



GOVERNMENT
PRINCIPALITY OF LIECHTENSTEIN

Liechtenstein's Second Initial Report under the Kyoto Protocol

Report 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



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Foreword

Liechtenstein ratified the Kyoto Protocol, which extends and specifies the United Nations Framework Convention on Climate Change (UNFCCC), on December 3rd 2004. Within the framework of the first commitment period (2008–2012), Liechtenstein committed to reduce its total greenhouse gas emissions on average by 8 % below 1990 levels. Liechtenstein committed to reduce its total greenhouse gas emissions on average by 16 per cent below 1990 levels within the framework of the second commitment period (2013–2020). The instrument of acceptance of the respective Doha Amendment to the Kyoto Protocol to the UNFCCC was submitted by Liechtenstein on February 23rd 2015.

According to Decision 2/CMP.8 ‘each Party with a quantified emission limitation and reduction commitment inscribed in the third column of Annex B to the Kyoto Protocol, as contained in Annex I to Decision 1/CMP.8, shall submit to the secretariat, by 15 April 2015¹, a report to facilitate the calculation of its assigned amount pursuant to Article 3, paragraphs 7bis, 8 and 8bis, of the Kyoto Protocol for the second commitment period and to demonstrate its capacity to account for its emissions and assigned amount’. Liechtenstein submits the required information with this Second Initial Report under the Kyoto Protocol, in conjunction with its National Greenhouse Gas Inventory 1990–2013.

This Second Initial Report under the Kyoto Protocol was prepared by the Office of Environment (OE).

¹ However, consider also Decision 6/CMP.9, paragraph 4: ‘Also requests the secretariat to make available to Parties included in Annex I, by June 2014 at the latest, the upgraded CRF Reporter in order to enable them to submit their inventories by the due date of 15 April 2015; in case the upgraded CRF Reporter is not available by June 2014, Parties may submit their greenhouse gas inventory after 15 April 2015 but not later than the corresponding delay in the CRF Reporter availability’.

1. Summary

The summary of Liechtenstein's Second Initial Report under the Kyoto Protocol includes the following statements:

- Liechtenstein continues to use 1990 as the base year for emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆), and also chooses 1990 as the base year for emissions of nitrogen trifluoride (NF₃). NF₃ emissions do not occur in Liechtenstein.
- Liechtenstein has not reached an agreement under Article 4 of the Kyoto Protocol to fulfil its commitments under Article 3 of the Kyoto Protocol jointly with other Parties and is thus responsible for its own level of emissions.
- The assigned amount for the second commitment period of Liechtenstein is 1'572'251 t CO₂ equivalent (1'572.25 kt CO₂ equivalent).
- The commitment period reserve of Liechtenstein is 1'415'025 t CO₂ equivalent (1'415.02 kt CO₂ equivalent).
- The definition of forest, the definition of afforestation and reforestation, the definition of deforestation, and the definition of forest management for the second commitment period remain the same as defined in the Initial Report for the first commitment period submitted by Liechtenstein (OEP, 2006).
- Forest management is accounted for in the second commitment period and Liechtenstein does not elect any additional activities under Article 3, paragraph 4, of the Kyoto Protocol. All lands under activities under Article 3, paragraphs 3 and 4, starting from 1 January 1990 onwards, are accounted for.
- Liechtenstein chooses to account over the entire commitment period for emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol.
- The forest management reference level (FMRL) of Liechtenstein inscribed in the appendix to the annex to Decision 2/CMP.7 amounts to 0.1 kt CO₂ equivalent per year (including the first-order decay function for Harvested Wood Products). The FMRL may be subject to technical corrections.
- Liechtenstein intends to apply, in the case of significant magnitude events, the provision to exclude emissions from natural disturbances for units of lands under forest management under Article 3, paragraph 4, of the Kyoto Protocol during the second commitment period in accordance with Decision 2/CMP.7. Liechtenstein will not apply this provision for afforestation and reforestation under Article 3, paragraph 3, of the Kyoto Protocol.

2. Liechtenstein's National Greenhouse Gas Inventory 1990-2013

The most recent annual National Greenhouse Gas Inventory (1990–2013; *OE*, 2016) of Liechtenstein is submitted in conjunction with this Second Initial Report under the Kyoto Protocol and serves as the basis to facilitate the calculation of Liechtenstein's assigned amount for the second commitment period (2013–2020). Liechtenstein's Common Reporting Format (CRF) tables of the National Greenhouse Gas Inventory 1990–2013 are submitted at the same time and on the basis of the same data as Liechtenstein's National Greenhouse Gas Inventory 1990–2013. Detailed information is provided in the submitted documents, namely the CRF tables and the National Inventory Report 2015.

The subsequent chapters provide the most important data at a glance.

2.1 Base year inventory

Table 1 provides an overview of Liechtenstein's greenhouse gas emissions in 1990, listed by different sectors and the greenhouse gases carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃).

Table 1: Liechtenstein's greenhouse gas emissions in the base year 1990.

	CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃	Total (excl. indirect CO ₂)	Indirect CO ₂	Total (incl. indirect CO ₂)
	[kt CO ₂ equivalent]									
1 Energy	199.24	1.29	1.10					201.64	NO	201.64
2 Industrial processes and product use	NO	NO	0.45	0.00	NO	NO	NO	0.45	NO	0.45
3 Agriculture	0.05	16.72	8.49					25.26	NO	25.26
5 Waste	0.03	1.10	0.91					2.03	NO	2.03
Total (excl. LULUCF)	199.32	19.11	10.95	0.00	NO	NO	NO	229.39	NO	229.39
4 Land use, land-use change and forestry	4.27	NO	0.31					4.58	NO	4.58
International bunkers	0.43	0.00	0.00					0.43	NO	0.43
Total (incl. LULUCF)	203.59	19.11	11.26	0.00	NO	NO	NO	233.97	NO	233.97

2.2 Greenhouse gas emissions from different sectors in Liechtenstein

The calculation and reporting of greenhouse gas emissions in the different sectors is based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (*IPCC*, 2006), often complemented by country-specific methodologies.

2.2.1 Energy

In Liechtenstein, the sector 1 Energy is the most relevant greenhouse gas source. In 2013, the sector emitted 197.8 Gg CO₂ equivalents which correspond to 79.7% of total emissions (248.3 kt CO₂, without LULUCF). The most important sources of emissions are fuel

combustion activities in the Energy sector. 83.6% (excluding LULUCF) of Liechtenstein's GHG emissions originate from the sector 1 Energy, which is 0.6% more than in 2012. The share of sector 1 Energy in the total emissions changed by -4.3% since 1990. The total emissions of the sector 1 Energy decreased in comparison to 1990 level (-1.9%).

