GOVERNMENT
PRINCIPALITY OF LIECHTENSTEIN

Liechtenstein's Seventh National Communication

Submission of December 2017
under the United Nations Framework Convention on Climate Change and the Kyoto Protocol

Imprint

Office of Environment (project management)
P.O. Box 684
9490 Vaduz
Liechtenstein

INFRAS Research and Consulting
8045 Zurich
Switzerland

For further information

Heike Summer, Office of Environment
heike.summer@llv.li

Cover image

Claudia De Biasi

Foreword

Climate change is one of the major challenges of today´s environmental policy – and it has wide impacts not only on nature and environment, but also on society and economy. Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. Since the temperature recording started in 1871 the temperature has increased in Liechtenstein by 1.9 °C.

These findings have also been taken into account when finalizing Liechtenstein's Seventh National Communication as well as Liechtenstein's Third Biennial Report – which is to be found as an Annex to the Seventh National Communication. In this regard, I am grateful that at the 23rd Conference of the Parties to the United Nations Framework Convention on Climate Change, which took place from 6th to 17th November 2017 in Bonn, Parties made good progress through constructive negotiations on the Paris implementation guidelines. The implementation of a mechanism, which allows each Party to enhance its reduction efforts in a transparent and effective way, is of utmost importance. We need a feasible process for all Parties and must assure the environmental integrity of the rules, procedures, and mechanisms.

The Liechtenstein Government is convinced that the global threat of climate change needs a global answer in the form of the legally binding Paris Agreement. Last year, the Paris Agreement entered into force and the process of implementation has begun. In the recent months, the process started to establish and agree on appropriate rules, procedures and mechanisms, to confront all of the challenges posed by our warming planet. Liechtenstein submitted its Intended Nationally Determined Contributions in April 2015 and became a member to the Paris Agreement in September 2017. The Government of Liechtenstein is committed to improving energy efficiency, promoting renewable energy production and setting incentives for the establishment of a low carbon economy in Liechtenstein.

Since the release of the Sixth National Communication in 2014, Liechtenstein's national climate protection framework has been further developed throughout all political areas – which is one of the major achievements of the updated National Climate Strategy launched by the Government in 2015 with the aim to widen its scope with a focus on the 2015 agreement in order to further domestic GHG reductions and strengthen public awareness. Being aware of our responsibility as well as taking into account our capability, Liechtenstein intends to reach a 40% reduction by 2030 compared to the 1990 greenhouse gas emissions. The focus is to reduce as much as possible domestically, but Liechtenstein also intends to make us of market mechanisms.

We are progressing on our path to decouple economic growth from greenhouse gas emissions. Regarding ambitious climate policies and especially regarding renewable energy, Liechtenstein included climate mitigation and adaptation action in its government program for the upcoming four years. Slowly but steadily, we will transform to a sustainable and renewable society.

Dominique Gantenbein

Minister of the Environment
Vaduz, December 2017

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1. Executive Summary

1.1 Introduction

This report summarizes the basic information and activities of the Principality of Liechtenstein with respect to climate. With a population of 37'662 at the end of 2015, Liechtenstein is a small central European State in the Alpine region. Its structure is comparable to that of its neighbouring countries, Switzerland and Austria. Liechtenstein is a constitutional hereditary monarchy on a democratic and parliamentary basis. The relations between Liechtenstein and Switzerland are very close and strongly influenced by the Customs and Currency Treaties between the two countries (customs and currency union). The Customs Treaty with Switzerland has significant impacts on environmental laws and strategies. Many Swiss environmental provisions and standards are also applicable in Liechtenstein or they are integrated into Liechtenstein's law on the basis of specific international treaty rules (e.g. CO_2 Act). At the same time, Liechtenstein has also implemented numerous parts from EU legislation and has participated in various EU programs since joining the European Economic Area (EEA) in 1995.

This report uses the draft guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications of May 2017 (UNFCCC 2017).

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

Liechtenstein's greenhouse gas emissions in the year 2015 (OE 2017) amount to 199.4 kt CO_2 equivalent (CO_2eq) excluding LULUCF sources or sinks (including LULUCF: 207.7 kt CO_2eq). This refers to 5.3 t CO_2eq per capita. Total emissions (excl. LULUCF) have declined by 13.0% compared to 1990 and by 1.2% compared to 2014.

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

Table 3-1 shows the emissions for individual gases and sectors in Liechtenstein for the year 2015. The most important emission sources are fuel combustion activities in the Energy sector. Emissions of CH_4 and N_2O mainly originate from the sector Agriculture, and F-gas emissions stem from the sector 2 Industrial processes and product use (IPPU) by definition.

Table 1-1 Summary of Liechtenstein's GHG emissions in 2015 by gas and sector in CO_2eq (kt). Numbers may not add to totals due to rounding.

Emissions 2015	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (kt)						
1 Energy	159.5	2.08	0.8	-	-	-	162.3
2 IPPU	NO	NO	0.2	10.4	0.04	0.04	10.7
3 Agriculture	0.05	15.92	8.1	-	-	-	24.1
5 Waste	0.02	1.50	0.8	-	-	-	2.3
Total (excluding LULUCF)	**159.6**	**19.5**	**9.8**	**10.4**	**0.04**	**0.04**	**199.4**
4 LULUCF	7.9	NO	0.4	-	-	-	8.3
Total (including LULUCF)	**167.5**	**19.5**	**10.3**	**10.4**	**0.04**	**0.04**	**207.7**
International Bunkers	*1.2*	*0.0002*	*0.01*	-	-	-	*1.2*

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

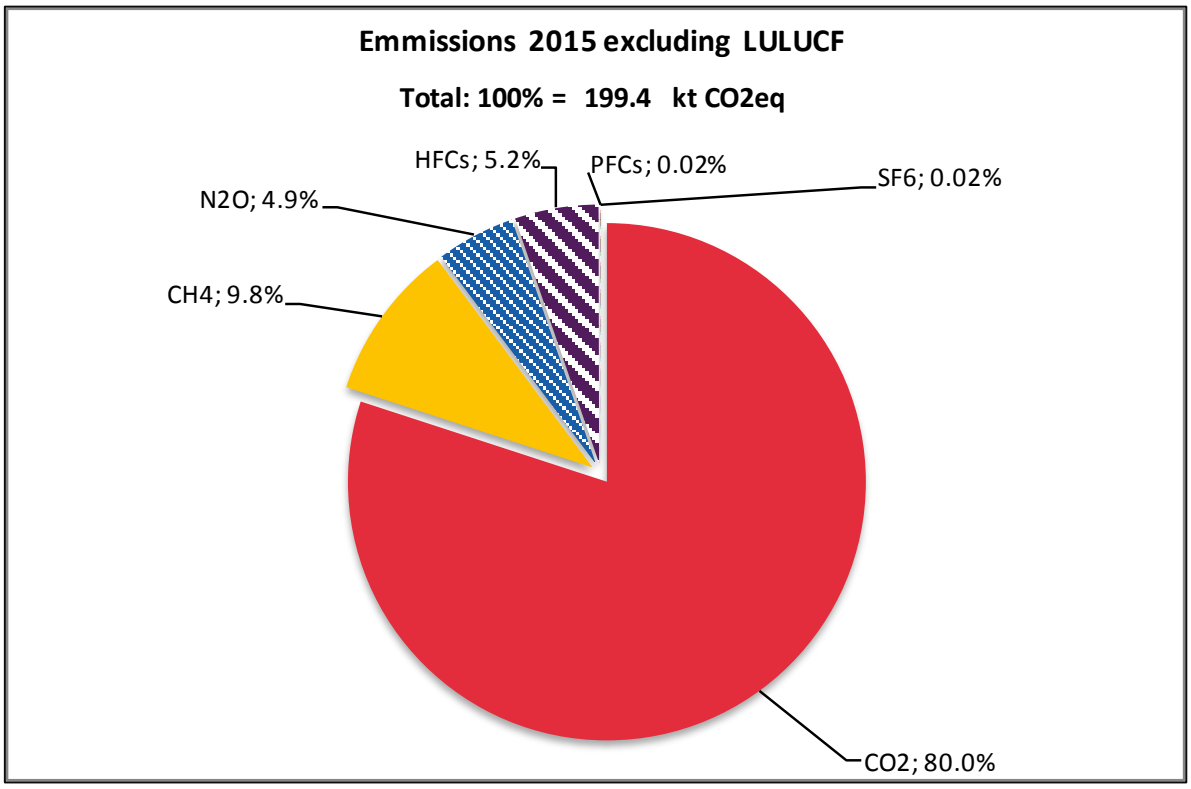

Figure 1-1 Liechtenstein's GHG emissions by gases excluding LULUCF emissions in 2015.

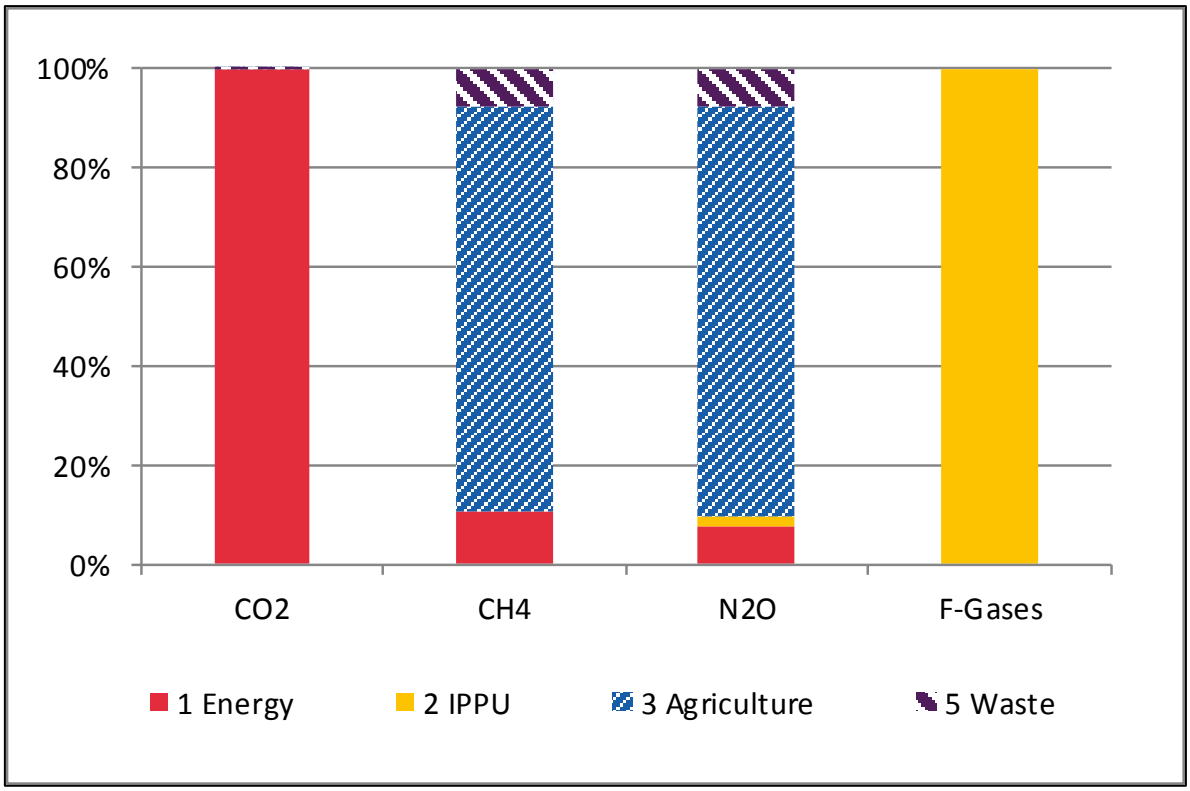

Figure 1-2 Relative contributions of the individual sectors (excluding LULUCF) to GHG emissions in 2015.

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

- Total emissions (in CO_2eq) excluding LULUCF sources or sinks decreased by 13.0% from 1990 to 2015.
- Total emissions (in CO_2eq) including LULUCF show a decrease of 10.7% in 2015 compared to 1990 levels.
- Accounting for 80.0% of the total emissions, CO_2 is the most dominant greenhouse gas emitted in Liechtenstein. CH_4 emissions represent 9.8% and N_2O emissions 4.9% of the total emissions.
- CO_2 emissions (excluding net CO_2 from LULUCF) declined by 19.7% between 1990 and 2015. In comparison to the previous reporting year 2014, CO_2 emissions (excluding net CO_2 from LULUCF) decreased by 1.1% in 2015.
- CH_4 emissions (excluding CH_4 from LULUCF) have slightly decreased by 0.2% since 1990. Compared to 2014, CH_4 emissions (excluding LULUCF) showed a decrease by 1.7% in 2015.
- N_2O emissions (excluding N_2O from LULUCF) declined by 9.7% in 2015 compared to 1990. Regarding 2014, N_2O emissions (without LULUCF) in 2015 slightly decreased by 0.2%.
- HFC emissions increased due to their role as substitutes for CFCs. SF_6 emissions originate from electrical transformation stations and play a minor role for the total of the synthetic gases (F-gases). PFC emissions have been occurring since 1997 and are increasing on a low level. The share of the sum of all F-gases (within total emissions excl. LULUCF) increased from 0.00005% (1990) to 5.3% (2015).

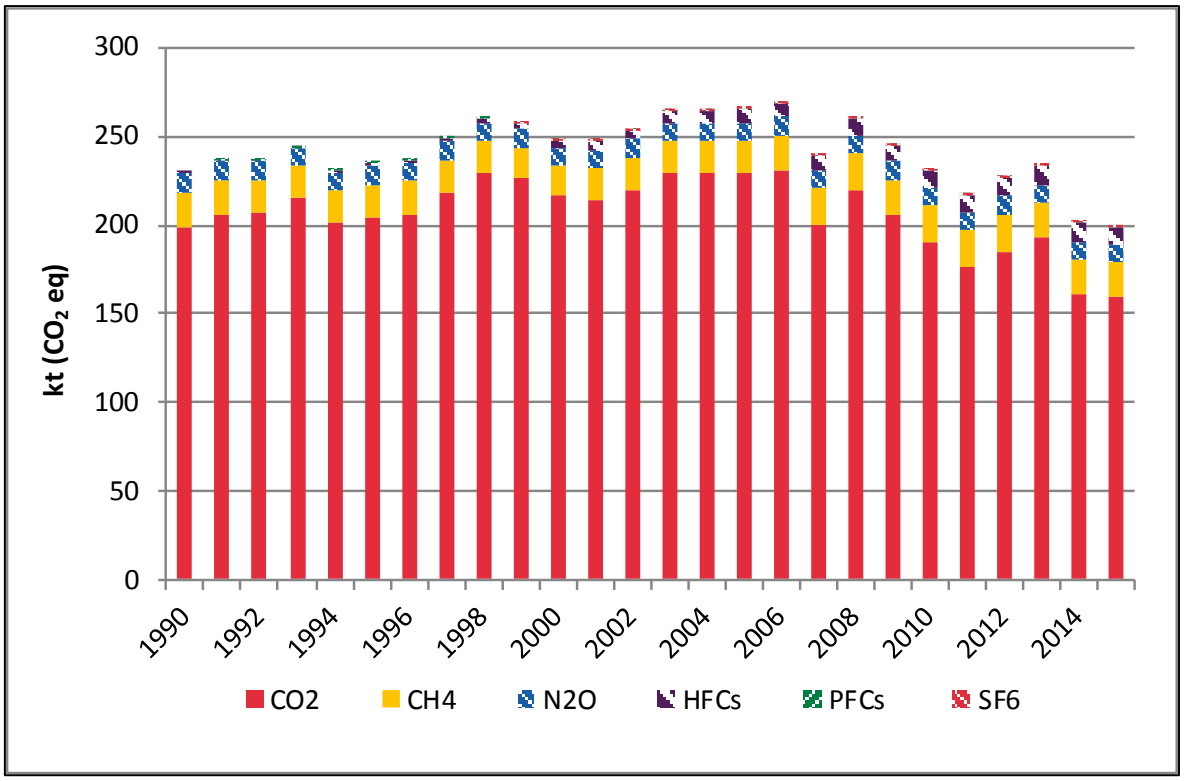

Figure 1-3 Trend of Liechtenstein's greenhouse gas emissions by gases 1990–2015. CO_2, CH_4 and N_2O correspond to the respective total emissions excluding LULUCF.

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

1.3 Policies and measures

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

In 2010 Liechtenstein therefore introduced an indicator-based system for an annual assessment of the countries path towards a sustainable development. To this respect the Government has chosen to link the indicator-based assessment to the sustainability definition of the Brundtland Commission. According to that definition sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The system is comparable to the indicator-based assessment of the Swiss Federal Office of Statistics and the European system of Eurostat.

The assessment of the country's sustainable development serves as an incentive for the development of respective policies and measures, especially in areas where an unsustainable development can be observed. To the extent possible, Liechtenstein also tries to make a contribution to the solution of global environmental problems. Climate protection enjoys a high political priority in this regard, constituting a primary field of action in Liechtenstein's environmental policy. Climate mitigation and adaptation action was included in the Government program for the upcoming four years.

Liechtenstein has integrated its climate policy very strongly into the individual sectorial policies. The focus is on energy policy, environmental policy, transport policy, agricultural and forestry policy. All of these areas encompass measures that contribute to the reduction of greenhouse gases. In order to ensure a coordinated implementation of these measures, the Government passed a Climate Protection Strategy in 2007. This strategy requires an interdisciplinary coordination in the fields of environment, energy, building, transportation, agriculture and forestry with respect to the development of climate policy measures. The strategy was revised in the year 2015. Liechtenstein's Ministry of Environment and the Office of Environment are the coordinating authorities with respect to the executions of the Climate Protection Strategy.

Because of the small size of the country, cross-border cooperation plays an important role. Especially important is the relationship with Switzerland and the cooperation among the countries in the Lake Constance area. Due to the customs treaty, cross-border measures and their bilateral implementation are simplified in many areas, because various Swiss enactments are directly applicable in Liechtenstein pursuant to the treaty.

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

The **Emissions Trading Act** (EHG) sets up the general framework for the fulfilment of Liechtenstein's reduction obligations originating from the respective ratification of the Kyoto Protocol. In 2012, the Government introduced a legally binding greenhouse gas reduction target of at least 20% compared to 1990 until 2020. In addition, the EHG states that emission reductions are first and foremost to be reduced by domestic measures. If reduction obligations cannot be achieved with domestic measures, the Government may participate in project activities abroad or in international emissions trading. Besides this, the EHG implements Directive 2003/87/EC (Emissions Trading Directive) into national law and obliges two industrial installations (2013) to participate within the European Emissions Trading Scheme. Due to comprehensive amendments of Directive 2003/87/EC, the EHG has been revised in 2012. The regulations of the EHG with respect to the participation of Liechtenstein in the Kyoto Protocols flexible mechanisms as well as with respect to domestic emissions trading are implemented by the Office of Environment.

The **CO_2 Act** corresponds to the CO_2 Act of Switzerland (in force since 2008) and introduces a levy on the consumption of fossil fuel (oil and gas). It is part of "The Bilateral Agreement between the Principality of Liechtenstein and the Swiss Confederation on Environmental Levies within the Principality of Liechtenstein". In 2013, the CO_2 Act has been revised. Besides the levy on fossil fuel, an obligation to compensate CO_2 emissions from the use of motor fuels (gasoline and diesel) as well as emission regulations for passenger cars has been introduced. From 2014 on Liechtenstein will levy 96 CHF per ton CO_2, which corresponds to around 25 Rp per litre heating oil (until 2013 it was 36 CHF per ton CO_2 which corresponded to around 10 Rp per litre of oil). Since 2014, approximately 2/3 of the total CO_2 levy revenues are earmarked for environmental purposes, thus strengthening the financial capabilities of the Government with respect to future measures within the national climate change framework.

Another important legal instrument in this context is the **Energy Ordinance of the respective Building Act** of 2007, in which the commitment to saving energy was legally enshrined.

Amongst the policies envisaged to meet Lichtenstein's commitments under the Convention, measures on the national level are given high priority. Accordingly, the following policies will be implemented in the near future:

- In the course of 2018, the emissions regulation for passenger cars, established in 2012 by the revised CO_2 Act, will be adjusted in order to also cover light vehicles. The CO_2 Act will be revised in 2021 as continuation of the existing act, but also to set the legal framework for the commitments under the Paris Agreement.
- Between 2018 and 2019, a new Energy Strategy 2030 will be defined.

1.4 Projections and the total effect of measures

This chapter covers Liechtenstein's greenhouse gas emissions under the three scenarios 'without measures' (WOM), 'with existing measures' (WEM) and 'with additional measures' (WAM) according to the guidelines for the preparation of national communications (UNFCCC 2017):

- The 'without measures' (WOM) scenario projection excludes all policies and measures implemented, adopted or planned after the year chosen as the starting point for that projection. For Liechtenstein's NC7, this starting year is the latest inventory year (2015) and the WOM scenario assumes that emissions stay constant in the period 2016-2030.
- The 'with existing measures' (WEM) scenario projection encompasses currently implemented and adopted policies and measures. In Liechtenstein, projections based on specific measures are only available for the sector Energy (1A Fuel combustion). For the waste sector, a projection exists in Liechtenstein's Waste Plan (Liechtensteiner Abfallplanung 2012-2070, Government 2011). Further projections for the sectors Energy (1B Fugitive emissions from fuels) as well as for IPPU (sector 2) and Agriculture (sector 3) were adopted from Switzerland's WEM projection in its NC7 (FOEN 2018). The projections for LULUCF were assumed to be constant (mean of the latest five inventory years) and the projection of international bunkers is based on a linear extrapolation of the reported inventory data.
- The 'with additional measures' (WAM) scenario projection also encompasses planned policies and measures. In Liechtenstein, additional measures only exist in the energy sector. Where necessary, the WAM scenario from Switzerland's NC7 was adopted (FOEN 2018).

The sector Energy is dominating Liechtenstein's greenhouse gas emissions. In the year 2015, emissions from this sector amounted 81.4% of Liechtenstein's total emissions. Therefore, the focus for the elaboration of Liechtenstein's projections in its NC7 lies on the Energy sector.

The aggregated projections in CO_2 equivalents under the WEM and WAM scenario are depicted in Table 1-2 and Figure 1-4 (WEM) and in Table 1-3 and Figure 1-5 (WAM). The aggregated projections under the WOM scenario are also indicated in Figure 1-4 and Figure 1-5. The actual GHG emission reduction for the years 1990-2015 amounts 13.0%. From then, further reductions by 20.5% (WEM scenario) and by 27.0% (WAM scenario) are projected in the years 2015-2030. The total reduction from 1990-2030 under the WEM scenario is anticipated to be 30.8%, for the WAM scenario 36.5%.

Table 1-2 Total GHG emissions in CO_2eq by sector for the WEM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030).

	CO_2eq in kt CO_2 equivalent									
							Reported data (GHG inventories)		Projections	
IPCC	Source/Sink Categories	1990	1995	2000	2005	2010	2015	2020	2025	2030
Total	Emissions, excl. LULUCF (Scenario WEM)	229.21	234.32	248.14	265.65	230.35	199.39	175.10	167.92	158.54
1	Energy	201.07	206.77	219.83	231.62	193.77	162.32	138.92	132.69	124.36
1A	Fuel combustion	200.70	206.16	218.99	230.52	192.63	161.17	137.76	131.53	123.20
	1A1 Energy industries	0.18	2.08	2.77	3.14	3.26	2.05	2.15	2.15	2.15
	1A2 Manufacturing industries & constr.	36.32	35.73	36.46	39.20	26.11	27.44	20.28	20.21	20.15
	1A3 Transport	76.75	81.84	91.31	81.88	77.84	61.87	61.05	59.64	55.35
	1A4 Other sectors	87.45	86.51	88.45	106.30	85.42	69.81	54.29	49.53	45.55
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
2	Industrial processes and product use	0.45	1.72	4.46	7.92	9.99	10.70	10.00	9.07	7.77
3	Agriculture	25.51	23.68	21.48	23.56	24.18	24.09	23.61	23.37	23.37
4	LULUCF	3.51	3.18	22.01	5.61	21.08	8.32	15.82	15.82	15.82
5	Waste	2.18	2.15	2.36	2.55	2.41	2.28	2.56	2.80	3.03
Memo item	International bunkers (aviation)	0.43	0.43	0.49	0.49	0.85	1.20	1.21	1.38	1.54

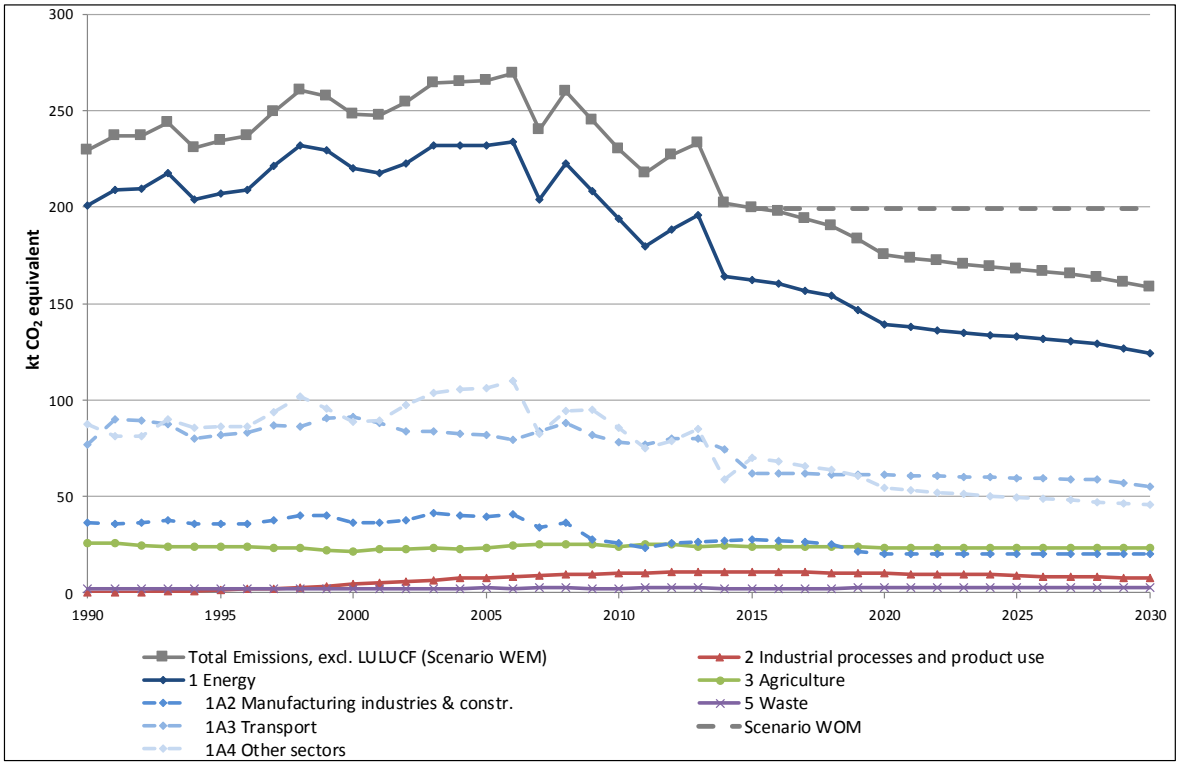

Figure 1-4 Total GHG emissions in CO_2eq by sector (excl. LULUCF) from 1990 to 2030 for the scenario WEM. The dashed line in grey 2015-2030 indicates scenario WOM.

Table 1-3 Total GHG emissions in CO_2eq by sector for the WAM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	CO_2eq in kt CO_2 equivalent									
							Reported data (GHG inventories)		Projections	
IPCC	Source/Sink Categories	1990	1995	2000	2005	2010	2015	2020	2025	2030
Total	Emissions, excl. LULUCF (Scenario WAM)	229.21	234.32	248.14	265.65	230.35	199.39	174.73	162.59	145.59
1	Energy	201.07	206.77	219.83	231.62	193.77	162.32	138.92	128.36	113.39
1A	Fuel combustion	200.70	206.16	218.99	230.52	192.63	161.17	137.76	127.19	112.23
	1A1 Energy industries	0.18	2.08	2.77	3.14	3.26	2.05	2.15	2.15	2.15
	1A2 Manufacturing industries & constr.	36.32	35.73	36.46	39.20	26.11	27.44	20.28	20.21	20.15
	1A3 Transport	76.75	81.84	91.31	81.88	77.84	61.87	61.05	58.49	50.75
	1A4 Other sectors	87.45	86.51	88.45	106.30	85.42	69.81	54.29	46.34	39.18
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
2	Industrial processes and product use	0.45	1.72	4.46	7.92	9.99	10.70	9.64	8.62	7.32
3	Agriculture	25.51	23.68	21.48	23.56	24.18	24.09	23.61	22.82	21.84
4	LULUCF	3.51	3.18	22.01	5.61	21.08	8.32	15.82	15.82	15.82
5	Waste	2.18	2.15	2.36	2.55	2.41	2.28	2.56	2.80	3.03
Memo item	International bunkers (aviation)	0.43	0.43	0.49	0.49	0.85	1.20	1.21	1.38	1.54

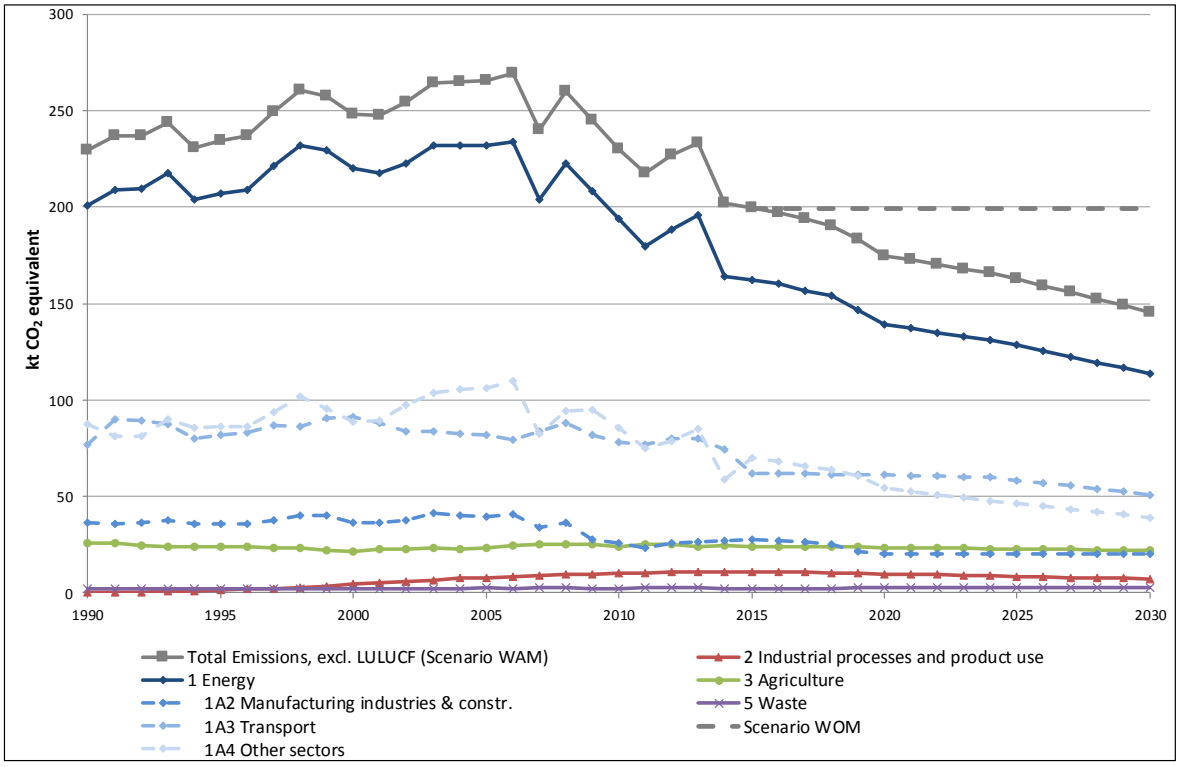

Figure 1-5 Total GHG emissions in CO_2eq by sector (excl. LULUCF) from 1990 to 2030 for the scenario WAM. The dashed line in grey 2015-2030 indicates scenario WOM.

With respect to the second commitment period (2013-2020) Liechtenstein's target of total GHG emissions (in CO_2 equivalent) is 20% below 1990 levels (which corresponds to 184 kt CO_2 eq in 2020). Regarding the achievement of this target, the priority remains on the implementation of domestic measures. The legal framework that ensured the focus on domestic reduction measures has been transferred into the new Emissions Trading Act from September 2012. Under current projections it seems however unlikely that Liechtenstein will achieve its reduction target within the second commitment period under the Kyoto Protocol by domestic measures only. The projections of average annual emissions from 2013 to 2020 lead to a shortage of around 22'400

CO_2 eq. To that respect Liechtenstein envisages to take the option of continuing its engagement within the Kyoto Protocol's flexible mechanism. This engagement is guided by the National Climate Strategy, which was revised in 2015.

Table 1-4 Kyoto targets for the second commitment period 2013-2020

Gross and net GHG emissions during the commitment period 2013-2020	
Kyoto protocol emissions (kt CO_2 eq.)	
Kyoto target 2020 (calculated assigned amount units per year, -84% of 1990)	194.51
Total projected gross GHG emissions WEM (projection for 2020)	192.12
Annually use of Kyoto mechanisms (CDM), based on projected emissions (WEM, 2013-2020)	17.64
Net GHG emissions	174.48
Gross and net GHG emissions during the commitment period 2013-2020	
Kyoto protocol emissions (kt CO_2 eq.)	
Kyoto target 2020 (calculated assigned amount units per year, -84% of 1990)	194.51
Total projected gross GHG emissions WEM (projection for 2020)	192.12
Annually use of Kyoto mechanisms (CDM), based on projected emissions (WEM, 2013-2020)	17.64
Net GHG emissions	174.48

1.5 Impacts, vulnerability assessment and adaptation

Liechtenstein is entirely located in the Alpine region. In recent years, various research programs on the effects of global climate warming in the Alpine region have been conducted. Trends in historic climate data up to 2016 and projections of possible developments in the 21st century indicate that noticeable impacts on climatic conditions are to be expected. For Liechtenstein, the most important impacts are related to raising temperatures, such as prolonged heat waves, droughts, an increased risk of landslides and debris flows. Overall, changes in climatic conditions are also expected to have a strong impact on biodiversity.

1.5.1 Climate change scenarios

The official scenarios on climate change currently used in Switzerland 'CH2011' were launched in 2011 under the aegis of the Swiss Federal Institute of Technology in Zurich and MeteoSwiss (CH2011, 2011). CH2011 presents a consolidated view on future climate change in Switzerland.[1] The north-eastern region also includes the principality of Liechtenstein. Findings and conclusion within "CH2011" are therefore also valid for Liechtenstein's future climate development.

The scenarios are based on a large number of European-scale regional climate model experiments available at that time from international projects. Statistical methods were used to produce multi-model estimates of changes and associated uncertainties in seasonal mean temperature and precipitation changes for three representative Swiss regions and three scenario periods. CH2011 uses two non-intervention emission scenarios (A2 and A1B) that anticipate increases in emissions, and one climate stabilization scenario (RCP3PD) that assumes emissions to be cut by about 50 %

[1] All paragraphs adopted from Switzerland's 7th National communication (FOEN 2018) are indicated in italic.

by 2050 and that stabilizes global warming at about 2°C with respect to pre-industrial conditions. Besides regional and seasonal mean changes, the new scenarios also provide changes in daily mean values at individual meteorological station sites in Switzerland. Scenario data were made available in digital form at http://www.ch2011.ch.

Figure 1-6 illustrates observed seasonal temperature changes for north-eastern Switzerland including Liechtenstein, as well as projected seasonal temperature changes for three different emission scenarios and selected time periods. Compared to the period 1980-2009 the best estimates for the non-intervention scenarios project increases of seasonal mean temperature of 2.7-4.8°C by 2085 for the A2 scenario and 2.4-4.1°C for the A1B scenario (CH2011-2, 2015).

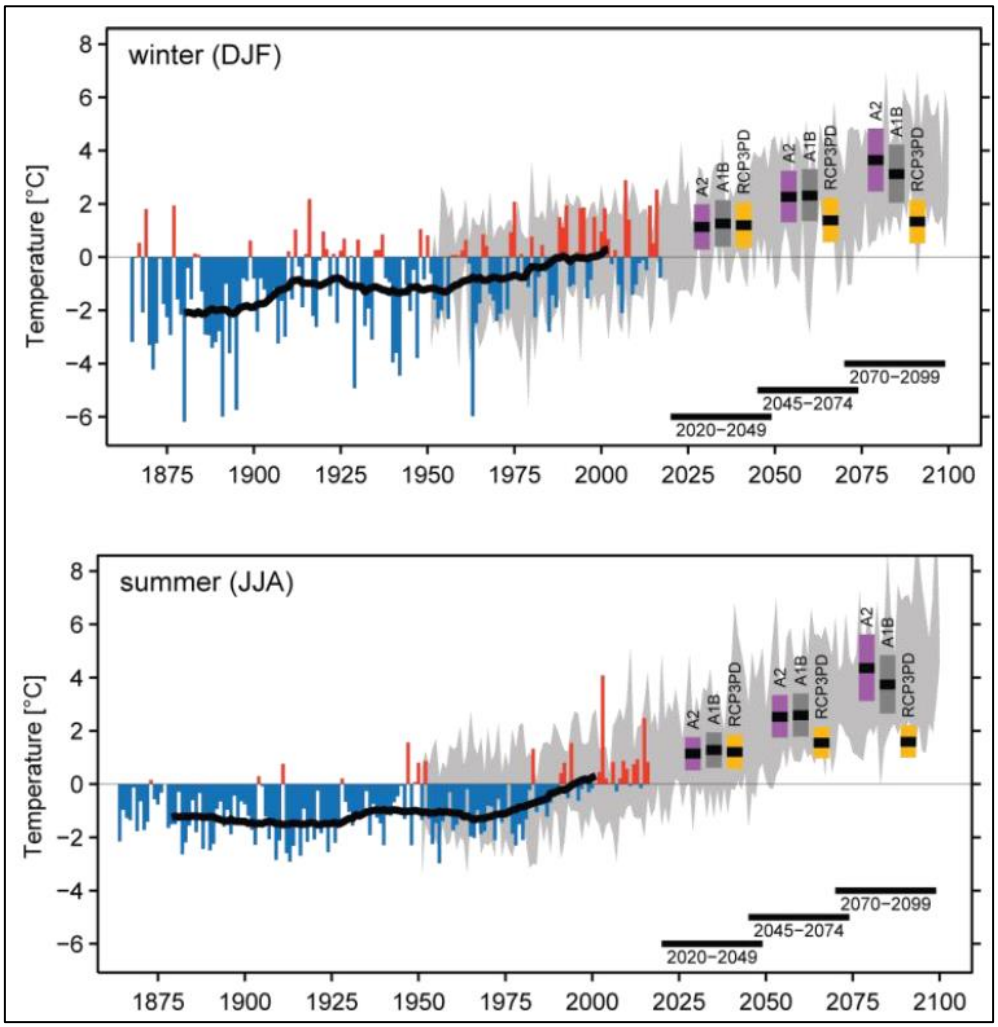

Figure 1-6 Past and future changes in seasonal temperature (°C) over north-eastern Switzerland (including the Principally of Liechtenstein). The changes are relative to the reference period 1980–2009. The thin coloured bars display the year-to-year differences with respect to the average of observations over the reference period, the heavy black lines are the corresponding smoothed 30-year averages. The grey shading indicates the range of year-to-year differences as projected by climate models for the A1B scenario (specifically, the 5–95 percentile range for each year across the available model set). The thick coloured bars show best estimates of the future projections, and the associated uncertainty ranges, for selected 30-year time-periods and for three greenhouse gas emission scenarios (CH2011 2011), updated with available observed data beyond 2011.

Annual precipitation amounts are projected to change towards the end of the 21st century (see Figure 6-2). Summer mean precipitation will likely decrease by the end of the century all over Switzerland (including Liechtenstein).

1.5.2 Climate change impacts

Observed climatic conditions and expected developments are summarized in the factsheet on climate trends and climate change provided by the Office of Environment (OE) of Liechtenstein (OE 2016).

The temperature has experienced significant changes in the past years (Figure 6-6). The mean annual temperature has increased by 0.7 °C between the reference period 1961-1990 (9.4 °C; MeteoSwiss, 2017b) and the current reference period 1981-2010 (10.1 °C; MeteoSwiss, 2017a). Since the temperature recording started in 1871 the temperature had increased in Liechtenstein by 1.9 °C (OE 2016). This development is consistent with general observations experienced during the past 100 years on the northern side of the alps.

The mean annual precipitation amount at the SwissMetNet station of Vaduz is 923 mm for the current standard reference period 1981-2010 (MeteoSwiss, 2017c). The mean annual precipitation amount has increased by 32 mm (+3.6%) between the reference period 1961-1990 (891 mm; MeteoSwiss, 2017d) and the current reference period 1981-2010 (923 mm; MeteoSwiss, 2017c). Cited from FOEN (2018):

In the near future (until 2035), annual runoff in Switzerland and Liechtenstein *is expected to change very little. In the long term (by 2085) the annual runoff is expected to fall slightly. However, the seasonal distribution of runoff (runoff regime) will shift in Switzerland and Liechtenstein. On the Rhine for example, a second seasonal runoff maximum will develop over time in winter in addition to the existing one in early summer.*

On the basis of existing observations and model results, it is possible to make some projections concerning the future climate change impacts on biodiversity in Switzerland and Liechtenstein*. Species will certainly move towards higher elevations, and new species will colonise Switzerland* and Liechtenstein*. Some species will probably disappear at the regional scale, partly in high mountains because of the decreasing area of the alpine and nival belts, partly in the lowlands because of the increasing summer droughts and existing obstacles to dispersal (landscape fragmentation). Moreover, disruptions in species interactions caused by individual migration rates or phenological shifts are likely to have consequences for biodiversity (Walther, 2010).*

In general, climate change in Switzerland and Liechtenstein *is expected to entail a shift of suitable areas for agricultural production, and to involve both positive (e.g. a longer vegetation period) and negative (e.g. increasing incidence of pest infestations owing to milder winters) aspects. Changes in the nature of extreme weather events, in particular more frequent, intense and longer-lasting summer heat waves, could also challenge agriculture, e.g. by reducing the reliability of harvests.*

In Switzerland and Liechtenstein*, the seasonal freezing level in wintertime (altitude, where surface air temperature is 0°C) has risen by about 200 meters per °C of warming from approximately 600 meters in the 1960s to approximately 900 meters in the 1990s (Scherrer and Appenzeller, 2006). If warming in winter continues as expected, the freezing level will further rise by about 280 meters until 2060 in case of a mitigation scenario (about +1.4°C, best estimate), by about 460 meters in case of a non-intervention scenario (about +2.3°C, best estimate) (CH2011, 2011).*

1.5.3 Assessment of risks and vulnerability to climate change

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

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

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

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

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

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

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

1.5.4 Domestic adaptation policies and strategies

To mitigate expected negative impacts of climate change, adaptation measures are required in different areas and sectors. Adaptation is therefore an essential element of Liechtenstein's climate strategy (OE 2015). The national climate change adaptation strategy of Liechtenstein (OE 2018) identifies the relevant impacts related to climate change and defines measures to limit or avoid negative impacts. Liechtenstein also actively participates in international adaptation projects of the Alpine Convention[2] and the Alpine space programme[3] (Climate Change Adaptation by Spatial Planning in the Alpine Space, Clisp). Liechtenstein was an official partner of the European project "C3-Alps"[4] on "Capitalising Climate Change Knowledge for Adaptation in the Alpine Space".

The outcomes of this project form the foundation of the national climate change adaptation strategy (OE 2018), which focuses on the sectors of water resources management, natural hazards, agriculture, forestry, energy, tourism, biodiversity, health and land use planning. Emphasis lies on impacts of increasing risks of drought periods, heat waves, flood events and spreading of new vector borne diseases and alien invasive species. The strategy also addresses consequences of a reduced snow cover on winter tourism and the runoff regime.

1.5.5 Monitoring and evaluation framework

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

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

1.5.6 Progress and outcomes of adaptation action

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

Natural hazard management: The Office of Civil Protection of Liechtenstein conducted a general risk assessment, which covers also risks related to natural causes (EBP, 2012). In addition,

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[2] http://www.alpconv.org/pages/default.aspx [13.10.2017]

[3] http://www.alpine-space.org/2007-2013/projects/projects/detail/CLISP/show/index.html [13.10.2017]

[4] http://www.alpine-space.org/2007-2013/projects/projects/detail/C3-Alps/show/index.html [13.10.2017]

Liechtenstein has established natural hazard maps (OCP, 2017). These maps provide regionalized information on the specific local risks of avalanches, rock fall, landslides and flooding. To address the expected increase in frequency and intensity of natural disasters, the Division of Forests and Landscape of Liechtenstein will regularly update these natural hazard maps, taking into account potential changes in frequency and magnitude of extreme events.

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

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

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

Forest service plans define forest management at the local level. These plans are updated every 10 years, taking into account possible needs for adaptation of management practices to changes in climatic conditions. Liechtenstein also developed a national forest development plan (OE, 2001), which addresses future forest management and is also periodically updated.

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

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

Biodiversity management: Liechtenstein developed a management plan for the control of invasive alien plant species (OE, 2015a). It provides a list of species that need to be controlled or watched. It also defines suitable measures to prevent alien species from invasive spreading and control measures for affected areas, such as appropriate disposal procedures. Many natural

habitats that are highly susceptible to changes in climatic conditions, such as alpine and aquatic habitats and wetland areas are already under protection in Liechtenstein. These regulations form the necessary framework for the development and implementation of measures for the preservation of these ecosystems. The national report on the implementation of the convention on biodiversity (OE, 2014) documents the state of Liechtenstein's ecosystems and the progress towards the achievement of "Aichi biodiversity targets".

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

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

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

1.6 Financial, technological and capacity-building support

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

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

Liechtenstein works closely together with the affected population and local organizations, with aid and development organizations in Liechtenstein, Switzerland, Austria and Germany as well as with European and international organizations. Liechtenstein, through its IHCD, maintains working relationships with a large number of partners. The bulk of Liechtenstein's support is provided in the form of financial resources. Nevertheless, the LED maintains three coordination offices on the ground, namely in Moldova, Bolivia and Zimbabwe from where it can directly supervise its projects.

In 2016, Liechtenstein's IHCD had resources in the amount of about 22.5 million Swiss francs, i.e. about 650 Swiss francs per capita. Total Official Development Assistance (ODA) amount was 24.2

million Swiss francs. The most recent ODA-percentage is 0.5% in the year 2014. Technology development and/or transfer as well as capacity-building are usually a component of programmes and projects of Liechtenstein that support developing countries in their endeavours to mitigate and adapt to climate change.

1.7 Research and systematic observation

1.7.1 Research

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

Two of the University's institutes (Institute for Architecture and Planning and Institute for Financial Services) are directly involved in the examination of sustainable and ecological developments within their specific fields of activities. One of the main focuses points of the Institute for Architecture is the establishment of concepts for a sustainable regional development with respect to settlement, transport and landscape. The Institute for Financial Services examines the impacts, challenges and opportunities of financial markets and market instruments on social or environmental developments.

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

Liechtenstein supports research activities abroad, with annual contributions to Switzerland (Swiss National Science Foundation, SNSF) and Austria (Austrian Science Fund, FWF), each amounting to 250'000 CHF (2017). As a member of the EEA, Liechtenstein also participates in the European research programs, but not in the Horizon 2020 programme.

Public institutions in Liechtenstein are also indirectly engaged in technology research. The University of Liechtenstein contributes a budget of 14.6 million CHF (2016) to the training of experts and 3 million CHF (2016) to research as a base amount. Approximately 2/3 of this sum is dedicated to economic institutes and 1/3 to the Institute of Architecture and Planning. As one of the co-owners Liechtenstein also supports the Interstate University of Applied Sciences of Technology Buchs (NTB) with an annual contribution of 580'000 CHF (2016).

Liechtenstein envisages contributing another 600'000 CHF annually (since 2014) to the establishment of RhySearch Innovation Center – a center of research and development, based in neighbouring Buchs, Switzerland. The activities of RhySearch are dedicated to small and midsized enterprises within the Rhine valley region and focus amongst others on the development of new energy systems.

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

1.7.2 Systematic observation

Liechtenstein collects a wide range of data relating to climate, both through its own measuring stations and through interregional cooperation, especially with Switzerland. Since 1974, the largest measuring station in the country has been in operation in Vaduz, measuring common meteorological data (air pressure, air temperature, relative humidity, wind direction, wind speed and direction, precipitation, sunshine duration etc.). A private company has also measured similar data at several locations since 1997.

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

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

1.8 Education, training and public awareness

1.8.1 Education at schools

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

Since 2005, environmental education officially forms part of Liechtenstein's all-encompassing educational program. Its origin is to be found on the national curriculum for Kindergarten, Primary and Secondary School of the Principality of Liechtenstein (2005, 2nd Edition). As one out of several reasons for the faculty of "Human and Environment" (topics are, among others: Climate, Weather, Economy, Industrialization) the respective curriculum states: "Students deal with humans as part of society and environment. They recognize dependencies as well as the possibility to act for or to influence relevant procedures." Thanks to this approach, environmental education influences the content of various school subjects – it is not only a part of subjects like "Biology" or "Nature" (ecology), but also of "Economy and Policy" (ecological and economic relations).

In addition to the abovementioned, the Government has set eco-friendly office and school supply goals: A specific catalogue recommends eco-friendly office and school supplies to teachers (paper, notebooks, writing implements, etc.). Moreover, various school projects on environmental education were conducted at Liechtenstein schools, including the establishment of environmental focal points.

1.8.2 Public outreach

Public outreach is the responsibility of the administrative office assigned to the area in question. In addition, some tasks are delegated to external institutions and individual outreach campaigns by NGOs are supported.

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

The population is also provided with information on individual environmental concerns through reports in the newspapers. Research and survey results concerning the condition of the mountain

region and information on environmental developments and changes are regularly brought to the attention of the population by public authorities via publication series, thematic brochures, posters, and reports in newspapers. Specialized excursions with school classes, population groups, and professional organizations conducted by various public authorities constitute an important component of public outreach.

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

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2. National circumstances relevant to greenhouse gas emissions and removals

2.1 Governmental structure

2.1.1 System of State

The Principality of Liechtenstein is a constitutional hereditary monarchy on a democratic and parliamentary basis. The power of the State is embodied in the Reigning Prince and the People. The relatively strong position of the Reigning Prince is balanced by far-reaching direct-democratic rights of the people.

2.1.2 Separation of powers

In the dualistic system of State of the Principality of Liechtenstein, the power of the State is embodied in both the Reigning Prince and the People. Separation of powers is further safeguarded by vesting separate rights in the executive branch (Government), the legislative branch (Parliament), and the judicial branch (courts).

2.1.3 Reigning Prince (Head of State)

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

2.1.4 Parliament

The Liechtenstein Parliament is elected every four years. Parliament consists of 25 Members. They are elected in universal, equal, direct, and secret elections in accordance with proportional representation. In the current legislative term (2017-2020), four parties are represented in Parliament. The Progressive Citizens' Party (FBP) is the strongest party with 9 seats. The Patriotic Union (VU) has 8 seats, the Independents (DU) have 5 seats and the Free List (FL) is represented with 3 seats.

The most important responsibilities of Parliament are participation in the legislative process, assent to international treaties, approval of State funds, election of judges on the proposal of the selection body, and supervision of the National Administration. Parliament elects the Government and proposes its appointment to the Reigning Prince. It can also trigger dismissal of the

Government when the Government loses its confidence. Parliament constitutes a quorum if at least two thirds of its Members are present.

2.1.5 Government

The Government consists of five Ministers: the Prime Minister, the Deputy Prime Minister, and three other Ministers. The Ministers are appointed by the Reigning Prince on the recommendation of Parliament. The Government is the supreme executive authority, to which 30 offices and several diplomatic missions abroad are subordinate. About 50 commissions and advisory councils support the work of the Administration.

2.1.6 Jurisdiction

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

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

2.1.7 Municipalities

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

2.1.8 Relations with Switzerland

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

The Customs Treaty ensures that all Swiss customs regulations and all other Swiss federal legislation shall apply to Liechtenstein to the extent to which their application is necessary for the customs union. All provisions of Swiss federal legislation that would give rise to a contribution requirement by the Swiss Confederation are exempt from this rule. In addition, all trade and customs treaties concluded between Switzerland and third countries apply to Liechtenstein pursuant to the Customs Treaty. Switzerland is also authorized to represent Liechtenstein at such negotiations and to conclude these treaties effective for Liechtenstein. In principle, the Customs

Treaty is limited to the transport of goods. In the 1990's, the Customs Treaty was adapted as a consequence of European integration. Since then, Liechtenstein has been able to become a State party to international conventions and a member of international organizations concerning the scope of the Customs Treaty, as long as Switzerland also belongs to these conventions and organizations. On the other hand, Liechtenstein may also join such conventions and organizations even if Switzerland does not join. In this event, Liechtenstein and Switzerland conclude a special agreement, such as in 1994 pursuant to Liechtenstein's accession to the European Economic Area (EEA). In addition to its effect under international law, the Customs Treaty also has symbolic significance for the particularly close relations between Liechtenstein and Switzerland. It has created the basis for legal alignment and harmonization in the fields of economics and social law, extending far beyond the scope of the treaty. These close links manifest themselves today in a wide range of agreements and treaties, including the areas of social security, vocational training, transport, indirect taxes, and cross-border police cooperation.

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

2.1.9 Liechtenstein and the EU

The relations between Liechtenstein and the EU are close, and cooperation is intensive. Since 1 May 1995, Liechtenstein has been linked with the European Union (EU) and its member States through an extensive association agreement – the Agreement on the European Economic Area (EEA). This agreement extends the Single Market of the EU by three of the four EFTA States, namely Liechtenstein, Iceland, and Norway. Including Croatia that joined on 1 July 2013, the EU now has 28 members and the EEA 31 members.

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

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

2.2 Population

At the end of 2015, Liechtenstein had a population of 37,622, a third (34.0%) of whom were foreign citizens (especially Swiss, Austrians, Germans and Italians). The population density in 2015 was 234 inhabitants per km^2. Figure 2-1 indicates the development of Liechtenstein's population between 1960 and 2015.

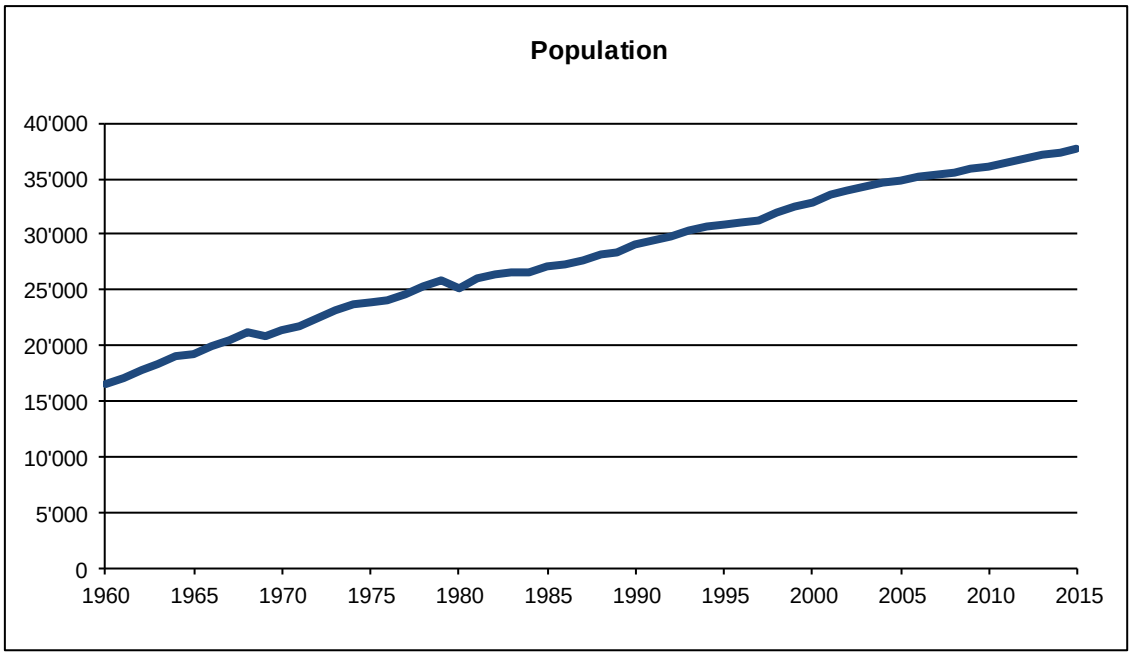


Figure 2-1 Population 1960-2015

2.3 Climate

Liechtenstein has a continental climate, i.e., the weather varies considerably over the course of the year. In the capital Vaduz, at 456 meters elevation, the average annual temperature was 11.1°C in the year 2015. The average precipitation has not changed appreciably in the last 20 years. In Vaduz, it is approximately 965 mm per year (annual average precipitation 1974-2015).

2.4 Geography

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

Figure 2-2 The Principality of Liechtenstein

2.5 Economy

At the end of 2016, Liechtenstein had 37,453 employed persons. More than half of the work force lives abroad commuting from Switzerland, Austria or Germany to Liechtenstein. Over two thirds of the work force are foreign citizens. In 2016, 61.4% of the employed persons worked in the sector services, 37.9% in the sector manufacturing and 0.7% in the sector agriculture and forestry.

In 2016 the annual unemployment rate was 2.3%.

The gross domestic product (GDP) and the gross national income (GNI) were determined for the first time in 1998, as part of Liechtenstein's National Economic Accounting. In 2014, the GDP stood at 6.1 billion (thousand million) Swiss francs and economic growth was 3.0%. The GNI was at 5.0 billion Swiss francs. A first estimation for the GDP in 2015 is 6.0 billion Swiss francs. Figure 2-3 shows the development of the GDP and GNI between 1998 and 2014.

According to economic sector, goods production generated 41% of gross value added in 2014, general services 27%, financial services 25%, and agriculture and households 7%.

