usually considers existing and new houses, existing and new apartments (electric and non electric heated), domestic water heating and 10 specific uses of electricity (cooking, refrigerators, washing machines, dryers, etc.). The heat load is estimated using a separate module made of 14 type-dwellings. In this module, energy consumptions are calculated taking into account the respective performances of 15 heat production, distribution or emission systems.

In the **tertiary sector**, about 30 sub-sectors are grouped into 8 categories, and 5 energy uses are distinguished (heating, ventilation, cooling, lighting and other electric uses). The activity variable is the floor area of the buildings.

In the **transportation sector**, the distinction is made between road transportation of persons, road transportation of goods, rail transportation and inland water transportation. For road transportation, the modelling is carried out in a separate module calculating emission levels as a function of the average specific energy consumptions of vehicles at the time of their first use and taking into account (European) regulations on polluting emissions applicable at that time.

Nevertheless, it is important to stress the fact that EPM is not an "off-the-shelf" model but rather a flexible tool that is adapted each time to reflect the available background information as well as the objectives that are pursued by the use of the model. Consequently, for Luxembourg, the model version was not as detailed as it is described above for the different sectors: assumptions made for the BAU scenario are presented in ECONOTEC Consultants (2009a).

For more details on the EPM model in general, and on results it can provide as well as on analytic possibilities it offers, refer to ECONOTEC Consultants (2000), ECONOTEC Consultants (2002) and ECONOTEC Consultants & VITO (2005).

V.2.5. Synthesis of the projection exercise for GHG emissions in Luxembourg

This section recapitulates the different points discussed in previous sections with regard to the particular projection exercise completed for this fifth National Communication.

Step 1

For each source category, fuel consumptions have been aggregated for the reference year 2006. The source category considered here are those covered by ECONOTEC in its study for the Department of the Environment, i.e. (sub-)categories and installations pertaining to CRF sectors 1 and 2. Tables in annex to the two ECONOTEC reports [ECONOTEC Consultants (2009a) & (2009b)] list the various (sub-)categories and installations for which emission projections have been calculated.

Step 2

For each source category, future total energy consumptions have been estimated by applying to the 2006 data the expected evolutions of the activity variable and of the specific source category consumption. The specific source category consumption evolution takes on board anticipated technical developments as well as the replenishment of the production installations, which both lead logically to a reduction of this specific consumption through time, even without any particular P&Ms implemented. These activity variable and specific consumption evolutions are exogenous and are expressed either in annual average growth rates (in percentages) for a given period of time or based on level assumptions for a certain year *[→ Tables V.2-1]*.

For the iron and steel industry, the glass production as well as for some power generation and chemicals installations, projected 2010 emissions corresponds to the emission permits allocation presented in the 2008-2012 (second) NAP [Ministry of the Environment (2006a)] and for the other years to emissions levels taking into account a flat or a 0.5% yearly growth, according to the (sub-)category *[→ Tables V.2-1]*.

Step 3

For each source category, future consumption by fuel type has been obtained by applying "market shares" to the future total energy consumption obtained at step 2. These "market shares" are also exogenous variables, which are specific to each source category. The EPM model uses, as a default, the reference year – i.e. 2006 – "market shares".

Step 4

For each source category, and each fuel type, emissions have been obtained by multiplying the consumption levels by the corresponding EFs.

This step is the final one for the reference or BAU scenario projections, i.e. the WOM scenario.

Step 5

For the WEM and WAM scenarios, the anticipated effects of the P&Ms have been applied to the WOM projections. The mitigation potentials of the P&Ms are mostly coming from FiFo-Köln, which derived them from the NEEAP *[→ Section V.2.2]*.

Step 6

Steps 1 to 5 have been performed by ECONOTEC. However, the Department of the Environment performed an adjustment. 2006 emissions levels in ECONOTEC's tables have been replaced by submission 2009v1.4 corresponding amounts where relevant, and projections have been adjusted so to allow consistency and comparability. The correction factor applied to projections is a simple rule of three:

$$corrected\ projection = 2009v1.4\ value_{2006} \times [projected\ value_i / historical\ value_{2006}].$$

with i= 2010, 2015 or 2020 and values into brackets = CO_2 projections from the ECONOTEC study

The projections in the 3 scenarios have then been adapted accordingly.

Step 7

ECONOTEC projections covering only a subset of the emission source categories, the Department of the Environment produced the missing projections – CH_4 and N_2O, CRF sectors 3, 4 & 6 and (sub-)categories 1A2b & 2F – using basic assumptions and simple methods. Indeed, the sources not covered by ECONOTEC represented only 8% of the total 2006 GHG emissions of Luxembourg (excl. LULUCF) *[→ Tables V.2-2]*.

V.3. PROJECTIONS[230]

Detailed projections results are available in the MMRT (*EmissionsProjections* sheet).[231] Consequently, this chapter only presents the projections in an aggregated way and in CO_2e.

For the presentation of the results, the following CRF sectors, categories and sub-categories are distinguished:

- "power generation" (1A1a) – including waste incineration;
- "industry" (1A2+2A+2C1);
- "road transportation" (1A3b);
- "residential, commercial and institutional sectors" (1A4a+1A4b);
- "agriculture" (1A4c+4);
- "other miscellaneous sources" (1A3a+1A3c+1A3d+1A5+1B2b+2F+3+6).

Historical data in the following tables and graphs (1990 to 2007) are extracted from the GHG inventory, submission 2009v1.4 of 15 May 2009.[232] 2008 estimates are "nowcasts" produced by the Department of the Environment during the 2009 summer *[→ Section III.1 & Box III.1-1]*. Projected emissions are estimated on the basis of the year 2006 *[→ Section V.2.1]*.

In *Tables V.3-1 to V.3-7*, data are presented both in 1000 tonnes of CO_2e (Gg) and in indices (with 1990 being equal to 100). The three scenarios – **WOM**, **WEM** & **WAM** – are presented for the projected years. *Figures V.3-1 to V.3-7* are limited to indices with 1990=100.

V.3.1. Power generation (1A1a)

TABLE V.3-1 – HISTORICAL AND PROJECTED EMISSIONS FOR THE POWER GENERATION SECTOR

Gg (1000 t.) CO_2 equivalent	CRF Categories	1990	1995	2000	2005	2006	2007	2008prov	2010	2015	2020
Power generation	*1A1a*	1301.82	835.43	188.84	1456.83	1526.88	1362.66	1144.02	1619.22	1619.22	1619.22
										WEM ↓	
									1619.22	1619.22	1619.22
										WAM ↓	
									1619.22	1619.22	1619.22
		100.00	64.17	14.51	111.91	117.29	104.67	87.88	124.38	124.38	124.38
										WEM ↓	
									124.38	124.38	124.38
										WAM ↓	
									124.38	124.38	124.38

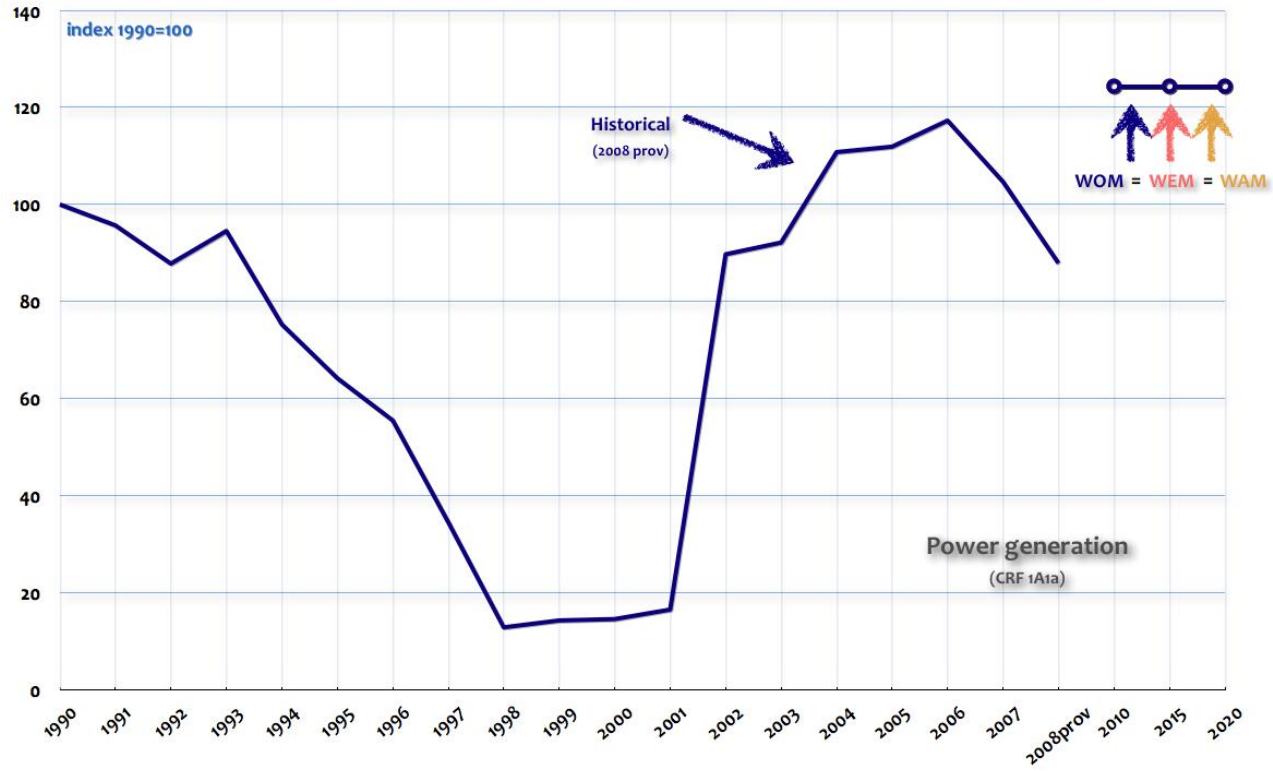
Source: Department of the Environment.

230 This section of the NC5 covers sections V.A, V.B and parts of V.D not discussed in Section V.2 of the Outline and General Structure of the NC5 according to IPCC reporting guidelines (para. 5).

231 Detailed projections are also available in ECONOTEC Consultants (2009b). However they do not cover the full spectrum of requested data and have been corrected by the Department of the Environment to reflect the latest GHG inventory submission (cf previous section).

232 Available at: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/lux_2009_crf_19may.zip.

FIGURE V.3-1 – HISTORICAL AND PROJECTED EMISSIONS FOR THE POWER GENERATION SECTOR



Source: Department of the Environment.

Projected emissions are identical for the three scenarios. Indeed, the P&Ms that might impact this sector are either embedded in the WOM scenario *[→ P&M IN01 on the EU-ETS 2008-2012]* or not estimated *[→ P&M IN03 & IN11]* ***[→ Tables IV.3-2 & IV.3-3]***. The 2010 projected CO_2 emissions in the WOM scenario are either based on the EU-ETS 2008-2012 allocation[233] for the TWINerg or on an extension of the 2006 emissions for waste incineration or on the EPM results for the other installations ***[→ Table V.2-1]***. For 2015 and 2020, the 2010 estimates have been reproduced. The rationale behind this hypothesis is that the development of further CHP installations using fossil fuels or natural gas is not favourable to Luxembourg with regard to the accounting of GHG emissions in inventories ***[→ Sections II.12.3, II.12.4 & IV.3.1.3]***.

233 Thatis to say, coming from the 2nd NAP [Ministry of the Environment (2006a)].

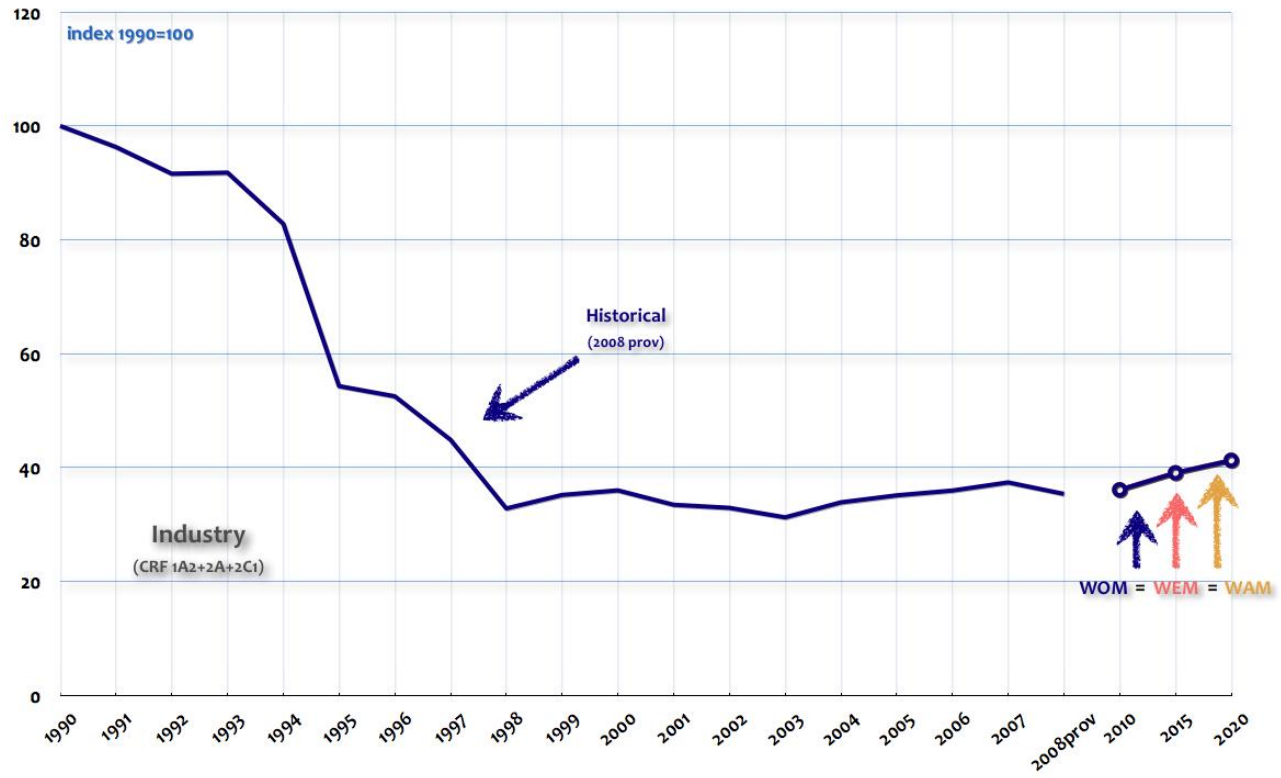
V.3.2. Industry (1A2+2A+2C1)

TABLE V.3-2 – HISTORICAL AND PROJECTED EMISSIONS FOR THE INDUSTRY SECTOR

Gg (1000 t.) CO_2 equivalent	CRF Categories	1990	1995	2000	2005	2006	2007	2008prov	2010	2015	2020
Industry	1A2	6719.85	3648.93	2418.18	2359.25	2416.17	2512.01	2376.23	2424.75	2625.34	2772.76
	2A									WEM ↓	
	2C1								2424.75	2625.34	2772.76
										WAM ↓	
									2424.75	2625.34	2772.76
		100.00	54.30	35.99	35.11	35.96	37.38	35.36	36.08	39.07	41.26
										WEM ↓	
									36.08	39.07	41.26
										WAM ↓	
									36.08	39.07	41.26

Source: Department of the Environment.

FIGURE V.3-2 – HISTORICAL AND PROJECTED EMISSIONS FOR THE INDUSTRY SECTOR



Source: Department of the Environment.

As for power generation, projected emissions are identical for the three scenarios since the P&Ms targeted to the industrial sector are either embedded in the WOM scenario *[→ P&M IN01 on the EU-ETS 2008-2012]* or not estimated *[→ P&M IN02, IN03 & IN11]* ***[→ Tables IV.3-2 & IV.3-3]***.[234] The projected emissions in the WOM scenario are based on various hypotheses that, for CO_2, combine the EU-ETS 2008-2012 allocations and the EPM results ***[→ Table V.2-1]***.

234 For IN02, without any insurance that the agreement between the FEDIL and the Government will be prolonged after 2010 – a year that could not have been estimated with regard to the P&M impact – the conservative hypothesis of a zero-gain in GHG mitigation has been chosen.

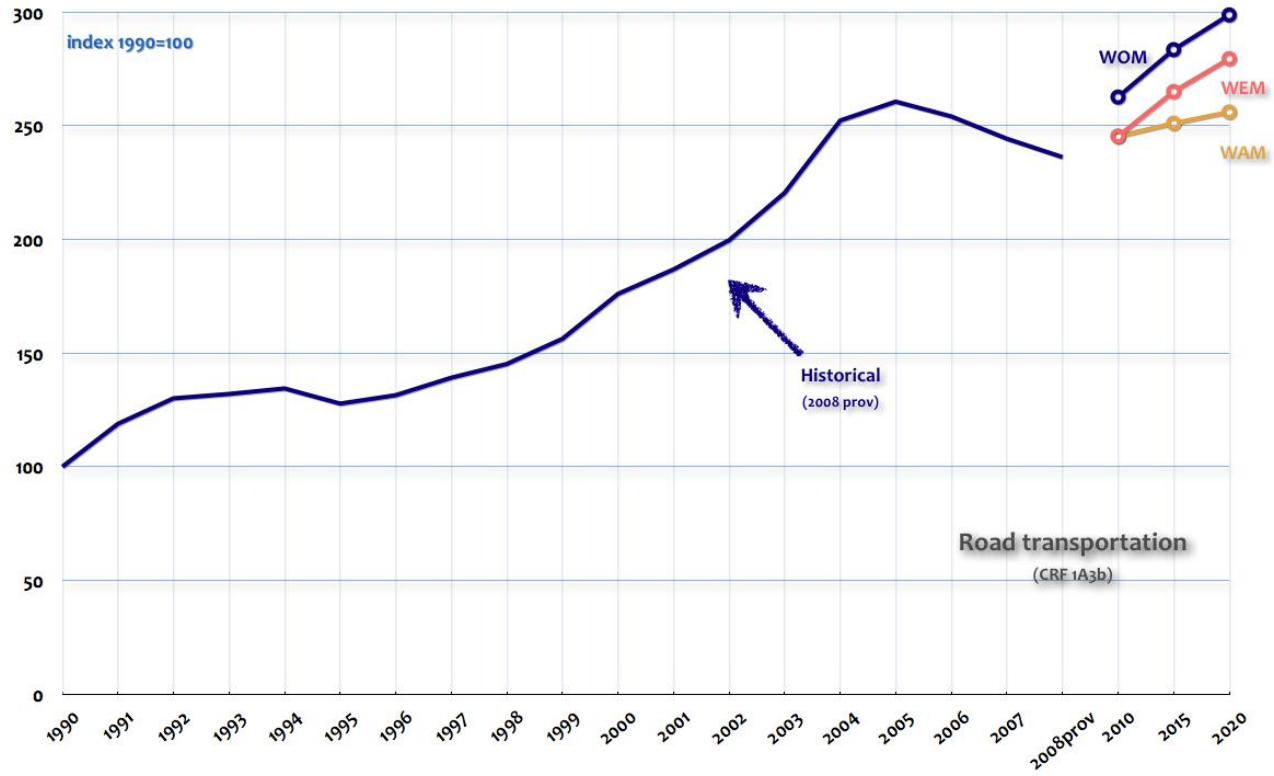
V.3.3. Road transportation (1A3b)

TABLE V.3-3 – HISTORICAL AND PROJECTED EMISSIONS FOR THE ROAD TRANSPORTATION SECTOR

Gg (1000 t.) CO_2 equivalent	CRF Categories	1990	1995	2000	2005	2006	2007	2008prov	2010	2015	2020
Road transportation	*1A3b*	2734.93	3494.23	4813.93	7127.13	6948.64	6680.50	6459.31	7181.64	7751.86	8169.88
										WEM ↓	
									6710.72	7247.67	7643.65
										WAM ↓	
									6710.72	6867.87	7002.87
		100.00	127.76	176.02	260.60	254.07	244.27	236.18	262.59	283.44	298.72
										WEM ↓	
									245.37	265.00	279.48
										WAM ↓	
									245.37	251.12	256.05

Source: Department of the Environment.

FIGURE V.3-3 – HISTORICAL AND PROJECTED EMISSIONS FOR THE ROAD TRANSPORTATION SECTOR



Source: Department of the Environment.

For the road transportation sector, projected emissions have been obtained using, for CO_2, the EPM specific module and, for CH_4 and N_2O, simplistic assumptions from the Department of the Environment *[→ Tables V.2-1 & V.2-2]*. For the WEM scenario, the biggest mitigation potentials are anticipated for P&Ms TR03 and TR04 (excise duties and biofuels respectively): from 97% of the total expected reduction by P&Ms targeted to the transport sector in 2010 to 90% in 2020. This is not surprising since other transport related measures – vehicles taxation and the premiums for energy efficient cars *[→ P&Ms TR01 & TR02]* – are targeting the national vehicle fleet, which, as of today, is responsible of less than 14% of the total GHG emissions (excl. LULICF) against some 38% for "road fuel exports".

The further reduction triggered by additional measures is the result of P&M TR12 on the further use of biofuels. The other additional measures could not be estimated *[→ P&Ms TR11 & TR13]* *[→ Tables IV.3-2 & IV.3-3]*.

