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Annex A Responses to recommendations and encouragements: Authors of the respective sections in the main text.

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General note

The timely submission of this report forms part of Switzerland reporting commitment under the United Nations Framework Convention on Climate Change (UNFCCC). The structure and content of the report and its corresponding BR CTF tables strictly follow the "UNFCCC biennial reporting guidelines for developed country Parties". The objectives of these guidelines for preparing the biennial reports are the following:

(a) To assist Parties included in Annex I to the Convention (Annex I Parties) in meeting their commitments for reporting under Articles 4 and 12 of the Convention enhanced by decision 1/CP.16;

(b) To ensure the provision of consistent, transparent, comparable, accurate and complete information by developed country Parties;

(c) To ensure that the biennial reports include information on the progress made by Annex I Parties in achieving their quantified economy-wide emission reduction targets, projected emissions, and the provision of financial, technological and capacity-building support to Parties not included in Annex I to the Convention (non-Annex I Parties);

(d) To facilitate the international assessment of emissions and removals related to progress towards the achievement of the quantified economy-wide emission reduction targets;

(e) To facilitate reporting by Annex I Parties of information on any economic and social consequences of response measures.

Contents

Foreword

In many parts of the world, an increasing awareness regarding climate change manifested itself in an impressive number of climate movements that emerged during the last years. These movements – omnipresent also in Switzerland – insistently demand that political decisions start to unequivocally reflect the urgent need for climate action as evidenced by the latest scientific assessments. During the Swiss national elections in autumn 2019, where parties with high ambition with regard to climate policy won a substantial number of seats in the Swiss Parliament, this demand for a more stringent climate policy was also expressed.

Two years ago, the Swiss Federal Council sent its draft of the third CO_2 Act to the Swiss Parliament. The third CO_2 Act will form the centrepiece of Switzerland's climate policy to achieve the emission reduction commitments up to 2030. During the most recent round of discussions in the Swiss Parliament, the Council of States proposed additional policies and measures, complementing the original draft. While the adoption of the third CO_2 Act is still pending, recent developments, in particular the latest elections, are promising that the current momentum will support the establishment of an effective legislation.

The report at hand is an update to Switzerland's seventh national communication and third biennial report, complementing the BR CTF tables that were updated as well. For Switzerland, complete and transparent reporting as agreed upon by the Parties to the UNFCCC is indispensable for building trust and, thus, for a targeted international collaboration with regard to climate change issues.

Tackling the challenges related to climate change remains a truly international task and strong international collaboration will remain fundamental. On the way forward, Switzerland is committed to contribute its fair share to ultimately reach the goals set in the Paris Agreement.

Christine Hofmann
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December 2019

1 Information on greenhouse gas emissions and trends

Comprehensive summary information from the national greenhouse gas inventory on emissions and emission trends prepared according to the UNFCCC Annex I inventory reporting guidelines are presented in BR CTF tables 1(a) to 1(d). The presented data cover the period from 1990 to 2017 and are fully consistent with the reporting tables (CRF) and the national inventory report of the most recent annual inventory submission of April 2019 (*FOEN*, 2019a). To further increase transparency, additional tables which support the descriptive summary in section 1.2 are provided below (Tab. 1 to Tab. 8). All data were calculated using the 2006 IPCC guidelines for national greenhouse gas inventories (*IPCC*, 2006) and the global warming potential values according to the fourth assessment report of the Intergovernmental Panel on Climate Change (*IPCC*, 2007) based on the effect of greenhouse gases over a 100-year time horizon[2]. Summary information on Switzerland's national inventory arrangements, including changes since the third biennial report, are presented in section 1.3. As required by the 'Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol', information on the national registry is reported in section 1.4.

1.1 Summary tables

Tab. 1 > Switzerland's greenhouse gas emissions by sector and gas, 2017. The total in the second last column includes indirect CO_2.

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NF_3	Indirect CO_2	Total	Share
	kt CO_2eq									
1 Energy	35'974	273.7	220.5	0.0	0.0	0.0	0.0	5.9	**36'474**	*77.2%*
2 Industrial processes and product use	2'129	2.9	38.6	1'512	30.8	196.5	0.5	87.5	**3'998**	*8.5%*
3 Agriculture	47.6	4'040	1'989	0.0	0.0	0.0	0.0	0.0	**6'077**	*12.9%*
5 Waste	9.6	536.4	144.8	0.0	0.0	0.0	0.0	1.1	**691.9**	*1.5%*
6 Other	11.5	0.6	0.5	0.0	0.0	0.0	0.0	1.1	**13.7**	*0.0%*
Total (excluding LULUCF)	**38'172**	**4'854**	**2'394**	**1'512**	**30.8**	**196.5**	**0.5**	**95.6**	**47'255**	***100.0%***
4 LULUCF	–1'658	13.9	46.4	0.0	0.0	0.0	0.0	0.0	–1'598	*–3.4%*
Total (including LULUCF)	36'514	4'868	2'440	1'512	30.8	196.5	0.5	95.6	45'657	*96.6%*
International aviation bunkers	5'302	0.5	43.4	0.0	0.0	0.0	0.0	0.0	5'345	*11.3%*
International marine bunkers	21.9	0.0	0.2	0.0	0.0	0.0	0.0	0.0	22.1	*0.0%*

FOEN (2019a)

[2] These global warming potential values are consistently used by Switzerland, i.e. in particular also regarding the definition of the quantified economy-wide emission reduction target (section 2.1.4) and for the calculation of the projections of greenhouse gas emissions (chapter 4).

Tab. 2 > Switzerland's greenhouse gas emissions by gas (excluding LULUCF and international bunkers, including emissions from the sectors 1, 2, 3, 5, and 6), selected years. Also provided are the shares of the different gases in total emissions.

	1990		1995		2000		2005	
	kt CO_2eq	Share	kt CO_2eq	Share	kt CO_2eq	Share	kt CO_2eq	Share
CO_2 (excluding LULUCF)	44'162	*82.3%*	43'414	*82.8%*	43'612	*83.0%*	45'780	*83.5%*
CH_4 (excluding LULUCF)	6'005	*11.2%*	5'688	*10.8%*	5'286	*10.1%*	5'182	*9.5%*
N_2O (excluding LULUCF)	2'831	*5.3%*	2'734	*5.2%*	2'626	*5.0%*	2'456	*4.5%*
HFCs	0.0	*0.0%*	242.0	*0.5%*	633.9	*1.2%*	1'049	*1.9%*
PFCs	116.5	*0.2%*	17.5	*0.0%*	49.9	*0.1%*	44.5	*0.1%*
SF_6	137.0	*0.3%*	93.2	*0.2%*	143.8	*0.3%*	203.2	*0.4%*
NF_3	0.0	*0.0%*	0.0	*0.0%*	0.0	*0.0%*	0.0	*0.0%*
Indirect CO_2	402.6	*0.8%*	265.4	*0.5%*	178.6	*0.3%*	118.5	*0.2%*
Total (excluding LULUCF, including indirect CO_2)	**53'654**	*100.0%*	**52'454**	*100.0%*	**52'531**	*100.0%*	**54'833**	*100.0%*

	2010		2015		2016		2017	
	kt CO_2eq	Share	kt CO_2eq	Share	kt CO_2eq	Share	kt CO_2eq	Share
CO_2 (excluding LULUCF)	45'043	*83.1%*	38'728	*80.8%*	39'187	*81.2%*	38'172	*80.8%*
CH_4 (excluding LULUCF)	5'127	*9.5%*	4'963	*10.4%*	4'917	*10.2%*	4'854	*10.3%*
N_2O (excluding LULUCF)	2'449	*4.5%*	2'330	*4.9%*	2'362	*4.9%*	2'394	*5.1%*
HFCs	1'308	*2.4%*	1'514	*3.2%*	1'491	*3.1%*	1'512	*3.2%*
PFCs	34.1	*0.1%*	24.7	*0.1%*	18.2	*0.0%*	30.8	*0.1%*
SF_6	148.0	*0.3%*	255.8	*0.5%*	207.1	*0.4%*	196.5	*0.4%*
NF_3	8.5	*0.0%*	0.5	*0.0%*	0.5	*0.0%*	0.5	*0.0%*
Indirect CO_2	109.5	*0.2%*	98.5	*0.2%*	95.2	*0.2%*	95.6	*0.2%*
Total (excluding LULUCF, including indirect CO_2)	**54'227**	*100.0%*	**47'914**	*100.0%*	**48'278**	*100.0%*	**47'255**	*100.0%*

FOEN (2019a)

Tab. 3 > Switzerland's greenhouse gas emissions by gas (excluding international bunkers, including emissions from the sectors 1, 2, 3, 4, 5, and 6), 1990–2017. Also indicated are the relative changes in emissions in 2017 relative to 1990 (last column). In 1990, there were virtually no emissions of HFCs and no emissions of NF_3, therefore the relative increases are not indicated for these gases (for absolute changes see Fig. 4).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	kt CO_2eq									
CO_2 (excluding net CO_2 from LULUCF)	44'162	46'141	46'016	43'605	42'679	43'414	44'099	43'035	44'613	44'442
CO_2 (including net CO_2 from LULUCF)	41'592	39'787	40'931	39'174	39'421	39'509	37'570	38'713	41'500	40'867
CH_4 (excluding CH_4 from LULUCF)	6'005	5'937	5'855	5'747	5'696	5'688	5'645	5'503	5'434	5'338
CH_4 (including CH_4 from LULUCF)	6'034	5'953	5'870	5'762	5'715	5'708	5'663	5'535	5'451	5'352
N_2O (excluding N_2O from LULUCF)	2'831	2'800	2'772	2'786	2'743	2'734	2'652	2'568	2'576	2'499
N_2O (including N_2O from LULUCF)	2'887	2'848	2'819	2'833	2'792	2'784	2'701	2'627	2'625	2'546
HFCs	0.0	1.5	15.4	32.1	78.9	242.0	293.8	358.2	453.6	531.2
PFCs	116.5	98.5	80.6	34.7	20.9	17.5	20.4	21.0	23.8	25.6
SF_6	137.0	139.2	141.4	120.5	106.9	93.2	90.1	124.2	152.6	139.9
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indirect CO_2	402.6	376.3	348.0	315.2	286.4	265.4	244.5	225.4	204.4	190.1
Total (excluding LULUCF, including indirect CO_2)	**53'654**	**55'493**	**55'227**	**52'640**	**51'611**	**52'454**	**53'045**	**51'835**	**53'457**	**53'166**
Total (including LULUCF, including indirect CO_2)	**51'170**	**49'203**	**50'205**	**48'271**	**48'421**	**48'619**	**46'583**	**47'604**	**50'410**	**49'652**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	kt CO_2eq									
CO_2 (excluding net CO_2 from LULUCF)	43'612	45'076	43'459	44'644	45'229	45'780	45'366	43'360	44'707	43'529
CO_2 (including net CO_2 from LULUCF)	49'119	43'973	40'606	40'847	41'834	43'229	43'701	42'812	42'326	40'347
CH_4 (excluding CH_4 from LULUCF)	5'286	5'324	5'281	5'200	5'167	5'182	5'195	5'174	5'250	5'157
CH_4 (including CH_4 from LULUCF)	5'301	5'338	5'300	5'221	5'180	5'196	5'209	5'190	5'263	5'171
N_2O (excluding N_2O from LULUCF)	2'626	2'585	2'516	2'417	2'374	2'456	2'374	2'435	2'422	2'387
N_2O (including N_2O from LULUCF)	2'674	2'631	2'566	2'468	2'420	2'502	2'422	2'483	2'469	2'434
HFCs	633.9	733.5	821.6	907.8	1'008.8	1'049	1'159	1'255	1'274	1'271
PFCs	49.9	30.4	30.4	66.7	65.0	44.5	54.9	46.7	38.5	33.6
SF_6	143.8	144.8	158.4	164.6	186.1	203.2	185.6	171.6	222.2	179.6
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	5.1
Indirect CO_2	178.6	168.5	151.1	136.7	122.6	118.5	117.9	115.1	114.2	112.6
Total (excluding LULUCF, including indirect CO_2)	**52'531**	**54'062**	**52'417**	**53'538**	**54'152**	**54'833**	**54'453**	**52'557**	**54'028**	**52'675**
Total (including LULUCF, including indirect CO_2)	**58'100**	**53'019**	**49'633**	**49'812**	**50'818**	**52'342**	**52'850**	**52'073**	**51'707**	**49'553**

	2010	2011	2012	2013	2014	2015	2016	2017	Relative change 1990 to 2017
	kt CO_2eq								
CO_2 (excluding net CO_2 from LULUCF)	45'043	40'979	42'248	43'179	39'229	38'728	39'187	38'172	*–13.6%*
CO_2 (including net CO_2 from LULUCF)	42'365	39'496	40'323	41'049	38'509	36'482	37'007	36'514	*–12.2%*
CH_4 (excluding CH_4 from LULUCF)	5'127	5'075	5'050	4'987	4'987	4'963	4'917	4'854	*–19.2%*
CH_4 (including CH_4 from LULUCF)	5'140	5'090	5'062	5'000	5'000	4'976	4'933	4'868	*–19.3%*
N_2O (excluding N_2O from LULUCF)	2'449	2'396	2'458	2'350	2'395	2'330	2'362	2'394	*–15.4%*
N_2O (including N_2O from LULUCF)	2'495	2'443	2'504	2'398	2'443	2'377	2'411	2'440	*–15.5%*
HFCs	1'308	1'381	1'455	1'436	1'472	1'514	1'491	1'512	*See caption*
PFCs	34.1	32.2	36.0	24.5	21.4	24.7	18.2	30.8	*–73.6%*
SF_6	148.0	159.5	208.9	252.5	258.8	255.8	207.1	196.5	*43.5%*
NF_3	8.5	6.2	0.4	0.1	0.4	0.5	0.5	0.5	*See caption*
Indirect CO_2	109.5	108.0	107.1	104.8	101.2	98.5	95.2	95.6	*–76.3%*
Total (excluding LULUCF, including indirect CO_2)	**54'227**	**50'137**	**51'563**	**52'334**	**48'465**	**47'914**	**48'278**	**47'255**	***–11.9%***
Total (including LULUCF, including indirect CO_2)	**51'608**	**48'716**	**49'696**	**50'265**	**47'806**	**45'728**	**46'163**	**45'657**	***–10.8%***

FOEN (2019a)

Tab. 4 > Switzerland's greenhouse gas emissions by sector (excluding LULUCF and international bunkers), selected years. Also indicated are the shares of the different sectors and source categories in total greenhouse gas emissions.

	1990		1995		2000		2005	
	kt CO_2eq	Share	kt CO_2eq	Share	kt CO_2eq	Share	kt CO_2eq	Share
1 Energy	41'826	*78.0%*	41'869	*79.8%*	42'181	*80.3%*	43'991	*80.2%*
1A1 Energy industries	2'519	*4.7%*	2'643	*5.0%*	3'172	*6.0%*	3'816	*7.0%*
1A2 Manufacturing industries and construction	6'443	*12.0%*	6'192	*11.8%*	5'925	*11.3%*	5'974	*10.9%*
1A3 Transport	14'639	*27.3%*	14'257	*27.2%*	15'927	*30.3%*	15'855	*28.9%*
1A4 Other sectors	17'641	*32.9%*	18'184	*34.7%*	16'648	*31.7%*	17'895	*32.6%*
1A5 Other (military)	219.6	*0.4%*	162.8	*0.3%*	151.2	*0.3%*	138.7	*0.3%*
1B Fugitive emissions from oil and natural gas	363.2	*0.7%*	430.9	*0.8%*	359.5	*0.7%*	312.8	*0.6%*
2 Industrial processes and product use	3'576	*6.7%*	2'911	*5.5%*	3'143	*6.0%*	3'771	*6.9%*
3 Agriculture	6'766	*12.6%*	6'523	*12.4%*	6'185	*11.8%*	6'094	*11.1%*
5 Waste	1'071	*2.0%*	873.9	*1.7%*	829.6	*1.6%*	844.5	*1.5%*
6 Other	12.2	*0.0%*	12.1	*0.0%*	13.0	*0.0%*	13.6	*0.0%*
Indirect CO_2	402.6	*0.7%*	265.4	*0.6%*	178.6	*0.4%*	118.5	*0.3%*
from 1 Energy	43.5	*0.1%*	27.5	*0.1%*	16.6	*0.0%*	12.5	*0.0%*
from 2 Industrial processes and product use	356.0	*0.7%*	235.2	*0.5%*	159.2	*0.3%*	103.5	*0.2%*
from 5 Waste	2.0	*0.0%*	1.7	*0.0%*	1.6	*0.0%*	1.4	*0.0%*
from 6 Other	1.0	*0.0%*	1.0	*0.0%*	1.1	*0.0%*	1.2	*0.0%*
Total (excluding LULUCF, including indirect CO_2)	**53'654**	*100.0%*	**52'454**	*100.0%*	**52'531**	*100.0%*	**54'833**	*100.0%*

	2010		2015		2016		2017	
	kt CO_2eq	Share	kt CO_2eq	Share	kt CO_2eq	Share	kt CO_2eq	Share
1 Energy	43'203	*79.7%*	37'071	*77.4%*	37'461	*77.6%*	36'468	*77.2%*
1A1 Energy industries	3'846	*7.1%*	3'292	*6.9%*	3'380	*7.0%*	3'299	*7.0%*
1A2 Manufacturing industries and construction	5'814	*10.7%*	4'962	*10.4%*	4'965	*10.3%*	4'918	*10.4%*
1A3 Transport	16'326	*30.1%*	15'321	*32.0%*	15'151	*31.4%*	14'884	*31.5%*
1A4 Other sectors	16'800	*31.0%*	13'142	*27.4%*	13'606	*28.2%*	13'017	*27.5%*
1A5 Other (military)	137.4	*0.3%*	135.2	*0.3%*	139.4	*0.3%*	127.6	*0.3%*
1B Fugitive emissions from oil and natural gas	279.2	*0.5%*	218.1	*0.5%*	219.2	*0.5%*	223.1	*0.5%*
2 Industrial processes and product use	3'968	*7.3%*	3'919	*8.2%*	3'914	*8.1%*	3'910	*8.3%*
3 Agriculture	6'159	*11.4%*	6'097	*12.7%*	6'093	*12.6%*	6'077	*12.9%*
5 Waste	774.8	*1.4%*	716.0	*1.5%*	703.0	*1.5%*	690.8	*1.5%*
6 Other	12.4	*0.0%*	12.5	*0.0%*	12.2	*0.0%*	12.6	*0.0%*
Indirect CO_2	109.5	*0.2%*	98.5	*0.2%*	95.2	*0.2%*	95.6	*0.2%*
from 1 Energy	8.2	*0.0%*	6.9	*0.0%*	6.1	*0.0%*	5.9	*0.0%*
from 2 Industrial processes and product use	99.0	*0.2%*	89.3	*0.2%*	86.9	*0.2%*	87.5	*0.2%*
from 5 Waste	1.3	*0.0%*	1.2	*0.0%*	1.2	*0.0%*	1.1	*0.0%*
from 6 Other	1.0	*0.0%*	1.0	*0.0%*	1.0	*0.0%*	1.1	*0.0%*
Total (excluding LULUCF, including indirect CO_2)	**54'227**	*100.0%*	**47'914**	*100.0%*	**48'278**	*100.0%*	**47'255**	*100.0%*

FOEN (2019a)

Tab. 5 > Greenhouse gas emissions and removals in different sectors and source categories (excluding international bunkers), 1990–2017. Also indicated are the relative changes in emissions in 2017 relative to 1990 (last column).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	kt CO_2eq									
1 Energy	41'826	44'214	44'251	42'081	40'973	41'869	42'741	41'821	43'394	43'190
1A1 Energy industries	2'519	2'802	2'895	2'563	2'605	2'643	2'861	2'861	3'224	3'249
1A2 Manufacturing industries and construction	6'443	6'677	6'261	6'097	6'042	6'192	5'941	5'906	6'111	5'976
1A3 Transport	14'639	15'131	15'453	14'385	14'570	14'257	14'319	14'875	15'084	15'693
1A4 Other sectors	17'641	19'001	19'035	18'421	17'141	18'184	19'037	17'602	18'416	17'745
1A5 Other (military)	219.6	202.2	194.0	185.7	180.2	162.8	151.9	161.9	160.9	146.8
1B Fugitive emissions from oil and natural gas	363.2	400.7	413.5	428.4	434.2	430.9	430.8	415.3	398.5	380.7
2 Industrial processes and product use	3'576	3'204	3'041	2'729	2'922	2'911	2'784	2'698	2'813	2'880
3 Agriculture	6'766	6'706	6'593	6'571	6'545	6'523	6'400	6'228	6'199	6'068
5 Waste	1'071	981	982	931	872.9	873.9	863.6	850.8	835.6	825.1
6 Other	12.2	12.2	12.2	12.2	12.2	12.1	12.1	12.1	11.1	12.4
Indirect CO_2	402.6	376.3	348.0	315.2	286.4	265.4	244.5	225.4	204.4	190.1
from 1 Energy	43.5	45.8	45.1	39.9	29.4	27.5	27.3	26.1	22.9	17.3
from 2 Industrial processes and product use	356.0	327.5	299.9	272.5	254.3	235.2	214.5	196.7	179.0	170.0
from 5 Waste	2.0	2.0	1.9	1.9	1.7	1.7	1.6	1.6	1.6	1.6
from 6 Other	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.1
Total (excluding LULUCF, including indirect CO_2)	**53'654**	**55'493**	**55'227**	**52'640**	**51'611**	**52'454**	**53'045**	**51'835**	**53'457**	**53'166**
4 LULUCF	–2'484	–6'289	–5'022	–4'368	–3'190	–3'835	–6'462	–4'231	–3'047	–3'514
Total (including LULUCF, including indirect CO_2)	51'170	49'203	50'205	48'271	48'421	48'619	46'583	47'604	50'410	49'652

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	kt CO_2eq									
1 Energy	42'181	43'597	41'996	43'189	43'555	43'991	43'602	41'553	42'945	41'835
1A1 Energy industries	3'172	3'313	3'390	3'387	3'682	3'816	4'032	3'719	3'837	3'674
1A2 Manufacturing industries and construction	5'925	6'181	5'735	5'827	5'972	5'974	6'148	5'946	6'018	5'701
1A3 Transport	15'927	15'626	15'551	15'716	15'796	15'855	15'971	16'294	16'644	16'438
1A4 Other sectors	16'648	17'981	16'833	17'802	17'666	17'895	17'017	15'179	16'040	15'622
1A5 Other (military)	151.2	148.4	154.6	140.1	128.9	138.7	142.8	135.6	130.6	132.6
1B Fugitive emissions from oil and natural gas	359.5	346.7	332.3	316.5	310.3	312.8	291.1	279.6	274.7	268.1
2 Industrial processes and product use	3'143	3'248	3'287	3'376	3'645	3'771	3'828	3'905	3'933	3'796
3 Agriculture	6'185	6'190	6'113	5'986	5'962	6'094	6'049	6'143	6'213	6'131
5 Waste	829.6	844.4	856.7	834.9	853.1	844.5	844.0	827.2	809.9	788.2
6 Other	13.0	13.8	12.9	14.1	13.9	13.6	12.5	13.9	13.0	12.7
Indirect CO_2	178.6	168.5	151.1	136.7	122.6	118.5	117.9	115.1	114.2	112.6
from 1 Energy	16.6	16.8	14.5	13.8	13.3	12.5	12.6	11.5	11.1	10.8
from 2 Industrial processes and product use	159.2	148.9	133.9	120.3	106.7	103.5	102.9	101.0	100.6	99.4
from 5 Waste	1.6	1.6	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3
from 6 Other	1.1	1.2	1.1	1.2	1.2	1.2	1.1	1.2	1.1	1.1
Total (excluding LULUCF, including indirect CO_2)	**52'531**	**54'062**	**52'417**	**53'538**	**54'152**	**54'833**	**54'453**	**52'557**	**54'028**	**52'675**
4 LULUCF	5'569	–1'043	–2'784	–3'726	–3'334	–2'491	–1'603	–483.9	–2'321	–3'122
Total (including LULUCF, including indirect CO_2)	58'100	53'019	49'633	49'812	50'818	52'342	52'850	52'073	51'707	49'553

	2010	2011	2012	2013	2014	2015	2016	2017	Relative change 1990 to 2017
	kt CO_2eq								
1 Energy	43'203	39'140	40'531	41'451	37'405	37'071	37'461	36'468	*–12.8%*
1A1 Energy industries	3'846	3'598	3'641	3'736	3'607	3'292	3'380	3'299	*30.9%*
1A2 Manufacturing industries and construction	5'814	5'376	5'387	5'478	5'079	4'962	4'965	4'918	*–23.7%*
1A3 Transport	16'326	16'144	16'259	16'167	16'059	15'321	15'151	14'884	*1.7%*
1A4 Other sectors	16'800	13'614	14'853	15'700	12'295	13'142	13'606	13'017	*–26.2%*
1A5 Other (military)	137.4	124.7	132.4	133.4	138.7	135.2	139.4	127.6	*–41.9%*
1B Fugitive emissions from oil and natural gas	279.2	283.3	259.4	235.6	226.3	218.1	219.2	223.1	*–38.6%*
2 Industrial processes and product use	3'968	3'995	3'990	3'975	4'046	3'919	3'914	3'910	*9.3%*
3 Agriculture	6'159	6'120	6'182	6'057	6'178	6'097	6'093	6'077	*–10.2%*
5 Waste	774.8	759.7	738.2	732.2	723.2	716.0	703.0	690.8	*–35.5%*
6 Other	12.4	13.4	14.0	14.4	11.5	12.5	12.2	12.6	*3.5%*
Indirect CO_2	109.5	108.0	107.1	104.8	101.2	98.5	95.2	95.6	*–76.3%*
from 1 Energy	8.2	8.1	8.2	8.3	8.1	6.9	6.1	5.9	*–86.4%*
from 2 Industrial processes and product use	99.0	97.5	96.5	94.1	90.9	89.3	86.9	87.5	*–75.4%*
from 5 Waste	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.1	*–43.9%*
from 6 Other	1.0	1.1	1.2	1.2	1.0	1.0	1.0	1.1	*1.4%*
Total (excluding LULUCF, including indirect CO_2)	**54'227**	**50'137**	**51'563**	**52'334**	**48'465**	**47'914**	**48'278**	**47'255**	***–11.9%***
4 LULUCF	–2'619	–1'420	–1'866	–2'069	–659.1	–2'186	–2'115	–1'598	*–35.7%*
Total (including LULUCF, including indirect CO_2)	51'608	48'716	49'696	50'265	47'806	45'728	46'163	45'657	*–10.8%*

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Tab. 6 > Emissions of precursor gases and SO_2 (excluding emissions from LULUCF), 1990–2017.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	kt													
NO_x	140.1	137.3	130.9	119.7	118.0	115.1	111.6	107.8	107.1	106.5	104.2	100.8	95.2	93.0
CO	731.5	698.3	645.8	568.3	524.8	490.4	474.7	443.7	423.5	409.8	383.8	364.4	339.8	331.8
NMVOC	300.6	282.7	262.2	235.9	217.5	202.5	190.6	178.0	165.1	156.3	147.3	139.6	127.8	118.5
SO_2	36.5	36.2	33.8	28.8	26.1	25.9	24.4	21.2	21.9	19.0	16.2	17.0	14.8	15.0

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	kt													
NO_x	91.5	91.0	88.1	85.3	83.7	78.1	76.6	71.8	71.8	71.6	67.8	63.7	61.9	59.5
CO	315.8	301.8	280.1	264.2	254.4	237.9	228.3	207.0	199.4	192.0	173.4	164.4	160.3	154.1
NMVOC	109.5	106.6	103.6	100.6	98.8	95.5	92.5	89.4	88.0	85.9	82.4	80.2	78.2	78.2
SO_2	14.8	13.8	13.2	11.5	11.6	10.3	10.4	8.4	8.7	8.1	7.4	5.7	5.3	5.3

FOEN (2019a)

Tab. 7 > Emissions of precursor gases and SO_2 by sector, 2017.