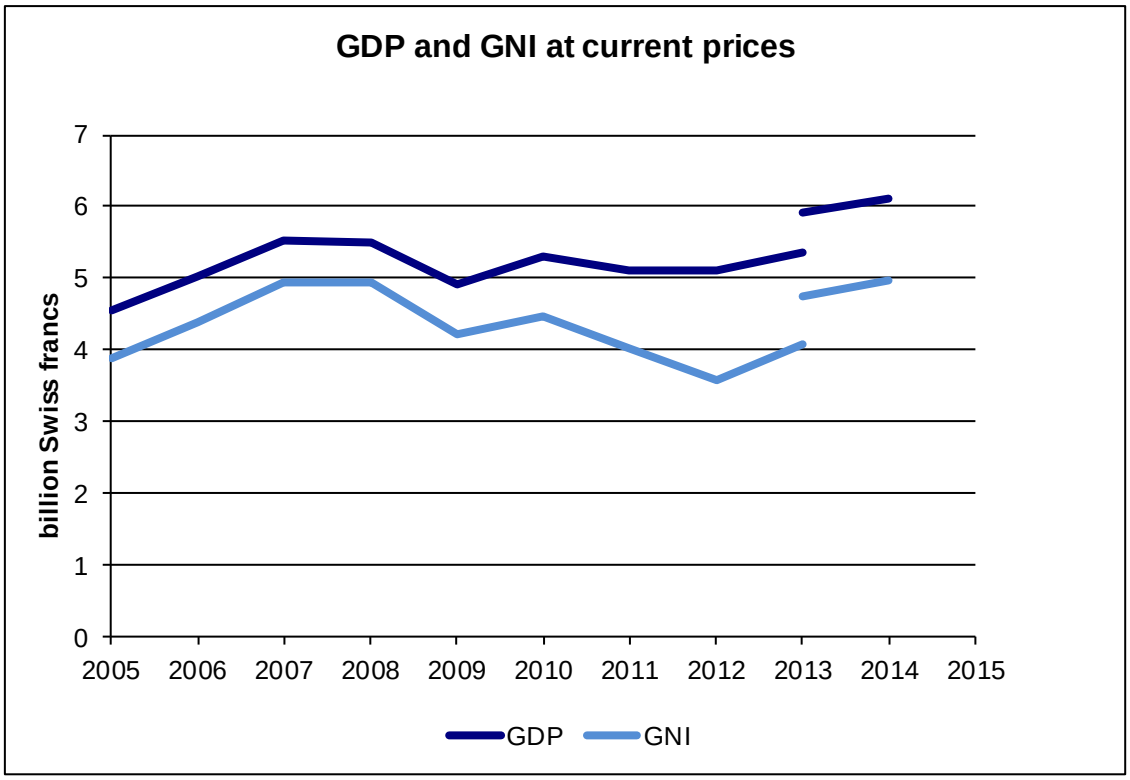


Figure 2-3 GDP and GNI at current prices 2005-2015; break in series in 2013 due to the changeover from ESA95 to ESA2010 (European System of Accounts)

Figure 2-4 shows the development of GDP per employed person (in full-time equivalents) and GNI per inhabitant. In 2014, GDP per employed person was 197,000 Swiss francs and GNI per inhabitant was 133,000 Swiss francs. A distinctive feature of the Liechtenstein GDP is that it derives to a considerable extent from the work done by working personnel domiciled abroad. In 2014, 53% of people at work in Liechtenstein were cross-border commuters from abroad. For this reason, it is not informative to calculate per capita GDP based on inhabitants. This would yield to misleading results in comparison with other countries.

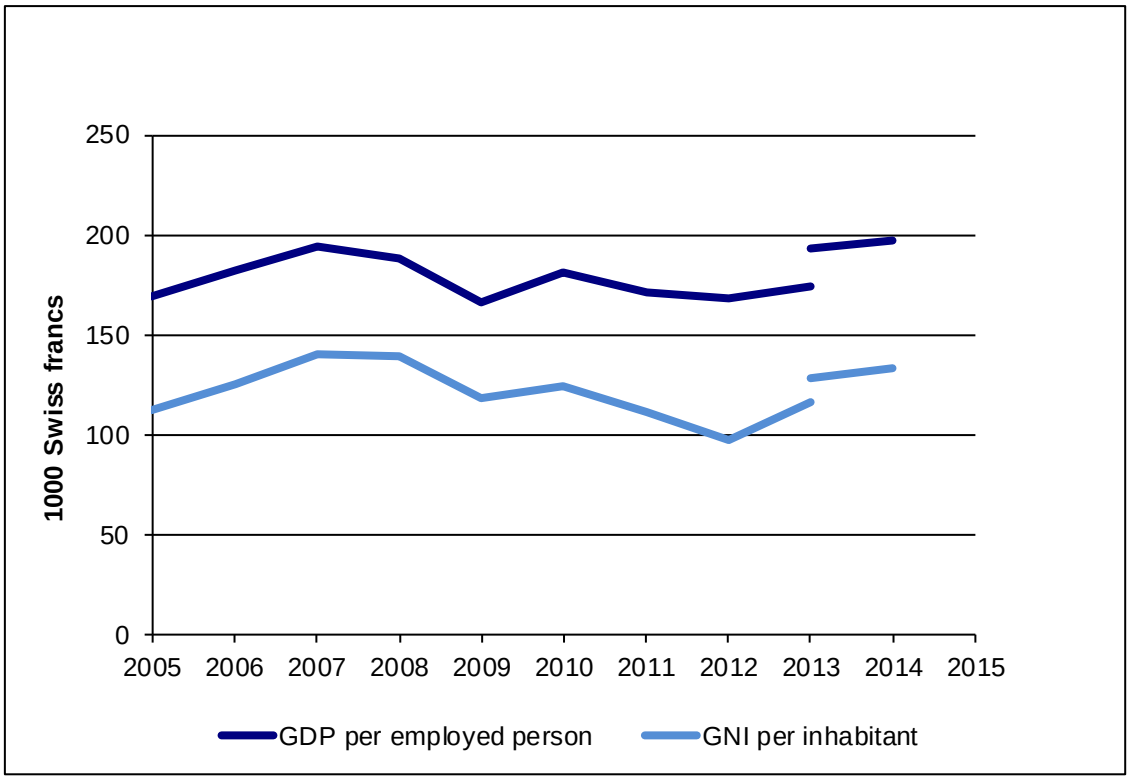


Figure 2-4 GDP at current prices per employed person (in full-time equivalents) and GNI at current prices per inhabitant 2005-2014; break in series in 2013 due to the changeover from ESA95 to ESA2010 (European System of Accounts)

2.6 Energy

2.6.1 Energy supply

Liechtenstein has no fossil fuel resources of its own. In the year 2016, 13% of the energy used comes from Liechtenstein. Regarding electricity, 22% was produced in Liechtenstein. Liechtenstein's own supply of energy is limited to firewood, ambient heat, and electricity (hydroelectric power plants, photovoltaic systems, biogas and natural gas block-heating plants).

Total energy consumption in 2016 was 1,202 GWh (4,329 TJ). Natural gas (21%) and electricity (33%) constitute the greatest share of the total energy consumption.

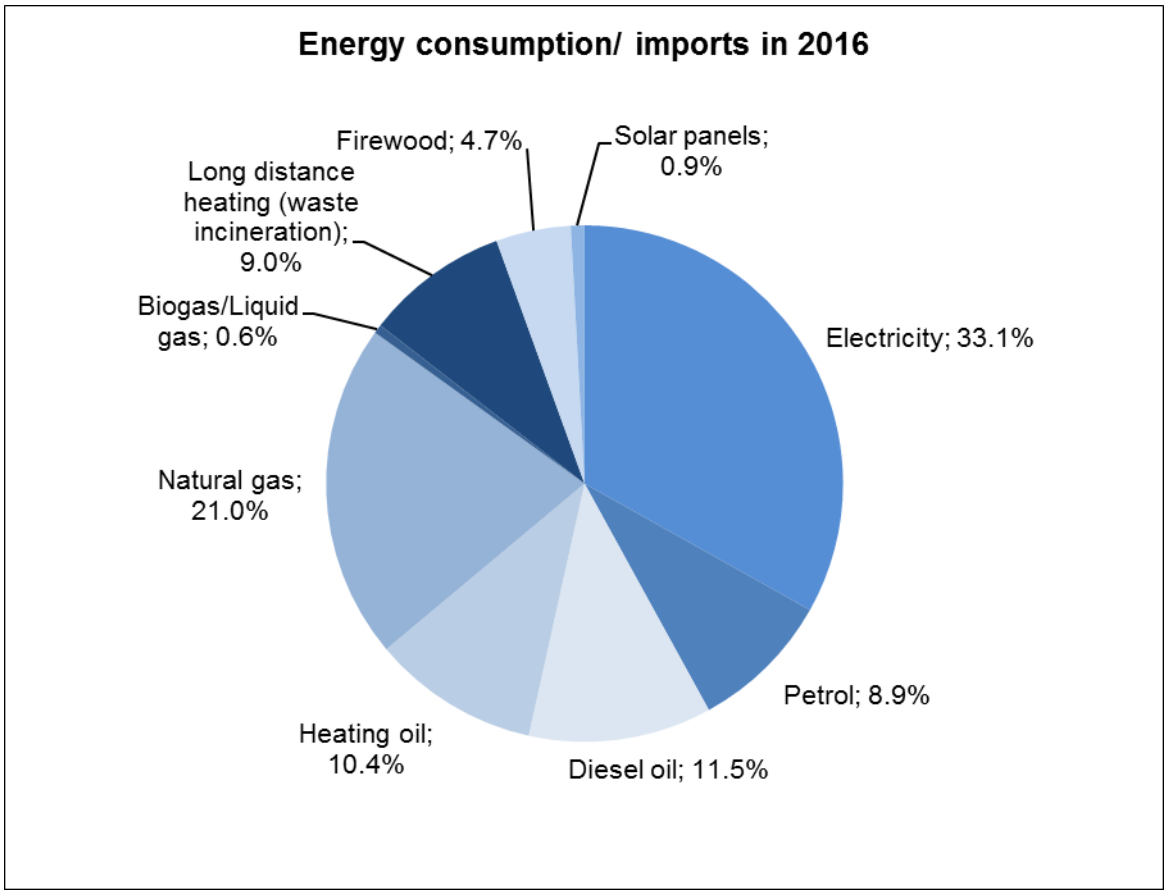


Figure 2-5 Total energy consumption/ imports by fuel in 2016.

In 2016, total energy consumption per capita reached 31.8 MWh. Figure 2-6 illustrates energy consumption per inhabitant between 1985 and 2016. In the last ten years, the development of the energy consumption per capita showed a decreasing tendency, with some yearly fluctuations.

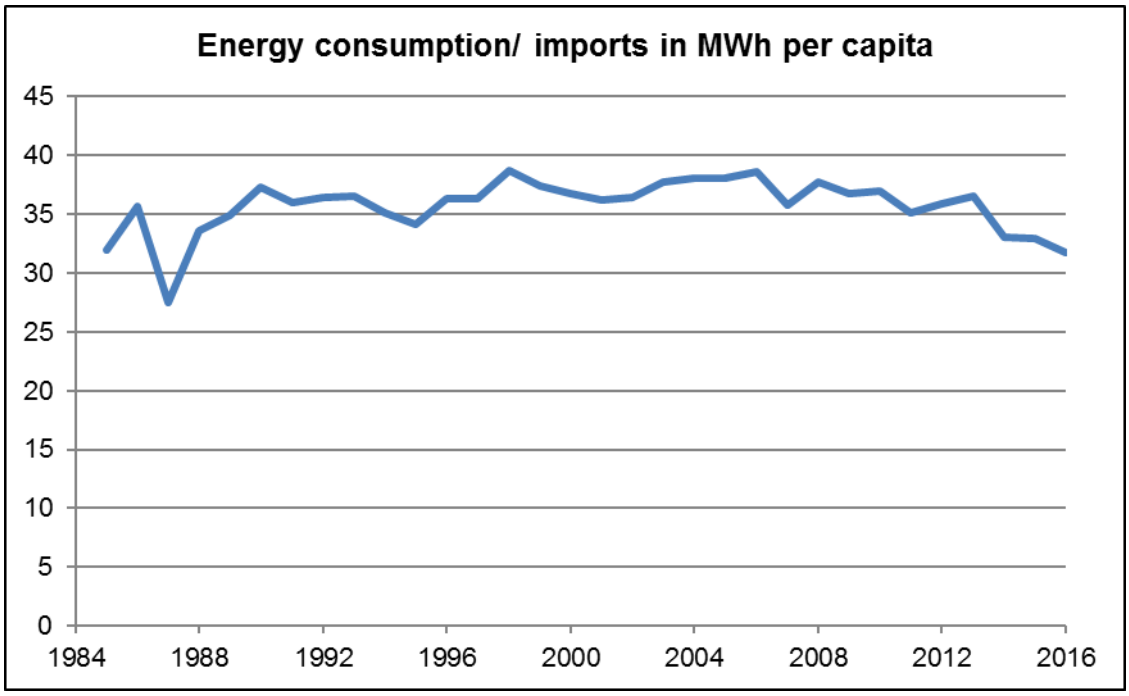
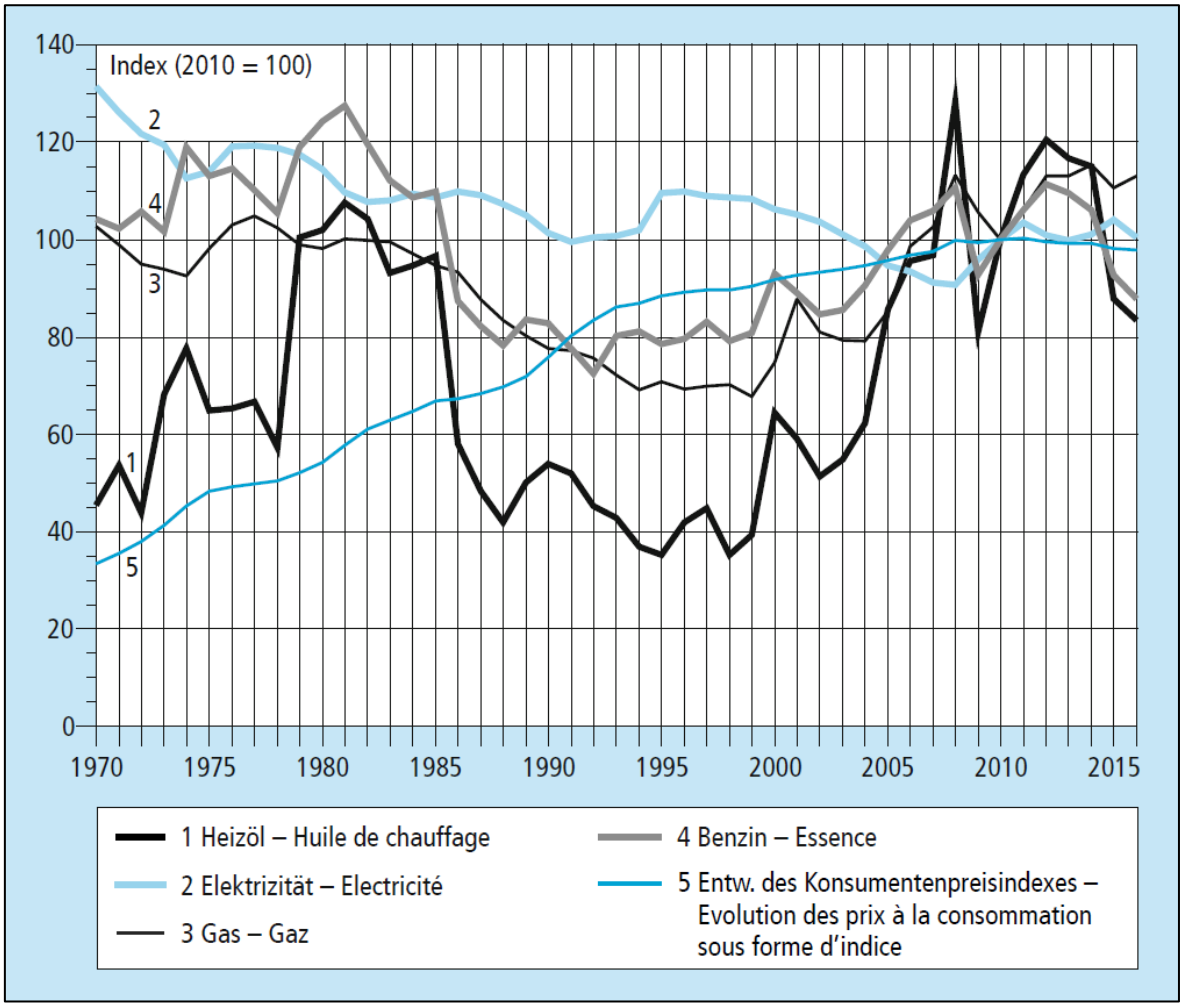


Figure 2-6 Energy consumption/ imports per capita 1985-2016.

2.6.2 Energy prices

Liechtenstein does not compile its own statistics on the development of energy prices; however, energy prices are comparable to those in Switzerland. Table 2-1 illustrates the development of real energy prices for the most important energy sources – electricity, natural gas, gasoline and gas oil – in Switzerland between 1965 and 2016. Prices for gas oil reached a historic low in the mid-90ties. In the following years, real energy prices of gas oil rose in tendency, with some outliers e.g. in 2008 and 2009. However, there was a decrease in the last five years with a substantial drop between 2014 and 2015. The development of the real energy prices of gasoline was similar, especially in the last five years. The real energy price for natural gas increased in tendency between the mid-90ties and 2008. Then the real prices fluctuated yearly and were in 2016 on the same level as five years ago. In contrast to the other energy sources, the development of real energy prices for electricity between the mid-90ties and 2008 showed a decreasing tendency. The prices increased in the following three years and then fluctuated yearly. The real price of 2016 was on a similar level as five years ago; however, the real price was lower than in the mid-90ties.

Table 2-1 Real energy prices of the most important energy sources 1970-2016, Index 2010=100 (SFOE 2016)



Translation: Heizöl=gas oil; Elektrizität=electricity; Gas=natural gas; Benzin=gasoline; Entw. des Konsumentenpreisindexes=development of the consumer price index

2.6.3 Electricity

In 2016, the electricity fed into the national network amounted to 399 GWh. About four fifths (78%) of the electricity consumed in Liechtenstein is being imported. Liechtenstein's own production amounts to approximately 89 GWh (hydroelectric plants, block-heating plants, and photovoltaic systems).

2.7 Transport

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

Over the last thirty years, the number of motor vehicles in Liechtenstein has more than doubled. In 2017, 29,676 automobiles were registered (degree of motorization: 785 automobiles per 1000 inhabitants). Figure 2-7 illustrates the development of the number of vehicles between 1970 and 2017.

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

Liechtenstein also follows the path established by Regulation (EC) 443/2009, which sets emission performance standards for new passenger cars. The Regulation's goal by 2015 is to set the average emissions for new passenger cars at 130g CO_2/km. From 2020 onwards this Regulation sets a target of 95 g CO_2/km. The current Liechtenstein data is still far from achieving this goal.

The average CO_2 emissions of all vehicles newly introduced into circulation was 139 g/km in 2016 (compared to 190 g/km in 2008). The emissions of petrol vehicles were 146 g/km, slightly higher on average than the 143 g/km emitted by diesel vehicles. CO_2 emissions rise with increasing engine sizes, engine power, and vehicle weight. In the past years, most of the technically achieved reductions in CO_2 emissions have been cancelled out by the larger and more powerful engines and heavier vehicles that continue to be popular. However, the proportion of fuel efficient, light vehicles rises and also the number of vehicles with alternative fuels (natural gas, hybrid) continues to increase.

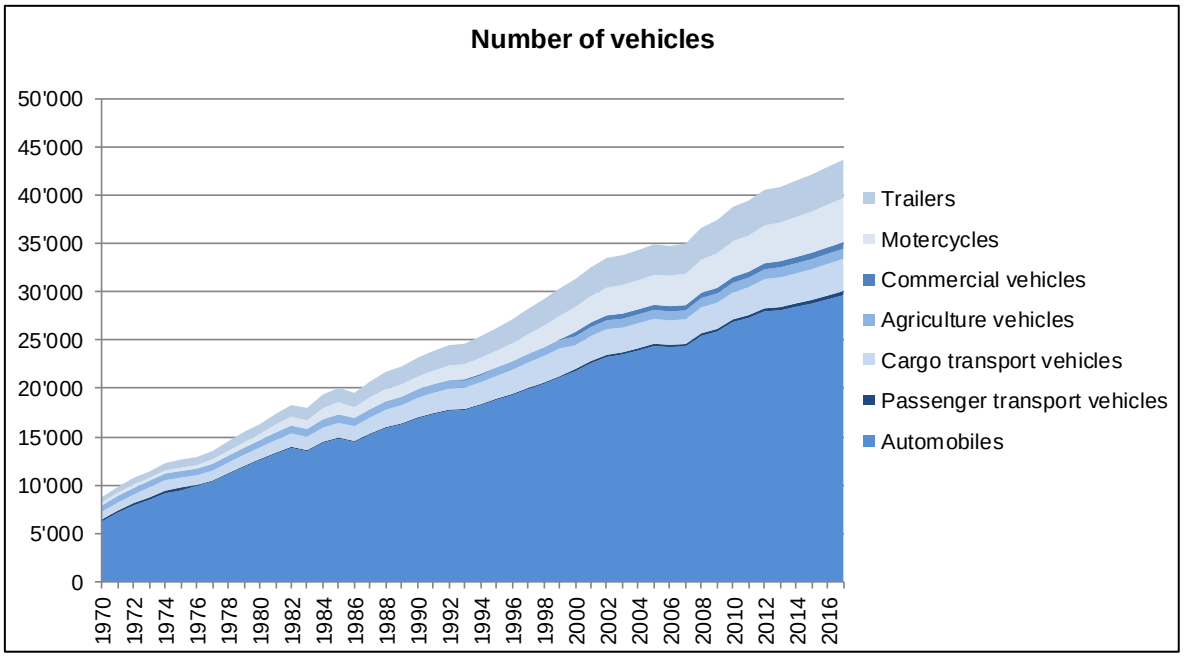


Figure 2-7 Number of vehicles 1970-2017.

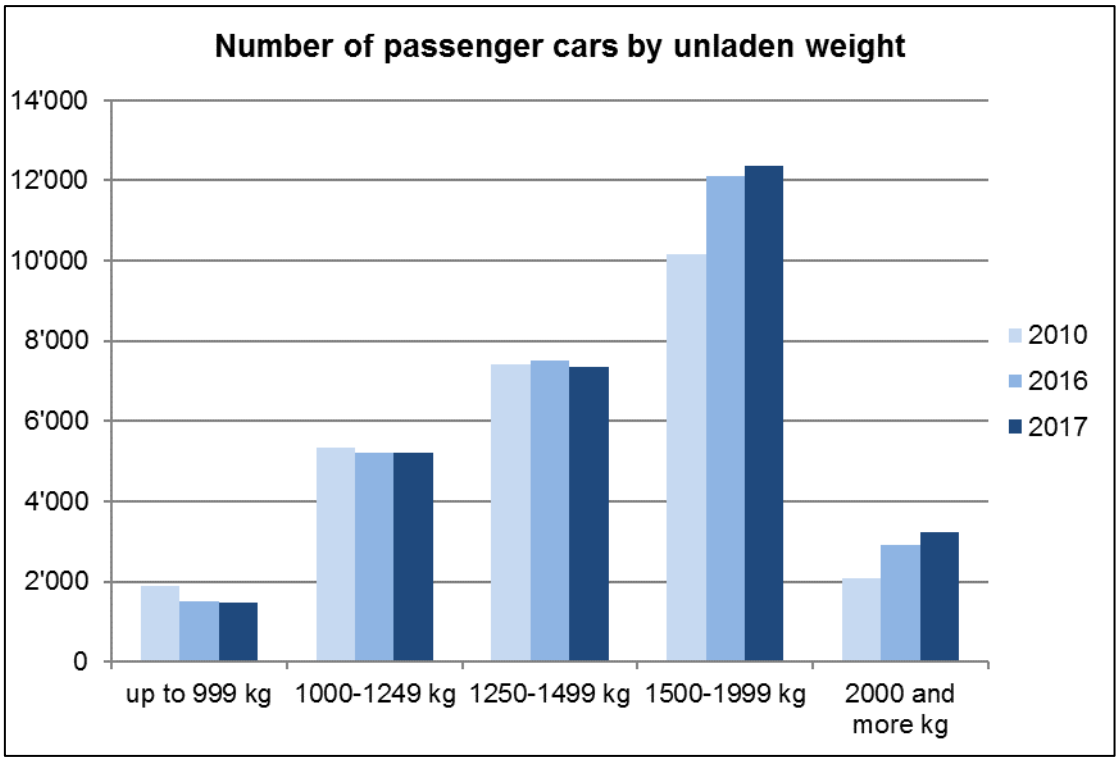


Figure 2-8 Number of passenger cars by unladen weight 2010, 2016 and 2017.

2.8 Industry

Liechtenstein's economy has a significant emphasis on industrial production. In 2015, the production sector provided 38.4% of employment, which is, in comparison with other European countries, extraordinarily high. The most important industrial branches are mechanical engineering, electrical machinery, vehicle components, dental technology, food products as well as construction work.

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

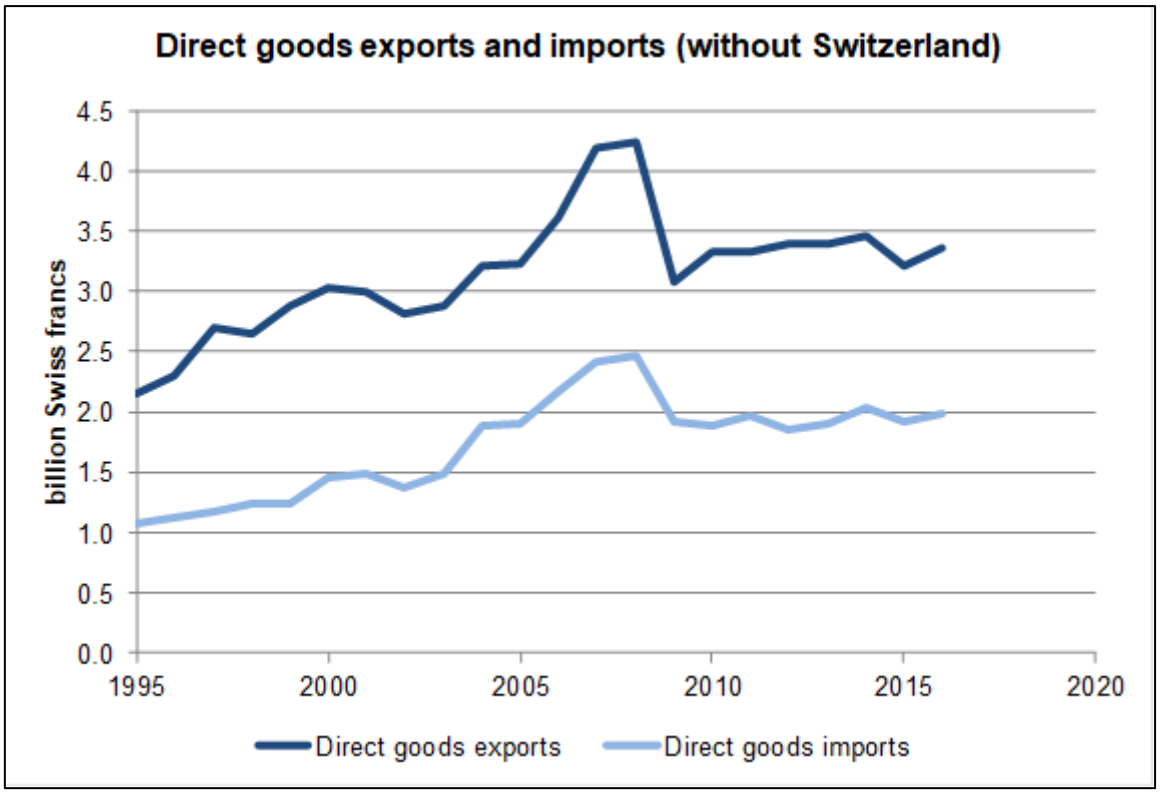


Figure 2-9 Direct goods imports and exports since 1995 in billion Swiss francs. Exchange of goods with Switzerland is not included.

2.9 Waste

After the implementation of fees on municipal waste considering the polluter-pays-principle in 1994 the amount of waste apparently declines, emissions from municipal solid waste (incineration) are minor in Liechtenstein.

The amount of landfill volume fluctuates strongly depending on building activities and market conditions. There are no managed waste disposal sites in Liechtenstein. There are three landfills which are managed (e.g. sealing, control of water quality), but they operate exclusively for inert materials and do therefore not cause any greenhouse gas emissions. The transition from “landfilling in the country” to “exporting MSW and industrial waste” to Switzerland for incineration started during the 1960ies and was concluded in 1974, when the last municipality in the country stopped landfilling. Before 1974, some waste (municipal and other) were landfilled along the river Rhine in sandy soils which were not suitable for agriculture. In the year 1998, those sites were recorded in a 'contaminated site register'. About 20 of all registered contaminated sites are from waste dumping. They are not managed (they are not really “landfills” but rather “contaminated sites”). No landfill gas was collected for flaring or energy recovery.

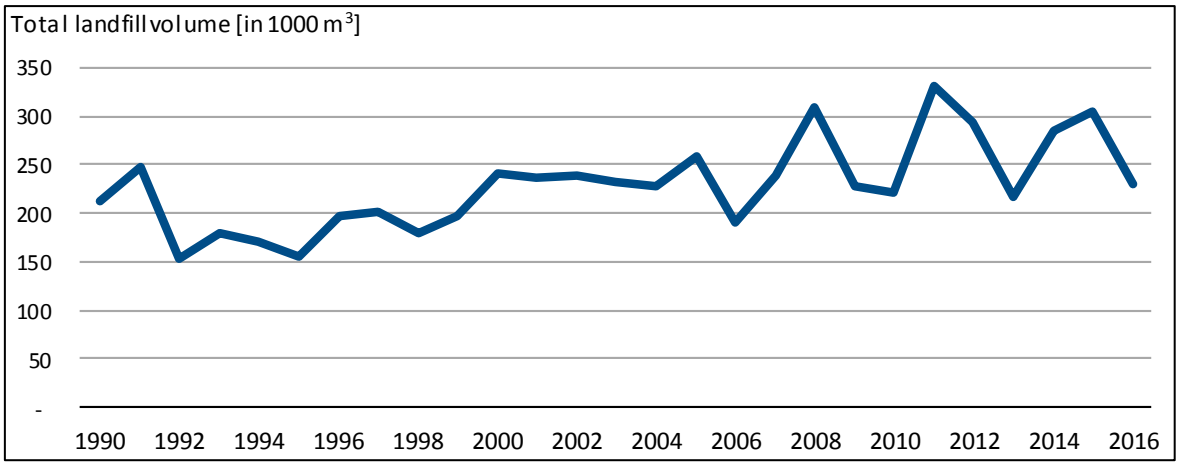


Figure 2-10 Development of landfill volumes since 1990 in 1000 cubic meters (OE 2017).

2.10 Building stock and urban structure

Between 1984 and 2014 the settlement area increased by 503 hectares (40.0%) to 17.6 km^2 or 11% of the country's area. The transport infrastructure covered 2.8% of the country's area in 2014. 4.0% of the country's area were living area. In 2016, there existed 10,604 residential buildings in Liechtenstein. In 1980 the number of residential buildings in Liechtenstein was 6,044.

2.11 Agriculture and Forestry

The country covers 160 km^2, 42% of which is forested, 33% agricultural (cropland, pastures, plantations, alp meadows), 11% populated, and 15% unproductive (as of the end of 2014).[5] Between 1984 and 2014 the agricultural area decreased from 58.3 km^2 to 52.3 km^2.

The abovementioned data (Chapter 2.10 and 2.11) originate from Liechtenstein's Land-use statistics from 2014 (published in the Environment statistics 2015) and from Liechtenstein's Buildings and dwellings statistics 2016.

References

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OS (Office of Statistics), 2017: Statistical yearbook 2017, Vaduz.

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

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OS (Office of Statistics), 2017: Energy statistics 2016, Vaduz.

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SFOE (Swiss Federal Office for Energy), 2017: Swiss Overall Energy Statistics 2016. Bern. Switzerland.

3. GHG Inventory information

3.1 Summary tables

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

3.2 Descriptive summary

3.2.1 Methodologies and data sources

GHG inventory

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

The emissions are modelled by using country-specific activity data (AD). Country-specific emission factors are applied if available. A number of default emission factors from IPCC are used. For a majority of emission sources, however, emission factors are adopted from the Swiss GHG inventory after checking their applicability. In those cases, the emission factors are reported as country-specific. As outlined above, there is a very close relationship between Liechtenstein and Switzerland based on the Customs Union Treaty between the two countries (see chp.2.1.8). **Therefore, a number of emission factors are adopted from Switzerland assuming that the Swiss emission factors actually represent the emission standards more accurately than default emission factors.** This assumption especially holds for:

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

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

1 Energy

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

2 Industrial processes and product use

- HFC and PFC emissions from 2F1 Refrigeration and air conditioning are reported and calculated with the rule of proportion applied to the Swiss emissions using country-specific AD as representative for the conversion (e.g. number of inhabitants).
- SF_6 emissions from 2G1 Electrical equipment are reported based on country-specific data.
- N_2O emissions from 2G3 Product uses are reported and are calculated with the rule of proportion applied on the Swiss emissions using country-specific AD (number of inhabitants) as representative for the conversion.
- CO and NMVOC emissions from 2D3b Road paving with asphalt and 2D3c Asphalt roofing. The emissions are estimated based on the Swiss emissions using the number of inhabitants as a reference value for the rough estimate of Liechtenstein's emissions
- Other emissions from industrial processes and product use (CO_2, CH_4, N_2O) are not occurring.

3 Agriculture

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

4 LULUCF

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

5 Waste

- Emissions for 5A Solid waste disposal, 5B Biological treatment of solid waste and 5D Wastewater treatment and discharge are estimated according to IPCC (2006) with country-specific AD.
- Emissions for 5C Incineration and open burning of waste a country-specific method is used, based on CORINAIR, adapted from the Swiss NIR (FOEN 2016).

3.2.2 Brief Description of Key Categories

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

- Base year 1990 level assessment without LULUCF categories
- Base year 1990 level assessment with LULUCF categories
- Reporting year 2015 level and trend assessment without LULUCF categories
- Reporting year 2015 level and trend assessment with LULUCF categories

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

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

3.2.2.1 GHG Inventory

KCA excluding LULUCF categories

For 2015, among a total of 196 categories, 11 have been identified as Approach 1 key categories by the CRF Reporter Software (see CRF Table7 of the reporting tables) with an aggregated contribution of 96.1% of the national total emissions (see Table 3-1). 10 categories are key categories according to level assessment and 9 according to trend assessment.

Within those 11 key categories, 7 stem from the energy sector, contributing 80.5% to total CO_2 equivalent emissions in 2015. The other key categories are from the sectors Agriculture (3 categories, contribution: 10.4%) and Industrial processes and product use IPPU (1 category, contribution: 5.1%).

The three major sources, all from the energy sector, sum up to a contribution of 65.2% of the national total emissions:

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

Compared to the previous submission for the reporting year 2014, the following two categories are not considered as key anymore in 2015:

- 3D2 Indirect N_2O emissions from managed soils, N_2O
- 5D Wastewater treatment and discharge, CH_4

On the other hand, one additional category is key in 2015:

- 1B2b Fugitive emissions from fuels, Oil and natural gas and other emissions from energy production, CH_4

Further details are shown in Table 3-1 below.

Table 3-1 List of Liechtenstein's Approach 1 key categories 2015 excluding LULUCF. Sorted by share of total emissions.

Key Category Analysis 2015 (excluding LULUCF) IPCC Source Categories (and fuels if applicable)	GHG	Emissions 2015 [kt CO_2eq]	Share of Total Emissions	Cumulative Total	Result of Assessment
1.A.3.b Road Transportation	CO2	61.32	30.8%	30.8%	KC Level & KC Trend
1.A.4 Other Sectors - Liquid Fuels	CO2	35.02	17.6%	48.3%	KC Level & KC Trend
1.A.4 Other Sectors - Gaseous Fuels	CO2	33.75	16.9%	65.2%	KC Level & KC Trend
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	14.51	7.3%	72.5%	KC Level & KC Trend
3.A Enteric Fermentation	CH4	13.25	6.6%	79.2%	KC Level & KC Trend
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	12.80	6.4%	85.6%	KC Level & KC Trend
2.F.1 Refrigeration and Air conditioning	F-gases	10.25	5.1%	90.7%	KC Level & KC Trend
3.D.1 Direct N2O Emissions From Managed Soils	N2O	4.87	2.4%	93.2%	KC Level
3.B Manure Management	CH4	2.67	1.3%	94.5%	KC Level
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2.02	1.0%	95.5%	KC Level & KC Trend
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH4	1.16	0.6%	96.1%	KC Trend

For the base year 1990, the level key category analysis is given in Table 3-2 below. There are 8 level key categories. There are no changes compared to the KCA of the previous submission.

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

Key Category Analysis 1990 (excluding LULUCF) IPCC Source Categories (and fuels if applicable)	GHG	Emissions 1990 [kt CO_2eq]	Share of Total Emissions	Cumulative Total	Result of Assessment
1.A.4 Other Sectors - Liquid Fuels	CO2	76.71	33.5%	33.5%	KC Level
1.A.3.b Road Transportation	CO2	75.29	32.8%	66.3%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	20.99	9.2%	75.5%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	15.20	6.6%	82.1%	KC Level
3.A Enteric Fermentation	CH4	13.66	6.0%	88.1%	KC Level
1.A.4 Other Sectors - Gaseous Fuels	CO2	10.21	4.5%	92.5%	KC Level
3.D.1 Direct N2O Emissions From Managed Soils	N2O	5.20	2.3%	94.8%	KC Level
3.B Manure Management	CH4	3.06	1.3%	96.1%	KC Level

KCA including LULUCF categories

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

The Approach 1 key category analysis for the submission year 2016 including LULUCF categories consists of a total of 223 categories. Eight categories are identified key from the LULUCF sector and contribute with a total of 8.0% to total emissions:

- 4A1 Forest land remaining forest land, CO_2
- 4A2 Land converted to forest land, CO_2
- 4B1 Cropland remaining cropland, CO_2
- 4C1 Grassland remaining grassland, CO_2
- 4C2 Land converted to grassland, CO_2
- 4E2 Land converted to settlements, CO_2
- 4F2 Land converted to Other Land, CO_2
- 4G Harvested wood products, CO_2

Additionally, two categories from the sector Energy and one from the sector Agriculture are key when performing the KCA for the full inventory:

- 1A3b Road Transportation, CH_4
- 1A4 Other Sectors – Biomass, CH_4
- 3D2 Indirect N_2O emissions from managed soils, N_2O

Compared to the KCA in the previous submission 2016 for the reporting year 2014, one additional LULUCF category is key:

- 4A1 Forest land remaining forest land, CO_2

Further details are shown in Table 3-3.

In the KCA 1990 including LULUCF categories, three key categories contributing 4.8% to total emissions are identified from the LULUCF sector (see Table 3-4):

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

Table 3-3 List of Liechtenstein's Approach 1 key categories 2015 including LULUCF. Sorted by share of total emissions.

Key Category Analysis 2015 (including LULUCF) IPCC Source Categories (and fuels if applicable)	GHG	Emissions 2015 (absolute value) [kt CO_2eq]	Share of Total Emissions	Cumulative Total	Result of Assessment
1.A.3.b Road Transportation	CO2	61.32	28.1%	28.1%	KC Level & KC Trend
1.A.4 Other Sectors - Liquid Fuels	CO2	35.02	16.0%	44.1%	KC Level & KC Trend
1.A.4 Other Sectors - Gaseous Fuels	CO2	33.75	15.5%	59.6%	KC Level & KC Trend
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	14.51	6.6%	66.2%	KC Level & KC Trend
3.A Enteric Fermentation	CH4	13.25	6.1%	72.3%	KC Level & KC Trend
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	12.80	5.9%	78.2%	KC Level & KC Trend
2.F.1 Refrigeration and Air conditioning	F-gases	10.25	4.7%	82.9%	KC Level & KC Trend
3.D.1 Direct N2O Emissions From Managed Soils	N2O	4.87	2.2%	85.1%	KC Level
4.B.1 Cropland Remaining Cropland	CO2	4.01	1.8%	86.9%	KC Level
4.E.2 Land Converted to Settlements	CO2	3.04	1.4%	88.3%	KC Level
3.B Manure Management	CH4	2.67	1.2%	89.5%	KC Level
4.A.1 Forest Land Remaining Forest Land	CO2	2.43	1.1%	90.7%	KC Level & KC Trend
4.C.2 Land Converted to Grassland	CO2	2.38	1.1%	91.7%	KC Level & KC Trend
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2.02	0.9%	92.7%	KC Level & KC Trend
3.D.2 Indirect N2O Emissions From Managed Soils	N2O	1.90	0.9%	93.5%	KC Level
4.A.2 Land Converted to Forest Land	CO2	1.51	0.7%	94.2%	KC Level
4.C.1 Grassland Remaining Grassland	CO2	1.48	0.7%	94.9%	KC Level
4.G Harvested Wood Products	CO2	1.37	0.6%	95.5%	KC Level & KC Trend
4.F.2 Land Converted to Other Land	CO2	1.18	0.5%	96.1%	KC Trend
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH4	1.16	0.5%	96.6%	KC Trend
1.A.4 Other Sectors - Biomass	CH4	0.66	0.3%	96.9%	KC Trend
1.A.3.b Road Transportation	CH4	0.10	0.0%	97.0%	KC Trend

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

Key Category Analysis 1990 (including LULUCF) IPCC Source Categories (and fuels if applicable)	GHG	Emissions 1990 (absolute value) [kt CO_2eq]	Share of Total Emissions	Cumulative Total	Result of Assessment
1.A.4 Other Sectors - Liquid Fuels	CO2	76.71	31.1%	31.1%	KC Level
1.A.3.b Road Transportation	CO2	75.29	30.5%	61.6%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	20.99	8.5%	70.1%	KC Level
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	15.20	6.2%	76.3%	KC Level
3.A Enteric Fermentation	CH4	13.66	5.5%	81.9%	KC Level
1.A.4 Other Sectors - Gaseous Fuels	CO2	10.21	4.1%	86.0%	KC Level
3.D.1 Direct N2O Emissions From Managed Soils	N2O	5.20	2.1%	88.1%	KC Level
4.G Harvested Wood Products	CO2	4.70	1.9%	90.0%	KC Level
4.B.1 Cropland Remaining Cropland	CO2	4.18	1.7%	91.7%	KC Level
3.B Manure Management	CH4	3.06	1.2%	92.9%	KC Level
4.E.2 Land Converted to Settlements	CO2	2.94	1.2%	94.1%	KC Level
3.D.2 Indirect N2O Emissions From Managed Soils	N2O	2.37	1.0%	95.1%	KC Level

3.2.2.2 KP-LULUCF inventory

Liechtenstein identified four key categories for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol (Afforestation, Deforestation, Forest Management and Harvested Wood Products). The approach relies on full inventory KCA (with LULUCF), KP - CRF association and qualitative assessment. Find more information in Liechtenstein’s national inventory report 2017 (OE 2017).

3.2.3 Trends in greenhouse gas emissions and removals

This chapter provides an overview of Liechtenstein's GHG emissions and removals as well as their trends in the period 1990–2015 (information from the national inventory report, OE 2017).

3.2.3.1 Aggregated greenhouse gas emissions 2015

Liechtenstein's greenhouse gas emissions in the year 2015 amount to 199.4 kt CO_2 equivalent (CO_2eq) excluding LULUCF sources or sinks (including LULUCF: 207.7 kt CO_2). This refers to 5.3 t CO_2eq per capita. Total emissions (excl. LULUCF) have declined by 13.0% compared to 1990 and by 1.2% compared to 2014.

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

Table 3-1 shows the emissions for individual gases and sectors in Liechtenstein for the year 2015. The most important emission sources are fuel combustion activities in the Energy sector. Emissions of CH_4 and N_2O mainly originate from the sector Agriculture, and F-gas emissions stem from the sector 2 Industrial processes and product use (IPPU) by definition.

Table 3-5 Summary of Liechtenstein's GHG emissions in 2015 by gas and sector in CO_2eq (kt). Numbers may not add to totals due to rounding.

Emissions 2015	**CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Total**
	CO_2 equivalent (kt)						
1 Energy	159.5	2.08	0.8	-	-	-	162.3
2 IPPU	NO	NO	0.2	10.4	0.04	0.04	10.7
3 Agriculture	0.05	15.92	8.1	-	-	-	24.1
5 Waste	0.02	1.50	0.8	-	-	-	2.3
Total (excluding LULUCF)	**159.6**	**19.5**	**9.8**	**10.4**	**0.04**	**0.04**	**199.4**
4 LULUCF	7.9	NO	0.4	-	-	-	8.3
Total (including LULUCF)	**167.5**	**19.5**	**10.3**	**10.4**	**0.04**	**0.04**	**207.7**
International Bunkers	*1.2*	*0.0002*	*0.01*	-	-	-	*1.2*

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

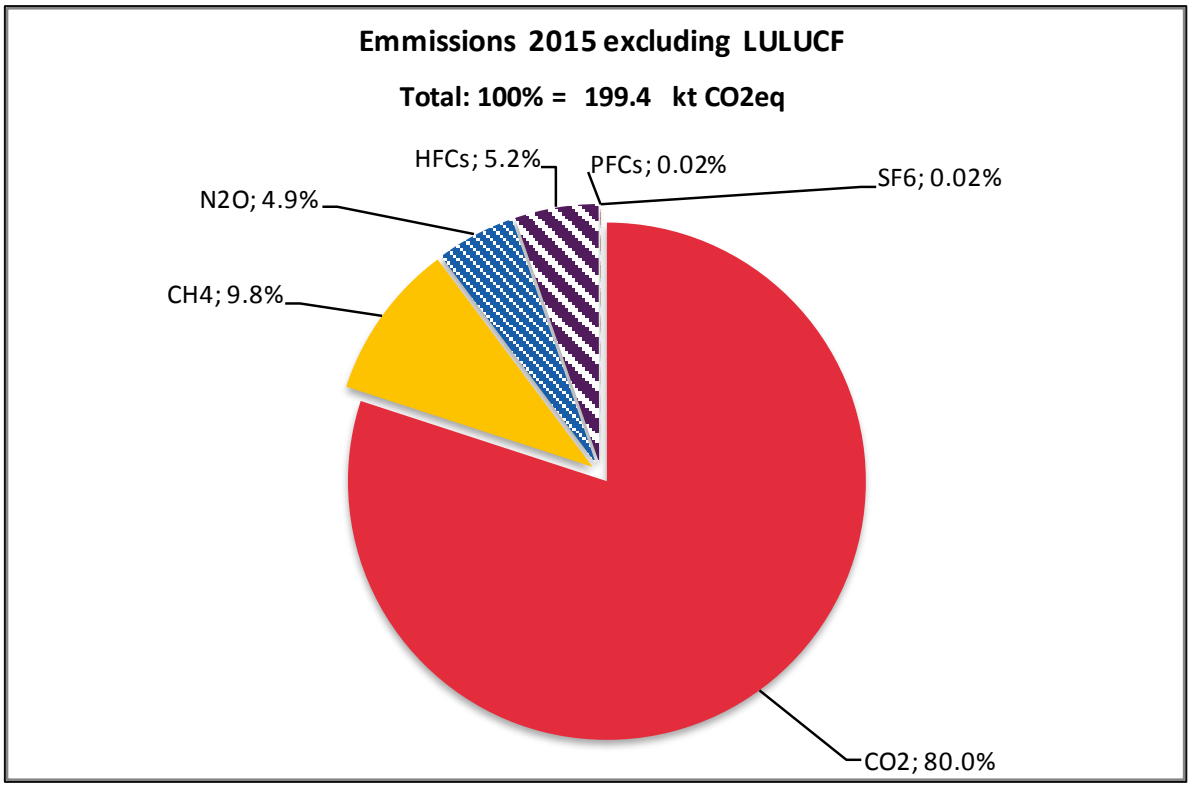

Figure 3-1 Liechtenstein's GHG emissions by gases excluding LULUCF emissions in 2015.

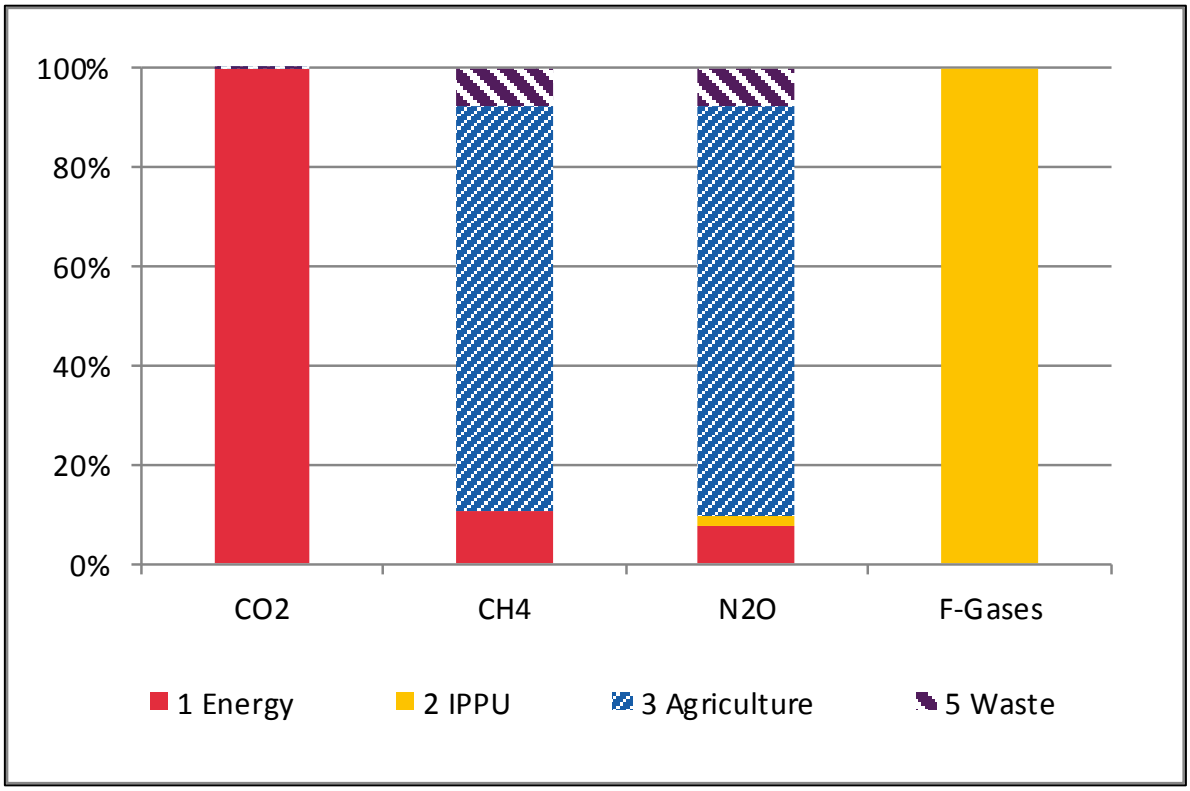

Figure 3-2 Relative contributions of the individual sectors (excluding LULUCF) to GHG emissions in 2015.

3.2.3.2 Emission trends by gas

Emission trends 1990–2015 by gas are summarized in Table 3-6 and in Figure 3-3.

Table 3-6 Summary of Liechtenstein's GHG emissions in CO_2eq (kt) by gas, 1990-2015. The last column shows the percentage change in emissions in 2015 as compared to the base year 1990. The percentage change of HFCs amounts to 9'974'954%.

Greenhouse Gas Emissions	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
	CO_2 equivalent (kt)									
CO_2 emissions incl. net CO_2 from LULUCF	202.0	196.0	207.5	212.5	218.4	206.9	200.6	224.8	227.1	222.7
CO_2 emissions excl. net CO_2 from LULUCF	198.8	206.2	206.8	214.9	201.0	204.1	205.8	218.2	229.1	226.4
CH_4 emissions incl. CH_4 from LULUCF	19.5	19.4	19.0	18.2	18.4	18.3	18.7	18.4	18.2	17.6
CH_4 emissions excl. CH_4 from LULUCF	19.5	19.4	19.0	18.2	18.4	18.3	18.7	18.4	18.2	17.6
N_2O emissions incl. N_2O from LULUCF	11.2	11.4	11.3	11.1	11.0	10.9	10.9	10.9	10.6	10.3
N_2O emissions excl. N_2O from LULUCF	10.9	11.1	11.0	10.8	10.7	10.6	10.6	10.6	10.2	10.0
HFCs	0.0	0.0	0.1	0.2	0.5	1.4	1.7	2.1	2.7	3.3
PFCs	NO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0
Total (including LULUCF)	232.7	226.8	237.9	242.0	248.4	237.5	231.9	256.2	258.6	254.0
Total (excluding LULUCF)	229.2	236.7	236.9	244.0	230.6	234.3	236.8	249.3	260.3	257.4

Greenhouse Gas Emissions	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	CO_2 equivalent (kt)									
CO_2 emissions incl. net CO_2 from LULUCF	238.4	213.6	219.7	233.3	234.8	234.1	239.9	218.9	239.8	227.6
CO_2 emissions excl. net CO_2 from LULUCF	216.7	214.5	219.9	229.2	229.2	228.9	231.1	200.7	219.5	205.3
CH_4 emissions incl. CH_4 from LULUCF	17.4	18.0	18.3	18.5	18.6	19.2	19.9	20.4	20.7	20.4
CH_4 emissions excl. CH_4 from LULUCF	17.4	18.0	18.3	18.5	18.6	19.2	19.9	20.4	20.7	20.4
N_2O emissions incl. N_2O from LULUCF	10.2	10.3	10.4	10.4	10.1	10.2	10.4	10.5	10.7	10.5
N_2O emissions excl. N_2O from LULUCF	9.8	9.9	10.0	10.0	9.7	9.9	10.0	10.1	10.3	10.1
HFCs	4.1	4.9	5.5	6.1	7.0	7.4	7.8	8.5	9.1	9.1
PFCs	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
SF_6	0.1	0.2	0.2	0.2	0.3	0.3	0.1	0.1	0.3	0.1
Total (including LULUCF)	**270.2**	**247.0**	**254.2**	**268.7**	**270.8**	**271.3**	**278.2**	**258.4**	**280.7**	**267.9**
Total (excluding LULUCF)	**248.1**	**247.6**	**254.0**	**264.2**	**264.8**	**265.7**	**269.0**	**239.9**	**260.0**	**245.2**

Greenhouse Gas Emissions	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**1990-2015**
	CO_2 equivalent (kt)						**%**
CO_2 emissions incl. net CO_2 from LULUCF	211.5	197.8	206.7	206.1	174.7	167.5	-17.1%
CO_2 emissions excl. net CO_2 from LULUCF	190.8	176.8	185.4	192.6	161.3	159.6	-19.7%
CH_4 emissions incl. CH_4 from LULUCF	19.8	20.3	20.7	19.8	19.8	19.5	-0.2%
CH_4 emissions excl. CH_4 from LULUCF	19.8	20.3	20.7	19.8	19.8	19.5	-0.2%
N_2O emissions incl. N_2O from LULUCF	10.3	10.7	10.6	10.4	10.3	10.3	-8.5%
N_2O emissions excl. N_2O from LULUCF	9.9	10.3	10.2	10.0	9.9	9.8	-9.7%
HFCs	9.7	10.0	10.4	10.6	10.6	10.4	see caption
PFCs	0.1	0.1	0.1	0.1	0.0	0.0	---
SF_6	0.0	0.0	0.0	0.2	0.1	0.0	---
Total (including LULUCF)	**251.4**	**238.9**	**248.5**	**247.1**	**215.6**	**207.7**	**-10.7%**
Total (excluding LULUCF)	**230.3**	**217.4**	**226.8**	**233.3**	**201.8**	**199.4**	**-13.0%**

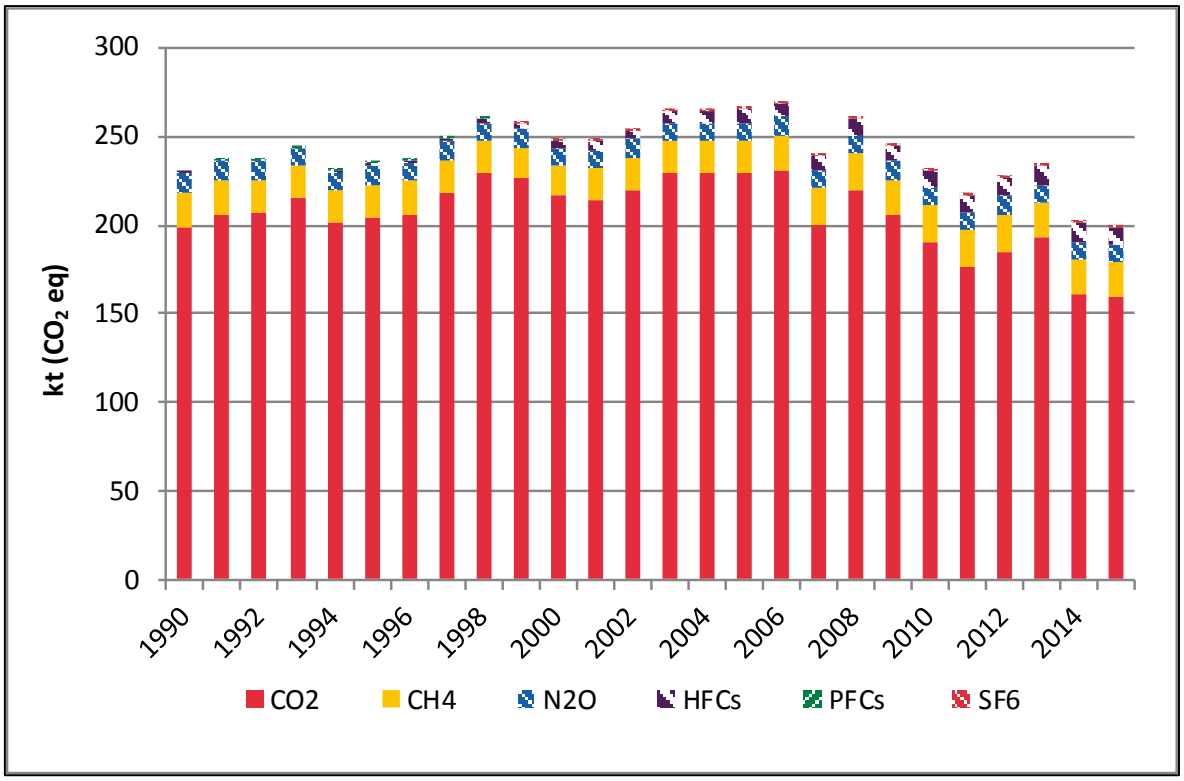

Figure 3-3 Trend of Liechtenstein's greenhouse gas emissions by gases 1990–2015. CO_2, CH_4 and N_2O correspond to the respective total emissions excluding LULUCF.