2.2.2 Industrial processes and product use

Due to the lack of heavy industry within the borders of Liechtenstein, only small contributors, in particular F-gases and asphalt roofing are relevant sources. The emissions in sector 2 therefore strongly increased between 1990 and 2013 by 2'697.3% mainly due to increasing F-gas emissions. Please note that the emissions reported under sector 2 Industrial processes and product use (IPPU) are still on a low level. F-gas emissions originated by definition from the sector 2 IPPU. The total emissions of sector 2 IPPU account for 12.7 kt CO₂ equivalent in 2013. Emissions of the Industrial processes and product use (IPPU sector play therefore a minor role in Liechtenstein's inventory and contribute to 5.1% of the total emissions excluding LULUCF. 12.3 kt CO₂ equivalent were emitted in sector 2F Product uses as ODS substitutes and another 0.4 kt CO₂ equivalent in sector 2G Other product manufacture and use. The total emissions increased by 2697% between 1992, when the substitution of CFC's became relevant, and 2013. This trend is in particular dominated by the increase in HFC emissions. N₂O emissions even decreased (-56%) between 1990 and 2013. Since 2012, the total F-gas emissions increased by 4.9%. At the same time, HFC emissions increased by 3.4% and PFC emissions by 10.5%. SF₆ emissions increased even more.

2.2.3 Agriculture

Total greenhouse gas emissions from Agriculture in 2013 were 23.9 kt CO₂ equivalents in total, which is a contribution of 9.6% to the total of Liechtenstein's greenhouse gas emissions (excluding LULUCF). Main agricultural sources of greenhouse gases in 2013 were enteric fermentation emitting 13.3 kt CO₂ equivalents, followed by agricultural soils with 6.5 kt CO₂ equivalents, manure management with 2.7 kt and urea application. In general, emissions trend was -5.6% between 1990 and 2013. The overall decreasing trend was interrupted by an increase between 2000-2007 and 2010-2012.

The emissions show a minimum around the year 2000 due to changes in the animal numbers. In 2013, the emissions are slightly below the 1990 level (-5.6%). Emissions of CH₄ and N₂O originated mainly from the sector Agriculture

2.2.4 Waste

In Liechtenstein, only few emissions occur from the sector Waste since all municipal solid waste is exported to a Swiss incineration plant. The increasing trend of the emissions compared to 1990 (11.3%) is due to increasing composting activities and a slight increase in emissions from waste water handling. In the sector 5 Waste a total of 2.3 kt CO₂ equivalents of greenhouse gases were emitted in 2013. 3.4% of the total emissions origin from 5A Solid waste disposal, 43.7% from 5B Biological treatment of solid waste, 1.8% from 5C Incineration and open burning of waste and 51.2% from the source category 5D

Waste water treatment and discharge. Emissions from 5E Other are not occurring in Liechtenstein.

The total greenhouse gas emissions show an increase from 1990 to 2013 by 11.3%.

2.2.5 Land use, land-use change and forestry

The dominant category when looking at the changes in net CO₂ emissions are source category 4C Grassland and 4G Harvested wood products. The total net emissions increased by 163.9% between 1990 and 2013.

Gain of living biomass on forest land: this is the growth of biomass on forest land remaining forest land; it is the largest sink of carbon.

Loss of living biomass on forest land: this is the decrease of carbon in living biomass (by harvest and mortality) on forest land remaining forest land; it is the largest source of carbon.

Land-use change, soil and Harvested Wood Products (HWP): this is all the rest including carbon removals/emissions due to land-use changes and use of soils, especially of organic soils, as well as the carbon stock changes in HWP. It also includes the N₂O emissions due to N mineralization in soils (up to 0.46 CO₂ eq) associated with land-conversions (CRF-table 4(III)) and nitrogen leaching and run-off on non-agricultural soils (indirect N₂O emissions; CRF-table 4(IV)). In all the years, loss of biomass exceeds the gains. Compared to these biomass changes in forests, the net CO₂ equivalent emissions arising from land-use changes, from soils and HWP are relatively small

2.3 Evolution of greenhouse gas emissions

Table 2 and Table 3 along with Figure 1 and Figure 2 show the evolution of greenhouse gas emissions in Liechtenstein from 1990 to 2013. Emissions and removals reported in the sector 'other' (sector 6) are not included in Annex A to the Kyoto Protocol and are therefore not included in national totals.

Table 2: Liechtenstein's greenhouse gas emissions from 1990 to 2013.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO₂ equivalent (kt)									
CO ₂ (incl. LULUCF)	203.6	213.8	214.3	222.9	209.4	211.7	214.0	227.2	237.9	236.7
CO ₂ (excl. LULUCF)	199.3	206.6	207.2	215.4	201.4	204.5	206.2	218.7	229.6	228.5
CH ₄ (incl. LULUCF)	19.1	19.0	18.6	17.7	17.9	17.7	18.1	17.8	17.6	17.0
CH ₄ (excl. LULUCF)	19.1	19.0	18.6	17.7	17.9	17.7	18.1	17.8	17.6	17.0
N ₂ O (incl. LULUCF)	11.3	11.6	11.5	11.2	11.1	11.1	11.0	11.0	10.8	10.6
N ₂ O (excl. LULUCF)	10.9	11.3	11.2	10.8	10.8	10.8	10.7	10.6	10.5	10.3
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)	234.0	244.3	244.4	252.0	238.9	241.9	244.9	258.1	269.1	267.7
Total (excluding LULUCF)	229.4	236.9	237.1	244.1	230.6	234.4	236.8	249.3	260.5	259.1

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	CO₂ equivalent (kt)									
CO ₂ (incl. LULUCF)	229.8	228.8	233.9	243.6	242.9	242.2	242.7	212.6	231.6	222.6
CO ₂ (excl. LULUCF)	221.8	219.4	224.2	233.4	233.3	232.8	234.3	203.9	222.7	208.3
CH ₄ (incl. LULUCF)	16.8	17.4	17.7	17.9	17.9	18.6	19.3	19.8	20.1	19.8
CH ₄ (excl. LULUCF)	16.8	17.4	17.7	17.9	17.9	18.6	19.3	19.8	20.1	19.8
N ₂ O (incl. LULUCF)	10.5	10.6	10.6	10.6	10.3	10.5	10.7	10.8	10.8	10.7
N ₂ O (excl. LULUCF)	10.2	10.3	10.3	10.3	10.0	10.1	10.3	10.4	10.4	10.3
HFCs	4.1	4.9	5.5	6.1	7.0	7.4	7.9	8.6	9.5	9.6
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)	261.3	261.9	268.0	278.5	278.5	279.1	280.8	252.0	272.4	262.9
Total (excluding LULUCF)	252.9	252.2	257.9	267.9	268.5	269.2	271.9	242.9	263.1	248.2

	2010	2011	2012	2013	1990-2013
	CO₂ equivalent (kt)				%
CO ₂ (incl. LULUCF)	207.8	190.4	199.2	206.0	1.2%
CO ₂ (excl. LULUCF)	193.5	179.3	187.9	194.7	-2.3%
CH ₄ (incl. LULUCF)	19.3	19.7	20.1	19.2	0.4%
CH ₄ (excl. LULUCF)	19.3	19.7	20.1	19.2	0.4%
N ₂ O (incl. LULUCF)	10.7	10.8	10.9	10.6	-5.4%
N ₂ O (excl. LULUCF)	10.3	10.4	10.4	10.2	-6.9%
HFCs	10.6	11.2	11.8	12.2	
PFCs	0.1	0.1	0.1	0.1	
SF ₆	0.0	0.0	0.0	0.2	
Total (including LULUCF)	248.5	232.2	242.1	248.3	6.1%
Total (excluding LULUCF)	233.7	220.6	230.3	236.5	3.1%