	NO_x	CO	NMVOC	SO_2
	kt			
1 Energy	55.0	150.0	16.9	4.4
2 Industrial processes and product use	0.3	1.9	42.0	0.8
3 Agriculture	3.9	NO, NA	17.7	NO
5 Waste	0.2	1.6	1.4	0.1
6 Other	0.1	0.7	0.2	0.0
Total (excluding LULUCF)	**59.5**	**154.1**	**78.2**	**5.3**
4 LULUCF	0.1	1.3	65.3	NO
Total (including LULUCF)	**59.6**	**155.4**	**143.5**	**5.3**

NA, not applicable; NO, not occurring
FOEN (2019a)

Tab. 8 > Net emissions (positive) and removals (negative) for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, 1990–2017.

Greenhouse gas source and sink activities	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Net emissions/removals (kt CO_2eq)									
A Article 3.3 activities	**88.3**	**88.2**	**87.5**	**89.0**	**99.9**	**110.5**	**111.3**	**113.9**	**123.2**	**125.3**
Afforestation/reforestation	–3.1	–6.0	–8.9	–11.5	–13.6	–15.0	–16.2	–17.2	–18.0	–18.7
Deforestation	91.4	94.2	96.4	100.5	113.4	125.5	127.5	131.1	141.1	144.1
B Article 3.4 activities	**–2'465**	**–5'371**	**–4'651**	**–5'010**	**–3'703**	**–4'614**	**–6'252**	**–4'429**	**–3'402**	**–3'545**
Forest management	–1'160	–4'548	–4'121	–4'535	–3'340	–4'111	–5'966	–4'174	–3'151	–3'141
Harvested wood products	–1'305	–822.8	–530.5	–475.5	–363.0	–503.4	–286.0	–255.0	–251.0	–403.6

Greenhouse gas source and sink activities	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Net emissions/removals (kt CO_2eq)									
A Article 3.3 activities	**126.1**	**127.8**	**129.7**	**131.6**	**133.4**	**131.8**	**132.8**	**128.5**	**115.2**	**128.8**
Afforestation	–19.5	–20.3	–21.1	–21.8	–22.6	–23.2	–23.8	–24.5	–25.2	–25.9
Deforestation	145.6	148.1	150.8	153.4	156.0	155.0	156.6	153.0	140.3	154.6
B Article 3.4 activities	**4'225**	**–2'139**	**–3'443**	**–3'466**	**–3'229**	**–3'440**	**–1'672**	**–1'132**	**–2'257**	**–3'231**
Forest management	4'934	–1'597	–3'036	–3'026	–2'623	–2'701	–1'129	–617.6	–1'875	–2'821
Harvested wood products	–709.1	–542.5	–407.5	–440.1	–605.7	–739.0	–542.2	–514.7	–382.4	–409.7

Greenhouse gas source and sink activities	2010	2011	2012	2013	2014	2015	2016	2017
	Net emissions/removals (kt CO_2eq)							
A Article 3.3 activities	**139.4**	**142.0**	**143.5**	**143.4**	**134.1**	**121.6**	**128.0**	**146.2**
Afforestation	–24.1	–21.9	–21.1	–20.1	–17.9	–19.4	–19.2	–18.9
Deforestation	163.5	164.0	164.6	163.5	152.0	141.0	147.2	165.1
B Article 3.4 activities	**–3'155**	**–1'850**	**–3'110**	**–2'877**	**–1'611**	**–3'096**	**–2'975**	**–2'902**
Forest management	–2'740	–1'391	–2'816	–2'788	–1'312	–2'868	–2'850	–2'736
Harvested wood products	–415.0	–458.6	–293.7	–89.5	–299.5	–228.2	–125.0	–166.1

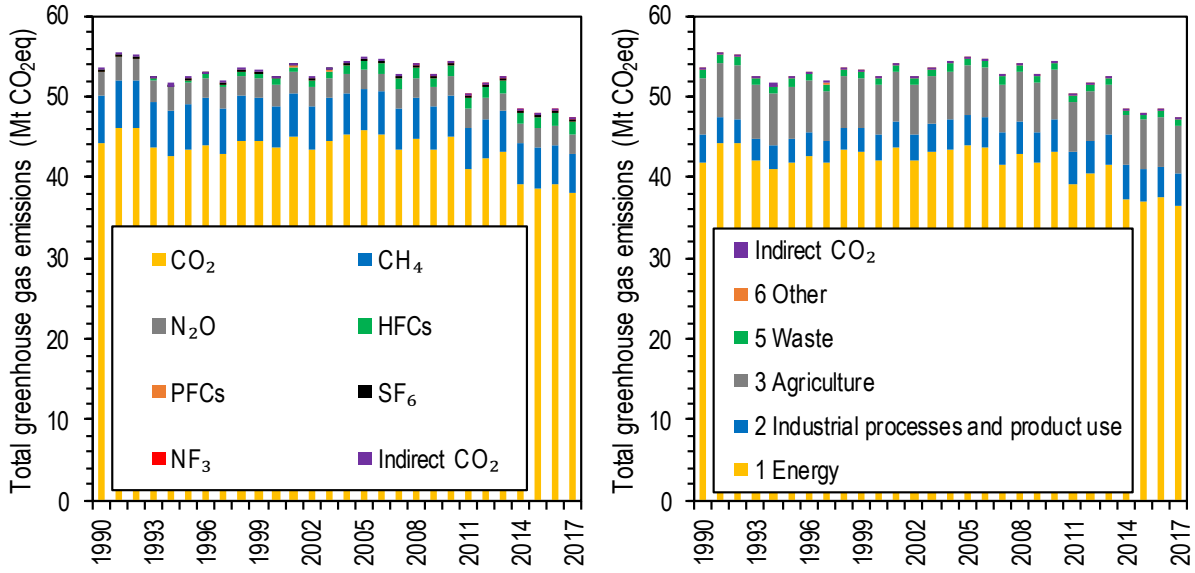
FOEN (2019a)

1.2 Descriptive summary

1.2.1 Aggregate greenhouse gas emissions

Switzerland's total greenhouse gas emissions (excluding LULUCF and international bunkers, including indirect CO_2) were 47.255 million tonnes of CO_2 equivalents in 2017 (Tab. 1), corresponding to 5.6 tonnes of CO_2 equivalents per capita. Between 1990 and 2017, total greenhouse gas emissions (excluding LULUCF) were mostly modulated by year-to-year changes in meteorological conditions which drive the amount of fuel needed for heating purposes (Fig. 1). This resulted in minimum emissions of 88.1 per cent in 2017 and maximum emissions of 103.4 per cent in 1991, relative to 1990. However, for the last years, a decreasing trend superimposed the variations from meteorological conditions. Indeed, average total emissions from 2013 to 2017 (last five years) were 9.1 per cent lower than average total emission from 1990 to 1994 (first five years of the reported period). Overall, total greenhouse gas emissions evolved largely in parallel with the emissions of CO_2 between 1990 and 2017, since CO_2 persistently constituted the major contributor and since the decrease of CH_4 and N_2O emissions was about offset by the increase of emissions of F-gases in terms of CO_2 equivalents (section 1.2.2, Tab. 2, Fig. 3 and Fig. 4).

Fig. 1 > Switzerland's total greenhouse gas emissions (excluding LULUCF and international bunkers, including emissions from the sectors 1, 2, 3, 5, and 6, including indirect CO_2), 1990–2017. Left: Subdivided by gas. Right: Subdivided by sector.



FOEN (2019a)

1.2.2 Emission trends by greenhouse gas

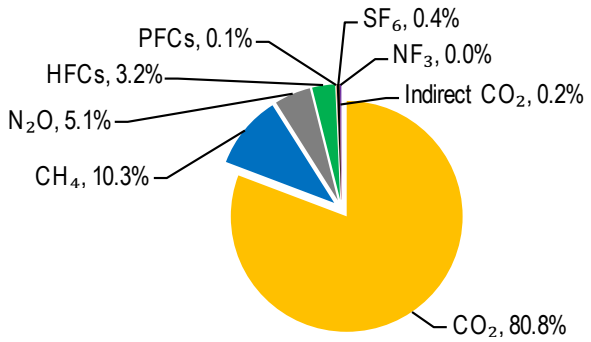
The relative contributions of the different gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3, and indirect CO_2) to total greenhouse gas emissions in the year 2017 are shown in Fig. 2.

Broken down by gas, the trends in greenhouse gas emissions in Switzerland, from 1990 to 2017, were as follows (Tab. 2, Tab. 3, Fig. 3 and Fig. 4):

- CO_2 was the dominant contributor gas over the full time period (Fig. 1). In 2017, emissions of CO_2 (not including indirect CO_2 and emissions from LULUCF) amounted to 38.172 million tonnes (4.5 tonnes per capita), corresponding to a share of 80.8 per cent in total greenhouse gas emissions (Fig. 2). CO_2 emissions primarily stem from fuel combustion activities, followed by emissions from industrial processes (mainly cement production);
- CH_4 accounted for a share of 10.3 per cent in total greenhouse gas emissions in 2017 (Fig. 2). Between 1990 and 2017, CH_4 emissions decreased by 19.2 per cent. This decrease is mainly attributable to reduced emissions from agriculture, where a reduction of livestock entailed less emissions from enteric fermentation. However, reduced CH_4 emissions from the energy and waste sectors also contribute to the observed decreasing trend in total CH_4 emissions. Particularly noteworthy is a change in waste legislation banning inputs into solid waste disposal sites as of the year 2000 (section 3.8.2), leading to further decreasing CH_4 emissions from waste disposal sites;

- N_2O accounted for a share of 5.1 per cent in total greenhouse gas emissions in 2017 (Fig. 2). Between 1990 and 2017, total N_2O emissions decreased by 15.4 per cent as N_2O emissions from manure management and agricultural soils declined in concert with CH_4 emissions due to decreasing livestock populations and decreasing use of fertiliser;
- Emissions of CH_4 and N_2O originated mainly from sector 3 'Agriculture';
- All emissions of F-gases are attributed by definition to sector 2 'Industrial processes and product use';
- F-gases increased their share in total greenhouse gas emissions from 0.5 per cent in 1990 to 3.7 per cent in 2017 (Fig. 2, Tab. 2). HFC emissions have substantially increased compared to 1990, because HFCs were introduced as substitutes for CFCs. In contrast, PFC emissions were 73.6 per cent lower in 2017 compared to 1990. In 2017, SF_6 emissions were 43.5 per cent higher compared to 1990, with relatively large year-to-year fluctuations. Emissions of NF_3 were of minor importance over the full time period;
- Net CO_2 emissions/removals from LULUCF also showed considerable year-to-year variability, as heavy storms in 1990 and 1999 ('Lothar') and other factors had a large influence on the wood harvesting and tree mortality rates in forests. From 1990 to 2017, wood harvesting generally increased but was still exceeded by the growth of the living biomass pool. Overall, a reduction in net removals within the land use, land-use change and forestry sector is observed between 1990 and 2017 (Fig. 7);
- Indirect CO_2 emissions resulting from the atmospheric oxidation of NMVOC and CO emissions show a decreasing trend, which is mainly due to the implementation of post-combustion facilities and reductions of emissions from solvent use. However, indirect CO_2 emissions are of minor importance over the full time period from 1990 to 2017 (see section 1.2.4 for details about the evolution of emissions of precursor gases and the calculation of the related indirect CO_2 emissions).

Fig. 2 > Contribution of individual gases to Switzerland's total greenhouse gas emissions (excluding LULUCF and international bunkers, including emissions from the sectors 1, 2, 3, 5, and 6, including indirect CO_2), 2017.



Total emissions 2017 (including indirect CO_2): 47'255 kt CO_2 eq (=100%)

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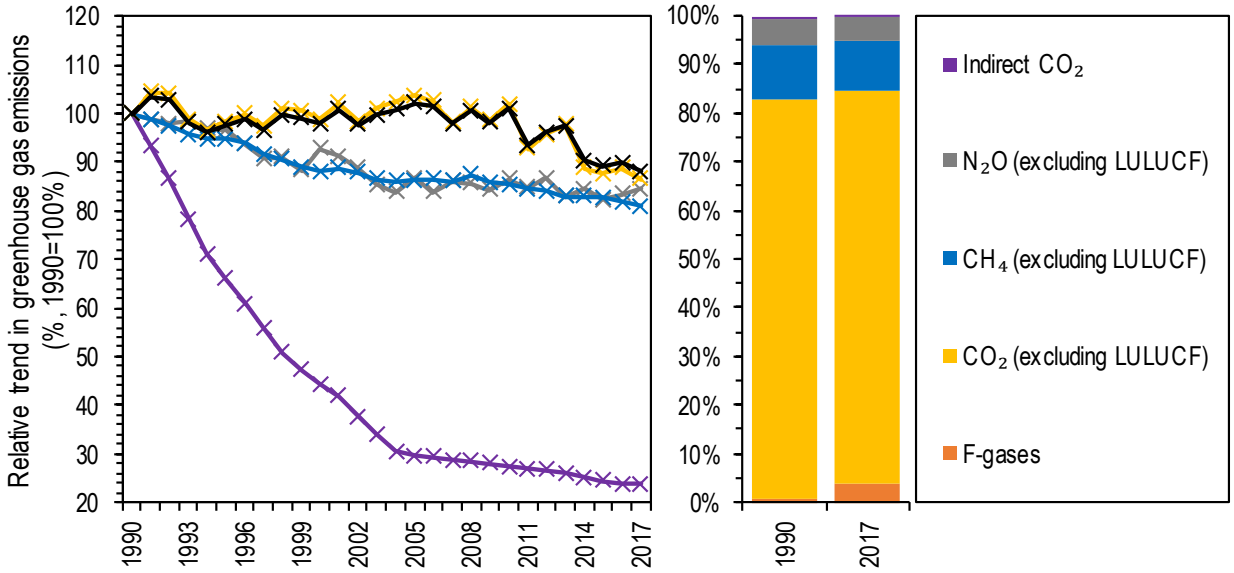
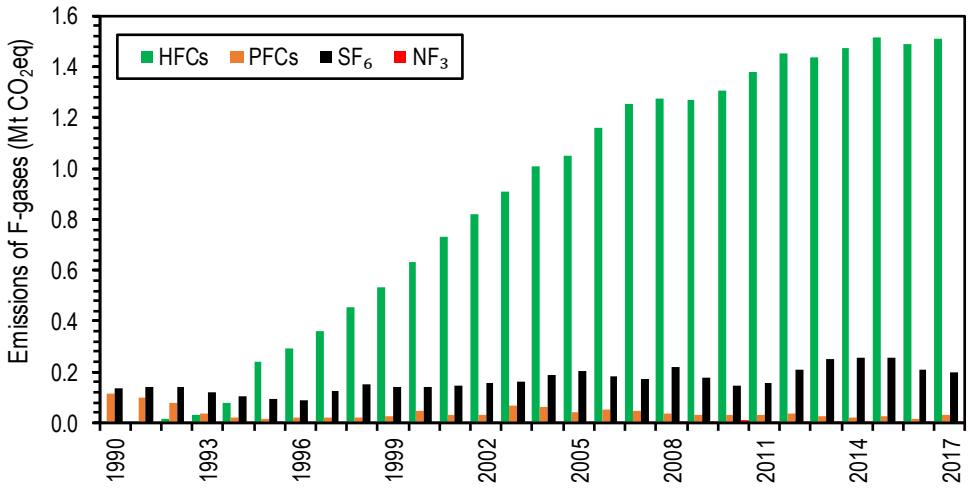
Fig. 3 > Left: Relative trends in emissions of the greenhouse gases CO_2, CH_4, N_2O, and indirect CO_2 (excluding LULUCF and international bunkers, including emissions from the sectors 1, 2, 3, 5, and 6), 1990–2017. The increase of emissions of F-gases, which amounts to about a factor of seven in 2017 relative to 1990, is shown in Fig. 4. However, F-gases are included in the total (black line). Right: Relative contributions of CO_2, CH_4, N_2O, F-gases, and indirect CO_2 to the total emissions in the years 1990 and 2017 (see also Fig. 2).



FOEN (2019a)

Fig. 4 > Absolute changes in emissions of HFCs, PFCs, SF_6, and NF_3 in Switzerland, 1990–2017. NF_3 emissions are hardly visible (due to values close to zero, see Tab. 3).



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1.2.3 Emission trends by sources and sinks

In the following, details about Switzerland's greenhouse gas emissions (and removals) by the different sectors are provided (Fig. 1 to Fig. 7, Tab. 4 and Tab. 5).

Sector 1 'Energy'

Sector 1 'Energy' represents the major source of greenhouse gases in Switzerland (77.2 per cent of total emissions in 2017); thus, the respective tables and figures also distinguish source categories (1A1 to 1A5 and 1B). The following characteristics are noteworthy:

- Despite differing trends in the source categories, the overall emissions from sector 1 'Energy' remained at a relatively constant level since 1990 (Fig. 6), with some fluctuations mainly caused by year-to-year variations in meteorological conditions. However, a decreasing trend became visible during the most recent years;

- In 2017, more than 91 per cent of Switzerland's electric power was generated by hydroelectric and nuclear power plants (see Table 24 in *SFOE*, 2019a). Therefore, source category 1A1 'Energy industries' plays a minor role (9.0 per cent of total emissions from sector 1 'Energy' in 2017) and represents waste incineration plants rather than classical thermal power stations. While overall emissions from source category 1A1 'Energy industries' increased by 30.9 per cent since 1990, fluctuations were caused by varying combustion activities in the petroleum refinery industry, waste incineration and new installations for district heating;

- Emissions from source category 1A2 'Manufacturing industries and construction' contributed 13.5 per cent to total emissions from sector 1 'Energy' in 2017. Emissions from this source category generally showed a decreasing trend and were 23.7 per cent lower in 2017 compared to 1990. The decreasing emissions mainly resulted from a switch in fuel consumption from other bituminous coal and residual fuel oil (i.e. fuels with relatively high emission factors) to other fossil fuels, natural gas, lignite and biomass (i.e. fuels with relatively low emission factors). For instance, the consumption of other bituminous coal in source category 1A2 'Manufacturing industries and construction' decreased by about 88 per cent since 1990, while the consumption of natural gas more than doubled. At the same time, the production in some industry branches substantially decreased (e.g. iron and aluminium production, cellulose and paper production), while it increased or remained about constant in other industry branches (e.g. steel production, food industry, fibreboard production);

- Emissions from source category 1A3 'Transport' (40.8 per cent of total emissions from sector 1 'Energy' in 2017) increased by 1.7 per cent from 1990 to 2017. Fluctuations indicate a fairly strong correlation between emissions and the economic development, as well as a dependency on the exchange rate between the Euro and the Swiss franc leading to more or less 'fuel tourism' (see also section 2.6 of Switzerland's seventh national communication for further discussions). Emissions from 1A3 'Transport' were highest in 2008 (13.7 per cent above the value in 1990) and slowly decreased during the last about ten years;

- Emissions from source category 1A4 'Other sectors' (35.7 per cent of total emission from sector 1 'Energy' in 2017) result from the use of fossil fuels by residential and commercial buildings. Year-to-year variations reflect the impact of meteorological conditions on heating demand. Indeed, emissions showed a strong correlation with the number of heating degree days, an index for cold weather conditions. Throughout the record, emissions generally increased when heating degree days increased and vice versa. From 1990 to 2017, the number of buildings and apartments increased, as well as the average floor space per person and workplace, resulting in a substantial increase of the total area heated. However, over the same period various policies and measures led to higher standards for insulation and to more efficient combustion equipment for both new and renovated buildings, which more than compensated for the emissions from the additional area heated (see section 2.10 of Switzerland's seventh national communication). Overall, emissions from source category 1A4 'Other sectors' decreased and were 26.2 per cent lower in 2017 compared to 1990;

- Source category 1A5 'Other' covers greenhouse gas emissions from non-road military vehicles including military aviation (0.3 per cent of total emissions from sector 1 'Energy' in 2017). Emissions decreased steadily during the 1990s, due to decreased use of military vehicles and aircrafts. Since 2004 they stabilised at about 60 per cent of the emissions in 1990;

- Emissions from category 1B 'Fugitive emissions from oil and natural gas' (0.6 per cent of total emissions from sector 1 'Energy') are dominated by emissions from transmission and distribution of natural gas. While the length of the natural gas net as well as the amount of gas consumed increased substantially since 1990, emissions from category 1B 'Fugitive emissions from oil and natural gas' decreased thanks to the gradual replacement of cast-iron pipes with polyethylene pipes. In 2017, emissions were 38.6 per cent lower compared to 1990.