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

- Total emissions (in CO_2eq) excluding LULUCF sources or sinks decreased by 13.0% from 1990 to 2015.
- Total emissions (in CO_2eq) including LULUCF show a decrease of 10.7% in 2015 compared to 1990 levels.
- Accounting for 80.0% of the total emissions, CO_2 is the most dominant greenhouse gas emitted in Liechtenstein. CH_4 emissions represent 9.8% and N_2O emissions 4.9% of the total emissions.
- CO_2 emissions (excluding net CO_2 from LULUCF) declined by 19.7% between 1990 and 2015. In comparison to the previous reporting year 2014, CO_2 emissions (excluding net CO_2 from LULUCF) decreased by 1.1% in 2015. The most important drivers of net CO_2 emissions are fuel prices and winter temperatures (heating degree days).
- CH_4 emissions (excluding CH_4 from LULUCF) have slightly decreased by 0.2% since 1990. Compared to 2014, CH_4 emissions (excluding LULUCF) showed a decrease by 1.7% in 2015.
- N_2O emissions (excluding N_2O from LULUCF) declined by 9.7% in 2015 compared to 1990. Regarding 2014, N_2O emissions (without LULUCF) in 2015 slightly decreased by 0.2%.
- HFC emissions increased due to their role as substitutes for CFCs. SF_6 emissions originate from electrical transformation stations and play a minor role for the total of the synthetic gases (F-gases). PFC emissions have been occurring since 1997 and are increasing on a low level. The share of the sum of all F-gases (within total emissions excl. LULUCF) increased from 0.00005% (1990) to 5.3% (2015).

3.2.3.3 Emission trends by sector

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

Table 3-7 Summary of Liechtenstein's GHG emissions by source and sink categories in CO_2eq (kt), 1990–2015. The last column shows changes in emissions (%) in 2015 compared to 1990.

Source and Sink Categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (kt)									
1 Energy	**201.1**	**208.6**	**209.4**	**217.6**	**203.6**	**206.8**	**208.6**	**221.1**	**232.0**	**229.4**
1A1 Energy industries	0.2	0.9	1.9	2.0	1.8	2.1	2.6	2.5	2.9	2.9
1A2 Manufacturing industries & constr.	36.3	36.0	36.4	37.6	35.7	35.7	35.8	37.6	40.4	39.9
1A3 Transport	76.8	90.1	89.4	87.2	79.9	81.8	83.1	86.8	86.4	90.5
1A4 Other sectors	87.5	81.3	81.3	90.2	85.7	86.5	86.4	93.5	101.6	95.3
1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B Fugitive emissions from fuels	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8
2 IPPU	**0.5**	**0.4**	**0.5**	**0.6**	**0.9**	**1.7**	**2.1**	**2.4**	**3.0**	**3.6**
3 Agriculture	**25.5**	**25.5**	**24.8**	**23.8**	**23.9**	**23.7**	**23.9**	**23.5**	**23.0**	**22.1**
5 Waste	**2.2**	**2.1**	**2.1**	**2.1**	**2.2**	**2.2**	**2.3**	**2.2**	**2.2**	**2.2**
Total (excluding LULUCF)	***229.2***	***236.7***	***236.9***	***244.0***	***230.6***	***234.3***	***236.8***	***249.3***	***260.3***	***257.4***
4 LULUCF	**3.5**	**-9.9**	**1.0**	**-2.1**	**17.8**	**3.2**	**-4.9**	**6.9**	**-1.7**	**-3.4**
Total (including LULUCF)	***232.7***	***226.8***	***237.9***	***242.0***	***248.4***	***237.5***	***231.9***	***256.2***	***258.6***	***254.0***

Source and Sink Categories	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO_2 equivalent (kt)									
1 Energy	**219.8**	**217.5**	**222.8**	**232.1**	**231.9**	**231.6**	**233.8**	**203.6**	**222.4**	**208.3**
1A1 Energy industries	2.8	2.9	2.5	2.8	3.0	3.1	2.9	2.6	2.9	3.0
1A2 Manufacturing industries & constr.	36.5	36.4	37.9	41.2	39.9	39.2	40.6	33.9	36.4	27.6
1A3 Transport	91.3	87.9	83.8	83.6	82.3	81.9	79.3	83.5	87.9	82.0
1A4 Other sectors	88.5	89.3	97.6	103.4	105.8	106.3	110.0	82.4	94.0	94.6
1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B Fugitive emissions from fuels	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.2	1.1
2 IPPU	**4.5**	**5.4**	**6.0**	**6.7**	**7.5**	**7.9**	**8.2**	**8.9**	**9.8**	**9.5**
3 Agriculture	**21.5**	**22.5**	**22.9**	**23.0**	**23.0**	**23.6**	**24.6**	**24.9**	**25.1**	**25.0**
5 Waste	**2.4**	**2.2**	**2.4**	**2.4**	**2.4**	**2.6**	**2.4**	**2.5**	**2.6**	**2.4**
Total (excluding LULUCF)	***248.1***	***247.6***	***254.0***	***264.2***	***264.8***	***265.7***	***269.0***	***239.9***	***260.0***	***245.2***
4 LULUCF	**22.0**	**-0.6**	**0.1**	**4.5**	**6.0**	**5.6**	**9.2**	**18.5**	**20.7**	**22.7**
Total (including LULUCF)	***270.2***	***247.0***	***254.2***	***268.7***	***270.8***	***271.3***	***278.2***	***258.4***	***280.7***	***267.9***

Source and Sink Categories	2010	2011	2012	2013	2014	2015	1990-2015
	CO_2 equivalent (kt)						%
1 Energy	**193.8**	**179.8**	**188.4**	**195.5**	**164.1**	**162.3**	**-19.3%**
1A1 Energy industries	3.3	3.1	2.8	3.0	2.5	2.0	1062.9%
1A2 Manufacturing industries & constr.	26.1	23.6	25.8	26.4	27.1	27.4	-24.5%
1A3 Transport	77.8	77.1	80.1	79.8	74.2	61.9	-19.4%
1A4 Other sectors	85.4	74.9	78.6	85.1	59.1	69.8	-20.2%
1A5 Other	NO	NO	NO	NO	NO	NO	-
1B Fugitive emissions from fuels	1.1	1.1	1.1	1.2	1.1	1.2	215.2%
2 IPPU	**10.0**	**10.2**	**10.6**	**11.1**	**11.0**	**10.7**	**2264.5%**
3 Agriculture	**24.2**	**24.9**	**25.1**	**24.0**	**24.4**	**24.1**	**-5.6%**
5 Waste	**2.4**	**2.6**	**2.6**	**2.6**	**2.4**	**2.3**	**4.6%**
Total (excluding LULUCF)	***230.3***	***217.4***	***226.8***	***233.3***	***201.8***	***199.4***	***-13.0%***
4 LULUCF	**21.1**	**21.4**	**21.7**	**13.9**	**13.8**	**8.3**	**137.2%**
Total (including LULUCF)	***251.4***	***238.9***	***248.5***	***247.1***	***215.6***	***207.7***	***-10.7%***

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

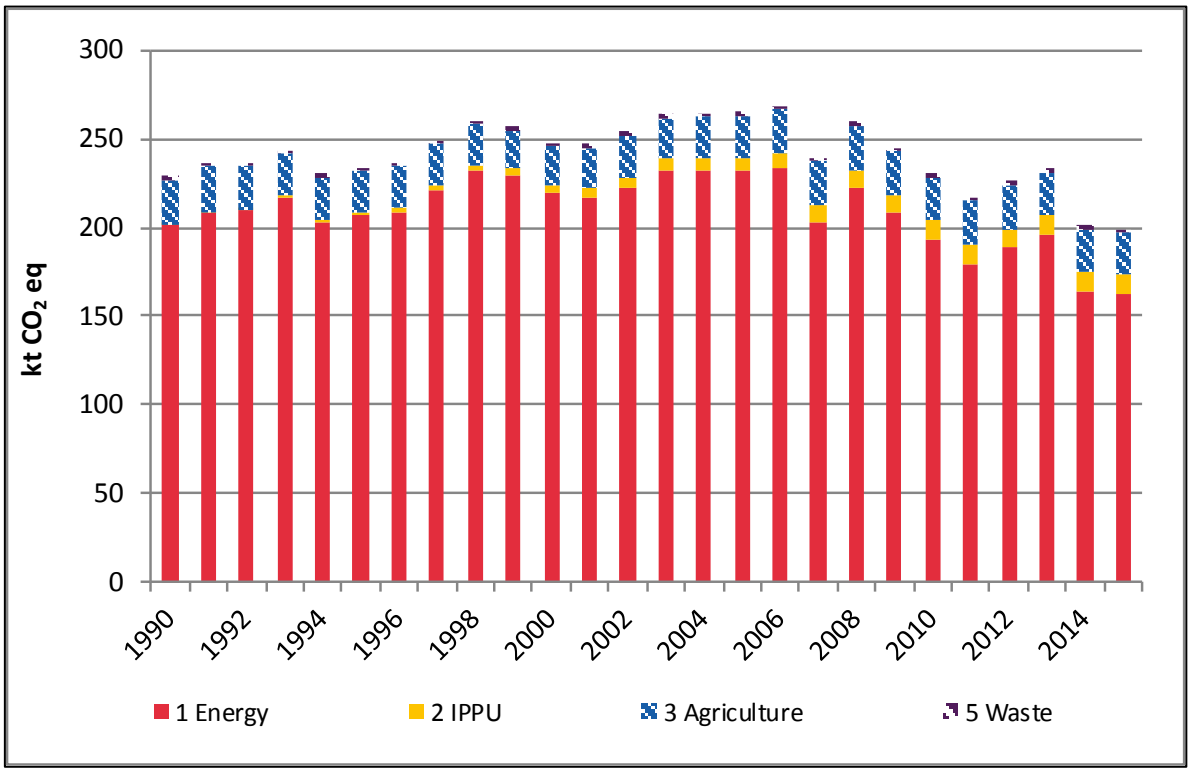

Figure 3-4 Trend of Liechtenstein's greenhouse gas emissions by main source categories in CO_2eq (kt), 1990–2015 (excl. net CO_2 from LULUCF).

The following emission trends are characteristic within the sectors:

Sector 1 Energy: In 2015, 81.4% of Liechtenstein's GHG emissions (excluding LULUCF) originate from sector 1 Energy, which is 1.3 percentage points more than in 2014. The share of sector 1 Energy in the total emissions have declined by 6.3 percentage points since 1990. Also, the total emissions of the sector 1 Energy clearly decreased in comparison to 1990 levels (19.3%). The source categories within sector 1 Energy show the following trends between 1990 and 2015:

- 1A1 Energy industries: Since 1990, Liechtenstein's gas-grid has been extended and natural gas has replaced gas oil as the main heating fuel in buildings. Total emissions have increased by about 1'060% since 1990.
- 1A2 Manufacturing industries and construction: Total emissions from this source category have declined by 24.5% since 1990. Gaseous fuels are the more important energy carrier in Liechtenstein, although emissions from gaseous fuels have decreased by 4.5% and emissions from liquid fuels have increased by 11.2% compared to 1990. Compared to 2014, the consumption of gaseous fuels has decreased by 6.5%.
- 1A3 Transport: In previous years, fuel consumption in road transportation increased in line with a general increase of road-vehicle kilometres of all vehicle categories. However, total emissions have started decreasing since 2014. In 2015, they declined by 16.6% compared to the previous year and the overall trend shows a decrease of 19.4% between 1990 and 2015.

This reduction is mainly provoked by a shift in the fuel prices, which decreased in Austria and increased in Liechtenstein between 2013 and 2015 (MK Consulting 2015).

- 1A4 Other sectors: GHG emissions in source category 1A4 have increased by 18.1% compared to the previous reporting year 2014. The main reasons for this increase are the climatic conditions, i.e. the increase in number of heating degree days in 2015. Figure 3-5 shows the substantial correlation of heating degree days and fuel consumption in Liechtenstein (correlation coefficient during the period 1990-2015 is 0.61). Furthermore, various emission reduction measures in Liechtenstein are influencing the fuel consumption, such as the increase of the CO_2-tax in 2010 or the installation of a district heating pipeline, which is suggested by the stronger declining trend of the CO_2 emissions than the trend of the heating degree days. This is also an indication of an increasing decoupling between heating activities and CO_2 emissions.

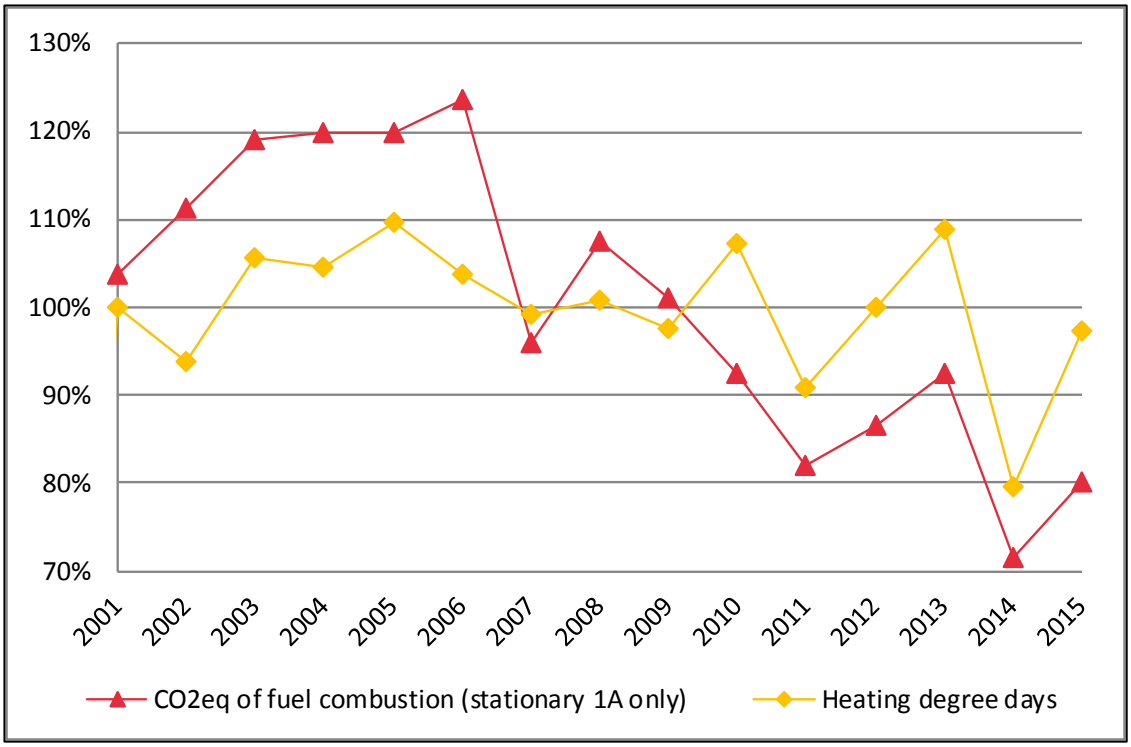

Figure 3-5 Relative trend for CO_2 emissions from 1A Fuel Combustion compared with the number of heating degree days. The drop of emissions in 2007 is driven by high oil and gas prices.

- 1A5 Other (mobile): Liechtenstein does not have any emissions under source category 1A5 because Liechtenstein has no army.
- 1B Fugitive emissions from fuels: In parallel with the build-up of Liechtenstein's gas supply network since 1990, the fugitive emissions strongly increased over the period 1990-2015 (215.2%).

Sector 2 Industrial processes and product use: Due to the lack of heavy industry within the borders of Liechtenstein, there are only small sources of F-gases and emissions are on a low level. Still, the use of F-gases increased throughout the period 1990-2015, which leads to rising emissions in sector 2 by almost a factor of 23 (2'265%).

Sector 3 Agriculture: In 2015, emissions are below the 1990 level by 5.6%. The main parameter influencing emissions in agriculture are animal numbers.

Sector 4 LULUCF: Figure 3-6 shows CO_2 emissions or removals by sources and sinks from LULUCF categories in Liechtenstein. The dominant categories when looking at the changes in CO_2 emissions are gain and loss of living biomass in forests. There is a considerable annual variation of loss of living biomass in forests dependent on the wood harvesting rate. In 1994 and 2000 as well as 2006-2014 the loss of living biomass in forests was larger than the gain. The total net emissions increased by 137.2% between 1990 and 2015.

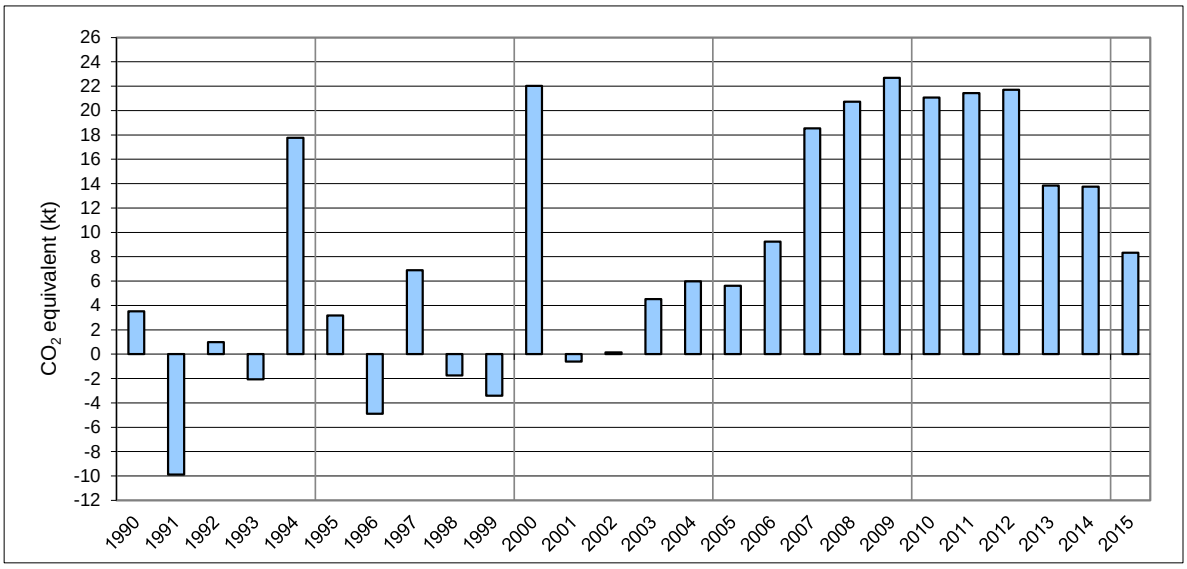

Figure 3-6 Liechtenstein's CO_2 emissions/removals of source category 4 LULUCF 1990–2015 in kt CO_2eq.

Sector 5 Waste: In Liechtenstein, only few emissions occur from the sector Waste since all municipal solid waste is exported to a Swiss incineration plant. The Waste sector shows a slightly increasing trend between 1990 and 2015 (plus 4.6%).

3.2.3.4 Emission trends for precursor greenhouse gases and SO_2

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

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

Table 3-8 Development of the emissions of NO_x, CO, NMVOC (in t) and SO_x as well as the further air pollutants for the years 1990-2015 as of submission 2017 (OE 2017b).

Pollutant	Unit	1985	1990	1995	2000	2005	2010	2015	Absolute diff. 2015 to Base 1990	relative diff. 2015 to Base 1990
NO_x	t	749	682	641	647	626	523	520	-162	-24%
CO	t	1670	1390	848	684	536	536	528	-862	-62%
NMVOC	t	1385	1177	625	416	288	263	237	-940	-80%
SO_x	t	146	132	74	45	45	27	20	-111	-85%
NH_3	t	273	255	245	219	217	219	211	-44	-17%
TSP	t	53	47	42	46	39	40	43	-4	-9%
PM10	t	50	44	40	43	36	37	39	-5	-11%
PM2_5	t	42	37	33	36	31	33	35	-2	-5%
Dioxin	mg	83	73	47	71	64	98	105	32	43%
ICDP	kg	2.9	3.2	2.3	4.2	3.3	4.4	3.4	0.2	6%
BKF	kg	1.7	1.9	1.4	2.7	2.3	3.6	3.4	1.5	78%
BBF	kg	4.7	5.1	3.6	6.7	5.2	7.0	5.5	0.4	8%
BAP	kg	5.0	5.4	3.8	7.1	5.5	7.3	5.4	0.0	0.3%
PAH 1 bis 4	kg	14.3	15.6	11.1	20.7	16.3	22.3	17.7	2.1	14%
Pb	kg	937	665	246	25	23	24	24	-640	-96%
Cd	kg	1.3	1.4	1.3	2.0	2.1	3.4	4.1	2.7	194%
Hg	kg	0.28	0.27	0.25	0.28	0.31	0.30	0.30	0.03	10%
HCB	g	0.48	0.49	0.40	0.59	0.58	0.83	0.89	0.40	80%

The complete CLRTAP Inventory data may be found on the internet (see OE 2017b):

http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2017_submissions/

3.2.3.5 Emission trends in KP-LULUCF inventory

Table 3-9 and Figure 3-7 illustrate the total net emissions occurring from activities under KP-LULUCF. Deforestation is an emission source, while afforestation and reforestation as well as forest management activities are sinks.

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

KP-LULUCF	2008	2009	2010	2011	2012	2013	2014	2015
	CO_2 equivalent (kt)							
Afforestation	-0.18	-0.19	-0.20	-0.21	-0.23	-0.24	-0.25	-0.26
Deforestation	4.17	4.26	4.34	4.42	4.51	4.59	4.51	4.51
Forest Mangement	13.72	10.51	8.91	12.82	13.11	5.22	5.14	-0.46

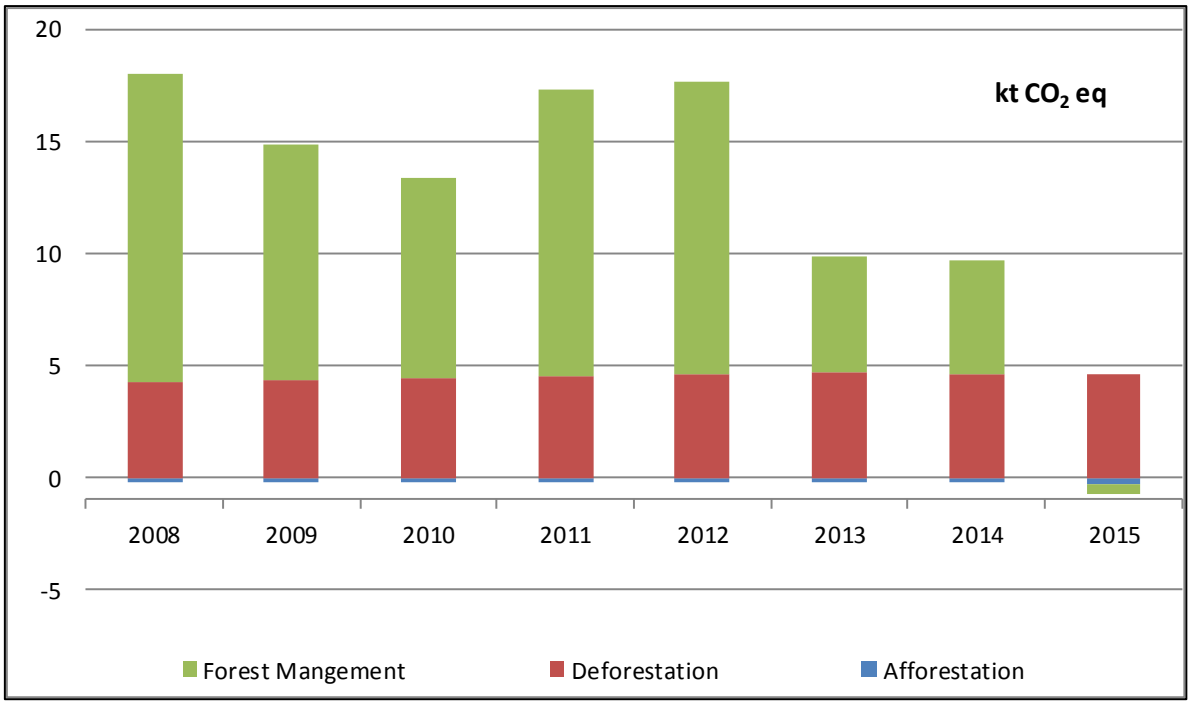

Figure 3-7 Trend of emissions of afforestation and reforestation, deforestation and forest management in Liechtenstein.

3.2.4 Recalculations

Some emissions have been recalculated due to updates in respective sectors. For the base year 1990, the recalculations carried out in the submission of the national inventory 2017 (see OE 2017, chp. 10) lead to an increase of 0.01% in the national total emissions (excluding LULUCF categories). In contrary, the national total emissions of the year 2014 decreased by 1.3% due to the recalculations (excluding LULUCF categories).

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

Accounting periodicity for activities under Article 3, paragraph 3:

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

For activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol, the Marrakech Accords (in the annex to decision 16/CMP.1) list the definitions to be specified by Parties. Liechtenstein's definitions for Forest, Afforestation and Deforestation are specified in the corrigendum to Liechtenstein's Initial Report (OEP 2007b, see there in chp. 4) and is still valid for the second commitment period: Liechtenstein applies the forest definition of the Swiss Land Use Statistics (AREA) of the Swiss Federal Statistical Office. AREA provides an excellent data base to derive accurate, detailed information of not only forest areas, but all types of land use and land cover. Thus, AREA offers a comprehensive, consistent and high-quality data set to estimate the surface area of the different land use categories in reporting under the Kyoto Protocol. Table 3-11 shows the activity coverage and the pools reported for the activities under Article 3, paragraph 3 and Forest Management under paragraph 4 of the Kyoto Protocol. The area change between the

previous and the current inventory year is shown in KP (LULUCF) NIR 2 - Land Transition Matrix 2015.

Table 3-11 KP(LULUCF), CRF table NIR 2, Submission 2017

Table NIR 2. LAND TRANSITION MATRIX

Areas and changes in areas between the previous and the current inventory year[1], [2]

	ARTICLE 3.3 ACTIVITIES		ARTICLE 3.4 ACTIVITIES					Other[6]	Total area at the end of the previous inventory year[7]
	Afforestation and reforestation	Deforestation	Forest management[5]	Cropland management (if elected)	Grazing land management (if elected)	Revegetation (if elected)	Wetland drainage and rewetting (if elected)		
	(kha)								
Article 3.3 activities									
Afforestation and reforestation	0.03	NO							0.03
Deforestation		0.19							0.19
Article 3.4 activities									
Forest management		0.01	6.18						6.18
Cropland management[3] (if elected)	NA		NA	NA	NA	NA	NA		NA
Grazing land management[3] (if elected)	NA		NA	NA	NA	NA	NA		NA
Revegetation[3] (if elected)	NA		NA	NA	NA	NA	NA		NA
Wetland drainage and rewetting[3] (if elected)	NA		NA	NA	NA	NA	NA		NA
Other[4]	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total area at the end of the current inventory year	0.03	0.20	6.18	NA	NA	NA	NA	NA	6.41

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

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

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

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

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

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

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

The net CO_2eq emissions add up to 2.48 kt. The corrected forest management reference level 2013-2020 is 0.36 kt CO_2eq.

Table 3-12 Summary table afforestation and reforestation, deforestation, forest management and HWP. FMRL: Forest Management Reference Level, incl. technical corrections.

Activity, year 2015	**Area** kha	**Net CO_2 emission/removal** kt CO_2	**N_2O emission** kt N_2O	**Net CO_2 eq emission/removal** kt CO_2 eq
A.1 Afforestation	0.034	-0.26	NO	-0.26
A.2 Deforestation	0.188	4.51	0.00021	4.57
B.1 Forest managment (FM)	6.176	-0.46	NO	-0.46
4.C HWP from FM	---	-1.37	NO	-1.37
Total emission/removal		2.42	0.00021	2.48
B.1.1 FMRL 2013-2020	---			0.36

3.3 National inventory arrangements

3.3.1 National entity

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

Dr. Heike Summer
Gerberweg 5, P.O. Box 684, 9490 Vaduz, Principality of Liechtenstein
heike.summer@llv.li; Tel.: +423 236 6196

3.3.2 National Registry

Directive 2009/29/EC was adopted in 2009 and provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

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

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

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

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

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

The following changes to the national registry of Liechtenstein have therefore occurred in 2015:

Reporting Item	**Description**
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None.
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.

Reporting Item	**Description**
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	New tables were added to the CSEUR database for the implementation of the CP2 SEF functionality. Versions of the CSEUR released after 6.7.3 (the production version at the time of the last Chapter 14 submission) introduced other minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. The database model, including the new tables, is provided in Annex A. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.7.3 of the national registry are listed in Annex B. Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing was completed in January 2017 and the test report is provided. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	The mandatory use of hard tokens for authentication and signature was introduced for registry administrators.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 6.7.3 of the national registry are listed in Annex B. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing was carried out in January 2017 and the test report is provided.

3.3.2.1 Publicly Accessible Information

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

https://ets-registry.webgate.ec.europa.eu/euregistry/LI/public/reports/publicReports.xhtml.

13/CMP.1 annex II paragraph 45 Account information	The requested information is publicly available for all accounts. The data of operator holding accounts can be viewed online at: https://ets-registry.webgate.ec.europa.eu/ euregistry/LI/public/reports/publicReports.xhtml The data of all accounts can be viewed online at: https://ets-registry.webgate.ec.europa.eu/ euregistry/LI/public/reports/publicReports.xhtml Representative name and contact information is classified as confidential due to Article 83 paragraph 8 and 9 Registry Regulation No. 1193/2011.
13/CMP.1 annex II paragraph 46 Joint implementation project information	This is information is available on the website: http://www.llv.li/#/12414
13/CMP.1 annex II paragraph 47 Unit holding and transaction	The information requested in (a), (d), (f) and (l) is classified as confidential due to Article 83 paragraph 1 Registry Regulation No. 1193/2011 as well as national data protection law and therefore not publicly available. Transactions of units within the most recent five-

information	year period are also classified as confidential, therefore the transactions provided are only those completed more than five years in the past. The information requested in (b), (c), (e), (g), (h), (i), (j) and (k) is publicly available at https://ets-registry.webgate.ec.europa.eu/ euregistry/LI/public/reports/publicReports.xhtml (b) In 2015 there was no issuance of AAU. (c) In 2015 no ERUs were issued. (e) No RMUs were issued for the reporting year 2015 in 2016. For the current reporting year, no verified units for issuance RMUs are available at the time of submission. (g) No RMUs were cancelled on the basis of activities under Article 3, paragraph 3 and 4 in the reported year. (h) No ERU, CER, AAU and RMU were cancelled on the basis of activities under Article 3, paragraph 1 in the reported year. (i) In 2016, no AAU, no ERU and no CER were voluntary cancelled. No RMU was cancelled. (j) In 2016, no ERUs, no CERs, no AAUs, and no RMUs, no tCER, no lCER were retired. (k) There was no actual carry over of ERU, CER, AAU or RMU from the previous commitment period. The planned carry-over will include 42'984 AAUs.
13/CMP.1 annex II paragraph 48 Authorized legal entities information	The following legal entities are authorized by the Member State to hold Kyoto units:

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

OHA: Operator Holding Account (installation and aircraft)

PHA: Person Holding Account

TA: Trading Account

NHA: National Holding Account

Additionally, all required information on Article 6 projects (JI) would be available on the internet website of the Office of Environment (OE) if there would be such a project in Liechtenstein. So far,

there are no JI projects in Liechtenstein (http://www.llv.li/#/12414). This information comprises names of projects, host counties, available documents and dates.

Personalized data and some information of individual holding accounts are considered as business secrets and the disclosure may prejudice their competiveness. Information on acquiring and transferring accounts of legal entities (companies) is therefore regarded as personal data. According to article 20 of the national Act on Data Protection (Datenschutzgesetz vom 14. März 2002, LGBl Nr.55) enacts that public authorities may disclose personal data if there is a legal basis or if there is an overriding public interest. Neither case is fulfilled and therefore the registry of Liechtenstein cannot make the information on acquiring and / or transferring accounts publicly available. All related information is considered as confidential and therefore paragraphs 44-40 of the Annex to Decision 13/CMP.1 are not applicable.

3.3.2.2 Internet address

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

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

3.3.2.3 Commitment period reserve (CPR)

The commitment period reserve and the assigned amount for the second commitment period is defined in Liechtenstein's Initial Report under the Kyoto Protocol (2nd CP) to facilitate the calculation of the assigned amount pursuant to Article 3, paragraphs 7bis, 8 and 8bis, of the Kyoto Protocol for the second commitment period 2013 - 2020.

According to the annex to Decision 11/CMP.1, paragraph 6, and taking into account Decision 1/CMP.8, paragraph 18, 'each Party included in Annex I shall maintain, in its national registry, a commitment period reserve which should not drop below 90 per cent of the Party's assigned amount calculated pursuant to Article 3, paragraphs 7bis, 8 and 8bis, of the Kyoto Protocol, or 100 per cent of eight times its most recently reviewed inventory, whichever is lowest.'

In its report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of Liechtenstein (FCCC/IRR/2016/LIE, UNFCCC 2016), the ERT calculated the assigned amount to be 1'556'044 t CO_2eq and the CPR to be 1'400'440 t CO_2eq.

3.3.3 Institutional, legal and procedural arrangements

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

Liechtenstein forms a customs and monetary union with its neighbouring country Switzerland, governed by a customs treaty (Government 1980). See section 2.1.8 for further information. Accordingly, for the determination of the GHG emissions, Liechtenstein appreciates having been authorised to adopt a number of Swiss methods and Swiss emission factors.

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

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

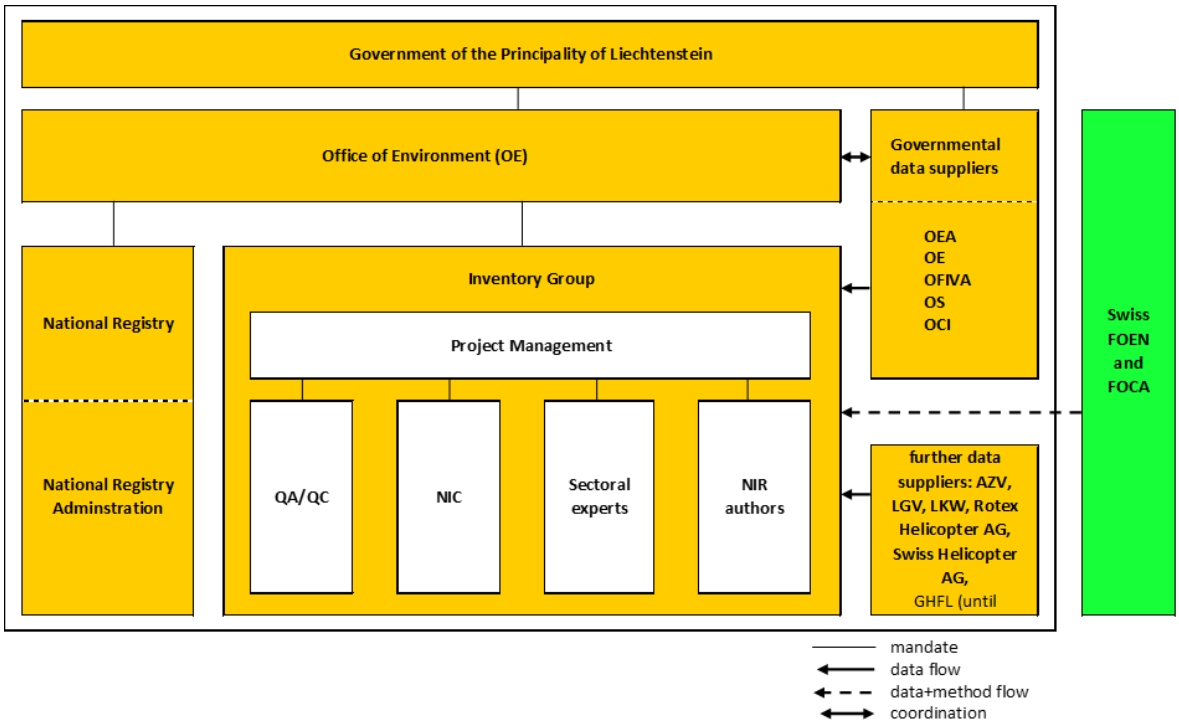

Figure 3-8 National Inventory System: Institutional setting and data suppliers. OE: Office of Environment; OEA: Office of Economic Affairs; OFIVA: Office of Food Inspections and Veterinary Affairs; OS: Office of Statistics: OCI: Office of Construction and Infrastructure; AZV: Liechtenstein's wastewater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

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

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

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

Among the governmental data suppliers are:

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

Further data suppliers are:

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

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

3.3.4 Overview of inventory planning, preparation and management

Inventory planning, preparation, and management are well-established in Liechtenstein and follow an annual cycle according to an official schedule (Table 3-10). The planning of the inventory starts with the initial reporting meeting in June, where the head of the inventory group and quality manger, the project manager/NIC, the project manager assistant as well as the emission modeler and the NIR authors participate. At the initial meeting, the work scheduled and priorities

with regard to inventory development are set. Decisions regarding planned improvements are taken as well using the latest key category analysis to prioritize the enhancements. Source and sink categories, which are key categories and hence need an additional improvement because of the recommendation by the ERT, are usually planned to implement in the next annual submission (priority 1), unless specified otherwise. All other potential improvements are planned to be implemented (priority 2) depending on available resources. The entire data compilation process lasts from June to October, including multiple quality control activities, in particular including quality checks of different versions of the reporting tables (CRF) from October to December. At the end of the annual process, the official UN review process in August and September provides further input for inventory improvements and therefore also for the inventory development plan (IDP).

Due to the transition to the new UNFCCC and IPCC guidelines, the inventory cycles for submissions 2015 and 2016 deviated uniquely. From 2017 onwards, the cycle will correspond again to the description above.

After inventory preparation, the NIR is passed through a multistage quality control cycle, too (see Table 3-10). NIR authors, the emission modeler, the head of the inventory group, the project manager and the project manager assistant as well as additional people of the Office of Environment (OE) and sector experts review the drafts of the NIR mutually. Thus, a maximum of quality assurance can be achieved. If the internal review suggests large revisions, they are taken up in the inventory development plan for future improvements too. Archiving of inventory material is made after submission by the OE and sectoral experts, by the contributing authors and by the QA/QC officer.

Table 3-10 Annual cycle of inventory planning, preparation and management.

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

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

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

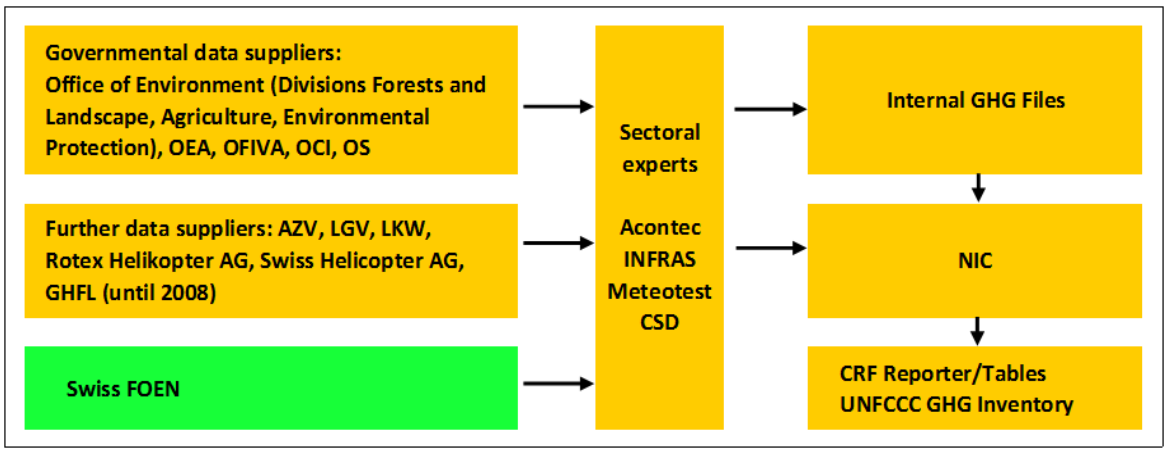

Figure 3-9 Data suppliers and data collection for setting up the UNFCCC GHG Inventory (see Glossary for abbreviations).

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

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

- Due to the Customs Union Treaty of the two states, the import statistics in the Swiss overall energy statistics (SFOE 2016) also includes the fossil fuel consumption of the Principality of Liechtenstein, except for gas consumption of Liechtenstein. Therefore, FOEN corrects its fuel consumption data by subtracting Liechtenstein's liquid fuel consumption from the data provided in the Swiss overall energy statistics to avoid double-counting. To that aim, OE calculates its energy consumption and provides FOEN with the data.
- FOEN, on the other hand, provides a number of methods and emission factors to OE, mainly for transportation, agriculture, LULUCF, F-gases, and industrial processes and product use. Liechtenstein has benefited to a large extent from the methodological support by the inventory core group within the FOEN and its willingness to share data and spreadsheet-tools in an open manner. Its kind support is herewith highly appreciated.

3.3.6 Quality assurance, quality control and verification plan

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

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

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

The QA/QC activities are coordinated by the quality manager of the GHG Inventory Group. The responsible person is Mr. Andreas Gstoehl, head of the Environmental Protection unit (e-mail: Andreas.Gstoehl@llv.li, phone: +423 236 61 86) in the Office of Environment (OE). The QA/QC activities are organised within the Inventory Group, see Figure 3-8.

Operational tasks are delegated to the NIR lead author. He distributes checklists to the project manager being also the National Inventory Compiler, to the sectoral experts and to other NIR authors. They fill in the procedures that they carried out. The lists are then sent back to the quality manager, who confirms the performance of the QA/QC activities. The activities are documented in the NIR (see OE 2017, Annex 8).

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

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

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

Quality assurance (QA)

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

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

- Liechtenstein carries out the following QA activities:
- Internal review: The draft NIR is passing an internal review. The project manager who is also the NIC, the project manager assistant, specialized staff members of the climate unit and other staff member of the OE are proofreading the NIR or parts of it (all personnel not directly involved in the preparation of a particular section of the inventory). They document their findings in checklists, which are sent back to the NIR authors (see OE 2017, Annex 8).
- The Swiss inventory management involves external experts for sectoral QA activities to review the Swiss GHG inventory. Since a number of Swiss methods and Swiss emission factors are used for the preparation of the Liechtenstein inventory as well, the results of the Swiss QA

activities are checked and analysed by Liechtenstein's experts as well. Positive reviews may be interpreted as positive for Liechtenstein too, and problematic findings must not only be taken into account in Switzerland but also in Liechtenstein. The following sectors have already been reviewed:

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

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

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

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

Quality control (QC)

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

The following QC activities are carried out:

- The annual cycle for inventory preparation contains meetings of the inventory group and meetings of governmental and other data suppliers with the OE. In these meetings, the activities, responsibilities and schedule for the inventory preparation process are being organised and determined.
- Regular meetings within the Office of Environment (OE), in particular between Heike Summer (project manager) and Andreas Gstöhl (head of the Environmental Protection unit / head of the inventory group / quality manager), take place. Beside technical issues, also political topics are discussed. As needed, important information is referred to the department or ministry. In addition, there are also regular meetings between Andreas Gstöhl and Helmut Kindle (chief officer/ national focal point).

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

- The NIR authors check the emission results produced by the sectoral experts, for consistency of cross-cutting parameters, correctness of emissions aggregation, and completeness of the GHG inventory. They compare the methods used with 2006 IPCC Guidelines (IPCC 2006), check the correct compiling of the methods in the NIR, the correct transcription of CRF data into NIR data tables and figures, the consistency between data tables and text in the NIR as well as the completeness of references in the NIR. Furthermore, they are responsible for the correctness of the key source, the uncertainty analysis and the complete implementation of specific planned improvements of the inventory development plan.
- The sectoral experts check the description of methods, numbers and figures in the NIR. They further incorporate recommendations by the ERT into respective text passages.
- The NIC checks the integrity of the database files, the consistency of time series, as well as the correct and complete inputs into the CRF Reporter. A final data check is done by a comparison of random data fields with the provided data modelling.
- Further staff members of the OE carry out a proof reading of single sectors.
- The project manager executes an overall checking function for the GHG inventory and the NIR: monitoring of the GHG emission modelling and key category analysis. The project manager checks the NIR for correctness, completeness, transparency and quality, checks for the complete archiving of documents and the completeness of the CRF submission documents.
- The OE raised its number of staff in the Climate Protection unit at the beginning of 2007 by two employees. They are responsible for emission modelling, GHG inventory, implementation of the emission trading system, national emissions trading registry, national allocation of

emission quotas and the Kyoto mechanisms (JI, CDM) and also contribute to further quality control.

- In order to provide an overview and to increase transparency, all authors, experts, and involved staff members of Liechtenstein's Government are listed in a separate table together with specific descriptions about their responsibilities. This table is available for the entire reporting period and helps to improve the QC management in general.
- The CRF Reporting Tables for the current submission, exported from the CRF Reporter software, underwent an iterative quality control in a triple check:
  - The emissions of the year 2015 were compared with those of the year 2014 within the current Reporting Table Summary2.
  - The emissions of the year 2014 were compared between the current Reporting Table Summary2 of submission 2017 and the Reporting Table Summary2 of submission 2016.
  - The emissions of the base year 1990 were compared between the current Reporting Table Summary2 of submission 2017 and the Reporting Table Summary2 of the submission 2016.
- The CRF Reporting Tables Summary2 are compared using Excel. For the comparable emissions and sinks the ratios in percent were calculated and the deviations from 100% were analysed. The findings due to this check were discussed among the core group members and the modelling specialists. Anomalies in data were investigated within more detailed CRF tables (e.g. Table1.A(a)s1) and explanations for those were sought. This procedure usually leads to the identification of errors in data, which are subsequently corrected before the submission.

The current NIR passes several quality controls. Table 3-10 illustrates the official quality control procedure of Liechtenstein's NIR. The first internal NIR draft is cross-checked by the NIR authors in terms of correctness, completeness, consistency and layout. The Office of environment (OE) and the emission modeller review the entire NIR as external experts, because experts of the OE are not directly involved in updating the NIR. They check the first draft of the NIR in detail and provide a detailed feedback on data, interpretation, completeness, consistency, transparency and implementation of the issues given by Liechtenstein's inventory development plan. The review forms for the OE experts and the emission modeller are attached in Annex 8. Afterwards, the NIR authors improve the NIR, considering the revisions made by the OE experts, and prepare the second internal draft, which also undergoes an internal cross-check. This second NIR draft is again reviewed by the OE and the emission modeller. Their inputs are implemented within the NIR, too. The NIR authors complete the final NIR version, including last internal cross-checks. Then, the Office of Environment (OE) submits the official National Inventory Report (NIR). This process guarantees the compliance of the QA/QC requirements according to the IPCC guidelines (IPCC 2006).

3.3.6.2 Verification activities

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

In many cases, the same emission factors as in the Swiss NIR are applied. Therefore, these factors are checked when copied from the Swiss NIR. As both countries have used similar methodologies, similar liquid/gaseous fuels mixes, similar vehicle fleet compositions, and their economic situation is similar, the comparison of total per capita CO_2 emission indicates completeness of source categories:

- If the national total emissions (without LULUCF) of the two countries are compared, very similar and highly correlated trends may be found. In 1990, Liechtenstein's emissions were 0.430% of the Swiss emissions. After a slight increase between 1993 and 2009, the share reached 0.422% in 2014. In the same period, the share of inhabitants increased slightly from 0.43% to 0.45%. This correlation may be interpreted as a simple form of verification, since Liechtenstein has used the same or similar methods and EF for many sectors, in which AD is linked to the number of inhabitants.
- Another indirect verification may be derived from the ambient air pollutant concentration measurements. Liechtenstein is integrated in a monitoring network of the eastern cantons of Switzerland (www.ostluft.ch). The results are commonly analysed and published (OSTLUFT 2015). They show that the local air pollution levels of NO_2, O_3 and PM10 in Liechtenstein vary in the same range as in the Swiss neighbouring measurement sites.

3.3.6.3 Treatment of confidentiality issues

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

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4. Policies and measures

4.1 Policymaking process

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

In 2010, Liechtenstein therefore introduced an indicator-based system for an annual assessment of the countries path towards a sustainable development. To this respect the Government has chosen to link the indicator-based assessment to the sustainability definition of the Brundtland Commission. According to that definition sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The system is comparable to the indicator-based assessment of the Swiss Federal Office of Statistics and the European system of Eurostat.

The assessment in Liechtenstein until today shows a mixed picture concerning sustainability. In the areas of international cooperation as well as education and culture the trends are going towards sustainability. The areas of employment, energy and climate as well as natural resources show a positive trend towards sustainability. The areas of living conditions, health and economy show no clear trend and the development must be assessed as neutral. In the areas of social cohesion and mobility, however, the developments are not going towards sustainability. The increasing motorisation rate and the decrease of the environmentally friendly passenger mobility lead to an unsustainable development in the area of mobility.

The assessment of the countries sustainable development also serves as an incentive for the development of respective policies and measures, especially in areas where an unsustainable development can be observed. To the extent possible, Liechtenstein also tries to make a contribution to the solution of global environmental problems. Climate protection enjoys a high political priority in this regard, constituting a primary field of action in Liechtenstein's environmental policy. Climate mitigation and adaptation action was included in the Government program for the upcoming four years.

Liechtenstein has integrated its climate policy very strongly into the individual sectorial policies. The focus is on energy policy, environmental policy, transport policy, agricultural and forestry policy. All of these areas encompass measures that contribute to the reduction of greenhouse gases. In order to ensure a coordinated implementation of climate policies within the various areas the Government passed a Climate Protection Strategy in 2007. The Strategy requires an interdisciplinary coordination in the fields of environment, energy, building, transportation, agriculture and forestry with respect to the development of climate policy measures. The strategy was revised in the year 2015. Liechtenstein’s Ministry of Environment and the Office of Environment are the coordinating authorities with respect to the execution of the Climate Protection Strategy.

Because of the small size of the country, cross-border cooperation plays an important role. Especially important is the relationship with Switzerland and the cooperation among the countries in the Lake Constance area. Thanks to the Customs Treaty, cross-border measures and bilateral

execution are simplified in many areas, because various Swiss enactments are directly applicable in Liechtenstein pursuant to the Treaty. In these cases, Liechtenstein executes the provisions similarly to a Swiss canton (e.g. mineral oil tax). Accordingly, most policy areas are very closely linked with Swiss policy, in terms of both content and execution.

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

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

Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures are dealt with on a case-by-case basis. Violations of a law can be punished.

Information in cases of non-compliance under domestic law foresees that in terms of breach of data delivery obligation (i.e. in order to prepare the NIR) "the Office of Environmental Protection may sanction the responsible persons up to 30,000 Swiss Francs in accordance with Art. 89 para 1 and Art. 73 Environmental Protection Act".

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

The Emissions Trading Act (EHG) sets up the general framework for the fulfilment of Liechtenstein's reduction obligations originating from the respective ratification of the Kyoto Protocol. In 2012, the Government introduced a legally binding greenhouse gas reduction target of at least 20% compared to 1990 until 2020. In addition, the EHG states that emission reductions are first and foremost to be reduced by domestic measures. If reduction obligations cannot be fulfilled through domestic measures, the Government may participate in project activities abroad or in international emissions trading. Besides this the EHG implements Directive 2003/87/EC (Emissions Trading Directive) into national law and obliges two industrial installations (2013) to participate within the European Emissions Trading Scheme. Due to comprehensive amendments of Directive 2003/87/EC, the EHG has been revised in 2012. The regulations of the EHG with respect to the participation of Liechtenstein in the Kyoto Protocols flexible mechanisms as well as with respect to domestic emissions trading are executed by the Office of Environment.

The CO_2 Act corresponds to the CO_2 Act of Switzerland (in force since 2008) and introduces a levy on the consumption of fossil fuel (oil and natural gas). In 2013, the CO_2 Act has been revised. Besides the levy on fossil fuel, an obligation to compensate CO_2 emissions from the use of motor fuels (gasoline and diesel) as well as emission regulations for passenger cars has been introduced.

The CO_2 Act is part of "The Bilateral Agreement between the Principality of Liechtenstein and the Swiss Confederation on Environmental Levies within the Principality of Liechtenstein", mentioned above.

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

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

4.2 Policies and measures and their effects

4.2.1 Cross Sectoral Policies

The deliberate decision was made not to establish superordinate environmental protection legislation; the relevant provisions are therefore to be found in the individual sectoral policies. However, the 2007 adopted Climate Protection Strategy requires a coordinated approach by the competent Ministries when drafting sectoral legislation. This approach was part of the revised Climate Protection Strategy which has been released in 2015.

Liechtenstein has implemented its climate related policies and measures strongly into individual sectoral policies. The responsibility of monitoring the effects of individual measures or policies are therefore beard by the respective administration offices that are in charge of the execution of the individual measure. These authorities provide an annual report of their activities (not only climate change related) which will be forwarded to the Liechtenstein Parliament. The reports are publicly available.

4.2.2 Environmental policy

4.2.2.1 Environmental Protection Act

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

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

With respect to climate and air quality related measures (see Air Quality Ordinance, Luftreinhalteverordnung) the Environmental Protection Act builds the legal basis for emission limits, for example combustion installation within industry and households. The principles applied within the Environmental Protection Act guarantee that the subsequent measures are linked to the most efficient and up-to-date technique requirements. As such the act governs the limitation of emissions for stationary installations, the maximum air pollution level, measures to be taken in the event emissions thresholds are exceeded, and the requirements on engine and heating fuel.

An Important element is the obligation to provide information to the public. Requirements on petrol and diesel oil, but also thresholds for particulate matters in air are regulated by Ordinance on Air Pollution. To this regard the annual average for sulfur dioxide (threshold) is 20 micrograms/m^3. The sale of leaded supreme petrol is prohibited since 2000. The lead content in unleaded petrol is 0.005 g/l, and the share of carcinogenic benzene may not exceed 1%. The sulfur content in diesel and petrol may not exceed 0.01 g/kg.

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

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

4.2.2.2 Environmental Levies

The bilateral Agreement between the Principality of Liechtenstein and the Swiss Confederation on Environmental Levies within the Principality of Liechtenstein was concluded in 2010. The agreement enables Liechtenstein to implement several environmental levies of Switzerland into national law while using the existing infrastructure of the Swiss authorities for the execution of the respective national laws. The environmental levies are:

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

Environmental levies on pollutants serve to "internalize" externalized costs, and to reduce the costs of pollution to society by increasing the proportion paid by polluters themselves.

4.2.3 Climate policy

In Liechtenstein, two laws substantially influence climate policy:

4.2.3.1 Emissions Trading Act

The Emissions Trading Act implements Directive 2003/87/EC (EU Emissions Trading Directive) and Directive 2004/101/EC. The Act obliges two industrial combustion installations (2013) to participate within the European Emissions Trading Scheme (EU ETS). Due to the revision of the underlying EU legislation 2008/2009 Liechtenstein was obliged to revise its Emissions Trading Act in 2012. After the period 2008 to 2012 Liechtenstein also participates from 2013 to 2020 in the EU ETS. In accordance with the new centralized allocation of the revised EU ETS scheme Liechtenstein submitted its so called “National Implementation Measures (NIM)” in 2011. The EFTA Surveillance Authority accepted Liechtenstein’s NIM’s in July 2013. Due to the new regulations only one of the

two installations covered by the EU ETS will receive free European Union Allowances (EUA) until 2020.

As before the operators of both installations have to submit, by end of March of each period year, an amount of EUA's that corresponds with the amount of CO_2 emitted the previous year. Therefore, the emissions have to be monitored and verified according to Commission Regulation (EU) No. 601/2012.

With respect to the countries Kyoto-obligation the revised Emissions Trading Act for the first time established a concrete reduction target of at least 20% compared to 1990 levels. In addition to that a priority on national reduction measures before considering the Protocol's flexible Mechanisms (CDM/JI/IET) was set. The concrete procedure is defined in a National Climate Protection Strategy which was released in 2015.

4.2.3.2 CO_2 Act

With respect to Liechtenstein's economy the CO_2-Act states the most comprehensive legislative measure. It envisages a contentious reduction of CO_2 emissions from the energy-related use of fossil energy sources until 2020. To achieve these reductions the CO_2 Act introduced a CO_2 levy on thermal fuels (oil, gas, coal) in 2008. The levy on fossil fuel consumption covers all the sectors of economy (except motor fuels such as petrol and diesel) as well as private households and is intended to promote the economical use of fossil fuels throughout Liechtenstein.

The Liechtenstein CO_2-Act is an integral part of the bilateral Agreement between the Principality of Liechtenstein and the Swiss Confederation on Environmental Levies within the Principality of Liechtenstein. Central elements of the levying system are executed by Swiss authorities, such as the levying through Swiss custom authorities or the granting of levy exemptions through the Swiss Federal Office of the Environment.

Due to a comprehensive revision of the Swiss CO_2-Act in 2011/2012 a respective adjustment within the Liechtenstein CO_2-Act became necessary and was introduced into national law in late 2013. The revision widened the scope and adjusted the incentive framework of the CO_2-Act.

To this respect the revised Act lead to:

- an increase of the CO_2 levy from 12 CHF per ton CO_2 (2008) to 36 CHF per ton CO_2 (2010) to 60 CHF per ton CO_2 (2014) to 84 CHF per ton CO_2 (2016) up to 96 CHF per ton CO_2 (2018)
- an increased allocation of financial means towards environmental measures
- the establishment of CO_2 emissions regulation for passenger cars (see 4.3.5)
- the establishment of a compensation obligation for importers of motor fuels (see 4.3.5)

From 2018 on Liechtenstein will levy 96 CHF per ton CO_2, which corresponds to around 25 Rp per litre heating oil (until 2013 it was 36 CHF per ton CO_2 which corresponded to around 10 Rp per litre oil).

Around 2/3 of the levy revenues originating from the economy will be returned to the sector by granting subsidies to employers' obligations within the "Old Age and Survivors Insurance". 1/3 of the revenues are earmarked for environmental policy measures such as for example the feed-in tariffs for renewable energy production.

In addition and contrary to the CO_2 levy in Switzerland, the revenues originating from private households are not returned but will continue to be used for financing environmental measures. Besides the need for strong sources of financial means the decision to not reimburse the revenues levied from households was also taken on administrative grounds. An efficient reimbursement

procedure is only possible by using subsidy grants within the compulsory health insurance (as it is the case in Switzerland). Since the health insurance system of Liechtenstein is already heavily subsided the originally intended steering effect would be too little to justify the respective bureaucratic efforts.

Since 2014, approximately 2/3 of the total CO_2 levy revenues are earmarked for environmental purposes, thus strengthening the financial capabilities of the Government with respect to future measures within the national climate change framework.

4.2.3.3 Policies planned

In the course of 2018, the emissions regulation for passenger cars, established in 2012 by the revised CO_2 Act, will be adjusted in order to also cover light vehicles. The CO_2-Act will be revised in 2018/2019 as continuation of the existing act, but also to set the legal framework for the commitments under the Paris Agreement.