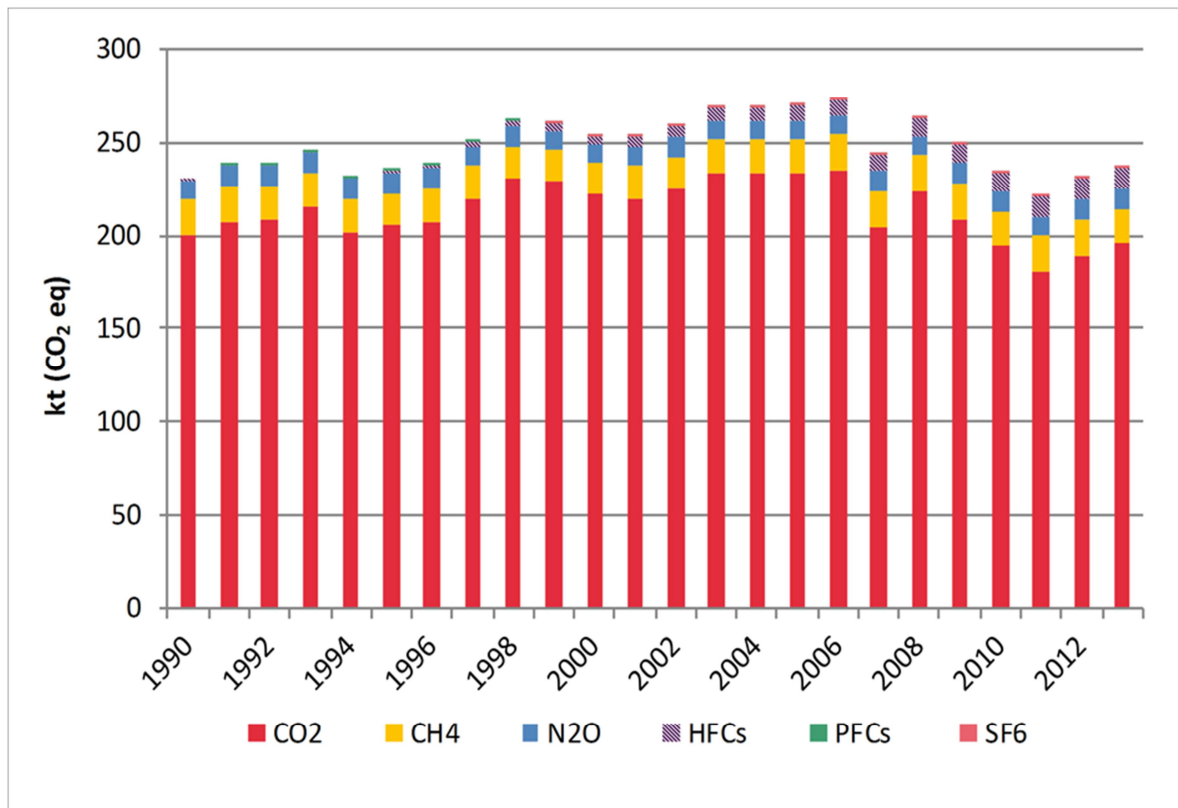


Figure 1 Trend of Liechtenstein's greenhouse gas emissions by gases 1990–2013. CO₂, CH₄ and N₂O correspond to the respective total emissions excluding LULUCF.

Table 3: Liechtenstein's greenhouse gas emissions from different sectors in the years 1990, 1995, 2000, 2005, 2010, 2011, 2012 and 2013. For the years 1990 and 2013, the relative contributions of each sector in per cent of total greenhouse gas emissions (incl. LULUCF) are given.

	1990		1995	2000	2005	2010	2011	2012	2013	
	[%]	[kt CO ₂ equivalent]								
1. Energy	86.18	201.64	207.26	225.07	235.66	196.57	182.42	191.07	197.76	79.66
1A. Energy industries	0.08	0.18	2.08	2.77	3.14	3.26	3.06	2.82	3.05	1.23
2A. Manufacturing industries and construction	15.54	36.36	34.96	35.56	37.83	24.77	22.36	24.86	25.51	10.28
3A. Transport	32.81	76.76	81.87	96.11	85.41	80.39	79.46	82.50	81.96	33.02
4A. Other sectors	37.60	87.97	87.74	89.79	108.11	86.93	76.34	79.68	85.99	34.64
1B Fugitive Emissions from fuels	0.16	0.37	0.60	0.83	1.17	1.22	1.20	1.22	1.25	0.50
2. Industrial processes	0.19	0.45	1.72	4.46	7.97	10.94	11.43	12.07	12.65	5.10
3. Agriculture	10.80	25.26	23.54	21.34	23.39	24.18	24.59	24.92	23.85	9.61
5. Waste	0.87	2.03	1.89	2.05	2.21	2.03	2.17	2.24	2.26	0.91
Total (excl. LULUCF)		229.39	234.40	252.92	269.22	233.71	220.61	230.31	236.53	
4. LULUCF	1.96	4.58	7.52	8.39	9.88	14.80	11.55	11.75	11.73	4.72
Total (incl. LULUCF)	100.00	233.97	241.93	261.31	279.11	248.52	232.16	242.06	248.25	100.00