Sector 2 'Industrial processes and product use'

Overall, emissions from sector 2 'Industrial processes and product use' showed a decreasing trend in the 1990s, a rebound between 1998 and about 2010, followed by about constant emissions during the last years (Fig. 5). Mainly driven by economic development in the respective sectors, CO_2 and N_2O emissions decreased from 1990 to about 1998, remaining about constant thereafter. However, increasing emissions of F-gases (mainly HFCs) led to a subsequent increase of total greenhouse gas emissions from sector 2 'Industrial processes and product use' to current emissions of 9.3 per cent higher compared to 1990. Recently, emissions of F-gases about levelled, indicating that peak emissions may have been reached (see chapter 4 for projected future trends). The sector's share in total greenhouse gas emissions was 8.3 per cent in 2017 (Tab. 4).

Sector 3 'Agriculture'

Sector 3 'Agriculture' is characterised by CH_4 emissions from enteric fermentation and manure management, as well as by N_2O emissions from agricultural soils and manure management. Overall, CO_2 equivalent emissions decreased by about 10 per cent from 1990 to 2004 and remained about constant thereafter (Fig. 5). The main drivers of this trend are declining livestock (cattle and swine) and reduced fertiliser use. Sector 3 'Agriculture' contributed 12.9 per cent to total greenhouse gas emissions in 2017 (Tab. 4).

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

Fig. 7 shows net emissions and removals from sector 4 'Land use, land-use change and forestry' (LULUCF) in Switzerland, which are dominated by biomass dynamics in forests. Throughout the period 1990–2017, except for 2000, the removals in the land use, land-use change and forestry sector were higher than the emissions. However, a strong year-to-year variation is evident. The reason for the positive value in 2000 is the winter storm 'Lothar' at the end of 1999 which caused great damages in the forest stands and led to increased harvesting. In 2017, the land use, land-use change and forestry sector was a net CO_2 sink of 3.4 per cent of total greenhouse gas emissions (Tab. 1). With regard to its emission reduction commitment, Switzerland accounts for afforestation, reforestation as well as deforestation under Article 3.3 of the Kyoto Protocol and for forest management under Article 3.4 of the Kyoto Protocol (see section 2.1.5 for details). The respective net emissions and removals are provided in Tab. 8 and displayed in Fig. 8.

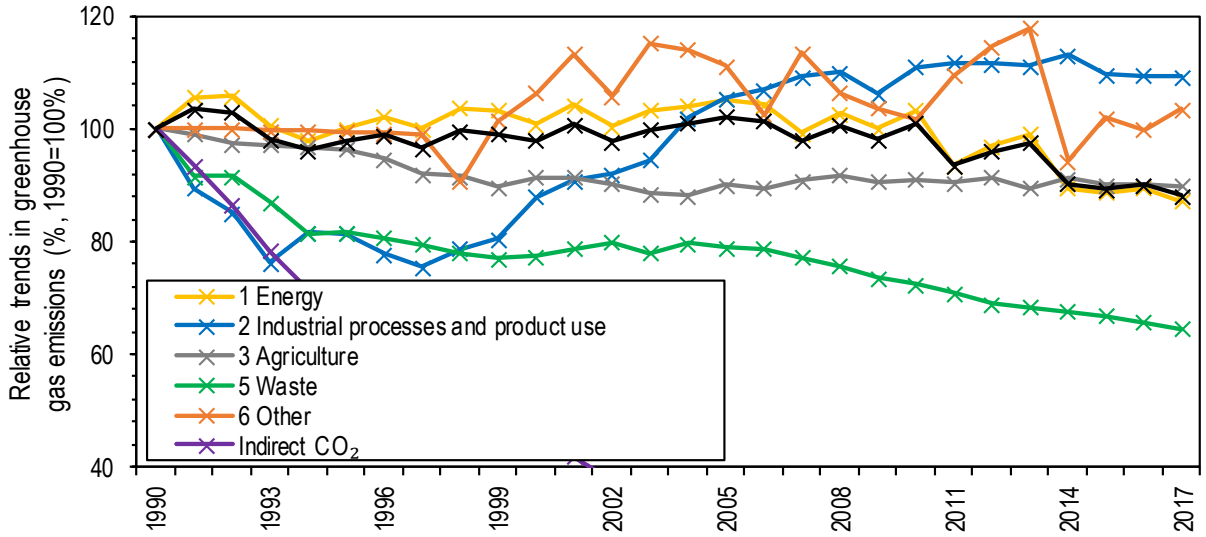
Sector 5 'Waste'

Sector 5 'Waste' contributed 1.5 per cent to total greenhouse gas emissions in 2017 (Tab. 1). Overall, emissions decreased by 35.5 per cent since 1990 (Fig. 5), however, the different source categories within the sector showed divergent evolutions. Emissions from solid waste disposal sites decreased by almost 60 per cent since 1990, as Switzerland continuously increased the share of municipal solid waste incinerated in waste incineration plants. Moreover, since the year 2000, further emission reductions have been induced by a change in legislation completely banning the disposal of combustible municipal solid wastes on solid waste disposal sites. In contrast, emissions from biological treatment of solid waste more than doubled since 1990, as the amount of composted organic waste and the number of biogas facilities increased. Emissions from wastewater treatment and discharge steadily increased since 1990, closely related to the increase in population. Finally, emissions from incineration and open burning of waste reported in sector 5 'Waste' showed a decreasing trend since 1990. However, the vast majority of emissions from incineration of waste are not reported in sector 5 'Waste', but in sector 1 'Energy'. Taken together, waste-related emissions (including emissions from waste management activities reported in sector 5 'Waste', as well as in the source categories 1A 'Energy industries' and 3D 'Agricultural soils') increased by 31.6 per cent since 1990 (data not shown in Fig. 5; see Fig. 7-3 and Fig. 7-4 in Switzerland's national inventory report; *FOEN*, 2019a).

Sector 6 'Other'

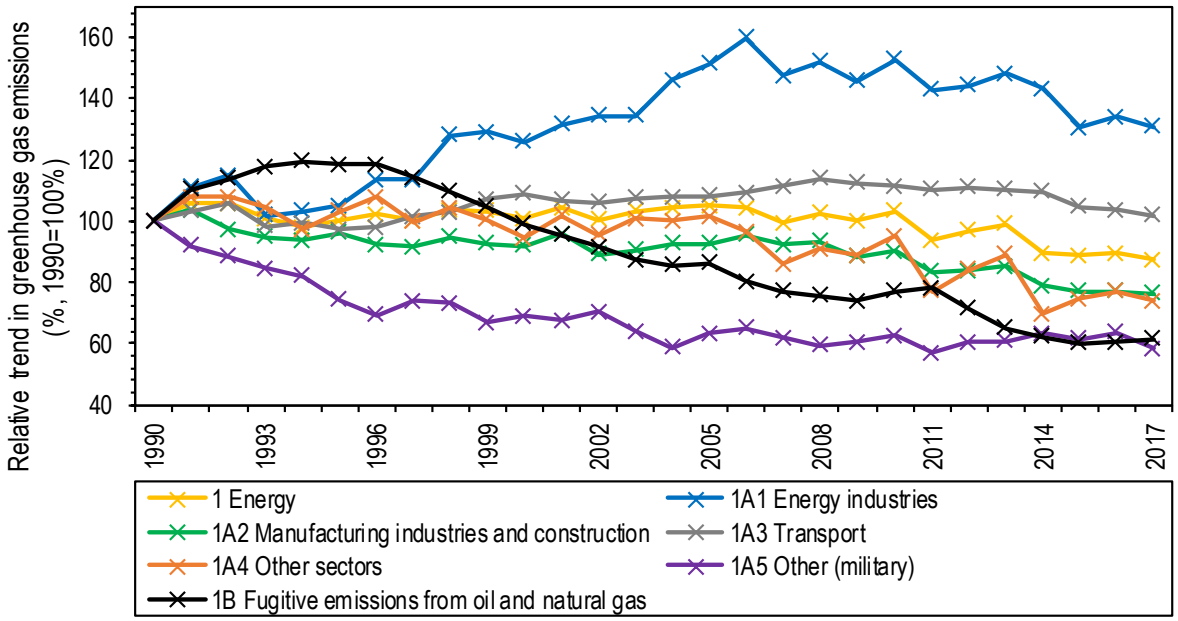
Sector 6 'Other' covers emissions from fire damage in buildings and motor vehicles. The contribution to total greenhouse gas emissions in 2017 was 0.03 per cent (Tab. 1); the sector is, thus, of minor importance. These emissions, as well as the indirect CO_2 emissions from sector 6, are not accounted for in the framework of Switzerland's emission reduction commitment (section 2.1.3). However, in agreement with the BR CTF tables, total emissions shown in the tables of this chapter include emissions from sector 6.

Fig. 5 > Relative trends in greenhouse gas emissions in the main sectors, 1990–2017. For the relative trend of indirect CO_2 emissions (only partly visible in this figure) see also Fig. 3.



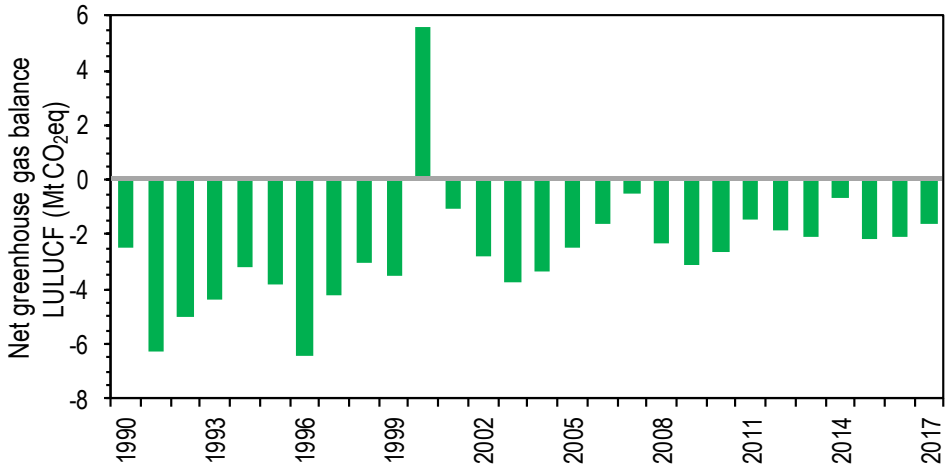
FOEN (2019a)

Fig. 6 > Relative emission trends in sector 1 'Energy' and its source categories (excluding indirect CO_2), 1990–2017.



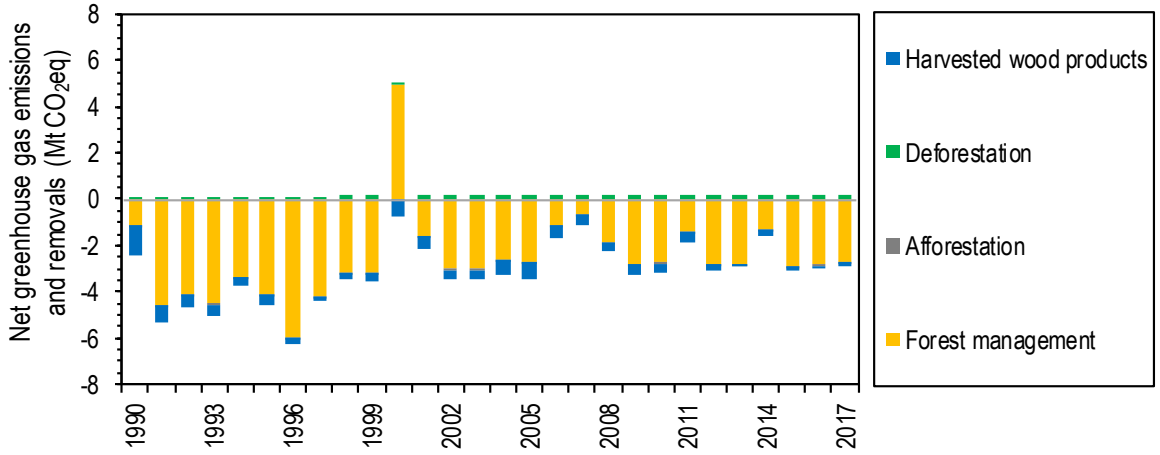
FOEN (2019a)

Fig. 7 > Net greenhouse gas balance of sector 4 'Land use, land-use change and forestry' (LULUCF), 1990–2017. Positive values refer to emissions, negative values to removals. The contributions of CH_4 and N_2O are very small compared to CO_2.



FOEN (2019a)

Fig. 8 > Net emissions and removals of greenhouse gases for activities under Article 3, paragraph 3 (afforestation, reforestation, deforestation) and paragraph 4 (forest management, harvested wood products) of the Kyoto Protocol, 1990–2017. Positive values refer to emissions, negative values refer to removals. As described in detail in section 2.1.5, these net emissions and removals further need to be offset against Switzerland's forest management reference level and the technical corrections to the forest management reference level for the accounting. In addition, the forest management cap needs to be respected.



FOEN (2019a)

1.2.4 Emission trends of precursor gases and SO_2

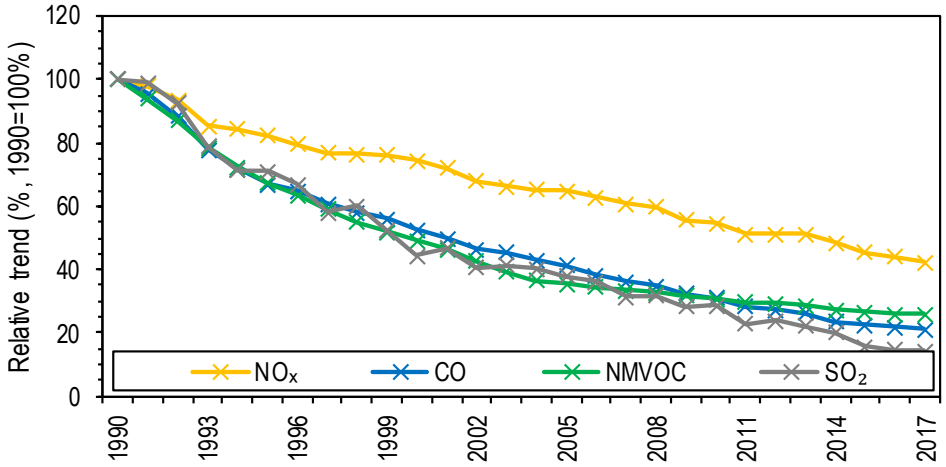
Emission trends of precursor gases showed a very pronounced decline since 1990 (Tab. 6 and Fig. 9). By 2017, emissions of the air pollutants NO_x, CO, NMVOC, and SO_2 were between 14.5 and 42.5 per cent of the emissions in 1990, owing to a strict air pollution control policy implementing emission reduction measures. The main reduction measures were abatement of exhaust emissions from road vehicles and stationary combustion equipment, taxation of solvents and sulphured fuels, and voluntary agreements with industry sectors (*FOEN*, 2010; *Swiss Confederation*, 1985; *Swiss Confederation*, 1997).

In 2017, sector 1 'Energy' was by far the largest source of precursor gases (Tab. 7), with the only exception being NMVOC, where sector 2 'Industrial processes and product use' and sector 4 'Land use, land-use change and forestry' (LULUCF) substantially contributed to total emissions. Fig. 10 shows the relative contributions of the various sectors for each individual gas in 2017 (data from Tab. 7, excluding emissions from LULUCF, which accounted for 45.5 per cent of total NMVOC emissions including LULUCF in 2017).

The atmospheric oxidation of the precursor gases lead to indirect emissions of CO_2 and N_2O, but only indirect CO_2 emissions are included in Switzerland's national total. Importantly, only fossil emissions and only emissions not already included under the direct CO_2 emissions in other sectors (e.g. when an oxidation factor of 100 per cent is applied) are

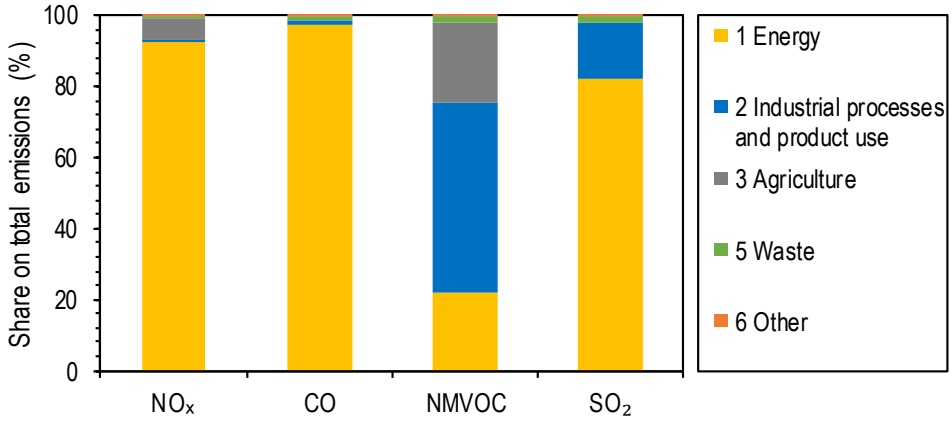
considered. Details about the calculation of indirect CO_2 emissions, as presented in Tab. 5, are discussed in chapter 9 of Switzerland's national inventory report (*FOEN*, 2019a).

Fig. 9 > Relative trends of emissions of precursor gases and SO_2 (excluding NMVOC from LULUCF), 1990–2017.



FOEN (2019a)

Fig. 10 > Relative contributions of individual sectors to emissions of precursor gases and SO_2 (excluding LULUCF), 2017.



FOEN (2019a)

1.3 National inventory arrangements

In the following, Switzerland's national greenhouse gas inventory system is presented in brief. An in-depth description is provided in Switzerland's national inventory report (*FOEN*, 2019a, chapter 1).

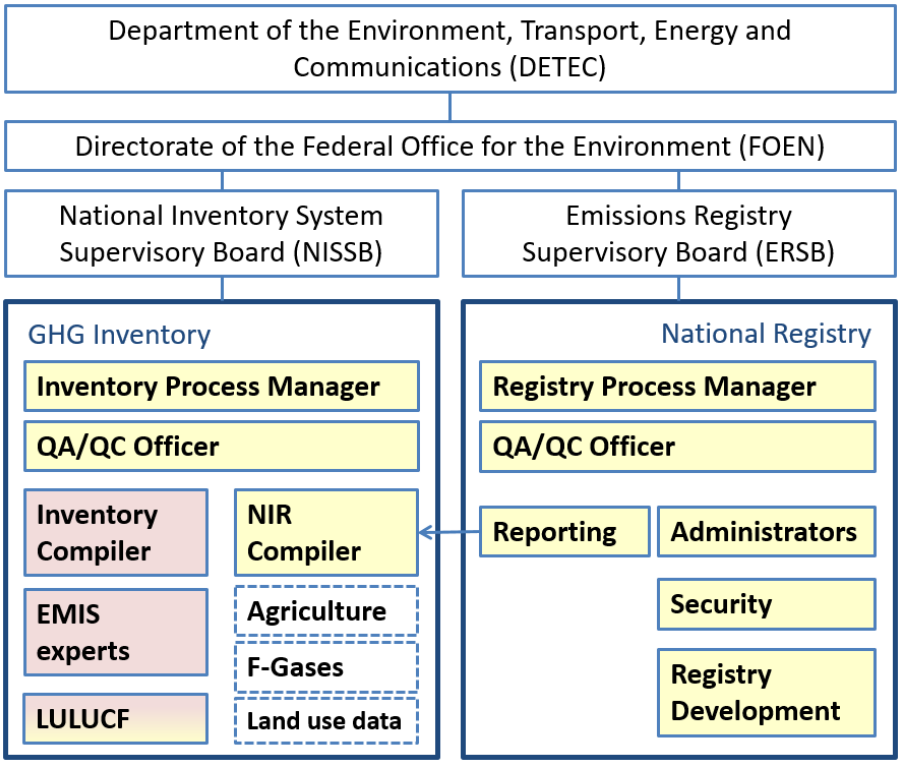
1.3.1 Name and contact information of national entity with overall responsibility

Swiss Federal Office for the Environment
National Greenhouse Gas Inventory System, Dr. Regine Röthlisberger
Climate Division, Section Climate Reporting and Adaptation
CH–3003 Bern, Switzerland
Phone: +41 (0)58 462 92 59
Email: climate@bafu.admin.ch
Web: *www.climatereporting.ch*

1.3.2 Roles and responsibilities: Institutional, legal and procedural arrangements

As shown in Fig. 11, Switzerland's national inventory system is developed and managed under the auspices of the Swiss Federal Department of the Environment, Transport, Energy and Communications. As stipulated in the second CO_2 Act of 23 December 2011 (Article 39), the Swiss Federal Office for the Environment, an office of the Swiss Federal Department of the Environment, Transport, Energy and Communications, is responsible for the assessment of matters relating to climate protection. Accordingly, the Swiss Federal Office for the Environment coordinates the national inventory system.

Fig. 11 > Institutional setting of Switzerland's national inventory system (NIS). The coloured boxes correspond to divisions of the Swiss Federal Office for the Environment (yellow: Climate Division; red: Air Pollution Control and Chemicals Division as well as Forest Division). The white boxes correspond to mandated experts outside the Swiss Federal Office for the Environment (marked with dashed lines) or to executive committees.



Swiss Federal Office for the Environment

In 2004, as part of the Swiss climate reporting project, the directorate of the Swiss Federal Office for the Environment mandated its Climate, Economics and Environmental Monitoring Division to design and establish the national inventory system in order to ensure full compliance with the reporting requirements of the UNFCCC and the Kyoto Protocol by 2006. With the formal approval of Switzerland's first initial report under Article 7, paragraph 4, of the Kyoto Protocol (*FOEN*, 2006) by the Swiss Federal Council on 8 November 2006, the national inventory system became operative. By

providing for structures and in defining tasks and responsibilities of institutions, organisations and consultants involved, the national inventory system itself is a key tool in ensuring and improving the quality as well as the process management of the national greenhouse gas inventory preparation. With the overall responsibility carried by the Climate Division of the Swiss Federal Office for the Environment, the national inventory system covers the following elements:

- Arrangements with partner institutions, relating to roles and responsibilities;
- Participation in the inventory development process;
- Data use, communication and publication;
- Inventory development plan;
- Setting-up and maintaining the QA/QC system;
- Official consideration and approval of data;
- Upgrading and updating of the national air pollution database EMIS;
- Data documentation and storage;
- Management of the national registry.

Two supervisory boards are currently in place with separate mandates and responsibilities. The **national inventory system supervisory board (NISSB)** oversees all aspects related to the national greenhouse gas inventory and the reporting obligations under the UNFCCC (including reporting of the national registry in the national inventory report). It is independent of the inventory preparation process and, by its composition, combines technical expertise and political authority. The **emission registry supervisory board (ERSB)** on the other hand deals with management issues related to the national registry. The main tasks of the two supervisory boards are:

- Official consideration of the annual inventory submission and recommendation of the inventory for official approval by the directorate of the Swiss Federal Office for the Environment;
- Assessment and approval of the recalculation of inventory data;
- Handling of any issues arising from the UNFCCC review process that cannot be resolved at the level of the inventory or registry project managers;
- Facilitation of any non-technical negotiation, consideration or approval processes involving other institutions within the federal administration;
- Support of the registry administration in maintaining a secure and reliable registry environment.

The national greenhouse gas inventory is coordinated by the **inventory process manager**. The process of inventory planning, preparation and management is well-established with responsibilities and decision-making power assigned to specific people or groups. The **inventory QA/QC officer** is responsible for enforcement of the defined quality standards of the national greenhouse gas inventory. The inventory QA/QC officer also advises the national inventory system supervisory board on matters relating to the conformity of the greenhouse gas inventory with reporting requirements.

The **greenhouse gas inventory working group** constitutes a fundamental element of the national greenhouse gas inventory and encompasses all scientific and technical personnel involved in the inventory preparation process or representing institutions that play a significant role as suppliers of data. The group as a whole meets at least once per year to take stock of the state of the inventory, to discuss priorities in the inventory development process, and to address specific issues of general interest that arise, e.g. from domestic or international reviews.

The **greenhouse gas inventory core group** meets four times per year and comprises the inventory experts employed by the Swiss Federal Office for the Environment or mandated on a regular basis, who are entrusted with major responsibilities for inventory planning, preparation and/or management. All inventory data are assembled and prepared for input into the CRF reporter by the greenhouse gas inventory core group, which is also responsible for ensuring the conformity of the inventory with the relevant guidelines. The greenhouse gas inventory core group consists of:

- The inventory project management (with overall responsibility for the integrity of the inventory, communication of data, and information exchange with the UNFCCC secretariat);
- The national inventory compiler (responsible for the national air pollution database EMIS, key category analyses, and for the reporting tables (CRF));
- The lead authors of the national inventory report (responsible for the report and carrying out centralised data assessments such as uncertainty analysis);
- Selected sectoral experts;
- The inventory QA/QC officer.