Summary of policies and measures (NA = not applicable)

Name of policy or measure[b]	Objective and/or activity affected	GHG affected	Type of instrument	Status[c]	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative,in CO_2 eq.)[d]			
						2010	2015	2020	2030
Climate Protection Strategy	Definition of a clear and transparent strategy for climate policy in Liechtenstein with precise action fields and measures to fulfil the requirements of the 2nd commitment period of the Kyoto Protocol	all	Planning Measure	Implemented 2007 Revised in 2015	Government of Liechtenstein	NA	NA	NA	NA
Environmental Protection Act	Legal basis for all regulations and ordinance, especially with respect to air pollution and waste treatment	all	Law	Implemented 2008	Office of Environment	NA	NA	NA	NA
Action Plan Air	Measure Plan according to air pollution control regulations within the Environmental Protection Act	All	Planning measure	In force since 2007	Office of Environment	NA	NA	NA	NA
Emissions regulations	Emissions regulations for stationary facilities (heating industry)	CO_2 , precurs or gases	Law	Implemented 1987, Revised 1992 and 2005		NA	NA	NA	NA
Water Protection Act	Cap on maximum number of cattle per land area	CH_4, N_2O	Law	Implemented 2003	Office of Environment	NA	NA	NA	NA
Emissions Trading Act	Implementation of Directive 2003/87/EC, Directive 2004/101/EC and Directive 2009/20/EC	all	Law	Implemented 2008 and revised in 2012	Office of Environment	NA	NA	NA	NA
CO_2 Act	Implementation of ecological steering levy modelled by Switzerland, reduction of CO_2 emissions from fossil fuels and inducement for an economical use of energy and renewable energies, Introduction of emissions regulations for new passenger cars, establishment of compensation requirements for emissions	CO_2	Steering Levy, Law	Implemented 2008, revised in 2013 To be revised in 2018/2019	Office of Environment, Swiss Federal Office of the Environment	NA	NA	NA	NA

	from mobile fuels								
Steam Pipeline	Acquisition of Steam from waste incineration plant in neighbouring city of Buchs (Switzerland) in order to replace fossil fuels for manufacturing industry	CO_2	Infrastructure measure	In operation since 2009	Private	17.5* kt CO_2	2.2* kt CO_2	2.2* kt CO_2	NA
Deep Geothermal Energy	Use of geological heat from deep thermal aquifers for electric power and heating	CO_2	Planning measure	Geophysical investigation 2008 – 2010 analysis finalized 2011, evaluation of long-distance incineration plant Buchs to Schaan in process	Office of Environment				3.94 kt CO_2 eq
Climate protection platform as part of the Environment Commission of the International Lake Constance Conference	Coordination, exchange of information	All	Data Collection	2005: Status Report on climate protection on Lake Constance with recommendations for activities 2005: Guidelines with practical examples 2007: Status Report on impact of climate change and potential adaptation strategies 2009: Status Report on renewable energies	Office of Environment	NA	NA	NA	NA
Elaboration of a hydro geological map as a basis for using near surface geothermal heat	Use of near surface geothermal energy for heating purposes	CO_2, precursor gases	Data Collection	2005 Completion of Map, in force since March 2006, Revisions according to the state of knowledge		NA	NA	NA	NA

4.2.4 Energy policy

The commitment to saving energy was legally enshrined in the Energy Ordinance in 2008 and further consolidated in 2008. The focus is on the following elements:

- Target values for the insulation of buildings (heat insulation requirements), for devices such as heaters, air conditioners and ventilation systems and requirements for the maintenance of such devices. These measures are governed by the revised Construction Act and relevant ordinances.
- An Energy Commission advises the Government on energy policy and communicates its views on all fundamental questions of energy policy. The Energy Commission consists of experts

from all relevant areas (architecture, energy industry, other industries, manufacturing and trades, administrative offices, environmental organizations).

- A Bureau of Energy Consumption and Conservation has been established within the Office of Economic Affairs. The Bureau advises municipalities and private parties on all areas of energy conservation, is responsible for the content and administration of subsidy applications, and elaborates and implements energy policy strategies. The Bureau provides information to the public through lectures, radio discussions, and personal talks.
- The promotion of energy conservation is a central concern of Liechtenstein's energy policy. Energy conservation in buildings is supported financially, especially with regard to renovation of old buildings, building services installations, block heating plants, and solar collectors.

The Energy Efficiency Act of 30. Mai 2008 and the relevant Ordinance of 30. Mai 2008 as well as the Energy Ordinance of 21. August 2007 on the Construction Act constitute the legal framework for the implementation of measures relating to buildings. A gratifying development is also that municipalities now supplement national Energy Conservation Act subsidies with their own funds. The Government intends to promote the measures for implementing the objectives laid down in the energy strategy with financial resources and advice. The increase of energy efficiency and, in particular, the increased use of renewable energies are of central importance for the reduction of greenhouse gas emissions and accordingly for a long-term climate policy.

In 2012, the Government adopted “The Energy Strategy 2020”. The strategy provides future-oriented impulses for the national energy policy. The focus areas of the concept are the promotion of efficient energy use, the use of renewable energies, and energy conservation. These goals correspond to the aims of the EU’s 20-20-20 climate package from 2008. Increase the share of renewable energy in total energy use from 8% to 20% by 2020. Increase the energy efficiency to 20% to stabilize the energy consumption on the level of 2008 by 2020 and 20% reduction of the CO_2 emission by 2020. The Energy Strategy 2020 also addressed the need to minimize adverse effects of its proposed measures as required by Art. 2 paragraph 3 of the Kyoto Protocol. The proposed set of measures has been checked against its compatibility with economic as well as social requirements.

In collaboration with the forestry sector, an increasing number of wood chip plants are used in public buildings to generate heat. The new Act and the Ordinance on the Liberalization of the Electricity Market provide mechanisms to support the conveyance of renewable energies. The Liechtenstein Power Authority also offers a "Green Electricity" label. All municipalities have received the “European energy award” by end of 2012.

The annual publication of Liechtenstein’s energy statistics, provided by the Office of Statistics, serves as a monitoring tool in order to evaluate the effect of the respective policies. Based on the Energy Strategy 2020 the Government has set up an administrative body that is responsible for the implementation and monitoring of measures set up by the Energy Strategy 2020. The detailed modalities and procedures that will lead the activities of that body are to be established in the course of 2014.

Policies implemented

The following measures are the focus of the efforts to promote energy conservation:

- Renovation of old buildings:
  Many older buildings are insufficiently insulated against heat loss. Subsidies of up to 200’000 CHF may be granted for subsequent heat insulation.

- Promotion of the Minergie standard: The standard requires buildings to offer a high level of comfort, economic efficiently, and low energy consumption. Monitored ventilation systems also optimize air quality. In Liechtenstein, the standard is employed for all new administrative buildings.
- Residential technical installations:
  If the building shell already fulfills the requirements for modern insulation, then residential technical installations with low consumption or operating with renewable energy can further enhance conservation. State subsidies may be granted up to 20'000 CHF.
- Solar collectors:
  Thermal solar collectors can produce most of the warm water needed, thereby reducing heating oil and electricity consumption. The State subsidizes such collectors with a contribution of 250 CHF per square meter.
- Photovoltaic:
  Photovoltaic systems generating electricity are subsidized with a contribution of 400 CHF per installed output (kW). The maximum subsidy per system is CHF 400'000.-. The generated electricity can be fed into the public network. Since 1. February 2015 applies a Feed-in remuneration for electricity with 10Rp per kWh.
- Demonstration facilities:
  Liechtenstein law also provides for the promotion of demonstration facilities, with which public understanding of energy conservation is enhanced and the use of new technology and new technical possibilities is demonstrated.
- Finally, a hydrogeological map will be developed as a foundation for using near-surface geothermal energy for heating purposes.

In 2016, CHF 1'097'235 were contributed to the renovation of old buildings, CHF 656'941 to residential technical installations, CHF 33'603 to solar collector systems, CHF 157'500 to heat pumps for hot water heating, CHF 487'382 to solar photovoltaic systems, CHF 326'480 to Minergie standard and CHF 1'663'352 to demonstration facilities and other measures. Almost all Liechtenstein municipalities provide additional funds to projects subsidized at the national level pursuant to the Energy Efficiency Act. In addition to these energy provisions, the Minergie standard is promoted and employed in public buildings. The reduction in heating energy consumption achieved by these measures entails that the relative share of energy consumption for heating water is rising. Covering this consumption through the use of solar energy is therefore becoming increasingly important.

Assessment on progress made was made with the midterm report on the Energy strategy. The report showed where the envisioned goals could be reached and which ones could not be reached in the given time frame. The report also showed that the effort in the energy sector has to be intensified in the upcoming years.

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

Policies planned

Between 2018 and 2019 a new Energy Strategy 2030 will be defined.

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

Name of policy or measure[b]	Objective and/or activity affected	GHG affected	Type of instrument	Status[c]	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative in CO_2 eq.)[d]			
						2010	2015	2020	2030
Energy Efficiency Act	Aims for the reduction of energy, the intelligent and economic use of energy as well as the promotion of renewable energies. Promotion of heat insulation (renovation of old buildings), residential technical installations (room heating and nonpotable water), solar energy (thermal solar collectors and photovoltaics) and demonstration facilities.	CO_2	Fiscal Measure (Subsidy)	Implemented 2008	Office of Economic Affairs	2.54 kt CO_2 eq	2.89 kt CO_2 eq	2.89 kt CO_2 eq	-0.09 kt CO_2 eq
Heated Regulations	Heated Outdoor areas and ramps, outdoor heating and warm air curtains, electric room heating and other stationary resistance heating of over 3KW are prohibited	CO_2	Law	Implemented 1993, Energy Ordinance, 2003	Building and Fire Authority	NA	NA	NA	NA
Heat insulation regulations	Buildings and installations must be planned as energy-efficient as possible (minimum insulation values), according to Ordinance / SIA Norm 380/1. If the building volume exceeds 2000 m^3, the heating requirements may not exceed 80% of the SIA value.	CO_2	Regulation	Implemented 1993 New Energy Ordinance 2003	Building and Fire Authority	NA	NA	NA	NA
Minergy standard for State Buildings	Requirement that all new State buildings have to comply with the Minergy Standard; Energy savings of 30% per building	CO_2	Law	Implemented 2003	Building and Fire Authority	NA	NA	NA	NA
Supply requirements	Determination of energy supply areas with the aim to join a district heating network	CO_2	Planning measure			NA	NA	NA	NA
Liechtenstein Energy Strategy 2020	Governmental Strategy that ensures a sustainable energy supply	CO_2	Planning measure	Implemented 2012 Mid-term report in 2017 To be revised 2018-19		NO	7.02 kt CO_2 eq	6.89 kt CO_2 eq	1.92 kt CO_2 eq
Green electricity (LiStrom Öko)	Auditing (SQS) and certification of all domestic production sites according to "naturemade" product mixture of renewable energy sources (hydropower plant) and new renewable energy sources (photovoltaic systems)	CO_2	Promotion by Liechtenstein Power Authority (LPA)	Implemented 2004	LPA	NA	NA	NA	NA
Promotion of photovoltaic systems of private owner	Through the sale of green electricity, the LPA pays 80 cents / kWh for energy generated from photovoltaic systems certified as "naturemade star" from 2004-2009.	CO_2	Promotion by the LPA	Implemented 2004		NA	NA	NA	NA
Promotion of energy generated by	The conveyance price for the energy volume for own use may be waived in the case of	CO_2	Electricity Market	Implemented 2002		NA	NA	NA	NA

systems for efficient energy production	production systems based on renewable energies or systems for efficient energy use.		Act						
Intelligent Energy Europe	Sustainable development in the field of energy, by making a balanced contribution to the attainment of the following general goals: energy supply security, competitiveness, and environmental protection.	CO_2	EU Program	Implemented 2003		NA	NA	NA	NA
Energy Star (labeling program for energy-saving office appliances)	The Energy Star label has already attained international significance. Appliances with the Energy Star label have a competitive advantage compared with non-labeled appliances. In a simple way, the label provides information to the consumer on the energy efficiency of the appliances. Reduction of CO_2 emissions by preventing unnecessary stand-by of electric appliances. Stand-by accounts for about 10% of energy use of appliances.	CO_2	Agreement between the US and the EU			NA	NA	NA	NA
Participation of municipalities in the Energy City label	Reduction of CO_2 emissions on the level of municipalities by increased use of renewable energies and high energy-efficient technologies for all premises. Since 2012 all 11 municipalities are certified with the Energy City Label.	CO_2, precursor gases	Labeling			NA	NA	NA	NA
Hydro Power	Extension of hydropower	CO_2	Planning measure	Planning phase for power plant Samina, Implemented in 2013	LPA	NA	NA	NA	NA

4.2.5 Transport policy

Transport policy in Liechtenstein takes into account the interests of society, the economy, and the environment. In 2008, a national transport policy (“Mobiles Liechtenstein 2015”) was approved by the Government, which includes a strategy for developing the transport sector in mid-term and long-tern. In this way, the Government has implemented or prepared a wide range of projects to promote public transportation and to reduce emissions arising from transport (expansion of the Liechtenstein Bus Authority, "Liechtenstein Takt" regional train schedule, preferential treatment of buses at traffic lights, subsidies of electric scooters and electric bicycles, tax exemptions for solar, hybrid, electronic, and natural gas vehicles, security measures along the way to school and in the area of pedestrian crossings, mobility campaigns and medium-term expansion of the railway offerings). The contents contained therein were designed for the outlook 2015. In 2016, the report on the overall transport policy and mobility strategy “Mobiles Liechtenstein 2015” was updated on to the current status 2016. As the mobility is in a fundamental upheaval at the

moment, driven by the technological progress - especially the rapidly advancing digitization - a variety of aspects of the mobility behavior are changing rapidly and new possibilities are developing. Therefore, the mobility concept outlook was chosen to be a «Status Report 2016 with outlook 2020". This should on one hand provide more certainty about the incipient developments and opportunities and on the other hand, enable a better basis for the development of a long-term mobility concept with a horizon 2020 to 2040.

Goods transport policy also plays an important role. Liechtenstein introduced a Heavy Vehicle Fee, analogous to Switzerland. This fee is based on the polluter-pays-principle and is differentiated according to distance driven and the total weight of the vehicle. It increases productivity in road traffic, contributes to a large-scale shift of heavy goods traffic from road to rail, and in this way also eases the burden on roads in Liechtenstein.

Liechtenstein also supports the efforts of importers to reduce specific fuel consumption in accordance with Swiss rules, and Liechtenstein is also required to declare consumption in accordance with EU directives. Based on the data that has been collected so far, it now appears possible to undertake taxation of automobiles also with respect to specific CO_2 emissions. The Government is still examining this option.

Since emissions from **aviation** in Liechtenstein are of minor importance (with only 0.31% of national total, excl. LULUCF) no specific national policies exist to address these sources. The respective emissions stem from only one small heliport. **No** international **shipping** activities occur in Liechtenstein. Based on national circumstances Liechtenstein does **NOT** promote and implement ICAO and IMO decisions to limit emissions from aviation and marine bunker fuels.

Policies implemented

Heavy Vehicle Fee

The Heavy Vehicle Fee was introduced on 1 January 2001 in parallel with Switzerland. It internalizes external costs. With the help of highly modern recording technology, the kilometers driven are measured. The fee applies to vehicles with a permissible total weight of 3.5 tons and above, and amounted to 1.6 cents per kilometer per ton of total weight in the first phase (2001 to 2005). In the second phase (since the beginning of 2005), the fee has been increased in multiple steps to 2.66 cents (at least 2.26 cents, at most 3.07 cents). It is graded according to emissions criteria (EURO norms). In this way, carriers are given an incentive to purchase the most modern vehicles and to use them efficiently and at full capacity. In addition, the measure increases the costs for goods transport on roads, which results in a movement of goods to the railways. One third of the revenue is earmarked for environment and transport issues. This amounts to approximately 3 million CHF.

Introduction of CO_2 emissions regulation for passenger cars

In 2012 Liechtenstein introduced CO_2 emissions regulations that apply to new passenger cars. The regulations were incorporated in the revised CO_2 Act in late 2013. Liechtenstein importers are required to reduce the level of CO_2 emissions from cars registered for the first time in Liechtenstein to an average of 130 grams per kilometer by 2015. If the CO_2 emissions per kilometer exceed the target level, a respective penalty applies.

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

According to the Swiss CO_2 Act producers and importers of fossil motor fuels are required to use domestic measures to compensate for 10% of the CO_2 emissions caused by the combustion of these fuels by 2020. The resulting surcharge required to finance respective compensations projects may not exceed 5 Rp. per liters. This framework basically also applies to importers of motor fuels in Liechtenstein. However, due to the high administrative workload such compensations system would cause for Liechtenstein authorities and the corresponding relatively low reduction potential of the country – in absolute terms – importers may pay the surcharge directly to the Government instead.

Promotion of green vehicles

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

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

Furthermore, the Government considers a system of motor vehicle taxation which implements a bonus-malus system based on the energy efficiency and/or emissions of vehicles.

In 2016 an electric car support program was launched in cooperation between the LIFE climate foundation and the national electricity provider LKW. Electric cars could apply for a subsidy up to CHF 3’000. In total the support program was limited to 100 car registrations.

Promotion of public transport

Public transport enjoys a high priority in Liechtenstein. For this purpose, the public transport schedule has been significantly improved in recent years, especially in cross-border transport ("Liechtenstein Takt"). In the recent years, continuous improvements in the public transport schedule were realized which entailed in a higher attractiveness of the public transport as well as higher frequencies and user numbers. In 2009 Liechtenstein, Austria and Austrian Railway signed a treaty to improve the railway infrastructure across Liechtenstein to establish a cross-border regional suburban train. The planning phase is finished and was audited by the Office of Environment by the end of 2014. At present are talks/negotiations scheduled on the final financing and start of the project.

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

Name of policy or measure[b]	**Objective and/or activity affected**	**GHG affected**	**Type of instrument**	**Status**[c]	**Implementing entity or entities**	**Estimate of mitigation impact, by gas (for a particular year, not cumulative,in CO_2 eq.)**[d]			
						2010	2015	2020	2030
Heavy Vehicle Fee	Relocation of goods transport from road to railways and reduction of transalpine road transport	CO_2 , Precurs or gases	Fiscal measure	Implemented 2001	Finance Administration	NA	NA	NA	NA
Promotion of solar, electric, natural gas and/or hybrid vehicles	Vehicle tax waived for electric, natural gas and hybrid vehicles	CO_2 , Precurs or gases	Fiscal Measure	Implemented 1999	Driver and Vehicle Licensing Office	NA	NA	NA	NA
Construction and operation of three public natural gas station	Infrastructure for providing fuel to private vehicles	CO_2	Investment measure, Infrastructur e measure	Implented 2007, further evaluation in progress (2009)	Building and Fire Authority	NA	NA	NA	NA
Supply of Biogas into natural gas fueling station	Supply of CO_2-free fuel for the natural gas filing station	CO_2, precurs ors gases	Investment measures, Infrastructur e measure	implemented in 2013	Building and Fire Authority, Bureau of Energy Consumption and Conservation; Office of Environment	NA	NA	NA	NA
PEMO project: Sustainable commuter mobility	Establishment of cooperative action of non motorized resp. human powered mobility and public transportation as well as private companies and municipalities in the cross-border region of Liechtenstein, Switzerland, Austria and Germany with a focus on daily commuters	CO_2, precurs or gases	Institutional measures	Started in 2016	Office of Construction and Infrastructure	NA	NA	NA	NA
Exhaust regulations	Adoption of the European exhaust regulations (EURO norms) and fuel regulations, Continuous reduction of road traffic emissions	Precurs or gases	Law	Implemented 1993	Driver and Vehicle Licensing Office	NA	NA	NA	NA
Promotion non motorized resp. human powered mobility	Cycle route concept Liechtenstein: The bicycle as well as the pedestrian network is being expanded continuously and made more attractive	CO_2, precurs or gases	Institutional measures	Started 2014; Ongoing	Ministry for Infrastructure, Economic Affairs and Sport	NA	NA	NA	NA
Zoning requirements	Limitation of the number of parking spaces for construction projects, where justified by municipal or national planning.	CO_2, precurs or gases	Law	Implemented 2003	Spatial Development and Building Permits Division	NA	NA	NA	NA
Internal Mobility Management for State Authority	Efficient and environmentally suitable improvement of traffic volume by increased usage of public transport and bicycle	CO_2, precurs or gases	Institutional measure	Implemented 2008	Office of Construction and Infrastructure	NA	NA	NA	NA
Promotion of public transport	Introduction of a extended regional train schedule by 2017	CO_2, precurs or gases	Institutional measure, fiscal measure	Planning of the necessary railway infrastructure	Office of Construction and Infrastructure	NA	NA	NA	NA

4.2.6 Agriculture

International challenges as well as the changing environment within agricultural policies require strong flexibility from Liechtenstein's farmers. The general demand for more efficient and sustainable farming procedures is constantly growing. International liberalization of world markets has also led to certain deregulation measures in Liechtenstein. Besides that, the agricultural sector has to provide an increasing amount of services that are not remunerated by markets but required by public interests. The new Agricultural Law, adopted in 2008, addresses the above mentioned issues and promotes the trend toward greater ecological agriculture in Liechtenstein. In order to maintain soil fertility, the environmental impact is minimized by environmentally friendly forms of production, such as integrated production and organic farming. Landscape maintenance and conservation is also considered as a task of agriculture and its importance will continue to increase.

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

Since 2002, the promotion of farm animals consuming roughage is included in the Direct Payment System. Livestock increased until 2012, but was stable over the past five years. (Liechtenstein agriculture primarily relies on animal husbandry, which generates 70% of agricultural revenue.)

The Water Protection Act, which entered into force in 2003 and is comparable to the Swiss law, specifies the thresholds for animal husbandry per area unit.

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

Name of policy or measure[b]	Objective and/or activity affected	GHG affected	Type of instrument	Status[c]	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative, in CO_2 eq.)[d]			
						2010	2015	2020	2030
Ecological equalization payments in agriculture	Product-independent contributions for conversions to ecological cultivation methods	CH_4, N_2O	Fiscal measure (direct payments)	Implemented 1996	Office of Environment	NA	NA	NA	NA
Preservation of soil for agricultural use	Agriculture: permanent protection of soil for agricultural use from misuse	CH_4, N_2O	Law	Implemented 1992	Office of Environment	NA	NA	NA	NA
Water Protection Act	Cap on maximum number of cattle per land area	CH_4, N_2O	Law	Implemented 2003	Office of Environment	NA	NA	NA	NA

4.2.7 Forestry

Covering an area of around 6'700 ha (43% of the country's territory), forests play a significant role in Liechtenstein. For this reason, sustainability in forestry has been accorded great importance ever since the introduction of the Forestry Regulations in 1865. Important goals of the current Forestry Act (1991) include the qualitative and quantitative (prohibition of clearing) preservation of the forest stocks and the promotion of nature-friendly forest management. In addition to the

Forestry Act, international agreements (such as the 1993 Helsinki Ministerial Conference on the Protection of Forests in Europe) provide the basis for modern forest management. The natural rejuvenation of forests with local tree species appropriate to the location, the promotion of graded forest stock structures, and the ecological improvement of the edges of forests are only some examples. In general, the promotion of biological diversity in forests is becoming an increasingly important part of Liechtenstein forest management. Liechtenstein now maintains forest reserves to the extend 19% of the forest area (1'274 ha), where all forms of forestry activities are prohibited as well as special forest areas of about 479 ha (7%) to preserve old and traditional forms of forest management or rare forest communities.

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

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

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

Name of policy or measure	**Objective and/or activity affected**	**GHG affected**	**Type of instrument**	**Status[c]**	**Implementing entity or entities**	**Estimate of mitigation impact, by gas (for a particular year, not cumulative in CO_2 eq.)[d]**			
						2010	2015	2020	2030
Cultivation regulations in the Forestry Act	Sustainable cultivation of forests	CO_2 (sinks)	Law	Implemented 1991 Last update: 2015	Office of Environment	NA	NA	NA	NA
Forest Regulation	Performance target	CO_2 (sinks)	Law	Implemented 1995 Last update: 2015	Office of Environment	NA	NA	NA	NA
Ordinance on forest reserves and protected areas	Performance target	CO_2 (sinks)	Law	Implemented 2000 Last update: 2007	Office of Environment	NA	NA	NA	NA
Forest Inventory 1998 and National Forest Program (2002 – 2012)	Binding specifications for future use of forests; development of a Forest Inventory 2010	CO_2 (sinks)	Planning measures, Law	Implemented 2001	Office of Environment	NA	NA	NA	NA
FSC certification of the entire forest stock	Performance target	CO_2 (sinks)	Operational planning	Implemented 2001	Office of Environment	NA	NA	NA	NA

4.2.8 Waste Management

Policies implemented

In Liechtenstein, the Ministry of Environment together with the Office of Environment is responsible for developing legislation and policies to ensure the recovery and environmentally sound disposal of waste, coordinating the planning of waste disposal facilities and for implementation of the policy framework in close collaboration with the eleven communes. The basis for waste legislation in Liechtenstein is the Environmental Protection Act (2008), see also chapter 4.2.3.

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

Moreover, the Ordinance on the Reduction of Risks relating to the Use of Certain Particularly Dangerous Substances, Preparations and Articles (Chemical Risk Reduction Ordinance, ORRChem) contains special regulations in terms of restrictions and bans of handling of chemicals of all sorts. Pursuant to the Customs Treaty, these new provisions are again applicable to Liechtenstein.

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

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

Name of policy or measure[b]	Objective and/or activity affected	GHG affected	Type of instrument	Status[c]	Implementing entity or entities	Estimate of mitigation impact, by gas (for a particular year, not cumulative,in CO_2 eq.)[d]			
						2010	2015	2020	2030
Environmental Protection Act	Legal basis for all regulations and ordinance, especially with respect to air pollution and waste treatment	all	Law	Implemented 2008	Office of Environmental Protection	NA	NA	NA	NA
REACH	Manufacturers and importers are required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database run by the European Chemicals Agency (ECHA)	all	Law	2007	Office of Environmental Protection	NA	NA	NA	NA
Ordinance on Prevention and disposal of waste	Interdiction of landfilling of combustible waste	CH_4, CO_2	Law	implemented since 2016	Office of Environmental Protection	NA	NA	NA	NA

The final draft of the Waste Management Plan which also includes the Waste Prevention Program is currently in a consultation phase at the level of communes and NGOs. The Waste Management Plan was developed in close collaboration with the concerned parties. The Waste Management Plan contains different measures concerning collaboration, disposal and biogenic waste for each commune and for the Office of Environmental Protection. It is planned to finalize the draft and submit the Plan for the Government's approval by the end of 2017. Therefore, statements on the impact on climate changes are not possible at the present time.

4.2.9 International cooperation

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

Liechtenstein is also State party to several other environmental agreements. The following agreements more or less closely related to climate should be mentioned in this context:

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

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

4.3 Policies and measures no longer in place

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

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5. Projections and the total effect of policies and measures

This chapter covers Liechtenstein's greenhouse gas emissions under the three scenarios 'without measures' (WOM), 'with existing measures' (WEM) and 'with additional measures' (WAM) according to the guidelines for the preparation of national communications (UNFCCC 2017):

- The 'without measures' (WOM) scenario projection excludes all policies and measures implemented, adopted or planned after the year chosen as the starting point for that projection. For Liechtenstein's NC7, this starting year is the latest inventory year (2015) and the WOM scenario assumes that emissions stay constant in the period 2016-2030.
- The 'with existing measures' (WEM) scenario projection encompasses currently implemented and adopted policies and measures. In Liechtenstein, projections based on specific measures are only available for the sector Energy (1A Fuel combustion). For the waste sector, a projection exists in Liechtenstein's Waste Plan (Liechtensteiner Abfallplanung 2012-2070, Government 2011). Further projections for the sectors Energy (1B Fugitive emissions from fuels) as well as for IPPU (2) and Agriculture (3) were adopted from Switzerland's WEM projection in its NC7 (FOEN 2018). The projections for LULUCF were assumed to be constant (mean of the latest five inventory years) and the projection of international bunkers is based on a linear extrapolation of the reported inventory data.
- The 'with additional measures' (WAM) scenario projection also encompasses planned policies and measures. In Liechtenstein, additional measures only exist in the energy sector. Where necessary, the WAM scenario from Switzerland's NC7 was adopted (FOEN 2018).

The sector Energy is dominating Liechtenstein's greenhouse gas emissions. In the year 2015, emissions from this sector amounted 81.4% of Liechtenstein's total emissions (see section 3.2.3). Therefore, the focus for the elaboration of Liechtenstein's projections in its NC7 lies on the Energy sector.

In section 5.1, the legal basis, considered measures and the WOM, WEM and WAM projections disaggregated by sector and gas are described. Section 5.2 depicts the aggregate effect of policies and measures (section 4), and section 5.3 gives an insight into the methods applied for the projections.

5.1 Projections

5.1.1 Legal basis

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

- Environment: Environmental Protection Act
- Climate: Emissions Trading Act and CO_2 Act

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

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

5.1.2 Policies and measures considered

This chapter gives an overview over estimated mitigation impacts of its reported policies and measures (see chp. 4).

Sector 1 Energy

The greenhouse gas reduction measures described in this section are taken from the Energy Efficiency Act (EEG 2008) and from Liechtenstein's Energy Strategy (Government 2012b).

Under the **Energy Efficiency Act** (EEG 2008, see also section 4.2.4), Liechtenstein introduced various measures to counter rising energy consumption. The most relevant measures in place are subsidies for the refurbishment of old buildings, solar collector systems and substitution of conventional heating to heat pumps and wood firing. In addition, municipalities in Liechtenstein individually complement these national measures. Further activities such as private energy savings initiatives (e.g. new heating) are not related to the EEG but also relevant for emission reductions.

Liechtenstein's Energy Strategy 2020 consists of a package of energy related measures. The target of the strategy is to reduce greenhouse gas emissions by 20% in 2020 compared to 2008. It distinguishes three scenarios:

- Scenario 1: Business as usual. Measures and instruments that are already in place are continued, but no further measures are planned. According to Scenario 1, energy use would increase by 12% (2008-2020) and the share of renewable would rise to 12.5% (compared to 8.2% in 2008).
- Scenario 2: Stabilizing energy use by energy efficiency and increasing the share of renewable energy. According to Scenario 2, energy use would stay constant between 2008 and 2020 and the share of renewable energy should rise to 20% (compared to 8.2% in 2008).
- Scenario 3: Forcing energy efficiency and renewable energies. According to Scenario 3, energy use would be reduced by 20% between 2008 and 2020 and the share of renewable energy should rise to 40% (compared to 8.2% in 2008).

For Liechtenstein's NC7, Scenario 2 from the Energy Strategy 2020 is chosen as basis for the WEM and WAM scenarios in the energy sector. This scenario is also specifically focused on in the "Action Plan Energy" that is presented in the Energy Strategy. The WEM scenario covers measures that are already implemented and that are planned to continue after 2020. The WAM scenario covers more pronounced or additional measures (mainly to be implemented and have an impact between 2020 and 2030).

In 2017, the Government published a half-time report (Government 2017) and updated the expected emission reductions of several measures. Liechtenstein's Energy Strategy 2020 will be updated to a longer time range in the coming years.

Table 5-1 shows the measures considered in the energy sector for each scenario WOM, WEM and WAM (considering the updated reduction expectations from the half-time report of the Energy Strategy 2020). Table 5-2 shows the aggregated effect of those measures in the energy sub-sectors.

Table 5-1 Measures considered for projections of emissions, cumulated over five years period, from the energy sector (negative sign refers to an increase instead of a reduction).

Sector	Measure	Scenario	Expected emission reductions [t CO2eq]			
			2016-2020	2021-2025	2026-2030	Total
1A1	Electricity generation with combined heat and power	WOM	-	-	-	-
		WEM	-99	-	-	-99
		WAM	-99	-	-	-99
1A2	Efficiency measures in industry and commerce	WOM	-	-	-	-
		WEM	66	66	66	197
		WAM	66	66	66	197
1A2	Use of heat recovery in industry and development of heat distribution	WOM	-	-	-	-
		WEM	5'497	-	-	5'497
		WAM	5'497	-	-	5'497
1A2 1A4	(Energetic) renovation of buildings	WOM	-	-	-	-
		WEM	3'285	1'095	1'095	5'475
		WAM	3'285	1'095	1'095	5'475
1A2 1A4	Incentive system "Minergie" standard (buildings)	WOM	-	-	-	-
		WEM	88	-	-	88
		WAM	88	-	-	88
1A2 1A4	Solar collectors and heat pump boilers	WOM	-	-	-	-
		WEM	813	690	690	2'193
		WAM	813	690	690	2'193
1A2 1A4	Wood heatings	WOM	-	-	-	-
		WEM	548	-	-	548
		WAM	548	-	-	548
1A2 1A4	Standards for electrical equipment and illumination	WOM	-	-	-	-
		WEM	5'376	-	-	5'376
		WAM	5'376	-	-	5'376
1A2 1A4	Incentive systems for energy suppliers	WOM	-	-	-	-
		WEM	1'430	-	-	1'430
		WAM	1'430	-	-	1'430
1A2 1A4	Use of biogas	WOM	-	-	-	-
		WEM	1'205	-	-	1'205
		WAM	1'205	-	-	1'205
1A2 1A4	Heating pumps (increased replacement of oil and gas heating)	WOM	-	-	-	-
		WEM	4'380	2'190	2'190	8'760
		WAM	4'380	5'375	5'375	15'130
1A3	Electric vehicles	WOM	-	-	-	-
		WEM	819	1'404	1'989	4'212
		WAM	819	1'404	1'989	4'212
1A3	Efficiency standards for road vehicles	WOM	-	-	-	-
		WEM	-	-	2'300	2'300
		WAM	-	1'150	5'750	6'900
1A4	New standards for new buildings	WOM	-	-	-	-
		WEM	-	788	-	788
		WAM	-	788	-	788

Table 5-2 Aggregated effect of considered measures in the energy sector (emissions, cumulated over five years period)

Sector	Measure	Scenario	Expected emission reductions [t CO2eq]			
			2016-2020	2021-2025	2026-2030	Total
1A1	Energy industries (total)	WOM	-	-	-	-
		WEM	-99	-	-	-99
		WAM	-99	-	-	-99
1A2	Manufacturing industries and construction (total)	WOM	-	-	-	-
		WEM	7'165	66	66	7'296
		WAM	7'165	66	66	7'296
1A3	Transport (total)	WOM	-	-	-	-
		WEM	819	1'404	4'289	6'512
		WAM	819	2'554	7'739	11'112
1A4	Other sectors (total)	WOM	-	-	-	-
		WEM	15'521	4'763	3'975	24'259
		WAM	15'521	7'948	7'160	30'629
1A5	Other (total)	WOM	*NO*	*NO*	*NO*	*NO*
		WEM	*NO*	*NO*	*NO*	*NO*
		WAM	*NO*	*NO*	*NO*	*NO*
1A	Fuel combustion (total)	WOM	-	-	-	-
		WEM	23'406	6'233	8'330	**37'968**
		WAM	23'406	10'568	14'965	**48'938**

No projections for sector 1B Fugitive emissions from fuel use are available for Liechtenstein. Therefore, the Swiss projections were adopted. Due to the bilateral agreement on environmental levies between Switzerland and Liechtenstein (see section 4.2.2), the Swiss projections are comparable to the circumstances in Liechtenstein.

5.1.3 'Without Measures' (WOM) scenario

For Liechtenstein's NC7, the starting year for the WOM scenario the latest inventory year (2015). The WOM scenario assumes that emissions stay constant in the period 2016-2030 and that no further measures are implemented in this time span (see Table 5-3).

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

Table 5-3 Projected annual emissions according to the WOM scenario (all pollutants), based on the reported emissions for 2015 of Liechtenstein's NIR 2017 (OE 2017)

		in kt CO_2 equivalent			
		CO_2	**CH_4**	**N_2O**	**F-Gases**
		Projections (constant)			
IPCC	**Source/Sink Categories**	**2016 - 2030**	**2016 - 2030**	**2016 - 2030**	**2016 - 2030**
Total	**Emissions, excl. LULUCF (Scenario WOM)**	**159.55**	**19.50**	**9.85**	**10.50**
1	**Energy**	**159.48**	**2.08**	**0.76**	**NO**
1A	Fuel combustion	159.48	0.92	0.76	NO
	1A1 Energy industries	2.02	0.02	0.00	NO
	1A2 Manufacturing industries & constr.	27.31	0.04	0.09	NO
	1A3 Transport	61.38	0.10	0.39	NO
	1A4 Other sectors	68.77	0.76	0.28	NO
	1A5 Other	NO	NO	NO	NO
1B	Fugitive emissions from fuels	NA,NO	1.16	NA,NO	NO
	1B1 Solid fuels	NO	NO	NO	NO
	1B2 Oil and natural gas	NA,NO	1.16	NA,NO	NO
2	**Industrial processes and product use**	**NO**	**NO**	**0.20**	**10.50**
3	**Agriculture**	**0.05**	**15.92**	**8.12**	**NO**
4	**LULUCF**	**7.91**	**NO**	**0.42**	**NO**
5	**Waste**	**0.02**	**1.50**	**0.76**	**NO**
Memo item	**International bunkers (aviation)**	**1.19**	**0.00**	**0.01**	**NO**

5.1.4 'With Existing Measures' (WEM) scenario

The most relevant reduction potentials in the WEM scenario are in the Energy sector. The potentials are defined through the Energy Efficiency Act and the Energy Strategy 2020.

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

5.1.4.1 Projection of CO_2 emissions in the WEM scenario

Table 5-4 and Figure 5-1 show the development of CO_2 emissions between 1990 and 2030.

From 1990 to 2015 (reported values), CO_2 emissions (excl. LULUCF) decreased by 19.7%. CO_2 emissions are dominated from the sector Energy. The fluctuations in the development of the emissions are mainly due to different weather conditions (warm and cold winters) and fluctuating heating degree days influencing category 1A4 Other sectors.

From 2015 to 2030, a further reduction of CO_2 emissions (excl. LULUCF) by 23.5% is predicted. A major share of these projected reductions is attributed to sector 1A4 Other sectors and 1A2 Manufacturing industries and construction, and in particular to the measures from the Energy Strategy 2020: (energetic) renovation of buildings and heating pumps. Less pronounced reductions are also predicted for sectors 1A3 Transport and 1A1 Energy industries.

In total, the reduction of CO_2 emissions (excl. LULUCF) under the WEM scenario in the period 1990-2030 is assumed to amount 38.6%.

Table 5-4 CO_2 emissions by sector for the WEM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	CO_2 in kt CO_2eq									
						Reported data (GHG inventories)		Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Total	**Emissions, excl. LULUCF (Scenario WEM)**	**198.78**	**204.05**	**216.72**	**228.87**	**190.81**	**159.55**	**136.42**	**130.27**	**122.03**
1	**Energy**	**198.70**	**203.99**	**216.66**	**228.81**	**190.75**	**159.48**	**136.35**	**130.20**	**121.96**
1A	Fuel combustion	198.70	203.99	216.66	228.81	190.75	159.48	136.35	130.20	121.96
	1A1 Energy industries	0.12	2.00	2.67	3.03	3.15	2.02	2.12	2.12	2.12
	1A2 Manufacturing industries & constr.	36.19	35.60	36.31	39.04	26.00	27.31	20.18	20.11	20.05
	1A3 Transport	75.36	80.30	89.86	81.15	77.18	61.38	60.57	59.17	54.92
	1A4 Other sectors	87.03	86.09	87.82	105.59	84.42	68.77	53.48	48.79	44.87
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2	**Industrial processes and product use**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
3	**Agriculture**	**0.06**	**0.05**	**0.05**	**0.05**	**0.04**	**0.05**	**0.05**	**0.05**	**0.05**
4	**LULUCF**	**3.20**	**2.87**	**21.66**	**5.22**	**20.67**	**7.91**	**15.02**	**15.02**	**15.02**
5	**Waste**	**0.03**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**	**0.03**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.48**	**0.84**	**1.19**	**1.20**	**1.36**	**1.52**

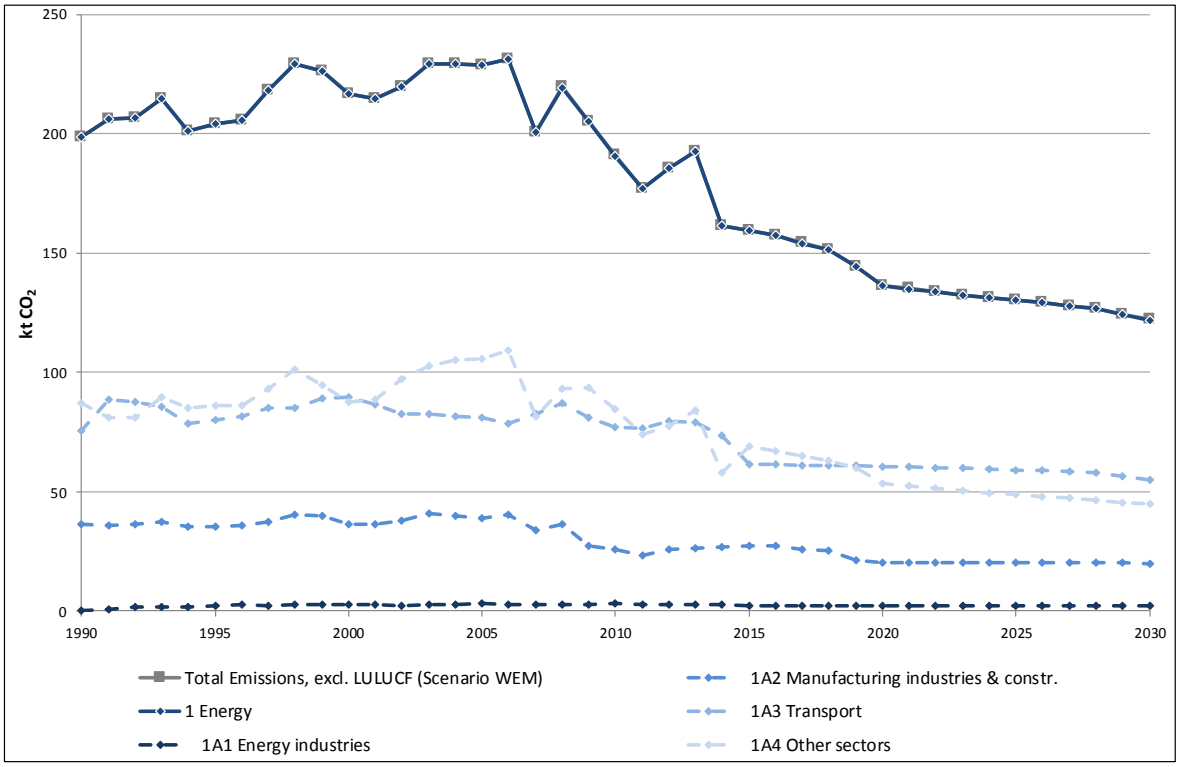

Figure 5-1 CO_2 emissions by sector (excl. LULUCF) from 1990 to 2030 for the scenario WEM

5.1.4.2 Projection of CH_4 emissions in the WEM scenario

Table 5-5 and Figure 5-2 show the development of CH_4 emissions between 1990 and 2030.

From 1990 to 2015 (reported values), CH_4 emissions (excl. LULUCF) decreased by 0.2%. The main contributor to CH_4 emissions is the sector Agriculture, where animal numbers have a high influence on emissions (especially category 3A Enteric fermentation).

From 2015 to 2030, a further reduction of CH_4 emissions (excl. LULUCF) by 1.3% is predicted. However, the decreasing trend (due to slight reductions in sectors Energy and Agriculture) is predicted turn into a slowly increasing trend from 2024 on, due to increasing CH_4 emissions from the sector Waste.

In total, the reduction of CH_4 emissions (excl. LULUCF) under the WEM scenario in the period 1990-2030 is assumed to amount 1.5%.

Table 5-5 CH_4 emissions by sector for the WEM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	CH_4 in kt CO_2eq									
						Reported data (GHG inventories)		Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Total	**Emissions, excl. LULUCF (Scenario WEM)**	**19.53**	**18.29**	**17.36**	**19.23**	**19.85**	**19.50**	**19.19**	**19.13**	**19.24**
1	**Energy**	**1.25**	**1.32**	**1.64**	**1.86**	**2.10**	**2.08**	**1.90**	**1.85**	**1.80**
1A	Fuel combustion	0.88	0.71	0.80	0.76	0.97	0.92	0.74	0.69	0.64
	1A1 Energy industries	0.00	0.02	0.03	0.04	0.04	0.02	0.02	0.02	0.02
	1A2 Manufacturing industries & constr.	0.05	0.06	0.06	0.06	0.04	0.04	0.03	0.03	0.03
	1A3 Transport	0.63	0.43	0.33	0.23	0.19	0.10	0.09	0.09	0.09
	1A4 Other sectors	0.20	0.20	0.38	0.43	0.70	0.76	0.59	0.54	0.49
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
2	**Industrial processes and product use**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
3	**Agriculture**	**16.72**	**15.46**	**14.04**	**15.53**	**16.10**	**15.92**	**15.61**	**15.45**	**15.45**
4	**LULUCF**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
5	**Waste**	**1.56**	**1.51**	**1.69**	**1.85**	**1.64**	**1.50**	**1.68**	**1.83**	**1.99**
Memo item	**International bunkers (aviation)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

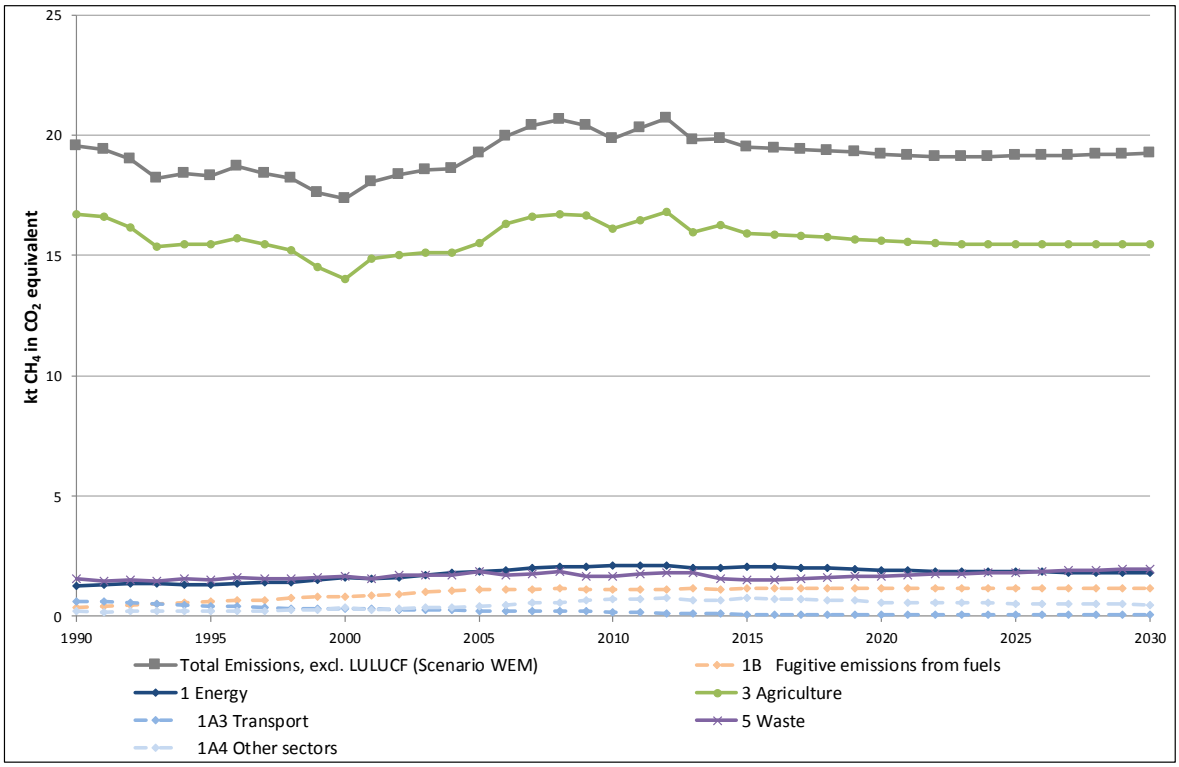

Figure 5-2 CH_4 emissions by sector (excl. LULUCF) from 1990 to 2030 for the scenario WEM

5.1.4.3 Projection of N_2O emissions in the WEM scenario

Table 5-6 and Figure 5-3 show the development of N_2O emissions between 1990 and 2030.

From 1990 to 2015 (reported values), N_2O emissions (excl. LULUCF) decreased by 9.7%. Similar to CH_4, the main contributor to N_2O emissions is the sector Agriculture, where animal numbers have a high influence on emissions (especially category 3A Enteric fermentation).

From 2015 to 2030, a further reduction of N_2O emissions (excl. LULUCF) by 2.1% is predicted. However, similar to CH_4, the decreasing trend (due to slight reductions in sectors Energy and Agriculture) is predicted turn into a slowly increasing trend from 2024 on, due to increasing N_2O emissions from the sector Waste.

In total, the reduction of N_2O emissions (excl. LULUCF) under the WEM scenario in the period 1990-2030 is assumed to amount 11.6%.

Table 5-6 N_2O emissions by sector for the WEM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	N_2O in kt CO_2eq									
					Reported data (GHG inventories)			Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Total	**Emissions, excl. LULUCF (Scenario WEM)**	**10.90**	**10.62**	**9.85**	**9.85**	**9.90**	**9.85**	**9.68**	**9.63**	**9.64**
1	**Energy**	**1.13**	**1.46**	**1.53**	**0.95**	**0.91**	**0.76**	**0.67**	**0.64**	**0.60**
1A	Fuel combustion	1.13	1.46	1.53	0.95	0.91	0.76	0.67	0.64	0.60
	1A1 Energy industries	0.05	0.06	0.07	0.07	0.07	0.00	0.00	0.00	0.00
	1A2 Manufacturing industries & constr.	0.09	0.08	0.08	0.09	0.08	0.09	0.06	0.06	0.06
	1A3 Transport	0.76	1.11	1.13	0.50	0.46	0.39	0.39	0.38	0.35
	1A4 Other sectors	0.23	0.22	0.25	0.29	0.30	0.28	0.22	0.20	0.18
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2	**Industrial processes and product use**	**0.45**	**0.36**	**0.26**	**0.23**	**0.20**	**0.20**	**0.19**	**0.17**	**0.15**
3	**Agriculture**	**8.73**	**8.18**	**7.40**	**7.99**	**8.04**	**8.12**	**7.96**	**7.88**	**7.88**
4	**LULUCF**	**0.31**	**0.30**	**0.35**	**0.39**	**0.41**	**0.42**	**0.79**	**0.79**	**0.79**
5	**Waste**	**0.59**	**0.62**	**0.66**	**0.68**	**0.74**	**0.76**	**0.86**	**0.94**	**1.01**
Memo item	**International bunkers (aviation)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**

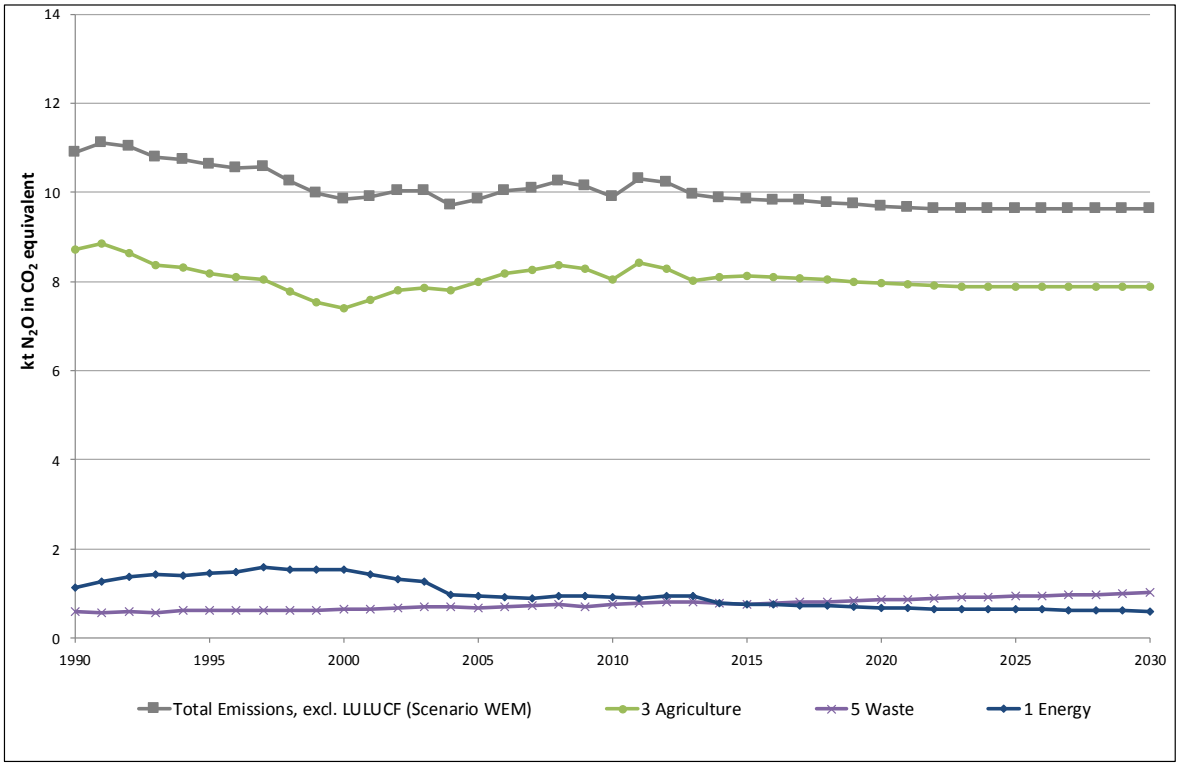

Figure 5-3 N_2O emissions by sector (excl. LULUCF) from 1990 to 2030 for the scenario WEM

5.1.4.4 Projection of F-Gas emissions in the WEM scenario

Table 5-7 and Figure 5-4 show the development of F-Gas emissions (HFC, PFC and SF_6) between 1990 and 2030.

From 1990 to 2015 (reported values), F-Gas emissions increased by a factor of 10^5, having reached a peak in 2013 and since then showing a slight decrease. F-Gas emissions are vastly dominated by HFC.

From 2015 to 2030, F-Gas emissions are expected to decrease by 27.3%.

In total, F-Gas emissions in the period 1990-2030 under the WEM scenario are assumed to increase by a factor of 73'000. However, the increasing trend is expected to have stopped in 2013.

Table 5-7 F-Gas emissions (HFC, PFC, SF_6) by sector for the WEM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	HFC, PFC and SF_6 in kt CO_2eq									
							Reported data (GHG inventories)		Projections	
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Total	**Emissions, excl. LULUCF (Scenario WEM)**	**0.00**	**1.35**	**4.21**	**7.69**	**9.79**	**10.50**	**9.81**	**8.90**	**7.63**
2F	Product uses as ODS substitutes	0.00	1.35	4.21	7.69	9.79	10.50	9.81	8.90	7.63
	HFC	0.00	1.35	4.11	7.37	9.69	10.42	9.74	8.84	7.57
	PFC	NO	0.00	0.01	0.07	0.07	0.04	0.04	0.03	0.03
	SF_6	NO	NO	0.09	0.26	0.02	0.04	0.03	0.03	0.03

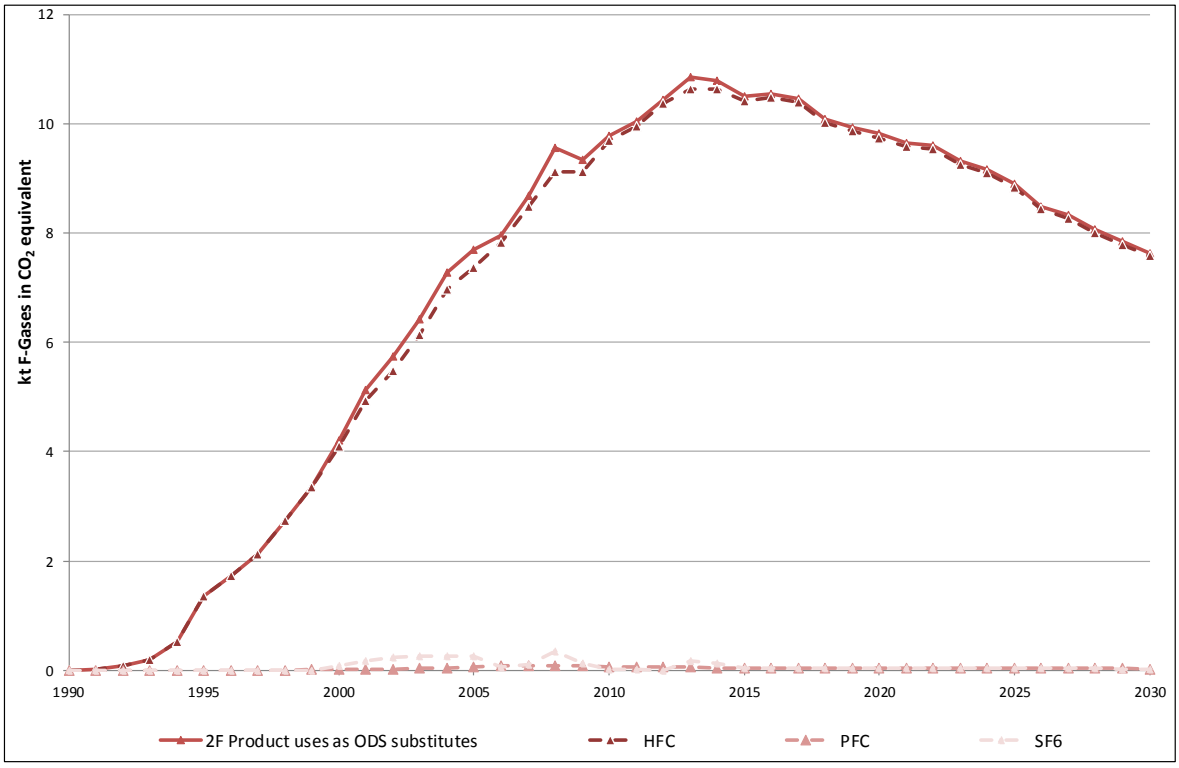

Figure 5-4 F-Gas emissions (HFC, PFC, SF_6) by sector from 1990 to 2030 for the scenario WEM

5.1.5 'With Additional Measures' (WAM) scenario

The WAM scenario includes further or more ambitious measures from the Energy Efficiency Act and from the Energy Strategy 2020, in particular concerning efficiency standards for road vehicles and increased replacement of oil and gas heating with heating pumps.