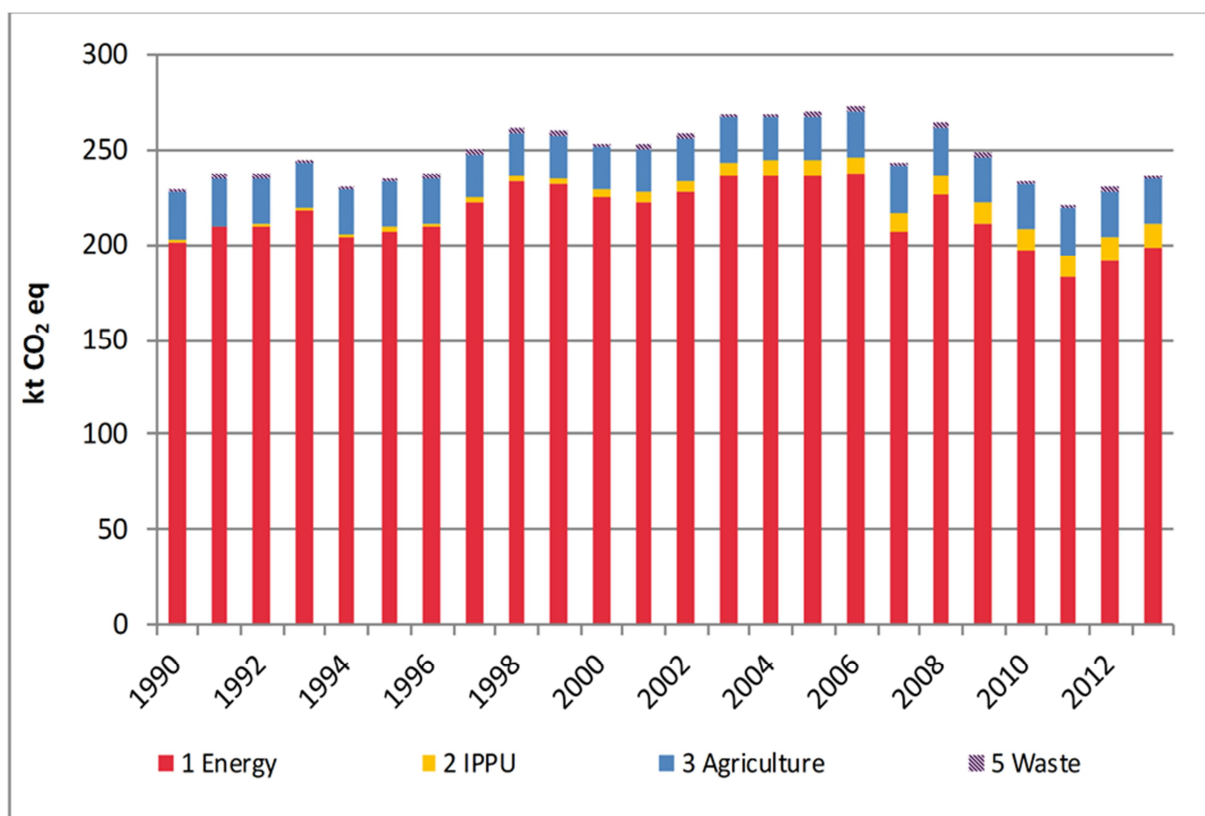


Figure 2 Trend of Liechtenstein's greenhouse gas emissions by main source categories in CO₂ equivalent (kt), 1990–2013 (excl. net CO₂ from LULUCF).

3. Base year selection for HFCs, PFCs, SF₆ and NF₃

For the first commitment period (2008–2012), Liechtenstein chose 1990 as the base year for HFCs, PFCs and SF₆, and this base year also applies for the second commitment period (2013–2020). Regarding NF₃, which is newly included for the second commitment period, Article 3, paragraph 8bis, of the Kyoto Protocol gives Parties the option to select 1995 or 2000 instead of 1990 as the base year.

The time series for the emissions of HFCs, PFCs, SF₆ and NF₃ in Liechtenstein are illustrated in Table 4. HFC emissions increased due to their role as substitutes for CFCs. SF₆ emissions originate from electrical transformation stations and play a minor role for the total of the synthetic gases (F-gases). PFC emissions are occurring since 1997 and are increasing on a low level. The share of the sum of all F-gases increased from 0.0% (1990) to 5.3% (2013).

Table 4: Emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃) from 1990 to 2013 (in kt CO₂ equivalent, two-year steps until 2010).

	1990	1992	1994	1996	1998	2000	2002
	[kt CO ₂ equivalent]						
HFCs	0.00	0.09	0.51	1.72	2.73	4.10	5.46
PFCs	0.00	0.00	0.00	0.00	0.00	0.01	0.02
SF ₆	NO	NO	NO	NO	NO	0.09	0.24
NF ₃	NO	NO	NO	NO	NO	NO	NO
Total	0.00	0.09	0.52	1.72	2.74	4.11	5.48

	2004	2006	2008	2010	2011	2012	2013
	[kt CO ₂ equivalent]						
HFCs	7.00	7.91	9.49	10.64	11.16	11.81	12.22
PFCs	0.05	0.08	0.08	0.07	0.06	0.06	0.06
SF ₆	0.26	0.06	0.35	0.02	0.01	0.00	0.00
NF ₃	NO	NO	NO	NO	NO	NO	NO
Total	7.05	7.98	9.57	10.71	11.22	11.87	12.28

For consistency reasons (same base year for all gases as in the first commitment period), Liechtenstein chooses 1990 as the base year for emissions of nitrogen trifluoride (NF₃). Greenhouse gas emissions from source category 2E (Electronic industry) are not occurring in Liechtenstein. This also holds for NF₃, which would have to be reported under the revised UNFCCC Guidelines (UNFCCC 2014). **Therefore, emissions of NF₃ are not occurring in Liechtenstein.**

4. Agreement under Article 4

Liechtenstein has not reached an agreement under Article 4 of the Kyoto Protocol to fulfil its commitments under Article 3 of the Kyoto Protocol jointly with other Parties and is thus responsible for its own level of emissions.

5. Calculation of the Assigned Amount

The assigned amount for the second commitment period is calculated according to Article 3, paragraphs 7bis, 8 and 8bis, of the Kyoto Protocol, on the basis of the National Greenhouse Gas Inventory submitted in conjunction with this report by Liechtenstein (OE, 2016).

In line with Article 3, paragraph 7bis, of the Kyoto Protocol 'the assigned amount for each Party included in Annex I shall be equal to the percentage inscribed for it in the third column of the table contained in Annex B of its aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A in 1990 [...] multiplied by eight'. Liechtenstein's quantified emission limitation or reduction commitment for the

second commitment period (2013–2020), as inscribed in the third column of the table contained in Annex B to the Doha Amendment to the Kyoto Protocol, is 84 per cent of base year emissions.

Article 3, paragraph 7bis, of the Kyoto Protocol further prescribes that ‘those Parties included in Annex I for whom land-use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990 emissions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from land-use change for the purposes of calculating their assigned amount’. **In Liechtenstein, land-use change and forestry constituted a net source in 1990 (see chapter 2) and is thus included in the base year emissions for the purposes of calculating the assigned amount.**

With respect to the choice offered by Article 3, paragraph 8 and 8bis, of the Kyoto Protocol regarding the base year for HFCs, PFCs, SF₆ and NF₃, Liechtenstein decided to use 1990 as the base year for all gases (see chapter 3). Liechtenstein calculated the assigned amount including all relevant values as represented in Table 5.

Table 5: Calculation of Liechtenstein’s assigned amount for the second commitment period (2013–2020) on the basis of *OE* (2016).

Base year emissions	Base year emissions multiplied by eight	Quantified emission limitation or reduction commitment (2013–2020)	Assigned amount for the second commitment period
[t CO ₂ equivalent]	[t CO ₂ equivalent]	[% of base year]	[t CO ₂ equivalent]
233'966	$233'966 \times 8 = 1'871'728$	84	$1'871'728 \times 84/100 = 1'572'251$

For the second commitment period Liechtenstein’s assigned amount is 1'572'251 t CO₂ equivalent (1'572.25 kt CO₂ equivalent).