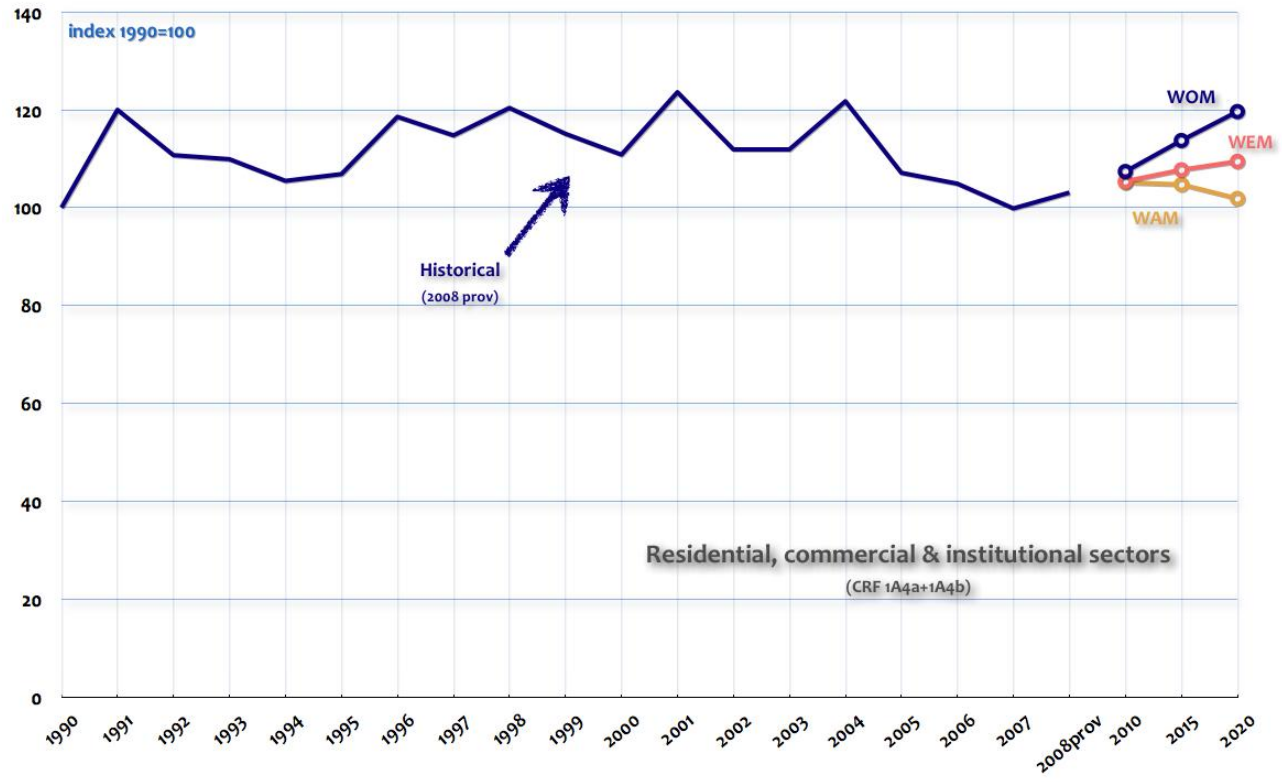
V.3.4. Residential, commercial and institutional sectors (1A4a+1A4b)

TABLE V.3-4 – HISTORICAL AND PROJECTED EMISSIONS FOR THE RESIDENTIAL, COMMERCIAL AND INSTITUTIONAL SECTORS

Gg (1000 t.) CO_2 equivalent	CRF Categories	1990	1995	2000	2005	2006	2007	2008prov	2010	2015	2020
Residential, commercial & institutional sectors	*1A4a* *1A4b*	1361.31	1454.74	1508.84	1458.22	1428.04	1359.20	1403.20	1461.73	1548.05	1628.55
										WEM ↓	
									1434.79	1466.56	1490.12
										WAM ↓	
									1431.26	1426.03	1387.01
		100.00	106.86	110.84	107.12	104.90	99.85	103.08	107.38	113.72	119.63
										WEM ↓	
									105.40	107.73	109.46
										WAM ↓	
									105.14	104.75	101.89

Source: Department of the Environment.

FIGURE V.3-4 – HISTORICAL AND PROJECTED EMISSIONS FOR THE RESIDENTIAL, COMMERCIAL AND INSTITUTIONAL SECTORS



Source: Department of the Environment.

For these sectors, CO_2 projections for the WOM scenario have been made using EPM and completed by simplistic assumptions made by the Department of the Environment for the other two GHG *[→ Tables V.2-1 & V.2-2]*. Most of the P&Ms identified are targeted toward the residential sector – look at all the measures whose ID starts with EC *[→ Tables IV.3-2 & IV.3-3]*.

As existing measures, the one for which the greater impacts are expected is clearly P&M EC03 setting new energy standards for new & existing buildings. Then, come all the P&Ms that are part

of the "PRIMe House" scheme *[→ P&Ms EC01a, EC01b, EC02 & EC04]*. The WAM scenario shows that the P&Ms should allow for a stabilisation of the emissions between 1.4 and 1.5 Mio. t CO_2e in the next decade.

Considering now the additional measures, a decrease in the emissions is even projected by 2020 compared to their level in 2010 by the WAM scenario. Continuations of the "PRIMe House" scheme after 2012, as well as the extension of regulatory practises for the non residential buildings, explain the declining trend that the WAM scenario anticipates.

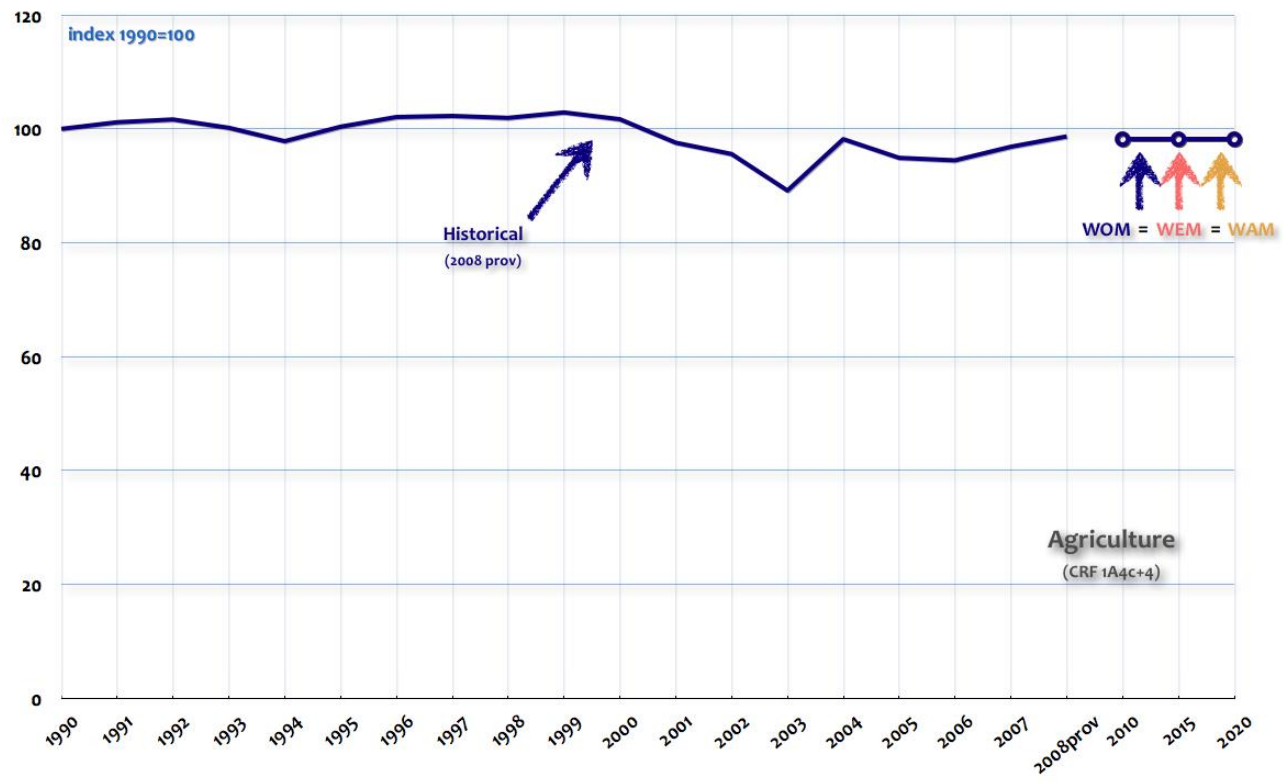
V.3.5. Agriculture (1A4c+4)

TABLE V.3-5 – HISTORICAL AND PROJECTED EMISSIONS FOR AGRICULTURE

Gg (1000 t.) CO_2 equivalent	CRF Categories	1990	1995	2000	2005	2006	2007	2008prov	2010	2015	2020
Agriculture	*1A4c 4*	792.05	795.12	805.50	751.77	748.32	767.24	781.60	777.78	777.78	777.78
										WEM ↓	
									777.78	777.78	777.78
										WAM ↓	
									777.78	777.78	777.78
		100.00	100.39	101.70	94.91	94.48	96.87	98.68	98.20	98.20	98.20
										WEM ↓	
									98.20	98.20	98.20
										WAM ↓	
									98.20	98.20	98.20

Source: Department of the Environment.

FIGURE V.3-5 – HISTORICAL AND PROJECTED EMISSIONS FOR AGRICULTURE



Source: Department of the Environment.

Projected emissions for agriculture related activities (combustion, animal husbandry, cultivation, and soils related emissions) have been estimated by the Department of the Environment using

basic assumptions *[→ Table V.2-2]* and kept constant over the period 2010-2020. As no P&Ms have been identified for agriculture, the three scenarios yield the same projected estimates.

V.3.6. Other miscellaneous sources (1A3a+1A3c+1A3d+1A5+1B2b+2F+3+6)

TABLE V.3-6 – HISTORICAL AND PROJECTED EMISSIONS FOR OTHER MISCELLANEOUS SOURCES

Gg (1000 t.) CO_2 equivalent	CRF Categories	1990	1995	2000	2005	2006	2007	2008prov	2010	2015	2020
Other miscellaneous sources	*1A3a/c/d*	207.84	161.51	235.85	237.52	235.96	231.90	229.90	230.62	239.09	247.35
										WEM ↓	
	1B2b								230.62	239.09	247.35
										WAM ↓	
	2F								230.62	239.09	247.35
	3	100.00	77.71	113.48	114.28	113.53	111.58	110.62	110.96	115.04	119.01
										WEM ↓	
	6								110.96	115.04	119.01
										WAM ↓	
									110.96	115.04	119.01

Source: Department of the Environment.

FIGURE V.3-6 – HISTORICAL AND PROJECTED EMISSIONS FOR OTHER MISCELLANEOUS SOURCES

Source: Department of the Environment.

Out of the various emission source categories grouped under this heading, the WOM scenario suggested increasing emissions over the period 2010-2020 for the CRF (sub-)categories 2F, 3, 6A and 6B (F-gases, solvents, landfill waste disposal and waste water handling). The projections were kept constant for the other sub-categories – 1A3a/c/d, 1B2b and 6D (domestic aviation, railways, inland navigation, fugitive emissions from natural gas distribution and composting). All the projections have been calculated on the basis of simple assumptions by the Department of the Environment *[→ Table V.2-2]*.

As no P&Ms have been identified for these miscellaneous sources, the three scenarios yield the same projected estimates.

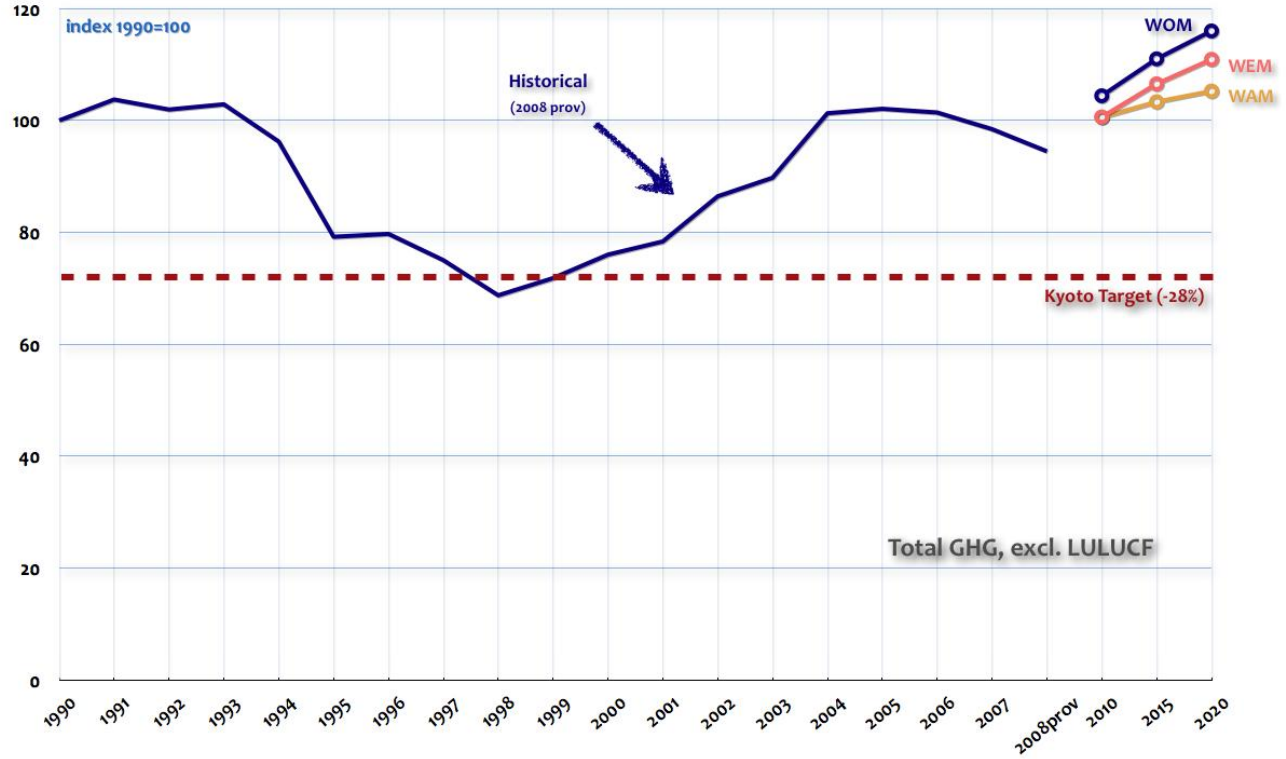
V.3.7. Total GHG, excl. LULUCF

TABLE V.3-7 – HISTORICAL AND PROJECTED EMISSIONS FOR TOTAL GHG, EXCL. LULUCF

Gg (1000 t.) CO_2 equivalent	CRF Categories	1990	1995	2000	2005	2006	2007	2008prov	2010	2015	2020
Total GHG, excl. LULUCF	1	13117.79	10389.96	9971.14	13390.71	13304.02	12913.52	12394.26	13695.75	14561.35	15215.55
	2									WEM ↓	
	3								13197.88	13975.65	14550.89
	4									WAM ↓	
	6								13194.36	13555.33	13807.00
		100.00	79.21	76.01	102.08	101.42	98.44	94.48	104.41	111.00	115.99
										WEM ↓	
									100.61	106.54	110.92
										WAM ↓	
									100.58	103.34	105.25

Source: Department of the Environment.

FIGURE V.3-7 – HISTORICAL AND PROJECTED EMISSIONS FOR TOTAL GHG, EXCL. LULUCF



Source: Department of the Environment.

Results of the projections exercise show that without P&Ms – BAU scenario – the emissions would be in 2020 16% higher than in 1990. The same percentage would reach 17.8% if the 2020 projected emissions are compared to the last historical year (i.e. 2007).

Existing measures would trigger CHG savings of about 497.9 kt CO_2e in 2010, 585.7 kt CO_2e in 2015 and 664.7 kt CO_2e in 2020. The additional measures would add 3.5 kt CO_2e in 2010, 420.3 kt CO_2e in 2015 and 743.9 kt CO_2e in 2020 to these savings. These reduction potentials differ from those indicated in *Tables IV.3-2 and IV.3-3* because the expected effects of P&Ms on CO_2

have been "extended" to the other GHG when the Department of the Environment estimated them. Indeed, since CH_4 and N_2O have mostly been estimated by using ratios over CO_2 *[→ Table V.2-2]* , the mitigation potential of a P&M has "automatically" been reported to these gases.

The WEM scenario yields 2020 emissions 10.9% higher than in 1990. The same percentage would reach 12.7% if the 2020 projected emissions are compared to the last historical year (i.e. 2007). For the WAM scenario, these percentages are respectively 5.3% and 6.9%.

With regard to the Kyoto Protocol emissions target, taking the year 2010 as reference for the commitment period, Luxembourg's GHG emissions would be 4.22 Mio. t CO_2e, 3.72 Mio. t CO_2e, and 3.71 Mio. t CO_2e too high for the WOM, WEM and WAM scenarios respectively; that is to say 32.6%, 28.8%, and 28.7% of the 2007 total GHG emissions (excl. LULUCF) – 34.0%, 30.0%, and 29.9% of the 2008 "nowcasted" total GHG emissions *[→ Section V.5]*.

V.3.8. Sensitivity analysis

It is not straightforward to produce a sensitivity analysis for the projections. Indeed, such an exercise is made **complex by the extremely high sensitivity of the projections to internal or external parameters**. Luxembourg is a small country and economy where, for instance, a single industrial project – internal parameter – or changes in relative road pricing or VAT differences compared to neighbouring countries – external parameters – could strongly influences the projected emissions.

Thus, if a large company discontinues its activities or a new one settles in Luxembourg, that could have significant impact on the GHG emissions, hence on their projections. The same holds if the Government decides to build a second gas and heat plant or if it chooses to stop subsidizing combined heat-power plant running either on fossil fuels or natural gas. In industry, changes in processes in existing units could also lead to noticeable changes in the emissions (if, for instance, the steel industry decides to use old tyres as a facilitating product for melting iron scrap in electrical arc furnaces instead of anthracite e.g., emission factors might change in such a way that projections could be severely impacted) *[→ Sections II.12.2, III.1.1 & IV.3.1.4]*.

For external parameters, changes in the policy of a neighbouring country might have a strong impact on national GHG emissions since "road fuel exports" is responsible of about 38% of the total GHG emissions (excl. LULUCF) in Luxembourg *[→ Sections II.8.2, III.1.1 & IV.3.1.2]*.

However, we have tried to evaluate uncertainties of the projections for each of the GHG source categories analyzed in the WOM, WEM and WAM scenarios *[→ Table V.3-8]*. It is not, strictly speaking, a sensitivity analysis but it gives, at least, an indication of the level of confidence for these projections.

TABLE V.3-8 – LEVEL OF UNCERTAINTY OF THE PROJECTIONS

Source category	WOM	WEM	WAM
Power generation	fair (if no new units start to operate, otherwise high)	NA	NA
Industry	high	NA	NA
Road Transportation	high	high	very high (biofuels use and future legislation)
Residential, commercial & institutional sectors)	fair	fair	high
Agriculture	fair	NA	NA
Other miscellaneous sources	high	NA	NA

Source: Department of the Environment own appraisal.

As planned improvements, options could be to analyze the impacts on the emissions of industrial projects (e.g., building a second gas and steam plant) or of cessation of activities (e.g., the closing of the cement production unit). Scenarios for the road transportation sector should also be regarded as an option for a sound sensitivity analysis Luxembourg's emissions projections. Finally, it should be investigated whether or not it would be possible to play with various hypotheses on population growth, prices of fuels, taxes and other fiscal instruments. For testing these hypotheses, the use of an equilibrium model could be a plus in this respect *[→ Section V.4]*.

V.4. IMPROVEMENT OF METHODOLOGIES[235]

The fifth National Communications reports the third GHG emission projections exercise led in Luxembourg.

In 2005, projections were based on an ad-hoc energy balance set up by the Ministry of Economy and Foreign Trade, the FiFo-Köln and the Ministry of the Environment Luxembourg. This balance did not fulfil the requirements on data quality defined by the CRF and the Directive 280/2004/EC. Projected emissions were obtained using the MS™ Windows based TRAMO-SEATS software for time series analysis.

In 2007, data from the GHG inventory submission of January 2008 could be used and that helped to significantly increase the quality of the projections. Moreover, for the quantitative assessment of impacts of measures on GHG emissions projections, the results from the NEEAP submissions of February 2008 could be applied as well as results from a study by Thöne (2008) analysing the specific feature of "road fuel exports. Baseline projected emissions were obtained using the PRIMES baseline from July 2007 as basis [National Technical University of Athens (2007)]. However, PRIMES projections were modified if necessary, and for the transport sector two framing scenarios were introduced.

The 2009 exercise relies on detailed data from the GHG inventory submissions of May 2009 – submission 2009v1.4. As for the 2007 exercise, most of the impacts of the various P&Ms identified

235 This section of the NC5 covers part of section V.D of the Outline and General Structure of the NC5 according to IPCC reporting guidelines (para. 5).

are coming from the NEEAP and from the study by Thöne (2008). Baseline projected emissions for the main gas (CO_2) and sectors (CRF 1A, CRF 2A-C) are obtained using ECONOTEC's EPM tool *[→ Section V.2]*.

It is foreseen to develop a specific air emissions projection tool for Luxembourg. At the Luxembourg Statistical Office, a Computable General Equilibrium model (CGE model) is being developed: LUXGEM. CGE models are widely employed for economic policy analysis and are built upon economic general equilibrium theory. The abstract modelling structure is combined with detailed micro-data on, e.g. relevant production processes, assumptions on supply and demand behaviour or the market structure. Hence, CGE models allow analysing the impact of structural changes, e.g. in input prices, taxes or other framework conditions on several markets of an economy. The model is currently being extended by a specific "energy module", that will allow the assessment of certain P&Ms in the Luxembourg energy market and, therefore, their corresponding impact on GHG development. Nevertheless, CGE models alone could not lead to appropriate GHG projections since their predictive power lies more in the interaction between economic parameters – "general equilibrium" – than in an accurate technological representation – CGE models are "top-down" models. Consequently, it is recommended to use the CGE approach as a framework model that will look at cross-sectoral effects of measures that would be better estimated using "bottom-up" technology driven models, though the latter do not encompass the impacts of measures in one sector on all the other sectors. As technology driven model, the Department of the Environment envisages to use the EPM tool.