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

5.1.5.1 Projection of CO_2 emissions in the WAM scenario

Table 5-8 and Figure 5-5 show the development of CO_2 emissions between 1990 and 2030. For the development of emissions between 1990 and 2015, see section 5.1.4.

From 2015 to 2030, a further reduction of CO_2 emissions (excl. LULUCF) by 30.3% is predicted. The main reason for this reduction are the additional measures in the Energy sector under the WAM scenario: efficiency standards for road vehicles and increased replacement of oil and gas heating with heating pumps.

In total, the reduction of CO_2 emissions (excl. LULUCF) under the WAM scenario in the period 1990-2030 is assumed to amount 44.1%.

Table 5-8 CO_2 emissions by sector for the WAM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	CO_2 in kt CO_2eq									
						Reported data (GHG inventories)		Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Total	**Emissions, excl. LULUCF (Scenario WAM)**	**198.78**	**204.05**	**216.72**	**228.87**	**190.81**	**159.55**	**136.42**	**125.99**	**111.19**
1	**Energy**	**198.70**	**203.99**	**216.66**	**228.81**	**190.75**	**159.48**	**136.35**	**125.92**	**111.12**
1A	Fuel combustion	198.70	203.99	216.66	228.81	190.75	159.48	136.35	125.92	111.12
	1A1 Energy industries	0.12	2.00	2.67	3.03	3.15	2.02	2.12	2.12	2.12
	1A2 Manufacturing industries & constr.	36.19	35.60	36.31	39.04	26.00	27.31	20.18	20.11	20.05
	1A3 Transport	75.36	80.30	89.86	81.15	77.18	61.38	60.57	58.03	50.35
	1A4 Other sectors	87.03	86.09	87.82	105.59	84.42	68.77	53.48	45.65	38.60
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2	**Industrial processes and product use**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
3	**Agriculture**	**0.06**	**0.05**	**0.05**	**0.05**	**0.04**	**0.05**	**0.05**	**0.04**	**0.04**
4	**LULUCF**	**3.20**	**2.87**	**21.66**	**5.22**	**20.67**	**7.91**	**15.02**	**15.02**	**15.02**
5	**Waste**	**0.03**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**	**0.03**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.48**	**0.84**	**1.19**	**1.20**	**1.36**	**1.52**

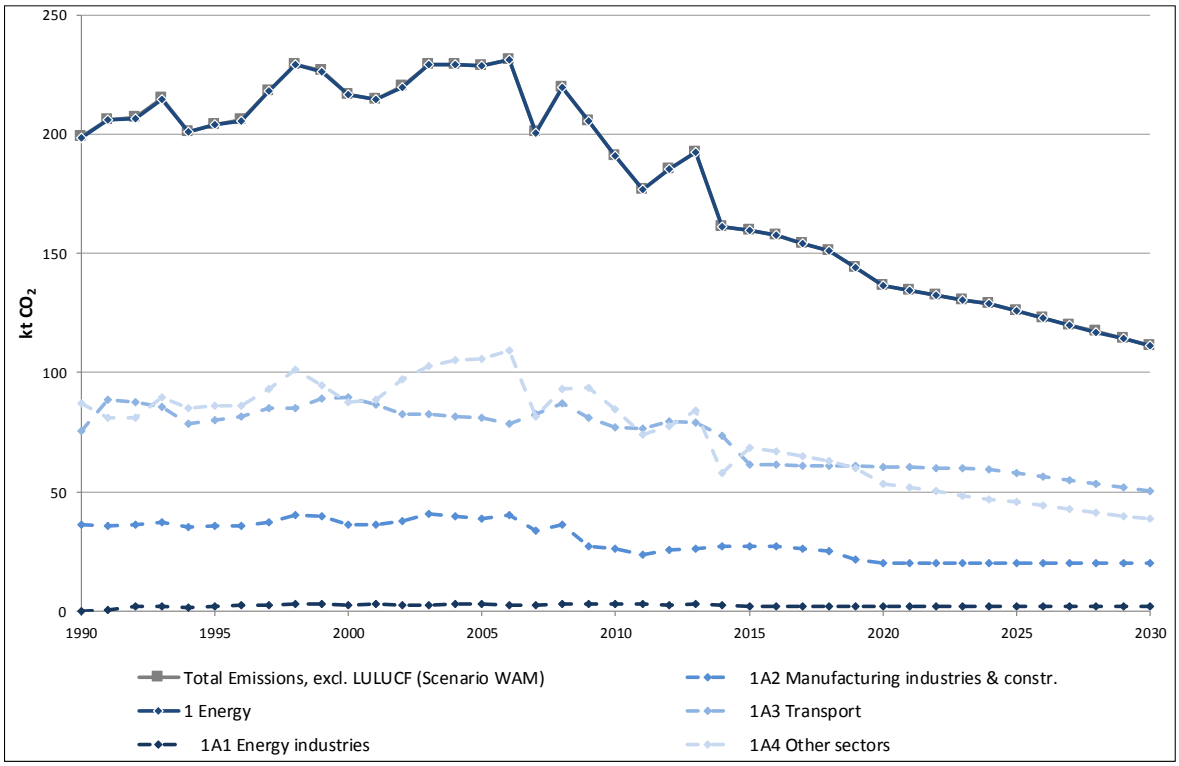

Figure 5-5 CO_2 emissions by sector (excl. LULUCF) from 1990 to 2030 for the scenario WAM

5.1.5.2 Projection of CH_4 emissions in the WAM scenario

Table 5-9 and Figure 5-6 show the development of CH_4 emissions between 1990 and 2030. For the development of emissions between 1990 and 2015, see section 5.1.4.

From 2015 to 2030, a further reduction of CH_4 emissions (excl. LULUCF) by 6.9% is predicted. The main reason for this reduction are the more pronounced reductions anticipated in Switzerland's WAM scenario for the Agriculture sector.

In total, the reduction of CH_4 emissions (excl. LULUCF) under the WAM scenario in the period 1990-2030 is assumed to amount 7.0%.

Table 5-9 CH_4 emissions by sector for the WAM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	CH_4 in kt CO_2eq									
						Reported data (GHG inventories)		Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Total	**Emissions, excl. LULUCF (Scenario WAM)**	**19.53**	**18.29**	**17.36**	**19.23**	**19.85**	**19.50**	**19.19**	**18.73**	**18.15**
1	**Energy**	**1.25**	**1.32**	**1.64**	**1.86**	**2.10**	**2.08**	**1.90**	**1.81**	**1.73**
1A	Fuel combustion	0.88	0.71	0.80	0.76	0.97	0.92	0.74	0.65	0.56
	1A1 Energy industries	0.00	0.02	0.03	0.04	0.04	0.02	0.02	0.02	0.02
	1A2 Manufacturing industries & constr.	0.05	0.06	0.06	0.06	0.04	0.04	0.03	0.03	0.03
	1A3 Transport	0.63	0.43	0.33	0.23	0.19	0.10	0.09	0.09	0.08
	1A4 Other sectors	0.20	0.20	0.38	0.43	0.70	0.76	0.59	0.50	0.43
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
2	**Industrial processes and product use**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
3	**Agriculture**	**16.72**	**15.46**	**14.04**	**15.53**	**16.10**	**15.92**	**15.61**	**15.09**	**14.44**
4	**LULUCF**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
5	**Waste**	**1.56**	**1.51**	**1.69**	**1.85**	**1.64**	**1.50**	**1.68**	**1.83**	**1.99**
Memo item	**International bunkers (aviation)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

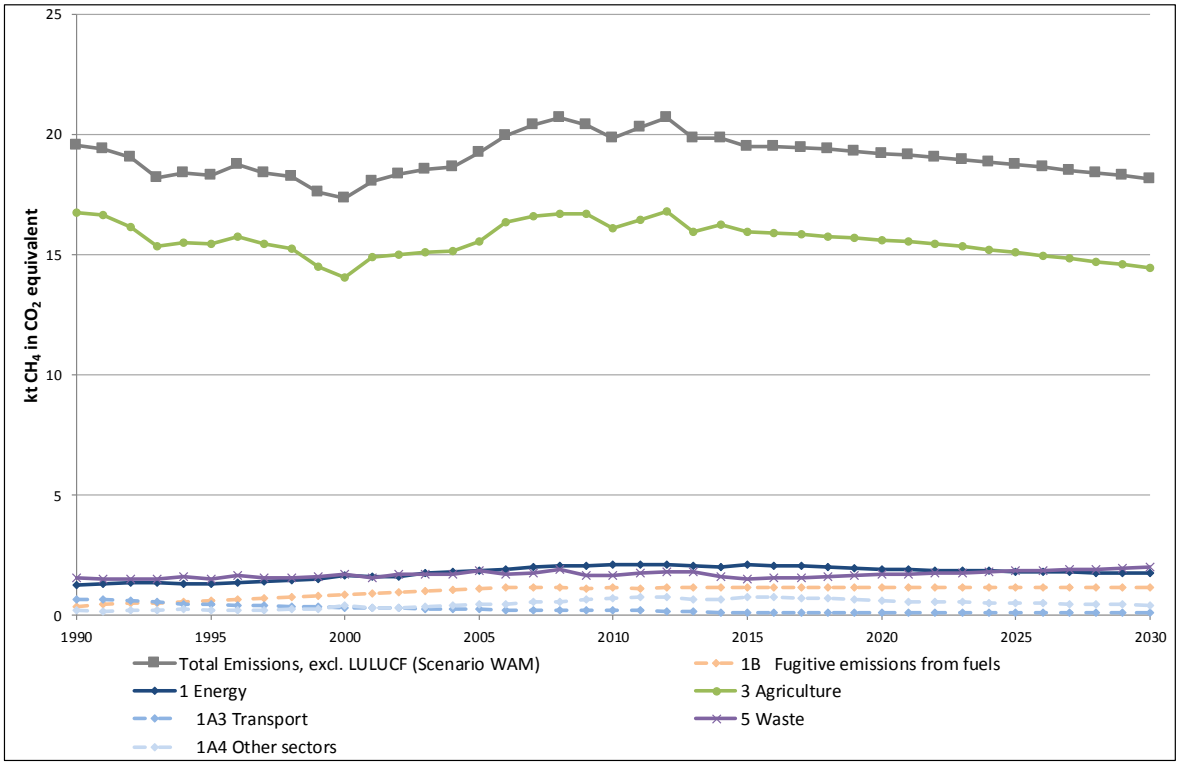

Figure 5-6 CH_4 emissions by sector (excl. LULUCF) from 1990 to 2030 for the scenario WAM

5.1.5.3 Projection of N_2O emissions in the WAM scenario

Table 5-10 and Figure 5-7 show the development of N_2O emissions between 1990 and 2030. For the development of emissions between 1990 and 2015, see section 5.1.4.

From 2015 to 2030, a further reduction of N_2O emissions (excl. LULUCF) by 8.0% is predicted. The main reason for this reduction are the more pronounced reductions anticipated in Switzerland's WAM scenario for the Agriculture sector.

In total, the reduction of N_2O emissions (excl. LULUCF) under the WAM scenario in the period 1990-2030 is assumed to amount 16.9%.

Table 5-10 N_2O emissions by sector for the WAM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	N_2O in kt CO_2eq									
						Reported data (GHG inventories)		Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Total	**Emissions, excl. LULUCF (Scenario WAM)**	**10.90**	**10.62**	**9.85**	**9.85**	**9.90**	**9.85**	**9.67**	**9.41**	**9.06**
1	**Energy**	**1.13**	**1.46**	**1.53**	**0.95**	**0.91**	**0.76**	**0.67**	**0.62**	**0.55**
1A	Fuel combustion	1.13	1.46	1.53	0.95	0.91	0.76	0.67	0.62	0.55
	1A1 Energy industries	0.05	0.06	0.07	0.07	0.07	0.00	0.00	0.00	0.00
	1A2 Manufacturing industries & constr.	0.09	0.08	0.08	0.09	0.08	0.09	0.06	0.06	0.06
	1A3 Transport	0.76	1.11	1.13	0.50	0.46	0.39	0.39	0.37	0.32
	1A4 Other sectors	0.23	0.22	0.25	0.29	0.30	0.28	0.22	0.19	0.16
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2	**Industrial processes and product use**	**0.45**	**0.36**	**0.26**	**0.23**	**0.20**	**0.20**	**0.18**	**0.16**	**0.14**
3	**Agriculture**	**8.73**	**8.18**	**7.40**	**7.99**	**8.04**	**8.12**	**7.96**	**7.69**	**7.36**
4	**LULUCF**	**0.31**	**0.30**	**0.35**	**0.39**	**0.41**	**0.42**	**0.79**	**0.79**	**0.79**
5	**Waste**	**0.59**	**0.62**	**0.66**	**0.68**	**0.74**	**0.76**	**0.86**	**0.94**	**1.01**
Memo item	**International bunkers (aviation)**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**

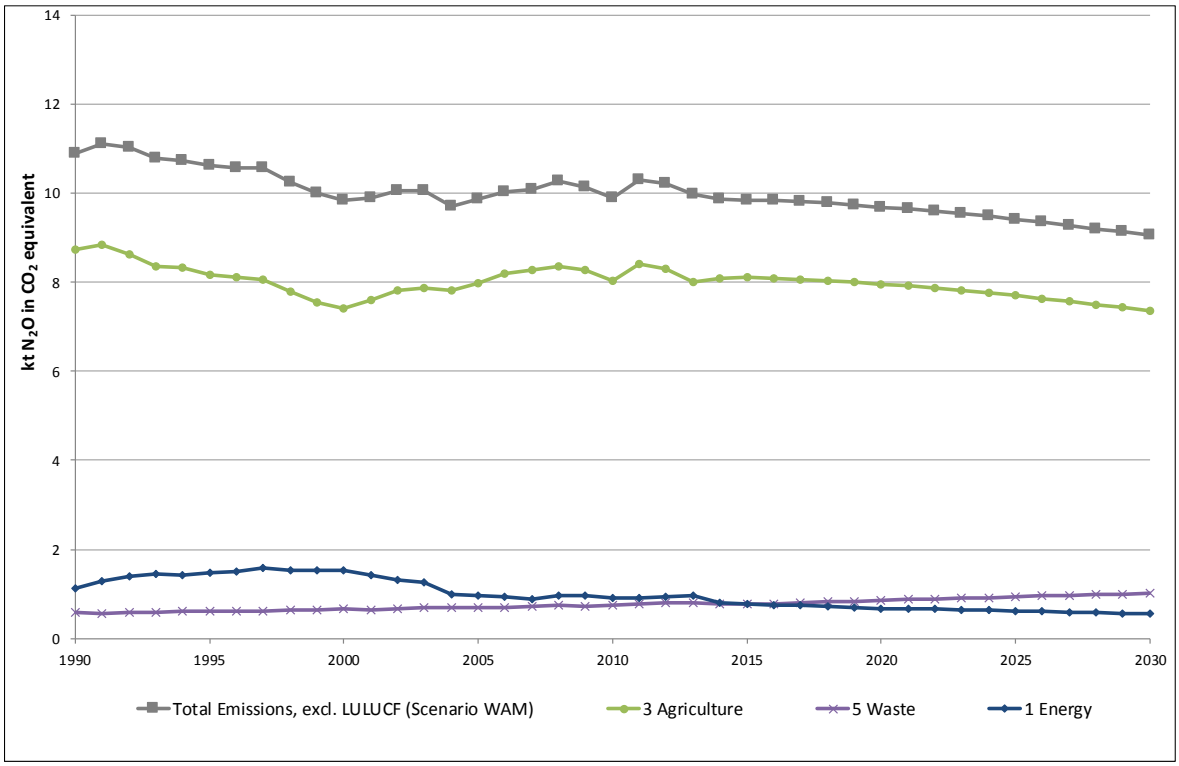

Figure 5-7 N_2O emissions by sector (excl. LULUCF) from 1990 to 2030 for the scenario WAM

5.1.5.4 Projection of F-Gas emissions in the WAM scenario

Table 5-11 and Figure 5-8 show the development of F-Gas emissions (HFC, PFC and SF_6) between 1990 and 2030. For the development of emissions between 1990 and 2015, see section 5.1.4.

From 2015 to 2030, F-Gas emissions are expected to decrease by 31.6%. The main reason for this reduction are the more pronounced reductions anticipated in Switzerland's WAM scenario for the IPPU sector.

In total, F-Gas emissions in the period 1990-2030 under the WAM scenario are assumed to increase by a factor of 69'000. However, the increasing trend is expected to have stopped in 2013.

Table 5-11 F-Gas emissions (HFC, PFC, SF_6) by sector for the WAM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	HFC, PFC and SF_6 in kt CO_2eq									
						Reported data (GHG inventories)		**Projections**		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Total	**Emissions, excl. LULUCF (Scenario WAM)**	**0.00**	**1.35**	**4.21**	**7.69**	**9.79**	**10.50**	**9.46**	**8.46**	**7.18**
2F	Product uses as ODS substitutes	0.00	1.35	4.21	7.69	9.79	10.50	9.46	8.46	7.18
	HFC	0.00	1.35	4.11	7.37	9.69	10.42	9.39	8.40	7.13
	PFC	NO	0.00	0.01	0.07	0.07	0.04	0.03	0.03	0.03
	SF_6	NO	NO	0.09	0.26	0.02	0.04	0.03	0.03	0.03

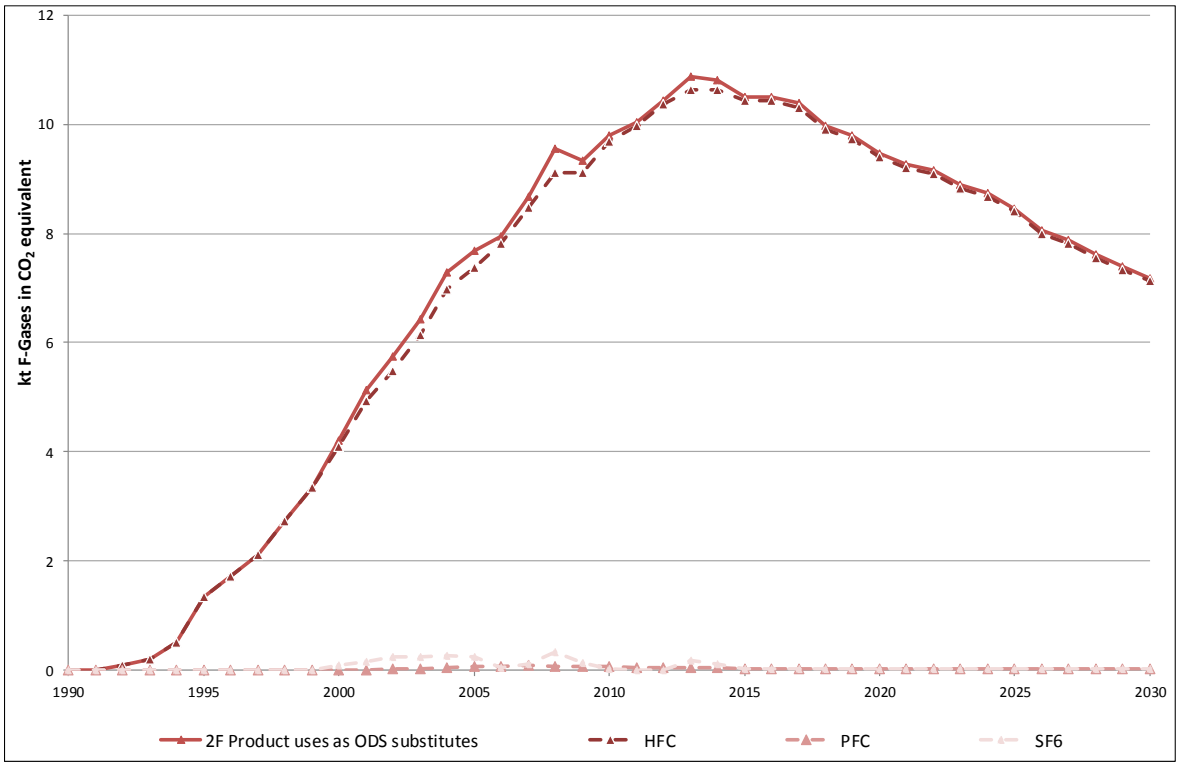

Figure 5-8 F-Gas emissions (HFC, PFC, SF_6) by sector from 1990 to 2030 for the scenario WAM

5.2 Assessment of aggregate effect of policies and measures

5.2.1 Aggregate effect in the WOM scenario

Table 5-12 shows the development of total GHG emissions in CO_2 equivalent between 1990 and 2030. Under the WOM scenario, emissions are assumed to stay constant since the latest inventory year (2015). The WOM scenario is included in the figures depicting the developments under the WEM and WAM scenarios (Figure 5-9 and Figure 5-10, respectively).

Table 5-12 Total GHG emissions in CO_2eq by sector for the WOM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	CO_2eq in kt CO_2 equivalent									
						Reported data (GHG inventories)		Projections		
IPCC	**Source/Sink Categories**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Total	**Emissions, excl. LULUCF (Scenario WOM)**	**229.21**	**234.32**	**248.14**	**265.65**	**230.35**	**199.39**	**199.39**	**199.39**	**199.39**
1	**Energy**	**201.07**	**206.77**	**219.83**	**231.62**	**193.77**	**162.32**	**162.32**	**162.32**	**162.32**
1A	Fuel combustion	200.70	206.16	218.99	230.52	192.63	161.17	161.17	161.17	161.17
	1A1 Energy industries	0.18	2.08	2.77	3.14	3.26	2.05	2.05	2.05	2.05
	1A2 Manufacturing industries & constr.	36.32	35.73	36.46	39.20	26.11	27.44	27.44	27.44	27.44
	1A3 Transport	76.75	81.84	91.31	81.88	77.84	61.87	61.87	61.87	61.87
	1A4 Other sectors	87.45	86.51	88.45	106.30	85.42	69.81	69.81	69.81	69.81
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.16
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.16
2	**Industrial processes and product use**	**0.45**	**1.72**	**4.46**	**7.92**	**9.99**	**10.70**	**10.70**	**10.70**	**10.70**
3	**Agriculture**	**25.51**	**23.68**	**21.48**	**23.56**	**24.18**	**24.09**	**24.09**	**24.09**	**24.09**
4	**LULUCF**	**3.51**	**3.18**	**22.01**	**5.61**	**21.08**	**8.32**	**8.32**	**8.32**	**8.32**
5	**Waste**	**2.18**	**2.15**	**2.36**	**2.55**	**2.41**	**2.28**	**2.28**	**2.28**	**2.28**
Memo item	**International bunkers (aviation)**	**0.43**	**0.43**	**0.49**	**0.49**	**0.85**	**1.20**	**1.20**	**1.20**	**1.20**

5.2.2 Aggregate effect in the WEM scenario

Figure 5-9 and Table 5-13 show the development of total GHG emissions in CO_2 equivalent between 1990 and 2030 for the WEM scenario. The total reduction from 1990-2030 under the WEM scenario is anticipated to be 30.8%.

Table 5-13 Total GHG emissions in CO_2eq by sector for the WEM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	CO_2eq in kt CO_2 equivalent									
							Reported data (GHG inventories)		Projections	
IPCC	Source/Sink Categories	1990	1995	2000	2005	2010	2015	2020	2025	2030
Total	Emissions, excl. LULUCF (Scenario WEM)	229.21	234.32	248.14	265.65	230.35	199.39	175.10	167.92	158.54
1	Energy	201.07	206.77	219.83	231.62	193.77	162.32	138.92	132.69	124.36
1A	Fuel combustion	200.70	206.16	218.99	230.52	192.63	161.17	137.76	131.53	123.20
	1A1 Energy industries	0.18	2.08	2.77	3.14	3.26	2.05	2.15	2.15	2.15
	1A2 Manufacturing industries & constr.	36.32	35.73	36.46	39.20	26.11	27.44	20.28	20.21	20.15
	1A3 Transport	76.75	81.84	91.31	81.88	77.84	61.87	61.05	59.64	55.35
	1A4 Other sectors	87.45	86.51	88.45	106.30	85.42	69.81	54.29	49.53	45.55
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
2	Industrial processes and product use	0.45	1.72	4.46	7.92	9.99	10.70	10.00	9.07	7.77
3	Agriculture	25.51	23.68	21.48	23.56	24.18	24.09	23.61	23.37	23.37
4	LULUCF	3.51	3.18	22.01	5.61	21.08	8.32	15.82	15.82	15.82
5	Waste	2.18	2.15	2.36	2.55	2.41	2.28	2.56	2.80	3.03
Memo item	International bunkers (aviation)	0.43	0.43	0.49	0.49	0.85	1.20	1.21	1.38	1.54

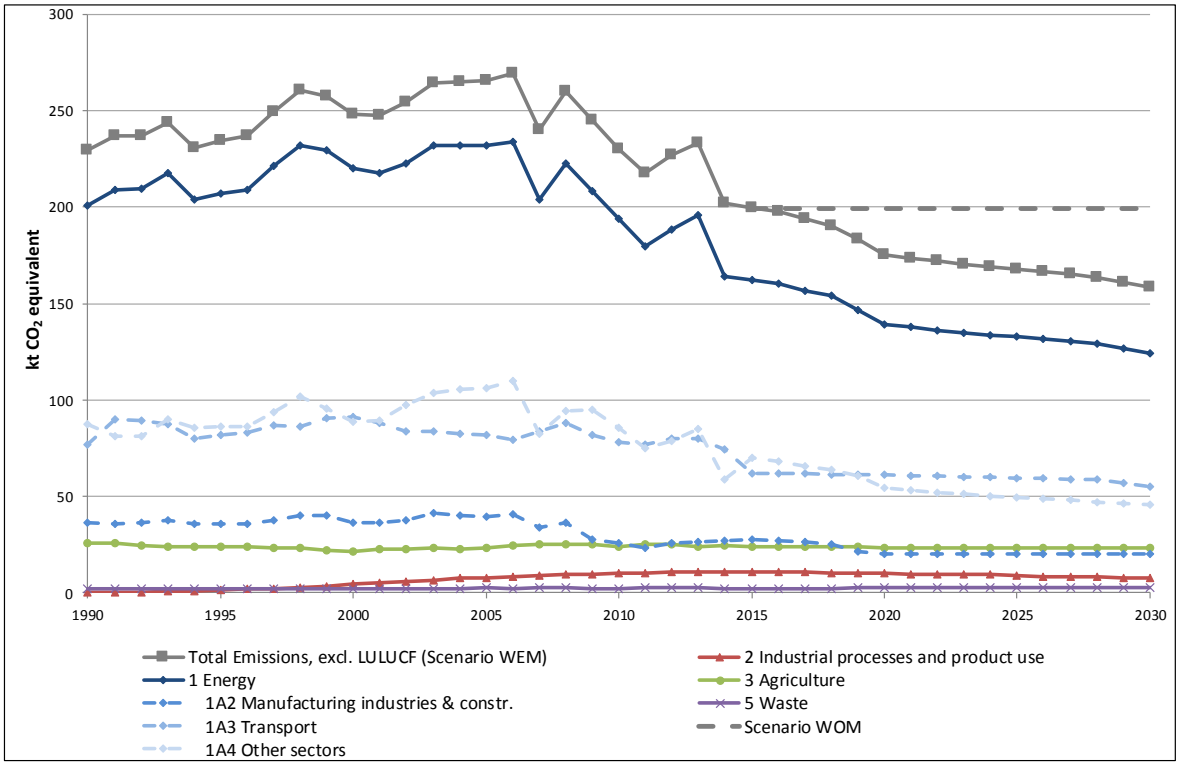

Figure 5-9 Total GHG emissions in CO_2eq by sector (excl. LULUCF) from 1990 to 2030 for the scenario WEM

5.2.3 Aggregate effect in the WAM scenario

Table 5-14 and Figure 5-10 show the development of total GHG emissions in CO_2 equivalent between 1990 and 2030 for the WAM scenario. The total reduction from 1990-2030 under the WAM scenario is anticipated to be 36.5%.

Table 5-14 Total GHG emissions in CO_2eq by sector for the WAM scenario (1990-2030; reported values for 1990-2015 from OE 2017; projected values for 2016-2030)

	CO_2eq in kt CO_2 equivalent									
						Reported data (GHG inventories)		Projections		
IPCC	Source/Sink Categories	1990	1995	2000	2005	2010	2015	2020	2025	2030
Total	Emissions, excl. LULUCF (Scenario WAM)	229.21	234.32	248.14	265.65	230.35	199.39	174.73	162.59	145.59
1	Energy	201.07	206.77	219.83	231.62	193.77	162.32	138.92	128.36	113.39
1A	Fuel combustion	200.70	206.16	218.99	230.52	192.63	161.17	137.76	127.19	112.23
	1A1 Energy industries	0.18	2.08	2.77	3.14	3.26	2.05	2.15	2.15	2.15
	1A2 Manufacturing industries & constr.	36.32	35.73	36.46	39.20	26.11	27.44	20.28	20.21	20.15
	1A3 Transport	76.75	81.84	91.31	81.88	77.84	61.87	61.05	58.49	50.75
	1A4 Other sectors	87.45	86.51	88.45	106.30	85.42	69.81	54.29	46.34	39.18
	1A5 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
	1B1 Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	0.37	0.60	0.83	1.09	1.14	1.16	1.16	1.16	1.17
2	Industrial processes and product use	0.45	1.72	4.46	7.92	9.99	10.70	9.64	8.62	7.32
3	Agriculture	25.51	23.68	21.48	23.56	24.18	24.09	23.61	22.82	21.84
4	LULUCF	3.51	3.18	22.01	5.61	21.08	8.32	15.82	15.82	15.82
5	Waste	2.18	2.15	2.36	2.55	2.41	2.28	2.56	2.80	3.03
Memo item	International bunkers (aviation)	0.43	0.43	0.49	0.49	0.85	1.20	1.21	1.38	1.54

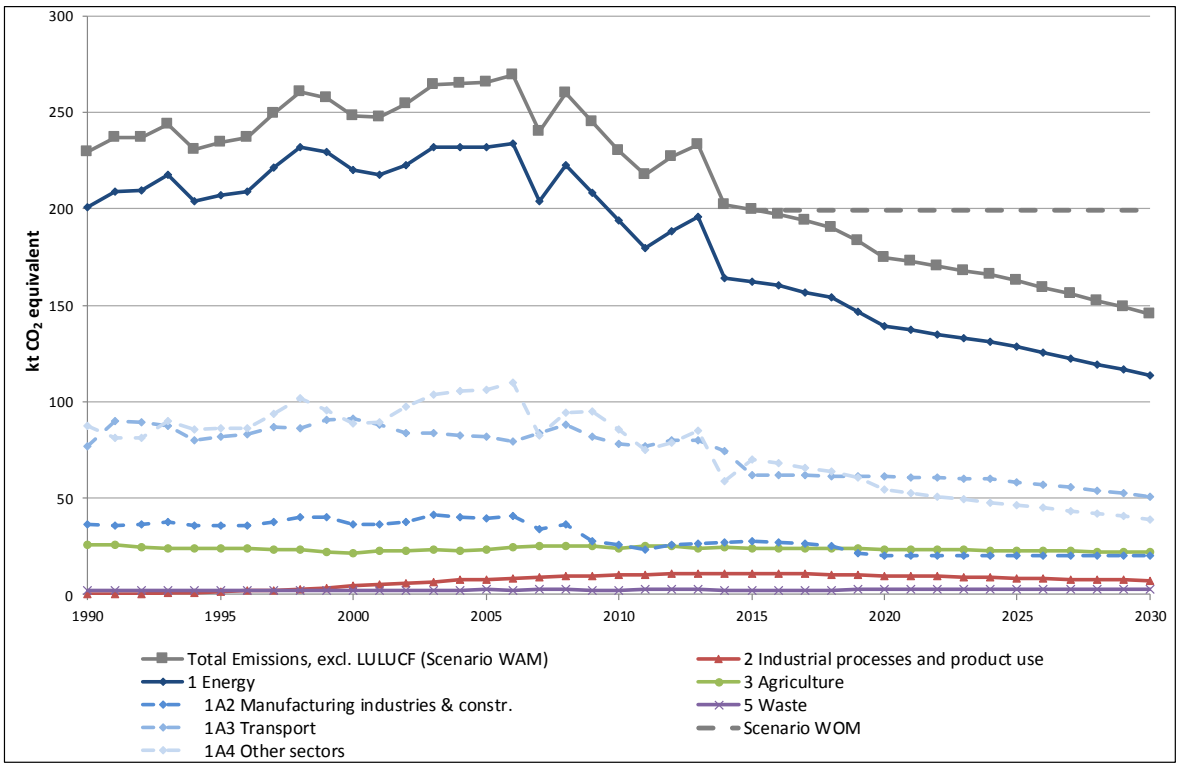

Figure 5-10 Total GHG emissions in CO_2eq by sector (excl. LULUCF) from 1990 to 2030 for the scenario WAM

5.2.4 Supplementary relating to mechanisms under Article 6, 12 and 17, of the Kyoto Protocol

First commitment period 2008-2012

The True-Up Period report submitted by Liechtenstein on 2. January 2016 contains the information required to be reported upon the expiration of the additional period for fulfilling the commitments for the first commitment period of the Kyoto Protocol (hereinafter referred to as the true-up period), in accordance with the relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol. The information contained in this report covers the period 1 January to 18 November 2015, as well as the period 1 January to 31 December 2014, in accordance with decision 15/CMP.1, annex, paragraph 20.

Second commitment period 2013-2020

With respect to the second commitment period (2013-2020), Liechtenstein's target of total GHG emissions (in CO_2 equivalent) is 20% below 1990 levels (which corresponds to 184 kt CO_2 eq in 2020).

Regarding the achievement of the abovementioned target, the priority remains on implementing domestic measures. The legal framework ensuring the focus on domestic reduction measures has been transferred into the new Emissions Trading Act in September 2012. Liechtenstein's focus lies on domestic emission reductions, international carbon credits will play a subsidiary role.

Article 4 paragraph 1 states:

"The emissions of GHG have to be reduced by 20 % compared to the year 1990 until 2020. In accordance with international obligations the Government may increase its reduction target by 40%. The Government informs the Parliament about any increase of the target.

Article 4 paragraph 2 states:

"The reduction of GHG emissions shall be achieved through respective domestic measures, in particular through policy measures within the field of energy, transportation, environment, forestry, agriculture, economy and finance."

Article 4 paragraph 3 states:

"Only these GHG emissions which cannot be reduced by domestic measures, in order to fulfill the reduction obligation according to paragraph 1, may be reduced by using project based mechanisms abroad or international emissions trading."

Under current projections it seems – however – unlikely that Liechtenstein will achieve its reduction target within the second commitment period under the Kyoto Protocol solely by domestic measures. The projections of average annual emissions from 2013 to 2020 lead to a shortage of around 17.64 kt CO_2 eq. This number is based on annual CO_2 emission estimates.

Regarding to fill the gap, Liechtenstein envisages taking the option of continuing its engagement within the Kyoto Protocol's flexible mechanism. This engagement will be guided by the National Climate Strategy, which was revised in 2015. The Government keeps the 2007 established focus on projects with high quality standards. With respect to the potential use of AAUs within the second commitment period, Liechtenstein declared to use its own surplus assigned amount units carried over from the first commitment period to comply with its commitments in the second commitment period.

Table 5-15 and Table 5-16 display the respective Kyoto targets, projected total emissions, the amount of Kyoto mechanisms intended to be used and the net GHG emissions in commitment period 2008-2012 and 2013-2020 respectively. However, the two tables must not be compared since diverging underlying concepts for the Kyoto targets exist for the two commitment periods.

Table 5-15 Kyoto Target 2008-2012

Gross and net GHG emissions during the commitment period 2008-2012	
Kyoto protocol emissions (kt CO_2 eq.)	
Kyoto target 2020 (assigned amount units per year, average 2008-2012)	211.99
Total projected gross GHG emissions WEM (projection for 2020)	232.05
Annually use of Kyoto mechanisms (CDM), based on projected emissions (WEM, 2013-2020)	46
Net GHG emissions	186.05

Table 5-16 Kyoto Target 2013-2020

Gross and net GHG emissions during the commitment period 2013-2020	
Kyoto protocol emissions (kt CO_2 eq.)	
Kyoto target 2020 (calculated assigned amount units per year, -84% of 1990)	194.51
Total projected gross GHG emissions WEM (projection for 2020)	192.12
Annually use of Kyoto mechanisms (CDM), based on projected emissions (WEM, 2013-2020)	17.64
Net GHG emissions	174.48

5.3 Methodology

5.3.1 Method for differentiating specific greenhouse gases

The initial calculation of the projections of Liechtenstein's greenhouse gas emissions are based on total emissions in CO_2 equivalent and not on specific gases. After this initial calculation, the differentiated projection for specific greenhouse gases (CH_2, CH_4, N_2O and F-Gases) was conducted based on factors derived from the latest NIR (OE 2017). These factors describe - for each source category - the share of a specific gas (e.g., CH_4) compared to total CO_2 equivalent emissions in the year 2015. The projection of the total emissions in CO_2eq can then be multiplied with these factors in order to calculate the gas-specific projection.

The factors for CO_2, CH_4 and N_2O are depicted in Table 5-17, the ones for F-Gases (HFC, PFC and SF_6) in Table 5-18.

Table 5-17 Factors describing the share of CO_2, CH_4 and N_2O emissions compared to the total CO_2eq emissions, based on the newest reported values (year 2015) in Liechtenstein's national inventory (OE 2017)

IPCC	Source/Sink Categories	**CO_2 factor** (share of CO_2 compared to total CO_2eq)	**CH_4 factor** (share of CH_4 compared to total CO_2eq)	**N_2O factor** (share of N_2O compared to total CO_2eq)	**F-Gases factor** (share of F-Gas compared to total CO_2eq)	**sum**
1	**Energy**					
1A	Fuel combustion					
	1A1 Energy industries	0.987	0.011	0.001	NO	1.000
	1A2 Manufacturing industries & constr.	0.995	0.002	0.003	NO	1.000
	1A3 Transport	0.992	0.002	0.006	NO	1.000
	1A4 Other sectors	0.985	0.011	0.004	NO	1.000
	1A5 Other	NO	NO	NO	NO	NO
1B	Fugitive emissions from fuels					
	1B1 Solid fuels	NO	NO	NO	NO	NO
	1B2 Oil and natural gas	NA,NO	1.000	NA,NO	NO	1.000
2	**Industrial processes and product use**	**NO**	**NO**	**0.019**	**0.981**	**1.000**
3	**Agriculture**	**0.002**	**0.661**	**0.337**	**NO**	**1.000**
4	**LULUCF**	**0.950**	**NO**	**0.050**	**NO**	**1.000**
5	**Waste**	**0.010**	**0.656**	**0.335**	**NO**	**1.000**
Memo item	**International bunkers (aviation)**	**0.991**	**0.000**	**0.009**	**NO**	**1.000**

Table 5-18 Factors describing the share of HFC, PFC and SF_6 emissions compared to the total CO_2eq emissions, based on the newest reported values (year 2015) in Liechtenstein's national inventory (OE 2017)

IPCC	Source/Sink Categories	**HFC factor** (share of HFC compared to total CO_2eq)	**PFC factor** (share of PFC compared to total CO_2eq)	**SF_6 factor** (share of SF_6 compared to total CO_2eq)	**sum**
2F	Product uses as ODS substitutes	0.993	0.004	0.004	1.000

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

The projections of emissions from the Energy sector are based on Liechtenstein's Energy Strategy 2020 (Government 2012b) and on the half-time report concerning the Energy Strategy (Government 2017). The basis for the projections is the Scenario 2 of the Energy Strategy, which is characterized by a stabilization of energy consumption, an enhancement of renewable energy sources and a reduction of CO_2 emissions (see Table 5-19 for details). Scenario 2 defines a package of measures, implemented stepwise until 2020, in order to reach the greenhouse gas emission target.

Table 5-19 Objectives 2020 of Liechtenstein's Energy Strategy (Scenario 2, base year 2008)

	2008	**Objectives 2020**
Energy demand	1'390 GWh	1'390 GWh *(±0%)*
Share of renewable and domestic energy sources	8.2%	20%
Greenhouse gas emissions	263 kt CO_2eq	184 kt CO_2eq *(-20%)*

The specific measures implemented in the projection are described and explained in section 5.1.2.

Projections 2016-2020

The half-time report (Government 2017) of the Energy Strategy 2020 provides detailed yearly greenhouse gas reduction potentials (CO_2eq) for each measure between the years 2008 and 2020. Two further steps had to be conducted to prepare the data for the projection of the years 2016-2020:

- The measures had to be assigned to the sub-categories of the Energy sector (i.e. 1A1, 1A2, 1A3, 1A4 and 1A5).
- Reduction potentials of some measures had to be divided between industry and households in order to match the NFR structure (in particular categories 1A2 and 1A4). Where possible, the shares were taken from Liechtenstein's NIR 2017 (OE 2017). Else, the shares were estimated by the expert of the energy department[6].

The projection was undertaken on the basis of the reported emissions 2015 (from Liechtenstein's NIR 2017, OE 2017). The energy consumption is assumed to be constant (according to Scenario 2 of the Energy Strategy 2020). The yearly emission reduction potentials were (consecutively) subtracted from the emissions 2015 in order to estimate the projected emissions for the years 2016-2020.

Projections 2021-2030

[6] Expert judgement by J. Senn, Energy Department of Liechtenstein, see Senn 2017.

For the projections 2021-2030, the yearly greenhouse gas reduction potentials (CO_2eq) from the Energy Strategy 2020 were extrapolated. The extrapolations were estimated by expert judgements (see footnote 6):

- The measures electric vehicles and heat pump boilers and efficiency measures in industry and commerce were linearly extrapolated according to the yearly reduction potentials 2016-2020 depicted in the half-time report of the Energy Strategy.
- The measures (energetic) renovation of buildings and heating pumps was continued on a lower level due to decreasing potential.
- The measures wood heatings, solar collectors, standards for electrical equipment/illumination, use of heat recovery in industry/development of heat distribution, incentive systems and biogas use were not continued due to missing knowledge about potential reductions and high uncertainties.

5.3.3 Methods for projecting the emissions from further sectors

Sector 1B Fugitive emissions from fuels

No projections for Liechtenstein are available for emissions from Fugitive emissions from fuels. Therefore, the Swiss projection of this sector was adopted for Liechtenstein. Due to the bilateral agreement on environmental levies between Switzerland and Liechtenstein (see section 4.2.2), the Swiss projections are comparable to the circumstances in Liechtenstein.

Sector 2 Industrial processes and product use (IPPU)

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

Sector 3 Agriculture

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

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

No projections for Liechtenstein are available for emissions from LULUCF. Sources and sinks have shown high fluctuations in the past decades, in particular due to fluctuations of the amount of living biomass on forest land. Accordingly, the projection was simplified by keeping total LULUCF emissions on a constant level from 2016-2030, based on the average of the reported net emissions of the last five inventory years (2011-2015).

Sector 5 Waste

The projection of emissions from the sector Waste was conducted according to Liechtenstein's Waste Plan (Liechtensteiner Abfallplanung 2012-2070, Government 2011). The study estimates activity data (AD; waste amount, in kg or in m^3) for different waste categories in the years 2020,

2050 and 2070 (base year: 2009). The following parameters were used for the projection of the waste categories:

- Municipal solid waste: Development of population (trend scenario).
- Composting: Development of settlement and building zones (one important driver of compost amount in Liechtenstein are building activities on undeveloped land, which generate a lot of organic waste).
- Wastewater treatment: Development of hydraulic population equivalents, development of residual water content in sewage system.

For the years that are not explicitly covered in the Waste Plan study (i.e., relevant for Liechtenstein's NC7, the years 2016-2019 and 2021-2030), the waste amounts were linearly interpolated within the two periods 2009-2020 and 2020-2050.

For the projections in NC7, the waste categories were attributed to the four sub-categories of the Waste sector (5A Solid waste disposal, 5B Biological treatment of waste, 5C Incineration and open burning of waste and 5D Wastewater treatment and discharge). The relative year-to-year changes of the AD (waste amount) according to Liechtenstein's Waste Plan was then applied to the emissions of the Waste sector according to the NIR 2017 (OE 2017) in order to generate an emission projection.

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

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6. Vulnerability assessment, climate change impacts and adaptation measures

Liechtenstein is entirely located in the Alpine region as elaborated in chapter 2. In recent years, various research programs on the effects of global climate warming in the Alpine region have been conducted. Trends in historic climate data up to 2016 and projections of possible developments in the 21st century indicate that noticeable changes in climatic conditions are to be expected. For Liechtenstein, the most important impacts are related to raising temperatures, such as prolonged heat waves and droughts and an increase in the risk of natural hazards (e.g. flooding, landslides, debris flows). Overall, changes in climatic conditions are also expected to have an impact on biodiversity. Since the temperature recording started in 1871 the temperature had increased in Liechtenstein by 1.9 °C (OE 2016).

The expected future impacts of climate change have primarily been studied in Switzerland and are mainly based on the Swiss Climate Change Scenarios 2011 (CH2011, 2011) and related updates (CH2011-2, 2015), which also cover the area of Liechtenstein. Observed climatic conditions and expected developments are summarized in the factsheet on climate trends and climate change provided by the Office of Environment (OE) of Liechtenstein (OE 2016).

To mitigate expected negative impacts of climate change, adaptation measures are required in different areas. Adaptation is therefore an essential element of Liechtenstein's climate strategy (OE 2015). The national climate change adaptation strategy of Liechtenstein (OE 2018) identifies the relevant impacts related to climate change and defines measures to limit or avoid negative impacts.

6.1 Climate modelling, projections and scenarios

6.1.1 Climate Change scenarios

The official scenarios on climate change currently used in Switzerland 'CH2011' were launched in 2011 under the aegis of the Swiss Federal Institute of Technology in Zurich and MeteoSwiss (CH2011, 2011). CH2011 presents a consolidated view on future climate change in Switzerland.[7]
The northeastern region also includes the principality of Liechtenstein. Findings and conclusion within "CH2011" are therefore also valid for Liechtenstein's future climate development. Therefore, respective paragraphs from Switzerland's *7th* National Communication (FOEN 2018) are adopted.

The scenarios are based on a large number of European-scale regional climate model experiments available at that time from international projects. Statistical methods were used to produce multi-

[7] All paragraphs adopted from Switzerland's *7th* National communication (FOEN 2018) are indicated in italic.

model estimates of changes and associated uncertainties in seasonal mean temperature and precipitation changes for three representative Swiss regions and three scenario periods. CH2011 uses two non-intervention emission scenarios (A2 and A1B) that anticipate increases in emissions, and one climate stabilization scenario (RCP3PD) that assumes emissions to be cut by about 50 % by 2050 and that stabilizes global warming at about 2°C with respect to pre-industrial conditions. Besides regional and seasonal mean changes, the new scenarios also provide changes in daily mean values at individual meteorological station sites in Switzerland. Scenario data were made available in digital form at http://www.ch2011.ch*.*

The CH2011 scenarios served as a basis for a variety of climate change impact studies in Switzerland. The largest such study 'CH2014-Impacts' led by the Oeschger Centre for Climate Change Research (OCCR), University of Bern, investigated quantitative impacts of climate change focusing on ecologic, economic and social impacts (CH2014-Impacts, 2014). The CH2011 scenarios further served as an important basis for framing the national climate change adaptation strategy (section 6.4.2).

Through the practical application of the scenarios, a number of shortcomings and limitations have been unveiled. To find a broader applicability among users, the existing CH2011 scenario products were extended as a response to specific user requests. These amendments were coordinated by members of the CH2011 community and were published as several extension articles (Bosshard et al., 2015; *Fischer et al.*, 2015b; *Fischer et al., 2016) along with respective data portals. The CH2011 scenarios together with their extensions constituted the basis of the recently published overview report on climate change in Switzerland coordinated by the Swiss Academy of Sciences (Akademien der Wissenschaften Schweiz*, 2016).

*With the advancement of new higher-resolved regional climate model projections over Europe from the EURO-CORDEX initiative (*http://www.euro-cordex.net/*) and with an improved scientific understanding, it is desirable to update the national scenarios of 2011. The new generation of climate change scenarios for Switzerland 'CH2018', to be launched in 2018, is developed as a focus area of the National Centre for Climate Services established in 2015 (*http://www.nccs.ch*, see also section 6.4.2). As in CH2011 (2011), this project involves several partners from academia and federal offices.*

While the results for CH2018 are still being produced, the results presented in the following are based on the former scenario generation CH2011 and its later extensions. Results from the CH2018 initiative will be made available through the website http://www.ch2018.ch *(from FOEN 2018).*

6.1.1.1 Expected temperature changes

Figure 6-1 illustrates observed seasonal temperature changes for northeastern Switzerland including Liechtenstein, as well as projected seasonal temperature changes for three different emission scenarios and selected time periods.

Compared to the period 1980-2009, the best estimates for the non-intervention scenarios project increases of seasonal mean temperature of 2.7-4.8°C by 2085 for the A2 scenario and 2.4-4.1°C for the A1B scenario (CH2011-2, 2015). For the climate stabilization scenario (keeping global temperature change below 2°C relative to pre-industrial levels), the climate would still change over the next decades, but is projected to stabilize at an annual mean warming of 1.2-1.8°C by the end of the century. Uncertainties due to climate model imperfections and natural variability typically amount to about 1°C (CH2011, 2011).

The projected increase in temperature for Switzerland is consistent with large-scale warming over Europe for all seasons. In winter, the warming is amplified in Northern Europe, partly due to decreased snow cover. In summer, stronger warming is projected in Southern Europe, partly driven by drier surface conditions.

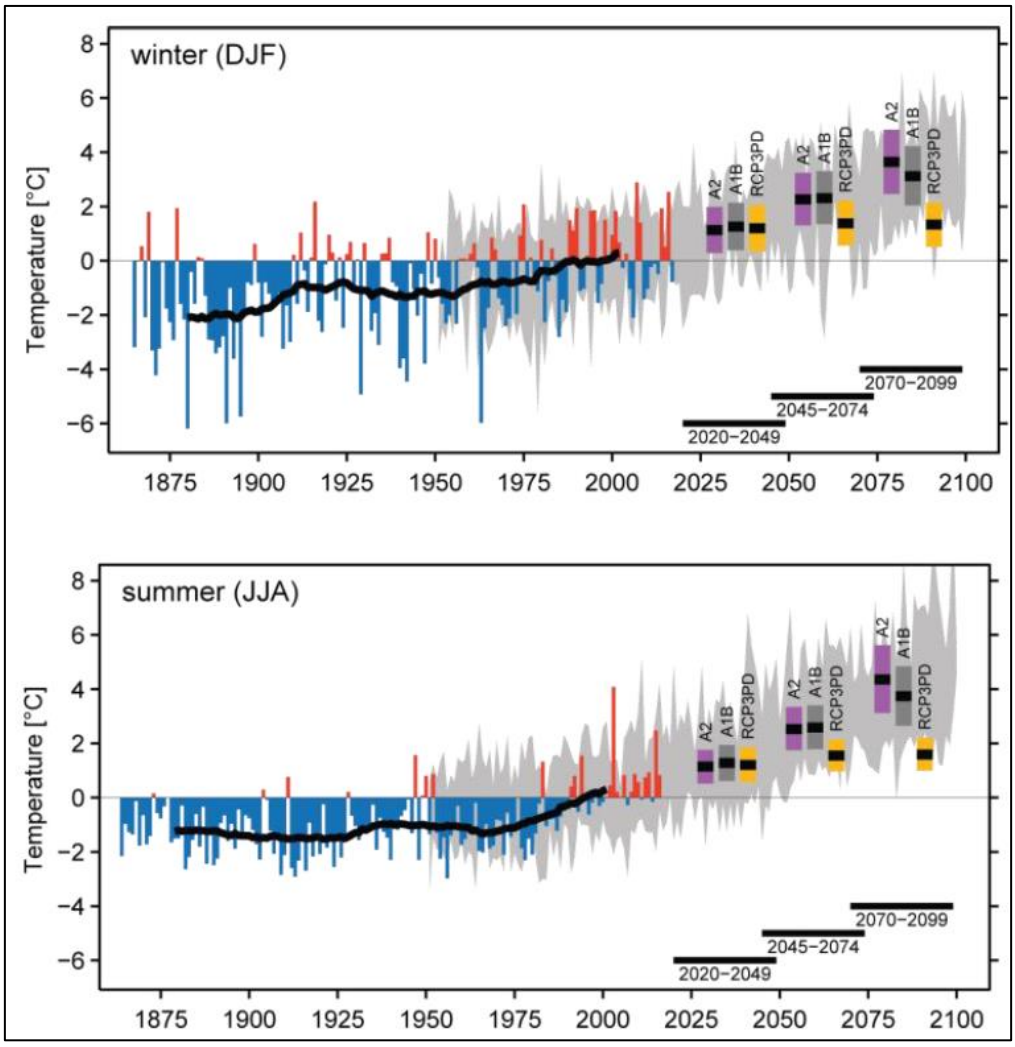

Figure 6-1 Past and future changes in seasonal temperature (°C) over northeastern Switzerland (including the Principally of Liechtenstein). The changes are relative to the reference period 1980–2009. The thin colored bars display the year-to-year differences with respect to the average of observations over the reference period, the heavy black lines are the corresponding smoothed 30-year averages. The grey shading indicates the range of year-to-year differences as projected by climate models for the A1B scenario (specifically, the 5–95 percentile range for each year across the available model set). The thick colored bars show best estimates of the future projections, and the associated uncertainty ranges, for selected 30-year time-periods and for three greenhouse gas emission scenarios (CH2011 (2011), updated with available observed data beyond 2011).

6.1.1.2 Expected precipitation changes

Precipitation is projected to change towards the end of the 21st century (see Figure 6-2). *Summer mean precipitation is projected to decrease by 21–28 % for the A2 scenario and 18–24 % for the A1B scenario. For the climate stabilization scenario (keeping global temperature change below 2 °C relative to preindustrial levels), the climate of Switzerland* and Liechtenstein *would still change over the next decades, but is projected to stabilize at an annual mean warming of 1.2–1.8 °C and a summer drying of 8–10 % by the end of the century. Uncertainties due to climate model imperfections and natural variability typically amount to about 15 % (from FOEN 2018).*

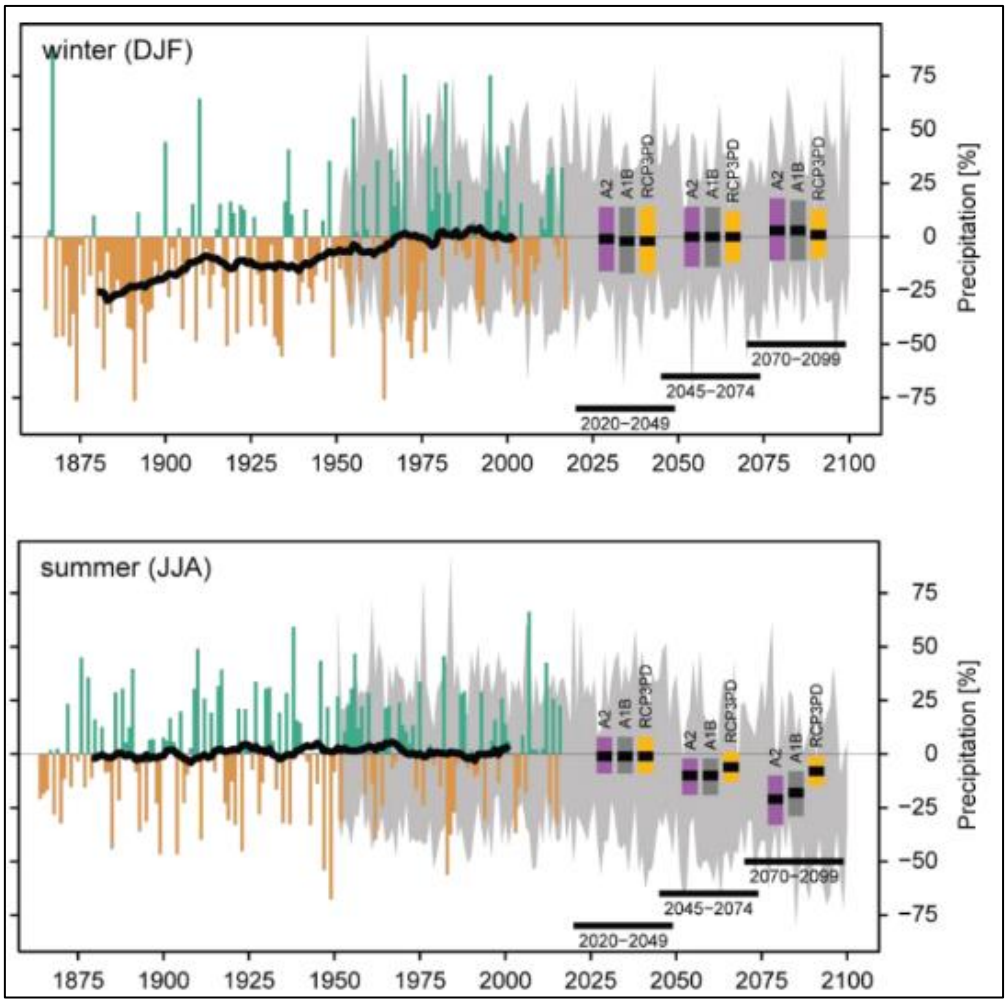

Figure 6-2 Past and future changes in precipitation (%) over north-eastern Switzerland (including the Principally of Liechtenstein). The changes in temperature and precipitation are relative to the reference period 1980–2009. The thin coloured bars display the year-to-year differences with respect to the average of observations over the reference period; the heavy black lines are the corresponding smoothed 30-year averages. The grey shading indicates the range of year-to-year differences as projected by climate models for the A1B scenario (specifically, the 5–95 percentile range for each year across the available model set). The thick coloured bars show best estimates of the future projections, and the associated uncertainty ranges, for selected 30-year time-periods and for three greenhouse gas emission scenarios.