The greenhouse gas inventory core group coordinates and integrates the activities of data suppliers within and outside the Swiss Federal Office for the Environment as well as those of mandated experts. Further data suppliers contributing to the greenhouse gas inventory are institutions of the Swiss federal administration, research institutions, industry associations, and other private entities (see *FOEN*, 2019a for details). Everyone is obliged by Article 46 of the Swiss Federal Act on the Protection of the Environment (*Swiss Confederation*, 1983) to provide the authorities with the information required to enforce the law and, if necessary, to conduct or acquiesce in the conduct of enquiries.

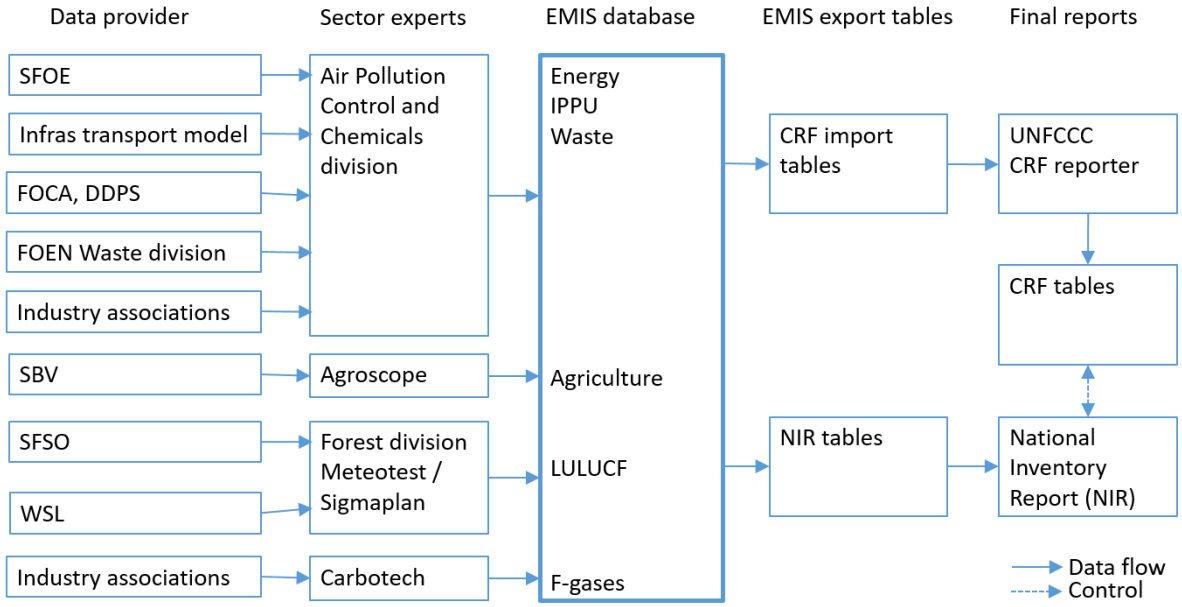
At the operational level, the national registry is largely run independently of the national greenhouse gas inventory. Its operation is coordinated by the **registry process manager**, whose work is overseen by the **registry QA/QC officer**.

1.3.3 Process of inventory preparation

The Air Pollution Control and Chemicals Division of the Swiss Federal Office for the Environment maintains the national air pollution database EMIS, which contains all data needed to prepare the greenhouse gas inventory. The database was established at SAEFL (former name of the Swiss Federal Office for the Environment) in the late 1980s. Its initial purpose was to record and monitor emissions of air pollutants, but it has since been extended to cover greenhouse gases as well. Its structure corresponds to the EMEP/CORINAIR system for classifying emission-generating activities. The data needed to prepare the national greenhouse gas inventory in the common reporting format (CRF), as requested by the UNFCCC, is collected by various data suppliers and compiled centrally by the Swiss Federal Office for the Environment. At the same time, background information on data sources, activity data, emission factors and methods used for emission estimation is documented in the database and/or the national inventory report. Since the individual data suppliers bear the main responsibility for the quality of data provided, they are also responsible for the collection of activity data, emission factors, and for the selection of methods compliant with the relevant guidelines.

Fig. 12 illustrates the data collection and processing steps leading to the reporting tables (CRF) required for reporting under the UNFCCC and the Kyoto Protocol. Most important input data for the national air pollution database EMIS comprise the Swiss overall energy statistics of the Swiss Federal Office of Energy, the Swiss wood energy statistics of the Swiss Federal Office of Energy, various statistics (of the Swiss Federal Office for the Environment) and models for emissions from road transport, statistics and models of non-road activities, modelled emissions based on the import statistics for F-gases (fluorinated greenhouse gases), waste and agricultural statistics, as well as extracts from the national forest inventory and the national forest statistics. Emissions and removals from sector 4 ‘Land use, land-use change and forestry’ (LULUCF) and KP-LULUCF are calculated by the Forest Division of the Swiss Federal Office for the Environment; a detailed description of the calculation of these emissions can be found in *FOEN* (2019a, chapter 6). Emissions from sector 3 ‘Agriculture’ are compiled by Agroscope, the Swiss Centre of Excellence for Agricultural Research (affiliated with the Swiss Federal Office for Agriculture). Emissions from all other sectors are calculated or compiled by the Air Pollution Control and Chemicals Division of the Swiss Federal Office for the Environment, in parts with the support of external companies shown in Fig. 12 (Carbotech, Meteotest, and Sigmaplan).

Fig. 12 > Data collection for the national air pollution database EMIS, from where the data is transferred via the CRF reporter to the reporting tables (CRF). The reporting tables are submitted by means of the UNFCCC submission portal and documented in the national inventory report. The authors of the national inventory report and the reviewers control the correctness of the data transferred from the database into the report (figures and tables shown in the national inventory report are exported directly from the database). The authors further check the correspondence between the exports and the reporting tables. DDPS: Swiss Federal Department of Defence, Civil Protection and Sport, FOCA: Swiss Federal Office of Civil Aviation, FOEN: Swiss Federal Office for the Environment, SBV: Swiss Farmers' Union, SFOE: Swiss Federal Office of Energy, SFSO: Swiss Federal Statistical Office, WSL: Swiss Federal Institute for Forest, Snow and Landscape Research.



Swiss Federal Office for the Environment

Methodologies: General description

Emissions calculations for the various sectors rely on standard methodologies (tier 1, tier 2, or tier 3) according to the 2006 IPCC guidelines for national greenhouse gas inventories (*IPCC*, 2006). Under the UNFCCC, these guidelines have been adopted for mandatory use in reporting on greenhouse gas inventories. For the sector 1 'Energy', import and fuel consumption statistics (fuel sales in the transport sector) taken from the Swiss overall energy statistics (e.g. *SFOE*, 2019a) are used as input data, while for the other sectors national statistics and data surveys are consulted.

1.3.4 Key category analysis

A key category analysis is performed annually following the 2006 IPCC guidelines for national greenhouse gas inventories (*IPCC*, 2006). Level and trend assessments are performed for both Approach 1 and Approach 2, considering the emissions from the base year 1990 and the latest year reported. Emissions from sector 4 'Land use, land-use change and forestry' (LULUCF) as well as indirect CO_2 emissions are included in the key category analysis. Under Approach 2, emissions are weighed with their uncertainty estimates. Tab. 9 presents an overview of the resulting key categories for 2017. More details are provided in Switzerland's latest national inventory report (*FOEN*, 2019a).

1.3.5 Recalculation of data

The inventory has been improved continuously and reached a consolidated state. Recalculations that further improve the inventory or that implement recommendations and encouragements from the various review procedures are considered (and approved) by the greenhouse gas inventory core group. Substantial recalculations that impact the national total are presented to the national inventory system supervisory board for approval. Recalculations are documented in *FOEN* (2019a, chapter 10).

1.3.6 Quality assurance and quality control (QA/QC) and verification plans

The national inventory system has an established quality management system (QMS) that complies with the requirements of ISO 9001:2015. Certification has been obtained in 2007 and is upheld since through annual audits. The quality management system is designed to comply with the revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention (FCCC/CP/2013/10/Add.3) to ensure and continuously improve

transparency, consistency, comparability, completeness, accuracy, and confidence in national greenhouse gas emission and removal estimates. While a detailed description of the QA/QC procedures, including verification plans, is given in *FOEN* (2019a, section 1.2.3) and in the quality manual (*FOEN*, 2019b), the most important elements are summarised in the following.

General QC procedures

Routine annual quality control procedures comprise checks related to new data and database operations, spot-checks for transcription errors, correct use of conversion factors and units, and correct calculations:

- There are checklists for the most important sectoral data suppliers, the experts of the national air pollution database EMIS, for the national inventory report compiler, and the QA/QC officer;
- Consistency of data between categories is to a large extent ensured by the design of the database, where specific emission factors and activity data that apply to various categories are used jointly by all categories to calculate emissions;
- Recalculations are compiled in a document and made available to the members of the greenhouse gas inventory core group;
- QC procedures regarding the reporting tables (CRF) comprise a detailed comparison of the tables of the previous submission with those of the current submission for the base year and the latest common year. In addition, the time-series consistency is incrementally checked by comparing the latest inventory year with the preceding year;
- Finally, Switzerland's national inventory report is subject to an internal review prior to submission.

Category-specific QC procedures

Whenever new emission factors are considered, they are compared to the default values of the 2006 IPCC guidelines and to the values used in previous years. Similarly, if new activity data have become available for a particular category, a comparison between existing and new activity data is performed. The general procedures regarding category-specific QC are also described in the quality manual (*FOEN*, 2019b), while specific activities are documented in the corresponding sectoral chapters.

Quality assurance procedures

As required by ISO 9001 there are periodic internal audits covering all processes. In addition, an external organisation is mandated to conduct the annual audit of the ISO 9001 quality management system. Results and suggestions for improvements from expert peer reviews commissioned on a case-by-case basis for specific sectors, as well as recommendations and encouragements from the UNFCCC expert review teams are added to the inventory development plan and considered by the core group for implementation in future submissions.

Verification activities

For sector 1 'Energy', the standard verification activity carried out on an annual basis is the comparison of the sectoral approach with the reference approach (see *FOEN*, 2019a for more details). In addition, the Swiss Federal Office for the Environment supports a long-term monitoring programme from which Switzerland's emissions of some fluorinated greenhouse gases can be estimated based on atmospheric measurements. Similar research projects are currently looking into developing independent estimates of CH_4 and N_2O emissions in Switzerland based on atmospheric measurements and inverse modelling of atmospheric transport.

Treatment of confidentiality issues

Nearly all of the data necessary to compile the Swiss greenhouse gas inventory are publicly available. There are a few exceptions (data referring to a single enterprise, disaggregated emissions of F-gases, some data regarding civil aviation, and unpublished land-use statistics), however, these will be made available to the UNFCCC expert review team upon request.

Public access to the greenhouse gas inventory

The Swiss Federal Office for the Environment operates a website (*http://www.climatereporting.ch*) where the Swiss greenhouse gas inventories (national inventory report, reporting tables (CRF), and UNFCCC review reports), the Swiss national communications and other reports submitted under the UNFCCC and the Kyoto Protocol are available. On this website, further background information cited in the Swiss greenhouse gas inventory is provided.

1.3.7 Procedures for official consideration and approval of the inventory

The process for the official consideration of the greenhouse gas inventory is defined in the mandate of the national inventory system supervisory board. At the national inventory system supervisory board meeting taking place after the completion of the inventory (generally in mid-March) the inventory project management hands over the national inventory report and the reporting tables (CRF) to the members of the board for consideration. Subsequently, the chair of the national inventory system supervisory board presents the inventory for official approval to the directorate of the Swiss Federal Office for the Environment.

1.3.8 Changes to the national inventory arrangements since the previous submission

There are no changes to arrangements with other institutions of the Swiss federal administration. Two four-year contracts with private companies have been renewed for another four-year period (regarding F-gases and LULUCF). The previous mandate comprising national inventory report compiling and uncertainty analysis was renewed under different terms and conditions. From May 2019, the responsibility for national inventory report compilation is held by the climate division of the Swiss Federal Office for the Environment, while two contractors – who both have been involved in the preparation of the inventory and the national inventory report previously – are mandated to support data operation in the national air pollution database EMIS and updating of the national inventory report. Uncertainty analysis (approach 1) is now performed by the Swiss Federal Office for the Environment. Provided that the necessary resources are available, approach 2 will be implemented in the national air pollution database EMIS software and reported again in future submissions.

Tab. 9 > Results of the key category analyses of Switzerland's greenhouse gas inventory. Key categories are ordered by NFR code, whereby categories which are not key categories are not shown. In addition to the emissions of all greenhouse gases from the sectors 1, 2, 3, 5, and 6, emissions from the sector land use, land-use change and forestry (4) as well as indirect CO_2 emissions are also considered. The last column indicates the key categories as follows: 'L1' indicates key categories from the level assessment of the most recent inventory year (2017) using Approach 1, 'L2' indicates key categories from the level assessment of the most recent inventory year (2017) using Approach 2, 'T1' indicates key categories from the trend assessment (1990/2017) using Approach 1, and 'T2' indicates key categories from the trend assessment (1990/2017) using Approach 2.

NFR code	Source categories and fuels if applicable	Greenhouse gas	Identification Criteria
1A1	Energy industries: Gaseous fuels	CO_2	L1, T1
1A1	Energy industries: Liquid fuels	CO_2	L1, T1
1A1	Energy industries: Other fuels	CO_2	L1, L2, T1, T2
1A2	Manufacturing industries and construction: Gaseous fuels	CO_2	L1, L2, T1, T2
1A2	Manufacturing industries and construction: Liquid fuels	CO_2	L1, T1
1A2	Manufacturing industries and construction: Other fuels	CO_2	L1, T1
1A2	Manufacturing industries and construction: Solid fuels	CO_2	L1, T1
1A3a	Civil aviation: Liquid fuels	CO_2	T1
1A3b	Road transportation: Gasoline	CH_4	T1
1A3b	Road transportation: Gasoline	CO_2	L1, T1
1A3b	Road transportation: Gasoline	N_2O	T1, T2
1A3b	Road transportation: Diesel	CO_2	L1, T1
1A4a	Commercial: Gaseous fuels	CO_2	L1, T1
1A4a	Commercial: Liquid fuels	CO_2	L1, T1
1A4b	Residential: Biomass	CH_4	T1
1A4b	Residential: Gaseous fuels	CO_2	L1, L2, T1, T2
1A4b	Residential: Liquid fuels	CO_2	L1, T1
1A4c	Agriculture and forestry: Liquid fuels	CO_2	L1
1B2	Oil and natural gas energy production	CH_4	L1, T1
2A1	Cement production	CO_2	L1, L2, T1
2C3	Aluminium production	CO_2	T1
2C3	Aluminium production	PFC	T1
2F1	Refrigeration and air conditioning	HFC	L1, L2, T1, T2
2G	Other product manufacture and use	N_2O	T2
2G	Other product manufacture and use	SF_6	L1
2	Indirect CO_2 emissions	CO_2	L2, T1, T2
3A	Enteric Fermentation	CH_4	L1, L2, T1
3B1–3B4	Manure management	CH_4	L1, L2
3B5	Indirect N_2O emissions from manure management	N_2O	L1, L2, T2
3Da	Direct emissions from managed soils	N_2O	L1, L2, T2
3Db	Indirect emissions from managed soils	N_2O	L1, L2, T1, T2
4A1	Forest land remaining forest land	CO_2 biogenic	L1, L2, T1, T2
4A2	Land converted to forest land	CO_2 biogenic	L1, L2, T1, T2
4B1	Cropland remaining cropland	CO_2 biogenic	L1, L2, T1, T2
4C1	Grassland remaining grassland	CO_2 biogenic	L1, L2, T1, T2
4C2	Land converted to grassland	CO_2 biogenic	L1, L2, T1, T2
4E2	Land converted to settlements	CO_2 biogenic	L2
4G	HWP Harvested wood products	CO_2 biogenic	L2, T1, T2
5A	Solid waste disposal	CH_4	L1, L2, T1, T2
5D	Wastewater treatment and discharge	CH_4	L1, L2
5D	Wastewater treatment and discharge	N_2O	L2

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1.4 National registry

1.4.1 General information

Name and contact information of the registry administrator

Swiss Federal Office for the Environment
Swiss Emissions Trading Registry
Climate Division, Mr. Marcel Kamber
CH–3003 Bern, Switzerland
Phone: +41 (0)58 462 05 66
Email: *emissionsregistry@bafu.admin.ch*
Registry: *https://www.emissionsregistry.admin.ch*
Web: *http://www.bafu.admin.ch/emissions-trading*

Cooperation with other Parties

Switzerland uses a registry software based on the Community Registry software, which was initially developed by the European Union in 2004. Further developments, updates and releases of the software are undertaken in cooperation with Dr. Lippke & Dr. Wagner GmbH. Switzerland cooperates with Monaco regarding registry issues.

Description of the database structure and capacity of Switzerland's national registry

Information on the database structure and capacity of Switzerland's national registry is regarded as confidential. The required information has been submitted in the ITL Registry Initialization Documentation in April 2013, and is available to the UNFCCC expert review team on demand.

Conformity to the technical standards for data exchange

In September 2015, the registry software successfully passed the CP2 Annex H test and therewith conforms to the technical specifications of data exchange standards (DES) for registry systems under the Kyoto Protocol, version 2.0.1.

Procedures employed to minimise and manage discrepancies and to correct problems

In case of discrepancies, the conformity of Switzerland's national registry to DES ensures the correct treatment and reception of information by the ITL. Thus, the common operational procedures of the UNFCCC are followed.

Internal incident and change management procedures were defined in cooperation with Dr. Lippke & Dr. Wagner GmbH, and the Swiss Federal Office of Information Technology, Systems and Telecommunication (FOITT).

Security measures

Information on security measures is regarded as confidential. The required information has been submitted in the ITL Registry Initialization Documentation in April 2013, and is available to the UNFCCC expert review team on demand.

Information publicly accessible by means of the user interface

Non-confidential information is publicly available on the website of the Swiss emissions trading registry at *https://www.emissionsregistry.admin.ch*. The national allocation plan is accessible under 'Allocation' in the Public Information menu. Information made available to the public is conforming to the criteria defined in Annex E to decision 13/CMP.1:

- § 45 13/CMP.1: Report 'Accounts' at *https://www.emissionsregistry.admin.ch*;
- § 46 13/CMP.1: No report available as no ERUs were issued by Switzerland;
- § 47 13/CMP.1: Information on unit holding and transactions for each calendar year is available in the SEF Tables at *http://www.climatereporting.ch*;
- § 48 13/CMP.1: Report 'Accounts' at *https://www.emissionsregistry.admin.ch*.

The following information is considered as confidential, and thus not publicly available (Decision 13/CMP.1, paragraphs are indicated in parentheses):

- The representative identifier of the account holder (13/CMP.1, paragraph 45(d));
- The representatives name and contact information (13/CMP.1, paragraph 45(e));
- The total quantity of ERUs, CERs, AAUs and RMUs in each account at the beginning of the year (the total quantity is only available by account type) (Decision 13/CMP.1, paragraph 47(a));
- The identity of the transferring accounts from which ERUs, CERs, AAUs and RMUs were acquired by Switzerland's national registry (Decision 13/CMP.1, paragraph 47(d));
- The identity of the acquiring accounts to which ERUs, CERs, AAUs and RMUs were transferred from Switzerland's national registry (Decision 13/CMP.1, paragraph 47(f));
- Current holdings of ERUs, CERs, AAUs and RMUs in each account (Decision 13/CMP.1, paragraph 47(l)).

Internet address of the interface to Switzerland's national registry

On the website of Switzerland's national registry at *https://www.emissionsregistry.admin.ch*, the user interface is available.

Measures taken to safeguard, maintain and recover data in the event of a disaster

Information on the data backup strategy is regarded as confidential. The required information has been submitted in the ITL Registry Initialization Documentation in April 2013, and is available to the UNFCCC expert review team on demand.

Test procedures

Basic tests are performed by the application support provider Dr. Lippke & Dr. Wagner GmbH, on the international transaction log (ITL) DEVELOPER environment. The Annex H test during the registry initialisation process successfully tested the software of Switzerland's national registry against the ITL. New versions, updates or bug fixes of the registry software are tested by the registry administration team in the REGISTRY environment before implementation in the PRODUCTION environment. Major changes are tested including the REGISTRY environment of the ITL. If test end criteria are reached and security testing was successful, the new version or update is installed in the PRODUCTION environment.

1.4.2 Recent changes

Since Switzerland's seventh national communication and third biennial report, regular security and usability updates, as well as bug fixing took place.

1.4.3 Status of Switzerland's national registry as of 2019

Switzerland's national registry got fully operational with the international transaction log (ITL) on 4 December 2007. Tab. 10 shows the total quantities of Kyoto Protocol units in Switzerland's national registry related to the first commitment period 2008–2012 (CP1), Tab. 11 the total quantities of Kyoto Protocol units in Switzerland's national registry related to the second commitment period 2013–2020 (CP2), by account type at the end of 2018 (submission of SEF Tables in 2018).

Tab. 10 > Total quantities of CP1 Kyoto Protocol units in Switzerland's national registry by account type at the end of 2018.

Standard Electronic Format (SEF) Table 1

	Unit type					
Account type	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Party holding accounts	–	–	–	–	–	–
Entity holding accounts	–	–	–	–	–	–
Article 3.3/3.4 net source cancellation accounts	172'587	–	1'013'340	–		
Non-compliance cancellation accounts	–	–	–	–		
Other cancellation accounts	4'796'312	3'651'820	–	7'896'871	114'793	–
Retirement account	236'857'347	558'645	8'267'540	16'038'197	–	–
tCER replacement account for expiry	–	–	–	–	–	
lCER replacement account for expiry	–	–	–	–		
lCER replacement account for reversal in storage	–	–	–	–		–
lCER replacement account for non-submission of certification report	–	–	–	–		–
Total	**241'826'246**	**4'210'465**	**9'280'880**	**23'935'068**	**114'793**	**–**

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Tab. 11 > Total quantities of CP2 Kyoto Protocol units in Switzerland's national registry by account type at the end of 2018.

Standard Electronic Format (SEF) Table 1

	Unit type					
Account type	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Party holding accounts	–	–	–	1'941'872	–	–
Entity holding accounts	–	–	–	22'626'286	–	–
Retirement account	–	–	–	–	–	–
Previous period surplus reserve account	5'794'523					
Article 3.3/3.4 net source cancellation accounts	–	–	–	–		
Non-compliance cancellation account	–	–	–	–		
Voluntary cancellation account	–	–	–	3'679'898	–	–
Cancellation account for remaining units after carry-over	–	–	–	–	–	–
Article 3.1 ter and quater ambition increase cancellation account	–					
Article 3.7 ter cancellation account	–					
tCER cancellation account for expiry					–	
lCER cancellation account for expiry						–
lCER cancellation account for reversal of storage						–
lCER cancellation account for non-submission of certification report						–
tCER replacement account for expiry	–	–	–	–	–	
lCER replacement account for expiry	–	–	–	–		
lCER replacement account for reversal of storage	–	–	–	–		–
lCER replacement account for non-submission of certification report	–	–	–	–		–
Total	**5'794'523**	**–**	**–**	**28'248'056**	**–**	**–**

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2 Quantified economy-wide emission reduction target

2.1 Description of Switzerland's quantified economy-wide emission reduction target

While all information regarding Switzerland's emission reduction commitment is summarised in BR CTF table 2, this chapter provides further background information in textual form.