Nevertheless, some other on-going projects might prove being relevant for GHG emission projections. Two of them are led by Luxembourg's *Centre de Ressources des Technologies pour l'Environnement* (CRTE):

- **LEAQ** – the "Luxembourg Energy Air Quality Model": the main purpose of LEAQ is to explore the possibilities of air quality improvement for Luxembourg. The project will be proposing a tool to calculate the lowest cost energy solution by modelling and choosing the energy devices that make up the Luxembourg's energy DMDs (DeMand Devices) currently enlisted as well as projected DMDs once technology advances occur. To do so, LEAQ envisages combining various models and sources, such as an air quality model, an energy model and a techno-economic model of the MARKAL type (ETEM). The aim is therefore to propose a tool for a complete air quality/energy/techno-economic integrated assessment for Luxembourg, from which information could be extracted for GHG projections (parameters, hypotheses, scenarios suggested by LEAQ, etc.);[236]
- **LUXEN** – this model for an integrated assessment of future energy scenarios for Luxembourg will interact with LEAQ project, and vice versa. LUXEN is also supplementary

[236] For more information: http://www.crte.lu/cms/crte/content.nsf/id/LEAQ?opendocument&language=en.

to CGE models in the sense that it intends to investigate the economic and environmental consequences of future energy demand-supply scenarios in Luxembourg by coupling the bottom-up model ETEM – extended with LCA data assessing the environmental impacts generated by the energy usages over their lifecycle – along with the top-down model LUGEM. Again, with energy combustion as main driver of GHG emissions in Luxembourg, such a project will be valuable for improving GHG projections.[237]

As a conclusion, Luxembourg believes that the **"bottom-up" and "top-down" approaches are complementary**. How these approaches could be combined is the essence of the various projects that have started or that will be undertaken in the coming months, with the view of producing first estimates for the next bi-annual report on P&Ms and GHG projections that is due to the EC by March 2011. The move to a more elaborated system for GHG projections would also offer better opportunities to realize relevant projections sensitivity analyzes.

V.5. SUPPLEMENTARITY RELATING TO MECHANISMS UNDER ARTICLE 6, 12 AND 17 OF THE KYOTO PROTOCOL

V.5.1. Bridging the gap – target assessment 2008-2012

Luxembourg has ratified the Kyoto Protocol on the 31st of May 2002, together with the other (then) 14 EU Member States. Luxembourg is having the highest quantified emission reduction obligations pursuant to Annex II to Decision 2002/358/EC: the burden sharing target for the trading period – i.e. between 2008 and 2012 – is set at 28% beyond the base year level of emissions. This corresponds to a disposable volume of 9.48 Mio. t CO_2e per year for the period between 2008 and 2012.[238]

Considering projected emissions developments in the three cases – WOM, WEM and WAM – and considering the assigned amount of 9.48 Mio. t CO_2e which can be disposed off annually in the time period between 2008 and 2012, Luxembourg **must** acquire additional emission permits to close the gap between the volume of Assigned Amount Units (AAUs) and GHG emissions emitted according to IPCC rules. This is being and will be done by making use of Joint Implementation (JI), the Clean Development Mechanism (CDM) and international emissions trading (IET),[239] pursuant to Articles 6, 12 and 17 of the Kyoto Protocol – the "Kyoto flexible mechanisms".

With regard to carbon sinks, though **Luxembourg has chosen to account for the activities under Article 3.3 of the Kyoto Protocol** (afforestation, reforestation and deforestation) for the whole commitment period, the value reported in the MMRT is zero. This stems from 3 main reasons:

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237 For more information: http://www.crte.lu/cms/crte/content.nsf/id/DKOR-7Y5JCW?opendocument&language=en.

238 Burden sharing exact value is 9 480 599 tonnes.

239 IET including Green Investment Schemes (GIS).

- firstly, so far it is not possible for Luxembourg to carry out reliable projections for LULUCF because these would need background information that is not yet entirely on hand. The GHG inventory is actually undergoing a thorough revision for the LULUCF sector that is not completely terminated yet.[240] Furthermore, outcomes of a new aerial cartography of Luxembourg have been delayed, and these are needed to finalize the update of Luxembourg's Forest National Inventory. The aerial analysis, combined with ESA satellite images, should also provide a way to evaluate changes in land use in the past[241] and, therefore, to develop a methodology to evaluate activities falling under Article 3.3 for the period 2008-2012;
- Luxembourg's relative forests surface is rather high (a bit less than 35% of the territory). Consequently, there is no strong demand for reforestation or afforestation, though the latter is needed in order to rejuvenate Luxembourg's ageing woods *[→ Section II.10.1]*. On the contrary, one might fear some deforestation in the years to come notably due to the fact that extra built-up surfaces might be needed – strong demographic increase, very high prices for building ground in Luxembourg *[→ Section II.2]* – and to the fact that renaturation work sometimes leads to the cutting down of non-native pine trees to re-create original habitats, which are not forests in the sense of the TBFRA2000 methodology and the definitions of the FAO. In a word, there's more probability that Luxembourg will keep its actual forests surface or see it slightly decline than the contrary;
- Luxembourg's forests cannot fix appreciable quantities of CO_2 because of their age, and consequently slow growth, associated with frequently neglectful management *[→ Section II.10.1]*. Afforestation by the plantation of young trees might even lead to emissions rather than to removals since new trees usually stock less carbon than mature ones. Nevertheless, there is a lack of reliable data for evaluating this phenomenon that could be compensated according to Article 3.4 of the Kyoto Protocol.[242] Hence, **Luxembourg decided not to account for net emissions and removals from activities under Article 3.4** for meetings its obligations under the first commitment period of the Kyoto Protocol.

As a result, no projections have been presented in the MMRT for CRF sector 5 – LULUCF and the expected annual reductions as a result of carbon sinks in the period 2008-2012 are nonexistent.

Consequently, the gap between the AAUs and anticipated emissions during the Kyoto commitment period **will only be offset by the use of "Kyoto flexible mechanisms"**. In the

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240 This can easily be seen when comparing the 2008 submissions with the 2009 ones. In the former, LULUCF was estimated only for CO_2 and forests under a generic heading: "carbon intake by temperate forests". Moreover, this estimate was identical for all the years covered by the inventory.

241 Luxembourg has land use data taking stock at various dates. However, there are usually some changes with regard to land use categories between the observations. Also, there is often 10 years or more between these observations, hence a period of time which is too long to evaluate with enough precision what could be the effects of reforestation, afforestation and deforestation over the Kyoto commitment period 2008-2012.

242 More generally, Article 3.4 of the Kyoto Protocol deals with forest management, cropland management, grazing land management and revegetation.

baseline case – without any measures/WOM – use of these mechanisms would reach 4.22 Mio. t CO_2e in 2010. Due to the reduction potential of existing measures – WEM – the purchase volume would be reduced to 3.72 Mio. t CO_2e for that year. The additional measures – WAM – would then limit the purchase volume in 2010 to 3.71 Mio. t CO_2e *[→ Section V.3.7]*. These observations are illustrated in ***Table V.5-1*** that is extracted from the MMRT (*SummaryOfResults* sheet, *Summary Table 4*).

TABLE V.5-1 – PROJECTED USE OF "FLEXIBLE MECHANISMS" UNDER THE KYOTO PROTOCOL

Summary Table 4

Target assessment (2010) LU 40165 LU Final v1.6

Sector	Emissions in Mt $CO_{2\ eq.}$, excluding LUCF	% of reference year
Kyoto reference year emissions	13.17	100.0%
Kyoto Commitment/burden sharing	9.48	72.0%
With existing P&Ms projections	13.20	100.2%
Gap (-ve means overachievement of target)	3.72	
With additional P&Ms projections	13.19	100.2%
Remaining gap	3.71	
Effect of flexible mechanisms	3.71	28.2%
Effect of carbon sinks	0.00	0.0%
Remaining gap (with use of flexible mechanisms and sinks)	**0.00**	**0.0%**

Source: Department of the Environment – EC MMRT.

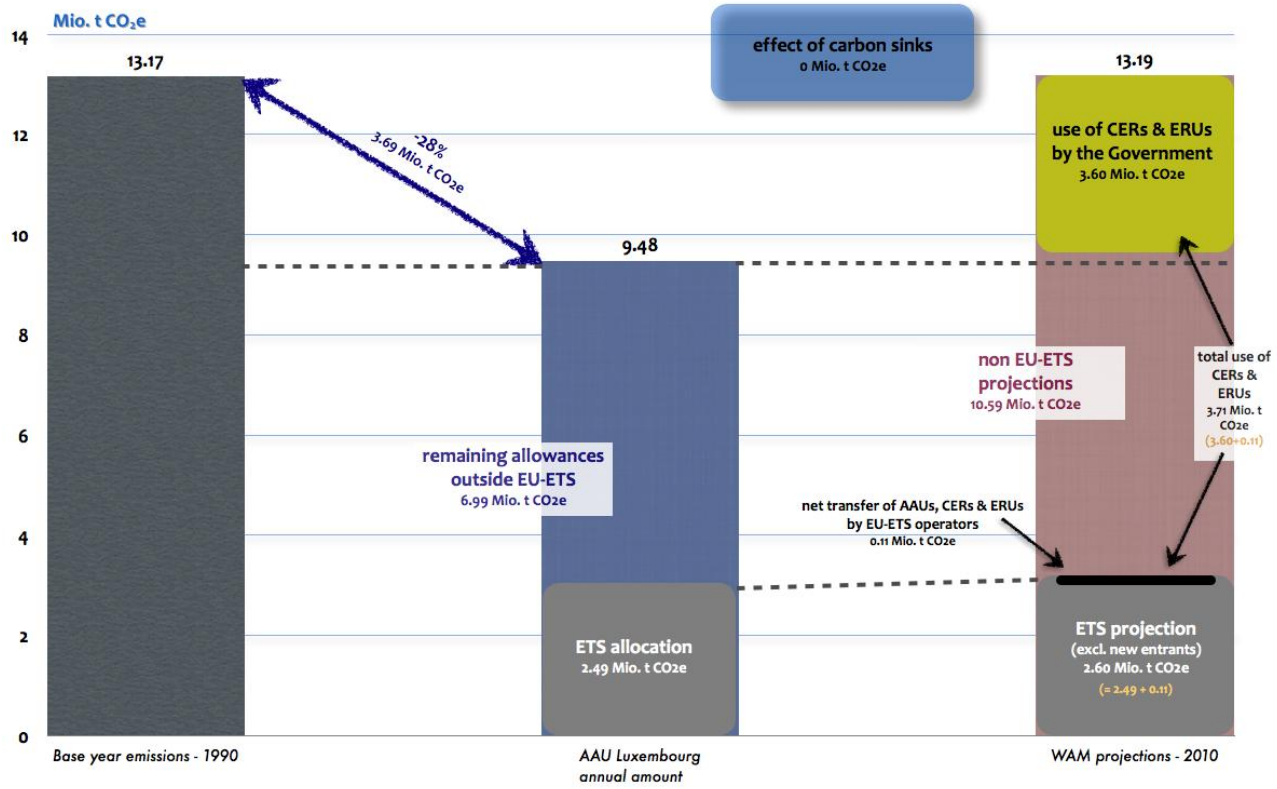
The EU-ETS is a very important policy instrument for the energy and industrial sectors. But it also plays a significant role in the determination of the amount of "flexible mechanisms" to be used by the national Government. The 2nd NAP (2008-2012) sets the quantity of allowances attributed to these sectors *[→ Section IV.1.2]*. These allowances are therefore not available anymore to the Government for covering the emissions outside the EU-ETS.

For the Kyoto commitment period, the average annual allocation to the installations covered by the EU-ETS amounts to 2.49 Mio. t CO_2e; after decision of the EC *[→ Section IV.1.2]*. The annual average quantity of allowances – or AAUs – for Luxembourg being 9.48 Mio. t CO_2e, the target for the sectors not covered by the EU-ETS amounts to 6.99 Mio. t CO_2e ***[→ Figure V.5-1]***.

The 2010 total GHG emissions projection for the WAM scenario is 13.19 Mio. t CO_2e ***[→ Table V.3-7]***. Out of this total, it is estimated that 2.6 Mio. t CO_2e should come from the EU-ETS sector if the turnaround observed in the economy end 2009 becomes stronger in 2010; i.e. emissions 0.11 Mio. t CO_2e above the EU-ETS allocated by the state. Consequently, the intended use of "flexible mechanisms" by the Government amounts to 3.60 Mio. t CO_2e (*3.71 – 0.11*). This amount corresponds to the sum of the quotas allocated to the EU-ETS sector and of the projected emissions

for the non EU-ETS sectors for the WAM scenario [*2.49 + (3.71 – 2.60) = 3.60 Mio. t CO_2e*] *[→ Table & Figure V.5-1]*.[243]

FIGURE V.5-1 – PROJECTED USE OF "FLEXIBLE MECHANISMS" UNDER THE KYOTO PROTOCOL: EU-ETS VS. NON ETS SECTORS



Source: Department of the Environment.

From the above estimates, Luxembourg now anticipates a **use of project-based mechanisms and international emissions trading (AAUs) between 18 and 20 Mio. t CO2e over the commitment period**: *3.6 Mio. t CO_2e x 5 years = 18 Mio. t CO_2e* , which is a minimum according to uncertainties in the projections and in the effective delivery of contracted projects. The expected AAUs should also include a provision if new production units generating emissions are starting their operations during the course of the commitment period.[244]

The CDM is expected to provide about half of the emission reductions, JI and IET the remaining half *[→ Table V.5-2]*.

[243] It is recalled that in the projections, 2010 data corresponds to that year and is not an average for the 2008-2012 period.

[244] We have already seen, notably in Section II.12.2, the potential impact that a single industrial project could have on the total GHG emissions of the country, due to the size of its economy.

TABLE V.5-2 – ANTICIPATED QUANTITATIVE CONTRIBUTION OF "FLEXIBLE MECHANISMS" FOR THE FIRST COMMITMENT PERIOD

Kyoto mechanism	Total projected quantities for the first commitment period *(Gg CO_2 equivalent)*
Total for all Kyoto mechanisms	[18;20] ➔ 19.0
International emissions trading - AAUs	*4.8*
All project based activities	*14.2*
joint implementation - ERUs	*5.3*
clean development mechanism - CERs	*8.9*

Note: includes only the quantities purchased through the investments and programmes of the Government. These quantities are only indicative and the distribution between JI and CDM may change over time.

In his latest estimates of the funds needed for the Kyoto mechanisms, Luxembourg now assumes an average purchase price of 18 € per t CO2e. Taking into account the 2% CDM levy and various anticipated commission fees and consultancy costs, **Luxembourg foresees Kyoto mechanisms related expenses of around 360 Mio. € for the time period between 2008 and 2012**. These expenses are not a fixed amount because they clearly depend on carbon market prices.

Ensuring that Luxembourg will meet its commitment under the Kyoto Protocol by using "Kyoto flexible mechanisms" has been re-affirmed in the new Government declaration made on the 29th of July 2009.[245] The Government also insists on the fact that projects under CDM and JI should comply with the ecological and social criteria established in the framework of the approval procedures of the UNFCCC *[→ Section IV.3.6]*.

V.5.2. How financing the use of "Kyoto flexible mechanisms"? – the "Kyoto Fund"

The Kyoto Mechanisms Fund (or "Kyoto Fund") contributes to financing the Kyoto flexibility mechanisms and national P&Ms to reduce GHG emissions. It buys carbon credits and finances or co-finances programmes and projects. It has been created by a Law of 23 December 2004.[246]

The Department of the Environment is in charge of the "Kyoto Fund" and decision-making responsibility for CDM and JI rests with the same Department.[247] At this stage, the target for Government use of the project-based mechanisms is as described above, i.e. the CDM is expected to provide about half of the emission reductions, JI and IET the remaining half. However, this can

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245 *"En ce qui concerne les mécanismes de Kyoto, le Gouvernement entend accélérer les procédures d'acquisition de crédits d'émission provenant de projets relevant de la mise en œuvre conjointe (MOC) et du mécanisme pour un développement propre (MDP) respectivement de l'échange des droits d'émission, afin de garantir que le Luxembourg puisse atteindre ses objectifs Kyoto et post-Kyoto"* (http://www.gouvernement.lu/gouvernement/programme-2009/programme-2009/programme-gouvernemental-2009.pdf, p. 42).

246 *Loi du 23 décembre 2004 1) établissant un système d'échange de quotas d'émission de gaz à effet de serre; 2) créant un fonds de financement des mécanismes de Kyoto; 3) modifiant l'article 13bis de la loi modifiée du 10 juin 1999 relative aux établissements classés* (http://www.legilux.public.lu/leg/a/archives/2004/0210/a210.pdf, p. 3792-3799)

247 The Department of the Environment is established as Luxembourg's designated national authority for CDM and is the designated focal point for JI.

change with time, depending on the development of carbon prices and of 'flexible mechanisms" schemes.

According to the Law, an inter-departmental committee – Cooperation Development Directorate of the Ministry of External Affairs, Ministry of Economic Affairs and External Trade, Department of the Environment, Ministry of Finance – will advice the Minister of Sustainable Development and Infrastructures. Various types of instruments will be deployed by the Government in order to acquire CERs and ERUs. Firstly, it is intended to sign voluntary and non binding Memoranda of Understanding with some potential host countries. Secondly, for the selection of projects and the purchase of CERs and ERUs, various intermediary organizations will be contracted along the following tracks:

- participation in carbon funds of multilateral and regional financial institutions;
- facilities with private international banks;
- bilateral purchase agreements.

The annual current budget of the "Kyoto Fund" is as follows:

- 2005 – 5.00 Mio. €;
- 2006 – 10.00 Mio. €;
- 2007 – 10.00 Mio. €;
- 2008 – 10.50 Mio. €;
- 2009 – 11.00 Mio. €;
- 2010 – 11.00Mio. €;
- 2011 – 11.00 Mio. € (prov.);
- 2012 – 11.00 Mio. € (prov.).

Additionally to this budgetary grant, 40% of the CO_2-based vehicle tax *[→ P&Ms TR01]* and 100% of the "Kyoto-cent" *[→ P&Ms TR03]* represent extra source of revenues for the "Kyoto Fund". Thus, for the "Kyoto-cent" a supplemental annual income of about 60 Mio. € has been anticipated for the years 2010-2012, but this is depending however on road fuel sales. For the CO_2-based vehicle tax, 27 to 28 Mio. € have been anticipated for the same period in the Budget Laws.

For 2008, 36% of the fund revenues were assigned to CDM and 32% to participation in carbon funds of international financial institutions (cf below). The remaining revenues were used for projects, programmes, activities and reports aiming at reducing GHG emissions at national level – the P&Ms describes in ***Sections IV.3.3 & IV.3.4***.

As the introduction to the "Kyoto Fund" above demonstrates, **the Fund is a very flexible tool** by nature since both its revenues and expenses are influenced by imponderable factors such as the "Kyoto-cent" revenue or the carbon market prices.

Some extra details on the expenses of the "Kyoto Fund"

For the period 2008-2012, the Fund committee foresees expenses of about 115 Mio. € for financing various national P&Ms, such as the "CAR-e" schemes *[→ P&Ms TR02]*.

At the worldwide level, Luxembourg participates in the following carbon funds of international financial institutions (for some 43°Mio. €):

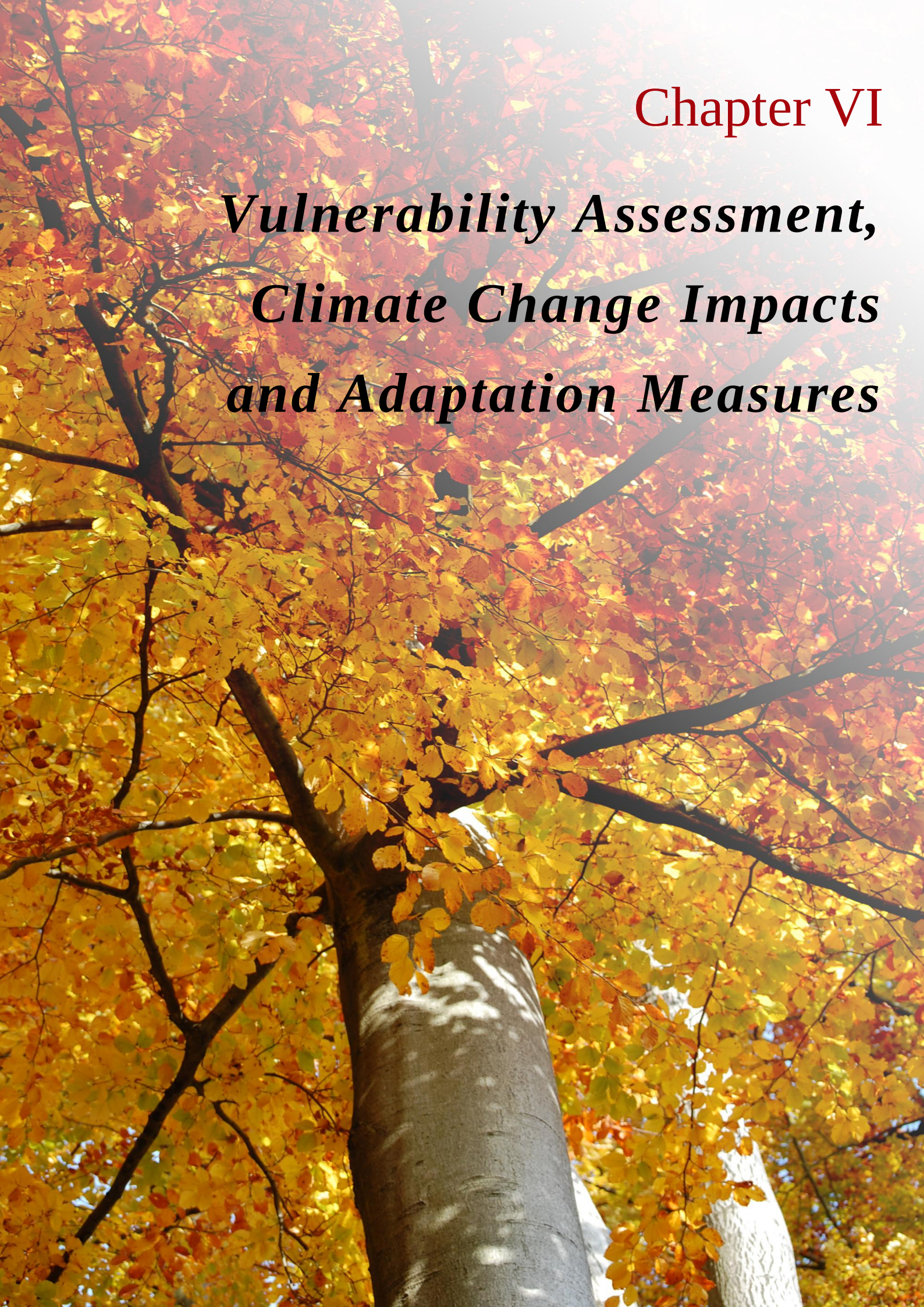
- "BioCarbon Fund" of the World Bank (5 Mio. $);
- "Community Development Carbon Fund" of the World Bank (10 Mio. $);
- "Multilateral Carbon Credit Fund" of the European Bank for Reconstruction and Development (10 Mio. €);
- "Carbon Fund for Europe" sponsored by the World Bank and the European Investment Bank (10 Mio. €);
- "Asia Pacific Carbon Fund" of the Asian Development Bank (15 Mio. $).