Liechtenstein lies in the centre of Europe. *Northern Europe will likely get wetter and Southern Europe will get drier, which is consistent with the global picture of drier subtropics and wetter high latitudes. In between those opposing trends, precipitation in the Alpine region could either increase or decrease in all seasons – except summer, when Mediterranean drying likely encompasses the Alps and Central Europe. The expected decrease in mean summer precipitation is pre-dominantly an effect of a reduced number of wet days, while the average intensity of precipitation remains at a level similar to today's climate. As a consequence, the probability of consecutive dry days increases (from FOEN 2018).*

6.1.1.3 Temperature extremes

By the end of the 21st century, and for the range of scenarios considered, it is very likely that the frequency, duration and intensity of summer warm spells and heat waves in Switzerland and Liechtenstein *will increase significantly. As an illustrative example, changes in the warm spell duration index (WSDI)*[8] *were calculated for each of the climate models considered in CH2011 (2011). Figure 6-3 shows that the multi-model ensemble projects an increase in WSDI of 10–80 days per summer by the end of the century in north-eastern Switzerland. Southern Europe is expected to experience stronger increases in warm spells and heat waves than Switzerland, and northern Europe somewhat weaker increases (from FOEN 2018).*

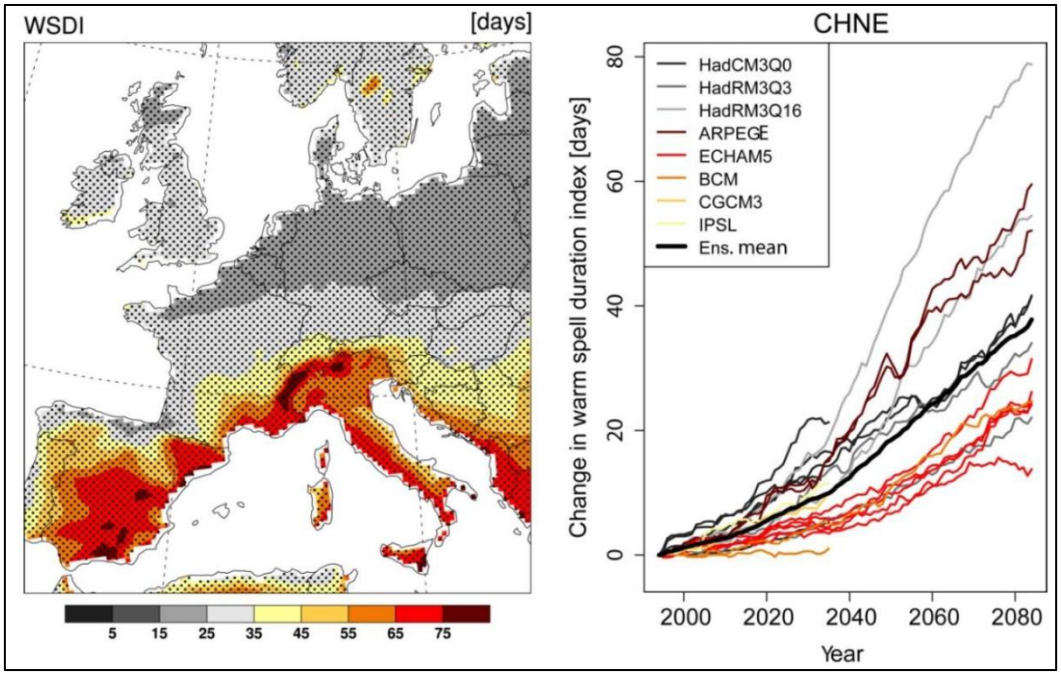

Figure 6-3 Projected changes in warm spell duration. Spatial changes in the warm spell duration index (WSDI; May–September) in 2070–2099 (with respect to 1980–2009) for the multi-model mean (left) forced with the A1B emission scenario. Stippled areas indicate significant changes (95 % confidence level) in more than 66 % of the climate models. 30-year running means of WSDI are shown on the right for the individual models and the multi-model mean (black line) for north-eastern Switzerland (CHNE), including Liechtenstein (CH2011, 2011).

During winter, the number of cold winter nights and days is likely to decrease. Over north-eastern Switzerland, including Liechtenstein, *the climate models considered in CH2011 (2011) project a strong reduction in cold winter nights of 50–90 % by the end of the century (from FOEN 2018).*

[8] A warm spell is defined as a period of at least six consecutive days with maximum temperatures exceeding the local 90th percentile for days in the reference period.

6.1.1.4 Precipitation extremes and droughts

On a global scale climate models simulate a significant future increase in heavy precipitation in the tropics and mid-to-high latitudes by the end of the century. Consistent with the global scale, for Switzerland and Liechtenstein*, regional climate models simulate more frequent and more intense heavy precipitation events (see Figure 6-4). In winter, heavy precipitation is increased at a similar rate as mean precipitation. In summer, heavy precipitation events show a tendency to increase despite the general decrease in mean precipitation (Rajczak et al., 2013).*

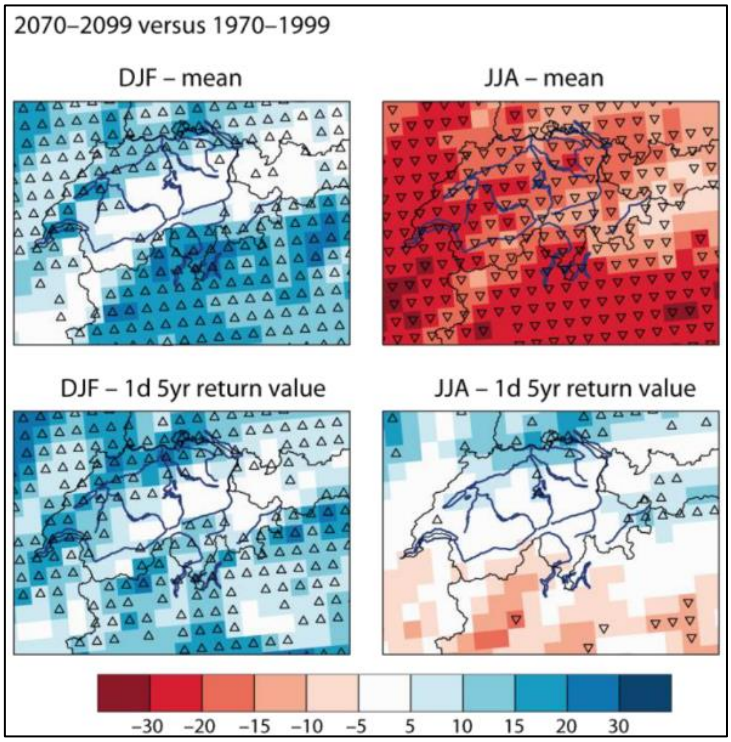

Figure 6-4 Projected changes of mean precipitation (upper panel) and heavy precipitation (lower panel) for winter (DJF) and summer (JJA) in Switzerland by the end of the century. Shown is the multi-model mean of ten regional climate models according to the A1B emission scenario. Change in heavy precipitation is described by the change of the daily precipitation sum with a return value of five years. Regions in which eight out of ten models agree on the mean sign of change are marked with a triangle symbol (Adapted from Rajczak et al. (2013)).

In parallel with these changes, a shift from solid (snow) to liquid (rain) precipitation is expected with increasing temperatures over Switzerland and Liechtenstein*, with potential implications for the frequency of floods.*

Together with the decrease in summer mean precipitation, the length of summer dry spells is likely to increase (CH2011, 2011), indicating an increased risk of drought for Switzerland and Liechtenstein*. However, model uncertainties in projecting changes of droughts are generally higher than for changes in heavy precipitation (from FOEN 2018).*

6.1.1.5 Wind storms

Confidence in projections of windiness in Central Europe remains relatively low and hence no robust projection for extreme wind storms in Switzerland and Liechtenstein *can be made. For*

instance, it remains unclear whether devastating winter storms such as 'Lothar' and 'Vivian' will become more or less frequent in the future. It is expected that low pressure systems and the accompanying storm winds over Northern Europe will intensify, while weakening over Southern Europe. Switzerland is located in-between these large-scale centers of change, which is why robust projections are hardly possible (Akademien der Wissenschaften Schweiz, 2016) (from FOEN 2018).

6.1.2 Other climate indicators and altitudinal differences in climate scenarios

Liechtenstein's climate scenarios for 2060 were assessed with respect to altitudinal differences (OE 2016). Selected climatic indicators (number of summer and frost days, duration of growing season, days with fresh snowfall) were analysed (Figure 6-5):

- The number of summer days is expected to increase by about 4 weeks in the lower areas and by about 2 to 3 weeks at altitudes between 600 and 1500 m a.s.l. At higher elevation, a few summer days are expected to occur.
- The number of frost days is expected to decrease at all levels. Depending on the climate scenario the reduction amounts to 25 up to 45 days.
- The length of the growing season increases in all scenarios and at all altitudes by about 25 at high altitudes and up to 40 days at low altitudes.
- The number of days with fresh snow show a reduction by about 10 days in all scenarios and at all altitudes.

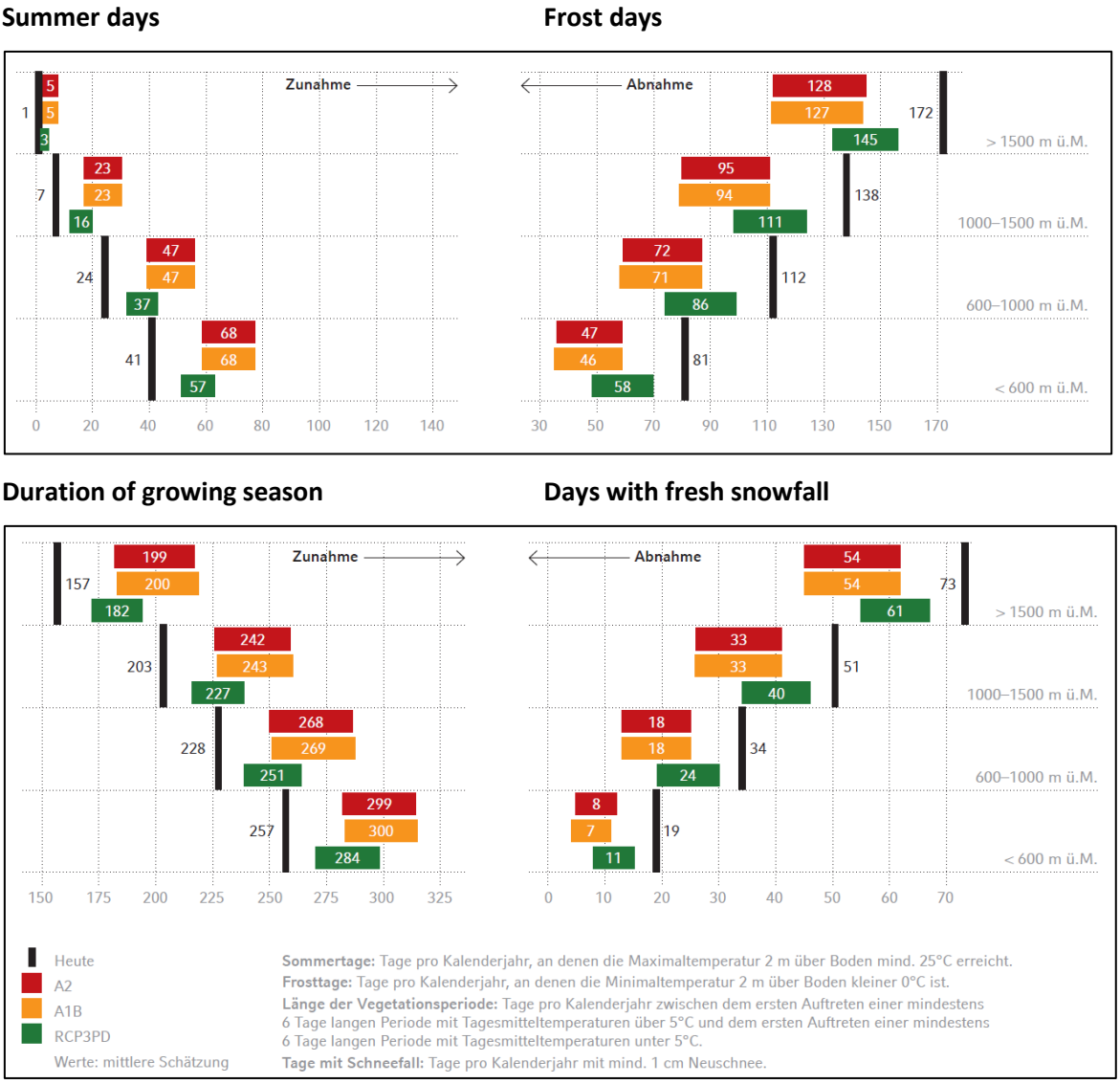

Figure 6-5 Expected future changes in climate indicators under the climate scenarios A2, A1B and RCP3PD at different altitudes as compared to today's climate (OE 2016). Summer days: Number of days per calendar year with a maximum temperature of 25 °C at 2 m above ground. Frost day: Number of days per calendar year with a maximum temperature of 0 °C at 2 m above ground. Duration of growing season: Number of days per calendar year between first occurrence of a 6-day period with daily mean temperatures above 5 °C and first occurrence of a 6-day period with daily mean temperatures below 5 °C. Days with fresh snowfall: Days per calendar year with at least 1 cm of fresh snow.

6.2 Climate change impacts

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

Based on the climate scenarios (section 6.1.1), potential future impacts of climate change are assessed. As the Swiss climate change impact studies also cover the alpine area with similar conditions as in Liechtenstein, relevant paragraphs are adopted from Switzerland's *7th* National Communication (FOEN 2018).

6.2.1 Observed changes in temperature

Liechtenstein's climate is directly connected to the topography of the Upper Rhine Valley and characterized by warm down slope winds. The mean annual temperature at the SwissMetNet[9] station of Vaduz is 10.1 °C for the current standard reference period 1981-2010 (MeteoSwiss, 2017a). Since the temperature recording started in 1871 the temperature had increased in Liechtenstein by 1.9 °C (OE 2016).

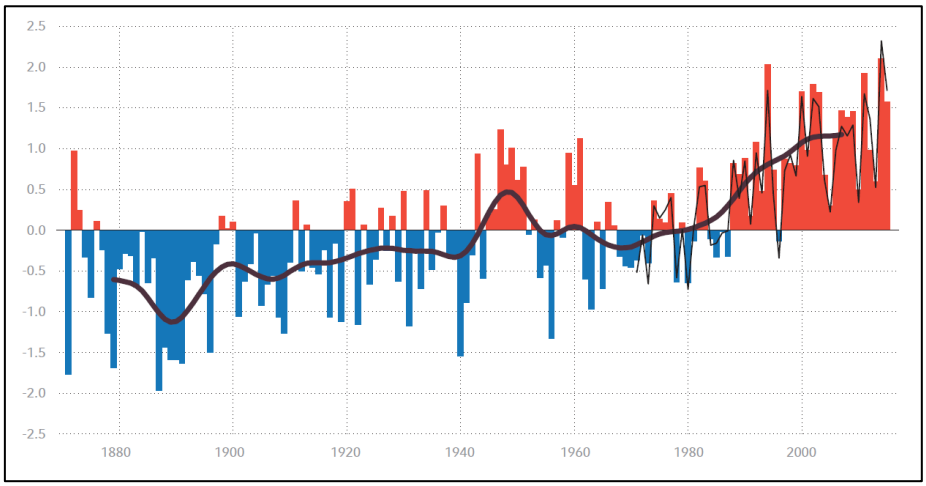

Figure 6-6 Past evolution of temperature (%) at the monitoring station of Bad Ragaz 1871–2015. The bars show the deviations relative to the reference period 1961–1990. Positive deviations are indicated by red bars, negative deviations are indicated by blue bars. The black line indicates the smoothed average. Data from the monitoring station in Vaduz are indicated by the black line (OE 2016).

6.2.2 Observed changes in precipitation

In Liechtenstein, systematic recording of precipitation began in 1961 at the SwissMetNet Station in Vaduz. In Switzerland, measurement began already in the middle of the 19th century. Compared to long-term changes of mean temperatures (see section 6.2.1), trends in mean precipitation amounts (Figure 6-7) and trends in daily maximum precipitation amounts are less pronounced (Figure 6-8).

The mean annual precipitation amount at the SwissMetNet station of Vaduz is 923 mm for the current standard reference period 1981-2010 (MeteoSwiss, 2017c). The mean annual precipitation amount has increased by 32 mm (+3.6%) between the reference period 1961-1990 (891 mm; MeteoSwiss, 2017d) and the current reference period 1981-2010 (923 mm; MeteoSwiss, 2017c). In order to provide data from before 1961, Figure 6-7 also includes data from

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

the geographically closest monitoring station Sargans. The annual total precipitation at the station Sargans shows a significant increase of 11% over a time period of 127 years (OE 2016).

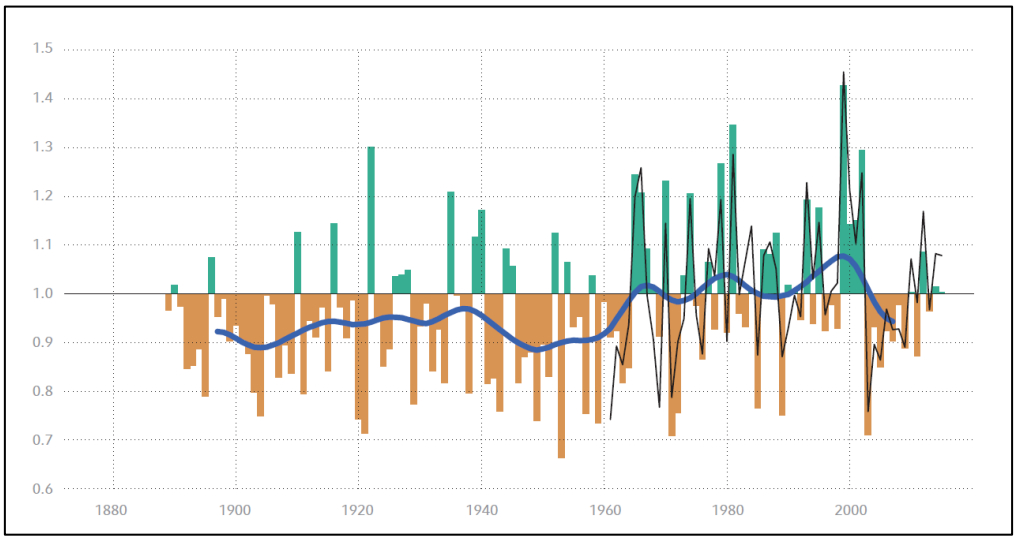

Figure 6-7 Past evolution of annual precipitation amount (%) at the monitoring station of Sargans 1889-2015. The monitoring station of Sargans is located in Switzerland next to the border to Liechtenstein. It lies geographically close to Vaduz. The bars show the deviations relative to the reference period 1961–1990. Positive deviations are indicated by green bars, negative deviations are indicated by brown bars. The blue line indicates the smoothed average. Data from the monitoring station in Vaduz are indicated by the black line (OE 2016).

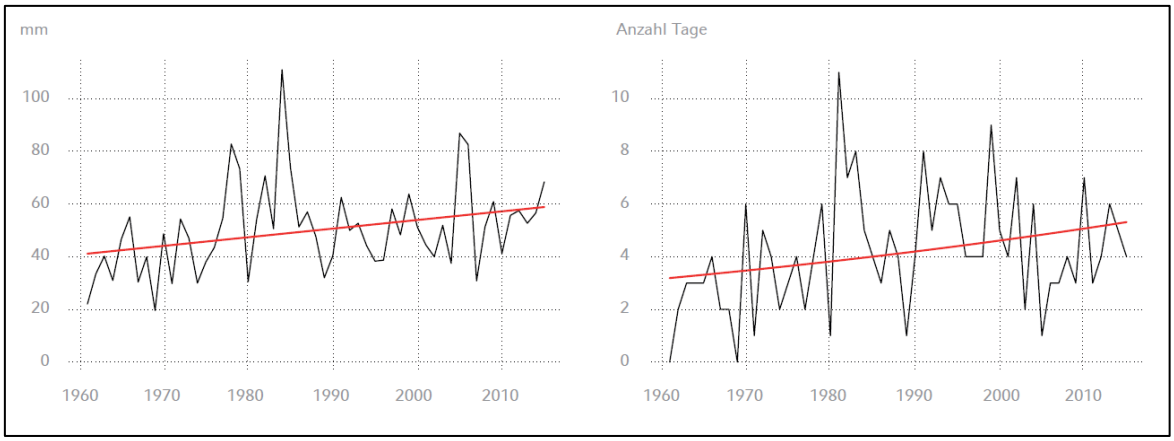

Figure 6-8 Maximum daily precipitation per year (left panel) and number of days with intense precipitation >26.1 mm (right panel) in Vaduz 1961-2015. The trend is indicated by the red line (OE 2016).

6.2.3 Impacts on the hydrological cycle and water resources

Liechtenstein's water resources are affected by changes in precipitation regime and temperature. Potential impacts of climate change are currently assessed in Switzerland. *Within the project 'Climate Change and Hydrology in Switzerland' (CCHydro) run by the Swiss Federal Office for the Environment (FOEN), the effects of climate change on the water balance in Switzerland during the 21th century were studied (FOEN, 2012a). The aim of this project was to present scenarios with*

enhanced spatial and temporal resolution for the hydrological cycle and runoff in the different climate regions and altitudes in Switzerland for the periods around 2035 and 2085, based on the latest climatic data. This would provide a basis for analyzing changes in extreme discharge values (high and low water), water temperatures, and water resources and their annual distribution regimes (Volken, 2010).

From the European ENSEMBLE project, ten climate model chains were selected. They correspond to an increase in greenhouse gas emissions based on the A1B emissions scenario. The delta change method was used for regional downscaling of the climate scenarios. The ten climate scenarios used in this study are described in CH2011 (2011). The PREVAH model was used to model the water regime and runoff (from FOEN 2018).

6.2.3.1 Stream flow scenarios

In the near future (until 2035), annual runoff in Switzerland and Liechtenstein *will change very little. In the long term (by 2085) the annual runoff will fall slightly (FOEN, 2012a). However, the seasonal distribution of runoff (runoff regime) will shift almost every-where in Switzerland* and Liechtenstein*. By the end of the century, catchments with a snowmelt driven runoff regime will only be found in isolated areas and the seasonal distribution of runoff will follow the rainfall distribution. In the not glaciated regions, runoff is expected to be higher in winter but lower in summer (Steger et al., 2013). On the Rhine for example, a second seasonal runoff maximum will develop over time in winter in addition to the existing one in early summer (Figure 6-9). In the catchments of the Alps and, in particular, their northern slope, low flow events will shift from winter to late summer and will be less pronounced (from FOEN 2018).*

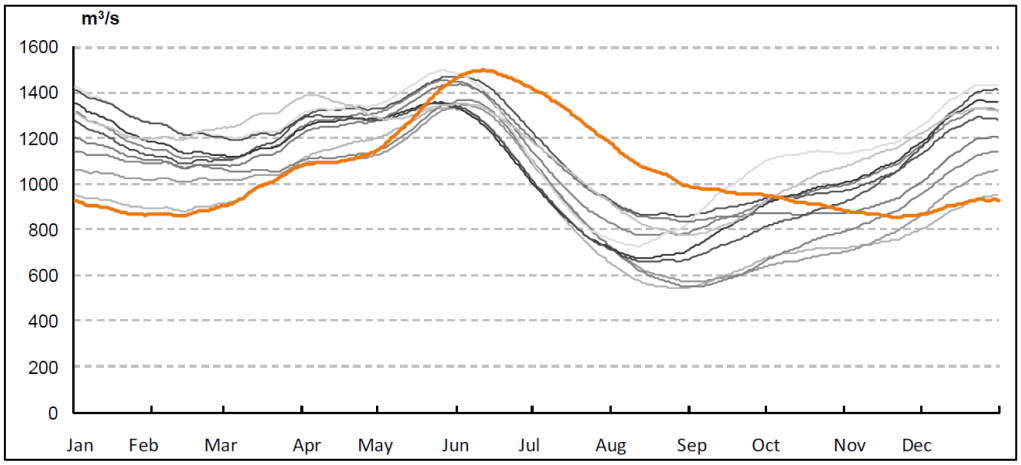

Figure 6-9 Discharge projections in River Rhine at Basel. The orange line indicates the control period, grey lines the ten climate scenarios over the period 2070-2099 (FOEN, 2012a).

6.2.3.2 Effects of climate change on water reservoirs

The runoff regime changes which have already been observed over the past decades, can be explained by the changes in climatic conditions (Ban et al., 2015; Fischer et al., 2015a; Rajczak et al., 2013). Since average annual air temperature in Liechtenstein increased by almost 1 °C over the past decades (section 6.2.1) and is expected to increase further (section 6.1.1), it is likely that this will have an impact on seasonal hydrological reserves in Liechtenstein. *The increase in temperature will lead to an increase in evapotranspiration. Therefore, less water will be available*

for runoff. The temperature increase will also be accompanied by a rise in the snow line. The average area covered by snow will be continually reduced, as is the depth and duration of the snow cover (section 6.2.4) *resulting in decreasing amounts of snow available for melting. During the period 1980–2009, some 40 % of the water flowing from Switzerland to the neighbouring countries consisted of snow melt. This proportion will fall to about 25 % by 2085.* Similar effects are expected in Liechtenstein. *This will lead to an increasing proportion of rainfall being free to drain away immediately, particularly in winter (from FOEN 2018).*

Change in the pattern of precipitation regime could have serious consequences for the natural enrichment of groundwater and water supply. The hot summer of 2003 and the prolonged precipitation deficit from 2003 to 2005 resulted in unusually low values for the groundwater levels and discharge rates at most of the monitoring stations of the National Groundwater Monitoring (NAQUA) (FOEN, 2009). Similar effects were observed in 2015 (FOEN, 2016a). Conversely, the floods of 1999 and the prolonged precipitation surplus from 2000 to 2002 resulted in very high groundwater levels and discharge rates. Based on the CH2011 climate scenarios, it must be assumed that precipitation intensity and strength will tend to increase in the long term and high groundwater levels and spring discharge rates may thus occur more frequently. However, summer droughts should happen more often and last longer in the future. Therefore, low ground-water levels and spring discharge rates may occur more frequently. So far, no clear trends have been identified for both the groundwater levels and the discharge rates (from FOEN 2018).

6.2.3.3 Impacts on water temperature and water quality

Regarding water chemistry, Swiss and Liechtenstein's *waters are in a good condition (FOEN, 2015b). Up to now there is no evidence that the water quality has altered due to climate change. This is not the case with regard to water temperature. Indeed, the significant rise in air temperature has simultaneously been followed by that of surface and groundwater temperature. Water temperatures of various rivers and streams have been continuously recorded since 1963 within the framework of the national temperature measurement network (Figure 6-10). This allows highlighting the effects of various natural and anthropogenic influences on the annual development of water temperatures. The analyses of those measurements show clear tendencies towards increased annual mean temperatures of up to 1.2°C, and 1.5 to 3°C in summer (Jakob et al., 2010). A rapid increase in temperature is noticeable in spring, irrespective of the altitude. The causes of this temperature change cannot always be clearly identified. Anthropogenic and natural climate change induced effects have a combined influence on the water temperature regime (Akademien der Wissenschaften Schweiz, 2016).*

The temperature changes impact decisively on the development and on the composition of aquatic life. A further rise of the water temperature in the future, especially at times of low flows, could probably also lead to a deterioration of the chemical water quality. The quality of drinking water resources could also change if groundwater temperatures increase. Indeed, the water temperature is one of the most important regulators of life processes in aquatic groundwater ecosystems. Temperature regulates the metabolic and redox processes and defines the evolution, the growth rate and the composition of biocenoses (from FOEN 2018).

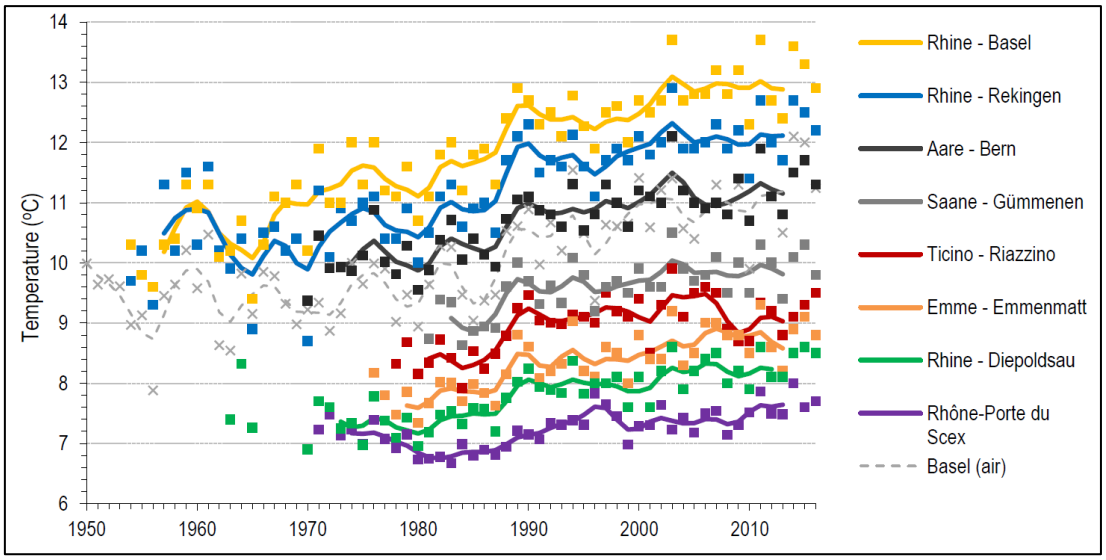

Figure 6-10 Change of yearly water temperature at different measuring stations 1954–2016. For comparison reasons, the air temperature at Basel is included in the graph. Yearly moving average over seven years is represented (line).

6.2.3.4 Water management

Knowledge regarding the future impacts of climate change on the water balance and on water management in Switzerland and Liechtenstein *is generally limited to a qualitative understanding. The reason for this is that only relatively uncertain scenarios for climate change (precipitation, extreme events) are available and that the spatial-temporal resolutions of these scenarios cannot adequately cope with the heterogeneous nature of the Alps. With the study 'Climate Change and Hydrology in Switzerland' (FOEN, 2012a) for the first time quantitative hydrological projections up to 2100 are available. According to these projections, the water resources in terms of availability and quantity will only change slightly by the end of the century. However, as a result of the rise of the snow line associated with increasing air temperature, the volumes of snow and ice stored in the Alps will greatly decrease. The redistribution of precipitation patterns (drier in summer, possibly wetter in winter) will at the same time cause seasonal flow redistribution. High and particularly low flow events will probably occur more frequently. While currently hydropower production benefits from these changes, a detailed impact analysis of the changing flow regimes on other sectors of the water management was subject to research (NRP 61 'Sustainable Water Management', http://www.nfp61.ch).*

The effect of climate change on the runoff and the groundwater tables will have consequences on water management. The existing flood protection measures must be reviewed. The water temperature has already significantly increased, in parallel to the air temperature. This restricts the cooling capacity of the rivers in dry and hot periods with regards to the discharge of heated water. Finally, the ecosystems in the rivers will be doubly affected by climate change, i.e. by both the higher air temperature and the seasonal redistribution of river flows. Higher air temperatures together with the associated higher water temperatures and lower water levels in summer are likely to put pressure on river ecology and thereby also on water use (agriculture, heat input from industrial cooling) and fishing.

6.2.4 Impacts on the cryosphere

6.2.4.1 Freezing level

In Switzerland and Liechtenstein*, the seasonal freezing level in wintertime (altitude, where surface air temperature is 0°C) has risen by about 200 meters per °C of warming from approximately 600 meters in the 1960s to approximately 900 meters in the 1990s (Scherrer and Appenzeller, 2006). If warming in winter continues as expected, the freezing level will further rise by about 280 meters until 2060 in case of a mitigation scenario (about +1.4°C, best estimate), by about 460 meters in case of a non-intervention scenario (about +2.3°C, best estimate) (CH2011, 2011).*

6.2.4.2 Snow

Liechtenstein is expecting a decreasing amount of snowfall (section 6.1.2). *According to Switzerland's 7th National Communication (see FOEN 2018) the precipitation falling as snow has been decreasing (Serquet et al. 2011) due to the already observed warming. Together with effects of snow melting, a reduction of snow depth and snow duration has been observed in the past decades. For example, on the plateau the number of days with a snow depth of at least five centimeters has been 50 % lower in the last 20 years than in the decades before (Marty, 2008). On the other hand, despite the warming trend winter temperatures above about 2000 meters above sea level are still predominantly below freezing and changes in snow cover have thus not yet been observed (Marty and Meister, 2012).*

From recent analyses (Schmucki et al., 2015; Serquet et al., 2011) it can be concluded that under future climate scenarios the snow season will get shortened in Switzerland and Liechtenstein *by 4–8 weeks per year. As the lower limit of the snow cover corresponds roughly to the freezing level, an upward shift of the snow line until the mid of this century is expected. The reduced snow pack will result in reduced runoff in spring and summer (from FOEN 2018).*

6.2.4.3 Permafrost

Within the Principally of Liechtenstein only small areas are covered by permafrost (see Permafrost Web-GIS). The related changes due to rising temperatures are adopted from Switzerland 7th National Communication (FOEN 2018).

The warming of permafrost in high mountain regions such as the Swiss Alps is a slow process with long-term implications. While first measurements of permafrost in rock glaciers have started in Switzerland in the late 1980s, systematic monitoring is performed since 2000 by the Swiss Permafrost Monitoring Network (PERMOS) and now also includes other landforms like debris or steep rock slopes. The evaluation of significant trends is difficult because time series mainly cover the past 10 very warm years and temperature anomalies associated with extreme warm years (such as 2003, 2009, and 2011) are superimposed over the longer-term trend. Further, several factors (surface and sub-surface properties, snow cover) may alter the magnitude and delay of the changes in ground temperatures compared to atmospheric changes resulting in high regional and local variability. However, in relation to operational observation (Figure 6-12), current conditions are above average warm with active layers at record depths for most of the sites in recent years (PERMOS, 2016). In addition, temperature trends at greater depth show clearer warming trends for a number of sites (PERMOS, 2016). Furthermore, the increasing rock glacier creep velocities as well as decreasing ice contents that are measured along with increasing ground temperatures are noteworthy at many sites. Analyses of documented rock fall events (PERMOS, 2016) with starting zones in high elevations indicate that the frequency of events with volumes of one million cubic kilometers or more has increased in the past about 20 years, as compared to the 20th century (Huggel et al., 2012; section 6.2.5).

A further temperature increase according to the CH2011 scenarios (CH2011, 2011) will cause warming or complete thawing of cleft ice in rock faces as well as further warming and increasing active layer depths of ice rich debris slopes and rock glaciers (Haeberli et al., 2010). The warming of the outer about 50 meters of frozen rock faces is already an effect of the temperature rise in the 20th century. It will penetrate into greater depths and increase the thermal imbalance. For summits and ridges such effects will be particularly pronounced as the warming may penetrate from different sides (Figure 6-11, Noetzli and Gruber, 2009). Processes related to warming of permafrost (Hasler, 2011) may increase the frequency and magnitude of rock fall. Combined with the increasing availability of sediment due to rock fall, deepening of active layers, glacier retreat and the possibility of mass movements into high mountain lakes, new and complex hazard situations may emerge in regions where they have not been reported from before (section 6.2.5).

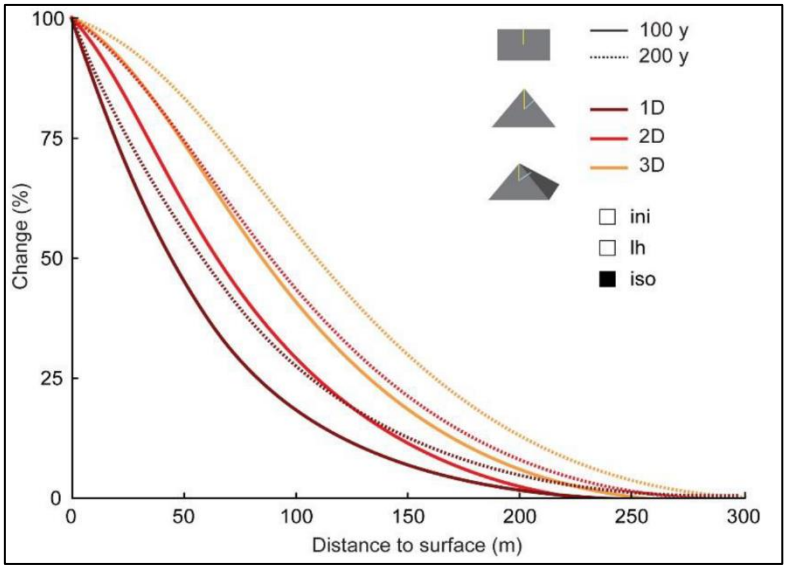

Figure 6-11 Percentage of a temperature signal at the surface that has penetrated to depth: This effect is shown for a one- (flat terrain), two- (ridge), and three-dimensional (pyramid) situation after 100 (solid lines) and 200 years (dotted lines). In the two- and three-dimensional situations values are plotted versus the shortest distance to the surface (from Noetzli and Gruber 2009).

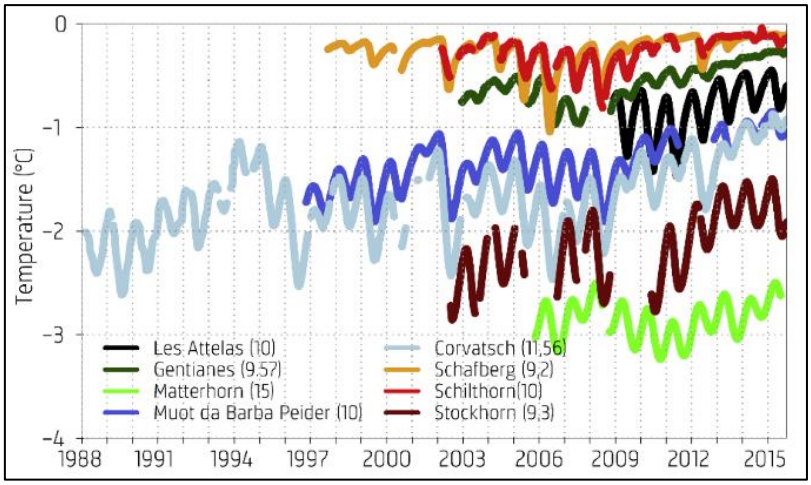

Figure 6-12 Borehole temperature. Synthesis results of more than 20 years of borehole temperature monitoring at the reference sites of the PERMOS network. Here, the temperatures at about 10 meters depth are shown (the exact depth is given in parenthesis). The results are very

heterogeneous, essentially because effects due to latent heat or surface cover (snow, coarse blocks) strongly influence the penetration of changes in climate conditions into the ground (from Swiss Permafrost Monitoring Network PERMOS).

6.2.5 Natural hazards

6.2.5.1 Floods

Floods in Switzerland and Liechtenstein *are dominantly caused by extreme precipitation, sometimes in connection with snowmelt and/or high lake water levels. During the last 500 years, periods with many and few floods alternated in Switzerland. Since the 1970s, Switzerland is in a period of high flood frequency. However, no direct relationship was found between flood frequency and mean air temperature (Schmocker-Fackel and Naef, 2010). From the projected temperature increase it can be deduced that the flood seasonality will be extended and flood volume will increase in the Alpine area (Köplin et al., 2013). The comparison of flooding patterns in different European countries suggests though that changes in large scale atmospheric circulation are responsible for the flood frequency fluctuations. Unfortunately, it is not yet possible to make any clear statements about future changes in atmospheric circulation and therefore of changes in extreme and very rare precipitation events in the Alpine area (CH2011, 2011) (adapted from FOEN 2018).*

In Switzerland, flooding was the most frequent type of extreme event occurring since 1972 (60 to 95 % of all loss events) with the highest estimated damage costs. Individual extreme events led to high damage in the past, but a trend in damages over time is not detectable from the data. More recent and future extreme events are expected to have a greater damage potential than earlier events due to the overall increase in values and assets located in hazard-prone zones over time (from FOEN 2018).

6.2.5.2 Rockfalls slope, debris flow and landslides

Changes in temperature and precipitation are likely to have a range of secondary effects on the occurrence of natural hazards, in particular in mountain environments. However, while theoretical understanding exists for increased mass-movement activity as a consequence of projected climate change, impacts can only hardly be detected in observational records for the time being (Stoffel and Huggel, 2012).

Important effects of climate change on slope stability are also related to the warming and thawing of permafrost (section 6.2.4). *Slopes currently underlain by degrading permafrost will probably become less stable at progressively higher altitudes with ongoing climate change. The probability of rock instability and the incidence of large (more than 1 million cubic meters) rock falls will likely increase in a warming climate (Huggel, 2009). Quite a large number of recent slope failures have been documented in permafrost areas and have been related to increasing temperatures.*

Changes in sediment supply and land-use are further key determinants for mass-movement frequency and magnitude. Recent observations in the Swiss Alps indicate that sediment supply can in fact change significantly as a result of permafrost degradation of rock and scree slopes or mass movements related to other processes (Huggel et al., 2012). As such, warming has been reported to exert indirect control on debris-flow magnitude and frequency through the delivery of larger quantities of sediment into the debris-flow channels under current conditions than in the past (Lugon and Stoffel, 2010). The volume of debris flows in many parts of the Swiss Alps has risen by one order of magnitude since the early 20th century (Stoffel, 2010) and is likely to further increase with ongoing permafrost degradation. The actual triggering conditions of debris flows have been shown to occur less frequently today as compared to the most of the 20th century (Schneuwly-

Bollschweiler and Stoffel, 2012), and are not expected to increase in the future (Stoffel et al., 2014). Despite uncertainties, recent developments at high-elevation sites have shown clearly that the sensitivity of mountain and hillslope systems to climate change is likely to be acute, and that events beyond historical experience will continue to occur as climate change continues.

At lower elevations, the temporal frequency of landslides might be affected by climate change, and the events could occur more frequently in winter and spring as a result of warmer temperatures and larger precipitation sums (Lopez Saez et al., 2013). The occurrence of debris flows and shallow landslides at lower elevations (Prealps, Plateau, and Jura) depends on the incidence of intense thunder-storms or long-lasting, persistent rainfalls. Such conditions are likely to become scarcer in future summers and more frequent in winters and springs. As a consequence, a shift might be expected in the seasonality of debris flows and shallow slides, and the occurrence of such events might increase in the decades to come (from FOEN 2018).

6.2.6 Biodiversity

Biodiversity is mostly similar to the biodiversity of adjacent regions in Switzerland. Therefore, the respective paragraphs are adopted from Switzerland's 7th National Communication (FOEN 2018). In Switzerland, t*he observed impacts of climate change on biodiversity and some perspectives for the future at the national level were reviewed in 2013 (Vittoz et al., 2013). For all taxonomic groups considered, the following impacts are already evident: elevation shifts of distribution towards mountain summits, spread of thermophile species, colonization by new species from warmer areas and phenological shifts. Additionally, in the driest areas, increasing droughts are affecting tree survival and fish species are suffering from warm temperatures in lowland regions (from FOEN 2018).*

6.2.6.1 Plants

Climate warming is already affecting the phenology of plants. In the region of Basel, the wild cherry (Prunus avium L.) now blooms, on average, 16 days earlier than in 1950 (North et al., 2007), and the growing season has lengthened an average of 2.7 days every decade since 1951 (Defila and Clot, 2005; OcCC, 2008). Longer growing seasons enable plants to grow at higher elevations. Many botanists have been resurveying plant species on mountain summits above 2'800 meters (e.g. Frei et al., 2010; Stöckli et al., 2011; Vittoz et al., 2009) and observed increases in plant species richness on most of the summits, with only a few summits showing a stable or decreasing species richness. As the direct anthropogenic influence on ecosystems increases towards lower elevations, it is increasingly difficult to disentangle the impacts due to direct human activities from those induced by climate change. However, Moradi et al. (2012) observed an increase of thermophile, rich-soil-indicator and shade-indicator species in Swiss montane fens. These changes were interpreted as a higher productivity in warmer conditions, on drier soils and/or under airborne nitrogen deposition. Similarly, the 12 % increase of xerophile species in the last 10 years observed by a national monitoring program in lowlands is possibly the consequence of drier conditions because of the warmer temperatures (Bühler, 2012) (from FOEN 2018).

6.2.6.2 Birds

The Swiss Bird Index SBI® Climate Change is an indicator developed by the Swiss Ornithological Institute to document the population trends since 1990 of 20 breeding birds for which an extension of range is expected by the end of the 21st century (e.g. thermophile species) and of 20 species for which a shrinking distribution range is expected (e.g. alpine species). The combined index for species with an expected range extension showed a strong increase (Zbinden et al., 2012). For example, the European bee-eater (Merops apiaster) has become a regular breeder in Switzerland and its population is increasing. A recent study identified a significant upward shift between 1999–

2002 and 2004–2007 in the distribution for 33 out of 95 species, with an average shift of 94 meters for the leading edge (Maggini et al., 2011). Conversely, the species for which a decrease of the range is expected under future climatic conditions did so far not show a declining trend on average (Zbinden et al., 2012). For some species of this group, however, significant population trends since 1990 have already become apparent (Revermann et al., 2012) (from FOEN 2018).

6.2.6.3 Insects

As poikilothermic[10] animals, insects depend strongly on warmth for their development and reproduction. Hence, warmer temperatures accelerate their growth. In the Swiss lowlands, Altermatt (2012) observed that 24 out of 28 butterfly species advanced their seasonal appearance over a 13-years monitoring period. This earlier onset allowed a longer reproduction period and 72 % of the multivoltine[11] butterfly species increased the frequency of supplementary generations (Altermatt, 2010). Changes in the elevational distribution were also observed in the comparison of old (1920–1941) and recent inventories in the Swiss National Park (Pasche et al., 2007). These distribution shifts are in agreement with projections of species distribution models. In Switzerland, an increase in mean temperature of 2°C by 2050 might lead, e.g., to a decrease of 3–15 butterfly species per square kilometer in lowlands because of the upward shift and to a slight increase above 1200 meters above sea level (BDM, 2009). But, on subalpine/alpine ridges, this increase will correspond to an almost complete species turnover (Pearman et al., 2011). Many thermophile aquatic species took advantage of the warmer temperatures to expand their distribution. Some species that were only sporadically observed at the beginning of the 20th century are now colonizing Switzerland (e.g. the dragonflies Aeshna affinis and Sympetrum meridionale). According to models, this could lead to increased species richness in ponds but also to the rarefaction or even extinction of species limited to cold, alpine lakes (Rosset and Oertli, 2011) (from FOEN 2018).

6.2.6.4 Projections for biodiversity

On the basis of existing observations and model results, it is possible to make some projections concerning the future climate change impacts on biodiversity in Switzerland and Liechtenstein. *Species will certainly move towards higher elevations, and new species will colonize Switzerland. Some species will probably disappear at the regional scale, partly in high mountains because of the decreasing area of the alpine and nival belts, partly in the lowlands because of the increasing summer droughts and existing obstacles to dispersal (landscape fragmentation). Moreover, disruptions in species interactions caused by individual migration rates or phenological shifts are likely to have consequences for biodiversity (Walther, 2010). Conversely, the inertia of the ecosystems (species longevity, restricted dispersal) and the local persistence of populations will probably result in lower extinction rates than expected with some models. The adaptation capacity of many species with respect to climate change will depend on their ability to colonize new favorable sites. However, dispersal will be limited by the strong fragmentation of the Swiss landscape (Meier et al., 2012) and this fragmentation forces many species to persist only in small, isolated populations, with low genetic diversity, which will limit their ability to adapt to new climatic conditions (Lavergne et al., 2010). It is thus important to reconnect populations by developing networks of suitable ecosystems with supplementary protected areas scattered across the whole country, along topographic gradients and connected to the larger European networks (Hannah, 2008) (from FOEN 2018).*

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10 Organism having a body temperature that varies with the temperature of its surroundings.

11 A species that has two or more broods of offspring per year

6.2.7 Forest and forestry

Liechtenstein's forests are mostly similar to the forests of adjacent regions in Switzerland. Therefore, the respective paragraphs are adopted from Switzerland's 7th National Communication (FOEN 2018). *Swiss and other international activities in forest research have considerably advanced the state-of-the-art and robustness of the tools that are available to assess climate change impacts on Swiss forests, the knowledge about these impacts, and the toolkit to develop appropriate response options. In addition, through these networks Swiss researchers have strengthened their international research network, such that Swiss forest research can benefit from, as well as contribute to, the international research efforts.*

The new platform SwissForestLab (http://www.envidat.ch/group/about/swissforestlab) unites all forest researchers nationally, aiming to provide a unique research platform and infrastructural network to assess the effects of a dynamically changing environment on forests and trees in Switzerland as well as worldwide. Initial research projects will be implemented in the course of the year 2017.

In forest ecosystems, different natural and anthropogenic environmental factors influence each other (in a mutually reinforcing or moderating way), and are modified themselves by natural site factors. The identification of one individual factor for an observed effect or its quantification is often impossible. However, due to increased research efforts the contribution of climate change on the forest dynamic becomes clearer (from FOEN 2018).

Climate change acts in different ways on the tree species and the composition of forests. It weakens the vigor of drought sensitive tree species and favors the competitiveness of more drought resistant species. Because the tree line is mainly determined by summer temperatures (Körner and Paulsen, 2004), warmer conditions induce an upward shift of its limit. As tree line in the Alps is lowered by cattle grazing, the upward shift that is observable since 1900 is simultaneously driven by climate changes and pasture abandonment (Gehrig-Fasel et al., 2007; Vittoz et al., 2008). Due to changes in minimum air temperature in spring (less extreme cold events), European ash (Fraxinus excelsior), silver fir (Abies alba Mill.), wild cherry (Prunus avium L.), sycamore (Acer pseudoplat-anus L.), sessile oak (Quercus petraea), and European beech (Fagus sylvatica L.) are successfully regenerating at and beyond the upper elevational limits of adult individuals (Vitasse et al., 2012).

One important factor enhancing the severity of drought periods is the eutrophication by the nitrogen deposition. In a long-term field experiment, the water use efficiency, i.e. the relation of assimilated carbon to water, was reduced with increasing nitrogen doses, leading to drought symptoms (Braun et al., 2012).

The reported findings are consistent with current knowledge on the ecophysiology of trees and, as far as presently known, with the reactions of forest stands under warmer conditions. However, the future forest composition is difficult to predict, since the influence of climate change on the forests is modified by a lot of other factors, like the site conditions, the regional peculiarities of the development, the influence of pests, diseases, insects, and especially at higher elevations, changes in agricultural practices (Bugmann et al., 2014). All these factors are affected by climate change, but the influences of each of them and their interactions at a given site is not easy to predict. If the development proceeds as predicted by climate models in many regions, a substantial shift in the tree species composition will occur, favoring more drought tolerant trees like oak species, whereas trees adapted to colder and wetter climate like the Norway spruces will be restricted to more feasible sites at higher elevations (from FOEN 2018).

6.2.8 Agriculture

In general, climate change in Switzerland and Liechtenstein *is expected to entail a shift of suitable areas for agricultural production, and to involve both positive (e.g. a longer vegetation period) and negative (e.g. increasing incidence of pest infestations owing to milder winters) aspects. Changes in the nature of extreme weather events, in particular more frequent, intense and longer-lasting summer heat waves, could also challenge agriculture, e.g. by reducing the reliability of harvests. The extent to which climate change will affect agriculture will depend, however, on the regional settings, the overall political framework and the specific economic situation of the farms. Economic considerations are expected to play a crucial role for the adoption of adaptation measures (from FOEN 2018).*

6.2.8.1 Water demand and supply for agriculture in a changing climate

Drought is a major threat to agricultural production. Even in Switzerland and Liechtenstein*, where drought is not a recurrent phenomenon under current climatic conditions, water scarcity can induce considerable damages. This was the case in 2003, when the unprecedented heat wave led to losses of about 500 million Swiss francs in the agriculture sector (from FOEN 2018).*

Climate scenarios for Switzerland propose decreasing precipitation amounts during the summer season (CH2011, 2011). Accordingly, results of hydrological simulations carried out for selected river catchments (Fig. 80) using two climate change scenarios representing the range of projections given in CH2011 (2011) indicate that already by 2060 average water requirement in parts of Switzerland could represent as much as 50 % of the river water supply (Fuhrer, 2012). In extreme years water demand could even easily exceed the supply, suggesting that conflicts concerning the utilization of water resources are likely to arise more frequently in the future if preventive measures are not taken (from FOEN 2018).

6.2.8.2 Implications of increasing summer temperatures for animal performance

Heat stress caused by elevated daytime temperatures and high humidity levels has the potential to considerably affect animal performance and health (Johnson, 1994). For Swiss agriculture, the risk of reduced animal performance is of concern especially in relation to milk production. A retrospective analysis of the so-called temperature-humidity index (THI, Thom 1958) has revealed that under current climatic conditions an important risk of heat stress for dairy cows (THI > 72) exists in the long-term only for Southern Switzerland (Fuhrer and Calanca, 2012). Therefore, currently no risk is expected for Liechtenstein.

This situation could change in the future, though, because according to the newest climate change scenarios for Switzerland (CH2011, 2011) summer temperatures could increase in average by up to 4°C until 2060 and up to 6°C until 2085, depending on the emission scenario used. The consequences are a marked increase in the average number of days with THI > 72. The increase is more distinct for the second half of the century under the A1B and A2 emission scenarios. As a result, critical conditions under the A1B and A2 emission scenarios are expected to persist on average for two (Northern Switzerland: Changins, Wädenswil) to three months (Southern Switzerland: Magadino) by the end of the century. This calls for the adoption of protective measures, both in relation to indoor and outdoor environments (from FOEN 2018). For Liechtenstein, the climate scenarios indicate an increase in seasonal mean temperature between 2.4 to 4.8 °C (section 6.1.1*).* Therefore, a similar risk as in the northern area of Switzerland are to be expected.

6.2.9 Energy

6.2.9.1 Impacts on heating degree day and cooling degree day

Heating degree days (HDDs) provide a measure that reflects the energy need for heating buildings. They are based on a reference temperature below which a building requires heating. For days where the average outside temperature is below this reference temperature, the HDD value equals the difference between the reference temperature and the daily average outside temperature, otherwise the HDD value is equal to zero. The sum of daily HDDs over a year provides an indication of the total heating requirement for that year. Cooling degree days (CDDs) are calculated analogously to HDDs and estimate the energy demand for air conditioning. Climate change is likely to modify these two measures (from FOEN 2018). Figure 6-8 shows the expected evolution of HDDs and CDDs computed from the Swiss climate change scenarios CH2011 (CH2011, 2011) for the years 2035, 2060 and 2085 using three emissions scenarios (RCP3PD, A1B and A2). In Liechtenstein, a similar evolution is expected.

In 2085, the energy demand for heating is expected to decrease between 8.2 and 20.6 % depending on the global emissions scenario. The impact on CDDs is much more important than the impact on HDDs, given the fact that the use of air conditioning in buildings currently is very limited in Liechtenstein *compared to warmer regions. Thus, the final impact on electricity consumption is highly dependent on the propagation of air conditioning* in Liechtenstein *in future decades.*

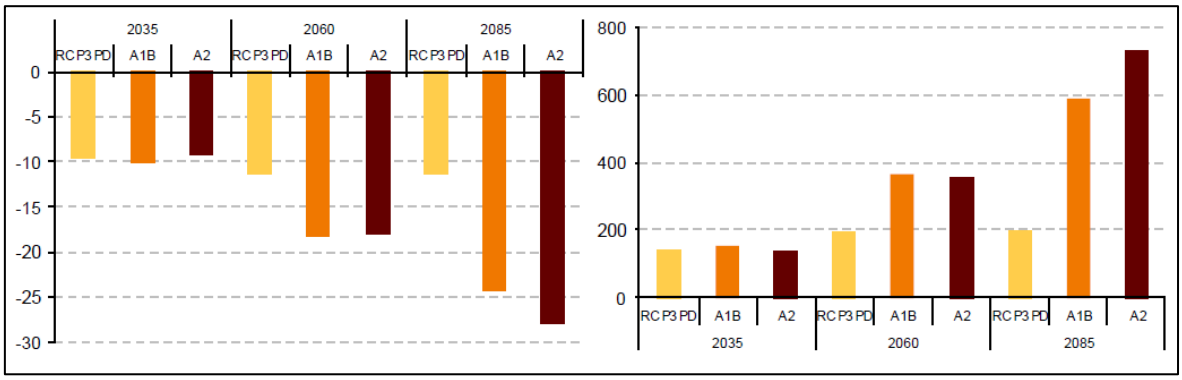

Figure 6-13 Changes in % of HDDs (left) and CDDs (right) in respect to the reference period 1980–2009 (from FOEN 2018 according to Faust et al. (2012).

6.2.9.2 Impacts on energy consumption

A recent study (Faust et al. 2012) simulated with an economic model the impacts of the future changes of HDDs and CDDs for the year 2050 in Switzerland. The findings are relevant for Liechtenstein as well. *Decrease in heating demand will lower the energy consumption of oil and natural gas that are mostly used in Switzerland for heating. On the contrary, the increase of space cooling demand will boost electricity consumption. The aggregated impacts are a decrease of oil, and an increase of electricity and natural gas, as natural gas will be used to generate the additional electricity. From an economic point of view, the effect of decreasing heating energy consumption strongly outweighs the effect of increasing cooling energy demand. These results are in line with the findings of other studies that states climate change leads to decreasing energy demand in the colder regions and increasing energy demand in the warmer parts of the world (Isaac and van Vuuren, 2009) (from FOEN 2018).*

6.2.9.3 Influence of climate change on hydroelectric power production

The implications of changes in runoff and runoff regime on hydraulic power production due to climate change were investigated in a comprehensive study by different Swiss research institutions (SGHL and CHy, 2011; Hänggi et al., 2011). The findings are relevant for Liechtenstein as well. *Results from the CH2011 emissions scenario A1B have been used for modelling of runoff changes in small and mesoscale catchments in different climatic regions of Switzerland. These results were combined with management models for different types of hydroelectric power plants in order to estimate changes of the production of electricity and of the turnover of the selected typical plants. Due to the fact that annual runoff regimes will be more balanced in the future, in many power plants – namely in run-of-river power plants – winter runoff and hence electricity production will increase. In summer, even with slightly lower runoff, production will not or only slowly decrease since water flow will exceed turbine capacity in most cases.*

Based on future production schemes and electricity markets as assumed at the time of the analysis, hydropower production in Switzerland during winter would increase by 10 % in 2021–2050 compared to the control period 1980–2009. For summer, a slight decrease was calculated. The annual production would slightly increase by 0.9 to 1.9 %. For individual hydropower sites changes may differ significantly.

6.2.10 Health

The projected increase in the frequency and intensity of heat waves (section 6.1.1) *in combination with high tropospheric ozone concentrations represents the greatest direct risk of climate change for people's health in Switzerland* and Liechtenstein*. The potential impact became manifest for the first time during the heat wave of 2003 when almost 1'000 cases of death were attributed to the extraordinary heat in Switzerland (Grize et al., 2005). The 2003 heat wave mostly hit the elderly and the very young and was more pronounced in cities where it was exacerbated by the urban heat island effect. Similar effects were registered during the 2015 heat wave (FOEN, 2016a).*

In Switzerland, the summer of 2015 was the second warmest summer (after 2003) since the beginning of measurements 150 years ago (MeteoSwiss, 2016). A study compared observed mortality from June to August 2015 with expected mortality in previous summers and estimated 804 excess deaths (5.4 %; 95 % confidence interval 3.0 to 7.9 %). Since 2003, the federal and cantonal authorities have developed measures to inform the population about expected heat waves and about protective measures. Evaluations indicate that the effect of a heat wave on mortality can be significantly reduced when heat action plans are put in place and people are taking the necessary precautions (Ragettli et al., 2017; Vicedo-Cabrera et al., 2016).