2.1.1 General information

By ratifying the UNFCCC in 1993, Switzerland committed to contribute to the stabilisation of greenhouse gas emissions at a level that prevents dangerous anthropogenic interference with the climate system. Switzerland's quantified economy-wide emission reduction target under the UNFCCC is – in a consistent manner – implemented under the Kyoto Protocol, making Switzerland's emission reduction commitment internationally binding. Accordingly, Switzerland, in 2003, ratified the Kyoto Protocol, which entered into force in 2005. In this context, Switzerland made a quantified emission limitation or reduction commitment of 92 per cent of the base year (1990) level for the first commitment period of the Kyoto Protocol (2008–2012). For the second commitment period of the Kyoto Protocol (2013–2020), Switzerland is continuing its emission reduction efforts and has submitted its instrument of acceptance of the Doha Amendment to the Kyoto Protocol on 28 August 2015. Therewith, Switzerland entered into a quantified emission limitation or reduction commitment of 84.2 per cent of the base year (1990) level for the second commitment period of the Kyoto Protocol (2013–2020). This quantified emission limitation or reduction commitment implements and details in a consistent manner Switzerland's quantified economy-wide emission reduction target of 20 per cent below the emissions of the year 1990, to be reached by 2020. Consistently implementing the quantified economy-wide emission reduction target under the UNFCCC under the quantified emission limitation or reduction commitment under the Kyoto Protocol means that Switzerland will assess the fulfilment of the quantified economy-wide emission reduction target under the UNFCCC by accounting against its quantified emission limitation or reduction commitment under the second commitment period of the Kyoto Protocol. By reaching its quantified emission limitation or reduction commitment under the second commitment period of the Kyoto Protocol, Switzerland will also consider the quantified economy-wide emission reduction target under the UNFCCC as fulfilled. Switzerland's targets are unconditional under both the UNFCCC and the Kyoto Protocol[3]. The international emission reduction commitment is implemented nationally by means of the second CO_2 Act and the corresponding policies and measures (for details see chapter 3). Based on the second CO_2 Act and in consistency with the international emission reduction commitment, Switzerland's national target is a reduction of domestic greenhouse gas emissions by at least 20 per cent by 2020 relative to 1990 levels (in contrast, Switzerland's international emission reduction commitment allows for the supplemental use of international carbon credits). An overview of Switzerland's current national and international emission reduction commitment is provided in Fig. 13.

To look ahead, Switzerland has been committing to the following nationally determined contribution (NDC)[4] in the framework of the Paris Agreement[5]:

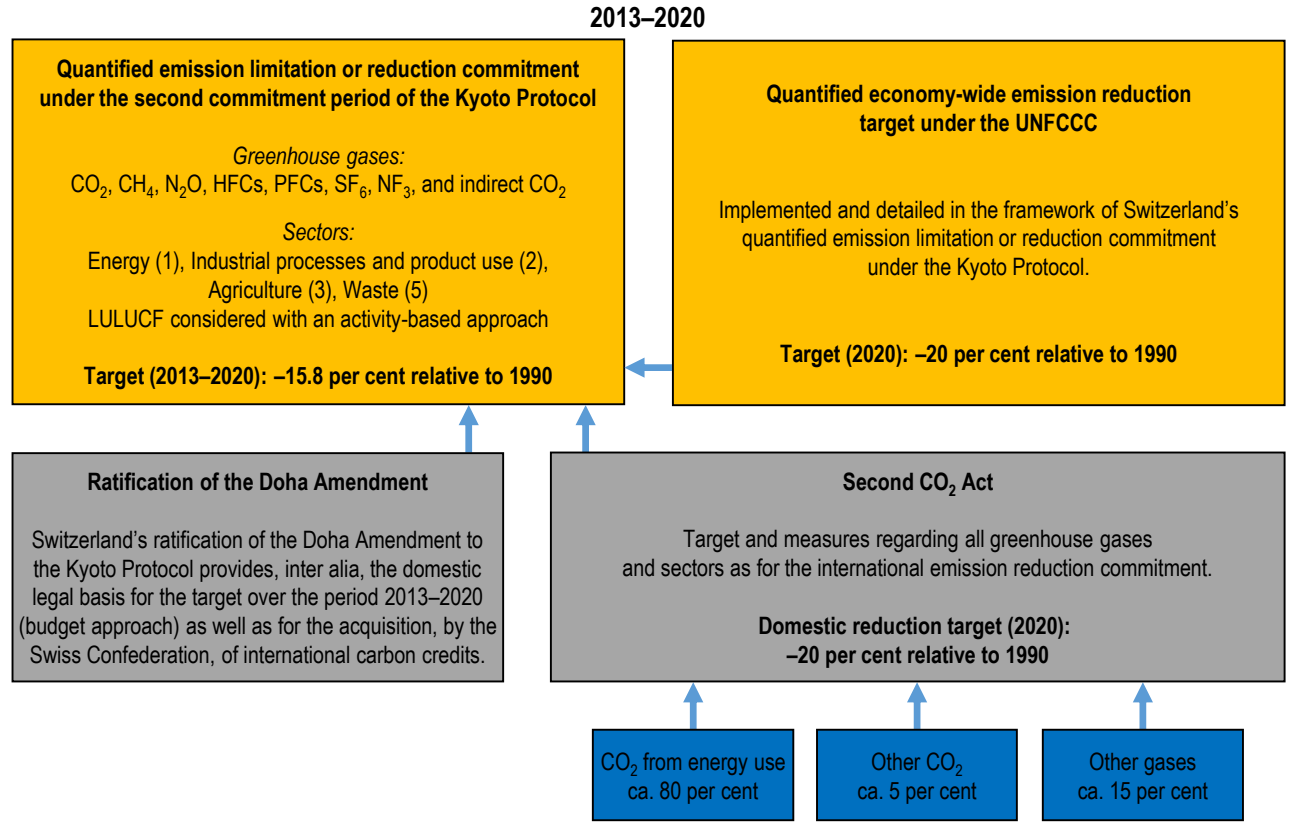
- Switzerland commits to reduce its greenhouse gas emissions by 50 per cent by 2030 compared to 1990 levels, corresponding to an average reduction of greenhouse gas emissions by 35 per cent over the period 2021–2030. By 2025, a reduction of greenhouse gases by 35 per cent compared to 1990 levels is anticipated. International carbon credits will partly be used.

[3] However, as part of a global and comprehensive agreement for the period beyond 2012, Switzerland reiterated its conditional offer to move from its target of a 20 per cent emission reduction by 2020 compared with 1990 levels to a 30 per cent emission reduction, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities (see FCCC/SB/2011/INF.1/Rev.1).

[4] *https://www4.unfccc.int/sites/ndcstaging*

[5] Switzerland deposited its instruments of ratification on 6 October 2017 with the Depositary, leading to the entry into force of the Paris Agreement for Switzerland on 5 November 2017.

Fig. 13 > Switzerland's current national and international emission reduction commitment. The national target under the second CO_2 Act, Switzerland's quantified economy-wide emission reduction target under the UNFCCC, as well as Switzerland's quantified emission limitation or reduction commitment under the second commitment period of the Kyoto Protocol are aligned and, thus, consistent. LULUCF: Land use, land-use change and forestry.



2.1.2 Base year

As mentioned above, the base year is 1990 for all sectors and gases covered. For the second commitment period of the Kyoto Protocol, Switzerland's base year emissions are defined in Switzerland's Second Initial Report under the Kyoto Protocol (in particular in the update following the in-country review by an expert review team coordinated by the UNFCCC secretariat, see also FCCC/IRR/2016/CHE). Accordingly, the relevant base year emissions are 53'706'729 tonnes of CO_2 equivalents and the assigned amount for the second commitment period of the Kyoto Protocol is 361'768'524 tonnes of CO_2 equivalents. These base year emissions are relevant for Switzerland's quantified emission limitation or reduction commitment under the second commitment period of the Kyoto Protocol, Switzerland's quantified economy-wide emission reduction target under the UNFCCC as well as for Switzerland's national target under the second CO_2 Act.

2.1.3 Gases and sectors covered

In the international context, Switzerland's quantified economy-wide emission reduction target under the UNFCCC as well as Switzerland's quantified emission limitation or reduction commitment under the Kyoto Protocol cover the full set of reported greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and NF_3). All targets also include indirect CO_2 emissions, as long as the indirect CO_2 emissions are of fossil origin and not already considered under the direct CO_2 emissions (e.g. when an oxidation factor of 100 per cent is applied, see also section 1.2.4). All targets include the emissions from the sectors energy (1), industrial processes and product use (2), agriculture (3), and waste (5). Land use, land-use change, and forestry is considered with an activity-based approach (Articles 3.3 and 3.4). From sector 'Other' (6), all emissions (in particular also indirect CO_2 emissions) are not included. The second CO_2 Act covers the same gases and sectors as relevant for the international reduction commitments.

2.1.4 Global warming potential values

Switzerland consistently uses the global warming potential values listed in the column entitled 'Global warming potential for given time horizon' in Table 2.14 of the errata to the contribution of Working Group I to the fourth assessment

report of the Intergovernmental Panel on Climate Change (*IPCC*, 2007), based on the effect of greenhouse gases over a 100-year time horizon. These global warming potential values are also reflected in Annex I of the Ordinance on the Reduction of CO_2 Emissions (CO_2 Ordinance; *Swiss Confederation*, 2012) for the period 2013–2020.

2.1.5 Approach to counting emissions and removals from the land use, land-use change and forestry sector

According to Article 3.7 of the Kyoto Protocol, the land use, land-use change and forestry sector is only included in the calculation of the assigned amount in case this sector constituted a net source of greenhouse gases in 1990. In Switzerland, the land use, land-use change and forestry sector was a net sink in 1990 and is therefore excluded from the base year level and target.

With regard to Switzerland's emission reduction commitment, the land use, land-use change and forestry sector is accounted for with an activity-based approach. Under Article 3.3 of the Kyoto Protocol, Switzerland accounts for afforestation, reforestation as well as deforestation, and under Article 3.4 of the Kyoto Protocol for forest management (*FOEN*, 2016c; *FOEN*, 2016d). Accordingly, Switzerland consistently applies the rules to counting emissions and removals from the land use, land-use change and forestry sector as established under the Kyoto Protocol. Importantly, the sum of emissions/removals for activities under Articles 3.3 and 3.4 needs to be further offset against Switzerland's forest management reference level and the technical corrections to the forest management reference level in order to get the accounting quantity. Further, the forest management cap[6] will need to be considered for the final accounting at the end of the commitment period.

2.1.6 Use of international market-based mechanisms

Switzerland's climate policy generally aims at domestic reductions of greenhouse gas emissions. However, Switzerland will use international carbon credits generated from the flexible mechanisms under the Kyoto Protocol – i.e. mainly CERs, but potentially also ERUs and units from other marked-based mechanisms – to compensate for some of its emissions over the period 2013–2020. Carried-over units, i.e. units carried over from the first to the second commitment period, may also be used. While the possible scale of contributions of international carbon credits needed by Switzerland in order to reach its emission reduction targets for the second commitment period is unknown, further details on the modalities pertaining to the supplemental use of international carbon credits are given in the following:

- The second CO_2 Act defines Switzerland's 20 per cent reduction target (by 2020, relative to 1990) as domestic. However, international carbon credits will play a role in the case of (i) the obligation to offset emissions from gas-fired combined-cycle power plants (section 3.3.6), (ii) the emissions trading scheme (section 3.2.6), (iii) negotiated reduction commitments (for exemption from the CO_2 levy, section 3.2.7), and (iv) the partial compensation of CO_2 emissions from motor fuel use (section 3.4.5). For the latter three measures, international carbon credits will only be used in case agreed or set targets are not achieved (i.e. as part of the sanction mechanism to enforce the law);
- Switzerland will use additional international carbon credits recognised under the Kyoto Protocol to meet the differences between the approaches used under national legislation (i.e. emission reduction target defined for the year 2020) and under the Kyoto Protocol (i.e. 'carbon budget' approach used to calculate the quantified emission limitation or reduction commitment for the period 2013–2020). International carbon credits to be used for this purpose are also available from the Climate Cent Foundation (section 3.4.4), which is obligated to use excess revenues from the period 2005–2012 for the acquisition of international carbon credits and to hand these over to the government (until 2022 at the latest);
- In case the Swiss Federal Council further increases the reduction target in order to comply with international agreements, parts of the additional reductions in greenhouse gas emissions may be achieved through measures carried out abroad;

[6] In accordance with Annex I to Decision 2/CMP.7 (paragraph 13), the forest management cap corresponds to 3.5 per cent of base year emissions excluding land use, land-use change and forestry times eight. For Switzerland the cap thus amounts to 15'037'884 tonnes of CO_2 equivalents for the entire commitment period 2013–2020.

- Switzerland is applying quality requirements to determine the eligibility of international carbon credits. These quality requirements are stipulated in Annex II of the CO_2 Ordinance[7] and detailed in a fact sheet[8] published by the Swiss Federal Office for the Environment;
- In Annex II of decision 2/CMP.8 Switzerland made a clear political declaration relating to AAUs carried over from the first commitment period of the Kyoto Protocol. Accordingly, under the Swiss domestic legislation applicable during the second commitment period, Switzerland will not use carried-over AAUs transferred from other Parties for compliance under Article 3 of the Kyoto Protocol for the second commitment period. Switzerland will adhere to arrangements in other countries relating to the transfer of AAUs under any arrangement that may link Switzerland's emissions trading scheme with the emissions trading schemes of other countries. Switzerland may use some of its own carried-over AAUs.

2.1.7 Any other information

As Switzerland's quantified economy-wide emission reduction target under the UNFCCC is – in a consistent manner – implemented under the Kyoto Protocol, Switzerland follows the accounting rules implemented and detailed in the framework of its quantified emission limitation or reduction commitment under the Kyoto Protocol.

References

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[7] *http://www.admin.ch/opc/en/classified-compilation/20120090/index.html#app2*

[8] *https://www.bafu.admin.ch/dam/bafu/en/dokumente/klima/formular/qualitaet_von_imauslanderzieltenemissionsverminderungen.pdf*

3 Progress in achievement of the quantified economy-wide emission reduction target[9]

Information on Switzerland's mitigation actions, including on the policies and measures implemented or planned to be implemented since the last national communication or biennial report to achieve the emission reduction commitments agreed on in the national and international context, is summarised in BR CTF table 3. This chapter provides details for each policy and measure, in particular also regarding the estimated mitigation impacts and, if applicable, a further strengthening of the policy and measure in the future.

The information reported in this chapter is widely identical to the information provided in chapter 4 on policies and measures of Switzerland's seventh national communication. Since the adoption of the draft of the third CO_2 Act by the Swiss Federal Council on 1 December 2017, which started the legislative process in the Swiss Parliament, the discussions with regard to Switzerland's climate policy mostly focused on the period after 2020. The legislative process is still ongoing, meaning that final outcomes are pending (for more details see section 3.2.4). Over the last two years, only minor changes with immediate effect were made to existing policies and measures.

Section 3.1 provides information related to the policymaking process in the context of environmental and climate policy, including the general framework of environmental legislation and some further background information on institutional arrangements at the domestic level. Section 3.2 focuses on policies and measures that are effective across sector boundaries. The subsequent sections are organised by sector and present individual mitigation actions (including their mitigation impacts) as listed in BR CTF table 3. Section 3.3 deals with non-transport policies and measures related to energy efficiency, reduced energy consumption, and renewable energy. Section 3.4 encompasses aspects of transport infrastructure, sustainable modes of transport, and vehicle emissions standards. The remaining mitigation actions cover the following areas: Industrial processes and product use (section 3.5), agriculture (section 3.6), land use, land-use change, and forestry (section 3.7), and waste (section 3.8). Information on the costs, non-greenhouse gas mitigation benefits and interactions of Switzerland's policies and measures is provided in section 3.9. The sections 3.10 to 3.12 briefly address the modification of longer-term trends in greenhouse gas emissions, policies and measures no longer in place, and policies and measures leading to an increase in greenhouse gas emissions. Detailed information on the assessment of the economic and social consequences of response measures (adverse effects) is presented in section 3.13. Information on Switzerland's domestic institutional arrangements, including institutional, legal, administrative and procedural arrangements used for domestic compliance, monitoring, reporting, archiving of information and evaluation of the progress towards the economy-wide emission reduction target is provided in the sections 3.1.2 and 3.1.3. Finally, section 3.14 provides details regarding the estimates of emission reductions and removals as well as regarding the use of units from the market-based mechanisms and land use, land-use change and forestry activities.

3.1 Policymaking process

This section provides specific information related to Switzerland's policymaking process in the context of environmental and climate policy. A general overview of the government structure – including background information on the general political organisation in Switzerland – is available in section 2.1 of Switzerland's seventh national communication.

3.1.1 Fundamental settings regarding environmental and climate policy

The Federal Constitution of the Swiss Confederation forms the overarching framework for environmental and climate policy in Switzerland. The commitment to long-term preservation of natural resources is listed prominently in the opening paragraphs as one of the main aims (*Swiss Confederation*, 1999a, Article 2). In pursuit of the United Nations Conference on Environment and Development held in Rio in 1992, the Swiss Federal Council has established an interdepartmental sustainable development committee consisting of all federal agencies with responsibilities in the field of sustainable development. This committee defined the priorities for action and oversaw implementation and monitoring

[9] In this chapter, the sections have partly been rephrased and complemented compared to the proposition in paragraph 74 and the annex of the 'Revision 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' (FCCC/SBI/2016/L.22). The reason for the conservative reorganisation is to structure the description of the different policies and measures (sections 3.2 to 3.8) and to provide additional information (sections 3.9 to 3.14).

of progress with the intention to make sustainability assessments an integral part of decision-making and policy evaluation. On 14 December 2018, the Swiss Federal Council set up the 2030 Agenda steering committee, therewith replacing the interdepartmental sustainable development committee[10]. The 2030 Agenda steering committee – where federal agencies which bear the main responsibility are represented at senior management level – steers and coordinates the efforts to achieve the 2030 Agenda for Sustainable Development of the United Nations. This includes monitoring the progress regarding achievement of the Sustainable Development Goals in Switzerland, preparing the national report to the United Nations, setting priorities to reflect the biggest challenges and opportunities for Switzerland, setting national targets, coordinating appropriate measures and cooperating with the cantons, communes and non-state actors. Further, by decision of the Swiss Federal Council, an interdepartmental committee on climate of the federal authorities ('IDA-Klima') was established as of 14 April 2008. The committee is responsible for the coordination between different policy areas and assures a coherent climate policy of the Swiss Confederation in compliance with the UNFCCC. The committee, led by the Swiss Federal Office for the Environment, thus coordinates the activities of all federal offices involved in climate policy. As stipulated in Article 39 of the second CO_2 Act (*Swiss Confederation*, 2011) and more generally also in Article 12 of the Ordinance on the Organisation of the Federal Department of the Environment, Transport, Energy and Communications (*Swiss Confederation*, 1999c), the Swiss Federal Office for the Environment is responsible for matters relating to climate protection. The related Ordinance on the Reduction of CO_2 Emissions (*Swiss Confederation*, 2012), in its chapter 11, details the responsibilities for the implementation of specific measures.

Strategies for sustainable development, long-term mitigation strategies and targets for greenhouse gas mitigation

The Swiss Federal Council set out its main policy focus areas for sustainable development in its sustainable development strategy 2016–2019 (*Swiss Federal Council*, 2016), adopted as part of the Swiss government's regular legislative planning cycle. This strategy represents an important contribution on the part of Switzerland to achieving the 2030 Agenda for Sustainable Development of the United Nations.

The sustainable development strategy 2016–2019, the fifth of its kind since 1997, centres around an action plan featuring measures that are grouped according to nine action areas, each covering a specific topic which is of central importance to the sustainable development of Switzerland. With a view to achieving the defined goals, the sustainable development strategy provides a model role for the Swiss Confederation, outlines horizontal (cross-sectoral) measures such as sustainability monitoring, sustainability assessments, the promotion of local sustainability processes and projects, and closer collaboration with other stakeholder groups. Finally, the sustainable development strategy sets out the institutional framework for its implementation.

One of the Swiss Federal Council's overarching objectives with regard to the incorporation of the sustainable development principle into the activities of the Swiss government is to combat global warming. The reduction of energy consumption, the increased use of renewable energies, and management of natural hazards form part of this endeavour. Switzerland's climate and energy policies are, thus, in line with the sustainable development strategy and are strongly coordinated. The third CO_2 Act, planned to come into effect in 2021, will be compatible with the goals of the Energy Strategy 2050 (for details regarding the Energy Strategy 2050 see section 3.3.1). The Swiss government is also engaged in elaborating and coordinating adaptation efforts, as reflected in the Swiss adaptation strategy (see section 6.4 of Switzerland's seventh national communication) and the corresponding adaptation actions (see section 6.5 of Switzerland's seventh national communication).

By ratifying the UNFCCC in 1993, the Kyoto Protocol in 2003, the Doha Amendment to the Kyoto Protocol in 2015, and the Paris Agreement in 2017, Switzerland internationally committed to contribute to the stabilisation of greenhouse gas emissions at a level that prevents dangerous anthropogenic interference with the climate system. The respective international targets, as well as the translation to Switzerland's national targets, are presented and discussed in chapter 2.

Principles and instruments of Switzerland's environmental and climate policy

Deduced from the Federal Constitution of the Swiss Confederation, the principles and instruments of Switzerland's environmental policy are stipulated in the Swiss Federal Act on the Protection of the Environment (*Swiss Confedera-*

[10] https://www.eda.admin.ch/deza/en/home/news/news.html/content/eda/en/meta/news/2019/3/22/74413

tion, 1983), in force since 1985 and revised several times since. The Environmental Protection Act is based on the following three main principles: (i) the principle of precaution, (ii) the control/limitation of ecological damage at the source, and (iii) the polluter pays principle. Consequently, Swiss environmental policy is addressing a wide spectrum of issues, ranging from pollution of air, water and soil, and exposure to noise, to protecting stratospheric ozone or reducing and managing waste. Several policy areas are linked directly or indirectly to the reduction of Switzerland's greenhouse gas emissions. Fiscal incentives are recognised as an essential instrument for promoting the efficient use of resources. The main instruments are the definition of legally binding emission limits, introduction of levies on substances or practices with negative environmental impacts as well as the obligation of environmental impact assessments for particular facilities and installations.

Switzerland's climate policy is based on the Federal Constitution of the Swiss Confederation, in particular Article 74 (environmental protection) and Article 89 (energy policy). The legal centrepiece supplementing the Environmental Protection Act and defining objectives, instruments, measures and general rules of implementation of climate policy on the needed level of detail is the Swiss Federal Act on the Reduction of CO_2 Emissions (CO_2 Act, see sections 3.2.2, 3.2.3, and 3.2.4). This Act also contains provisions related to enforcement and evaluation. The implementation of the CO_2 Act is further detailed in the Ordinance on the Reduction of CO_2 Emissions (CO_2 Ordinance), where, inter alia, specific responsibilities for the implementation of measures are assigned. Tab. 12 shows detailed references to enforcement and administrative procedures for some core policies and measures defined in the second CO_2 Act and the corresponding CO_2 Ordinance.

Apart from the Environmental Protection Act and the CO_2 Act, there are various other legal provisions that are related to environmental and climate issues. The Energy Act (*Swiss Confederation*, 2016), the Forest Act (*Swiss Confederation*, 1991), the Spatial Planning Act (*Swiss Confederation*, 1979), the Agriculture Act (*Swiss Confederation*, 1998b), the Road Traffic Act (*Swiss Confederation*, 1958), the Heavy Vehicle Charge Act (*Swiss Confederation*, 1997a), the Mineral Oil Tax Act (*Swiss Confederation*, 1996) and the Ordinance on the Avoidance and Management of Waste (*Swiss Confederation*, 2015) have as well components that contribute to environmental policy goals including greenhouse gas emissions reduction and reduction of greenhouse gas precursor gases.

Tab. 12 > Enforcement and implementation responsibilities for core provisions of the second CO_2 Act and the corresponding CO_2 Ordinance.