The government did also sign emissions reduction purchase agreements (ERPA) for CDM projects in El Salvador and in China:

- project "*Landfill Gas to Energy Facility at the Nejapa Landfill Site, El Salvador*": the project was registered at the UNFCCC's web site on 12 March 2006, with the CDM Registration Reference Number 0167, and all relevant information can be found there. The first issuance of CERs was in 2007. The number of CERs to be acquired by Luxembourg amounts to 325 000 CERs;
- project signed with *Crédit Suisse Energy LLC* which concerns the delivery of 370 000 guaranteed CERs. 185 000 CERs have been delivered on February 15, 2009 and 185 000 CERs will be delivered on February 15, 2010.

On the whole, approximately 4.5 Mio. t of CO_2 are covered nowadays by CERs coming from 8 ERPA projects (either direct between Luxembourg and a third Party or via the carbon funds). JI projects are planned to start from 2010 onwards.

As for international emissions trading, Luxembourg plans to buy AAUs (50% at European level & 50% at international level).



Chapter VI

Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

In line with the recommendations of the UNFCCC reporting guidelines, paragraph 49, Chapter VI presents the expected impacts of climate change in Luxembourg *[→ Section VI.1]*, but only a few words are provided on vulnerability assessment *[→ Section VI.2]* and adaptation measures *[→ Section VI.3]* since these two areas are currently under discussion and will be developed in the next two years.

This chapter is usefully supplemented by the description of the climatic circumstances in Luxembourg *[→ Section II.4]*

VI.1. EXPECTED IMPACTS OF CLIMATE CHANGE IN LUXEMBOURG: FORESTS AND WATER IN THE FOREFRONT

According to a report published by the EEA [European Environment Agency, Joint Research Centre, World Health Organization (2008)], reproducing an EEA map based on IPCC reports showing key past and projected impacts and effects for the main bio-geographic regions of Europe, Luxembourg is part of the "central & eastern Europe" area (cf Map S.1, p. 19 of the aforementioned report). The threats identified for this peculiar region are:

1. more temperature extremes;
2. less summer precipitation;
3. more river floods in winter;
4. higher water temperature;
5. higher crop yield variability;
6. increased forest fire danger;
7. lower forest stability.

Two of these threats are of main concern for Luxembourg: **floods and forest stability**. Temperatures extremes and summer precipitation reduction are also causes for concern: impacts on human health and especially on the most fragile persons and the elderly (heat, air quality) and impacts on water quality in summer when rivers flows are usually at their lowest.

According to the researchers of the *Centre de Recherche Public-Gabriel Lippmann*,[248] the projected changes in air temperature *[→ Section II.4.2]* are likely to induce a modification of the vegetation period in Luxembourg. The start of the vegetation period is defined as the exceeding of the 5°C daily mean temperature threshold in spring for at least 30 successive days; the end of the vegetation period corresponds to the undershooting of this threshold until the end of the year [Chmielewski & Rötzer (2001)].

[248] The remaining paragraphs of this section have been adapted from a text prepared by Pfister, L., Junk, L. & Hoffmann, L.

In Luxembourg, the vegetation period is expected to be initiated earlier in spring and to last longer into the autumn *[→ Illustration VI.1-1]*. During the early stages of the vegetation period this might cause an increased risk of frost damages to vegetation.

The increase of temperatures, especially during the winter period *[→ Section II.4.1]*, already has significant impacts on the phenology of plants (earlier flowering dates) and animals (e.g. earlier breeding dates of birds, advancement of life cycle of insects, three instead of two yearly cycles), but also on the migratory behaviour of birds and insects (i.e. species now winter in Luxembourg that in former times migrated to Spain or northern Africa). Furthermore, the temperature changes have an impact on the bio-geography of plants and animals, with new species with a Mediterranean distribution, formerly unknown in Luxembourg, which recently appeared in the country fauna (e.g. Nomophila noctuella, Udea ferrugalis, Brenthis daphne) and flora (some moss species). Bio-climatic approaches also indicate that some relict species of the last glaciation period (e.g. Lycaena helle) will disappear from Luxembourg with the expected temperature increase.

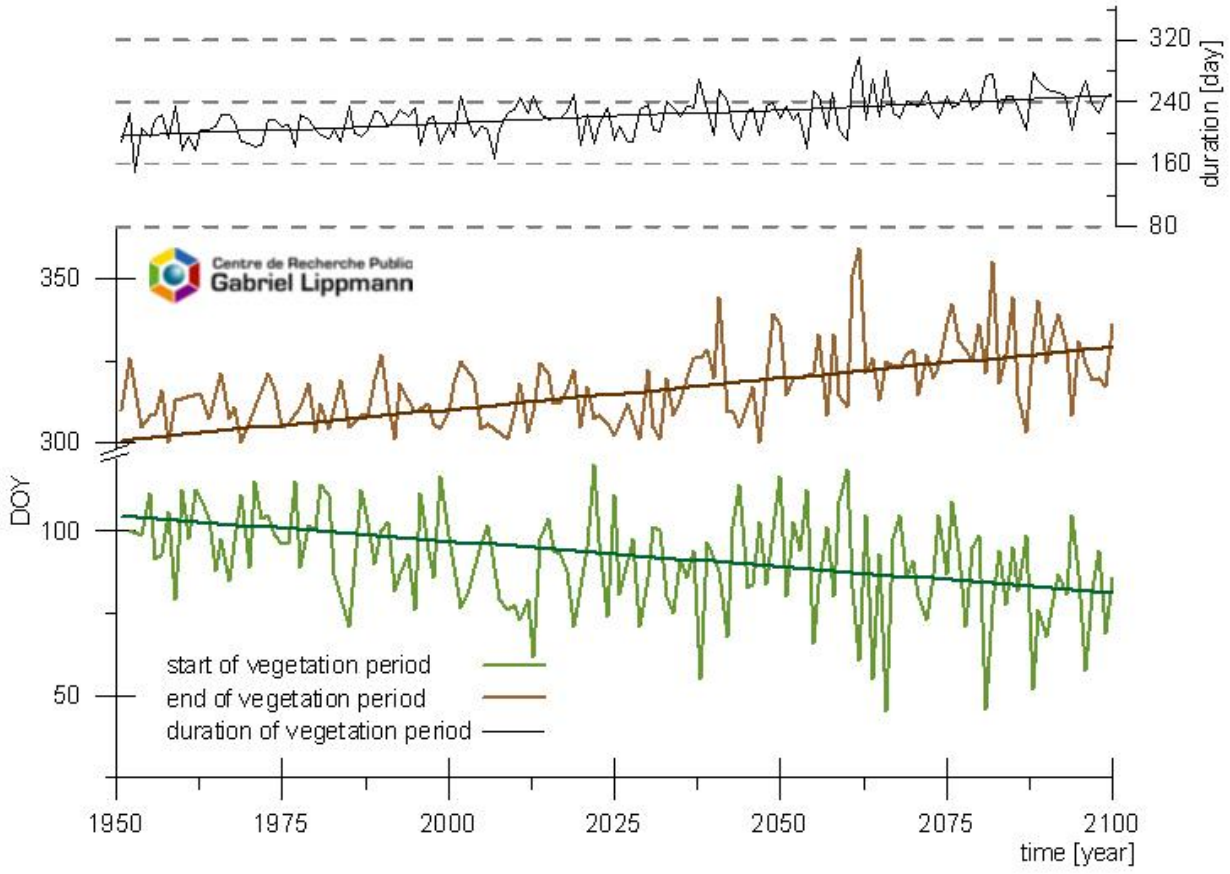
The climate projections for the second half of this century will also have significant impacts on the bio-meteorological conditions in Luxembourg. The higher air temperatures, especially during night times (important recreation time for humans) also increase the likelihood of extreme heat events such as the one that struck Europe in August 2003. Besides impact on the human health, this will also lead to more frequent and more stringent stress conditions for agricultural plants and forestry, most severely impacting perennial forest trees. Observations on the phytosanitary state of Luxembourg forest – a rather "old" forest – show a sharp degradation – which seems to have stabilised nowadays – resulting, among other factors, from climate change *[→ Section II.10.1]*. The ageing of the forest also increases the risk of outbreak of diseases and of infestation by insects and other parasites that could proliferate if more mild winters and overall general temperatures are recorded in Luxembourg.

With regard to water, the most analysed phenomena so far are floods. It is known that; due to major redistributions of, essentially, winter rainfalls *[→ Section II.10.1]*, a higher inundation frequency is being recorded since the river systems have reacted to these changes with a statistically significant increase of maximum daily runoff during winter [Pfister et al. (2005a)]. This is why an observation hydro-climatic network (*réseau d'observation hydro-climatologique*) has been put in place from the mid 1990s.[249] Its main functions consist in continuously (24h/24h) monitoring Luxembourg's water courses, and in the realization and the updating of an atlas of areas of the national territory subjected to swellings and floods. The network also suggests anti-flooding measures and participates to renaturation projects aiming at re-creating natural areas which used to act as natural reservoirs for containing rising waters.[250]

[249] http://www.hydroclimato.lu/.

[250] For an example, look at http://www.luxnatur.lu/alzrena1.htm.

ILLUSTRATION VI.1-1 – START, END AND DURATION OF THE VEGETATION PERIOD



Source: *Centre de Recherche Public-Gabriel Lippmann*, unpublished.

Notes:

(1) based on selected ENSEMBLES data sets, A1B emission scenario.

(2) end and duration of the vegetation period as defined by Chmielewski & Rötzer (2001).

(2) DOY = day(s) of year.

VI.2. VULNERABILITY ASSESSMENT: IN NEED OF MORE ANALYZES

Vulnerability refers to the risk of adverse impacts from climate change, such as extreme weather events, droughts or floods, on both natural and human systems. In Luxembourg, **a thorough vulnerability assessment has not been done yet**. However, with the preparation, by end 2011, of a national adaptation plan *[→ Section VI.3]* such an assessment will have to be produced.

From the partial analysis in the previous section, the risk of adverse effects seems to be higher for water courses (inundations), heat waves (health, air quality), overall yearly average temperature rise (new diseases) and for Luxembourg's forest health. In other domains, there is not enough information and studies available for Luxembourg yet to learn lessons – fuel combustion: more or less fuel for heating or cooling houses and other buildings – biodiversity: impacts of "alien" species coming up from southern regions on local fauna and flora? – agriculture: are longer vegetation periods a good thing or will they be accompanied by drawbacks such as water shortages, extreme weather events, frost damages due to early blossoming?

VI.3. ADAPTATION MEASURES: TOWARDS AN ACTION PLAN

As for other EU Member States, and further to the EC white paper on adaptation to climate change",[251] Luxembourg will have to prepare a **national climate change adaptation plan that should be adopted by the Government by end 2011**. It will capitalize on the various measures that are already in place but that are not yet compiled and linked in an effective action plan, as it is the case for GHG mitigation with the national "Action Plan for reducing CO_2 emissions" [Ministry of the Environment (2006b)].

[251] *Adapting to climate change: towards a European framework for action* (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF).

Chapter VII

Financial Resources and Transfer of Technology

It is not yet possible for Luxembourg to comply with all the requirements set out in the annotated outline for the 5th National Communication of Annex I Parties. After introductory notes on Luxembourg's development cooperation, partly in line with paragraph 50 of the UNFCCC reporting guidelines *[→ Section VII.1]*, some information will be given on the provision of "new and additional" resources: GEF and LDC's Trust Fund accordingly to paragraph 51 of the UNFCCC reporting guidelines *[→ Section VII.2]*. With regard to paragraph 52 of these guidelines, it is not possible yet for Luxembourg to report precise information *[→ Section VII.3]*. Provision of financial resources – paragraph 53 – is somehow provided, including for Article 11 of the Kyoto Protocol – paragraph 43 of the Kyoto Protocol reporting guidelines *[→ Section VII.4]*. Activities related to transfer of technology – paragraphs 54 to 56 of the UNFCCC reporting guidelines – are briefly discussed too *[→ Section VII.5]*. Finally, as recommended by paragraph 39 of the Kyoto Protocol reporting guidelines, a table is indicating where information on the implementation of Article 10 is presented throughout the Communication *[→ Section VII.6]*.

This whole chapter has been prepared by the Development Cooperation Directorate of the Ministry of Foreign Affairs.[252]

VII.1. LUXEMBOURG'S DEVELOPMENT COOPERATION

The primary objective of the "Luxembourg Development Cooperation" is the **eradication of poverty**, notably in least developed countries. Its activities are conceived with respect to the principles of sustainable human development, in its social, economic and environmental aspects.

As concerns Official Development Assistance (ODA), Luxembourg has been among the group of (currently five) industrialised countries which allocate more than 0.7% of their gross national income (GNI) to development cooperation since 2000. In 2008, ODA amounted to 287.6 Mio. € (414.97 Mio. $), representing over 0.97% of GNI. As in the past, this ODA is be implemented through the instruments of bilateral and multilateral cooperation, technical cooperation and cooperation with development NGOs. It is expected that ODA should reach 1% of GNI in the foreseeable future.

From a geographic point of view, and in order to maximise its effectiveness and impact, Luxembourg's development cooperation follows a policy of targeted intervention in a limited number of partner countries. Five out of these ten partner countries, which are chosen primarily by taking into account the composite human development index (HDI) of the UNDP, are located in sub-Saharan Africa.[253] All ten of them are concerned by the negative effects of climate change. Development cooperation activities with these countries are distinguished by a heightened sense

252 http://cooperation.mae.lu/fr.

253 The 5 sub-Saharan countries are Burkina Faso, Cape Verde, Mali, Niger and Senegal. The 5 other countries are El Salvador, Laos, Namibia, Nicaragua and Vietnam.

of partnership with both public authorities and civil society. This spirit of partnership, which is achieved through actual ownership of the programmes and projects by the beneficiaries themselves, is the cornerstone of the multi-annual cooperation programmes, the "Indicative Cooperation Programmes".

In September 2009, the Luxembourg Ministry of Foreign Affairs Directorate for Development Cooperation presented a draft strategy on environment and climate change. This draft strategy is part of a set of 10 themes and is currently being discussed with all other relevant ministerial departments, with partner country governments, as well as with civil society organisations, in view of its finalisation by the end of the first trimester of 2010.[254]

Luxembourg's strategy concerning protection of the environment in development cooperation is focused on Millennium Development Goal (MDG) No 7 and notably its first two targets: (i) integrating the principles of sustainable development into country policies and programmes and reversing the loss of environmental resources and (ii) reducing biodiversity loss. In this regard, particular attention is attached to the necessity to protect natural resources from the negative effects of climate change. As for all of its development policies, Luxembourg considers that those pertaining to climate change can only produce long term results if they are fully integrated into the national sustainable development strategies of partner countries. The draft strategy foresees a fourteen-point action plan for bilateral development cooperation, as well as ten proposals for action in the field of multilateral and NGO development activities and humanitarian affairs.

In order to improve reporting of ODA statistics to the OECD's Development Assistance Committee (DAC), Luxembourg is currently mainstreaming the DAC policy marker system in all projects and programmes. This system includes an "Aid to Environment" marker, as well as the four so-called Rio markers, covering ODA targeting the actions of UN convention on biodiversity, the convention to combat desertification, as well as the UNFCCC (concerning mitigation). In December 2009, the DAC adopted a working definition of a climate change adaptation policy marker, which is to be used starting 2010 for all activities which will be reported in 2011.

At the meeting of the EU's Development Cooperation Ministers in the margins of the 15th Conference of the Parties to the UNFCCC in Copenhagen on 14th December 2009, Luxembourg Development Cooperation Minister underlined the importance of the integration of adaptation issues into development cooperation policy. Climate change is adding in problems and in complexity to the challenges of poverty eradication, even more so in developing countries. Such new and more complex problems call for additional financial means, on top of existing ODA commitments. It is therefore useful to refer to the OECD-DAC criteria and markers for climate-related ODA, which must be made further use of in addition to traditional MDG-related ODA.

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254 The themes are (i) agriculture and food safety, (ii) humanitarian relief, (iii) local development, (iv) water and sewing, (v) education, (vi) environment and climate change, (vii) gender issue, (xiii) governance, (ix) micro-finance, and (x) health [Ministry of Foreign Affairs Directorate for Development Cooperation (2009)].

VII.2. PROVISION OF "NEW AND ADDITIONAL" RESOURCES

Luxembourg is represented in the Global Environment Facility (GEF) by its Ministry of Finance and has been a member of the GEF since 1997, currently with a share of 16 Mio. of SDR. Through its Directorate for Development Cooperation in the Ministry of Foreign Affairs, Luxembourg has made a contribution of 4.12 Mio. $ to the Least Developed Countries (LDCs) Trust Fund for the years 2005 to 2008. An additional special contribution of 1 Mio. € was made in 2007 *[→ Table VII.2-1]*.

TABLE VII.2-1 – LUXEMBOURG'S FINANCIAL CONTRIBUTIONS TO THE GEF AND THE LDCS TRUST FUND

Mio. €	2006	2007	2008
Global Environment Facility	1.04	1.48	1.31
Least Developed Countries Trust Fund	1.55	1.78	0.776

Source: Ministry of Foreign Affairs Directorate for Development Cooperation.

VII.3. ASSISTANCE TO DEVELOPING COUNTRY PARTIES THAT ARE PARTICULARLY VULNERABLE TO CLIMATE CHANGE

The draft strategy on environment and climate change of the Luxembourg Development Cooperation Directorate [Ministry of Foreign Affairs Directorate for Development Cooperation (2009)] is to be taken into consideration in the context of the annual Partnership Commissions with partner country governments, in which joint development cooperation activities are decided on, based on national strategies. Bilateral aid is delivered in the framework of multi-annual indicative cooperation programmes (PIC) negotiated with partners, which include an adequate minimal budgetary envelope. In this context, it should be noted that the second generation of PICs includes – where deemed appropriate by partner countries – programmes for environmental protection. An example could be the support for natural resources management project (BKF/012) in the Bobo Dioulasso Basin in Burkina Faso, to which Luxembourg contributes 5.96 Mio. € for the years 2006 to 2011.

Luxembourg is reforming its reporting procedures with regard to introducing the DAC policy markers in all of its development cooperation activities in order to allow for more reliable reporting. With the adoption of the DAC's working definition of a climate change adaptation policy marker and its introduction – foreseen in 2010 – Luxembourg is going to be able to report more precisely starting in 2011.

VII.4. PROVISION OF FINANCIAL RESOURCES

Cooperation with multilateral partners is an important component of Luxembourg's development cooperation policy, notably in the context of achieving the MDGs. In order to achieve a high degree of predictability, multilateral aid is delivered through multi-annual framework agreements:

the annual contributions are aimed to be at least at the same level as those of the previous year, subject to the evolution of Luxembourg's ODA and annual approval by budget authorities.

In 2008, the share of multilateral cooperation of total ODA was 30.60%, distributed as follows *[→ Table VII.4-1]*.

TABLE VII.4-1 – MULTILATERAL COOPERATION

Mio. €	Total: 88.02 Mio. €	% of multilateral ODA	% of total ODA: 30.60%
United Nations (Agencies, Programmes, etc.)	41.01	46.70%	14.29%
European Union	24.57	27.92%	8.54%
World Bank	11.74	13.33%	4.08%
Regional Development Banks	1.41	1.60%	0.49%
Other	9.19	10.44%	3.19%

Source: Ministry of Foreign Affairs Directorate for Development Cooperation.

A synthesis table has also to be produced according to the reporting guidelines for table 4 on financial contributions to multilateral institutions and programmes *[→ Table VII.4-2]*.

TABLE VII.4-2 – MULTILATERAL COOPERATION: FINANCIAL CONTRIBUTIONS ACCORDING TO "TABLE 4" FORMAT

Institution or programme	*Contribution (Mio. €)*		
	2006	2007	2008
European Union			
EC budget	8.11	8.68	9.04
European Development Fund (EDF)	7.28	7.66	8.39
European Investment Bank (EIB)	2.50	0.75	1.50
United Nations			
FAO	0.97	1.63	2.28
UNDP	6.55	17.04	13.53
UNEP	0.33	0.41	0.60
UNICEF	5.61	7.52	6.48
International Financial Institutions			
WB	4.05	6.46	3.726
IDA/AID	9.69	5.80	5.8
IBRD (incl. GEF/CGIAR)	3.03	4.36	5.22
EBRD	0.50	0.535	1.95
AsDB	2.39	1.46	1.41
Other multilateral institutions			
OECD	0.20	0.37	0.25

Source: Ministry of Foreign Affairs Directorate for Development Cooperation.

Table VII.4-3 summarizes financial resources with regard to the implementation of Article 11 of the Kyoto Protocol.