According to Article 3, paragraph 7ter, ‘any positive difference between the assigned amount of the second commitment period for a Party included in the Annex I and average annual emissions for the first three years of the preceding commitment period multiplied by eight shall be transferred to the cancellation account of that Party’. As highlighted in Table 6, the respective difference is negative for Liechtenstein. Accordingly, no transfer of assigned amount units (AAUs) to the cancellation account is needed for Liechtenstein.

Table 6: Calculations with regard to Article 3, paragraph 7ter, on the basis of *OE* (2016).

Average emissions for the first three years of preceding commitment period (2008, 2009, 2010)	Average emissions for the first three years of preceding commitment period (2008, 2009, 2010) multiplied by eight	Assigned amount for the second commitment period (see Table 5)	Difference between the assigned amount for the second commitment period and average annual emissions for the first three years of the preceding commitment period multiplied by eight
[kt CO ₂ equivalent]	[kt CO ₂ equivalent]	[kt CO ₂ equivalent]	[kt CO ₂ equivalent]
261	$261 \times 8 = 2'090$	1'572	$1'572 - 2'090 = -518$

6. Calculation of the Commitment Period Reserve

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 view of the changes in the reporting guidelines for the second commitment period, Liechtenstein understands the 'most recently reviewed inventory' to be the National Greenhouse Gas Inventory submitted on 15 April 2016 (OE, 2016), i.e. the inventory submitted in conjunction with this Second Initial Report under the Kyoto Protocol. The values regarding the two criteria for the commitment period reserve are presented in Table 7.

Table 7: Calculation of Liechtenstein's commitment period reserve on the basis of *OE* (2016). The lower value resulting from the two different calculations corresponds to the commitment period reserve.

90 per cent of assigned amount (see chapter 5)	Total emissions with LULUCF in 2013 (see Table 2 and Table 3) times eight
[t CO ₂ equivalent]	[t CO ₂ equivalent]
$1'572'251 \times 90/100 = 1'415'025$	$248'252 \times 8 = 1'986'018$

Accordingly, a commitment period reserve of 1'415'025 t CO₂ equivalent (1'415.025 kt CO₂ equivalent) results for Liechtenstein.

7. Selected definitions for reporting under Article 3, paragraphs 3 and 4

Liechtenstein defined forest, afforestation, reforestation, deforestation and forest management in its Initial Report for the first commitment period (*OEP*, 2006). According to Decision 2/CMP.7, paragraph 20, the definition of forest selected for the first commitment period (2008–2012) also applies for the second commitment period (2013–2020).

The definition of forest, the definition of afforestation and reforestation, the definition of deforestation, and the definition of forest management for the second commitment period remain the same as defined in Liechtenstein's Initial Report for the first commitment period (*OEP*, 2006).

8. Election of activities under Article 3, paragraph 4

In the Initial Report for the first commitment period (*OEP*, 2006), Liechtenstein did not choose to account for forest management among the elective activities under Article 3, paragraph 4, of the Kyoto Protocol. In the second commitment period, accounting for forest management is mandatory for all Parties included in Annex I.

Forest management is accounted for in the second commitment period and Liechtenstein does not elect any additional activities under Article 3, paragraph 4, of the Kyoto Protocol. All lands under activities under Article 3, paragraphs 3 and 4, starting from 1 January 1990 onwards, are accounted for.

In accordance with the annex to Decision 2/CMP.7, paragraph 13, additions to the assigned amount resulting from forest management under Article 3, paragraph 4, and from forest management project activities undertaken under Article 6, are capped in the second commitment period (3.5 per cent of base year emissions excluding LULUCF times eight). For LIE the cap amounts to $229.39 \times 0.035 \times 8 = 64.23$ kt CO₂ for the entire commitment period 2013–2020.

The activity data of afforestation and deforestation under Article 3, paragraph 3, and forest management under Article 3, paragraph 4, of the Kyoto Protocol are retrieved from the Land Use Statistics (*OE*, 2016). The same database and methodology for the classification of lands is used for the first and for the second commitment period. As in the first commitment period, afforested and deforested areas since 1990 remain in the respective category over the entire second commitment period. Hence, the areas of afforestations and deforestations under Article 3, paragraph 3, have been increasing since 1990. Also for the area under forest management (Article 3, paragraph 4) a continuous time series is available (see chapter 6.2 in *OE*, 2016). The land transition matrix (Table 11.2 in *OE*, 2016) shows the changes in areas between the previous (2012) and the current inventory year (2013).

9. Choice of accounting periodicity for activities under Article 3, paragraphs 3 and 4

According to Decision 2/CMP.8, Annex I, paragraph 1(h), each Party shall determine for each activity under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, whether it intends to account annually or for the entire commitment period.

Liechtenstein chooses to account over the entire commitment period for emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol.

10. Definition of forest management reference level (FMRL)

Detailed information on the FMRL of Annex I Parties was requested in Decision 2/CMP.6, paragraph 4. Annex II to Decision 2/CMP.6 provides guidelines for the calculation of the national FMRL and the additional information to be submitted by 28 February 2011. The calculation of Liechtenstein's FMRL is documented in OEP (2011), see also annex to this report.

Liechtenstein's forest management reference level (FMRL) inscribed in the appendix to the annex to Decision 2/CMP.7 amounts to 0.1 kt CO₂ equivalent per year. The FMRL was subject to technical corrections².

OEP (2011) was subject to a technical assessment following the guidelines in Part II of Annex II to Decision 2/CMP.6. A detailed description of this assessment (UNFCCC, 2011) can be found in the annex to this report.

In December 2011, the details for accounting of the LULUCF sector under the Kyoto Protocol were adopted (Decision 2/CMP.7) and in December 2013, the IPCC supplement '2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol' (IPCC, 2014) was adopted. The latter provides inter alia detailed information on the development of the FMRL and also on the accounting of harvested wood products (HWP). Based on the technical assessment report (see annex in UNFCCC, 2011) and following guidance of IPCC (2014), the following corrections of Liechtenstein's FMRL have been made:

Liechtenstein's FMRL is documented by OEP (2011). It is inscribed in the appendix to the annex to Decision 2/CMP.7 and amounts to +0.10 kt CO₂ eq. yr⁻¹. OEP (2011) was subject to a technical assessment. Based on the technical assessment report (UNFCCC 2011) and applying guidance of IPCC (2014), the following technical corrections of Liechtenstein's FMRL have been made in the Submission of NIR 2015 (see Table 8):

- Wood harvesting; carbon stock changes in living biomass: No correction.
- Carbon stock changes in mineral soils: The new model version Yasso07 has been implemented in Switzerland since 2013. The most recent results from Switzerland are adopted.
- Calculation of carbon stock changes in HWP: carbon stock changes in HWP are calculated following the IPCC methodology (IPCC 2014); the historical time series has been updated (see Chapter 6.11).

² The FMRL may be subject to technical corrections according to the annex to Decision 2/CMP.7, paragraph 15: 'After adoption of the reference level for forest management, if the reported data on forest management or forest land remaining forest land used to establish the reference level are subject to recalculations, a technical correction shall be applied to include in the accounting the impact of the recalculations on the reported data that have been used by the Party to set the reference level'.