Instrument/measure	CO_2 Act	CO_2 Ordinance	Enforcement	Implementation level
Objectives	Article 3	Article 3	If a sector-specific interim target is not achieved, the Swiss Federal Department of Environment, Transport, Energy and Communications, after hearing the cantons and affected parties, shall request the Swiss Federal Council for additional measures.	Swiss Confederation
CO_2 levy on heating and process fuels	Articles 29–33	Articles 93–103	The CO_2 Ordinance defines a reduction pathway that needs to be followed (Article 94). If the targets set in the CO_2 Ordinance are not met, the CO_2 levy is increased automatically.	Swiss Confederation
Emissions trading scheme	Articles 15–21	Articles 40–65	Companies taking part in the emissions trading scheme have to cover their emissions with emission allowances (to a limited amount international carbon credits are also accepted). Emissions not covered entail a sanction of 125 Swiss francs per tonne of CO_2 equivalents.	Swiss Confederation
Negotiated reduction commitments (for exemption from the CO_2 levy)	Article 31	Articles 66–79	Companies have to commit to reduce their greenhouse gas emissions. If commitments are not fulfilled, a sanction of 125 Swiss francs is due per tonne of CO_2 equivalents that has been emitted in excess.	Swiss Confederation
National buildings refurbishment programme	Article 34	Articles 104–113	Annual reporting on effectiveness of implementation.	Cantons and contractual agreement between the Swiss Confederation and the cantons
Building codes of the cantons	Article 9	Article 16	Regulated at cantonal level. Cantons have to report annually to the Swiss Confederation on their activities.	Cantons
Obligation to offset emissions from gas-fired combined-cycle power plants	Articles 22–25	Articles 80–92	If the obligation to fully compensate the emissions is not fulfilled, the operators of gas-fired combined-cycle power plants have to pay a contractual sanction for non-compliance with the commitment.	Swiss Confederation
CO_2 emission regulations for newly registered vehicles	Articles 10–13	Articles 17–37	If targets are not met, importers of vehicles (passenger cars and light duty trucks) have to pay a sanction.	Swiss Confederation
Partial compensation of CO_2 emissions from motor fuel use	Articles 26–28	Articles 86–92	If the obligation to compensate is not fulfilled, a sanction of 160 Swiss francs per tonne of CO_2 must be paid. Additionally, the missing emission reductions must be covered by CERs.	Swiss Confederation

The website of the Swiss Federal Office for the Environment contains information regarding legislative arrangements and enforcement and administrative procedures publicly accessible[11]. In particular, the Swiss Federal Office for the Environment publishes recommendations on the implementation of the legal provisions in cases where more detailed information is necessary. These recommendations do not have legal force but are giving more precise instructions on the application of the legal instruments. For instance, in the context of the second CO_2 Act and the corresponding CO_2 Ordinance, the Swiss Federal Office for the Environment has published recommendations related to the implementation of compensation projects in Switzerland[12], the exemption from the CO_2 levy on heating and process fuels for energy intensive companies[13], and the emissions trading scheme[14].

In Switzerland, the CO_2 Act (Article 5 and 6) and the corresponding CO_2 Ordinance (Article 4 and Annex 2) provide the legal basis for the implementation and use of flexible mechanisms under the Kyoto Protocol. SwissFlex, the national secretariat for the flexible mechanisms[15], is the designated national authority under the Clean Development Mechanism and the designated focal point under the Joint Implementation. It was established in 2004 and announced to the UNFCCC in 2007. Activities relating to the implementation of the flexible mechanisms as well as enquiries concerning the mechanisms and the examination and approval of project proposals are coordinated by an interdepartmental working group. Besides the Swiss Federal Office for the Environment, the members of this group are drawn from the Swiss Federal Office of Energy, the Swiss State Secretariat for Economic Affairs, the Swiss Agency for Development and Cooperation, and the Swiss Federal Department of Foreign Affairs. SwissFlex publishes and regularly updates the list of letters of approval/authorisation issued under the Clean Development Mechanism[16] and under the Joint Implementation[17].

In view of the world-wide dimension of environmental problems, Switzerland seeks to enhance and support international efforts to tackle problems at the global level. Environmental issues are an integral part of Swiss foreign policy, and Switzerland is contributing at a political as well as at a technological level to solve environmental problems in multilateral contexts.

3.1.2 Monitoring and evaluation of policies and measures

Regarding the monitoring of the overall progress achieved by Switzerland's policies and measures to mitigate greenhouse gas emissions over time (self-assessment), the national greenhouse gas inventories – which are annually submitted to the UNFCCC and also published on the website of the Swiss Federal Office for the Environment[18] – are fundamental. Further, Article 40 of the second CO_2 Act (section 3.2.3) obliges the Swiss Federal Council to periodically evaluate the effectiveness of single policies and measures, and to consider the necessity of additional measures. These evaluations, which need to take into account other climate-relevant parameters such as economic development, population growth and the expansion of traffic, have to be reported to the Swiss Parliament. However, apart from some exceptions (see below), the second CO_2 Act does not define the exact dates or periodicity of the assessments. In the following, the most significant monitoring approaches and ex-post evaluations (either completed or performed repeatedly) are presented.

Sectoral interim targets

Article 3 of the CO_2 Ordinance stipulates sectoral interim targets for the greenhouse gas emissions in 2015:

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11 https://www.bafu.admin.ch/bafu/en/home/topics/climate.html

12 http://www.bafu.admin.ch/uv-1315-d

13 http://www.bafu.admin.ch/uv-1316-d

14 http://www.bafu.admin.ch/uv-1317-d

15 Website of the Swiss national secretariat for the flexible mechanisms: https://www.bafu.admin.ch/bafu/en/home/topics/climate/services/swissflex--national-secretariat-for-the-flexibility-mechanisms.html

16 2019: https://www.bafu.admin.ch/dam/bafu/en/dokumente/klima/fachinfo-daten/List_of_LoAs_2017.pdf
2006–2018: https://www.bafu.admin.ch/dam/bafu/en/dokumente/klima/statistik/Liste_2006-2016.zip

17 2007–2012: https://www.bafu.admin.ch/dam/bafu/en/dokumente/klima/fachinfo-daten/complete_list_ofloas2007-2012.pdf (as to date no AAUs were issued for the second commitment period of the Kyoto Protocol, no letters of approval/authorisation were issued under the Joint Implementation after 2012).

18 http://www.bafu.admin.ch/greenhouse-gases

- Buildings sector: no more than 78 per cent of 1990 emissions;
- Transport sector: no more than 100 per cent of 1990 emissions;
- Industry sector: no more than 93 per cent of 1990 emissions.

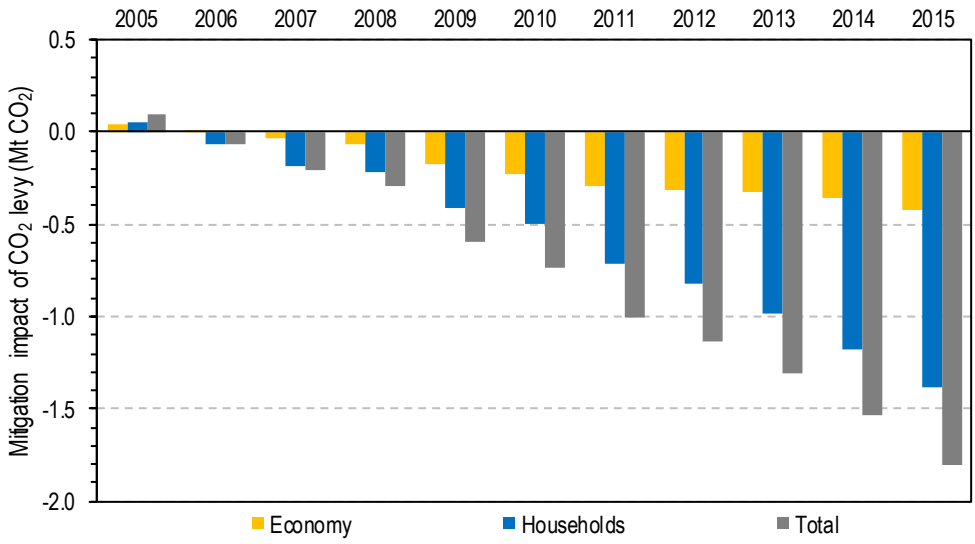
The evaluation of the sectoral interim targets took place based on the greenhouse gas inventory published by the Swiss Federal Office for the Environment in April 2017. In contrast to the transport sector, the buildings sector and the industry sector achieved their interim targets[19].

CO_2 levy on heating and process fuels

In the context of the CO_2 Ordinance (Article 94), the Swiss Federal Council has defined intermediate reduction targets regarding the CO_2 emissions from heating and process fuels for the years 2012, 2014, and 2016 (see also section 3.2.5). If these targets are not met, the CO_2 levy on heating and process fuels is increased automatically to the levels laid down in the CO_2 Ordinance. The decision for an increase of the CO_2 levy on heating and process fuels is taken on the basis of the annual national CO_2 statistics which relies on the official national energy statistics published by the Swiss Federal Office of Energy each year (the CO_2 statistics also forms the basis for the upcoming greenhouse gas inventory). As the consumption of heating and process fuels strongly depends on temperature and solar radiation during the winter season, the corresponding CO_2 emissions are normalised regarding weather conditions before confrontation with the targets.

The Swiss Federal Office for the Environment has undertaken an evaluation of the CO_2 levy on heating and process fuels with the goal to estimate the impact of the CO_2 levy on heating and process fuels on emissions since its introduction using both a modelling approach as well as data collected from a firm-level survey (*FOEN*, 2015; *FOEN*, 2016). However, given that the CO_2 Act envisages numerous (and mutually reinforcing) instruments, interdependencies between these instruments are expected. Sorting out the mitigation impact of an individual policy and measure is, thus, very difficult, especially for instruments such as the CO_2 levy on heating and process fuels that have an impact in more than one sector. In 2017, an update of the model based estimations, using a more refined approach that contributed to a more robust assessment of the mitigation impact of the CO_2 levy, was published (*Ecoplan*, 2017). Fig. 14 shows the main results, i.e. the mitigation impact that the model attributed to the CO_2 levy for the last years (economy, households and total).

Fig. 14 > Mitigation impact of the CO_2 levy for the years 2005 to 2015, estimated with an econometric model. As explained in *Ecoplan* (2017)[20], up to 0.5 million tonnes of CO_2 of the total mitigation impact indicated for 2015 may be attributed to the national buildings refurbishment programme and the negotiated reduction commitments (for exemption from the CO_2 levy).



Ecoplan (2017)

[19] https://www.newsd.admin.ch/newsd/message/attachments/48115.pdf

[20] See also https://www.bafu.admin.ch/dam/bafu/de/dokumente/klima/externe-studien-berichte/wirkungsabschaetzung-zur-co2-abgabe.pdf.

CO_2 emission regulations for newly registered vehicles

The CO_2 emission regulations for newly registered vehicles (section 3.4.2) are enforced by a sanction mechanism. Accordingly, compliance with the CO_2 emission regulations is monitored and evaluated on a case-by-case basis for small importers (in case the imported vehicle exceeds the CO_2 emission regulations a sanction has to be paid before the vehicle is licensed), or quarterly to annually for large importers. Data on the specific CO_2 emissions of newly registered vehicles are evaluated and published annually by the Swiss Federal Office of Energy.

Further, Article 37 of the CO_2 Ordinance requests that the Swiss Federal Department of Environment, Transport, Energy and Communications reports to the competent commissions of the Council of States and the National Council on the effectiveness of the CO_2 emission regulations for newly registred vehicles every three years, starting in 2016. Accordingly, the first report was presented in December 2016 (*DETEC*, 2016) and the second will follow soon.

Partial compensation of CO_2 emissions from motor fuel use

According to chapter 7 of the CO_2 Ordinance, fossil fuel importers are bound to offset part of the CO_2 emissions from motor fuel sold in Switzerland (section 3.4.5). To implement this obligation, sales of motor fuels as well as the corresponding CO_2 emissions are monitored continuously by the Swiss Federal Customs Administrations.

The Swiss Federal Audit Office evaluated the activities related to the partial compensation of CO_2 emissions from motor fuel use and published the respective report – including a summary in English – in 2016 (*Swiss Federal Audit Office*, 2016).

National buildings refurbishment programme

Cantons have to report on measures implemented within the national buildings refurbishment programme (section 3.3.3) as well as on the development of corresponding CO_2 emissions from buildings on cantonal territory[21]. Facilitated by the Swiss Federal Office for the Environment, the cantons submitted their first reports on CO_2 emissions from buildings in a standardised format in 2018. Results concerning e.g. CO_2 emissions and energy consumption are available for the year 2016 (*FOEN and SFOE*, 2018).

An ex-post evaluation of the national buildings refurbishment programme is performed annually. Further, a report on the first five years of the programme, including the cumulative effects, was published in March 2016, as requested by Article 34 of the second CO_2 Act (*Swiss Federal Council*, 2016a).

The Swiss Federal Audit Office evaluated the activities related to the national buildings refurbishment programme and published the respective report – including a summary in English – in 2013 (*Swiss Federal Audit Office*, 2013).

Emissions trading scheme

The Swiss Federal Audit Office evaluated the activities related to the emissions trading scheme and published the respective report – including a summary in English – in 2017 (*Swiss Federal Audit Office*, 2017a).

Negotiated reduction commitments (for exemption from the CO_2 levy)

The Swiss Federal Office of Energy mandated the evaluation of the activities related to the negotiated reduction commitments (for exemption from the CO_2 levy; see section 3.2.7) and published the respective report in 2016 (*Ecoplan*, 2016).

Energy Act

The Energy Act (*Swiss Confederation*, 2016) sets guidelines for the consumption of energy and electricity as well as for the energy production using renewable sources and hydropower. Monitoring of the respective indicators is part of the Energy Strategy 2050. The second monitoring report was published on 21 November 2019[22]. The relevant indicators regarding enhanced energy efficiency and the use of renewable energies evolve as anticipated, so that the intermediate

[21] See https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/climate-policy/buildings/kantonale-berichterstattung.html for more details.

[22] See https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-77173.html.

targets prescribed for 2020 (see section 3.3.1) are expected to be achieved. In the longer term, however, it appears that further efforts are needed to gradually restructure the energy system and, in particular, to promote the development of renewable energies and energy efficiency.

Technology fund

The Swiss Federal Audit Office evaluated the activities related to the technology fund (see section 3.10) and published the respective report – including a summary in English – in 2017 (*Swiss Federal Audit Office*, 2017b).

Other monitoring processes

Several other measures require regular reporting of emissions or of compliance with specific commitments. They are therefore closely monitored on a regular basis. For instance, firms participating in the emissions trading scheme and firms with an individual (negotiated) reduction target that are exempt from the CO_2 levy are obliged to monitor their greenhouse gas emissions and to provide an annual report to the Swiss Federal Office for the Environment.

3.1.3 Institutional arrangements for the monitoring of greenhouse gas mitigation policy

No fundamental changes in domestic institutional arrangements, including legal, administrative and procedural arrangements have occurred since Switzerland's last submission. The Swiss Federal Office for the Environment, being responsible for matters relating to climate protection (see section 3.1.1), is generally also responsible for the monitoring of progress made with greenhouse gas mitigation policies and measures (see section 3.1.2). In addition, the Swiss Federal Audit Office, in the framework of its activities as an independent inspecting authority, regularly inspects the implementation of greenhouse gas mitigation policies and measures. Institutional arrangements related to Switzerland's national greenhouse gas inventory system and the national registry are documented in section 1.3 and 1.4, respectively. The Act on Archiving (*Swiss Confederation*, 1998c) regulates the archiving of documents of the Swiss Confederation, ensuring that documents from all federal institutions that are valuable for legal, political, economic, historical, social or cultural reasons are archived by the Swiss Federal Archives[23]. The compulsory archiving of course also covers all information prepared with regard to e.g. the greenhouse gas inventory, the national and international reporting obligations, the legislative process, and the implementation of policies and measures.

3.2 Cross-sectoral policies and measures

3.2.1 Overview

While policies and measures addressed in sections 3.3 to 3.8 may have side effects beyond their specific policy domain, the policies and measures presented in section 3.2 are clearly cross-sectoral in nature, i.e. they cannot be assigned to one of the 'classical' policy sectors.

Tab. 13 gives an overview of the most relevant cross-sectoral policies and measures. More details and background information on each policy and measure are presented below.

Tab. 13 > Summary of cross-sectoral climate policies and measures. The sector affected is 'cross-cutting' for all policies and measures presented in this table.

Name of policy or measure [a]	Greenhouse gas(es) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO_2eq)
								2020
First CO_2 Act (1999) *	CO_2	Average reduction of CO_2 emissions from fossil fuel use by 10 per cent over the years 2008–2012 (relative to 1990).	Regulatory	Expired (replaced by second CO_2 Act)	First legal basis of Switzerland's climate policy including the implementation of the first commitment period of the Kyoto Protocol.	2000	FOEN	IE [b]
Second CO_2 Act (2011) *	CO_2, CH_4, N_2O, HFCs, PFCs,	Reduction of all greenhouse gas emissions by 20 per cent by 2020 (relative to 1990).	Regulatory	Implemented	Current legal basis of Switzerland's climate policy including the implementation of the second commitment period of the Kyoto Protocol and	2013	FOEN	IE [b]

[23] See https://www.bar.admin.ch/bar/en/home.html for more details.

	SF_6, NF_3				containing provisions covering mitigation as well as adaptation.			
Third CO_2 Act (2021)	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3	Decrease of total greenhouse gas emissions (relative to 1990) by (i) 50 per cent by 2030 (at least 30 per cent domestic and at most 20 per cent abroad) and (ii) 35 per cent in the mean over the years 2021–2030 (at least 25 per cent domestic and at most 10 per cent abroad).	Regulatory	Planned	Update of the CO_2 Act providing the legal basis of Switzerland's climate policy consistent with the Paris Agreement. While mostly covering the same policies and measures as the second CO_2 Act, the third CO_2 Act foresees a strengthening of the policies and measures in order to reach the more ambitious national and international targets.	2021	FOEN	IE [b]
CO_2 levy on heating and process fuels *	CO_2	Promote energy efficiency, less CO_2 intensive energy sources and reduced use of fossil heating and process fuels.	Economic, fiscal	Imple-mented (strength-ening planned)	Surcharge on fossil heating and process fuels. Two thirds of the revenues are redistributed to households and businesses, up to one third goes into the national buildings refurbishment programme and – to a small extent – to a technology fund granting loan guarantees for the development of new low-emission technologies.	2008	FOEN	2'000
Emissions trading scheme *	CO_2, N_2O, PFCs	Reducing CO_2 emissions of emission-intensive industries using market-based mechanism.	Economic	Imple-mented (strength-ening planned)	Emissions trading scheme based on the cap and trade principle, enabling the cost-effective achievement of climate-protection targets. Large greenhouse gas-intensive companies are required to participate, medium-sized companies may voluntarily participate. Companies included in the emissions trading scheme are exempt from the CO_2 levy on heating and process fuels.	2008	FOEN	800
Negotiated reduction commitments (for exemption from the CO_2 levy) *	CO_2, N_2O, PFCs	Emission reduction targets agreed with companies exempt from the CO_2 levy on heating and process fuels.	Regulatory	Imple-mented (strength-ening planned)	Binding agreements with eligible small and medium-sized companies. Emission reduction targets take the technological potential and economic viability of measures into account. Targets are calculated from the starting point along a simplified or individual linear reduction course to the endpoint in the year 2020. Alternatively, economically viable measures (measures target) can be determined.	2008	FOEN, SFOE	400

[a] Policies and measures marked with an asterisk (*) are included in the 'with measures' projection.

[b] The first, second and third CO_2 Acts are the legal framework for various measures. While the expected mitigation impacts of individual policies and measures are presented along with these policies and measures, the total mitigation impacts of the CO_2 Acts correspond to the objectives indicated in the third column.

IE, included elsewhere
FOEN, Swiss Federal Office for the Environment; SFOE, Swiss Federal Office of Energy

3.2.2 First CO_2 Act (1999)

The first CO_2 Act (*Swiss Confederation*, 1999b) entered into force in May 2000. It formed the legal framework for the implementation of Switzerland's emissions reduction commitment under the Kyoto Protocol by limiting CO_2 emissions from fossil fuel use for heating and transport to 10 per cent below 1990 levels over the period 2008–2012. The overall target was further divided into a reduction target of 15 per cent on heating and process fuels and eight per cent on motor fuels. These targets were set to assure compliance with the target under the Kyoto Protocol, assuming that the aggregate level of other greenhouse gas emissions remained unchanged compared to 1990.

The primary instruments to reach the targets for the period 2008–2012 were:

- Voluntary actions in various areas;

- A subsidiary CO_2 levy on heating and process fuels;
- Measures in other policy areas (waste, agriculture, F-gases) that are relevant to climate change mitigation;
- An emissions trading scheme (cap and trade);
- The complementary use of flexible mechanisms under the Kyoto Protocol.

Estimate of mitigation impact

The expected mitigation impact of the first CO_2 Act corresponds to its objective, i.e. an average reduction by 10 per cent of CO_2 emissions from fossil fuel use over the years 2008–2012 relative to 1990. However, as the first CO_2 Act formed the legal framework for various measures, the mitigation impact is indicated in Tab. 13 and BR CTF table 3 as 'included elsewhere' (i.e. under the policies and measures presented below).

3.2.3 Second CO_2 Act (2011)

The second CO_2 Act (*Swiss Confederation*, 2011) is the current centrepiece of Swiss climate policy. Fully revising the first CO_2 Act, it entered into force on 1 January 2013 and covers the period from 2013–2020. Apart from defining objectives it forms the foundation for several policies and measures to reach the set targets. Some policies and measures developed or initiated in the context of the first CO_2 Act – such as the CO_2 levy on heating and process fuels, the national buildings refurbishment programme, and the CO_2 emission regulations for newly registered vehicles – are continued.

The national reduction target of the second CO_2 Act stipulates the reduction of domestic greenhouse gas emissions by at least 20 per cent by 2020 compared to the 1990 level (see chapter 2). In contrast to the first CO_2 Act, all gases covered by the Kyoto Protocol are addressed. The second CO_2 Act sets incentives for increasing use of renewable energies, improvement of energy efficiency and development of innovative low-emission technologies. In addition, it gives the Swiss government the responsibility to coordinate measures aimed at adaptation to the impacts of climate change at the national level.

The reduction target of –20 per cent by 2020 compared to the 1990 level is shared between the building, industry and transport sectors, but also tackles emissions from agriculture and of synthetic greenhouse gases. For 2015, the CO_2 Ordinance sets interim targets which correspond to reductions of 22 and seven per cent for the buildings and industry sectors, respectively, as well as zero emissions growth for the transport sector compared to the 1990 level. An evaluation of sectoral achievement of the interim targets was performed in 2017. While the buildings sector and the industry sector both reached their targets, emissions in the transport sector were four per cent higher than in 1990. Only indicative sectoral targets exist regarding reductions by 2020 (by 40 per cent for the buildings sector, by 15 per cent for the industry sector, and by 10 per cent for the transport sector, all compared to the 1990 level).

Planned strengthening

The second CO_2 Act is currently under revision, details of the planned strengthening are presented in section 3.2.4.

Estimate of mitigation impact

The expected mitigation impact of the second CO_2 Act corresponds to its objective, i.e. to a reduction of greenhouse gas emissions of 20 per cent by 2020 relative to the 1990 level. However, as the second CO_2 Act forms the legal framework for various measures, the mitigation impact is indicated in Tab. 13 and BR CTF table 3 as 'included elsewhere' (i.e. under the policies and measures presented below).

3.2.4 Third CO_2 Act (2021)

The third CO_2 Act will replace the second CO_2 Act and cover the period 2021–2030. It translates Switzerland's commitments under the Paris Agreement into national law and defines reduction targets for greenhouse gas emissions (see discussion of the estimate of mitigation impact below) as well as the corresponding instruments. Since the Swiss Parliament has already approved Switzerland's international emission reduction target under the Paris Agreement in 2017, the focus now lies on adopting the corresponding instruments to reach the target. Accordingly, the Swiss Federal Council prepared – under the aegis of the Swiss Federal Office for the Environment – a draft of the third CO_2 Act, taking into account the feedbacks from consultations of the public and all relevant federal departments and federal offices. The Swiss Federal Council adopted the draft on 1 December 2017, launching therewith the debate in the Swiss Parliament.

The draft predominantly proposes the continuation and strengthening of the main instruments, with the following cornerstones (subject to parliamentary discussion):

- The CO_2 levy on heating and process fuels shall continue to be an important pillar of Swiss climate policy. The maximum possible level of the CO_2 levy on heating and process fuels proposed is 210 Swiss francs per tonne of CO_2. As in the current legislation under the second CO_2 Act, the CO_2 levy on heating and process fuels shall augment automatically if defined intermediate targets should be missed;
- The emissions trading scheme shall be continued and will deliver the most of the mitigation effort from industry. Importantly, the emissions trading schemes of Switzerland and the European Union will be linked (see section 3.2.6 for details);
- The negotiated reduction commitments (for exemption from the CO_2 levy) has proven to be a useful instrument to cut emissions at the level of companies. It shall continue with little changes;
- The draft of the third CO_2 Act proposes subsidiary limits of specific emissions (in CO_2 per square metre energy reference area) for existing and for new buildings instead. These limits enter into force if defined intermediate mitigation targets should be missed in 2026/2027;
- The partial compensation of CO_2 emissions from motor fuel use shall continue. Until 2030, the compensation level will rise up to no more than 90 per cent of total emissions from motor fuels. At least 15 per cent shall be compensated in Switzerland, the rest under Article 6 of the Paris Agreement;
- CO_2 emission regulations for newly registered vehicles shall be continued and strengthened in line with the European Union.