TABLE VI.3-3 – SUMMARY OF INFORMATION ON FINANCIAL RESOURCES AND TECHNOLOGY TRANSFER

Official development assistance (ODA) – 2008 (Mio. €)	287.68
Climate-related aid in bilateral ODA	not available
Climate-related support programmes	not available
Contributions to GEF (Mio. SDR)	16.00
JI and CDM under the Kyoto Protocol (Mio. €) (1)	110.00
Other (bilateral/multilateral) – participation to carbon funds (Mio. €)	43.00

Sources: Department of the Environment and Ministry of Foreign Affairs Directorate for Development Cooperation.

Note:

(1) This amount represents the investments financed so far. The "Kyoto Fund" has an actual deposit of 360 Mio. €.

VII.5. ACTIVITIES RELATED TO TRANSFER OF TECHNOLOGY

The draft strategy on environment and climate change [Ministry of Foreign Affairs Directorate for Development Cooperation (2009)] aims to integrate gradually ecological and climatic considerations in the Luxembourg Development Cooperation's acquisition policy and to promote sustainable and renewable energies, clean technologies, as well as technology transfer and access to environmental information. The new reporting criteria which are going to be applied across the board starting in 2010 will facilitate reporting on individual projects/programmes in the following National Communication.

VII.6. INFORMATION UNDER ARTICLE 10 OF THE KYOTO PROTOCOL

Information on activities, actions and programmes undertaken in fulfilment of the commitments under Article 10 of the Kyoto Protocol are given in various parts of the 5th National Communication. *Table VII.6-1* below provides an overview, where this information is located.

TABLE VII.6-1 - INFORMATION UNDER ARTICLE 10 OF THE KYOTO PROTOCOL – CORRESPONDENCE TABLE

Art. 10.a	National system for the development and continuous improvement of the national inventory	*Section III.2*
Art. 10.b	Domestic (and regional) programmes aimed at mitigating climate change	*Section IV.2*
	Domestic adaptation strategies and measures	*Section VI.3*
Art. 10.c	Activities related to transfer of technology transfer	*Section VII.5*
Art. 10.d	Research and systematic observation	*Chapter VIII*
Art. 10.e	Education, training and public awareness	*Chapter IX*

Chapter VIII

Research and Systematic Observation

Chapter VIII briefly describes the rare actions undertaken in Luxembourg in the fields of research and systematic observation and tries to stick with UNFCCC reporting guidelines, paragraphs 57 to 64. It is, however, not yet possible for Luxembourg to provide relevant and complete information related to Articles 10d and 10f of the Kyoto Protocol.[255]

In fact, due to its size and the few research centres that are located on its territory, Luxembourg is not very active in the field of research and systematic observation and they are no general systematic policy on and funding of research and systematic observation.

With regard to the general policy – section VIII.A of the UNFCCC reporting guidelines – a metrological service – the Findel-Airport station *[→ Section II.4]* that is operating under the authority of the Aerial Navigation Administration[256] – is contributing to the GCOS system, in particular to the system for terrestrial climate observation (GSN= GCOS Surface Network). This network is composed of roughly a thousand stations all around the world, selected according to their performance and their continuity in the field of the data collection. Luxembourg has one official station in this network – the one at Findel-Airport, ref. 06590 – that disposes of climatologically records from 1947 on, which are recorded on 24h/24h basis.

Data collected for the GSN are transmitted, on a monthly basis, via an encoded message "CLIMAT" to the "*Deutscher Wetterdienst*". The management of the "CLIMAT" messages and their introduction into the GSN system is under the responsibility of this German service.

Concerning research – section VIII.B of the UNFCCC reporting guidelines – some activities are led by the *Centre de Recherche Public-Gabriel Lippmann*, for which some of their activities and findings have been presented in ***Section II.4*** and ***Chapter VI***. More information on these activities will be available in the coming weeks from this research centre and will then be communicated to the UNFCCC Secretariat.

About systematic observation – section VIII.C of the UNFCCC reporting guidelines – there are no activities in Luxembourg about ocean climate observing systems [VIII.C (b)] and in supporting developing countries [VIII.C (d)]. Concerning atmospheric climate observing systems [VIII.C (a)], an extension of a system of automatic stations, on the territory of Luxembourg, is under discussion but any decision has been taken yet.

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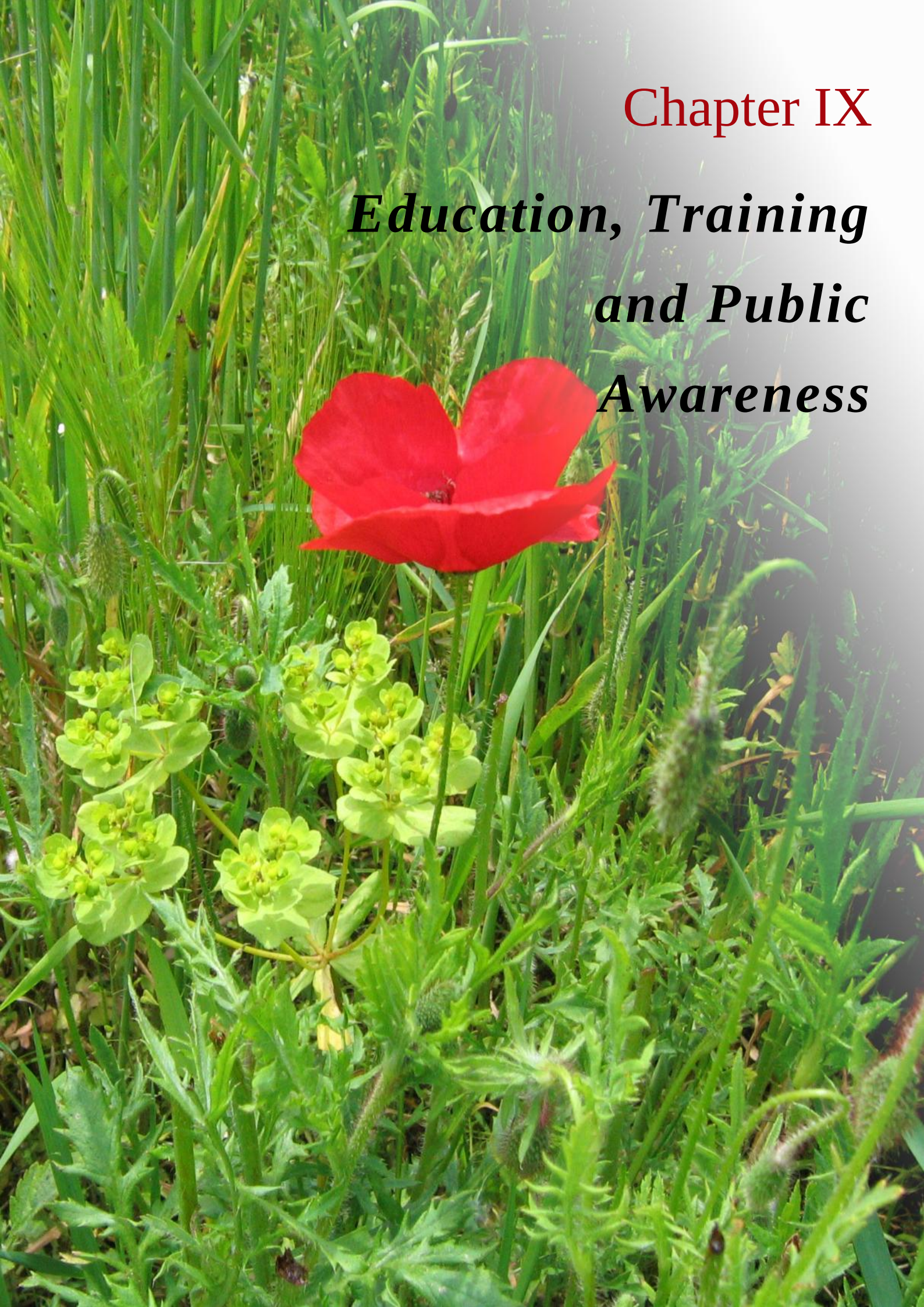
255 The text of this chapter has been adapted from a text prepared Claude Alesch of the Aerial Navigation Administration.

256 This Administration is connected to the Department of Transport of the MDDI: http://www.aeroport.public.lu/fr/meteo/index.html.



Chapter IX

Education, Training and Public Awareness

Chapter IX describes actions undertaken in Luxembourg in the fields of education, training and public awareness in line with UNFCCC reporting guidelines, paragraphs 65 and 66. This chapter is divided in four sections: public information and awareness *[→ Section IX.1]*, education *[→ Section IX.2]*, training programmes *[→ Section IX.3]*, and involvement of the "civil society" *[→ Section IX.4]*.

IX.1. PUBLIC INFORMATION AND AWARENESS

IX.1.1. Operations led by or involving the Department of the Environment

The Department of the Environment conducts regular awareness and information campaigns on environmental issues; with biodiversity, waste, climate change and energy savings being the most recurrent themes. In general campaigns are supported by mass mailings of flyers to all households and businesses.

Different campaigns are linked to the issue of climate change – they are presented chronologically.

Mid-2006, a wide awareness operation was launched at EU level: "**You Control Climate Change**". The aim of this action was to make EU citizens aware of the issue of climate change and its impacts and to show that, even at individual level, it is possible to act, for instance, by walking instead of taking the car for short journeys, by totally switching off appliances rather to leave them in sleep mode or by reducing the heating system by one or two degrees centigrade – in a word the main motto of that campaign was that "even small changes in the daily behaviour can help prevent GHG emissions without affecting quality of life, and, moreover, they can help save money". Alongside other EU Member States, Luxembourg relayed this campaign at national level organizing public events, preparing posters, showing a TV spot and releasing a brochure *[→ Illustration IX.1-1]*. Though actions at national level were limited in time, the EC's climate change campaign website is still regularly updated.[257]
(http://www.environnement.public.lu/air_bruit/dossiers/CC-meilleures_pratiques_consommation_energie/index.html)

In 2007, the Government decided to reinforce the financial incentives for the promotion of energy savings and the use of renewable energy sources in the residential sector and published a revised Regulation in that direction that entered into force on the 1st of January 2008: *[P&Ms EC01a & 01b] [→ Section IV.3.3.2]*. To support this measure, a wide awareness campaign has been launched in **October 2007** under the slogan "**Think Climate, Act Clever !**". This operation is one of the actions identified in Luxembourg's "Action Plan for reducing CO_2 emissions" [Ministry of the Environment (2006b)] *[→ Section IV.1.2]* and was planned to last a bit more than 6 months (up to June 2008). To raise awareness, both a booklet *[→ Illustration IX.1-2]* and videos have been

[257] http://ec.europa.eu/environment/climat/campaign/index_en.htm. This operation is an on-going one that is regularly updated.

produced. A free of charge telephone number ("green number") was put into operation at the same time to inform and answer to citizens.

(http://www.environnement.public.lu/energies_renouvelables/dossiers/think_climate/index.html)

The booklet ***[→ Illustration IX.1-3]*** contains handy advices and tips on often easy to implement energy savings measures with regard to heating, ventilation, lightning and electrical appliances. It also presents useful information on how to increase energy efficiency in refurbished buildings or for new constructions.

(http://www.environnement.public.lu/energies_renouvelables/dossiers/think_climate/brochure_think_climate_2007.pdf)

Under the heading "*Clever, den Energiespuertipp*", 20 videos were produced and hosted on a dedicated web page of the main national radio and TV channel RTL. These videos deal with green or solar energy, building insulation, financial incentives possibilities according to the Regulation, etc.

(http://www.youmake.tv/users/clever)

Also in **2007** and **2008**, a web-platform aiming at helping consumers to choose the most energy efficient products in a variety of domains has been initiated by both the Ministry of the Environment and an ecological NGO – the *Mouvement Ecologique*. Nowadays, this platform – ***OekoTopten.lu*** – is managed by the Mouvement Ecologique and its partner, *OekoZenter Lëtzebuerg*.[258] The Department of the Environment provides a financial support to the activities of this information web site that, for the moment, identifies the most energy-efficient products in four domains: households (electrical appliances such as fridges, freezers, cookers, ovens, washing machines and dishwashers), mobility (cars and electrical bikes), lightning bulbs and TVs. This buying guide according to various ecological and energy savings criteria is a perfect complement to other initiatives such as the "Think Climate, Act Clever!" campaign or the various "PRIMe" schemes presented below.

(http://www.oekotopten.lu/ in French and German)

Since 2008, communication focus has been put on financial incentives in place aiming at promoting energy efficiency and the use of renewable energy sources. The "Think Climate, Act Clever!" booklet of 2007 has been completed in **January 2008** by a brochure detailing the various subsidies and grants that could be obtained by the households in the building and construction sector ***[→ Illustration IX.1-3]***. This brochure replaced a previous leaflet issued in 2005 to reflect the revised Regulation that entered into force on the 1st of January 2008: *[P&Ms EC01a & 01b]* ***[→ Section IV.3.3.2]***.

(http://www.environnement.public.lu/energies_renouvelables/publications/regime_aides_financieres_tc/index.html in French & http://www.environnement.public.lu/energies_renouvelables/publications/foerderprogramm_wohnbereich_tc/index.html in German)

258 *OekoTopten.lu* is a member of the European network *Euro-Topten Plus* (http://www.topten.info/).

To enhance the visibility of the various financial incentives, the Government launched the "PRIMe" concept. In **November 2008**, the various financial measures dealing with energy use in residential buildings have been grouped under the "**PRIMe House**" brand: *[P&Ms EC01a, 01b, EC02 & EC04] [→ Section IV.3.3.2].*[259]

(http://www.environnement.public.lu/energies_renouvelables/dossiers/primehouse/index.html)

In **January 2009**, the "PRIMe" family was expanded to fridges, freezers and combinations of these two equipments: *[P&M EC06] [→ Section IV.3.3.2]*. This new scheme was labelled "**PRIMe Cool**".

(http://www.environnement.public.lu/energies_renouvelables/dossiers/primecool/index.html)

Finally, the incentives for buying energy efficient – low emissions cars – "CAR-e" & "CAR-e Plus" *[P&M TR02] [→ Section IV.3.3.1]* – also joined the "PRIMe" concept: "**PRIMe Car-e**" & "**PRIMe CAR-e Plus**".

(http://www.car-e.lu/)

In **November 2009**, the Department of the Environment initiated an information campaign for promoting the use of **low energy lightning bulbs**. Following an EU Regulation aiming at a gradual withdrawal of incandescent bulbs,[260] this operation consisted of three main actions: informing on the EC Regulation, raising awareness and concern, and encouraging the use of low energy bulbs. The tools used were TV and radio spots, announcements and advertisements in the newspapers as well as a leaflet distributed to households and available in retail shops and supermarkets. The involvement of the retailers is of course a key point in the success of this operation and in the promotion of low energy bulbs. The *OekoTopten* platform contains a section on lightning bulbs as indicated above.

(http://www.environnement.public.lu/energies_renouvelables/dossiers/ampoules/index.html)

A last tool put in place to inform and raise awareness is ***My Energy***. As presented in ***Section IV.3.3.2*** *[P&M EC07]*, an Energy Agency was created in 1991 to promote renewable energy projects and to inform citizens, the economic sector as well as municipalities on a better use of energy, renewable energy sources and financial public support. During the course of 2008, this Agency was reformed and renamed *Energieagence*.[261] This Agency is a partnership grouping the Department of the Environment, the Ministry of Economic Affairs and External Trade, the electricity and natural gas distributing company *Enovos* (previously *Cegedel*) and the *SEO* (*Société Electrique de l'Our*). Then, the *My Energy* EIG has been established in **2008** to serve as principal contact point for information and advices on energy consumption reduction and on the use or the domestic production of renewable energy sources. *My Energy* partners are the Department of the Environment, the Ministry of Economic Affairs and External Trade and the *Energieagence*. With its team of advisers, My Energy provides services in the following domains:

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259 Refer also to Box IV.3-2 in the same section.

260 EU Regulation (EC) 244/2009: http://www.environnement.public.lu/energies_renouvelables/dossiers/ampoules/reg_eur.pdf.

261 http://www.energieagence.lu/fr.

- how to reduce energy consumption in existing buildings and how to refurbish them in that direction?
- how to ensure low energy and/or energy efficient new constructions?
- how to develop the use of renewable energy sources?
- how to save energy in our every day life?
- what are the financial incentives offered by the Government?
- what is the regulation with regard to the energy balance of housing?

The web site of *My Energy* acts also as an information gateway to all these issues. (http://www.myenergy.lu/fr)

The majority of the actions presented above have also been described when detailing the existing policies and measures: *[P&Ms EC07 & IN03]* ***[→ Section IV.3.3.2 & 3]***.

Finally, an opinion survey conducted in 2007 [Ministry of the Environment (2007)] showed that 32% of the citizens consider the environment "extremely important", 46% "very important", 20% "important", and 2% "of little or no importance". The main topics of interest are climate change, waste reduction and air pollution. Respondents say they are ready to change their habits by saving energy and buying more environmentally friendly products.

IX.1.2. Other operations

Some initiatives aiming at a more environmental friendly behaviour can also be connected to the climate change thematic.

In **2007**, the *SuperDrecksKëscht* (SDK) – cf Box II.11-1 in ***Section II.11*** – initiated a project with the goal of **increasing the visibility of ecological products in the shops and helping consumers in making environmentally correct choices**. For this purpose, supermarkets and retailers are marking these products with the label "Product recommended by the SuperDrecksKëscht". Ecological products selection is done on the basis of predetermined criteria:

- products with environmental friendly packaging, which can be recycled (labelled plastic material or metals);
- products with no or low level of dangerous substances therein; level decided using the criteria of the "*Blaue Engel*" initiative,[262] of the EU-environment label and from EU regulations;
- long lasting products with low energy requirements (determined according to the energy consumption indicated on the packaging);

[262] http://www.blauer-engel.de/ for details (in German).

- products which offer ease of recycling after their usage (or that could be at least used for energy production).

Today, the following product groups are included in the scheme: rechargeable batteries and accessories, low energy lamps and LED-lamps, paints.
This initiative is supported by the "**Clever akafen**" campaign ***[→ Illustration IX.1-4]***[263] and involves, besides the SDK, the *Chambre des Métiers* (chamber of trades), the *Confédération Luxembourgeoise du Commerce* (retail, services and transport employer's association) and the *Union Luxembourgeoise des Consommateurs* (consumer's association). [264] At the present time, some 150 shops participate to the "*Clever akafen*" programme: supermarkets, DIY shops, painting companies and electrical appliances retail shops.
(http://www.superdreckskescht.lu/?t=66&language=EN)

In **June 2008**, the *Energieagence*, the *Centre de Recherche Public Henri Tudor* (CRTE) and *Enovos* created the non-profit organisation ***MyClimateLux***. The main goal of this organisation is to offer, to both the households and the enterprises located in Luxembourg, a range of products and services that turn on four axis:

- raising awareness regarding the causes and the reality of climate change;
- reducing GHG emissions through ad hoc advices to enterprises;
- compensating, on a voluntary basis, residual CO_2 emissions that cannot be avoided;
- realizing projects aiming for mitigating climate change on the national territory.

The actions of *MyClimateLux* are relying on programmes, projects and experiences gained since 2002 in compensating GHG by *MyClimate*. *MyClimate* – "The Climate Protection Partnership" – is a Swiss foundation with which *MyClimateLux* signed a partnership agreement.
The principle behind *MyClimate* is that individuals or businesses compensate for their own GHG emissions and that the money collected that way is used for mitigation projects.
(http://www.myclimate.lu/fr/index.php)

In **October 2008**, the, at that time, Ministry of Transport (today Department of Transport of the MDDI) initiated a campaign promoting "**eco-driving**". Under the motto "*Cool fueren, Spirit Spueren*", a leaflet ***[→ Illustration IX.1-5]***, TV and radio spots, and a dedicated website were launched. Through this campaign, tips for reducing energy consumption when driving are presented in three languages: French, German and Portuguese. These tips were presented as means to increase overall road safety, to reduce fuel consumption, hence GHG emissions, to

263 "*Clever akafen*" could be translated as "buy clever".

264 More information on these partners is available on the following web pages: http://www.cdm.lu/, http://www.clc.lu/ and http://www.ulc.lu/.

extend vehicles lifespan and to improve driving comfort by reducing aggressive and stressful behaviours.[265]

(http://www.ecoconduite.lu/)

In **February 2009**, the Ministry of Economic Affairs and External Trade launched a campaign to inform on the energy performance certificate or "**energy passport**" – *passeport énergétique* in French, *Energiepass* in German – that became compulsory for all residential building since the 1st January 2010: cf Box IV.3-3. This campaign consisted of a press conference completed by a TV spot.

(http://www.eco.public.lu/salle_de_presse/com_presse_et_art_actu/2009/02/09_Energiepass/index.html)

Brochures were already available since 2008, the year the "energy passport" was put into place *[→ Illustration IX.1-6]*.

(http://www.eco.public.lu/attributions/dg3/d_energie/energyefficient/depliant_passeport_energetique.pdf &

http://www.eco.public.lu/attributions/dg3/d_energie/energyefficient/Doc-Mineco-DG3-2008-001_fr.PDF)

Finally, various municipalities organize awareness campaigns at local level, mainly on energy savings and renewable energy sources. They are sometimes financially helped by grants from the MDDI.