Additional direct effects of climate change on health are expected from the increase of other extreme events such as floods, mudslides and, possibly, storms. Given the well-developed immediate disaster control measures in Switzerland, health effects are likely to be manageable. However, extreme events may entail severe psychological consequences for the directly affected population which may last longer and are often underestimated (Akademien der Wissenschaften Schweiz, 2016).

The increase in temperature and in CO_2 concentration has been paralleled by an increase in total measured pollen in Switzerland, Liechtenstein and in Europe as a whole, especially of tree pollen (hazel, alder, birch, ash). The starting dates of the pollen season of several allergenic pollen types have shifted to earlier periods of the year. People sensitized to a variety of different pollen may start suffering earlier from hay fever or asthma symptoms and for a prolonged period of the year if pollen production starts earlier in the year and the amount of pollen increases. However, there is no clear evidence that the increase in the occurrence of allergic diseases, which was observed in many westernized countries including Switzerland since the 1960s, is causally linked to pollen

concentrations in the air. Research shows that environmental factors such as pollen which trigger symptoms in already diseased people are not necessarily the same as those causing the development of the disease (Ziello et al., 2012; Clot et. al., 2012; Frei and Gassner, 2008).

Another important potential health risk of climate change is the occurrence of vector-borne diseases. The diseases result from a transmission of an infectious agent through an animal vector (mosquito, ticks) usually through biting or touching. Increasing temperatures favor growth of vectors and replication rates of infectious agents, e.g. viruses. In Switzerland, the most common vector-borne diseases are tick-borne encephalitis (FSME) and Lyme disease. In recent years, outbreaks of some vector-borne diseases, such as Dengue and Chikungunya fever have been observed in neighbouring countries such as Italy and France, and the respective vector (the mosquito Aedes aegypti) is present in Switzerland, too. Yet, it is still highly uncertain what future developments are to be expected as many other factors such as human behavior, population density, international trade and global tourism affect disease transmission. Surveillance of disease outbreaks and vector spread are the first steps to develop adapted plans for intervention and prevention (from FOEN 2018).

6.2.11 Tourism

Liechtenstein's tourism focuses on alpine tourism. Therefore, the reflections and data on Switzerland's alpine tourism also provide relevant information for Liechtenstein. *In Switzerland, ski resorts in the foothills of the Prealps may not operate profitably in the future (Lehmann Friedli, 2011; Serquet et al., 2013; Klein et al., 2016). Due to a lack of wintery atmosphere in the absence of snow, winter sports will lose their appeal to tourists. With climate change progressing, the altitudinal threshold for snow-reliability will continue to rise.*

The Swiss ski resorts currently considered snow-reliable have been assessed for an increase of 1°C, 2°C and 4°C based on the altitude of the station. It appears that the number of ski resorts with economically sufficient snow conditions may drop by at least a fifth for a temperature rise of 2°C. However, from a national tourism perspective the affected resorts are not so significant. In case of a 4°C rise in temperature, low elevation ski resorts will be extremely affected while many high-altitude ski resorts remain snow-reliable.

New opportunities for the tourism sector may arise by changing conditions in summer. Pleasant temperatures at higher altitudes and a tendency towards less rainfall may contribute to reposition the alpine region as a summer holiday destination. At the same time, numerous places at lakes and rivers might become an alternative to seaside holiday resorts at the Mediterranean Sea, which tend to lose attractiveness as excessive heat and drought conditions become more frequent. However, more tourists in summer will not compensate for the loss of income of mountain resorts in winter. At present, these resorts heavily depend on winter tourism to maintain profitability (Lehmann, 2013).

Changes in natural hazards are another element relevant to mountain tourist destinations. Melting permafrost destabilizes ground conditions. This may affect infrastructures which are placed at high altitude. Hotel and restaurant buildings, masts of cable cars, avalanche barriers, etc. are vulnerable when anchored in permafrost ground (Müller, 2003). These phenomena are known in Switzerland, but the surveys start to deliver preliminary figures. A current adaptation measure is to use floating foundations for high-altitude infrastructure like cable car stations and masts or avalanche barriers (Akademien der Wissenschaften Schweiz, 2016). A related problem is the frequency of rock fall and debris flows which will increase due to the combination of melting glaciers, melting permafrost, rising snow line and more intense precipitation (see sections 6.2.2 and 6.2.3). This may present an additional risk to climbers and hikers at high altitudes. Furthermore, the threat to alpine routes from rock fall und rockslides will increase. As potential

loss expenses can be much higher than expenses for adaptation measures (e.g. due to glacial lake outburst floods), it is important to invest in strategies to minimize the risk. In addition, possible failures and a negative image due to safety issues can cause additional economic damage (Lehmann, 2013) (from FOEN 2018).

6.3 Assessment of risks and vulnerability to climate change

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

The Swiss adaptation strategy consist of two reports. *In 2012, the Swiss Federal Council adopted the first part of the Swiss adaptation strategy, determining the goals, challenges and fields of action (Swiss Confederation, 2012a), followed in 2014 by the second part of the strategy, an action plan (Swiss Confederation, 2014) to implement the goals of the first part (see section 6.4 in FOEN 2018). With targeted measures, Switzerland shall minimize the risks of climate change and take advantage of opportunities arising as a result of climate change (from FOEN 2018).*

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

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

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

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

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

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

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

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

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

6.4 Domestic adaptation policies and strategies

To mitigate expected negative impacts of climate change, adaptation measures are required in different areas and sectors. Adaptation is therefore an essential element of Liechtenstein's climate strategy (OE 2015). The national climate change adaptation strategy of Liechtenstein (OE 2018) identifies the relevant impacts related to climate change and defines measures to limit or avoid negative impacts. Liechtenstein also actively participates in international adaptation projects of the Alpine Convention[12] and the alpine space programme[13] (Climate Change Adaptation by Spatial Planning in the Alpine Space, Clisp). Liechtenstein was an official partner of the European project "C3-Alps"[14] on "Capitalising Climate Change Knowledge for Adaptation in the Alpine Space". The outcomes of this project form the foundation of the national climate change adaptation strategy (OE 2018). In the following, first, the C3-Alps project "Capitalising Climate Change Knowledge for Adaptation in the Alpine Space" is presented. Then, the measures of the adaptation strategy are outlined.

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

6.4.1.1 Project Framework

C3-Alps is a European project funded by the Alpine Space Programme under the European Territorial Cooperation 2007-2013. C3-Alps started in January 2012 and ran until December 2014.

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12 http://www.alpconv.org/pages/default.aspx [13.10.2017]

13 http://www.alpine-space.org/2007-2013/projects/projects/detail/CLISP/show/index.html [13.10.2017]

14 http://www.alpine-space.org/2007-2013/projects/projects/detail/C3-Alps/show/index.html [13.10.2017]

The lead partners were the Umweltbundesamt and the Federal Environment Agency Austria. The partnership was composed of 17 Project Partners from Austria (4), Italy (4), Germany (3), Switzerland (2), France (1), Slovenia (1), the Principality of Liechtenstein (1) plus UNEP's regional office for Europe, and included international organisations, national and regional government authorities, national agencies, provinces/regions, research institutions and institutes of applied sciences.

6.4.1.2 Project Description

C3-Alps synthesized, transferred and implemented in policy and practice results of previous Alpine Space projects on climate change adaptation. The capitalization approach aimed at

- generating new and directly usable forms of state-of-the-art synthesis adaptation knowledge in the Alps, harmonized across sectors and useful to adaptation decision-makers,
- providing effective and tailor-made communication and transfer to target groups,
- enhancing effectiveness of adaptation policy and governance frameworks, and
- initiating, supporting and pioneering tailored and cross-cutting adaptation processes, strategies, action plans and decision support in pilot regions and municipalities.

From a national perspective, the project's further aim was to strengthen climate change adaptation in Liechtenstein. In close co-operation between the Office of Environment, sub-contractor CIPRA International and the relevant departments of the national administration, the abovementioned national climate change adaptation strategy has been developed and finalized in 2017 (OE, 2017).

6.4.2 Liechtenstein's climate change adaptation strategy

The national climate change adaptation strategy covers the sectors of water resources management, natural hazards, agriculture, forestry, energy, tourism, biodiversity, health and land use planning (OE 2018). Emphasis lies on impacts of increasing risks of drought periods, heat waves, flood events and spreading of new vector borne diseases and alien invasive species. The strategy also addresses consequences of a reduced snow cover on winter tourism and the runoff regime. The following sections summarize ongoing and planned activities related to climate change adaptation.

6.5 Monitoring and evaluation framework

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

The implementation of measures is coordinated and monitored by Liechtenstein's working group for climate change adaptation, which consists of members of the office of construction and infrastructure, the office of civil protection, office of public health, the office of food safety and veterinary, the office of environment and the office for economic affairs. The working group is coordinated by the office of environment. In annual meetings, this working group exchanges information on the state of implementation and coordinates planned and ongoing activities related to climate change adaptation. After five years, the working group will evaluate the progress and outcomes of adaptive measures and revise the adaptation strategy accordingly.

6.6 Progress and outcomes of adaptation action

The national climate change adaptation strategy covers the sectors of water resources management, natural hazards, agriculture, forestry, energy, tourism, biodiversity, health and land use planning (OE 2018). Emphasis lies on impacts of increasing risks of drought periods, heat waves, flood events and spreading of new vector borne diseases and alien invasive species. The strategy also addresses consequences of a reduced snow cover on winter tourism and the runoff regime. The following sections summarize planned and ongoing activities related to climate change adaptation.

6.6.1 Water resources management

Urban drainage and water supply planning are important instruments in the management of water resources in Liechtenstein. These plans are updated regularly, taking into account changes in climatic conditions that may affect supply of drinking water and urban drainage systems.

Rising demand for irrigation of agricultural crops may requires changes in current regulations. Liechtenstein plans to examine the need for adaptation of the existing regulatory framework on the use of ground and surface water for irrigation purposes.

In Liechtenstein, a continuous monitoring network for water temperatures is in place and impacts on aquatic biodiversity are regularly monitored. Impacts of increased use of water for cooling and heating purposes and related impacts on groundwater temperatures are currently under assessment.

Currently, an integrated water utilization plan is implemented in certain regions of Liechtenstein. These plans coordinate competing demands for water in situations of limited water supply. If in future an increase in drought periods is observed, it is planned to implement similar plans in other regions that are affected by water shortage.

6.6.2 Natural hazard management

The office for civil protection of Liechtenstein conducted a general risk assessment, which covers also risks related to natural causes (EBP, 2012). In addition, Liechtenstein has established natural hazard maps (OCP, 2017). These maps provide regionalized information on the specific local risks of avalanches, rock fall, landslides and flooding. To address the expected increase in frequency and intensity of natural disasters, the Division of Forests and Landscape of Liechtenstein will regularly update these natural hazard maps, taking into account potential changes in frequency and magnitude of extreme events.

Furthermore, a statistical evaluation of extreme precipitation events was performed. The results show that currently there is no need to adjust dimensioning requirements of urban drainage systems in Liechtenstein.

The Federal Office for the Environment Switzerland (FOEN) operates a model for prediction of discharge and water levels for the river Rhine. This model is continuously improved, thereby improving early warning systems for flood events also in Liechtenstein.

In future, a regular examination of protective structures against flooding, rock fall and avalanches is planned and enforcement of emergency planning in case of flooding and forest fires is envisaged (OE 2018).

6.6.3 Agriculture

The agricultural sector benefits from a prolonged growing season. However, the expected increase in drought periods, extreme rainfall events and a more rapid spreading of invasive

species, pathogens and parasites under a warming climate are expected to reduce crop yields. Besides crop production, also animal husbandry might be affected by existing and new pathogens.

The Swiss Federal Food Safety and Veterinary Office (FSVO) provides biweekly information on the spreading of most important animal diseases. This system helps to reduce the risk of further spreading, since it allows to take preventive action. In analogy to the early warning system for animal diseases, the development of a similar system for plant diseases is intended. Liechtenstein is closely collaborating with the Swiss authorities.

In future, agricultural fields will require more irrigation. Especially during longer drought periods, the use of water for irrigation purposes conflicts with other water demands. Coordination of different interests by means of integrated water utilization plans will therefore become more important (see also section 6.6.1).

Switzerland is developing recommendations for dealing with increasing heat stress in animal husbandry. As soon as these are published, Liechtenstein will adopt these recommendations. If necessary, adaptation to the specific local circumstances is considered.

Under changing climatic conditions, existing recommendations for crop cultivation might not be suitable anymore. Liechtenstein is planning to examine the need for adapting these recommendations to expected future climatic conditions (OE 2018).

Measures for protection against soil erosion during extreme rainfall events and wind storms are already implemented. By reducing wind speeds, these measures also help to reduce loss of water, thereby reducing the risk of drought conditions.

6.6.4 Forestry

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

Conditions of forests in Liechtenstein are evaluated regularly with respect to the provision of different ecosystem services. Forest service plans define forest management at the local level. These plans are updated every 10 years, taking into account possible needs for adaptation of management practices to changes in climatic conditions. Liechtenstein also developed a national forest development plan (OE, 2001), which addresses future forest management and is also periodically updated.

Especially in areas that are sensitive to changes in climatic conditions and in areas that are important for protection against natural hazards, artificial regeneration of forests is required. In order support adaptation of these forests to more frequent drought conditions and elevated risks of wind storms, tree species need to be selected in accordance with expected future environmental conditions (e.g. conversion of spruce and fir stocks into mixed deciduous and coniferous forests).

To limit further spreading of alien plant species, Liechtenstein developed an action plan. It defines suitable measures to prevent alien species from invasive spreading and control measures for affected areas, such as appropriate disposal procedures (OE 2018).

6.6.5 Energy

The expected rise in temperature and increased risk of heat waves are expected to lead to higher demand for cooling and air conditioning. Adaptive measures in Liechtenstein focus primarily on passive cooling, which comprises for example structural measures in buildings, such as improved isolation and shading, and planning measures. Under current regulations, use of cooling and air conditioning devices is restricted in order to avoid increasing energy consumption and related GHG emissions. Current regulations also allow to prevent a drastic increase in energy demand for cooling purposes under future climatic conditions.

Recently, one of Liechtenstein's hydroelectric power plants (Samina) has been transformed into a pumped-storage plant. This measure increases flexibility in power production and facilitates adaptation to expected changes in the runoff regime due to climate change (OE 2018).

6.6.6 Tourism

Summer tourism of Liechtenstein is expected to benefit from climate change related developments. Tourist destinations at higher elevations, which exhibit generally lower temperatures, might become more popular if heat waves occur more frequently in urban areas. On the other hand, winter tourism is strongly affected due to reduced snow cover, especially in skiing resorts at low to medium altitudes.

To some extent the production of artificial snow allows to compensate for a reduced snow cover, but only up to a certain temperature threshold. At higher temperatures production of artificial snow is currently not feasible. In addition, the energy consumption is high and therefore a substantial increase in artificial snow production would not be in line with Liechtenstein's energy strategy (see section 4.2.4). Therefore, adaptation measures focus primarily on diversification of touristic attractions in order to compensate for a shorter skiing season. Promotion of new touristic activities and related marketing strategies aim at generating additional revenue that compensates for potential losses due to a shortening of the skiing season. Emphasis lies on strategies that promote different forms of sustainable tourism (e.g. health tourism).

Transfer of knowledge among affected areas on possible adaptation measures for the tourism sector is another crucial element. Experience from existing pilot projects on climate adaptation in Swiss tourist destinations will be considered in the future development of tourist services and touristic attractions (OE 2018).

6.6.7 Biodiversity management

Liechtenstein developed a management plan for the control of invasive alien plant species (OE, 2015a). It provides a list of species that need to be controlled or watched. It also defines suitable measures to prevent alien species from invasive spreading and control measures for affected areas, such as appropriate disposal procedures.

Many natural habitats that are highly susceptible to changes in climatic conditions, such as alpine and aquatic habitats and wetland areas are already under protection in Liechtenstein. These regulations form the necessary framework for the development and implementation of measures for the preservation of these ecosystems. The national report on the implementation of the

Convention on Biodiversity (OE, 2014) documents the state of Liechtenstein's ecosystems and the progress towards the achievement of "Aichi Biodiversity Targets".

According to the Water Framework Directive[15] of the EU, the ecologic state of all large water courses needs to be assessed regularly. Recent assessments in Liechtenstein based on indicator species show that deficits still exist for a number of rivers and streams. In particular, there is a lack of structural diversity (OE 2015b). Liechtenstein is planning to implement targeted revitalization measures in order to improve conditions in aquatic habitats (OE 2018).

6.6.8 Health

Health impacts due to the expected increase in duration and frequency of heat waves can be mitigated by structural measures on buildings (e.g. isolation, shades, dimensioning of windows in new buildings) and planning measures (e.g. green areas, shading, orientation of new buildings). Liechtenstein plans to promote implementation of such measures by providing financial incentives (e.g. for energy-efficient refurbishment of existing buildings) and regulations and standards for new buildings. These measures help to reduce the need for active cooling, which would an increase in energy demand and should therefore be minimized. Negative impacts of prolonged heat waves can also be reduced by changes in behavior, such as avoiding strenuous activities during daytime. Switzerland provides a list of recommendations[16] and informs about potential risks. Liechtenstein adopts these recommendations.

The expected increase in water temperatures might lead to an increase in microbial pollution in drinking water resources. The continuous monitoring system for the quality of drinking water that is currently implemented in Liechtenstein allows to detect potential microbial pollution and take necessary corrective measures in case of elevated pollution levels. The existing system will allow to identify potential future changes in pollution levels thereby providing a basis for further adaptation measures.

Ozone levels might rise under future climatic condition, which would entail a higher risk of respiratory diseases. Ozone concentrations are measured continuously and in collaboration with Switzerland, model simulations are performed, which provide information on the spatial distribution. In case of elevated concentrations over longer time periods, the population is informed about the risks and recommended protective measures.

Increasing temperatures might lead to a spreading of vector borne diseases that currently do not exist in Liechtenstein. The Swiss Federal Office of Public Health provides a list of infectious diseases requiring notification[17]. This list already includes certain diseases that might spread under warming climatic conditions (e.g. dengue fever, chikungunya fever). The Swiss regulation and recommendations are also adopted in Liechtenstein, thereby allowing for an early detection of a potential spreading of new diseases. The need for further measures is assessed in collaboration with Switzerland. If Switzerland adopts concrete measures for surveillance and control of specific vector organisms, Liechtenstein will examine, whether similar measures are also necessary in Liechtenstein. Currently, focus lies on providing regular information on potential

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[15] http://www.llv.li/#/117899/wasserrahmenrichtlinie [13.10.2017]

[16] https://www.bag.admin.ch/bag/de/home/themen/mensch-gesundheit/klimawandel-gesundheit/hitzewelle.html [13.10.2017]

[17] https://www.bag.admin.ch/bag/de/home/themen/mensch-gesundheit/uebertragbare-krankheiten/meldesysteme-infektionskrankheiten/meldepflichtige-ik.html [13.10.2017]

new risks to medical professionals and on drafting recommendations on how to address these risks (OE 2018).

6.6.9 Land use planning

Existing land use planning instruments implemented in Liechtenstein allow to coordinate different land uses. Land use planning is closely linked to other sectors and requires close collaboration with all involved stakeholders. Therefore, existing land use planning instruments also play a key role in the adaptation to climate change. For example, green areas in urban environments exhibit a cooling effect and provide shade thereby reducing potential negative impacts on human health due to prolonged heat waves. Improved circulation of air in urban areas also improves air quality, which lowers the risk of respiratory diseases. Furthermore, planning measures also help to reduce the risks of damages due to natural hazards. For example, designation of flood retention areas and mapping of zones at risk of damage due to natural hazards (e.g. landslides, rock fall, avalanches) help to limit damages on buildings and infrastructure (OE 2018).

6.6.10 Cross sectoral measures

Monitoring: Continuous observation of climatic change and related impacts are an essential prerequisite in the assessment of risks and vulnerabilities. Based on data from existing monitoring networks, both new risks and changes in frequency or intensity of existing risks can be detected, which allows to plan and implement adaptive measures already at an early stage. MeteoSwiss operates a dense monitoring network that provides data on meteorological and climatic conditions in Liechtenstein and neighbouring areas. In addition, monitoring systems for natural hazards, biodiversity and forest development are implemented in Liechtenstein, which allows to assess climate impacts at the sectoral level.

Knowledge-sharing: Exchange of knowledge on climate related risks and sharing of experience in the development and implementation of adaptive measures facilitates adaptation to climate change. Liechtenstein is actively participating in international networks (e.g. Lake Constance Conference[18], International Water Body Protection Commission for Lake Constance[19]) that address impacts of climate change on water resources management (IGKB, 2015).

Scientific research: Consequences of climate change and related impacts at the sectoral level are still subject of ongoing research projects. Therefore, an improved assessment of climate change impacts strongly relies on scientific studies. Liechtenstein will take into account new evidence from scientific research and pilot projects in the future development of adaptation measures. If necessary, active participation in research projects is considered.

Information and awareness rising: Rising of awareness on risks and impacts of climate change are a prerequisite for successful implementation of adaptive measures. Therefore, frequent exchange of information with stakeholders from all sectors will be promoted. To this end, Liechtenstein will provide practical information material that can support decision making processes at the sectoral level (OE 2018).

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[18] http://www.bodenseekonferenz.org/23031/Home/index_v2.aspx [13.10.2017]

[19] http://www.igkb.org/aktuelles/klimbo-klimawandel-am-bodensee/ [13.10.2017]

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7. Financial, technological and capacity-building support

Liechtenstein is not a Party included in Annex II to the Convention and is therefore not obliged to adopt measures and fulfil obligations as defined in Article 4, paragraphs 3, 4 and 5, of the Convention. However, Liechtenstein would like to provide the following information on provision of support required under the Convention. In addition, the following chapter also serves to provide information as required by Art. 10 and 11 of the Kyoto Protocol.

7.1 Finance

7.1.1 Introduction

International solidarity is one of the priorities of Liechtenstein's foreign policy. In particular, international humanitarian assistance and development cooperation with developing countries and with countries affected by disasters and armed conflicts is a traditional focus of Liechtenstein's foreign policy. The operational tasks of International Humanitarian Cooperation and Development (IHCD) are carried out by the Office for Foreign Affairs, the Immigration and Passport Office and the Liechtenstein Development Service (LED). The overall coordination of the IHCD activities lies with the Office for Foreign Affairs. Under the application of the International Humanitarian Cooperation and Development (IHCD) Law, the Office for Foreign Affairs developed a concrete strategy for supporting projects that contribute to combat climate warming, the pollution of the seas and the loss of biodiversity. In this context, there is a specific focus in the development of mountainous regions. The regional focus of projects has traditionally been in the South Caucasus

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

Liechtenstein works closely together with the affected population and local organizations, with aid and development organisations in Liechtenstein, Switzerland, Austria and Germany as well as with European and international organisations. Liechtenstein, through its IHCD, maintains working relationships with a large number of partners. The bulk of Liechtenstein's support is provided in the form of financial resources. Nevertheless, the LED maintains three coordination offices on the ground, namely in Moldova, Bolivia and Zimbabwe from where it can directly supervise its projects.

Emergency and Reconstruction Assistance offers short-term, urgent assistance in the event of natural disasters, political crises, and armed conflicts. The primary focus is preserving human Life and protecting the affected population. Additionally, the medium-term development of social structures and infrastructure is supported in order to facilitate a quick return to normal life. The

urgency of the situation is the main criterion for Emergency and Reconstruction Assistance. Accordingly, there are no geographic priorities. However, special attention is paid to emergency situations that are largely ignored and underfunded by the international community. Since 2011, Liechtenstein has been a member of the Good Humanitarian Donorship (GHD) group. This international initiative is dedicated to compliance with key principles of humanitarian engagement.

International Refugee and Migration Assistance are based on a sustainable and comprehensive approach to dealing with global refugee and migration issues. Bilateral activities focus on the Balkan countries. People in need of protection, including minorities, receive support for local integration and long-term improvement of their living conditions. As part of a holistic view of migration, possibilities of circular migration, readmission agreements, and visa questions are also discussed. At the multilateral level, compliance with international legal, human rights, and humanitarian standards for refugees, internally displaced persons, returnees, stateless persons, and other persons in need of international protection is promoted. Furthermore, the climate displacement has also been an area of specific activities.

The largest pillar of IHCD is **Bilateral Development Cooperation**, which is the responsibility of the Liechtenstein Development Service (LED). For this purpose, the LED receives about 65 % of the overall resources each year, most of which are used for development projects with local partners (Southern Partners) or partner organisations from Europe (Northern Partners). In Chişinău (Republic of Moldova), La Paz (Bolivia), and Harare (Zimbabwe), the LED maintains its own coordination offices. The LED is currently engaged in ten priority countries. These are Moldova, Bolivia, Peru, Senegal, Mali, Burkina Faso, Niger, Mozambique, Zimbabwe, and Zambia. Thematically, the LED focuses on rural development and education. Human rights, social justice, gender equality, climate, and the protection of the environment and resources are important crosscutting themes. Since the sectoral strategies Food Security and Intercultural Bilingual Education and the Microfinance directive were adopted, these areas have received greater consideration. Furthermore, the LED deploys human resources from Liechtenstein to development projects and arranges internships. Further fields of its work are public relations and awareness-raising through publications, exhibitions, and educational work in schools. The cooperation between the Liechtenstein Government and the LED, a foundation under private law, is governed by an ownership strategy, which is supplemented and further specified by annual performance mandates. The LED foundation council decides on individual projects.

An intact environment and the sustainable development and use of natural resources are necessary preconditions for the social and economic development of a region. Not only the shortage of certain natural resources, but also the lack of access to these resources, constitutes a growing problem for many poor regions. IHCD seeks to protect the environment and natural resources as a basis of life also for coming generations. Of particular note from the perspective of environmental policy is Liechtenstein's engagement through financial and human resources, such as the provision of experts and the promotion of sustainable mountain region development in the Carpathians, the Caucasus, and Central Asia.

7.1.2 Provision of financial resources (including under Art. 11 of the Kyoto Protocol)

In 2016, Liechtenstein’s IHCD had resources in the amount of about 22.5 million Swiss francs, i.e. about 650 Swiss francs per capita. The total Official Development Assistance (ODA) amount was 24.2 million Swiss francs. The average exchange rate for US$ was 0.985 in 2016. The most recent ODA-percentage for the year 2014 is 0.5 %.

An overview of Liechtenstein’s financial contributions as part of its International Humanitarian Cooperation and Development in 2016 can be found in the 2016 Annual Report of the

Government to Parliament (pp. 111-118).[20] The following table provides an overview of contributions related to the environment in 2016.

Table 7-1 Financial contributions within Liechtenstein's International Humanitarian Cooperation and Development in 2016 related to the environment in 2016

Type of contribution	**Partner**	**Amount (CHF)**
Basel Convention: annual contribution	UNEP	529
Combatting soil erosion through windbreaks in Georgia	Community & Environment (C&E)	85'512
Climate Convention: annual contribution	UNFCCC	3'174
Protection of virgin forests in Adjara / Georgia	C&E	85'176
Developing Institutions to prevent climate displacement and land conflict in Myanmar	Displacement Solutions	50'000
PPP Solar Energy Project in Barrio Alto / Peru	Peru 2021	50'153
Adaptation to climate change through preservation of forests and reforestation	SAFIRE	87'857
CleanStart: Promotion of energy efficiency and renewable energies through microfinance	UNCDF	50'000
LoCAL: Improvement of adaptation to climate change by supporting local Government in Tuvalu	UNCDF	50'000
Contribution to International Renewable Energy Agency	IRENA	1'362
Contribution to the EMEP Trust Fund	UNECE	452
Convention on Biological Diversity: annual contribution	UNEP	1'302
Convention on Long-range Transboundary Air Pollution: annual contribution	UNECE	492
Convention on the Conservation of Migratory Species of Wild Animals (CMS): annual contribution	UNEP	507
Kyoto Protocol: annual contribution	UNFCCC	1'930
Multilateral fund of the Montreal Protocol (Ozone Fund): annual contribution	UNEP	17'887
Permanent Secretariat of the Alpine Convention: annual contribution	Secretariat of the Alpine Convention	19'024

[20] See http://www.llv.li/files/srk/rb16-rechenschaftsbericht-2016.pdf (in German).

Ramsar Convention: annual contribution	IUCN	1'000
Rotterdam Convention: annual contribution	UNEP	250
Stockholm Convention: annual contribution	UNEP	485
UNCCD: annual contribution	UNCCD	735
UNEP: annual contribution / Environment Fund	UNEP	9’293
World Conservation Union (IUCN): annual contribution	IUCN	15’520
Contamination reduction in the region of Chernobyl	OSCE	30’000
TOTAL		**564’437**

Table 7-2 Overview of the most important contributions as part of Liechtenstein's international engagement in environmental protection, 2016

Multilateral contributions

	Multilateral contributions (CHF) (SDC only)			
	2013	**2014**	**2015**	**2016**
Multilateral institutions:				
1. European Bank for Reconstruction and Development (EBRD)	**0**	**0**	**20’000**	**0**
2. United Nations Development Programme (UNDP)	**225’000**	**175’000**	**175’000**	**125’000**
3. UNEP	**25’089**	**16’743**	**19’088**	**30’253**
4. UNFCCC (Kyoto Adaptation Fund)	**2’612**	**2’636**	**0**	**5’104**
5. UNCCD	**822**	**791**	**708**	**735**
6. International Union for the Conservation of Nature (IUCN)	**0**	**30’839**	**15’489**	**15’520**
7. Green Climate Fund	**0**	**0**	**50’000**	**0**
Total	**253’523**	**226’019**	**280’285**	**176’612**

Summary of information on financial resources and technology transfer

Official development assistance (ODA in 2016)	**24'204'500 CHF**
Climate-related aid in bilateral ODA	
Climate-related support programmes	

Contributions to GEF (USD million)	
Pledge for third GEF replenishment	
Activities implemented jointly	
JI and CDM under the Kyoto Protocol (2008 – 2012)	**7'920'000 CHF**
JI and CDM under the Kyoto Protocol (2013 – 2020)	**tbd**
Other (bilateral/multilateral)	

Abbreviations: CDM = clean development mechanism, GEF = Global Environment Facility, JI = joint implementation.

Table 7-2: Multilateral contributions

7.2 Technology development and transfer

Technology development and/or transfer is often a component of programmes and projects that support developing countries in their endeavours to mitigate and adapt to climate change. Due to the countries size and its limited resources within the administration Liechtenstein has not set up a particular "transfer-of-technology" framework. The example below provides information on a project supported by Liechtenstein that has a technology transfer component.

In connection with the protection and preservation of the environment, Liechtenstein as an Alpine country is particularly engaged on behalf of the development of mountain regions. Under the umbrella of the Alpine Convention, Alpine countries cultivate a partnership with mountain regions in the Balkans, the Carpathians, the Caucasus, and Central Asia.

Table 7-3 Water and Energy Saving Project, Tansania

Project / programme title: Water and Energy Saving Project, Tansania

Goal: Improvement of food security through adapted water and energy saving irrigation technologies

Recipient country	Sector	Total funding	Years in operation
Tansania	Irrigation Technology	CHF 250'000	6

Description:

- Food security through small irrigation system (pepal pump)
- Provide access to so called swiss-PEP irrigation technology for local peasants

Expected added value of the programme:

- Pedal pumps are produced locally
- Operation of pedal pumps is largely CO_2 neutral
- Improvement of food security and reduction of CO_2 emissions

Technology transferred:

- Transfer of swiss-PEP irrigation technology

Impact on greenhouse gas emissions/sinks: Reduction of 5'850 t of CO_2 per year

Liechtenstein Development Service, LED (2016)

7.3 Capacity-building

Capacity-building is an essential component of almost all programmes and projects of Liechtenstein, which support developing countries in their endeavours to mitigate and adapt to climate change. Due to the highly integrated character, it is not possible for Liechtenstein to single out the capacity-building components of all its development cooperation projects and programs.

As part of the global effort, Liechtenstein, with the help of PPPs, started last year a joint cooperation in Peru between the Government and private foundations and associations in order to raise the means of climate finance. It's planned to continue this process with new partners for a project in Mali.

All activities and projects related to capacity building or the transfer of technology take place within the framework of IHCD, which is based on the Law on IHCD from 2007 (LGBl. 2007 Nr. 149). The law provides for four categories of development cooperation:

- - Bilateral development cooperation
- - Multilateral development cooperation
- - Emergency and Reconstruction Assistance
- - Refugee and Migration assistance

Capacity building and transfer of technology are however not specially mentioned in the law. However, where such activities take place, they are either bilateral or multilateral projects.

Regarding capacity building or the transfer of technology, there are no specific focus countries. Focus countries exist only within the different categories of IHCD. As for the projects related to environment, most of them take place within multilateral development cooperation. There, the region of the South Caucasus is a focus area.

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8. Research and systematic observation

8.1 General policy on and funding of research and systematic observation

8.1.1 Basic research

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

Two of the University's institutes (Institute for Architecture and Planning and Institute for Financial Services) are directly involved in the examination of sustainable and ecological developments within their specific fields of activities. One of the main focus points of the Institute for Architecture is the establishment of concepts for a sustainable regional development with respect to settlement, transport and landscape. The Institute for Financial Services examines the impacts, challenges and opportunities of markets and market instruments, such as micro finance or carbon markets, on social or environmental developments.

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

Liechtenstein supports research activities abroad, with annual contributions to Switzerland (Swiss National Science Foundation, SNSF) and Austria (Austrian Science Fund, FWF), each amounting to 250'000 CHF (2017). As a member of the EEA, Liechtenstein also participates in the European research programs, but not in the Horizon 2020 programme. Some research is done in conjunction with other Alpine countries by participating in Interreg projects. Interreg is a series of five programmes to stimulate cooperation between regions in the European Union, funded by the European Regional Development Fund with a budget of 10.1 billion.

Actions relating to research and systematic observation addressing international activities are limited to a membership of the IPCC. Liechtenstein is not a member of WMO.

8.1.2 Technological research

Public institutions in Liechtenstein are also indirectly engaged in technology research. The University of Liechtenstein contributes a budget of 14.6 million CHF (2016) to the training of experts and around 3 million CHF (2016) to research as a base amount. Approximately 2/3 of these sums are dedicated to economic institutes and 1/3 to the Institute for Architecture and

Planning. As one of the co-owners Liechtenstein also supports the Interstate University of Applied Sciences of Technology Buchs (NTB) with an annual contribution of 580’000 CHF (2016).

Liechtenstein is contributing another 600’000 CHF annually (since 2014) to the establishment of RhySearch Innovation Center – a center of research and development, based in neighbouring Buchs, Switzerland. The activities of RhySearch are dedicated to small and midsized enterprises within the Rhine valley and focus amongst others on the development of new energy systems.

8.1.3 Direct international engagement

Liechtenstein is engaged in several collaborations with its neighbouring States and with international bodies and advocates cross-border coordination of land use planning. Liechtenstein is involved in the Interreg III B program "Alpine Space". Through the various Interreg projects, Liechtenstein supports the focus areas of water protection (including agricultural measures), transportation and joint monitoring of air pollutant emissions in the Lake Constance region.

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

The University of Liechtenstein in Vaduz, the Federal Institute for Forest, Snow and Landscape Research (WSL) in Birmensdorf (Switzerland) and the University of Innsbruck (Austria) have entered into a cooperation agreement to conduct research projects in the field of Architecture and Sustainable Planning within the Alpine Rhine Valley.

8.2 Research

In 2013 the Institute for Architecture and Planning took the lead in an international research project that focuses on the development of a transparent solar collector combined with an innovative indoor air conditioning system (FLUIDGLASS). The project runs from 2013 to 2017 and is supported by the European Commission. Organizations that also contribute to the development of FLUIDGLASS include the Buchs NTB Interstate University of Applied Sciences (Switzerland), the Technical University of Munich and the University of Stuttgart (Germany) as well as the National Institute of Solar Energy in Chambéry (France).

The Institute for Architecture and Planning also holds the “Chair for Sustainable Spatial Development”, which is involved in the "Alpstore” research project (2012 – 2014). The project seeks strategies to use a variety of mobile and stationary storage systems to allow for extended accessibility and integration of renewable energies in the alpine region. Besides this project the institute is engaged in several other re-search initiatives such as the Interreg supported "BAER– Bodensee/Lake Constance–Alpine Rhine Valley Energy and Climate Region", a consortium effort by five regional universities, and a series of projects which deal with urban and landscape integrated solutions for the autonomous supply of renewable energy. Based on the outcome of these research projects, recommendations will be formulated for planners and policy makers.

Since 2014 the same institute hosts the Green Summit Bodensee. This event addresses the current situation on major and minor issues of sustainability.

The Institute for Financial Services is also involved in several research projects that cover the environmental and social aspects of financial markets. The institute holds the “Chair of Company, Foundation and Trust Law”, which explores the need for an appropriate legal framework of philanthropic activities in the non-profit-sector (since 2010). Between 2011 and 2013 the Institute for Financial Services (“Chair in Business Administration, Banking and Financial Management”) concluded a research project exploring options for the improvement of social impacts within microfinance by the combination with carbon markets. Based on the conclusion, a follow-up project was implemented.

The Institute of Financial Services is also representing the University of Liechtenstein within the board of LIFE Climate Foundation, a non-for-profit organization that aims at the promotion of a sustainable and credible advancement of climate and environmental protection through an effective inclusion of financial intermediaries and the general public.

8.3 Systematic observation

Liechtenstein collects a wide range of data relating to climate, both through its own measuring stations and through interregional cooperation, especially with Switzerland. The data is fed into the Global Climate Observing System (GCOS). Since 1974, the largest measuring station in the country has been in operation in Vaduz, measuring the usual meteorological data (air pressure, air temperature, relative humidity, wind direction, wind strength, precipitation, sunshine duration etc.). A private company has also measured similar data at several locations since 1997.

Since 1970, the Office of Civil Protection has measured snow depth at around 10 locations (since 2013).In addition, the Office of Environment has taken water samples at various locations since the 1960's, to monitor quality and determine the groundwater table.

Since 2001, the Eastern Swiss cantons and Liechtenstein execute a joint monitoring network of air pollutants since 2001, in order to measure the quality of air (OSTLUFT). The cooperation under OSTLUFT is founded on a contractual basis. The organization's tasks are the monitoring of the air quality, the attribution of measured air pollutant concentrations to the emission sources and to evaluate the effects of reduction measures in the OSTLUFT region.

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

References

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9. Education, training and public awareness

9.1 Education at schools

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

Since 2005, environmental education officially forms part of Liechtenstein's all-encompassing educational program. Its origin is to be found on the national curriculum for Kindergarten, Primary and Secondary School of the Principality of Liechtenstein (2005, 2nd Edition). As one out of several reasons for the faculty of "Human and Environment" (topics are, among others: Climate, Weather, Economy, Industrialization) the respective curriculum states: "Students deal with humans as part of society and environment. They recognize dependencies as well as the possibility to act for or to influence relevant procedures." Thanks to this approach, environmental education influences the content of various school subjects – it is not only a part of subjects like "Biology" or "Nature" (ecology), but also of "Economy and Policy" (ecological and economic relations).

In addition to the abovementioned, the Government has set eco-friendly office and school supply goals: A specific catalogue recommends eco-friendly office and school supplies to teachers (paper, notebooks, writing implements, etc.). Moreover, various school projects on environmental education were conducted at Liechtenstein schools. These included:

Environmental volunteering (or focal points) at various schools: Teachers are exempted from one teaching period in exchange for assuming responsibility for instruction on environmental issues. The environmental focal points initiate and support concrete environmental projects at their schools. This has resulted in forest days, school gardens, environmentally friendly recess areas, field trips, and much more.

Various other support activities: The Office of Education promotes environmental consciousness, amongst others through the publication of various teaching materials (e.g., "School on the Farm") and the organization of specific continuing education courses for teachers. In addition, several national and international events covering environmental topics are organized on a regular basis, for example the participation of a group of students in the "Youth Parliament of the Alpine Convention" (YPAC, since 2006) or of the organization of events on the occasion of the Environment Day in June.

The Institute for Architecture and Planning (University of Applied Science) offers a concrete climate, energy and environmentally relevant education with the Urban Sustainability, Climate and Planning Education (short UrbanSCAPE) program. It provides an in-depth, English language Master's level program, anchored with the goal of climate protection and energy autonomy in space planning.

The Institute for Financial Services has introduced a focus on environmental commodities within its Department of Banking and Financial Management. The Institute's intention is to strengthen academic education in the field of social and responsible investments in the future.

Education at schools will also become a topic with regard to climate related capacity building support in developing countries. The Government will examine these aspects (capacity building, public awareness) in the framework of Liechtenstein's engagement within its climate finance activities. The concrete goals within Liechtenstein's climate finance were formulated in 2015 and were incorporated into the Government's revised National Climate Strategy.

9.2 Public outreach

Public outreach is the responsibility of the administrative office assigned to the area in question. In addition, some tasks are delegated to external institutions and individual outreach campaigns by NGOs are supported.

The Government also supports initiatives and projects in the field of environmental protection:

- In 2010, an architectural competition for projects that serve as showcases within the field of sustainable housing and renovations of old buildings throughout the alpine region was launched. In 2013 the Government continued the competition together with the Swiss Federal Office of Spatial Development, the University of Liechtenstein and the International Alpine Convention, CIPRA. The new cooperation created the international reward for architecture „Constructive Alps" with a price worth 50'000,- Euro. The competition is now in its fourth round after being held in 2015 and 2017 as well. The next call for submissions will start in 2018 for the 2019 competition.
- Further financial support was provided to the Implementation of a personal carbon footprint program within the framework of a social networking platform (KLIMACODE).

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

The Office of Environment annually distributes an environmental protection calendar to the public. Each year, the environmental protection calendar focuses on a different environmental topic. School children participate in the production process of the calendar, by asking them to contribute a drawing to the calendar's theme. In this way, children are already sensitized to the environment.

Through the establishment of an emissions register and the network of measuring stations mentioned in chapter 8, the population can be provided with precise information on the pollutant emissions of individual facilities and vehicles. The compiled data will be published each year in a report.

9.3 Cooperation with private institutions and NGOs

Since 2012, the Government provides financial support to LIFE Climate Foundation Liechtenstein (established in 2009) on a regular basis. The Non-for-Profit foundation concluded a cooperation agreement with the Swiss Climate Foundation. Since 2012, Liechtenstein based SMEs are eligible to apply for financial (upfront) support if they implement efficiency measures or if they seek financial help for the development of innovative projects that demonstrate a GHG mitigation impact. Additionally, LIFE Climate Foundation aims to further strengthen public awareness by

organizing respective events and workshops which cover the topics climate change and other ecological topics.

The foundation acts within the framework of a real Public-Private Partnership. The participation of representatives from the country's economy as well as from science and policy sectors provide important access to the relevant players and driving forces within environmental and carbon markets. The close cooperation with the University of Liechtenstein's Institute for Financial Services offers the possibility to examine environmental questions related to financial issues on an academic basis. Further information is available on http://www.climatefoundation.li.

Various institutions are also engaged in public information and education. In particular, these include the Liechtenstein Environmental Protection Society (www.lgu.li), the Solar Society (www.solargenossenschaft.li) and the Liechtenstein Transport Association (www.vcl.li).

Another important institution in this field is CIPRA (International Commission for the Protection of the Alps), which is headquartered in Liechtenstein and publishes the "Summary Academy on the Alps" each year since 1998. The Summer Academy is a valuable continuing education program for young people with a university or technical college degree who are interested in an interdisciplinary, transnational approach to Alpine issues. The Summer Academy consists of a three-week basic course on the Alps and an optional four-week practice-oriented project component. Experts from all the Alpine countries are hired as instructors. The State of Liechtenstein supports this project financially.

References

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10. Annex

Annex 1: Summary and trend tables for Liechtenstein's Greenhouse Gas Inventory

Summary 1.A: Summary Report for National Greenhouse Gas Inventories (2015)

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES
(Sheet 1 of 3)

Inventory 2015
Submission 2017 v6
LIECHTENSTEIN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]	PFCs[1]	Unspecified mix of HFCs and PFCs[1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)			(kt)					
Total national emissions and removals	167.46	0.78	0.03	10.42	0.04	NO	0.00	NO	NE,NA,NO	NE,NA,NO	0.16	NE,NA,NO
1. Energy	159.48	0.08	0.00						NE,NO	NE,NO	NE,NO	NE,NO
A. Fuel combustion Reference approach(2)	159.62											
Sectoral approach(2)	159.48	0.04	0.00						NE,NO	NE,NO	NE,NO	NE,NO
1. Energy industries	2.02	0.00	0.00						NO	NO	NO	NO
2. Manufacturing industries and construction	27.31	0.00	0.00						NE,NO	NE,NO	NE,NO	NE,NO
3. Transport	61.38	0.00	0.00						NE,NO	NE,NO	NE,NO	NO
4. Other sectors	68.77	0.03	0.00						NE	NE	NE	NE
5. Other	NO	NO	NO						NO	NO	NO	NO
B. Fugitive emissions from fuels	NA,NO	0.05	NA,NO						NO	NO	NO	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NA,NO	0.05	NA,NO						NO	NO	NO	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	NO	NO	0.00	10.42	0.04	NO	0.00	NO	NO	NO	0.16	NO
A. Mineral industry	NO								NO	NO	NO	NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO						NO	NO	0.16	NO
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				10.42	0.04							
G. Other product manufacture and use	NO	NO	0.00		NO		0.00		NO	NO	NO	NO
H. Other[3]	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given at the end of the table on sheet 3.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Sheet 2 of 3)

Inventory 2015
Submission 2017 v6
LIECHTENSTEIN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs [1]	PFCs[1]	Unspecified mix of	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
3. Agriculture	0.05	0.64	0.03						NA,NE,NO	NA,NE,NO	NE,NA,NO	NO
A. Enteric fermentation		0.53										
B. Manure management		0.11	0.00								NO	
C. Rice cultivation		NO									NA	
D. Agricultural soils		NA,NO	0.02						NA,NE,NO	NA,NE,NO	NA,NE,NO	
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		NA,NO	NA,NO						NA,NO	NA,NO	NA,NO	
G. Liming	NO											
H. Urea application	0.05											
I. Other carbon-contining fertilizers	NO											
J. Other	NA	NA	NA						NA	NA	NA	NO
4. Land use, land-use change and forestry [4]	7.91	NO	0.00						NE,NO	NE,NO	NE,NO	NO
A. Forest land [4]	-3.94	NO	NO						NE,NO	NE,NO	NE	
B. Cropland [4]	4.35	NO	0.00						NO	NO	NE	
C. Grassland [4]	3.85	NO	0.00						NO	NO	NE	
D. Wetlands [4]	0.38	NO	0.00						NO	NO	NE	
E. Settlements [4]	3.45	NO	0.00						NO	NO	NE	
F. Other land [4]	1.18	NO	0.00						NO	NO	NE	
G. Harvested wood products	-1.37											
H. Other [4]	NO	NO	NO						NO	NO	NO	NO
5. Waste	0.02	0.06	0.00						NA,NO	NA,NO	NA,NO	NA,NO
A. Solid waste disposal [5]	NO	0.00							NO	NO	NO	
B. Biological treatment of solid waste [5]		0.03	0.00						NA,NO	NA,NO	NA,NO	
C. Incineration and open burning of waste [5]	0.02	0.00	0.00						NA,NO	NA,NO	NA,NO	NA,NO
D. Wastewater treatment and discharge		0.03	0.00						NA,NO	NA,NO	NA,NO	
E. Other [5]	NO	NO	NO						NA	NA	NA	NA
6. Other ***(please specify)*** [6]	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given at the end of the table on sheet 3

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 3 of 3)

Inventory 2015
Submission 2017 v6
LIECHTENSTEIN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]	PFCs[1]	Unspecified mix of HFCs and PFCs[1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Memo items:[7]												
International bunkers	1.19	0.00	0.00						NE,NO	NE,NO	NE,NO	NE,NO
Aviation	1.19	0.00	0.00						NE	NE	NE	NE
Navigation	NO	NO	NO						NO	NO	NO	NO
Multilateral operations	NO	NO	NO						NO	NO	NO	NO
CO_2 emissions from biomass	20.60											
CO_2 captured	87.64											
Long-term storage of C in waste disposal sites	NA											
Indirect N_2O			NO									
Indirect CO_2	NO											

(1) The emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), unspecified mix of HFCs and PFCs and other fluorinated gases are to be expressed as carbon dioxide (CO_2) equivalent emissions. Data on disaggregated

(2) For verification purposes, Parties are requested to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in the documentation box to table 1.A(c). For

(3) 2.H. Other includes pulp and paper and food and beverages industry.

(4) For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(5) CO_2 from categories solid waste disposal on land and waste incineration should only be included if it stems from non-biogenic or inorganic waste streams. Only emissions from waste incineration without energy recovery are to be reported in the waste sector, whereas emissions from incineration with energy recovery are to be reported in the energy sector.

(6) If reporting any country-specific category under sector "6. Other", detailed explanations should be provided in Chapter 8: Other (CRF sector 6) of the national inventory report (NIR).

(7) Parties are asked to report emissions from international aviation and international navigation and multilateral operations, as well as CO_2 emissions from biomass and CO_2 captured, under Memo Items. These emissions should not be included in the national total emissions from the energy sector. Amounts of biomass used as fuel are included in the national energy consumption but the corresponding CO_2 emissions are not included in the national total as it is assumed that the biomass is produced in a sustainable manner. If the biomass is harvested at an unsustainable rate, net CO_2 emissions are accounted for as a loss of biomass stocks in the Land Use, Land-use Change and

Summary 2: Summary Report for CO_2 Equivalent Emissions (1990)

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1990
Submission 2017 v6
LIECHTENSTEIN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	201.98	19.53	11.21	0.00	NO	NO	NO	NO	232.72
1. Energy	198.70	1.25	1.13						201.07
A. Fuel combustion (sectoral approach)	198.70	0.88	1.13						200.70
1. Energy industries	0.12	0.00	0.05						0.18
2. Manufacturing industries and construction	36.19	0.05	0.09						36.32
3. Transport	75.36	0.63	0.76						76.75
4. Other sectors	87.03	0.20	0.23						87.45
5. Other	NO	NO	NO						NO
B. Fugitive emissions from fuels	NO,NA	0.37	NO,NA						0.37
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NA	0.37	NO,NA						0.37
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	NO	NO	0.45	0.00	NO	NO	NO	NO	0.45
A. Mineral industry	NO								NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO						NO
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				0.00	NO				0.00
G. Other product manufacture and use	NO	NO	0.45		NO	NO			0.45
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.06	16.72	8.73						25.51
A. Enteric fermentation		13.66							13.66
B. Manure management		3.06	1.16						4.22
C. Rice cultivation		NO,NA							NO,NA
D. Agricultural soils		NA,NO	7.57						7.57
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		NO,NA	NO,NA						NO,NA
G. Liming	NO								NO
H. Urea application	0.06								0.06
I. Other carbon-containing fertilizers	NO								NO
J. Other	NA	NA	NA						NA
4. Land use, land-use change and forestry[1]	3.20	NO	0.31						3.51
A. Forest land	-2.25	NO	NO						-2.25
B. Cropland	4.54	NO	0.01						4.55
C. Grassland	1.82	NO	0.01						1.83
D. Wetlands	0.16	NO	0.00						0.16
E. Settlements	3.19	NO	0.20						3.38
F. Other land	0.44	NO	0.03						0.47
G. Harvested wood products	-4.70								-4.70
H. Other	NO	NO	NO						NO
5. Waste	0.03	1.56	0.59						2.18
A. Solid waste disposal	NO	0.48							0.48
B. Biological treatment of solid waste		0.48	0.08						0.56
C. Incineration and open burning of waste	0.03	0.01	0.00						0.04
D. Waste water treatment and discharge		0.59	0.51						1.10
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO

Memo items:[2]									
International bunkers	0.43	0.00	0.00						0.43
Aviation	0.43	0.00	0.00						0.43
Navigation	NO	NO	NO						NO
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	5.51								5.51
CO_2 captured	89.66								89.66
Long-term storage of C in waste disposal sites	NA								NA
Indirect N_2O			NO						
Indirect CO_2 [3]	NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									229.21
Total CO_2 equivalent emissions with land use, land-use change and forestry									232.72
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

Summary 2: Summary Report for CO_2 Equivalent Emissions (2015)

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2015
Submission 2017 v6
LIECHTENSTEIN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	167.46	19.50	10.26	10.42	0.04	0.04	NO	NO	207.71
1. Energy	159.48	2.08	0.76						162.32
A. Fuel combustion (sectoral approach)	159.48	0.92	0.76						161.17
1. Energy industries	2.02	0.02	0.00						2.05
2. Manufacturing industries and construction	27.31	0.04	0.09						27.44
3. Transport	61.38	0.10	0.39						61.87
4. Other sectors	68.77	0.76	0.28						69.81
5. Other	NO	NO	NO						NO
B. Fugitive emissions from fuels	NA,NO	1.16	NA,NO						1.16
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NA,NO	1.16	NA,NO						1.16
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	NO	NO	0.20	10.42	0.04	0.04	NO	NO	10.70
A. Mineral industry	NO								NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO						NO
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				10.42	0.04				10.46
G. Other product manufacture and use	NO	NO	0.20		NO	0.04			0.24
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.05	15.92	8.12						24.09
A. Enteric fermentation		13.25							13.25
B. Manure management		2.67	1.35						4.02
C. Rice cultivation		NO							NO
D. Agricultural soils		NA,NO	6.77						6.77
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		NA,NO	NA,NO						NA,NO
G. Liming	NO								NO
H. Urea application	0.05								0.05
I. Other carbon-containing fertilizers	NO								NO
J. Other	NA	NA	NA						NA
4. Land use, land-use change and forestry[(1)]	7.91	NO	0.42						8.32
A. Forest land	-3.94	NO	NO						-3.94
B. Cropland	4.35	NO	0.02						4.37
C. Grassland	3.85	NO	0.04						3.89
D. Wetlands	0.38	NO	0.01						0.39
E. Settlements	3.45	NO	0.20						3.65
F. Other land	1.18	NO	0.07						1.26
G. Harvested wood products	-1.37								-1.37
H. Other	NO	NO	NO						NO
5. Waste	0.02	1.50	0.76						2.28
A. Solid waste disposal	NO	0.12							0.12
B. Biological treatment of solid waste		0.70	0.12						0.82
C. Incineration and open burning of waste	0.02	0.01	0.00						0.03
D. Waste water treatment and discharge		0.67	0.64						1.31
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO

Memo items:[(2)]									
International bunkers	1.19	0.00	0.01						1.20
Aviation	1.19	0.00	0.01						1.20
Navigation	NO	NO	NO						NO
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	20.60								20.60
CO_2 captured	87.64								87.64
Long-term storage of C in waste disposal sites	NA								NA
Indirect N_2O			NO						
Indirect CO_2 [(3)]	NO								
Total CO_2 equivalent emissions without land use, land-use change and forestry									199.39
Total CO_2 equivalent emissions with land use, land-use change and forestry									207.71
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

Annex 2: Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol

Table 10-1 Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC7

Information reported under Article 7, paragraph 2	NC7 section
National systems in accordance with Article 5, paragraph 1	3.3.3
National registries	3.3.2
Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17	5.2.4
Policies and measures in accordance with Article 2	4.2
Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures	4.1
Information under Article 10	
Art. 10(a)	3.2.1
Art. 10(b)	4.2, 6.4, 6.6
Art. 10(c)	7.2, 7.3
Art .10(d)	8
Art .10(e)	9
Financial resources	7

Abbreviations

AD	Activity Data
AWNL	Amt für Wald, Natur und Landschaft (OFNLM)
AZV	Abwasserzweckverband der Gemeinden Liechtensteins (Liechtenstein's wastewater administration union)
CH_4	Methane
CHF	Swiss francs
chp.	Chapter
CIPRA	International Commission for the Protection of the Alps
CLRTAP	UNECE Convention on Long-range Transboundary Air Pollution
CO	Carbon monoxide
CO_2 (CO_2eq)	Carbon dioxide (equivalent)
CORINAIR	CORe Inventory of AIR emissions (under the European Topic Centre on Air Emissions and under the European Environment Agency)
CP	Commitment period
CRF	Common reporting format
ETH/ETHZ	Swiss Federal Institute of Technology, Zurich
EF	Emission factor
EMEP	European Monitoring and Evaluation Programme (under the Convention on Long-range Transboundary Air Pollution)
ERT	Expert Review Team
FL	Fürstentum Liechtenstein (Principality of Liechtenstein)
FOEN	Swiss Federal Office for the Environment
GCOS	Global Climate Observing System
GDP	Gross domestic product
g	Gramme
GHFL	Genossenschaft für Heizöllagerung im Fürstentum Liechtenstein (Cooperative society for the Storage of Gas Oil in the Principality of Liechtenstein)
GHG	Greenhouse gases
GJ	Giga Joule (10^9 Joule = 1'000 Mega Joule)
GWP	Global Warming Potential, factor for converting CH_4, N_2O, HFC, PFC, and SF_6 emissions into CO_2 equivalents
ha	hectare
HWP	Harvested Wood Products
HFC	Hydrofluorcarbons
IDP	Inventory Development Plan
IPCC	Intergovernmental Panel on Climate Change
HVF	Heavy Vehicle Fee
KC, KCA	Key Category, Key Category Analysis
kg	Kilogramme (1'000 g)
kha	Kilo hectare (1'000 ha)

KP	Kyoto Protocol
kt	Kilo tonne (1'000 tons)
LGV	Liechtensteinische Gasversorgung (Liechtenstein's gas utility)
LKW	Liechtensteinische Kraftwerke (Liechtenstein's electric power company)
LULUCF	Land Use, Land-Use Change and Forestry
MJ	Mega Joule (10^6 Joule = 1'000'000 Joule)
MSW	Municipal solid waste
MWh	Mega Watt hour (1 MWh = 3.6 MJ)
NA	Not applicable (notation key)
NF_3	Nitrogen trifluoride
NFR	Nomenclature for reporting (category codes)
NGO	Non-governmental organization
NIC	National Inventory Compiler
NIR	National Inventory Report
NIS	National Inventory System
NMVOC	Non-methane volatile organic compounds
NO_X	Nitrogen oxides
N_2O	Nitrous oxide
OA	Office of Agriculture
OCP	Office of Civil Protection
OE	Office of Environment
OEA	Office of Economic Affairs
OEP	Office of Environmental Protection, former name of today's Office of Environment (OE) since 2012
OFIVA	Office of Food Inspection and Veterinary Affairs
OFNLM	Office of Forests, Nature and Land Management
OS	Office of Statistics
PFC	Perfluorinated carbon compounds (e.g. Tetrafluoromethane)
QA/QC	Quality assurance, quality control
SDC	Swiss Agency for Development and Cooperation
SF_6	Sulfur hexafluoride
SFOE	Swiss Federal Office of Energy
SLP	Office of Land Use Planning
SO_2	Sulphur dioxide
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

ANNEX
Liechtenstein's Biennial Report 3

December 2017

Table of contents

1. Introduction

The Government of Liechtenstein is pleased to present its Third Biennial Report (BR3). Liechtenstein's Third Biennial Report follows the UNFCCC biennial reporting guidelines for developed country Parties.