For the reporting in the framework of its fourth biennial report, Switzerland takes into account – as a planned policy and measure – the status of the draft of the third CO_2 Act as of 1 December 2017. While the Swiss Parliament currently proposes substantial changes to this draft, the final outcome is still unknown, and the discussions in the Parliament will continue into the year 2020. Moreover, an optional referendum – which allows citizens to veto decisions made by the Swiss Parliament – may represent the last obstacle before the third CO_2 Act can enter into force.

Estimate of mitigation impact

The expected mitigation impact of the third CO_2 Act corresponds to its objective, i.e. a reduction of total greenhouse gas emissions (relative to 1990) by (i) 50 per cent by 2030 (at least 30 per cent domestic and at most 20 per cent abroad) and (ii) 35 per cent in the mean over the years 2021–2030 (at least 25 per cent domestic and at most 10 per cent abroad). As the third CO_2 Act will form the legal framework for the strengthening of various policies and measures currently implemented under the second CO_2 Act, its mitigation impact is indicated in Tab. 13 and BR CTF table 3 as 'included elsewhere' (i.e. under the policies and measures presented below).

3.2.5 CO_2 levy on heating and process fuels

By increasing the price of fossil heating and process fuels, the CO_2 levy sets an incentive to use fossil fuels more efficiently, to invest in low carbon technologies, and to switch to low-carbon or carbon-free energy sources. The CO_2 levy was introduced in January 2008 at an initial rate of 12 Swiss francs per tonne of CO_2. The CO_2 ordinance foresees an automatic increase of the rate to a maximum of 120 Swiss francs per tonne of CO_2 in case CO_2 emissions from heating and process fuels exceed the intermediate targets shown in Tab. 14.

Tab. 14 > Intermediate targets set out in Article 94 of the CO_2 ordinance to the second CO_2 Act, including corresponding increases of the CO_2 levy in case of non-compliance with the intermediate targets (the intermediate targets set out in Article 3 of the CO_2 ordinance to the first CO_2 Act are not shown here[24]). The attainment of the targets is evaluated based on the CO_2 statistics which is annually published at the beginning of July and which contains CO_2 emissions from heating and process fuels from the previous year. Accordingly, the relevant CO_2 emissions from heating and process fuels for the year 2016 are available as of July 2017, but will only be included in the greenhouse gas inventory submitted to the UNFCCC in 2018.

As of 1 January 2014:
• Increase to 60 Swiss francs per tonne of CO_2 if the CO_2 emissions from heating and process fuels in 2012 exceed 79 per cent of 1990 emissions.
⇨ The rate of the CO_2 levy was increased to 60 Swiss francs per tonne of CO_2.
As of 1 January 2016:
• Increase to 72 Swiss francs per tonne of CO_2 if the CO_2 emissions from heating and process fuels in 2014 exceed 76 per cent of 1990 emissions; • Increase to 84 Swiss francs per tonne of CO_2 if the CO_2 emissions from heating and process fuels in 2014 exceed 78 per cent of 1990 emissions.
⇨ The rate of the CO_2 levy was increased to 84 Swiss francs per tonne of CO_2.
As of 1 January 2018:
• Increase to 96 Swiss francs per tonne of CO_2 if the CO_2 emissions from heating and process fuels in 2016 exceed 73 per cent of 1990 emissions; • Increase to 120 Swiss francs per tonne of CO_2 if the CO_2 emissions from heating and process fuels in 2016 exceed 76 per cent of 1990 emissions.
⇨ The rate of the CO_2 levy was increased to 96 Swiss francs per tonne of CO_2.

As a basic principle, proceeds from the CO_2 levy on heating and process fuels are refunded pro-rata to the Swiss population (on a per capita basis) and to the Swiss economy (in proportion to wages paid). However, following a parliamentary decision in June 2009, a third (or a maximum of 300 million Swiss francs per year up to the end of 2017 and a maximum of 450 million Swiss francs as of 2018) of the revenues from the CO_2 levy is earmarked to finance the national buildings refurbishment programme (see section 3.3.3). This programme is partly co-funded out of cantonal budgets and co-managed by the Swiss government and the cantons. Additionally, 25 million Swiss francs per year are invested in a technology fund to promote innovative technologies that reduce greenhouse gas emissions and the consumption of resources, support the use of renewable energy and increase energy efficiency (see section 3.10).

Planned strengthening

The Swiss Federal Council proposes to increase the maximum levy rate to 210 Swiss francs per tonne of CO_2 as part of the current revision of the CO_2 Act. As under the current legislation, the levy shall be increased step-wise depending on the evolution of greenhouse gas emissions from heating fuels.

Estimate of mitigation impact

The CO_2 levy is expected to lead to a reduction of about two million tonnes of CO_2 in 2020. This estimate is consistent with the model-based estimate by *Ecoplan* (2009) when transferred to the actual levy of 96 Swiss francs per tonne of CO_2. The proposed increase of the maximum rate to 210 Swiss francs per tonne of CO_2 is projected to reduce another 1.3 million tonnes of CO_2 in 2030 (compared to a scenario where the rate is held constant at its current maximum level rate of 96 Swiss francs per tonne of CO_2). The estimate for the mitigation impact for 2020 used in this report is higher compared to the value presented in Switzerland's seventh national communication and third biennial report. The main reason is that the mitigation impact is now based on a CO_2 levy rate of 96 Swiss francs per tonne of CO_2 while it was previsouly based on a CO_2 levy rate of 72 Swiss francs per tonne of CO_2.

3.2.6 Emissions trading scheme

Switzerland introduced its emissions trading scheme in 2008 in order to give companies – especially those industries with substantial CO_2 emissions resulting from the use of heating and process fuels as well as from cement production – the flexibility in contributing to CO_2 reduction goals under the same rules as their international competitors (at the same time being exempt from the CO_2 levy on heating and process fuels). The emissions trading scheme is based on the cap and trade principle. For the period 2013–2020, Switzerland's emissions trading scheme has been aligned with the emissions trading scheme of the European Union with a view to link both systems. Notable amendments included the mandatory nature of the emissions trading scheme for large, greenhouse gas-intensive companies and partial auctioning of emission allowances. Rules for allocation of free emission allowances were harmonised and based on the same benchmarks of emissions performance as in the European Union.

[24] https://www.admin.ch/opc/de/classified-compilation/20070960/201205010000/641.712.pdf

Planned strengthening

For the period 2021–2030, the emissions trading schemes of Switzerland and the European Union are planned to be linked, after further developments to ensure compatibility of the two systems. Most importantly, this requires identical sectoral coverage. Therefore, Switzerland will have to include aircraft operators and gas-fired combined-cycle power plants in its emissions trading scheme. The maximal amount of available emission allowances (cap) will be reduced at 2.2 per cent per year instead of 1.74 per cent per year. The technical negotiations between Switzerland and the European Union on the linking of their emissions trading schemes have been completed in January 2016. The required bilateral agreement has been signed on 23 November 2017. The European Union approved the agreement at the beginning of 2018, and the Swiss Parliament approved it on 22 March 2019. The exchange of the instruments of ratification was planned to take place in December 2019[25], allowing the agreement to enter into force on 1 January 2020. The ratification by the Swiss Parliament also includes the approval of amendments to Swiss legislation to include aircraft operators and gas-fired combined-cycle power plants in the emissions trading scheme. As soon as the linking is in force, the obligation to offset emissions from gas-fired combined-cycle power plants will expire (see section 3.3.6).

Estimate of mitigation impact

Based on the rate of reduction of the cap of 1.74 per cent per year and considering actual emissions covered by the emissions trading scheme, the mitigation impact of the emissions trading scheme until 2020 is estimated to be approximately 0.8 million tonnes of CO_2. Under the planned strengthening, the increase of the rate of reduction to 2.2 per cent per year from 2021 on will lead to an additional mitigation impact of one million tonne of CO_2 in 2030.

3.2.7 Negotiated reduction commitments (for exemption from the CO_2 levy)

Companies with substantial CO_2 emissions that are engaged in an activity listed in Annex 7 of the CO_2 Ordinance may apply for exemption from the CO_2 levy without participation in the emissions trading scheme, provided they commit to emission reductions. Companies have to elaborate emission reduction targets, which take into account the technological potential and economic viability of measures. The emissions reduction targets of companies are calculated from the starting point along a linear reduction course to the endpoint in the year 2020, either based on a simplified determination of the reduction course or an individual reduction course including a systematic analysis. As a further option, for companies that emit no more than 1'500 tonnes of CO_2 equivalents per year, economically viable measures (measures target) can be determined in a standardised procedure instead of a reduction course. The elaboration of negotiated reduction commitments and their implementation is assisted by two organisations mandated by the government (Swiss Energy Agency of the Economy and Cleantech Agency Switzerland, see section 9.2 of Switzerland's seventh national communication).

Planned strengthening

The current mechanism with negotiated reduction commitments for companies with substantial CO_2 emissions has proven to be a valuable instrument. As part of the current revision of the CO_2 Act, the Swiss Federal Council proposes its continuation with several adjustments aiming to reduce administrative costs and overlaps with cantonal instruments.

Estimate of mitigation impact

For 2020, the estimated mitigation impact of the negotiated reduction commitments (for exemption from the CO_2 levy) is estimated at about 400 thousand tonnes of CO_2 equivalents (Tab. 13 and BR CTF table 3). This estimation is based on the sum of reduction commitments of exempt companies, i.e. on total reductions needed to meet their negotiated targets. The additional mitigation impact of the continuation of the instrument beyond 2020 can be roughly estimated at 200 thousand tonnes of CO_2 equivalents by 2030, which corresponds to a 10 per cent decrease of total emissions of exempt companies. This estimation is tentative, because the details of the design and implementation of the instrument are subject to ongoing discussions.

[25] Just before the submission of Switzerland's fourth biennial report, the process of ratification was successfully completed (for more details see the press release under *https://www.admin.ch/gov/en/start/documentation/media-releases.msg-id-77446.html*). However, due to the short time lag between the exchange of the instruments of ratification and the submission of Switzerland's fourth biennial report, the linking of the emissions trading schemes of Switzerland and the European Union is still considered as a planned measure in this report.

3.3 Energy

3.3.1 Overview

Energy policy was anchored in the Federal Constitution of the Swiss Confederation in 1990, when an energy article was added. This article stipulates that the Swiss government and the cantons are obliged to use their competences to ensure an adequate, broad-based, secure, economic and ecological energy supply, and the economical and efficient use of energy. This comprehensive list of requirements places high demands on energy policy at the federal and cantonal levels, including the ability to find compromise solutions that meet all criteria.

The energy article in the Federal Constitution of the Swiss Confederation is elaborated further in the Energy Act, the Nuclear Energy Act and the Electricity Supply Act. In addition to legal instruments and related measures, the energy policies of the Swiss government and the cantons are also based on 'energy perspectives' (models and scenarios of future energy production and consumption), 'strategies' (goal-oriented policy packages), implementation programmes focussing on information and promotion, and the periodic evaluation of energy-related measures at the municipal, cantonal and federal level.

Following the reactor disaster of Fukushima in 2011 the Swiss Federal Council and the Swiss Parliament decided on Switzerland's progressive withdrawal from nuclear energy sources. This decision, together with further far-reaching changes in the international energy environment, requires an upgrading of the Swiss energy system. For this purpose the Swiss Federal Council has developed the Energy Strategy 2050.

On September 2013, the Swiss Federal Council submitted the first set of measures in the Energy Strategy 2050 (*Swiss Federal Council*, 2013a) to the Swiss Parliament. The Energy Strategy 2050 is a legal and policy package to advance the energy transition of Switzerland towards a low-carbon economy. The first package of measures of the Energy Strategy 2050 entered into force on 1 January 2018. The strategy addresses the impacts of the country's decision for a progressive withdrawal from nuclear energy. The existing nuclear power plants will shut down at the end of their technically safe operating life and will not be replaced with new ones. The first nuclear power plant closed down for commercial reasons on 20 December 2019 and the last one will likely be running beyond the mid-2030s. Nuclear energy provides about 35 per cent of Switzerland's electricity generation. The consequent generation gap will need to be filled by other options while maintaining low carbon generation and the high standards of supply security. A further set of market reform measures and a revision of the CO_2 Act are currently being prepared to set the country on course for its 2030 climate target and aspirational 2050 goals.

The Energy Strategy 2050 sets a number of priorities to assure the future energy supply, such as reduction in energy consumption, broadening of the portfolio of energy sources, expansion and restructuring of the electricity transmission grid as well as energy storage. As part of the Energy Strategy 2050, emphasis is placed on increased energy savings (energy efficiency), the expansion of hydropower and implementation of new renewable energies.

Within the context of the Energy Strategy 2050, priority areas particularly relevant to climate policy goals are:

- **Reduction in energy consumption:** The Energy Act (*Swiss Confederation*, 2016) contains reference values of –16 per cent energy consumption per person and –3 per cent electricity consumption per person until 2020 and of –43 per cent energy consumption per person and –13 per cent electricity consumption per person until 2035 compared to 2000. On this basis, the energy strategy shall contribute to achieve the long-term goals of Switzerland's climate policy – to reduce greenhouse gas emissions to 1 to 1.5 tonnes of CO_2 equivalents per year and person by 2050. The government intends to encourage the economical use of energy in general and of electricity in particular. Enhanced efficiency measures include minimum requirements for appliances (best practice, energy label) and other regulations, bonus malus mechanisms (efficiency bonus), measures to raise public awareness (strengthening of the SwissEnergy programme, described below) and measures regarding the production of heat;
- **Broadening of electricity supply:** Hydropower and new renewable electricity generation should be bolstered in particular. Their share in the current energy mix needs to be expanded substantially. This is the main aim of the feed-in system which supports renewable electricity generation by means of funds raised by an electricity network surcharge. However, in order to meet demand, fossil fuel-based electricity generation may need to be expanded by constructing gas-fired combined-cycle power plants intended to provide peak load, but also combined

heat and power plants for base load in winter. The government is retaining its climate policy objectives (see section 3.3.6), therefore emissions caused by new fossil fuel-based power plants must be compensated;

- **Expansion and restructuring of electricity transmission grid and energy storage:** The increasing share of intermittent power production by renewable energies (wind, solar) requires the expansion and restructuring of transmission grids and of the pool of power plants to ensure temporary power balancing as well as the necessary storage and reserve capacities. 'Smart grids' are important prerequisites for future domestic production infrastructures and electricity exchange. They allow direct interaction between consumers, the network and power producers and offer great potential with regard to optimising the electricity system, delivering energy savings and, consequently, bringing down costs;
- **Strengthening energy research:** An action plan on 'Coordinated Energy Research Switzerland' was created as a consequence of the Swiss decision to phase out nuclear energy. It aims at building up capacities in energy research and strengthening thematic focal points in seven clearly defined fields of action. Within the framework of the Energy Strategy 2050, the Swiss Parliament adopted the 'Coordinated Energy Research' action plan for the period from 2013 to 2016 as a supplement to the existing energy research programme. This action plan is supporting the implementation of the Energy Strategy 2050 by providing additional research capacity at universities and colleges of technology in the area of application-oriented energy research. For the implementation of this action plan, eight specialised competence centres were created (Swiss Competence Centres for Energy Research SCCER, see section 8.1.1 of Switzerland's seventh national communication).

In December 2017, the Swiss Parliament endorsed a proposal dealing with the modernisation and expansion of the electricity grid. The idea behind the electricity grid strategy (SSN) is to establish new legislative conditions for the development of the grid. The aim of the proposal is to ensure the prompt needs-oriented development of Switzerland's electricity grids to guarantee the security of the electricity supply. The electricity grid strategy entered into force on 1 June 2019.

On 27 September 2019, the Swiss Federal Council decided to adhere to the opening up of the electricity market. At the same time he commissioned Swiss Federal Department of the Environment, Transport, Energy and Communications to draw up a bill to amend the Energy Act. As an accompanying measure to open the market, the incentives to invest in domestic renewable energies should be improved and thus the security of supply strengthened. Moreover, the revision of the Electricity Supply Act envisions a strategic supply reserve based on hydropower storage plants. Based on an auctioning mechanism, owners of storage plants can withhold some of the energy for critical supply situations as they may occur at the end of winter, when the water reservoirs tend to be empty.

Tab. 15 gives an overview of the most climate-relevant policies and measures in the energy sector. The following sections provide more details and background information on each policy and measure.

Tab. 15 > Summary of policies and measures in the energy sector. The sector affected is 'energy' for all policies and measures presented in this table. Compared to the previous submission, the policy and measure "Negotiated commitments on energy efficiency" has been renamed to "Exemption from electricity network surcharge".

Name of policy or measure [a]	Greenhouse gas(es) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO_2eq)
								2020
SwissEnergy programme *	CO_2	Promotion of energy efficiency and the increased use of renewables.	Information, education	Implemented	Major policy instrument engaging cantons, municipalities, industry, as well as environmental and consumer associations for awareness raising and the promotion of increased energy efficiency and the enhanced use of renewable energy.	2001	SFOE	NE [b]
National buildings refurbishment programme *	CO_2	Refurbishment of existing buildings envelope and Incentives for renewable energy, energy recuperation and optimisation of building technology.	Economic	Implemented (strengthening planned)	The programme increases the energy efficiency of buildings and promotes the use of renewable energies in the buildings sector. Financed by one third of the revenue from the CO_2 levy on heating and process fuels, with additional	2010	SFOE, FOEN, cantons	1'120

					funds provided by the cantons.			
Building codes of the cantons *	CO_2	Stringent energy consumption standards for new buildings.	Regulatory	Implemented (strengthening planned)	A set of common energy and insulation standards (model ordinances) to reduce energy consumption of buildings agreed on by the cantonal energy directors. Implementation of the latest set of measures was endorsed in 2015, but so far only transposed into cantonal laws by seven cantons.	1992	Cantons, in coordination with SFOE	1'760
Exemption from electricity network surcharge *	CO_2	Exemption from the electricity network surcharge under the Energy Act.	Economic, voluntary/negotiated agreements	Implemented	Full or partial refund of the electricity network surcharge (raised for the promotion of renewable energies) to energy-intensive companies if they commit to enhance energy efficiency in a target agreement. The target agreements need to follow the guidance provided by the Swiss government and have to be elaborated in collaboration with two specialised organisations.	2014	SFOE	NE [b]
Obligation to offset emissions from gas-fired combined-cycle power plants *	CO_2	Avoid new large sources of CO_2 from electricity or heat generation.	Regulatory	Implemented (strengthening planned)	Fossil thermal power plants with a capacity larger than 100 megawatts obtain planning permission only if their CO_2 emissions are fully compensated. Under the second CO_2 Act, at least half of the compensation has to be achieved domestically.	2008	FOEN	NA [c]
Negotiated reduction commitment of municipal solid waste incineration plant operators	CO_2	Contribution to emission reduction by municipal solid waste incineration plant operators through energy efficiency measures and metal recuperation.	Regulatory	Implemented	Agreement committing the association of municipal solid waste incineration plant operators to establish a monitoring system and to reduce net CO_2 emissions. Implementation of the agreement exempts municipal solid waste incineration plant operators from participation in the emissions trading scheme.	2014	FOEN	200 [d]

[a] Policies and measures marked with an asterisk (*) are included in the 'with measures' projection.

[b] See the respective sections (3.3.2 and 3.3.5) for more information regarding the mitigation impact.

[c] It is currently uncertain when (and if) new gas-fired combined-cycle power plants will be realised in Switzerland. In any case, the obligation to offset emissions from gas-fired combined-cycle power plants aims at ensuring their climate-neutral operation (partly using international carbon credits).

[d] Agreed (net) emission reduction commitment is 200 thousand tonnes of CO_2 equivalents below 2010 emissions by 2020. The recuperation of metals may lead to (indirect) reductions of greenhouse gas emissions outside Switzerland.

NA, not applicable; NE, not estimated
FOEN, Swiss Federal Office for the Environment; SFOE, Swiss Federal Office of Energy

3.3.2 SwissEnergy programme

In 2001, the Swiss Federal Council launched the 'SwissEnergy' programme, in line with the Energy Act and the CO_2 Act that came into force in 1999 and 2000, respectively. It aims at reducing fossil fuel use and CO_2 emissions as required by the CO_2 Act and contains targets for electricity generation and heat production from renewable sources. The SwissEnergy programme represents a major policy instrument for awareness raising and promoting an increase in energy efficiency and the enhanced use of renewable energy (see section 9.2 of Switzerland's seventh national communication). Measures are mostly voluntary in nature, supporting the effect of regulatory measures. Running initially from 2001 to 2010, the programme has been extended to 2020.

SwissEnergy is managed by the Swiss Federal Office of Energy. Projects are normally run in close cooperation with cantons, municipalities, and industry, as well as environmental and consumer associations. Programme results are subject to detailed monitoring and verification. SwissEnergy's yearly budget has been increased from about 30 million Swiss francs in 2012 to around 50 million Swiss francs per year up to 2020, to support the Energy Strategy 2050.

In recent years, several tasks formerly vested with SwissEnergy have become a legal obligation: promotion of renewables has shifted from a programme-type activity supplementing a modest and inadequate feed-in tariff to a comprehensive feed-in system, whose enforcement and continuity is guaranteed by law. Many minimum efficiency performance standards, previously introduced in the form of voluntary agreements (cars, some appliances) or codes of conduct (some energy-using products), are now legally mandated and aligned with the standards of the European Union. Hence, the role of SwissEnergy is shifting towards that of a facilitator for the above mentioned regulations and laws.

Estimate of mitigation impact

The SwissEnergy programme covers a number of fields each requiring the use of very different – and very specific – instruments and means of communication. The focus of the programme is on soft measures (information, consulting, training and continuing education, quality assurance), therefore the mitigation impact cannot be quantified for lack of methodology. In addition, the SwissEnergy programme provides advice about implementation of regulations and promotional programmes and is primarily responsible for ensuring that enough trained people are available and that measures are publicised. These are necessary activities, but their mitigation impact cannot be looked at in isolation from the measures being applied. For all these reasons, the mitigation impact of the SwissEnergy programme is reported as 'not estimated' in Tab. 15 and BR CTF table 3.

3.3.3 National buildings refurbishment programme

In order to increase the refurbishment rate of buildings and to promote the use of renewable energies in the buildings sector, a third of the revenues from the CO_2 levy on heating and process fuels were earmarked for this purpose in the framework of the first CO_2 Act. In 2009, the Swiss Parliament adopted the national buildings refurbishment programme (operational since 1 January 2010). The programme was collectively developed by the cantons, represented by the Conference of Cantonal Energy Directors and the Swiss federal administration (Swiss Federal Office of Energy, Swiss Federal Office for the Environment). The cantons are responsible for its implementation. The duration of the programme is limited to ten years. A mid-term evaluation has been submitted to the Swiss Parliament in 2016. Some numbers on the cost-effectiveness of the programme on the basis of the most recent annual reporting (*EnDK*, 2015) are given below.

With the revision of the CO_2 Act in 2011, the Swiss Parliament increased the maximum amount earmarked for the national buildings refurbishment programme from 200 million to 300 million Swiss francs per year. Available funds are linked to the actual level of the CO_2 levy. With the increases of the CO_2 levy at the beginning of 2014 and 2016, more financial means are available to promote measures to reduce greenhouse gas emissions from buildings.

Until 2016, the national buildings refurbishment programme was divided into two distinct parts: (i) part A, refurbishment of existing building envelope and (ii) part B, promotion of renewable energy, energy recuperation and optimisation of building technology. This segregation of tasks was abolished as a result of reorganisation of the programme in 2017.

1.7 billion Swiss francs have been paid out as part of the national building refurbishment programme since 2010. In 2018, disbursements amounted to 211 million Swiss francs, one fifth higher than in 2017. As in previous years, most of this was paid out for the thermal insulation of individual components. However, the contributions to system renovations increased sharply in 2018 and, for the first time since the programme began, payments were also made to indirect measures such as training and education.

Average costs per tonne of CO_2 reduced was 64 Swiss francs (combined funds from the federal and the cantonal level). Beyond the national buildings refurbishment programme, several cantons provide financial support to measures such as promotion of photovoltaics and consulting of building owners. However, there is no systematic overarching evaluation of the quantitative effect of these measures on CO_2 emissions.