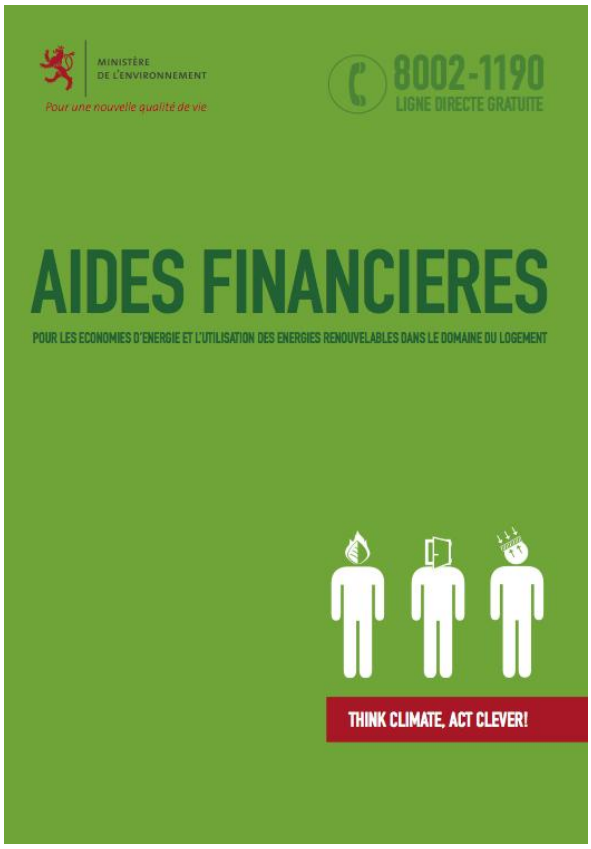
TABLES, FIGURES & ILLUSTRATIONS

ILLUSTRATION IX.1-1 – 2006 CAMPAIGN "LE CHANGEMENT CLIMATIQUE: VOUS POUVEZ LE MAITRISER"

265 From end 2008 onwards, the Department of Transport organises "eco-driving" lessons for driving school instructors and examiners so that this aspect could be included in the driving lessons. From 2009 onwards, these "eco-driving" lessons were opened to all road users on a voluntary basis.

ILLUSTRATION IX.1-2 – 2007 CAMPAIGN "THINK CLIMATE, ACT CLEVER!"

ILLUSTRATION IX.1-3 – 2008 BROCHURE "AIDES FINANCIÈRES / FÖREDERPROGRAMM"



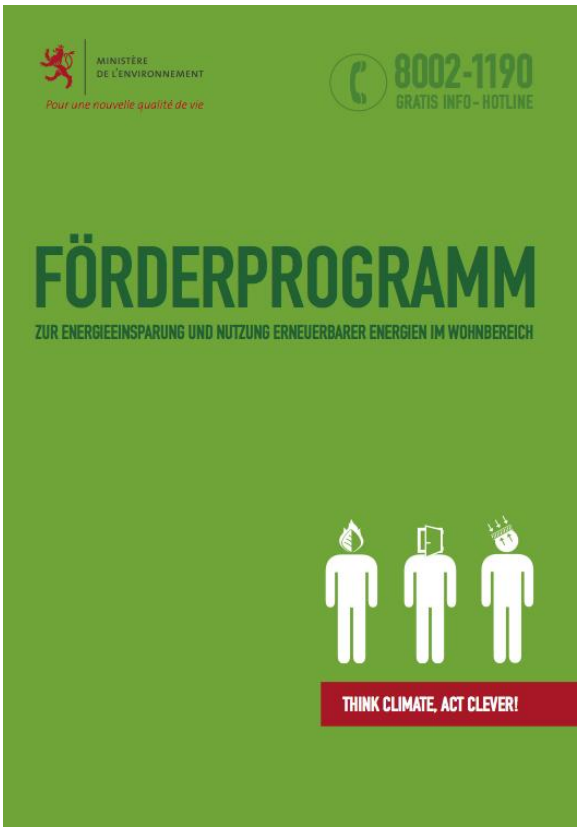


ILLUSTRATION IX.1-4 – 2007 CAMPAIGN "CLEVER AKAFEN"

ILLUSTRATION IX.1-5 – 2008 CAMPAIGN "COOL FUEREN, SPIRIT SPUEREN"

ILLUSTRATION IX.1-6 – ENERGY PASSPORT

IX.2. EDUCATION

A range of actions and initiatives exist in Luxembourg to make children and students conscious of various environmental issues as well as familiar to the concept of sustainable development. Examples of such activities can be read in a distinct section of the environmental web portal. (http://www.environnement.public.lu/kanner/theme_du_mois/index.html)

With regard to climate change, the main activity has been launched in **October 2007**: the "***Klimaquiz***", a competition opened to primary school classes for children between 9 and 11 years old. This operation, foreseen in Luxembourg's "Action Plan for reducing CO_2 emissions" [Ministry of the Environment (2006b)] *[→ Section IV.1.2]*, lasted up to end April 2008 when prize winners have been announced during a closing ceremony in a theatre and the ultimate winner nominated after a quiz on climate change involving the four classes that made it to the final stage. The "*Klimaquiz*" was a common project of the Ministry of the Environment, the National Education Ministry, the *Natur Musée* (national museum of natural history) [266] and the NGO ASTM.[267]Children had to prepare materials dealing with the issue of climate change: it could have been plays, videos, interviews, energy savings tips, etc.; whatever the children found the most suitable to raise awareness and talk about climate change. To support this work, each participating classes received educational brochures: one for the teachers, one for the pupils.[268] (http://klimaquiz.web.myschool.lu/)

IX.3. TRAINING PROGRAMMES

Training programmes in Luxembourg in connection with the climate change problematic are **mostly vocational training initiatives in the field of energy efficiency in buildings**. Several bodies, mainly professional associations or Orders, organizes such trainings. For example:

- the OAI with its 2009 Energy & Construction cycle;[269]
- the *Energie fir d'Zufunft* label of the *Chambre des Métiers* (chamber of trades) that requires vocational trainings for enterprises.[270]

IX.4. "CIVIL SOCIETY" INVOLVEMENT

As emphasized in ***Sections IV.1.2 & IV.1.3***, "civil society" – i.e. stakeholders such as NGOs, professional associations, etc. – have been involved in the setting up of the 2006 "Action Plan for

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266 http://www.mnhn.lu/.

267 *Action Solidarité Tiers Monde*: http://www.astm.lu/.

268 These brochures can be downloaded here (in German): http://klimaquiz.web.myschool.lu/, click on "Materialien zum Downloaden".

269 http://www.oai.lu/index.php?page=45 and http://www.oai.lu/image_news/348/348.jpg.

270 For instance, the 2009-2010 programme: http://www.cdm.lu/pls/CDM/download_file?id=97544&lg=FR&td=CO&ctype=1.

reducing CO_2 emissions" [Ministry of the Environment (2006b)]. That was also the case in 2007, when the Action Plan has been evaluated *[→ Section IV.1.2]*,[271] and it will be again the case in 2010 for the vast consultation announced on climate change and sustainable development *[→ Section IV.1.3]*.

Several NGOs, as well as professional associations such as the FEDIL – the Business Federation of Luxembourg – regularly organize seminars and information sessions that touch upon climate change, renewable energy sources, energy efficiency, mobility, etc.

[271] A one day forum was organized (*Klimaschutz schaaft Chancen*) opened to contributions from various stakeholders: http://www.environnement.public.lu/actualites/2007/04/index.html.

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Annex A.I – Summary tables on emission trends

Excerpts from Luxembourg's 2009v1.4 GHG inventory submission to the UNFCCC secretariat [Ministry of the Environment (2009c)]. The complete inventory is available on: http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/lux_2009_crf_19may.zip.

See Also tables III.1-2, III.1-3 & III.1-4 and the associated figures for details *[→ Section III.1]*.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**11453.26**	**453.54**	**525.10**	**87.04**	**NA,NO**	**3.94**	**12522.88**
1. Energy	**11138.38**	**72.51**	**134.38**				**11345.27**
A. Fuel Combustion (Sectoral Approach)	11138.30	22.01	134.38				11294.69
1. Energy Industries	1358.55	1.47	2.65				1362.66
2. Manufacturing Industries and Construction	1797.60	1.81	19.94				1819.34
3. Transport	6571.27	10.93	101.12				6683.32
4. Other Sectors	1398.13	7.78	9.89				1415.81
5. Other	12.75	0.03	0.78				13.56
B. Fugitive Emissions from Fuels	0.08	50.50	NA,NO				50.58
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	0.08	50.50	NA,NO				50.58
2. Industrial Processes	**692.67**	**NA,NO**	**NA,NO**	**87.04**	**NA,NO**	**3.94**	**783.66**
A. Mineral Products	489.19	NO	NO				489.19
B. Chemical Industry	NO	NO	NO	NA	NA	NA	NA,NO
C. Metal Production	203.49	NA,NO	NA	NA	NA,NO	NA,NO	203.49
D. Other Production	NO						NO
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NA,NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				87.04	NA,NO	3.94	90.98
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**12.98**		**5.83**				**18.81**
4. Agriculture		**345.13**	**365.50**				**710.64**
A. Enteric Fermentation		246.90					246.90
B. Manure Management		98.24	25.65				123.89
C. Rice Cultivation		NA,NO					NA,NO
D. Agricultural Soils [3]		NA,NE	339.85				339.85
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry [1]	**-390.78**	**NE,NO**	**0.13**				**-390.64**
A. Forest Land	-396.47	NE,NO	NE,NO				-396.47
B. Cropland	6.46	NO	0.13				6.59
C. Grassland	-0.76	NO	NO				-0.76
D. Wetlands	NE,NO	NO	NO				NE,NO
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE,NO	NE,NO	NE,NO				NE,NO
G. Other	NE	NE	NE				NE
6. Waste	**IE,NA,NO**	**35.89**	**19.25**				**55.14**
A. Solid Waste Disposal on Land	NA,NO	24.98					24.98
B. Waste-water Handling		3.70	11.79				15.48
C. Waste Incineration	IE	IE	IE				IE
D. Other	NO	7.21	7.47				14.68
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	1328.53	0.20	11.52				1340.24
Aviation	1328.40	0.20	11.52				1340.11
Marine	0.13	0.00	0.00				0.13
Multilateral Operations	**IE**	**IE**	**IE**				**IE**
CO_2 Emissions from Biomass	**357.10**						**357.10**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	12913.52
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	12522.88

TABLE 10 EMISSION TRENDS
CO_2
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**10525.81**	**11078.54**	**10898.28**	**11044.95**	**10285.13**	**8397.32**	**8497.05**	**7981.04**	**7308.09**	**7664.02**
A. Fuel Combustion (Sectoral Approach)	10525.78	11078.51	10898.25	11044.92	10285.10	8397.28	8497.01	7981.00	7308.05	7663.97
1. Energy Industries	1299.25	1242.90	1140.24	1227.91	977.54	833.07	720.17	446.75	164.20	182.38
2. Manufacturing Industries and Construction	5107.88	4937.32	4691.07	4725.24	4214.86	2662.70	2597.58	2192.20	1539.43	1657.23
3. Transport	2701.49	3207.13	3501.26	3546.66	3607.58	3423.22	3523.36	3729.88	3895.85	4196.24
4. Other Sectors	1366.41	1640.41	1514.92	1500.71	1443.91	1459.62	1621.46	1573.21	1648.91	1583.93
5. Other	50.75	50.75	50.75	44.40	41.21	18.67	34.43	38.96	59.68	44.19
B. Fugitive Emissions from Fuels	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
2. Industrial Processes	**1595.57**	**1518.48**	**1448.49**	**1428.47**	**1335.39**	**975.05**	**919.47**	**810.58**	**651.52**	**689.19**
A. Mineral Products	610.65	580.73	595.20	505.28	564.56	509.66	502.87	516.48	510.84	541.49
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Production	984.91	937.74	853.29	923.19	770.83	465.38	416.60	294.10	140.69	147.70
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	14.64	14.06	13.32	12.62	11.66	12.16	12.18	12.11	11.33	11.11
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry[(2)]	**208.31**	**31.27**	**-339.37**	**-450.90**	**-281.42**	**-384.99**	**-559.24**	**-600.88**	**-345.35**	**-470.18**
A. Forest Land	205.10	27.95	-342.81	-454.46	-285.40	-388.73	-562.84	-604.96	-349.99	-473.92
B. Cropland	3.97	4.09	4.21	4.32	4.75	4.50	4.37	4.84	5.40	4.50
C. Grassland	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**12344.32**	**12642.34**	**12020.72**	**12035.13**	**11350.77**	**8999.53**	**8869.46**	**8202.85**	**7625.60**	**7894.13**
Total CO_2 emissions excluding net CO_2 from LULUCF	**12136.02**	**12611.07**	**12360.09**	**12486.04**	**11632.18**	**9384.52**	**9428.70**	**8803.73**	**7970.95**	**8364.31**
Memo Items:										
International Bunkers	**402.05**	**417.77**	**405.22**	**402.12**	**508.89**	**577.98**	**628.22**	**766.40**	**863.74**	**1014.48**
Aviation	401.98	417.69	405.15	402.02	508.80	577.90	628.15	766.32	863.66	1014.39
Marine	0.07	0.07	0.07	0.10	0.08	0.08	0.08	0.08	0.08	0.09
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass	166.27	168.15	170.95	166.54	164.68	161.00	143.40	154.68	143.30	152.27

TABLE 10 EMISSION TRENDS
CO_2
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**8171.86**	**8569.75**	**9614.79**	**10143.78**	**11533.66**	**11668.12**	**11530.73**	**11138.38**	**5.82**
A. Fuel Combustion (Sectoral Approach)	8171.82	8569.71	9614.72	10143.71	11533.58	11668.05	11530.65	11138.30	5.82
1. Energy Industries	186.10	211.59	1164.36	1195.78	1438.08	1452.84	1522.69	1358.55	4.56
2. Manufacturing Industries and Construction	1682.39	1573.82	1524.34	1471.03	1603.89	1687.48	1691.46	1797.60	-64.81
3. Transport	4730.44	5026.57	5375.56	5937.34	6794.48	7016.55	6842.18	6571.27	143.25
4. Other Sectors	1519.60	1692.66	1531.06	1530.20	1684.13	1495.25	1464.73	1398.13	2.32
5. Other	53.29	65.06	19.40	9.37	13.00	15.92	9.59	12.75	-74.87
B. Fugitive Emissions from Fuels	0.05	0.05	0.07	0.07	0.08	0.08	0.08	0.08	175.55
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	0.05	0.05	0.07	0.07	0.08	0.08	0.08	0.08	175.55
2. Industrial Processes	**715.45**	**659.03**	**674.75**	**615.86**	**657.49**	**649.90**	**702.87**	**692.67**	**-56.59**
A. Mineral Products	569.40	504.27	519.34	463.92	505.04	496.98	493.08	489.19	-19.89
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal Production	146.05	154.76	155.40	151.94	152.45	152.92	209.79	203.49	-79.34
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use	9.99	11.12	11.28	11.29	13.24	12.86	12.14	12.98	-11.29
4. Agriculture									
A. Enteric Fermentation									
B. Manure Management									
C. Rice Cultivation									
D. Agricultural Soils									
E. Prescribed Burning of Savannas									
F. Field Burning of Agricultural Residues									
G. Other									
5. Land Use, Land-Use Change and Forestry[(2)]	**-471.51**	**-542.27**	**-546.32**	**-559.19**	**-518.13**	**-493.55**	**-388.82**	**-390.78**	**-287.60**
A. Forest Land	-476.01	-547.17	-551.84	-564.62	-523.17	-500.07	-394.49	-396.47	-293.30
B. Cropland	5.27	5.67	6.28	6.19	5.80	7.29	6.43	6.46	62.79
C. Grassland	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	0.00
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0.00
6. Waste	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**IE,NA,NO**	**0.00**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
B. Waste-water Handling									
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	0.00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total CO_2 emissions including net CO_2 from LULUCF	**8425.80**	**8697.64**	**9754.49**	**10211.74**	**11686.26**	**11837.33**	**11856.93**	**11453.26**	**-7.22**
Total CO_2 emissions excluding net CO_2 from LULUCF	**8897.31**	**9239.90**	**10300.82**	**10770.93**	**12204.39**	**12330.88**	**12245.75**	**11844.04**	**-2.41**
Memo Items:									
International Bunkers	**979.95**	**1058.45**	**1146.38**	**1193.50**	**1300.25**	**1319.13**	**1237.48**	**1328.53**	**230.44**
Aviation	979.84	1058.35	1146.27	1193.39	1300.15	1318.99	1237.33	1328.40	230.46
Marine	0.10	0.10	0.11	0.11	0.11	0.14	0.15	0.13	83.18
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	0.00
CO_2 Emissions from Biomass	153.41	155.86	156.38	174.09	188.58	183.84	194.93	357.10	114.77

TABLE 10 EMISSION TRENDS
CH_4
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	2.64	2.92	2.92	2.82	2.79	2.74	2.91	2.83	2.81	2.84
A. Fuel Combustion (Sectoral Approach)	1.77	2.01	1.97	1.84	1.79	1.62	1.66	1.55	1.52	1.51
1. Energy Industries	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.05
2. Manufacturing Industries and Construction	0.16	0.15	0.14	0.14	0.13	0.09	0.10	0.08	0.07	0.07
3. Transport	1.19	1.40	1.39	1.27	1.24	1.10	1.13	1.03	0.99	0.98
4. Other Sectors	0.38	0.41	0.39	0.39	0.38	0.38	0.40	0.40	0.42	0.41
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Fugitive Emissions from Fuels	0.87	0.91	0.95	0.98	0.99	1.12	1.24	1.28	1.29	1.33
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0.87	0.91	0.95	0.98	0.99	1.12	1.24	1.28	1.29	1.33
2. Industrial Processes	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**
A. Mineral Products	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 Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use										
4. Agriculture	**16.98**	**17.26**	**16.76**	**17.01**	**16.89**	**17.45**	**17.62**	**17.49**	**17.53**	**18.00**
A. Enteric Fermentation	12.90	12.84	12.31	12.41	12.29	12.63	12.78	12.53	12.40	12.39
B. Manure Management	4.08	4.42	4.45	4.60	4.59	4.81	4.84	4.96	5.13	5.62
C. Rice Cultivation	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**
A. Forest Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,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	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**2.57**	**2.48**	**2.40**	**2.34**	**2.27**	**2.21**	**2.18**	**2.16**	**2.14**	**2.08**
A. Solid Waste Disposal on Land	2.28	2.20	2.12	2.05	1.98	1.92	1.90	1.85	1.81	1.75
B. Waste-water Handling	0.29	0.28	0.28	0.27	0.26	0.26	0.25	0.24	0.23	0.22
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	NO	NO	NO	0.02	0.03	0.03	0.03	0.06	0.11	0.11
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**22.19**	**22.66**	**22.08**	**22.18**	**21.94**	**22.39**	**22.70**	**22.48**	**22.49**	**22.92**
Total CH_4 emissions excluding CH_4 from LULUCF	**22.19**	**22.66**	**22.08**	**22.18**	**21.94**	**22.39**	**22.70**	**22.48**	**22.49**	**22.92**
Memo Items:										
International Bunkers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
Marine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass										

TABLE 10 EMISSION TRENDS
CH_4
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	2.89	2.91	3.51	3.50	3.76	3.59	3.63	3.45	30.67
A. Fuel Combustion (Sectoral Approach)	1.51	1.49	1.43	1.38	1.37	1.25	1.17	1.05	-40.77
1. Energy Industries	0.04	0.04	0.06	0.06	0.07	0.07	0.07	0.07	66.32
2. Manufacturing Industries and Construction	0.08	0.07	0.07	0.07	0.08	0.08	0.08	0.09	-45.02
3. Transport	0.98	0.95	0.90	0.86	0.82	0.71	0.63	0.52	-56.34
4. Other Sectors	0.41	0.42	0.39	0.39	0.41	0.38	0.38	0.37	-1.46
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-58.17
B. Fugitive Emissions from Fuels	1.37	1.42	2.09	2.12	2.39	2.34	2.46	2.40	175.55
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	1.37	1.42	2.09	2.12	2.39	2.34	2.46	2.40	175.55
2. Industrial Processes	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**0.00**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use									
4. Agriculture	**17.60**	**17.57**	**17.10**	**16.60**	**16.36**	**16.53**	**16.34**	**16.43**	**-3.19**
A. Enteric Fermentation	12.22	12.28	11.94	11.59	11.48	11.46	11.35	11.76	-8.87
B. Manure Management	5.38	5.28	5.15	5.01	4.88	5.06	4.99	4.68	14.77
C. Rice Cultivation	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.00
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	0.00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**0.00**
A. Forest Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	0.00
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0.00
6. Waste	**2.18**	**1.91**	**1.72**	**1.77**	**1.71**	**1.72**	**1.75**	**1.71**	**-33.54**
A. Solid Waste Disposal on Land	1.76	1.51	1.28	1.27	1.22	1.22	1.21	1.19	-47.81
B. Waste-water Handling	0.21	0.21	0.20	0.19	0.19	0.18	0.18	0.18	-39.69
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	0.00
D. Other	0.21	0.20	0.24	0.31	0.30	0.32	0.36	0.34	100.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total CH_4 emissions including CH_4 from LULUCF	**22.67**	**22.39**	**22.33**	**21.87**	**21.83**	**21.84**	**21.72**	**21.60**	**-2.68**
Total CH_4 emissions excluding CH_4 from LULUCF	**22.67**	**22.39**	**22.33**	**21.87**	**21.83**	**21.84**	**21.72**	**21.60**	**-2.68**
Memo Items:									
International Bunkers	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	230.12
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	230.46
Marine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.18
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	0.00
CO_2 Emissions from Biomass									

TABLE 10 EMISSION TRENDS
N_2O
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**0.20**	**0.22**	**0.26**	**0.29**	**0.30**	**0.28**	**0.30**	**0.32**	**0.34**	**0.35**
A. Fuel Combustion (Sectoral Approach)	0.20	0.22	0.26	0.29	0.30	0.28	0.30	0.32	0.34	0.35
1. Energy Industries	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
2. Manufacturing Industries and Construction	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.04	0.05
3. Transport	0.12	0.14	0.18	0.21	0.23	0.23	0.24	0.26	0.26	0.26
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	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01
B. Fugitive Emissions from Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Industrial Processes	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**
A. Mineral Products	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 Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
4. Agriculture	**1.35**	**1.35**	**1.40**	**1.35**	**1.29**	**1.33**	**1.35**	**1.35**	**1.34**	**1.31**
A. Enteric Fermentation										
B. Manure Management	0.13	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.08
C. Rice Cultivation										
D. Agricultural Soils	1.22	1.24	1.29	1.25	1.19	1.23	1.25	1.25	1.25	1.24
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. 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	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,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	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**0.03**	**0.03**	**0.03**	**0.03**	**0.04**	**0.04**	**0.03**	**0.04**	**0.04**	**0.04**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.01	0.01
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**1.61**	**1.63**	**1.72**	**1.70**	**1.65**	**1.67**	**1.71**	**1.73**	**1.74**	**1.72**
Total N_2O emissions excluding N_2O from LULUCF	**1.61**	**1.63**	**1.72**	**1.70**	**1.65**	**1.67**	**1.71**	**1.73**	**1.74**	**1.72**
Memo Items:										
International Bunkers	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**
Aviation	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03
Marine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass										