The Biennial Report complements the existing national reports "GHG Inventory" and "National Communication". Liechtenstein's BR3 has been prepared as Annex to Liechtenstein's Seventh National Communication. Due to the fact that both reports have to be submitted by 1st of January 2018 and considering the overlap of some information to be reported according to the respective guidelines, Liechtenstein decided to refer to the respective sections of its Seventh National Communication in those cases, where such overlap would occur within the Biennial Report.

Liechtenstein's third Biennial Report has been prepared by:

Office of Environment Liechtenstein

Environmental Protection Division

P.O. Box 684, 9490 Vaduz, Liechtenstein.

2. Information on GHG emissions and trends

Summary of Liechtenstein's latest greenhouse gas inventory

Liechtenstein's greenhouse gas emissions in the year 2015 (OE 2017) amount to 199.4 kt CO_2 equivalent (CO_2eq) excluding LULUCF sources or sinks (including LULUCF: 207.7 kt CO_2eq). This refers to 5.3 t CO_2eq per capita. Total emissions (excl. LULUCF) have declined by 13.0% compared to 1990 and by 1.2% compared to 2014.

Among the different greenhouse gases, CO_2 accounts for the largest share of total emissions. The most important emission sources are fuel combustion activities in the Energy sector. Emissions of CH_4 and N_2O mainly originate from the sector Agriculture and F-gas emissions stem from the sector 2 Industrial processes and product use (IPPU) by definition.

National Inventory Arrangements

The Government of the Principality of Liechtenstein bears the overall responsibility for Liechtenstein's National Inventory System (NIS). By Liechtenstein's Emission Trading Act (Emissionshandelsgesetz, Government 2012), the Office of Environment (OE) is in charge of establishing emission inventories and is therefore also responsible for all aspects concerning the establishing of the National Inventory System (NIS) under the Kyoto Protocol. The responsibility of the OE for establishing the NIS is also described in the report of the Government to the parliament for ratifying the Kyoto Protocol. The Government mandated the realization of the NIS to its Office of Environment (OE). Please note that the Office of Environment was reorganized in 2013. The Office of Agriculture (OA), the Office of Forest, Nature and Land Management (OFNLM) and the Office of Environmental Protection (OEP) have been merged to the Office of Environment (OE). The former Office of Land Use Planning (SLP) was reorganized in 2013 and the Local Land Use Planning Bureau has been incorporated into the Office of Construction and Infrastructure (OCI). No change since the last submission.

For further information please refer to chapter 3 of Liechtenstein's Seventh National Communication.

Notation key used: NO means no emissions occurring. NE means no estimated emissions.

Table 1 LIE_BR3_v0.1

Emission trends: summary [1]
(Sheet 1 of 3)

GREENHOUSE GAS EMISSIONS	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997
	kt CO_2 eq								
CO_2 emissions without net CO_2 from LULUCF	198.78	198.78	206.15	206.78	214.87	200.96	204.05	205.81	218.23
CO_2 emissions with net CO_2 from LULUCF	201.98	201.98	195.97	207.47	212.50	218.42	206.92	200.60	224.80
CH_4 emissions without CH_4 from LULUCF	19.53	19.53	19.40	19.02	18.18	18.39	18.29	18.72	18.41
CH_4 emissions with CH_4 from LULUCF	19.53	19.53	19.40	19.02	18.18	18.39	18.29	18.72	18.41
N_2O emissions without N_2O from LULUCF	10.90	10.90	11.12	11.02	10.78	10.73	10.62	10.56	10.56
N_2O emissions with N_2O from LULUCF	11.21	11.21	11.42	11.33	11.08	11.03	10.93	10.86	10.88
HFCs	0.00	0.00	0.01	0.09	0.20	0.51	1.35	1.72	2.11
PFCs	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	229.21	229.21	236.68	236.91	244.04	230.59	234.32	236.81	249.32
Total (with LULUCF)	232.72	232.72	226.80	237.90	241.97	248.36	237.49	231.91	256.21
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997
	kt CO_2 eq								
1. Energy	201.07	201.07	208.64	209.44	217.58	203.62	206.77	208.59	221.14
2. Industrial processes and product use	0.45	0.45	0.45	0.51	0.60	0.90	1.72	2.06	2.44
3. Agriculture	25.51	25.51	25.53	24.85	23.76	23.86	23.68	23.89	23.54
4. Land Use, Land-Use Change and Forestry[b]	3.51	3.51	-9.88	0.99	-2.07	17.76	3.18	-4.90	6.89
5. Waste	2.18	2.18	2.06	2.12	2.09	2.22	2.15	2.27	2.20
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	232.72	232.72	226.80	237.90	241.97	248.36	237.49	231.91	256.21

Note: All footnotes for this table are given on sheet 3.

[1] The common tabular format will be revised, in accordance with relevant decisions of the Conference of the Parties and, where applicable, with decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol."

Table 1 LIE_BR3_v0.1

Emission trends: summary [1]
(Sheet 2 of 3)

GREENHOUSE GAS EMISSIONS	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
CO_2 emissions without net CO_2 from LULUCF	229.11	226.43	216.72	214.55	219.90	229.20	229.24	228.87	231.05	200.74
CO_2 emissions with net CO_2 from LULUCF	227.05	222.69	238.39	213.58	219.66	233.35	234.83	234.09	239.90	218.88
CH_4 emissions without CH_4 from LULUCF	18.22	17.60	17.36	18.04	18.35	18.54	18.62	19.23	19.94	20.38
CH_4 emissions with CH_4 from LULUCF	18.22	17.60	17.36	18.04	18.35	18.54	18.62	19.23	19.94	20.38
N_2O emissions without N_2O from LULUCF	10.24	9.99	9.85	9.90	10.04	10.04	9.71	9.85	10.03	10.09
N_2O emissions with N_2O from LULUCF	10.57	10.33	10.20	10.27	10.41	10.42	10.10	10.25	10.43	10.49
HFCs	2.74	3.35	4.11	4.94	5.48	6.13	6.97	7.37	7.82	8.48
PFCs	0.00	0.01	0.01	0.02	0.02	0.04	0.05	0.07	0.08	0.08
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	0.00	0.09	0.17	0.24	0.25	0.26	0.26	0.06	0.11
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	260.32	257.38	248.14	247.61	254.03	264.20	264.85	265.65	268.99	239.88
Total (with LULUCF)	258.59	253.97	270.15	247.00	254.16	268.73	270.83	271.26	278.23	258.43
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy	232.03	229.40	219.83	217.50	222.78	232.12	231.95	231.62	233.83	203.58
2. Industrial processes and product use	3.04	3.64	4.46	5.36	5.97	6.65	7.51	7.92	8.17	8.89
3. Agriculture	23.04	22.09	21.48	22.53	22.87	23.01	22.99	23.56	24.57	24.91
4. Land Use, Land-Use Change and Forestry[b]	-1.74	-3.40	22.01	-0.61	0.13	4.53	5.98	5.61	9.25	18.55
5. Waste	2.20	2.24	2.36	2.23	2.41	2.42	2.41	2.55	2.42	2.51
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	258.59	253.97	270.15	247.00	254.16	268.73	270.83	271.26	278.23	258.43

Note: All footnotes for this table are given on sheet 3.

Table 1 LIE_BR3_v0.1

Emission trends: summary [(1)]
(Sheet 3 of 3)

GREENHOUSE GAS EMISSIONS	*2008*	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
									(%)
CO_2 emissions without net CO_2 from LULUCF	219.49	205.35	190.81	176.83	185.42	192.63	161.33	159.55	-19.74
CO_2 emissions with net CO_2 from LULUCF	239.80	227.64	211.48	197.85	206.71	206.06	174.68	167.46	-17.09
CH_4 emissions without CH_4 from LULUCF	20.66	20.38	19.85	20.29	20.70	19.81	19.83	19.50	-0.16
CH_4 emissions with CH_4 from LULUCF	20.66	20.38	19.85	20.29	20.70	19.81	19.83	19.50	-0.16
N_2O emissions without N_2O from LULUCF	10.26	10.14	9.90	10.30	10.22	9.97	9.87	9.85	-9.68
N_2O emissions with N_2O from LULUCF	10.67	10.55	10.31	10.71	10.64	10.38	10.28	10.26	-8.45
HFCs	9.12	9.12	9.69	9.96	10.37	10.63	10.64	10.42	9,974,953.52
PFCs	0.08	0.07	0.07	0.06	0.06	0.06	0.04	0.04	100.00
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	0.00
SF_6	0.35	0.14	0.02	0.01	0.00	0.17	0.12	0.04	100.00
NF3	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (without LULUCF)	259.96	245.20	230.35	217.44	226.77	233.27	201.82	199.39	-13.01
Total (with LULUCF)	280.68	267.90	251.42	238.88	248.48	247.12	215.58	207.71	-10.74
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	0.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
									(%)
1. Energy	222.45	208.28	193.77	179.76	188.38	195.55	164.05	162.32	-19.27
2. Industrial processes and product use	9.75	9.53	9.99	10.23	10.62	11.06	10.99	10.70	2,264.53
3. Agriculture	25.12	25.00	24.18	24.91	25.13	24.02	24.39	24.09	-5.56
4. Land Use, Land-Use Change and Forestry[b]	20.72	22.70	21.08	21.44	21.71	13.86	13.76	8.32	137.21
5. Waste	2.65	2.40	2.41	2.55	2.63	2.64	2.39	2.28	4.64
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (including LULUCF)	280.68	267.90	251.42	238.88	248.48	247.12	215.58	207.71	-10.74

Notes :

(1) Further detailed information could be found in the common reporting format tables of the Party's greenhouse gas inventory, namely "Emission trends (CO_2)", "Emission trends (CH_4)", "Emission trends (N_2O)" and "Emission trends (HFCs, PFCs and SF_6)", which is included in an annex to this biennial report.

(2) 2011 is the latest reported inventory year.

(3) 1 kt CO_2 eq equals 1 Gg CO_2 eq.

Abbreviation: LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[b] Includes net CO_2, CH_4 and N_2O from LULUCF.

Custom Footnotes

Table 1 (a) LIE_BR3_v0.1

Emission trends (CO_2)

(Sheet 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year* [a]	1990	1991	1992	1993	1994	1995	1996	1997
	kt								
1. Energy	198.70	198.70	206.07	206.70	214.79	200.89	203.99	205.74	218.17
A. Fuel combustion (sectoral approach)	198.70	198.70	206.07	206.70	214.79	200.89	203.99	205.74	218.17
1. Energy industries	0.12	0.12	0.79	1.82	1.88	1.76	2.00	2.50	2.44
2. Manufacturing industries and construction	36.19	36.19	35.83	36.21	37.47	35.52	35.60	35.66	37.50
3. Transport	75.36	75.36	88.52	87.75	85.64	78.36	80.30	81.57	85.16
4. Other sectors	87.03	87.03	80.93	80.92	89.80	85.25	86.09	86.00	93.06
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
C. CO2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Mineral industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05
A. Enteric fermentation									
B. Manure management									
C. Rice cultivation									
D. Agricultural soils									
E. Prescribed burning of savannas									
F. Field burning of agricultural residues									
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Urea application	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land Use, Land-Use Change and Forestry	3.20	3.20	-10.19	0.69	-2.37	17.46	2.87	-5.20	6.57
A. Forest land	-2.25	-2.25	-18.51	-7.58	-11.11	8.35	-5.52	-14.17	-3.10
B. Cropland	4.54	4.54	4.53	4.52	4.51	4.50	4.49	4.48	4.48
C. Grassland	1.82	1.82	1.81	1.80	1.79	1.79	1.78	1.77	1.97
D. Wetlands	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.18
E. Settlements	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.22
F. Other land	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.53
G. Harvested wood products	-4.70	-4.70	-1.81	-1.85	-1.36	-0.97	-1.67	-1.08	-0.71
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Biological treatment of solid waste									
C. Incineration and open burning of waste	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02
D. Waste water treatment and discharge									
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO
International bunkers	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.44	0.45
Aviation	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.44	0.45
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass	5.51	5.51	4.37	5.67	5.31	6.40	5.04	4.91	5.61
CO2 captured	89.66	89.66	82.31	83.53	92.09	88.48	88.15	87.83	95.41
Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indirect N2O									
Indirect CO2 (3)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CO2 equivalent emissions with land use, land-use change and forestry	201.98	201.98	195.97	207.47	212.50	218.42	206.92	200.60	224.80
Total CO2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA
Note: All footnotes for this table are given at the end of the table on sheet 6.									

Note: All footnotes for this table are given on sheet 3.

Table 1 (a) LIE_BR3_v0.1

Emission trends (CO_2)

(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy	229.05	226.37	216.66	214.48	219.83	229.13	229.17	228.81	230.99	200.67
A. Fuel combustion (sectoral approach)	229.05	226.37	216.66	214.48	219.83	229.13	229.17	228.81	230.99	200.67
1. Energy industries	2.83	2.83	2.67	2.83	2.42	2.73	2.85	3.03	2.75	2.48
2. Manufacturing industries and construction	40.24	39.70	36.31	36.30	37.77	41.06	39.71	39.04	40.41	33.80
3. Transport	84.91	89.05	89.86	86.53	82.64	82.54	81.49	81.15	78.65	82.78
4. Other sectors	101.08	94.79	87.82	88.82	97.00	102.80	105.13	105.59	109.18	81.60
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
C. CO2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Mineral industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.04	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.04
A. Enteric fermentation										
B. Manure management										
C. Rice cultivation										
D. Agricultural soils										
E. Prescribed burning of savannas										
F. Field burning of agricultural residues										
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Urea application	0.04	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.04
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
J. Other	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA
4. Land Use, Land-Use Change and Forestry	-2.06	-3.74	21.66	-0.97	-0.24	4.15	5.60	5.22	8.85	18.14
A. Forest land	-11.55	-13.25	12.35	-11.69	-11.23	-7.36	-5.37	-5.55	-0.86	8.21
B. Cropland	4.48	4.48	4.48	4.48	4.48	4.45	4.43	4.41	4.39	4.36
C. Grassland	2.17	2.37	2.57	2.77	2.97	3.10	3.23	3.36	3.49	3.63
D. Wetlands	0.20	0.22	0.25	0.27	0.29	0.29	0.30	0.30	0.31	0.31
E. Settlements	3.26	3.30	3.34	3.38	3.41	3.42	3.43	3.44	3.45	3.45
F. Other land	0.61	0.70	0.78	0.87	0.95	0.99	1.03	1.07	1.11	1.15
G. Harvested wood products	-1.24	-1.56	-2.10	-1.03	-1.11	-0.74	-1.45	-1.82	-3.03	-2.97
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Biological treatment of solid waste										
C. Incineration and open burning of waste	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
D. Waste water treatment and discharge										
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
International bunkers	0.46	0.48	0.49	0.50	0.45	0.50	0.34	0.48	0.83	0.82
Aviation	0.46	0.48	0.49	0.50	0.45	0.50	0.34	0.48	0.83	0.82
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass	6.21	6.77	10.27	7.05	7.19	8.93	9.66	10.38	11.73	15.13
CO2 captured	103.96	97.98	94.56	92.37	100.77	108.14	111.06	112.47	117.18	92.69
Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indirect N2O										
Indirect CO2 (3)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CO2 equivalent emissions with land use, land-use change and forestry	227.05	222.69	238.39	213.58	219.66	233.35	234.83	234.09	239.90	218.88
Total CO2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Note: All footnotes for this table are given at the end of the table on sheet 6.										

Note: All footnotes for this table are given on sheet 3.

Table 1(a) LIE_BR3_v0.1

Emission trends (CO_2)

(Sheet 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
									%
1. Energy	219.42	205.28	190.75	176.75	185.35	192.56	161.27	159.48	-19.74
A. Fuel combustion (sectoral approach)	219.42	205.28	190.75	176.75	185.35	192.56	161.27	159.48	-19.74
1. Energy industries	2.81	2.87	3.15	2.95	2.71	2.92	2.48	2.02	1,567.43
2. Manufacturing industries and construction	36.25	27.46	26.00	23.49	25.63	26.31	27.02	27.31	-24.53
3. Transport	87.19	81.30	77.18	76.40	79.46	79.17	73.59	61.38	-18.56
4. Other sectors	93.17	93.65	84.42	73.92	77.55	84.16	58.18	68.77	-20.97
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Fugitive emissions from fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	0.00
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	0.00
C. CO2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	0.00
A. Mineral industry	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 industry	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	0.05	0.04	0.04	0.05	0.04	0.04	0.04	0.05	-19.21
A. Enteric fermentation									
B. Manure management									
C. Rice cultivation									
D. Agricultural soils									
E. Prescribed burning of savannas									
F. Field burning of agricultural residues									
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Urea application	0.05	0.04	0.04	0.05	0.04	0.04	0.04	0.05	-19.21
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	0.00
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
4. Land Use, Land-Use Change and Forestry	20.31	22.29	20.67	21.02	21.29	13.44	13.35	7.91	147.17
A. Forest land	10.16	6.96	5.33	9.07	9.28	1.58	1.51	-3.94	75.31
B. Cropland	4.34	4.34	4.35	4.35	4.36	4.36	4.36	4.35	-4.08
C. Grassland	3.76	3.78	3.81	3.84	3.87	3.89	3.86	3.85	111.60
D. Wetlands	0.32	0.33	0.35	0.37	0.38	0.40	0.38	0.38	140.03
E. Settlements	3.46	3.46	3.46	3.45	3.45	3.45	3.45	3.45	8.22
F. Other land	1.19	1.19	1.19	1.19	1.18	1.18	1.18	1.18	167.24
G. Harvested wood products	-2.91	2.23	2.18	-1.25	-1.22	-1.43	-1.40	-1.37	-70.83
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-20.10
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Biological treatment of solid waste									
C. Incineration and open burning of waste	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-20.10
D. Waste water treatment and discharge									
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
International bunkers	0.80	0.97	0.84	0.91	1.11	1.05	1.18	1.19	178.78
Aviation	0.80	0.97	0.84	0.91	1.11	1.05	1.18	1.19	178.78
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO2 emissions from biomass	15.29	18.02	19.07	20.56	20.95	18.39	18.40	20.60	273.66
CO2 captured	104.44	107.82	99.82	91.15	95.08	98.58	74.69	87.64	-2.25
Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Indirect N2O									
Indirect CO2 (3)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total CO2 equivalent emissions with land use, land-use change and forestry	239.80	227.64	211.48	197.85	206.71	206.06	174.68	167.46	-17.09
Total CO2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Note: All footnotes for this table are given at the end of the table on sheet 6.									

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[b] Fill in net emissions/removals as reported in CRF table Summary 1.A of the latest reported inventory year. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

Custom Footnotes

Table 1(b) LIE_BR3_v0.1

Emission trends (CH_4)

(Sheet 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year* [a]	1990	1991	1992	1993	1994	1995	1996	1997
	kt								
1. Energy	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06
A. Fuel combustion (sectoral approach)	0.04	0.04	0.03	0.04	0.03	0.03	0.03	0.03	0.03
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
4. Other sectors	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03
C. CO2 transport and storage									
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Mineral industry									
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.67	0.67	0.67	0.65	0.61	0.62	0.62	0.63	0.62
A. Enteric fermentation	0.55	0.55	0.54	0.53	0.50	0.51	0.51	0.52	0.51
B. Manure management	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11
C. Rice cultivation	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
D. Agricultural soils	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
G. Liming									
H. Urea application									
I. Other carbon-containing fertilizers									
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products									
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.06
A. Solid waste disposal	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
B. Biological treatment of solid waste	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH4 emissions with CH4 from LULUCF	0.78	0.78	0.78	0.76	0.73	0.74	0.73	0.75	0.74
Memo items:									
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass									
CO2 captured									
Long-term storage of C in waste disposal sites									
Indirect N2O									
Indirect CO2 (3)									

Note: All footnotes for this table are given on sheet 3.

Table 1(b) LIE_BR3_v0.1

Emission trends (CH_4)

(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy	0.06	0.06	0.07	0.06	0.07	0.07	0.07	0.07	0.08	0.08
A. Fuel combustion (sectoral approach)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4. Other sectors	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05
C. CO2 transport and storage										
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Mineral industry										
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.61	0.58	0.56	0.60	0.60	0.60	0.61	0.62	0.65	0.66
A. Enteric fermentation	0.50	0.48	0.46	0.49	0.50	0.50	0.51	0.52	0.54	0.55
B. Manure management	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11
C. Rice cultivation	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
D. Agricultural soils	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
G. Liming										
H. Urea application										
I. Other carbon-containing fertilizers										
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.06	0.06	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07
A. Solid waste disposal	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B. Biological treatment of solid waste	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH4 emissions with CH4 from LULUCF	0.73	0.70	0.69	0.72	0.73	0.74	0.74	0.77	0.80	0.82
Memo items:										
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass										
CO2 captured										
Long-term storage of C in waste disposal sites										
Indirect N2O										
Indirect CO2 (3)										

Note: All footnotes for this table are given on sheet 3.

Table 1(b) LIE_BR3_v0.1

Emission trends (CH_4)

(Sheet 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
									%
1. Energy	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	66.75
A. Fuel combustion (sectoral approach)	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.04	4.72
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	527.73
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-11.91
3. Transport	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	-84.78
4. Other sectors	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	285.38
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Fugitive emissions from fuels	0.05	0.04	0.05	0.04	0.05	0.05	0.05	0.05	215.23
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	0.05	0.04	0.05	0.04	0.05	0.05	0.05	0.05	215.23
C. CO2 transport and storage									
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	0.00
A. Mineral industry									
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	0.67	0.67	0.64	0.66	0.67	0.64	0.65	0.64	-4.79
A. Enteric fermentation	0.56	0.55	0.54	0.55	0.56	0.53	0.54	0.53	-3.01
B. Manure management	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	-12.73
C. Rice cultivation	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NO	0.00
D. Agricultural soils	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	0.00
G. Liming									
H. Urea application									
I. Other carbon-containing fertilizers									
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
4. Land use, land-use change and forestry	NO	NO	NO	NO	NO	NO	NO	NO	0.00
A. Forest land	NO	NO	NO	NO	NO	NO	NO	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	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Harvested wood products									
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	0.08	0.07	0.07	0.07	0.07	0.07	0.06	0.06	-3.98
A. Solid waste disposal	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	-75.32
B. Biological treatment of solid waste	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	45.48
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-20.10
D. Waste water treatment and discharge	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	14.12
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total CH4 emissions with CH4 from LULUCF	0.83	0.82	0.79	0.81	0.83	0.79	0.79	0.78	-0.16
Memo items:									
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	180.31
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO2 emissions from biomass									
CO2 captured									
Long-term storage of C in waste disposal sites									
Indirect N2O									
Indirect CO2 (3)									

Abbreviations : CRF = common reporting format, LULUCF = land use, land-use change and

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

Custom Footnotes

Table 1(c) LIE_BR3_v0.1

Emission trends (N_2O)

(Sheet 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year*[a]	1990	1991	1992	1993	1994	1995	1996	1997
	kt								
1. Energy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
A. Fuel combustion (sectoral approach)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Other sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
C. CO2 transport and storage									
2. Industrial processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Mineral industry									
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
A. Enteric fermentation									
B. Manure management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Rice cultivation									
D. Agricultural soils	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
G. Liming									
H. Urea application									
I. Other carbon containing fertlizers									
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F. Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Harvested wood products									
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Solid waste disposal									
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N2O emissions with N2O from LULUCF	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Memo items:									
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass									
CO2 captured									
Long-term storage of C in waste disposal sites									
Indirect N2O	NO	NO	NO	NO	NO	NO	NO	NO	NO
Indirect CO2 (3)									

Note: All footnotes for this table are given on sheet 3.

Table 1(c) LIE_BR3_v0.1

Emission trends (N_2O)

(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Fuel combustion (sectoral approach)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3. Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Other sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive emissions from fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
C. CO2 transport and storage										
2. Industrial processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Mineral industry										
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
A. Enteric fermentation										
B. Manure management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Rice cultivation										
D. Agricultural soils	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
G. Liming										
H. Urea application										
I. Other carbon containing fertlizers										
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F. Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. Solid waste disposal										
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N2O emissions with N2O from LULUCF	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
Memo items:										
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 emissions from biomass										
CO2 captured										
Long-term storage of C in waste disposal sites										
Indirect N2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Indirect CO2 (3)										

Note: All footnotes for this table are given on sheet 3.

Table 1(c) LIE_BR3_v0.1

Emission trends (N_2O)

(Sheet 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
									%
1. Energy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-32.42
A. Fuel combustion (sectoral approach)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-32.42
1. Energy industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-94.61
2. Manufacturing industries and construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.45
3. Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-48.57
4. Other sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.37
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Fugitive emissions from fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	0.00
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	0.00
C. CO2 transport and storage									
2. Industrial processes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-55.65
A. Mineral industry									
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-55.65
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	-6.95
A. Enteric fermentation									
B. Manure management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.29
C. Rice cultivation									
D. Agricultural soils	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-10.51
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	0.00
G. Liming									
H. Urea application									
I. Other carbon containing fertlizers									
J. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
4. Land use, land-use change and forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.52
A. Forest land	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.27
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	362.00
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	283.92
E. Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.80
F. Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	175.54
G. Harvested wood products									
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.32
A. Solid waste disposal									
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.48
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-20.10
D. Waste water treatment and discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.85
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total direct N2O emissions with N2O from LULUCF	0.04	0.04	0.03	0.04	0.04	0.03	0.03	0.03	-8.45
Memo items:									
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	180.31
Navigation	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO2 emissions from biomass									
CO2 captured									
Long-term storage of C in waste disposal sites									
Indirect N2O	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Indirect CO2 (3)									

Abbreviations : CRF = common reporting format, LULUCF = land use, land-use change an

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

Custom Footnotes

Table 1(d) LIE_BR3_v0.1

Emission trends (HFCs, PFCs and SF_6)

(Sheet 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year*[a]	1990	1991	1992	1993	1994	1995	1996	1997
	kt								
Emissions of HFCs and PFCs - (kt CO2 equivalent)									
Emissions of HFCs - (kt CO2 equivalent)	0.00	0.00	0.01	0.09	0.20	0.51	1.35	1.72	2.11
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_3F_8	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given on sheet 3.

Table 1(d) LIE_BR3_v0.1

Emission trends (HFCs, PFCs and SF_6)

(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
Emissions of HFCs and PFCs - (kt CO2 equivalent)										
Emissions of HFCs - (kt CO2 equivalent)	2.74	3.35	4.11	4.94	5.48	6.13	6.97	7.37	7.82	8.48
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unspecified mix of HFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_3F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given on sheet 3.

Table 1(d) LIE_BR3_v0.1

Emission trends (HFCs, PFCs and SF_6)

(Sheet 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
									%
Emissions of HFCs and PFCs - (kt CO2 equivalent)									
Emissions of HFCs - (kt CO2 equivalent)	9.12	9.12	9.69	9.96	10.37	10.63	10.64	10.42	9,974,953.52
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-134a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,476,479.00
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-143a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-365mfc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Unspecified mix of HFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_3F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of PFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
NF3	NO	NO	NO	NO	NO	NO	NO	NO	0.00

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[c] Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO2 equivalent emissions.

[d] In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories", HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is kt of CO2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.)

For further information please refer to chapter 3 of Liechtenstein's Seventh National Communication.

3. Quantified Economy-wide Emission Reduction Target (QEWER)

Liechtenstein's quantified economy-wide emission reduction target

Liechtenstein quantified economy-wide emission reduction target is -20% of its 1990 total GHG emissions by 2020.

Table 2(a) LIE_BR3_v0.1

Description of quantified economy-wide emission reduction target: base year[a]

Party	*Liechtenstein*	
Base year /base period	1990	
Emission reduction target	% of base year/base period	% of 1990 [b]
		20.00
Period for reaching target	BY-2020	

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Optional.

Table 2(b) LIE_BR3_v0.1

Description of quantified economy-wide emission reduction target: gases and sectors covered[a]

Gases covered		*Base year for each gas (year):*
CO_2		1990
CH_4		1990
N_2O		1990
HFCs		1990
PFCs		1990
SF_6		1990
NF_3		
Other Gases (specify)		
Sectors covered[b]	Energy	Yes
	Transport[f]	Yes
	Industrial processes[g]	Yes
	Agriculture	Yes
	LULUCF	Yes
	Waste	Yes
	Other Sectors (specify)	

Abbreviations : LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] More than one selection will be allowed. If Parties use sectors other than those indicated above, the explanation of how these sectors relate to the sectors defined by the IPCC should be provided.

[f] Transport is reported as a subsector of the energy sector.

[g] Industrial processes refer to the industrial processes and solvent and other product use sectors.

Table 2(c) LIE_BR3_v0.1

Description of quantified economy-wide emission reduction target: global warming potential values (GWP)[a]

Gases	*GWP values* [b]
CO_2	4th AR
CH_4	4th AR
N_2O	4th AR
HFCs	4th AR
PFCs	4th AR
SF_6	4th AR
NF_3	
Other Gases (specify)	

Abbreviations: GWP = global warming potential

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Please specify the reference for the GWP: Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) or the Fourth Assessment Report of the IPCC.

Table 2(d) LIE_BR3_v0.1

Description of quantified economy-wide emission reduction target: approach to counting emissions and removals from the LULUCF sector[a]

Role of LULUCF	LULUCF in base year level and target	Included
	Contribution of LULUCF is calculated using	Land-based approach

Abbreviation: LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

Use of international market based mechanisms

Liechtenstein will continue the use of carbon credits generated from the flexible mechanisms of the Kyoto Protocol and from new market based mechanisms under the Convention in order to ensure the achievement of the abovementioned reduction target. Current projections, as contained in Liechtenstein's 7th National Communication (Chapter 5.2.4), forecast an annual demand of around 17'640 t CO_2eq to be reduced abroad. This number is based on annual emissions estimates of 192.12 kt CO_2.

However, in order to calculate the exact amount of carbon credits until 2020 the Government will have to conclude further estimations and projections, based on the effective implementation of policy measures which have been proposed in the Government's Energy Strategy 2020.

As described above Liechtenstein has not yet calculated the exact amount of required carbon credits from abroad. During COP 18 in 2012 in Doha, Qatar Liechtenstein declared not to acquire AAUs for compliance purposes under the second commitment period of the Kyoto Protocol (FCCC/KP/CMP/2012/L.9). Liechtenstein may, however, use a limited amount of its own AAUs to be carried over in the second commitment period (see Table 2 (e)I).

Table 2(e)I LIE_BR3_v0.1

Description of quantified economy-wide emission reduction target: market-based mechanisms under the Convention[a]

Market-based mechanisms under the Convention	*Possible scale of contributions (estimated kt CO_2 eq)*
CERs	62.73
ERUs	0.00
AAUs[i]	
Carry-over units[j]	42.98
Other mechanism units under the Convention (specify)[d]	

Abbreviations: AAU = assigned amount unit, CER = certified emission reduction, ERU = emission reduction unit.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[d] As indicated in paragraph 5(e) of the guidelines contained in annex I of decision 2/CP.17 .

[i] AAUs issued to or purchased by a Party.

[j] Units carried over from the first to the second commitment periods of the Kyoto Protocol, as described in decision 13/CMP.1 and consistent with decision 1/CMP.8.

Table 2(e)II LIE_BR3_v0.1

Description of quantified economy-wide emission reduction target: other market-based mechanisms[a]

Other market-based mechanisms (Specify)	*Possible scale of contributions (estimated kt CO_2 eq)*

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

Table 2(f) LIE_BR3_v0.1

Description of quantified economy-wide emission reduction target: any other information[a,b]

no source of NF3 in Liechtenstein

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] This information could include information on the domestic legal status of the target or the total assigned amount of emission units for the period for reaching a target. Some of this information is presented in the narrative part of the biennial report.

Custom Footnotes

For further information please refer to chapter 5.2.4 of Liechtenstein's Seventh National Communication.

4. Progress in achievement of QEWER target

Mitigation actions and their effects in Liechtenstein

Liechtenstein has implemented its climate related policies and measures strongly into individual sectorial policies. The responsibility of monitoring the effects of individual measures or policies is therefore beard by the respective administration offices that are in charge of the execution of the individual measure. These authorities provide an annual report of their activities (not only climate change related) which will be forwarded to the Liechtenstein Parliament. The reports are publicly available.

Liechtenstein's legislative and administrative main arrangements to meet its commitments under the Kyoto Protocol are to be found in the Emissions Trading Act and the CO_2 Act. There is no change in domestic institutional arrangements, including institutional, legal, administrative and procedural arrangements used for domestic compliance, monitoring, reporting and archiving of information, and an evaluation of the progress made towards its target since the last report. This information could be found in the CO_2 Act and in the Emissions Trading Act.

The Emissions Trading Act (EHG) sets up the general framework for the fulfilment of Liechtenstein's reduction obligations originating from the respective ratification of the Kyoto Protocol. In 2012 the Government introduced a legally binding greenhouse gas reduction target from at least 20% compared to 1990 until 2020. In addition, the EHG states that emission reductions are first and foremost to be reduced by domestic measures. If the reduction obligations cannot be fulfilled through domestic measures the government may participate in project activities abroad or in international emissions trading. Besides this the EHG implements Directive 2003/87/EC (Emissions Trading Directive) into national law and obliges two industrial installations (2013) to participate within the European Emissions Trading Scheme. Due to comprehensive amendments of Directive 2003/87/EC the EHG has been revised in 2012. The regulations of the EHG with respect to the participation of Liechtenstein in the Kyoto Protocols flexible mechanisms as well as with respect to domestic emissions trading are executed by the Office of Environment.

The CO_2 Act corresponds with the CO_2 Act of Switzerland (in force since 2008) and introduces a levy on the consumption of fossil fuel (oil and natural gas). In 2013 the CO2 Act has been revised. Besides the levy on fossil fuel an obligation to compensate CO_2 emissions from the use of motor fuels (gasoline and diesel) as well as emission regulations for passenger cars has been introduced.

The CO_2 Act is part of "The bilateral Agreement between the Principality of Liechtenstein and the Swiss Confederation on Environmental Levies within the Principality of Liechtenstein".

The Emissions Trading Act provides the basis for the coordination of different sectors on climate measures, the framework for the purchase of emission reduction units abroad, etc. The CO_2 Act is coordinated on the basis of the bilateral treaty on environmental levies between Liechtenstein and Switzerland through the relevant Swiss authorities.

In terms of measurable mitigation action, the most relevant measures are to be found in the energy sector, since over 80 % of Liechtenstein's CO_2 emissions are energy related. To this regard the Energy Efficiency Act and the Energy Strategy 2020 serve as central drivers for the achievement of Liechtenstein's GHG reduction targets until 2020:

The **Energy Efficiency Act** (2008) and the relevant Ordinance (2008) as well as the Energy Ordinance (2007) on the Construction Act constitute the legal framework for the implementation of measures relating to buildings. A gratifying development is also that municipalities now supplement national Energy Conservation Act subsidies with their own funds. The Government intends to promote the measures for

implementing the objectives laid down in the energy strategy with financial resources and advice. The increase of energy efficiency and in particular the increased use of renewable energies are of central importance for the reduction of greenhouse gas emissions and accordingly for a long-term climate policy.

In 2012 the Government adopted the "**Energy Strategy 2020**". The strategy provides future-oriented impulses for the national energy policy. The focus areas of the concept are the promotion of efficient energy use, the use of renewable energies, and energy conservation. These goals correspond to the aims of the EU's 20-20-20 climate package from 2008. Increase the share of renewable energy in total energy use from 8% to 20% by 2020. Increase the energy efficiency to 20% to stabilize the energy consumption on the level of 2008 by 2020 and 20% reduction of the CO_2 emission by 2020. The Energy Strategy 2020 also addressed the need to minimize adverse effects of its proposed measures as required by Art. 2 paragraph 3 of the Kyoto Protocol. The proposed set of measures has been checked against its compatibility with economic as well as social requirements.

Most environmental acts only have climate change mitigation co-benefits and the mitigation effects can't be estimated. No estimates can be given for planned measures as there is no legal framework in place yet. Estimates might be given as soon as there is an update of Liechtenstein's Energy Strategy. It will be updated in the course of 2018/2019.

For further information please refer to chapter 4 of Liechtenstein's Seventh National Communication.

Table 3
Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects

Name of mitigation action [a]	*Sector(s) affected* [b]	*GHG(s) affected*	*Objective and/or activity affected*	*Type of instrument* [c]	*Status of implementation* [d]	*Brief description* [e]	*Start year of implementation*	*Implementing entity or entities*	*Estimate of mitigation impact (not cumulative, in kt CO_2 eq)* [f]
									2020
Energy Efficiency Act*	Energy	CO_2	Aims for the reduction of energy, the intelligent and economic use of energy as well as the promotion of renewable energies. Promotion of heat insu¬lation (renovation of old buildings), residential technical installations (room heating and nonpotable water), solar energy (thermal solar collectors and photovoltaics) and demon¬stration facilities.	Fiscal	Implemented		2008	Office of Economic Affairs	2.89
Liechtenstein Energy Strategy 2020*	Energy	CO_2	Governmental Strategy that ensures a sustainable energy supply	Other (Planning measure)	Implemented		2012	Government of Liechtenstein / Office of Economic Affairs	6.89

Note: The two final columns specify the year identified by the Party for estimating impacts (based on the status of the measure and whether an ex post or ex ante estimation is available).

Abbreviations: GHG = greenhouse gas; LULUCF = land use, land-use change and forestry.

[a] Parties should use an asterisk (*) to indicate that a mitigation action is included in the 'with measures' projection.

[b] To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors, cross-cutting, as appropriate.

[c] To the extent possible, the following types of instrument should be used: economic, fiscal, voluntary agreement, regulatory, information, education, research, other.

[d] To the extent possible, the following descriptive terms should be used to report on the status of implementation: implemented, adopted, planned.

[e] Additional information may be provided on the cost of the mitigation actions and the relevant timescale.

[f] Optional year or years deemed relevant by the Party.

Custom Footnotes

Estimates of emission reductions and removals and the use of units from the market-based mechanisms and LULUCF

Information on the effective quantity of units from market based mechanisms under the Convention is provided in Table 4(b).

Table 4 LIE_BR3_v0.1

Reporting on progress[a, b]

	Total emissions excluding LULUCF	*Contribution from LULUCF*[d]	*Quantity of units from market based mechanisms under the Convention*		*Quantity of units from other market based mechanisms*	
Year[c]	*(kt CO_2 eq)*	*(kt CO_2 eq)*	*(number of units)*	*(kt CO_2 eq)*	*(number of units)*	*(kt CO_2 eq)*
Base year/period (1990)	231.56*					
2010	246.03*					
2011	230.15*					
2012	239.95*					
2013	246.62*					
2014	215.97*					
2015	207.70*		51.71*			
2016			54.00*			

Abbreviation: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] For the base year, information reported on the emission reduction target shall include the following: (a) total GHG emissions, excluding emissions and removals from the LULUCF sector; (b) emissions and/or removals from the LULUCF sector based on the accounting approach applied taking into consideration any relevant decisions of the Conference of the Parties and the activities and/or land that will be accounted for; (c) total GHG emissions, including emissions and removals from the LULUCF sector. For each reported year, information reported on progress made towards the emission reduction targets shall include, in addition to the information noted in paragraphs 9(a–c) of the UNFCCC biennial reporting guidelines for developed country Parties, information on the use of units from market-based mechanisms.

[c] Parties may add additional rows for years other than those specified below.

[d] Information in this column should be consistent with the information reported in table 4(a)I or 4(a)II, as appropriate. The Parties for which all relevant information on the LULUCF contribution is reported in table 1 of this common tabular format can refer to table 1.

Custom Footnotes

Table 4(a)I LIE_BR3_v0.1

Progress in achieving the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector in 2015 [a,b]

	Net GHG emissions/removals from LULUCF categories [c]	*Base year/period or reference level value* [d]	*Contribution from LULUCF for reported year*	*Cumulative contribution from LULUCF* [e]	*Accounting approach* [f]
	(kt CO_2 eq)				
Total LULUCF					Land-based approach
A. Forest land					Land-based approach
1. Forest land remaining forest land					Land-based approach
2. Land converted to forest land					Land-based approach
3. Other [g]					Land-based approach
B. Cropland					Land-based approach
1. Cropland remaining cropland					Land-based approach
2. Land converted to cropland					Land-based approach
3. Other [g]					Land-based approach
C. Grassland					Land-based approach
1. Grassland remaining grassland					Land-based approach
2. Land converted to grassland					Land-based approach
3. Other [g]					Land-based approach
D. Wetlands					Land-based approach
1. Wetland remaining wetland					Land-based approach
2. Land converted to wetland					Land-based approach
3. Other [g]					Land-based approach
E. Settlements					Land-based approach
1. Settlements remaining settlements					Land-based approach
2. Land converted to settlements					Land-based approach
3. Other [g]					Land-based approach
F. Other land					Land-based approach
1. Other land remaining other land					Land-based approach
2. Land converted to other land					Land-based approach
3. Other [g]					Land-based approach
G. Other					Land-based approach
Harvested wood products					Land-based approach

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Parties that use the LULUCF approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[c] For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its Kyoto Protocol, explain in the biennial report how the value was derived.

[d] Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.

[e] If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.

[f] Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).

[g] Specify what was used for the category "other". Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its Kyoto Protocol.

Custom Footnotes

Table 4(a)I LIE_BR3_v0.1

Progress in achieving the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector in 2016 [a, b]

	Net GHG emissions/removals from LULUCF categories [c]	*Base year/period or reference level value* [d]	*Contribution from LULUCF for reported year*	*Cumulative contribution from LULUCF* [e]	*Accounting approach* [f]
	(kt CO_2 eq)				
Total LULUCF					Land-based approach
A. Forest land					Land-based approach
1. Forest land remaining forest land					Land-based approach
2. Land converted to forest land					Land-based approach
3. Other [g]					Land-based approach
B. Cropland					Land-based approach
1. Cropland remaining cropland					Land-based approach
2. Land converted to cropland					Land-based approach
3. Other [g]					Land-based approach
C. Grassland					Land-based approach
1. Grassland remaining grassland					Land-based approach
2. Land converted to grassland					Land-based approach
3. Other [g]					Land-based approach
D. Wetlands					Land-based approach
1. Wetland remaining wetland					Land-based approach
2. Land converted to wetland					Land-based approach
3. Other [g]					Land-based approach
E. Settlements					Land-based approach
1. Settlements remaining settlements					Land-based approach
2. Land converted to settlements					Land-based approach
3. Other [g]					Land-based approach
F. Other land					Land-based approach
1. Other land remaining other land					Land-based approach
2. Land converted to other land					Land-based approach
3. Other [g]					Land-based approach
G. Other					Land-based approach
Harvested wood products					Land-based approach

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Parties that use the LULUCF approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[c] For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its Kyoto Protocol, explain in the biennial report how the value was derived.

[d] Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.

[e] If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.

[f] Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).

[g] Specify what was used for the category "other". Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its Kyoto Protocol.

Custom Footnotes

Table 4(a)II

LIE_BR3_v0.1
Source: Submission 2018 v6, LIECHTENSTEIN

Progress in achievement of the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land-use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol[a,b,c]

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	*Base year*[d]	*Net emissions/removals*[e]									*Accounting parameters*[h]	*Accounting quantity*[i]
		2013	2014	*2015*	*2016*	2017	2018	2019	2020	Total[g]		
	($kt CO_2 eq$)											
A. Article 3.3 activities												
A.1. Afforestation/reforestation		-0.24	-0.25	-0.26						-0.76		-0.76
Excluded emissions from natural disturbances(5)			NO	NO						NO		NO
Excluded subsequent removals from land subject to natural disturbances(6)			NO	NO						NO		NO
A.2. Deforestation		4.66	4.57	4.57						13.80		13.80
B. Article 3.4 activities												
B.1. Forest management										5.71		4.63
Net emissions/removalse		3.80	3.74	-1.83						5.71		
Excluded emissions from natural disturbances(5)			NO							NO		NO
Excluded subsequent removals from land subject to natural disturbances(6)			NO							NO		NO
Any debits from newly established forest (CEF-ne)(7),(8)												
Forest management reference level (FMRL)(9)											0.10	
Technical corrections to FMRL(10)											0.26	
Forest management capl											64.17	4.63
B.2. Cropland management (if elected)			NO							NO		NO
B.3. Grazing land management (if elected)			NO							NO		NO
B.4. Revegetation (if elected)			NO							NO		NO
B.5. Wetland drainage and rewetting (if elected)			NO							NO		NO

Note: 1 kt CO_2 eq equals 1 Gg CO_2 eq.

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Developed country Parties with a quantified economy-wide emission reduction target as communicated to the secretariat and contained in document FCCC/SB/2011/INF.1/Rev.1 or any update to that document, that are Parties to the Kyoto Protocol, may use table 4(a)II for reporting of accounting quantities if LULUCF is contributing to the attainment of that target.

[c] Parties can include references to the relevant parts of the national inventory report, where accounting methodologies regarding LULUCF are further described in the documentation box or in the

[d] Net emissions and removals in the Party's base year, as established by decision 9/CP.2.

[e] All values are reported in the information table on accounting for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.

[f] Additional columns for relevant years should be added, if applicable.

[g] Cumulative net emissions and removals for all years of the commitment period reported in the current submission.

[h] The values in the cells "3.3 offset" and "Forest management cap" are absolute values.

[i] The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7, paragraph 4, of the Kyoto Protocol.

[j] In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following afforestation and reforestation since 1990 shall not be greater than the credits accounted for on that unit of land.

[k] In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3 paragraph 3, may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3, paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.

[l] In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period of the Kyoto Protocol only, additions to and subtractions from the assigned amount of a Party resulting from Forest management under Article 3, paragraph 4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.

Custom Footnotes

Information on the effective quantity of units from market based mechanisms under the Convention is provided in Table 4(b).

Table 4(b) LIE_BR3_v0.1

Reporting on progress[a, b, c]

Units of market based mechanisms			*Year*	
			2015	*2016*
Kyoto Protocol units[d]	*Kyoto Protocol units*	*(number of units)*	51715	54000
		(kt CO_2 eq)		
	AAUs	*(number of units)*	42984	
		(kt CO2 eq)		
	ERUs	*(number of units)*		
		(kt CO2 eq)		
	CERs	*(number of units)*	8731	54000
		(kt CO2 eq)		
	tCERs	*(number of units)*		
		(kt CO2 eq)		
	lCERs	*(number of units)*		
		(kt CO2 eq)		
Other units[d,e]	*Units from market-based mechanisms under the Convention*	*(number of units)*		
		(kt CO_2 eq)		
	Units from other market-based mechanisms	*(number of units)*		
		(kt CO_2 eq)		
Total		*(number of units)*	51715	54000
		(kt CO_2 eq)		

Abbreviations: AAUs = assigned amount units, CERs = certified emission reductions, ERUs = emission reduction units, lCERs = long-term certified emission reductions, tCERs = temporary certified emission reductions.
Note: 2011 is the latest reporting year.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] For each reported year, information reported on progress made towards the emission reduction target shall include, in addition to the information noted in paragraphs 9(a-c) of the reporting guidelines, on the use of units from market-based mechanisms.

[c] Parties may include this information, as appropriate and if relevant to their target.

[d] Units surrendered by that Party for that year that have not been previously surrendered by that or any other Party.

[e] Additional rows for each market-based mechanism should be added, if applicable.

Custom Footnotes

For further information please refer to chapter 4 of Liechtenstein's Seventh National Communication.

5. Projections

The projections of Liechtenstein's greenhouse gas emissions are calculated under the three scenarios '*without measures' (WOM), 'with existing measures' (WEM) and 'with additional measures' (WAM) according to the guidelines for the preparation of national communications (UNFCCC 2017):*

- *The 'without measures' (WOM) scenario projection excludes all policies and measures implemented, adopted or planned after the year chosen as the starting point for that projection. For Liechtenstein's NC7, this starting year is the latest inventory year (2015) and the WOM scenario assumes that emissions stay constant in the period 2016-2030.*
- *The 'with existing measures' (WEM) scenario projection encompasses currently implemented and adopted policies and measures. In Liechtenstein, projections based on specific measures are only available for the sector Energy (1A Fuel combustion). For the waste sector, a projection exists in Liechtenstein's Waste Plan (Liechtensteiner Abfallplanung 2012-2070, Government 2011). Further projections for the sectors Energy (1B Fugitive emissions from fuels) as well as for IPPU (sector 2) and Agriculture (sector 3) were adopted from Switzerland's WEM projection in its NC7 (FOEN 2018). The projections for LULUCF were assumed to be constant (mean of the latest five inventory years) and the projection of international bunkers is based on a linear extrapolation of the reported inventory data.*
- *The 'with additional measures' (WAM) scenario projection also encompasses planned policies and measures. In Liechtenstein, additional measures only exist in the energy sector. Where necessary, the WAM scenario from Switzerland's NC7 was adopted (FOEN 2018).*

The sector Energy is dominating Liechtenstein's greenhouse gas emissions. In the year 2015, emissions from this sector amounted 81.4% of Liechtenstein's total emissions. Therefore, the focus for the elaboration of Liechtenstein's projections in its NC7 lies on the Energy sector.

The aggregated projections in CO_2 equivalents under the WEM and WAM scenario are depicted in the following tables. The actual GHG emission reduction for the years 1990-2015 amounts 13.0%. From then, further reductions by 20.5% (WEM scenario) and by 27.0% (WAM scenario) are projected in the years 2015-2030. The total reduction from 1990-2030 under the WEM scenario is anticipated to be 30.8%, for the WAM scenario 36.5%.

Table 5 LIE_BR3_v0.1

Summary of key variables and assumptions used in the projections analysis [a]

Key underlying assumptions		*Historical* [b]						Projected			
Assumption	*Unit*	*1990*	*1995*	2000	2005	2010	2011	2015	2020	2025	2030
Population	*thousands*	29.03	30.92	32.86	34.90	36.14	36.47	38.03	39.59	40.99	42.18
Population growth	*%*								1.55	1.55	1.55

[a] Parties should include key underlying assumptions as appropriate.

[b] Parties should include historical data used to develop the greenhouse gas projections reported.

Custom Footnotes

Table 6(a) LIE_BR3_v0.1

Information on updated greenhouse gas projections under a 'with measures' scenario[a]

	GHG emissions and removals[b]							GHG emission projections	
	(kt CO_2 eq)							(kt CO_2 eq)	
	Base year (1990)	1990	1995	2000	2005	2010	2015	2020	2030
Sector[d,e]									
Energy	201.10	201.10	206.80	219.80	231.60	193.80	162.30	138.92	124.36
Transport	76.80	76.80	81.80	91.30	81.90	77.80	61.90	61.05	55.35
Industry/industrial processes	0.50	0.50	1.70	4.50	7.90	10.00	10.70	10.00	7.77
Agriculture	25.50	25.50	23.70	21.50	23.60	24.20	24.10	23.61	23.37
Forestry/LULUCF	3.50	3.50	3.20	22.00	5.60	21.10	8.30	15.82	15.82
Waste management/waste	2.20	2.20	2.20	2.40	2.60	2.40	2.30	2.56	3.03
Other (specify)									
Gas									
CO_2 emissions including net CO_2 from LULUCF	202.00	202.00	206.90	238.40	234.10	211.50	167.50	151.44	137.05
CO_2 emissions excluding net CO_2 from LULUCF	198.80	198.80	204.10	216.70	228.90	190.80	159.55	136.42	122.03
CH_4 emissions including CH_4 from LULUCF	19.50	19.50	18.30	17.40	19.20	19.80	19.50	19.19	19.24
CH_4 emissions excluding CH_4 from LULUCF	19.50	19.50	18.30	17.40	19.20	19.80	19.50	19.19	19.24
N_2O emissions including N_2O from LULUCF	11.20	11.20	10.90	10.20	10.20	10.30	10.30	10.47	10.43
N_2O emissions excluding N_2O from LULUCF	10.90	10.90	10.60	9.80	9.90	9.90	9.80	9.68	9.64
HFCs	0.00	0.00	1.40	4.10	7.40	9.70	10.40	9.74	7.57
PFCs	NO	NO	NO	0.00	0.10	0.10	0.00	0.04	0.03
SF_6	NO	NO	NO	0.10	0.30	0.00	0.00	0.03	0.03
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other (specify)									
Total with LULUCF[f]	232.70	232.70	237.50	270.20	271.30	251.40	207.70	190.92*	174.36*
Total without LULUCF	229.20	229.20	234.40	248.10	265.80	230.30	199.25	175.10	158.54

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", at a minimum Parties shall report a 'with measures' scenario, and may report 'without measures' and 'with additional measures' scenarios. If a Party chooses to report 'without measures' and/or 'with additional measures' scenarios they are to use tables 6(b) and/or 6(c), respectively. If a Party does not choose to report 'without measures' or 'with additional measures' scenarios then it should not include tables 6(b) or 6(c) in the biennial report.

[b] Emissions and removals reported in these columns should be as reported in the latest GHG inventory and consistent with the emissions and removals reported in the table on GHG emissions and trends provided in this biennial report. Where the sectoral breakdown differs from that reported in the GHG inventory Parties should explain in their biennial report how the inventory sectors relate to the sectors reported in this table.

[c] 20XX is the reporting due-date year (i.e. 2014 for the first biennial report).

[d] In accordance with paragraph 34 of the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", projections shall be presented on a sectoral basis, to the extent possible, using the same sectoral categories used in the policies and measures section. This table should follow, to the extent possible, the same sectoral categories as those listed in paragraph 17 of those guidelines, namely, to the extent appropriate, the following sectors should be considered: energy, transport, industry, agriculture, forestry and waste management.

[e] To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors (i.e. cross-cutting), as appropriate.

[f] Parties may choose to report total emissions with or without LULUCF, as appropriate.

For further information please refer to chapter 5 of Liechtenstein's Seventh National Communication.

6. Provision of financial, technological and capacity-building support to developing country Parties

According to the biennial reporting guidelines the reporting obligations concerning financial, technological and capacity-building support to developing country parties only apply to Annex II Parties to the Convention (see FCCC/CP/2011/9/Add.1, Annex I, Chapter VI). Since Liechtenstein is not listed in Annex II to the Convention the Government does not consider itself to be bound by the respective provisions.

However, due to Liechtenstein's activities within the Fast Start Finance Period 2010 to 2012 as well as with regard to the Government decision of 2012 to continue its engagement within the framework of international climate finance Liechtenstein has chosen to report these activities under paragraph 25, Chapter 7 "Other Reporting matters".

With respect to future submissions Liechtenstein aims at using that reporting format and opportunity to also address the request by Parties made in conjunction with the work program on long term finance at COP 19 in Warsaw[1].

[1] see paragraph 10 http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf

7. Other reporting elements

Liechtenstein's emissions measurements, reporting and verification and emission projections

Liechtenstein accounts yearly for the national greenhouse gas inventory (NIR).

The annual publication of Liechtenstein's energy statistics, provided by the Office of Statistics, serves as a monitoring tool in order to evaluate the effect of the respective policies. Based on the Energy Strategy 2020 the Government has set up an administrative body that is responsible for the implementation and monitoring of measures set up by the Energy Strategy 2020.

Liechtenstein's activities within international climate finance

Liechtenstein has repeatedly underscored its commitment to achieving the international Official Development Assistance (ODA) target of 0.7%. Liechtenstein's most recent ODA percentage for the year 2013 is 0.65. As part of the global effort, Liechtenstein committed a respective climate finance contribution:

With calculations taking into account the national level of emissions, the financial capacity and the population size, the Liechtenstein Parliament decided in 2010 to introduce a new fast-start financing budget line of CHF 700'000 for the years 2011 and 2012. This budget was new and additional to the already existing IHCD budget. Liechtenstein's fast-start financing commitment was therefore not diverting from other important development priorities, but instead complemented and strengthened existing priorities. In 2012, the Parliament decided to extend its engagement in climate finance until 2015 with a total budget of CHF 600'000 on a voluntary basis. As a result, Liechtenstein has provided more than 1.5 Million USD of climate finance since 2011. In 2015, the Parliament decided to give permanence to the climate finance commitment and integrated climate finance into the regular budget of IHCD. As a result, the Government expects to support climate related projects with at least CHF 200'000 annually, starting from 2016.

Within its climate finance engagement Liechtenstein's prime concern is the delivery of effective results and benefits which address the sustainable development and climate change needs and priorities of developing countries. Moreover, Liechtenstein aims at giving support in planning and realizing sustainable development by further defining a responsible development framework, evaluating capacities, making wise use of and therefore securing resources. To this respect Liechtenstein's climate finance not only aims to assist in governance and capacity-building, but also to foster effects like safe living conditions and guaranteeing subsistence, which is respecting dignity and creating additional sources of income and constant progress in the field of education and jobs.

Project actions and components covered by Liechtenstein's support under climate finance therefore need to:

- show a need driven approach, because they are developed by recipients and reflect their priorities;
- allow recipients to gain ownership of the processes and projects;
- activate the self-organization of local populations;
- support socially, economically and environmentally friendly initiatives;
- contribute solving gender problems, empowering women, raising awareness among young people and civil society and finally strengthening peace and security.

In general, support is given to development country partners to help them both adapt to and mitigate the effects of climate change. For the sake of performance and efficiency, Liechtenstein prefers a bilateral

allocation of climate finance projects. Therefore, the realization of projects is focused on traditional cooperation partners under the umbrella of the Mountain Partnership or partners of the Liechtenstein Development Service (LED).

Liechtenstein's **adaptation** assistance focuses on improving resilience to extreme weather conditions and other hazards, by investing in infrastructure which can better withstand climate change impacts, and through other practical measures to help local communities be more prepared.

To assist in **mitigating** climate change, Liechtenstein is placing emphasis on supporting energy efficiency programmes and renewable energy systems in the Caucasus, Central Asia and African countries. Liechtenstein strives to allocate these official funds in a balanced manner by supporting climate projects, which are reflecting recipient needs as regards sustainable development and which are politically supported by respective authorities.

With regard to the implementation of efficient and effective development policies, both partnerships and networks are indispensable: partnerships, which for their mutual benefit are embracing governments, institutions and civil society. Such Public Private Partnerships (PPP) with their potential for mobilizing private funds and knowledge in order to carry out governmental obligations and at the same time making best use of each partners strengths must much more determine successful environment and development policies in future as they do today. Therefore, from the very start of its climate finance activities, Liechtenstein has always strived for supplementing its national fast-start contributions by private or institutional sources.

For further information please refer to chapter 7 of Liechtenstein's Seventh National Communication.