Table 8: Summary of the technical correction of the FMRL. Values from FMRL as defined in OEP (2011d) and corrected values (this chapter) are listed per pool.

kt CO ₂ /yr	FMRL submitted 2011	FMRL corrected 2015	Technical correction
Wood harvesting, stock change in living biomass	1.30	1.30	--
Stock change of organic soil carbon	1.20	0.00	-1.20
Stock change in HWP	-2.40	-1.18	1.22
FMRL 2013-2020	0.10	0.12	0.02

The new version of the model Yasso07 has been implemented since Switzerland's GHG inventory 2013 and improvements related to input data, model parameterization and model calibration have been made (see Didion 2014). For the FMRL submitted by OEP (2011d) the results of an older version (2006) of the Swiss Yasso model application was adopted to estimate the carbon stock change in mineral soils for Liechtenstein (1.20 kt CO₂/year). The most recent Yasso07 results do not confirm this emission value but indicate that the carbon stock change in mineral soil is practically zero (FOEN 2015, Figure 6-5). This new result is adopted for Liechtenstein (see Table 8).

Carbon stock changes in HWP are calculated following the IPCC methodology (IPCC 2014) which is different from the methodology applied in OEP (2011d). For the recalculation of the FMRL only the in-country production of sawnwood from domestic harvest is included. Further, the historical time series has been updated (Chapter 6.11, OE 2016).

For calculating the carbon stock change in HWP for the FMRL 2013-2020, the annual production of sawnwood 2013-2020 was estimated by the average production from 2000 to 2009. I.e. a business as usual scenario was assumed based on the ten-year average 2000-2009 (7'616 m³). With this production value the time series of gains and losses shown in Chapter 6.11 (OE, 2016) were extended until 2020 (Table 9). The resulting average CO₂ removal 2013-2020 is -1.18 kt CO₂/year, which was used to correct the FMRL (Table 8).

Table 9: Calculation of the annual CO₂ removal by HWP for the FMRL in the 2nd Commitment Period 2013-2020.

Harvested wood products	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean 2000-2009
Sawnwood production, m ³	8'125	7'000	7'100	6'725	7'525	7'955	9'331	9'331	9'331	3'732	7'616
Gains sawnwood, kt C	2.03	1.75	1.78	1.68	1.88	1.99	2.33	2.33	2.33	0.93	
Losses sawnwood, kt C	-1.46	-1.47	-1.47	-1.48	-1.48	-1.49	-1.51	-1.52	-1.54	-1.54	
Net emissions/removals, kt CO₂	-2.10	-1.03	-1.11	-0.74	-1.45	-1.82	-3.03	-2.97	-2.91	2.23	

Harvested wood products	2010	2011	2012
Sawnwood production, m ³	7'616	7'616	7'616
Gains sawnwood, kt C	1.90	1.90	1.90
Losses sawnwood, kt C	-1.54	-1.55	-1.55
Net emissions/removals, kt CO₂	-1.34	-1.32	-1.29

Harvested wood products	2013	2014	2015	2016	2017	2018	2019	2020	Mean 2013-2020
Sawnwood production, m ³	7'616	7'616	7'616	7'616	7'616	7'616	7'616	7'616	7'616
Gains sawnwood, kt C	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90
Losses sawnwood, kt C	-1.56	-1.57	-1.57	-1.58	-1.59	-1.59	-1.60	-1.60	-1.58
Net emissions/removals, kt CO₂	-1.26	-1.24	-1.22	-1.19	-1.17	-1.15	-1.12	-1.10	-1.18

11. Calculation of harvested wood products (HWP) prior to the second commitment period

As defined in Decision 2/CMP.7, delayed emissions are calculated on the basis of the annual stock change of semi-finished wood products using the first-order decay function (IPCC, 2014; Tier 2, Equation 2.8.5):

$$C(i + 1) = e^{-k} \cdot C(i) + \left[\frac{(1 - e^{-k})}{k} \right] \cdot Inflow(i)$$

Equation 1

$$\Delta C(i) = C(i + 1) - C(i)$$

With i , the year; $C(i)$, the carbon stock of the HWP pool from the beginning of year i (in kt C); k , the decay constant of first-order decay (in year⁻¹, $k = \ln(2)/HL$, where HL is the half-life, i.e. the number of years it takes to lose one half of the material currently in the HWP pool); $Inflow(i)$, the inflow to the HWP pool during year i (in kt C year⁻¹); $\Delta C(i)$, the carbon stock change of the HWP pool during year i (in kt C year⁻¹).

To calculate the pool of HWP in use according to Equation 1, the half-lives were used as suggested in the annex to Decision 2/CMP.7, paragraph 29:

- 35 years for sawn wood.
- 25 years for wood based panels, which is not occurring in Liechtenstein.
- Because of the limited contribution of paper and paperboard, this category was not taken into account.

Historical time series and the applied method are described in detail in Liechtenstein's National Inventory Report (OE, 2016; Chapter 6.11).

12. Exclusion of natural disturbances

Liechtenstein intends to apply, in the case of significant magnitude events, the provision to exclude emissions from natural disturbances for units of lands under forest management under Article 3, paragraph 4, of the Kyoto Protocol during the second commitment period in accordance with Decision 2/CMP.7. Liechtenstein will not apply this provision for afforestation and reforestation under Article 3, paragraph 3, of the Kyoto Protocol.

In cases or events in which emissions from natural disturbances are higher than the nationally established threshold value (i.e. background level plus the margin) and all other requirements defined in Decision 2/CMP.7 and IPCC (2014) are met, Liechtenstein will evaluate and decide whether the effort would be justified to exclude them. Basically, the event would have to be of sufficient magnitude to be worth the effort to exclude these lands from the reporting, including determining their exact geographical location, continued monitoring of them and provision of information on efforts taken to rehabilitate them.

To develop the background level and margin of Liechtenstein, country-specific information on the background level of emissions associated with natural disturbances in forests under forest management is given below.

12.1 Definition of the types of natural disturbances to be excluded from accounting

Disturbance types which are considered for the calculation of the background level and the margin are based on events which have occurred during the calibration period from 1990 to 2009 including inter alia wildfires (only CO₂ emissions), insect pest (e.g. *Scolytinae* sp.) and disease infestations, extreme weather events (such as the heat wave in summer 2003, which caused drought), as well as geological disturbances like landslides and avalanches.

12.2 Establishment of a consistent and initially complete time series for the calibration period

No complete time series are available for the calibration period. For some disturbance types, incomplete or regional data are available, but no regular inventory (e.g. insect attacks, drought stress). For some disturbance types, there are no specific data at all since they are not systematically monitored (e.g. geological disturbances) or a monitoring network has not been established yet.

Therefore, a time series of emissions from disturbances is derived from values of mortality from Liechtenstein's National Forest Inventory (NFI; LWI, 2012). The NFI values for mortality include mortality caused by all types of natural disturbances, plus mortality after harvesting as well as density-related mortality (e.g. caused by competition for light). Non-CO₂ greenhouse gas emissions are not included in the NFI mortality and are thus not included in the calculation of the background level. These emissions are added to the FMRL (see chapter 10).