TABLE 10 EMISSION TRENDS
N_2O
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**0.38**	**0.37**	**0.34**	**0.37**	**0.43**	**0.45**	**0.43**	**0.43**	**119.21**
A. Fuel Combustion (Sectoral Approach)	0.38	0.37	0.34	0.37	0.43	0.45	0.43	0.43	119.21
1. Energy Industries	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	56.85
2. Manufacturing Industries and Construction	0.06	0.04	0.04	0.04	0.04	0.07	0.06	0.06	51.96
3. Transport	0.28	0.29	0.29	0.31	0.34	0.34	0.33	0.33	173.39
4. Other Sectors	0.01	0.01	0.01	0.01	0.03	0.02	0.03	0.03	161.29
5. Other	0.02	0.02	0.00	0.00	0.01	0.01	0.00	0.00	-86.38
B. Fugitive Emissions from Fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
2. Industrial Processes	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**0.00**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	0.00
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-37.08
4. Agriculture	**1.33**	**1.23**	**1.22**	**1.09**	**1.25**	**1.14**	**1.14**	**1.18**	**-12.72**
A. Enteric Fermentation									
B. Manure Management	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.08	-36.84
C. Rice Cultivation									
D. Agricultural Soils	1.26	1.15	1.15	1.02	1.18	1.07	1.07	1.10	-10.12
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	0.00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. 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**
A. Forest Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	0.00
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0.00
6. Waste	**0.05**	**0.05**	**0.05**	**0.05**	**0.06**	**0.06**	**0.06**	**0.06**	**106.22**
A. Solid Waste Disposal on Land									
B. Waste-water Handling	0.03	0.04	0.03	0.03	0.04	0.04	0.04	0.04	26.24
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	0.00
D. Other	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.02	100.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total N_2O emissions including N_2O from LULUCF	**1.78**	**1.66**	**1.63**	**1.53**	**1.76**	**1.66**	**1.65**	**1.69**	**5.28**
Total N_2O emissions excluding N_2O from LULUCF	**1.78**	**1.66**	**1.63**	**1.53**	**1.76**	**1.66**	**1.65**	**1.69**	**5.28**
Memo Items:									
International Bunkers	**0.03**	**0.03**	**0.03**	**0.03**	**0.04**	**0.04**	**0.03**	**0.04**	**230.44**
Aviation	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.04	230.46
Marine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.18
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	0.00
CO_2 Emissions from Biomass									

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990) (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	1995 (Gg)	1996 (Gg)	1997 (Gg)	1998 (Gg)	1999 (Gg)
Emissions of HFCs[3] - ($Gg\ CO_2$ equivalent)	**14.21**	**14.21**	**14.21**	**14.21**	**14.21**	**14.21**	**19.97**	**25.73**	**31.49**	**37.25**
HFC-23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-41	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-43-10mee	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-134	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-134a	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-143	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-143a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-236fa	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
HFC-245ca	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Unspecified mix of listed HFCs[4] - ($Gg\ CO_2$ equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Emissions of PFCs[3] - ($Gg\ CO_2$ equivalent)	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**
CF_4	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_2F_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs[4] - ($Gg\ CO_2$ equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF6[3] - ($Gg\ CO_2$ equivalent)	**2.91**	**2.91**	**2.91**	**2.91**	**2.91**	**2.91**	**3.03**	**3.15**	**3.28**	**3.40**
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**43.01**	**50.92**	**58.82**	**66.73**	**74.63**	**82.54**	**87.04**	**87.04**	**512.67**
HFC-23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	400.00
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59726.09
HFC-41	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
HFC-43-10mee	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
HFC-125	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	5076.20
HFC-134	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
HFC-134a	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	312.27
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00
HFC-143	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
HFC-143a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3709.60
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41340.00
HFC-236fa	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
HFC-245ca	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**0.00**
CF_4	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_2F_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
c-C_4F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Emissions of SF6[3] - (Gg CO_2 equivalent)	**3.52**	**3.57**	**3.62**	**3.68**	**3.73**	**3.78**	**3.86**	**3.94**	**35.45**
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.45

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	12344.32	12642.34	12020.72	12035.13	11350.77	8999.53	8869.46	8202.85	7625.60	7894.13
CO_2 emissions excluding net CO_2 from LULUCF	12136.02	12611.07	12360.09	12486.04	11632.18	9384.52	9428.70	8803.73	7970.95	8364.31
CH_4 emissions including CH_4 from LULUCF	466.01	475.88	463.74	465.70	460.77	470.12	476.75	471.99	472.24	481.39
CH_4 emissions excluding CH_4 from LULUCF	466.01	475.88	463.74	465.70	460.77	470.12	476.75	471.99	472.24	481.39
N_2O emissions including N_2O from LULUCF	498.78	504.46	532.63	527.39	512.58	518.34	529.26	537.37	539.11	534.45
N_2O emissions excluding N_2O from LULUCF	498.65	504.33	532.50	527.26	512.45	518.20	529.12	537.23	538.97	534.31
HFCs	14.21	14.21	14.21	14.21	14.21	14.21	19.97	25.73	31.49	37.25
PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
SF_6	2.91	2.91	2.91	2.91	2.91	2.91	3.03	3.15	3.28	3.40
Total (including LULUCF)	**13326.23**	**13639.81**	**13034.21**	**13045.34**	**12341.23**	**10005.10**	**9898.47**	**9241.09**	**8671.71**	**8950.63**
Total (excluding LULUCF)	**13117.79**	**13608.40**	**13373.44**	**13496.11**	**12622.52**	**10389.96**	**10457.57**	**9841.83**	**9016.93**	**9420.67**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	10642.61	11206.87	11040.68	11193.10	10437.03	8542.38	8650.90	8140.36	7471.07	7831.63
2. Industrial Processes	1612.68	1535.59	1465.61	1445.58	1352.51	992.16	942.47	839.46	686.29	729.84
3. Solvent and Other Product Use	23.90	22.98	21.88	20.85	19.57	19.74	19.42	19.00	17.88	17.30
4. Agriculture	775.27	781.29	785.20	776.84	754.92	778.38	788.82	786.47	784.10	785.24
5. Land Use, Land-Use Change and Forestry (5)	208.44	31.41	-339.23	-450.77	-281.28	-384.86	-559.10	-600.74	-345.22	-470.04
6. Waste	63.34	61.67	60.07	59.74	58.49	57.30	55.97	56.53	57.60	56.66
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**13326.23**	**13639.81**	**13034.21**	**13045.34**	**12341.23**	**10005.10**	**9898.47**	**9241.09**	**8671.71**	**8950.63**

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.4
LUXEMBOURG

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	8425.80	8697.64	9754.49	10211.74	11686.26	11837.33	11856.93	11453.26	-7.22
CO_2 emissions excluding net CO_2 from LULUCF	8897.31	9239.90	10300.82	10770.93	12204.39	12330.88	12245.75	11844.04	-2.41
CH_4 emissions including CH_4 from LULUCF	476.10	470.18	468.92	459.22	458.41	458.63	456.11	453.54	-2.68
CH_4 emissions excluding CH_4 from LULUCF	476.10	470.18	468.92	459.22	458.41	458.63	456.11	453.54	-2.68
N_2O emissions including N_2O from LULUCF	551.33	515.68	505.96	473.95	544.92	515.02	511.39	525.10	5.28
N_2O emissions excluding N_2O from LULUCF	551.20	515.54	505.83	473.82	544.79	514.88	511.26	524.96	5.28
HFCs	43.01	50.92	58.82	66.73	74.63	82.54	87.04	87.04	512.67
PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
SF_6	3.52	3.57	3.62	3.68	3.73	3.78	3.86	3.94	35.45
Total (including LULUCF)	**9499.77**	**9737.98**	**10791.82**	**11215.31**	**12767.95**	**12897.29**	**12915.33**	**12522.88**	**-6.03**
Total (excluding LULUCF)	**9971.14**	**10280.11**	**11338.01**	**11774.37**	**13285.95**	**13390.71**	**13304.02**	**12913.52**	**-1.56**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
1. Energy	8349.84	8744.46	9795.25	10330.46	11745.22	11882.12	11740.68	11345.27	6.60
2. Industrial Processes	761.99	713.53	737.19	686.27	735.85	736.22	793.78	783.66	-51.41
3. Solvent and Other Product Use	15.81	16.54	16.76	16.80	18.80	18.47	17.88	18.81	-21.29
4. Agriculture	782.18	749.90	737.40	686.65	732.56	699.54	695.54	710.64	-8.34
5. Land Use, Land-Use Change and Forestry[5]	-471.37	-542.13	-546.19	-559.06	-518.00	-493.42	-388.69	-390.64	-287.41
6. Waste	61.32	55.69	51.42	54.19	53.52	54.36	56.14	55.14	-12.94
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)[5]	**9499.77**	**9737.98**	**10791.82**	**11215.31**	**12767.95**	**12897.29**	**12915.33**	**12522.88**	**-6.03**

[1] 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 COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[2] Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[3] 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 CO_2 equivalent emissions.

[4] In accordance with the UNFCCC reporting guidelines, 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 Gg of CO_2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

[5] Includes net CO_2, CH_4 and N_2O from LULUCF.

Tables below details methodologies, data sources and emission factors used by Luxembourg for submission 2009v1.4. They are constructed on the basis of the table presented in Annex I of Community Decision 2005/166/EC. They are an expansion of table Summary 3 of the CRF.

Table I -1: Community summary report for methods, activity data and emission factors used (Energy)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4					
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method a (2)
1. Energy										
A. Fuel Combustion										
1. Energy Industries										
a. Public Electricity and Heat Production		T1 T2	NS PS IS	CS D		T1	NS PS IS	D		T1
b. Petroleum Refining		NA	NO	NA		NA	NO	NA		NA
c. Manufacture of Solid Fuels and Other Energy Industries		NA	NO	NA		NA	NO	NA		NA
2. Manufacturing Industries and Construction										
a. Iron and Steel		T1 T2	NS PS IS	CS D PS		T1	NS PS IS	D		T1
b. Non-Ferrous Metals		T1 T2	NS PS	CS D		T1	NS PS	D		T1
c. Chemicals		T1 T2	NS PS	CS D		T1	NS PS	D		T1
d. Pulp, Paper and Print		NA	NO	NA		NA	NO	NA		NA
e. Food Processing, Beverages and Tobacco		T1 T2	NS PS	CS D		T1	NS PS	D		T1
f. Other *(as specified in table 1.A(a)s2)*		T1 T2	NS PS IS	CS D PS		T1	NS PS IS	D		T1
3. Transport										
a. Civil Aviation		T1	NS PS	D		T1	NS PS	D		T1
b. Road Transportation		COPERT IV	NS	D OTH		COPERT IV	NS	D OTH		COPER
c. Railways		T1	NS PS	D		T1	NS PS	D		T1
d. Navigation		T1	PS	D		T1	PS	D		T1
e. Other Transportation *(as specified in table 1.A(a)s3)*		NA	NA	NA		NA	NA	NA		NA
4. Other Sectors										
a. Commercial/Institutional		T1 T2	NS IS	CS D		T1	NS IS	D		T1
b. Residential		T1 T2	NS IS	CS D		T1	NS IS	D		T1
c. Agriculture/Forestry/Fisheries		T1	NS IS	D		T1	NS IS	D		T1
5. Other										
a. Stationary		T1	NS IS	D		T1	NS IS	D		T1
b. Mobile		T1	NS IS	D		T1	NS IS	D		T1
B. Fugitive Emissions from Fuels										
1. Solid Fuels										
a. Coal Mining		NA	NO	NA		NA	NO	NA		NA
b. Solid Fuel Transformation		NA	NO	NA		NA	NO	NA		NA
c. Other *(as specified in table 1.B.1)*		NA	NO	NA		NA	NO	NA		NA
2. Oil and Natural Gas										
a. Oil		NA	NE	NA		NA	NE	NA		NA
b. Natural Gas		T1	NS	D		T1	NS	D		
c. Venting and Flaring		NA	NO	NA		NA	NO	NA		NA
d. Other *(as specified in table 1.B.2)*		NA	NA	NA		NA	NA	NA		NA

Table I -2: Community summary report for methods, activity data and emission factors used (industrial processes)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O				HFCs				PFCs				SF_6			
CATEGORIES	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]	Key source [1]	Method applied [2]	Activity data [3]	Emission factor [4]
2. Industrial Processes																								
A. Mineral Products		CS T2	PS	CS PS		NA	NO	NA		NA	NO	NA												
1. Cement Production		T2	PS	CS PS																				
2. Lime Production		NA	NO	NA																				
3. Limestone and Dolomite Use		NA	IE	NA																				
4. Soda Ash Production and Use		NA	IE	NA																				
5. Asphalt Roofing		NA	NO	NA																				
6. Road Paving with Asphalt		NA	NO	NA																				
7. Other *(as specified in table 2(I)A-G)*		CS	PS	PS		NA	NO	NA		NA	NO	NA												
B. Chemical Industry		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA
1. Ammonia Production		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA
2. Nitric Acid Production										NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA
3. Adipic Acid Production		NA	NO	NA						NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA
4. Carbide Production		NA	NO	NA		NA	NO	NA						NA	NO	NA		NA	NO	NA		NA	NO	NA
5. Other *(as specified in table 2(I)A-G)*		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA
C. Metal Production		CS T2	NS PS	CS		NA	NO	NA		NA	NO	NA						NA	NO	NA		NA	NO	NA
1. Iron and Steel Production		CS T2	NS PS	CS		NA	NO	NA										NA	NO	NA		NA	NO	NA
2. Ferroalloys Production		NA	NO	NA		NA	NO	NA										NA	NO	NA		NA	NO	NA
3. Aluminium Production		NA	NO	NA		NA	NO	NA										NA	NO	NA		NA	NO	NA
4. SF_6 Used in Aluminium and Magnesium Foundries																						NA	NO	NA
5. Other *(as specified in table 2(I)A-G)*		NA	NO	NA		NA	NO	NA		NA	NO	NA						NA	NO	NA		NA	NO	NA
D. Other Production		NA	NO	NA																				
1. Pulp and Paper																								
2. Food and Drink		NA	NO	NA																				
E. Production of Halocarbons and SF_6														NA	NO	NA		NA	NO	NA		NA	NO	NA
1. By-product Emissions														NA	NO	NA		NA	NO	NA		NA	NO	NA
2. Fugitive Emissions														NA	NO	NA		NA	NO	NA		NA	NO	NA
3. Other *(as specified in table 2(II)*														NA	NO	NA		NA	NO	NA		NA	NO	NA
F. Consumption of Halocarbons and SF_6														CS	Q	CS		NA	NO	NA		CS	Q	CS
1. Refrigeration and Air Conditioning Equipment														CS	Q	CS		NA	NO	NA		NA	NO	NA
2. Foam Blowing														CS	NS	CS		NA	NO	NA		NA	NO	NA
3. Fire Extinguishers														NA	NO	NA		NA	NO	NA		NA	NO	NA
4. Aerosols/ Metered Dose Inhalers														CS	Q	CS		NA	NO	NA		NA	NO	NA
5. Solvents														NA	NO	NA		NA	NO	NA		NA	NO	NA
6. Other applications using ODS substitutes														NA	NO	NA		NA	NO	NA		NA	NO	NA
7. Semiconductor Manufacture														NA	NO	NA		NA	NO	NA		NA	NO	NA
8. Electrical Equipment														NA	NO	NA		NA	NO	NA		CS	Q	CS
9. Other *(as specified in table 2(II)*														NA	NO	NA		NA	NO	NA		CS	Q	CS
G. Other		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA		NA	NO	NA

Table I -3: Community summary report for methods, activity data and emission factors used (solvent and other product use, agriculture)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
3. Solvent and Other Product Use												
A. Paint Application		M	NS	M								
B. Degreasing and Dry Cleaning		M	NS	M						NA	NE	NA
C. Chemical Products, Manufacture and Processing												
D. Other		M	NS	M						CS	NS	CS
4. Agriculture												
A. Enteric Fermentation						T1 T2	NS	CS D				
1. Cattle						T2	NS	CS				
2. Buffalo						NA	NO	NA				
3. Sheep						T1	NS	D				
4. Other						T1	NS	D				
B. Manure Management						T1 T2	NS	CS D		T1	EJ	D
1. Cattle						T2	NS	CS		T1	EJ	D
2. Buffalo						NA	NO	NA		NA	NO	NA
3. Sheep						T1	NS	D		T1	EJ	D
4. Other						T1	NS	D		T1	EJ	D
8. Swine						T1	NS	D		T1	EJ	D
13. Solid Storage and Dry Lot										T1	EJ	D
C. Rice Cultivation						NA	NO	NA				
D. Agricultural Soils						NA	NO	NA		T1 T1a T1b	EJ NS	D
1. Direct Soil Emissions						NA	NA	NA		T1a T1b	EJ NS	D
2. Pasture, range and paddock manure										T1	EJ	D
3. Indirect Emissions						NA	NA	NA		T1b	EJ NS	D
4. Other *(as specified in table 4.D)*						NA	NO	NA		NA	NO	NA
E. Prescribed Burning of Savannas						NA	NO	NA		NA	NO	NA
F. Field Burning of Agricultural Residues						NA	NO	NA		NA	NO	NA
G. Other						NA	NO	NA		NA	NO	NA

Table I -4: Community summary report for methods, activity data and emission factors used (land-use change and forestry, waste, other)

GREENHOUSE GAS SOURCE AND SINK	CO_2				CH_4				N_2O			
CATEGORIES	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)	Key source (1)	Method applied (2)	Activity data (3)	Emission factor (4)
5. Land-Use, Land-Use Change and Forestry												
A. Forest Land		T1 T2	Q	CS D		NA	NE	NA		NA	NE	NA
1. Forest Land remaining Forest Lands		T2	Q	CS		NA	NE	NA		NA	NE	NA
2. Land converted to Forest Lands		T1	Q	CS D		NA	NO	NA		NA	NE	NA
B. Cropland		T1	Q	CS D		NA	NO	NA		T1	Q	D
1. Cropland remaining Cropland		T1	Q	CS D		NA	NO	NA		NA	NO	NA
2. Land converted to Cropland		T1	Q	CS D		NA	NO	NA		T1	Q	D
C. Grassland		T1	Q	D		NA	NO	NA		NA	NO	NA
1. Grassland remaining Grassland		NA	NO	NA		NA	NO	NA		NA	NO	NA
2. Land converted to Grassland		T1	Q	D		NA	NO	NA		NA	NO	NA
D. Wetlands		NA	NE	NA		NA	NO	NA		NA	NO	NA
1. Wetlands remaining Wetlands		NA	NE	NA		NA	NO	NA		NA	NO	NA
2. Land converted to Wetlands		NA	NO	NA		NA	NO	NA		NA	NO	NA
E. Settlements		NA	NE	NA		NA	NE	NA		NA	NE	NA
1. Settlements remaining Settlements		NA	NE	NA		NA	NE	NA		NA	NE	NA
2. Land converted to Settlements		NA	NE	NA		NA	NE	NA		NA	NE	NA
F. Other Land		NA	NE	NA		NA	NE	NA		NA	NE	NA
1. Other Land remaining Other Land						NA	NE	NA		NA	NE	NA
2. Land converted to Other Land		NA	NE	NA		NA	NE	NA		NA	NE	NA
G. Other (please specify)		NA	NE	NA		NA	NE	NA		NA	NE	NA
Harvested Wood Products		NA	NE	NA		NA	NE	NA		NA	NE	NA
6. Waste												
A. Solid Waste Disposal on Land		NA	NO	NA		T2	NS	D				
1. Managed Waste Disposal on Land		NA	NO	NA		T2	NS	D				
2. Unmanaged Waste Disposal Sites		NA	NO	NA		NA	NO	NA				
3. Other *(as specified in table 6.A)*		NA	NA	NA		NA	NA	NA				
B. Wastewater Handling						T1	NS	D		T1	NS	D PS
1. Industrial Wastewater						NA	NE	NA		T1	PS	PS
2. Domestic and Commercial Wastewater						T1	NS	CS		T1	NS	D
3. Other *(as specified in table 6.B)*						NA	NA	NA		NA	NA	NA
C. Waste Incineration		T2	NS Q	D		T1	NS Q	D		T1	NS Q	D
D. Other		NA	NO	NA		T1	NS PS	D		T1	NS PS	D
7. Other (as specified in Summary 1.A)												
Memo Items: (8)												
International Bunkers		T1	NS	D		T1	NS	D		T1	NS	D
Aviation		T1	NS	D		T1	NS	D		T1	NS	D
Marine		T1	NS	D		T1	NS	D		T1	NS	D
CO_2 Emissions from Biomass		T1	NS PS	D OTH								

Legend for tables I -1 to I -4

(1) Key sources of the Community. To be completed by Commission/EEA with results from key category analysis from previous inventory submission.

(2) Use the following notation keys to specify the method applied:

D (IPCC default), **T1a, T1b, T1c** (IPCC Tier 1a, Tier 1b and Tier 1c, respectively), **C** (CORINAIR), **COPERT X** (Copert Model X = Version)
RA (Reference Approach), **T2** (IPCC Tier 2), **CS** (Country Specific).
T1 (IPCC Tier 1), **T3** (IPCC Tier 3), **M** (Model)

If using more than one method within one source category, enumerate the relevant methods. Explanations regarding country-specific methods or any modifications to the default IPCC methods, as well as information regarding the use of
Different methods per source category where more than one method is indicated, should be provided in the documentation box.