12.3 Definition of the background level and the margin

An average value for mortality is derived from the LFI datasets for the years 1999 to 2009 (for more detailed information see Chapter 6.4.2.1 in *OE*, 2016). To calculate annual values of mortality for the years 1999-2009, the average amount of mortality was weighted by the percentage of the relative harvesting amounts taken from the forest statistics (AI, 2014). These relative harvesting amounts are considered to be a good proxy for mortality caused by natural disturbances, since in the past, in years with high mortality rates, harvesting rates (including salvage logging) were also higher.

Based on this time series, the background level and the margin have been calculated using the iterative approach described in Chapter 2.3.9.6 of IPCC (2014). Yearly values of LFI mortality, including all types of natural disturbances, are shown in Table 10. The time series for the calibration period from 1990 to 2009, the background level and the margin are visualized in Figure 3.

Table 10: Yearly values of NFI mortality for the calibration period from 1999 to 2009 including all types of natural disturbances which occurred during that period, the results of the iteration process (arithmetic mean, twice the standard deviation and the upper confidence interval).

Year	Iteration 1 Area specific emission [t CO ₂ /ha/year]	
1999	1.64	
2000	3.48	
2001	1.76	
2002	1.79	
2003	2.07	
2004	2.21	
2005	2.19	
2006	2.52	
2007	3.17	
2008	3.31	
2009	3.08	
MEAN = background level		2.48
Margin (2 *SD)		1.35
Upper CI = background level + margin		3.82

- The background level amounts to 2.48 t CO₂ ha⁻¹ year⁻¹, which is equal to a mean mortality from 1999 to 2009.
- The margin amounts to 1.35 t CO₂ ha⁻¹ year⁻¹.
- Emissions from natural disturbances higher than the upper confidence interval (background level + margin) of 3.82 t CO₂ ha⁻¹ year⁻¹ can be excluded from the accounting.

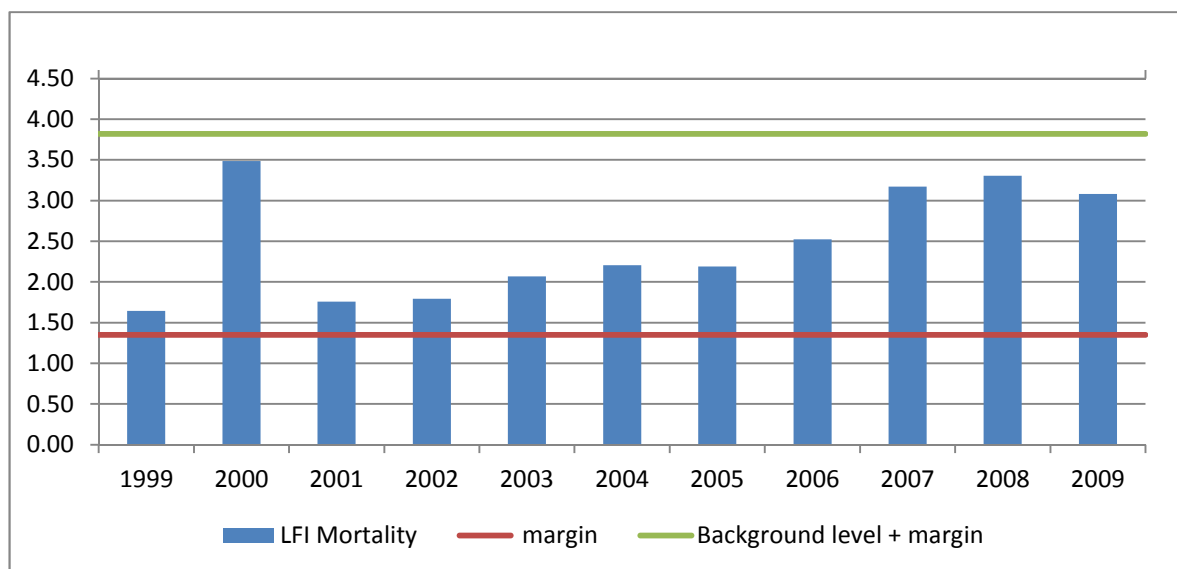


Fig. 3 Time series of NFI-mortality for the calibration period from 1999 to 2009, background level and upper confidence interval (background level + margin).

12.4 Ensuring that the method applied does not lead to expectation of net credits or debits

To provide the information needed, the requirements listed in Box 2.3.6 of IPCC (2014) have to be evaluated. Using the standard procedure for the calculation of the background level and the margin, all of the *listed requirements* are fulfilled:

1. *There is no observed trend in natural disturbance emissions during the calibration period that is not considered in the background level estimation or expected during the commitment period.*

Table 10 and Figure 3 show that all data within the background group are used for calculating the background level.

2. *The background level of emissions for FM, included in the FMRL is equal to the average of the annual emissions from natural disturbances during the calibration period which are in the background group.*

Yes, see Table 10.

3. *Any emissions from natural disturbances during the commitment period that fall into the background group are not separately excluded from accounting. During the commitment period, emissions are only excluded from accounting when the annual emissions are greater than the background level plus the margin.*

Yes, see Table 10

4. *A test application of the constructed background level and the margin on the annual emissions in the calibration period leads to the same background group as used during the construction of the background level.*

Yes, see Table 10.

13. Description of the National System

The National Greenhouse Gas Inventory System as described in Liechtenstein's Initial Report for the first commitment period (OEP, 2006) is still operational. While minor changes have been documented annually in the National Inventory Reports, a detailed description of the current National Greenhouse Gas Inventory System is presented in Liechtenstein's National Inventory Report (OE, 2016). The institutional setting is shown in Figure 4.