(3) Use the following notation keys to specify the sources of activity data used :

NS (national statistics), **IS** (International statistics), **AS** (associations, business organizations)
RS (regional statistics), **PS** (Plant Specific data). **Q** (specific questionnaires, surveys)

If keys above are not appropriate for national circumstances, use additional keys and explain those in the documentation box.
Where a mix of AD sources has been used, use different notations in one and the same cells with further explanations in the documentation box.

(4) Use the following notation keys to specify the emission factor used:

D (IPCC default), **CS** (Country Specific),
C (CORINAIR), **PS** (Plant Specific).

Where a mix of emission factors has been used, use different notations in one and the same cells with further explanations in the documentation box.

Documentation box:
* The full information on methodological issues, such as methods, activity data and emission factors used, can be found in the relevant sector sections of chapter 5 of the NIR. If any additional information is needed to understand the content of this table, use this documentation box to provide references to the relevant section of the NIR where further details can be found.
* Where a mix of methods/ emission factors has been used within one source category, use this documentation box to specify those methods/emission factors for the various sub-sources where they have been applied (see also footnotes 2 to 4 to this table).

1.A.1.a - CO2 - method	a T1 method has been applied for liquid fuels, a T2 method for solid & gaseous & other fuels. The latter covers municipal solid waste incineration with energy recovery. For biomass, a T2 method has been applied for the years 1990 & 1991, then, from 1992 onwards, a mix of T1 & T2 methods were applied according to the bio-fuel.
1.A.1.a - CO2 - EF	CS EFs have been used for solid and gaseous fuels.
1.A.1.a - all gases - AD	for liquid fuels: PS for steel industry up to 1997 (power plant runned by the steel industry and stopped when Luxembourg's steel industry move from blast furnaces to electrical arc furnaces was completed); NS & PS for all other plants; for solid fuels: PS for steel industry up to 1997 (see above). 1.A.1.a - solid fuels = NO from 1998 onwards since the last blast furnaces stopped its activities in September 1997 and since Luxembourg has no thermal power plant using solid fuels; for gaseous fuels: PS for steel industry up to 1997 (see above) ; NS & PS for all other plants (including Twinerg); for other fuels: covers municipal solid waste incineration with energy recovery. AD are a mix of NS (waste treated every year by the incinerator) and of Q data (analysis of the incinerated waste composition for the years 1992-94, 2001 and 2004-05).
1.A.2.a - CO2 - method	a T1 method has been applied for liquid fuels, a T2 method for gaseous fuels and a mix of T1 & T2 methods for solid fuels.
1.A.2.a - CO2 - EF	CS EFs have been used for gaseous fuels and a mix of CS & PS EFs for solid fuels.
1.A.2.a - all gases - AD	a combination of PS data (bottom-up) and NS & IS (top-down) was used.
1.A.2.b - CO2 - method	a T1 method has been applied for liquid fuels, a T2 method for gaseous fuels.
1.A.2.b - CO2 - EF	CS EFs have been used for gaseous fuels.
1.A.2.b - all gases - AD	a combination of PS data (bottom-up) and NS & IS (top-down) was used.
1.A.2.c - CO2 - method	a T1 method has been applied for liquid fuels, a T2 method for gaseous fuels.
1.A.2.c - CO2 - EF	CS EFs have been used for gaseous fuels.
1.A.2.c - all gases - AD	a combination of PS data (bottom-up) and NS (top-down) was used.
1.A.2.e - CO2 - method	a T1 method has been applied for liquid fuels, a T2 method for gaseous fuels.
1.A.2.e - CO2 - EF	CS EFs have been used for gaseous fuels.
1.A.2.e - all gases - AD	a combination of PS data (bottom-up) and NS (top-down) was used.
1.A.2.f - CO2 - method	a T1 method has been applied for all fuels except gaseous fuels for which a T2 method has been used.
1.A.2.f - CO2 - EF	CS EFs have been used for gaseous fuels and PS EFs have been used for other fuels (shredded tyres, fluff & sewage sludge)
1.A.2.f - all gases - AD	a combination of PS data (bottom-up) and NS & IS (top-down) was used.
1.A.3.b - road transportation - method	for COPERT IV one should read that COPERT IV method has been applied on NS for the vehicle fleet in Luxembourg. Then, the amount of fuel calculated via COPERT IV is deduced from the total amount of fuel sold in Luxembourg, the difference being 'fuel exports'. The latter is estimated using a T1 method with IEF calculated on the basis of domestic consumption, since not enough information on the type of transit vehicles fueling in Luxembourg is available.
1.A.3.b - road transportation - EF	for biomass (2004-2007 only), use of the EF suggested by the European Commission, hence the OTH notation key.
1.A.3.d - all gases - AD	consumption data from shipping activities was obtained directly from the operators, hence PS
1.A.4.a - all gases - method	a T1 method has been applied for liquid & solid fuels and for biomass, a T2 method for gaseous fuels.
1.A.4.a - all gases - EF	CS EFs have been used for gaseous fuels.
1.A.4.b - all gases - method	a T1 method has been applied for liquid & solid fuels and for biomass, a T2 method for gaseous fuels.
1.A.4.b - all gases - EF	CS EFs have been used for gaseous fuels.
1.A.4.c - all gases - AD	a combination of NS and IS was used.
1.A.5.a - all gases - AD	a combination of NS and IS was used.
1.A.5.b - all gases - AD	a combination of NS and IS was used.
2.A.1 - CO2 - EF	CS EF based on PS CaO content in clinkers provided every 5 years by the sole cement manufacturer operating in Luxembourg.
2.C.1 - CO2 - AD	NS for iron production (blast furnaces operating from 1990 to 1997) and steel production (basic oxygen furnace operating from 1990 to 1997). PS for sinter production (1990 to 1997) and steel production from electrical arc furnace (from 1993 onwards).
2.C.1 - CO2 - method	CS for every type of production and for every year, except T2 for blast furnaces and basic oxygen furnace in 1990 and T2 for electrical arc furnace (from 2004 onwards).
2.F.1 - HFCs - AD	based on a study realized end 1999 by the Environment Agency and the Centre des Ressources des Technologies pour l'Environnement (CRTE) and inter- and extrapolated using CS methods.
2.F.4 - HFCs - AD	based on a study realized end 1999 by the Environment Agency and the Centre des Ressources des Technologies pour l'Environnement (CRTE) and inter- and extrapolated using CS methods.
2.F.8 - SF6 - AD	based on a study realized end 1999 by the Environment Agency and the Centre des Ressources des Technologies pour l'Environnement (CRTE) and inter- and extrapolated using CS methods.
2.F.9 - SF6 - AD	based on a study realized end 1999 by the Environment Agency and the Centre des Ressources des Technologies pour l'Environnement (CRTE) and inter- and extrapolated using CS methods.
4.A.1 - CH4 - AD	the various AD needed to calculate CH4 emissions for cattle are coming from NS except for the Digestible Energy (DE) parameter for which we have used the German values.
4.B.1 - CH4 - AD	the various AD needed to calculate CH4 emissions for cattle are coming from NS except for the Digestible Energy (DE) parameter for which we have used the German values.
4.B.1/3/4/8/13 - N2O - AD	nitrogen excretion values per AWMS are deriving from an expert judgement (EJ).
4.D.1 - N2O - method	T1a for CRF categories 4.D.1.1/4 and T1b for CRF categories 4.D.1.2/3/6.
4.D.1 - N2O - AD	experts judgements (EJ) for nitrogen excretion values per AWMS (CRF category 4.D.1.2) and for sewage sludge production & spreading (CRF category 4.D.1.6).
4.D.2 - N2O - AD	nitrogen excretion values per AWMS are deriving from an expert judgement (EJ).
4.D.3 - N2O - AD	nitrogen excretion values per AWMS and sewage sludge production & spreading are deriving from experts judgements (EJ).
5 - CO2 & N2O - AD	land use and land use change data was obtained from the Corine Land Cover databas, hence Q.
6.C - all gases - AD	mix of NS (waste treated every year by the incinerator) and of Q data (analysis of the incinerated waste composition for the years 1992-94, 2001 and 2004-05). These data are reported under 1.A.1.a - other fuels.
6.D - CH4 & N2O - AD	mix of NS (for all the public recycling centers) and of PS data (Soil-Concept project).
CO2 emissions from biomass - AD	a combination of PS and NS, IS was used for 1.A.3.b, 1.A.4.a, 1.A.4.b & 1.A.4.c.

Annex A.II – Security measures for the National Registry of Luxembourg

Extracts from the reports of Dr. Lippke & Dr. Wagner GmbH – software development & maintenance – and of Colt Telecom GmbH – hardware and network hosting, technical support and adaptive maintenance.

Uitreksel uit de SLA met de softwareleverancier dr. Lippke & dr. Wagner GmbH
(Nassauische Straße 25, 10717 Berlin, Germany)

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tus/) to make the tests auditable and transparent.

2. Automatic tests to prove the compliance to the regulation
   Although much more difficult, we seek to implement tests that prove the compliance to the regulations especially the Annex H test listed in the regulation. We will use JMeter (http://jakarta.apache.org/jmeter/) to, run the tests and to be able to document the results.
3. Manuel Tests
   besides the automated or semi-automated test we will run manual test, which will be logged as well using a proxy server to be able to document all traffic between the testing client and the system.

REF. 3.3 DATA PROTECTION AND SECURITY REQUIREMENTS

The data managed in the greenhouse gas registry constitute sensitive trade and business data which should be handled confidentially. A monitoring and safety mechanism within the project is to be established by the contractor to safeguard against the deliberate abuse of data and against unlawful external and internal interventions. The registry administrator has the right to accept or change any provision of the monitoring and safety mechanism proposed by or agreed upon with the contractor at any time in the course of this project.

The contractor shall inform the registry administrator immediately of any breach against the safety mechanism that has come to his attention.

The contractor shall inform the registry administrator of any need for altering or improving the monitoring and safety mechanism. Any alterations to it shall be approved by the Registry Administrator before effectively entering into force.

All members of the project team will have to agree on and sign a non disclosure and confidentiality agreement before being allowed to perform any task on this contract.

We are well aware of the fact that the data from the register is confidential. We have taken precautions against theft or loss of confidentiality not only for this project. Our environments are secured against the internet by a number of security methods, including firewalls and proxy routing. Our venue is protected by an alarm system which is directly linked to a professional security service on a 7x24 hour basis.

REF. 3.4 USER AND PROPERTY RIGHTS

All software adaptations, software developments, software corrections and functional, technical, procedural documents elaborated or implemented by the contractor within the framework of the project become the exclusive property of the Belgian State and can be freely used by the registry administrator without prior concent or prior approval from the contractor. The contractor may not encumber, sell, rent, lease, license or otherwise trans-

Summarized the benefits of COLT LANLinks are:

- Transparent redundant connections between sites
- Connected sites are in the same Broadcast Domain
- Transparent Layer 2 for different protocols (802.1q VLAN technology, 802.3, ...)
- Layer 3 Routing can be done individually on top
- High availability due to SDH-based backbone infrastructure (based on multi-redundant SDH long distance network and metro networks)
- Several possible levels of additional redundancy (high resilience options)
- Highly scalable connections (finest steps 2 Mbit/s)

4.8 Security

4.8.1 Access Security

Access Security is guaranteed by the following policies:

- COLT ensures active access control by means of authorisation lists, safety locks, video camera surveillance, security systems, 24-hr security service and key-card access systems.
- Each COLT Data Centre is equipped with an independent intrusion detection system connected to the control centre.
- All critical external (windows, entrance doors, shutters) and internal elements (entrance doors, emergency exits) are monitored.
- The hosting racks are all individually locked and all COLT Data Centre equipment rooms are monitored by CCTV.
- Physical access to the hosting infrastructure of the registry is only allowed for authorized COLT personnel and authorized personnel of the Software Service Provider (accompanied always by COLT personnel).
- The platform can be inspected through audits of the customer. Audits have to be announced in advance according to the COLT guidelines for external audits.

All security policies are documented in process descriptions and guidelines. COLT employees have to follow the relevant policies:

- Building Access
- COLT Physical Security Policy (CDGP27)
- Operation of Data Centres and Internet Solution Centres
- Operation of Key Sites
- Operation of Nodes and Network Operating Centres
- Physical Protection of Key Sites
- PHYSICAL-LOGICAL ACCESS PROCESS
- Security of Data Centres and Internet Solution Centres
- Security of Nodes and Network Operating Centres

4.8.2 Firewall and Border Security

The firewalls used are based on Cisco PIX 515E. On the production site, two firewalls are implemented as stateful failover cluster. On the disaster site, a single PIX515E is used.

Each firewall offers 6 Fast-Ethernet connections. 5 are used to implement security zones and separate the Internet from different DMZs, the 6th interface is used for the connection to the management LAN.

The following security zones are used:

- Internet
- CRWEB (Webservers)
- CRWS/CRBM (Application Servers)
- DB (Database Cluster)
- MAIL (Mailserver)

The communication between the zones is controlled by firewall policies. A direct access to the Internet users is only allowed to the web servers. Access to the Application servers from the ITL/CITL is only allowed through a VPN connection to the firewall.

All firewalls use an integrated VAC+ (VPN accelerator card) to ensure the follwing maximum performance:

- Up to 190 Mbps cleartext throughput
- Up to 135 Mbps IPSec VPN throughput with VAC+

For definition of the COLT service, see 14.7 COLT Managed Hosted Firewall.

4.8.3 Network Security

Despite the firewall deployment, network security is assured by the following:

Backbone protection against DoS attacks

A "denial-of-service" (DoS) attack is an explicit attempt by attackers to prevent legitimate users of a service from using that service. COLT has implemented different solutions to minimise DoS attacks, including: strong filtering the routing tables to prevent routing to RFC 1918 and RFC 3330 prefixes, filtering at the edge to prevent the forwarding of packets with RFC 1918 and RFC 3330 source addresses and filtering from the customers to prevent the forwarding of packets with source addresses others than the customers prefixes.

COLT has implemented different solutions to detect DoS attacks in its core IP network and to take actions to defend its core IP network.

VLAN security

All switches have a network security configuration applied to secure the device and the network. As the use of the native VLAN 1 adds a security risk this VLAN will be disabled. Used interfaces will be moved to their associated VLANs and all unused interfaces will be moved to a dedicated VLAN for unused interfaces. All unused interfaces are administratively down.

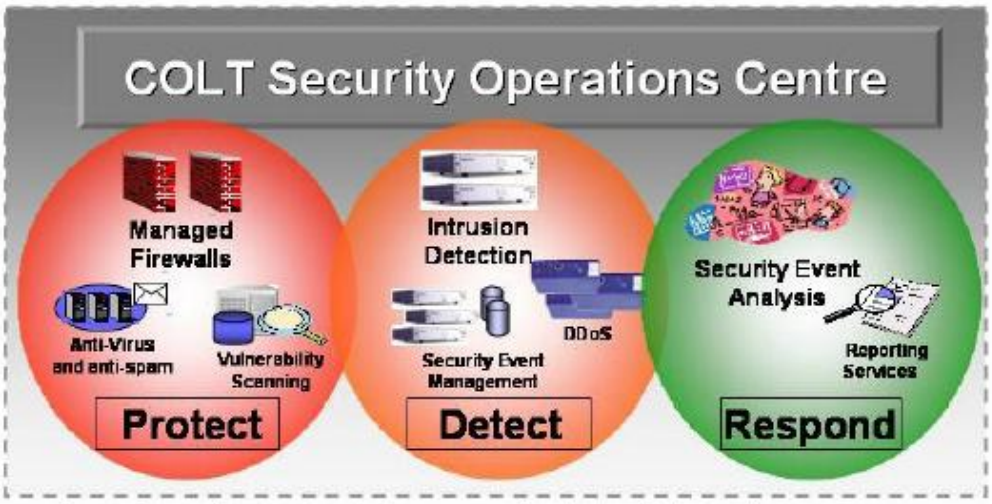
All switches use different VLANs for the DMZs (De-Militarized Zones) of the solution. The VLANs are interconnected over the firewalls with dedicated interfaces or, in case of future DMZ separation, with VLAN trunks to the firewalls.

4.8.4 Security Operations Center

COLT's Security Operations Centre (SOC) is a state-of-the-art facility fully integrated into COLT's Network and System Operations Management Centres. It is comprised of a dedicated and specially trained group of security professionals that understand the unique requirements and disciplines of information and network security, while anticipating customer's security needs.

The SOC is a core component of COLT's Managed Security Services Product Offering and provides customers with centralised and real-time security event monitoring, detection and rapid response. The SOC enables COLT to provide a consistent and feature rich security product offering to our customers, including;

- Managed Firewall, IDS, IPS and DDOS Services
- Security Event and Alarm Management, including reporting, incident response coordination and support.
- Vulnerability Scanning Services
- Managed Desktop and Application Security Services, including Anti-virus, Content Filtering and Anti-spam protection.



- Protection against unauthorised access
- Detection of malicious activities
- Response to security policy breaches
- Device installation and management
- Event detection and correlation
- Patch management
- Centralised 24x7 Security Operations

4.8.5 Security Event Monitoring

All surveilled systems originate a lot of log entries. These log entries can be consolidated and analyzed to get the real security information behind the pure log. The logs are collected from the following entities:

- Firewalls
- Intrusion Detection Systeme
- Vulnerability Scanner
- Dedicated Host Security Systeme
- Content Security Systeme
- Integrity Checker

The Security Event Management System (SEM) filters relevant security information from millions of log entries in real time. The information get correlated to receive only those messages which signal a real security threat.

These messages are processed by the SOC, analyzed and rated by security specialists.

COLT uses the Enterprise Security Manager ESM by Arcsight. The following tasks are processed by ESM:

- Monitoring of all security related logs from security devices like firewalls, IDS, IPS, …
- Normalization of the different structured log
- Real-time log correlation
- Automated analyzing and rating of security related events
- Gererating of reports

The SEM process can be shortly described with "Centralize / Correlate -> Analyze / Prioritize -> Investigate / Respond -> Report/ Remember"

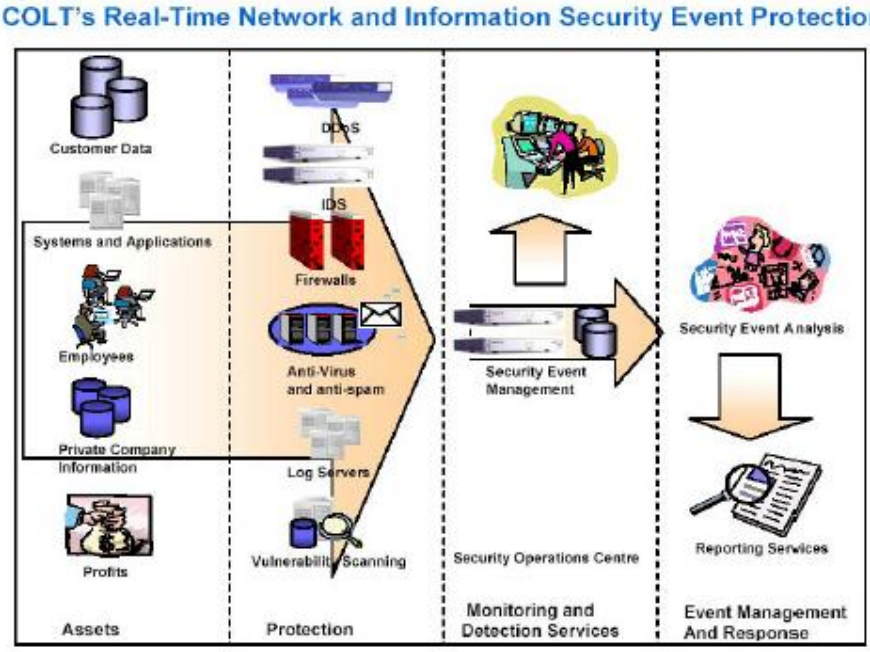


Figure 11: Real-Time Network and Information Security Event Protection

4.8.6 Windows Server Security

Previous versions of the Microsoft Windows operating system where inherently insecure and while Microsoft has greatly improved the security in and around Microsoft Windows 2003 there are still a number of settings that can be changed to further enhance the security of a system.

COLT acknowledges that these settings may not be suitable for every solution and should be discussed fully with the Software Service Provider before implementation as they may have negative effects on customer applications; however they should be seen as a standard starting point for all Microsoft Windows™ 2003 installations. COLT uses standardized questionnaires to be filled out by the Software Service Provider and the COLT implementation team.

Windows Server Security is based on security policies for the following topics:

- Standard Account Policy
- Standard Account Lockout Policy
- Standard Kerberos Policy
- Standard Audit Policy
- Standard User Rights Policy
- Standard Security Settings Policy
- Standard Event Log Policy
- Standard System Services Policy
- Standard Windows Server 2003 File System ACL's
- Antivirus software deployment
- And many others

For definition of the COLT service, see 14.9 COLT Managed Hosted Windows Server.

4.8.7 Linux Server Security

The standard Linux build is based on the RedHat Enterprise Linux 4 (x86) with the latest update at time of installation. COLT is customizing the Linux server builds and adds appropriate modules and software packages.

Linux Server Security is based on security policies for the following topics:

- Restrict unnecessary Network Services
- Restrict Direct root Login
- Restrict root permissions
- Setting up chrooted environments
- Setting Up Time Synchronization using NTP
- Configuring Additional Logging
- Fix File Permissions
- And many others

For definition of the COLT service, see 14.10 COLT Managed Hosted Linux Server.

Annex A.III – Summary of reporting of the Supplementary Information under Article 7, paragraph 2, of the Kyoto Protocol

SUPPLEMENTARY INFORMATION UNDER THE KYOTO PROTOCOL – CORRESPONDENCE TABLE

Information reported under Article 7, paragraph 2	NC5 Section
National systems in accordance with Article 5, paragraph 1	*Section III.2*
National registries	*Section III.3*
Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17	*Section V.5*
Policies and measures in accordance with Article 2	*Section IV.3*
Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures	*Chapter IV.2*
Information under Article 10 Art. 10a Art. 10b Art. 10c Art. 10d Art. 10e	*Section III.2* *Section IV.2* *Section VII.5* *Chapter VIII* *Chapter IX*