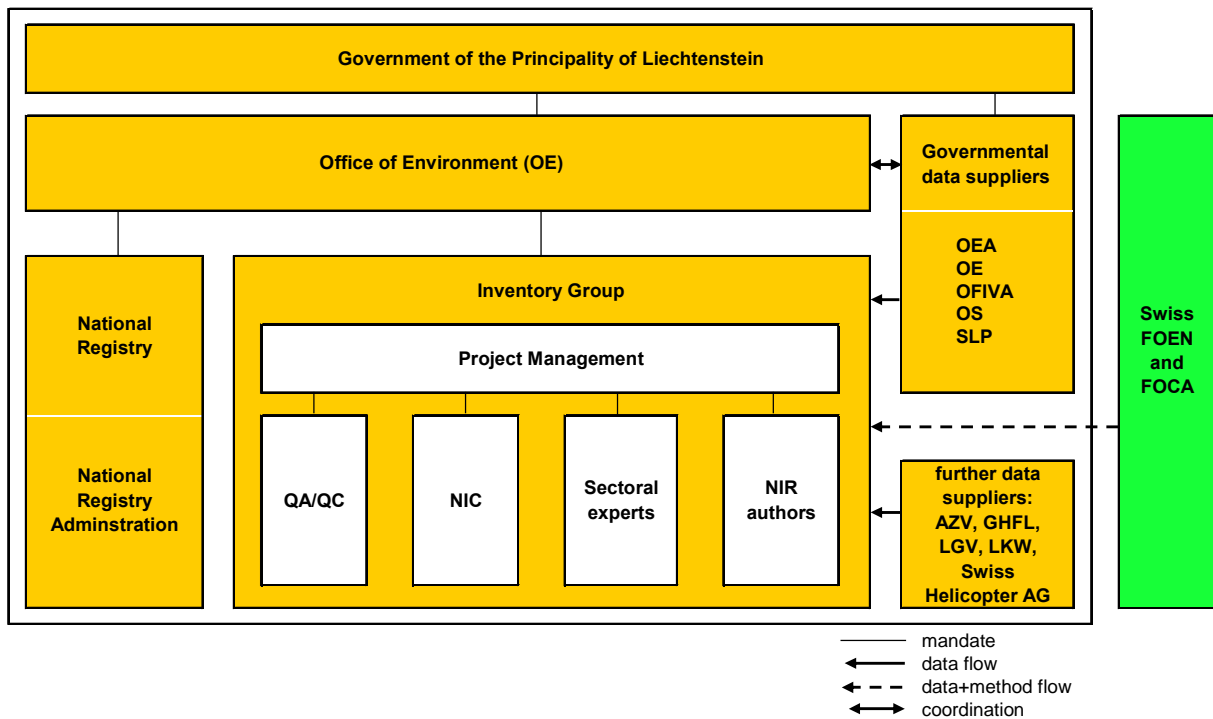


Figure 4 National Inventory System: Institutional setting and data suppliers.

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.

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.

Further elements of the Liechtenstein’s National Greenhouse Gas Inventory System are described in Chapter 1 of Liechtenstein’s National Inventory Report (OE, 2016).

14. Description of the National Registry

Under the terms of Art.7 of the Kyoto Protocol, each Party included in Annex I shall provide the necessary supplementary information in its National Inventory Report (NIR) to demonstrate compliance with Art.3 of the Kyoto Protocol. Decision 15/CMP.1 is – inter alia – focusing on the reporting requirements for changes in the national registries. Additionally decision 15/CMP.1 refer to Art. 5, para 1, defining the national Guidelines for national systems. Each Party shall describe the changes that have occurred in the system as well as in the registry, compared with the information reported in its last submission.

The changes described are in comparison with the NIR submitted in April 2013 (OE 2013). There are no changes since the last submission.

The access to Liechtenstein's national registry is: <https://www.emissionshandelsregister.li>

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The consolidation of European national registries (including all EU Member States, Iceland, Liechtenstein and Norway) was a significant change to the system of registries. After certification of the consolidated System of EU registries on 1st June 2012, on 19 June 2012, 29 registries became operational under the Consolidated System of European Union Registries (CSEUR). A detailed description is given in the EU Commission Regulation 920/2010. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidating national registries. This description includes:

- Readiness questionnaire
- Application logging
- Change management procedure
- Disaster recovery
- Manual Intervention
- Operational Plan
- Roles and responsibilities
- Security Plan
- Time Validation Plan
- Version change Management

The required documents are confidential and accessible for assessors only. Therefore the documents which are mentioned are not available within this document. The documents could be made available to the ERT upon request.

As before, annual changes of the registry environment will be reported in the National Inventory Reports.

References

- AI 2014:** Umweltstatistik 2014. Office of Statistics, Vaduz. <http://www.llv.li/files/as/umweltstatistik-2014-internet.pdf>
- FOEN 2015:** Switzerland's Greenhouse Gas Inventory 1990-2013. National Inventory Report 2015. Submission under the United Nations Framework Convention on Climate Change and under the Kyoto Protocol. Swiss Federal Office for the Environment, Bern, 27 April 2015. <http://www.bafu.admin.ch/klima/13879/13880/15473/index.html?lang=en>
- IPCC, 2006:** 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change. <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm>
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- LWI 2012:** Liechtenstein's National Forest Inventory (Liechtensteinisches Landeswaldinventar (LWI) – Ergebnisse der dritten Erhebung 2010). Office of Environmental Protection (OEP, former AWLN), Vaduz. http://www.llv.li/files/au/pdf-llv-au-landeswaldinventar_2012_awnl.pdf
- OEP 2006.** Liechtenstein's Initial Report under Article 7, paragraph 4, of the Kyoto Protocol. Office of Environment, Vaduz. Including the Update following the UNFCCC review (FCCC/IRR/2007/LIE). <http://www.llv.li/#/11786/klimaberichte>
- OEP 2011:** Liechtenstein's Submission on Reference Levels for Forest Management under the Kyoto Protocol (FMRL). Office of Environmental Protection (OEP), Vaduz. https://unfccc.int/files/meetings/ad_hoc_working_groups/kp/application/pdf/awgkp_liechtenstein_2011.pdf [18.11.2015]
- OE 2013:** Greenhouse Gas Inventory 1990–2011: National Inventory Report, CRF-tables, Kyoto Protocol LULUCF table 2011, SEF and SIAR tables from the National Registry. Submission of 15 April 2013 under the United Nations Framework Convention on Climate Change and under the Kyoto Protocol. Office of Environment (OE), Vaduz.
- OE 2016:** Greenhouse Gas Inventory 1990–2013: National Inventory Report, CRF-tables, Kyoto Protocol LULUCF table 2013, SEF and SIAR tables from the National Registry. Submission of 15 April 2016 under the United Nations Framework Convention on Climate Change and under the Kyoto Protocol. Office of Environment (OE), Vaduz.
- UNFCCC 2011:** Report of the technical assessment of the forest management reference level submission of Liechtenstein submitted in 2011 (FCCC/TAR/2011/LIE). <http://unfccc.int/resource/docs/2011/tar/lie01.pdf>

Annexes

Liechtenstein's Second Initial Report under the Kyoto Protocol is accompanied by the following two documents (in pdf form), as requested in footnote 1, page 5 of Decision 2/CMP.8 ('Parties shall include the submission pursuant to Decision 2/CMP.6, paragraph 4, and the corresponding technical assessment report pursuant to Decision 2/CMP.6, paragraph 5, as annexes to the report. Any technical corrections resulting from recommendations in the technical assessment report shall be reported in the inventory submission for the first year of the second commitment period'):

- **Liechtenstein's submission FMRL**

OEP, 2011: Liechtenstein's Submission on Reference Levels for Forest Management under the Kyoto Protocol (FMRL). Office of Environmental Protection (OEP), Vaduz.
https://unfccc.int/files/meetings/ad_hoc_working_groups/kp/application/pdf/awgkp_liechtenstein_2011.pdf

- **Technical assessment of the submission FMRL**

UNFCCC, 2011: Report of the technical assessment of the forest management reference level submission of Liechtenstein submitted in 2011 (FCCC/TAR/2011/LIE).
<http://unfccc.int/resource/docs/2011/tar/lie01.pdf>