Since the adoption of the revised Energy Act (*Swiss Confederation*, 2016) in May 2017, more funding is available to the national buildings refurbishment programme as of 1 January 2018 and the maximum amount earmarked for the national buildings refurbishment programme has increased from 300 million to 450 million Swiss francs per year. The time limitation previously set for the programme as of 2019 was also abolished.

Planned strengthening

Within the framework of Switzerland's climate policy for the years after 2020, the Swiss Federal Council proposes to maintain the partial earmarking of funds until 2025.

Estimate of mitigation impact

A model which allots a CO_2 mitigation impact to each measure realised (e.g., per square metre of insulation) was used to calculate the mitigation impact of the national buildings refurbishment programme. For the calculation, free rider effects (measures that would have been realised also in the absence of subsidies) were also taken into consideration and assumptions were made concerning the funds to be allotted. The model, taking into account the investements available up to 2020, provides a mitigation impact of 1.12 million tonnes of CO_2 equivalents by 2020 (Tab. 15 and BR CTF table 3).

3.3.4 Building codes of the cantons

The cantons are responsible to decree any regulations in the buildings sector. Under the second third CO_2 Acts they are required to define standards for the continuous reduction of CO_2 emissions in new and existing buildings (Article 9).

In order to harmonise the building codes throughout Switzerland, the cantons, under the guidance of the Conference of Cantonal Energy Directors, agreed on model ordinances. Model ordinances were first established in 1992 and have been updated periodically since (i.e. in 2000, 2008, and 2014, see *EnDK*, 2014). Due to the lack of acceptance in some cantons (referendums by citizens), as of October 2019 the model ordinances have been introduced in seven cantons so far. For this reason, the planned introduction of emissions standards at the federal level under the third CO_2 Act may become a viable option (see planned strengthening below and section 3.2.4).

Planned strengthening

According to the draft of the third CO_2 Act (see section 3.2.4), the introduction of emissions standards at the federal level is planned, unless the emissions from buildings, in the mean of the years 2026 and 2027, decrease to at least 50 per cent of 1990 levels due to cantonal measures (i.e. the model ordinances as mentioned above). With the planned emissions standards, the one-to-one replacement of a fossil heating systems would practically be forbidden.

Estimate of mitigation impact

The mitigation impact of the building codes of the cantons on greenhouse gas emissions mainly results from insulation requirements for building refurbishment and new constructions. The estimate of 1.76 million tonnes of CO_2 equivalents by 2020 indicated in Tab. 15 and BR CTF table 3 is based on assumptions about the energy reference area, rate of refurbishment, heat consumption before and after renovation, and heat consumption of new buildings (used as input into the computable general equilibrium model of *EPFL and Infras* (2016) and *EPFL* (2017) for the calculation of projections, see chapter 4).

3.3.5 Exemption from electricity network surcharge

The Energy Act foresees financial contributions for the promotion of renewable energies (feed-in system). The contributions are financed by means of electricity network surcharges, which amounted (at the most) to 0.015 Swiss francs per kilowatt-hour up to 2017 and to 0.023 Swiss francs per kilowatt-hour as of 2018.

Since 2014, energy intensive companies with an electricity bill exceeding 10 per cent of their gross value added can be fully exempt from the electricity network surcharge, and those with an electricity bill between 5 and 10 per cent of their gross value added can be partially exempt from the electricity network surcharge, if they commit to a binding energy efficiency target. This target covers total energy use, not only electricity consumption. Additional eligibility conditions are an annual refund larger than 20 thousand Swiss francs and a minimum annual off-take of 1'333 gigawatt-hours from the electricity grid. Companies must pay the electricity network surcharge first and can then file for reimbursement in the following fiscal year. Measures under the target agreement usually have a payback period of four years at most for process improvements and up to eight years for infrastructure investment.

Estimate of mitigation impact

The influence on CO_2 emissions cannot be estimated, because it is not yet clear how many companies will make target agreements to increase energy efficiency. Accordingly, the mitigation impact of the exemption from electricity network surcharge is indicated as 'not estimated' in Tab. 15 and BR CTF table 3.

3.3.6 Obligation to offset emissions from gas-fired combined-cycle power plants

Currently, no gas-fired combined-cycle power plants are in operation in Switzerland, and it is unclear whether there will be a need for such power plants to cover future electricity demand. Nevertheless, since 2008, gas-fired combined-cycle power plants with a capacity larger than 100 megawatts obtain planning permission only if their CO_2 emissions are fully compensated. Compared to the first CO_2 Act, the possibility to use flexible mechanisms under the Kyoto Protocol to compensate for CO_2 emissions has been raised from 30 to 50 per cent under the second CO_2 Act, i.e. at least half of the compensation has to be achieved domestically.

Planned strengthening

With the planned linking of the Swiss emissions trading scheme with the one of the European Union (see section 3.2.6), gas-fired combined-cycle power plants shall be implemented in the emissions trading scheme. As in the European Union, there will be no free allocation for producing electricity. Therefore, future gas-fired combined-cycle power plants in Switzerland will have to compensate their emissions by buying emission allowances in the emissions trading scheme. Once the linking of the emissions trading schemes of Switzerland and the European Union will enter into force, the obligation to offset emissions from gas-fired combined-cycle power plants will expire.

Estimate of mitigation impact

It is currently uncertain when (and if) gas-fired combined-cycle power plants will be realised in Switzerland. Accordingly, the mitigation impact of the obligation to offset emissions from gas-fired combined-cycle power plants is indicated in Tab. 15 and BR CTF table 3, for 2020, as 'not applicable'. However, the policy and measure will ensure the climate-neutral operation of gas-fired combined-cycle power plants in any case (partly using international carbon credits).

3.3.7 Negotiated reduction commitment of municipal solid waste incineration plant operators

Greenhouse gas emissions from waste incineration plants have been increasing to about two million tonnes of CO_2 equivalents (roughly four per cent of the national total) by 2015, mainly due to growth of the economy and the population. In the context of national climate mitigation commitments, municipal solid waste incineration plant operators are expected to contribute to emission reduction efforts. In 2014, the Swiss Federal Department of Environment, Transport, Energy and Communications concluded an agreement with the Swiss Association of municipal solid waste incineration plants. This agreement commits the association to reduce net CO_2 emissions by 200 thousand tonnes by 2020, compared to 2010 levels, and to reduce cumulative net emissions over the period 2010–2020 by one million tonnes. Additionally, the association was obliged to establish a monitoring system to track progress towards these targets, and it must report progress to the Swiss Federal Office for the Environment annually. Since the potential for direct emission reductions at the incineration plants is limited, improvements in the efficiency of the use of the heat generated and avoided emissions (mostly occurring outside Switzerland) through the recuperation of metals are taken into account (bottom ash of the municipal solid waste incineration plants containing on average about 10 per cent scrap iron and significant amounts of non-iron metals such as aluminium, copper, brass etc.). Implementation of the agreement exempts municipal solid waste incineration plant operators from participation in the emissions trading scheme.

The agreement between the Swiss Federal Department of Environment, Transport, Energy and Communications and the Swiss Association of municipal solid waste incineration plants is valid until 2021. Negotiations on a possible follow-up agreement covering the period until 2030 will be taken up in due time.

Estimate of mitigation impact

The expected mitigation impact of the agreement corresponds to its objectives, i.e. 200 thousand tonnes of CO_2 equivalents by 2020 (Tab. 15 and BR CTF table 3). However, the agreement does not include a reduction target for the emissions from waste incineration plants, implying that these emissions might still increase, but rather builds on improve-

ments in the efficiency of the use of energy and the avoidance of emissions through increased recuperations of metals (potentially leading to indirect reductions of greenhouse gas emissions outside Switzerland).

3.4 Transport

3.4.1 Overview

Switzerland has over the years developed an integral for transport concept, seeking better coordination between transport modes, spatial planning, and taking into account environmental and sustainability concerns. While several strategies aim at to reducing specific energy consumption or CO_2 emissions from the transport sector – like the newly adopted road map 2022 for e-mobility in Switzerland (goal: 15 per cent of newly registered cars have to be electric cars by 2022)[26] – many are part of the general transport policy approach that involves reducing unnecessary motorised mobility, shifting traffic from road to more environmentally friendly modes, and improving intermodal transport chains and interconnectivity. The guidelines for this more comprehensive national transport concept were laid down in the 1980s by the Swiss Coordinated Transport Policy Bill[27].

The latest projections (*ARE*, 2016) for passenger and freight transport still show significant growth rates for the coming decades. Sustainable management of this growth represents a major challenge. Spatial development and infrastructure planning are key factors influencing future emissions from the transport sector. The coordination of spatial planning and transport infrastructure development by concentrating population and transport growth in areas where non-motorised and public transport offer comparative advantages is a viable option to curb transport growth and urban sprawl. Switzerland has therefore adjusted its spatial planning tools on the federal and cantonal level by developing the Agglomeration Programme (see below). For over 20 years, the coordination of pedestrian and hiking networks has been laid down in the Federal Constitution of the Swiss Confederation. As a reaction to a federal popular initiative and to strengthen non-motorised transport, the Swiss Federal Council formulated a counter-proposal to lay down cycle networks in a similar manner. The Swiss population voted in favour of this counter-proposal on 23 September 2018. Respective measures and actions will have to follow soon.

Switzerland has an excellent and very dense rail infrastructure that is permanently maintained, modernised and improved. The first phase of a major expansion of rail transport capacity, RAIL 2000, was opened on 12 December 2004. It marked a milestone for Swiss public passenger transport, as rail service levels increased by 12 per cent from one day to the next (more trains and faster connections between Swiss cities). As a follow-up of RAIL 2000, the Swiss Federal Act on the Future Development of Rail Infrastructure (*Swiss Confederation*, 2009) was enacted in 2009 to further modernise and expand the Swiss rail network. At present, work is progressing rapidly and nearing completion on the New Rail Link through the Alps – enhancing capacity and reducing travel time for freight transport – with the opening of the last of three base tunnels, the Monte Ceneri, in September of 2020 (after Lötschberg in 2007 and Gotthard in 2016). Furthermore, there are and other projects under way for expanding rail capacity by 2025 for passenger and freight transport are under way. By also improving connections to the European high-speed rail network, Swiss transport policy encourages the modal shift of short-distance international passenger traffic from air to rail.

In the past, financing of the major rail infrastructure projects was secured on the basis of the temporary 'FinÖV', a public transport fund, which drew revenues from the heavy vehicle charge. As from 1 January 2016 – subsequent to a federal popular vote in 2014 – operation, maintenance, and extension of rail infrastructure are financed through a single, open-ended 'Rail Infrastructure Fund'.

From 2007 to 2017, funding for development and maintenance of road infrastructure was provided through the 'Infrastructure Fund for Agglomeration Transport, the National Highway Network and Major Roads in Mountain Areas and Peripheral Regions'. In 2018, the above-mentioned fund has been replaced by the 'Fund for the National Road Motorway Network and the Agglomeration Traffic' (unlimited in time). Out of these funds, Switzerland runs an agglomera-

[26] Roadmap Elektromobilität 2022. Online: https://roadmap2022.brainstore.com/?locale=de&node_name=roadmap_elektromobilitaet_2022%2Fhome.

[27] Gesamtverkehrskonzeption (1977). Stab GVF. Online: https://www.alptransit-portal.ch/de/ereignisse/ereignis/die-gesamtverkehrskonzeption/?no_cache=1&cHash=ea54b930f67a615ddf8bf179ba7ae582.

tion programme aimed at providing financial resources for infrastructure projects that promote public and non-motorised transport in sub-urban regions and agglomerations.

The two-lane Gotthard road tunnel connecting northern Switzerland to the Ticino and Italy was opened in 1980. After 35 years of operation, it needs major refurbishment. The Swiss Federal Council and the Swiss Parliament have proposed to construct a second tunnel. This would allow for closing of the first tunnel during refurbishment works without lengthy interruption of this important traffic link. In addition, two tunnels would lead to safer operating conditions in the future. A referendum on this proposal was held in February 2016 and approved. The referendum was motivated by concerns that the two tunnels will be opened to four-lane traffic once refurbishment of the first tunnel is completed, – leading to a conflict with the intention of Article 84 of the Federal Constitution of the Swiss Confederation stating that the capacity of the transit routes in the Alpine region may not be increased (section 3.4.6) – a facultative referendum was taken against the construction of a second tunnel. However, the proposition of the Swiss Federal Council and the Swiss Parliament was approved in a popular vote in February 2016. The second road tunnel is scheduled to open in 2027.

As the share of emissions from Switzerland's domestic aviation is very small, Switzerland's aviation policy is focused on international aviation, and, thus, mainly targets bunker fuels. Switzerland joined the International Civil Aviation Organisation in 1947 and the European Civil Aviation Conference in 1955. Under the air transport agreement between Switzerland and the European Union, which came into effect on 1 June 2002, Switzerland adopted European civil aviation legislation that was in force when the agreement was concluded and regularly adapts the agreement to new legislation entering into force in the European Union. In 2006, Switzerland joined the European Aviation Safety Agency (EASA). Switzerland's aviation legislation and policy is therefore shaped by the regulations of the International Civil Aviation Organisation and European Civil Aviation Conference, as well as by developments within the European Union. Switzerland's foreign relations are further governed by bilateral and multilateral agreements; bilateral aviation agreements were concluded with more than 130 countries. The reduction of aircraft fuel consumption is strongly driven by market forces. In Switzerland, the CO_2 emissions per passenger kilometre for the whole aircraft fleet have been reduced by 42 per cent between 1990 and 2015, therefore showing an average improvement of 1.7 per cent per year during this period. Switzerland expects this number to even improve during the next decade, by fleet renewal, efficiency improvement packages and production cut-off triggered by the new standard. The international orientation of Switzerland's aviation policy is reflected in the policies and measures presented in section 3.4.9, 3.4.10 and 3.4.11.

Tab. 16 gives an overview of the climate-relevant policies and measures of the transport sector, while the following sections provide more details and background information on each policy and measure.

Tab. 16 > Summary of policies and measures in the transport sector. The sector affected is 'transport' for all policies and measures presented in this table. The policy and measure "International exhaust gas regulations (NMVOC)" was reported in the industry sector in previous submissions.

Name of policy or measure [a]	Greenhouse gas(es) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO_2eq)
								2020
CO_2 emission regulations for newly registered vehicles *	CO_2	Reduction of average fuel consumption and CO_2 emissions from new passenger cars and light duty trucks.	Regulatory	Implemented (strengthening planned)	CO_2 emission targets for newly registered vehicles in line with regulations of the European Union. The target by 2020 for passenger cars (fleet average) has been set at 95 grams of CO_2 per kilometre, for light commercial vehicles at 147 grams of CO_2 per kilometre. Vehicle importers have to pay a sanction if the individually specified target is not met.	2012	SFOE, FEDRO	210
Energy label for new motor vehicles *	CO_2	Raise visibility of cars with low average fuel consumption and CO_2 emissions.	Information, regulatory	Implemented (strengthening planned)	Mandatory label displayed at the point of sale providing information on the fuel consumption (litres per 100 kilometre) and CO_2 emissions (in grams of CO_2 per kilometre) of every passenger car.	2003	SFOE	IE [b]
Climate Cent *	CO_2, CH_4,	Compensation of transport emissions (i) through funding of	Voluntary agreement	Expired (imple-	Voluntary agreement with a private sector initiative in place	2005	Climate Cent	NA [c]

	N_2O	mitigation projects within Switzerland and (ii) by use of international carbon credits.		mented from 2005 to 2012)	of a CO_2 levy on fossil motor fuels. Obligation (i) to offset two million tonnes of CO_2 during the first commitment period of the Kyoto Protocol (2008–2012) through investments in domestic emission reduction projects and (ii) to purchase a total of 16 million international carbon credits. Financed by a surcharge of 0.015 Swiss francs per litre on motor fuels.		Foundation	
Partial compensation of CO_2 emissions from motor fuel use *	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3	Domestic mitigation projects as compensatory measure (instead of a CO_2 levy on motor fuels).	Regulatory	Implemented (strengthening planned)	Obligation for importers to offset part of the CO_2 emissions from motor fuel use through investments in domestic emission reduction projects. Financed by a surcharge on imported fuels not exceeding 0.05 Swiss francs per litre of fuel. The share of CO_2 emissions to be offset is gradually increased from 2 to 10 per cent by 2020.	2013	Foundation for Climate Protection and Carbon Offset, FOEN	1'500
Heavy vehicle charge *	CO_2	Reduction of transalpine road traffic, increase of transport rates on rail, limit increase in heavy vehicles on the road.	Fiscal	Implemented	Charges applied to passenger and freight transport vehicles of more than 3.5 tonnes gross weight, aiming at a shift of transalpine transport from road to rail. The level of the charge depends on the distance driven, the maximum weight, and emissions standards of the individual vehicle.	2001	FCA, FOT	140
Mineral oil tax reduction on biofuels and natural gas *	CO_2	Promotion of low carbon motor fuels.	Fiscal	Implemented	Tax reduction of 0.4 Swiss francs per litre of petrol equivalent for natural and liquefied petroleum gas (LPG). Complete tax exemption for biogas and other fuels from renewable sources if certain (ecological and social) criteria are met. Tax revenue losses are compensated by increasing tax rates on liquid fossil motor fuels.	2008	FCA, in collaboration with FOEN and SECO	220
International exhaust gas regulations (NMVOC) *	Indirect CO_2	Improvement of air quality through O_3 abatement.	Regulatory	Implemented	Limits for NMVOC emissions of motor vehicles, also leading to a reduction of indirect CO_2 emissions.	1974	FEDRO	200
Inclusion of aviation in the emissions trading scheme	CO_2	Limit/offset CO_2 emissions from international aviation.	Regulatory, economic	Planned	Inclusion of (international) aviation into the emissions trading scheme. Implementation is contingent on the linking of the emissions trading schemes of the European Union and Switzerland.	2020 [d]	FOCA, FOEN	NA [e]
CO_2 emissions standard for aircraft	CO_2	Reduction of average fuel consumption and CO_2 emissions from new and in-production aircraft.	Regulatory	Adopted	CO_2 emission targets for new aircraft designs from 2020, for in-production aircraft from 2023 and production cut-off from 2028.	2020	FOCA	NA [e]
Carbon offsetting and reduction scheme for international civil aviation (CORSIA)	CO_2	Carbon neutral growth of international civil aviation as of 2020.	Regulatory	Planned	Emissions from international civil aviation above 2020 levels will have to be offset by operators. Applicable standards and recommended practices are currently being developed by the International Civil Aviation Organisation.	2021	FOCA, FOEN	NA [e]

[a] Policies and measures marked with an asterisk (*) are included in the 'with measures' projection.

[b] The mitigation impact of the energy label for new motor vehicles is included in the mitigation impact of the CO_2 emission regulations for newly registered vehicles.

[c] Total domestic reductions achieved by the Climate Cent Foundation during the first commitment period (2008–2012) was 2.7 million tonnes of CO_2 equivalents. The ongoing mitigation impact of Climate Cent Foundation projects after 2012 is contained in the subsequent measure 'Partial compensation of CO_2 emissions from motor fuel use'. Total contribution of international carbon credits acquired by the Climate Cent Foundation during the first commitment period (2008–2012) was 16.0 million tonnes of CO_2 equivalents.

[d] A prerequisite for the inclusion of aviation in the emissions trading scheme is the linking of the emissions trading schemes of Switzerland and the European Union.

The process of ratification of the required bilateral agreement is currently pending in the Swiss Parliament, but may be completed as of 2020 (see also section 3.2.6).

[e] The mitigation impact of these adopted/planned measures will develop after 2020 (preparatory measures may be implemented beforehand).

IE, included elsewhere; NA, not applicable
FCA, Swiss Federal Customs Administration; FEDRO, Swiss Federal Roads Office; FOCA, Swiss Federal Office of Civil Aviation; FOEN, Swiss Federal Office for the Environment; FOT: Swiss Federal Office of Transport; SECO, Swiss State Secretariat for Economic Affairs; SFOE, Swiss Federal Office of Energy

3.4.2 CO_2 emission regulations for newly registered vehicles

Because a voluntary agreement signed in 2002 by the Association of Swiss Automobile Importers to reduce the specific fuel consumption of first-time registration cars was insufficient, the Swiss Parliament amended the CO_2 Act in 2011 to include CO_2 emission targets for newly registered vehicles. The prescriptions came into effect in July 2012 and are based on the European Union regulation. In the first phase from 2012 through 2019, a fleet average target of 130 grams of CO_2 per kilometre applied. In consequence, the fleet average emission was reduced from 155 grams of CO_2 per kilometre in 2011 to 135 grams of CO_2 per kilometre in 2015, rising again to 138 grams of CO_2 per kilometre in 2018. Average fleet emissions therefore slightly exceeded the target throughout the period to date. Most vehicle importers reached their individual targets, penalty payments for those importers with excess emissions amounted to a yearly maximum of 31.7 million Swiss francs in 2018. Swiss legislation follows the European Union regulation for further decarbonising road traffic. Targets of 95 grams of CO_2 per kilometre by 2020 for new passenger cars and of 147 grams of CO_2 per kilometre by 2020 for light commercial vehicles entered into force as of 1 January 2018 as part of the Energy Strategy 2050 (section 3.3.1).

Planned strengthening

For the period from 2025 onwards, the Swiss Federal Council has proposed to further decrease the emission reduction targets in line with the European Union.

Estimate of mitigation impact

The mitigation impact is estimated at 0.21 million tonnes of CO_2 equivalents per year by 2020 (Tab. 16 and BR CTF table 3, see also *SFOE*, 2017). This mitigation impact is calculated by comparing a scenario where the new vehicle fleets attain the targets for 2020 with only little delay to a scenario where only autonomous technological progress leads to a (slow) decrease of specific CO_2 emissions. Due to ongoing fleet turnover, the yearly average impact in the period from 2020 to 2030 amounts to 0.46 million tonnes of CO_2. The additional mitigation impact for the proposed targets from 2025 onward is estimated at 0.3 million tonnes of CO_2 per year[28].

3.4.3 Energy label for new motor vehicles

Since 2003, the compulsory energy label for newly sold cars informs customers at the point of sale about fuel consumption and specific CO_2 emissions. It classifies cars into one of seven energy efficiency classes from A to G using well-to-wheel energy consumption. Evaluation criteria are adapted at yearly intervals to follow technological development in the automotive sector. The label as well as the customer information regulations are strengthened from January 2020 onward. Curb mass of new vehicles will not be considered any more for energy efficiency evaluation, while new car advertisements have to display the colour band efficiency rating. The energy label supports the efforts with regard to the CO_2 emission regulations for newly registered vehicles (section 3.4.2).

Estimate of mitigation impact

The energy label for new motor vehicles is a purely informative measure for car buyers. An estimate from 2005 found a positive impact on energy efficiency. However, there is no recent quantitative estimate. Surveys demonstrate that energy efficiency and low fuel consumption are important criteria for the purchase of new cars and the energy label is known among a majority of car buyers. A positive overall impact on energy efficiency is expected. In any case, the mitigation impact of the energy label for new motor vehicles is included in the mitigation impact of the CO_2 emission

[28] An earlier proposition that was discussed in the European Union aimed at reducing the emission reduction targets for new passenger cars to 68 to 78 grams of CO_2 per klilometre and for new light commercial vehicles to 105 to 120 grams of CO_2 per kilometre. A reduction to the lower ends of these ranges (68 and 105 grams of CO_2 per kilometre, respectively) would lead to an additional mitigation impact of 300 thousand tonnes of CO_2 by 2030. While this proposition is no longer valid, it was used in the WAM scenario (see section 4.3.1) as a proxy for the quantification of the mitigation impact of a further strengthening of the CO_2 emission regulations for newly registered vehicles.

regulations for newly registered vehicles (section 3.4.2), and, thus, reported as 'included elsewhere' in Tab. 16 and BR CTF table 3.

3.4.4 Climate Cent

The first CO_2 Act in 1999 (section 3.2.2) did not contain a CO_2 levy on motor fuels. Instead, the Swiss Confederation entered into a voluntary agreement with the Climate Cent Foundation, a private sector initiative, in 2005. The agreement contained the obligation to account for annual emission reductions of 3.2 million tonnes of CO_2 equivalents through the purchase of international carbon credits (CERs, ERUs) and 0.4 million tonnes of CO_2 equivalents through investments in domestic emission reduction projects, respectively, during the period 2008–2012. The so-called 'Climate Cent', setting a surcharge of 0.015 Swiss francs per litre on motor fuels, was in effect from October 2005 to August 2012.

As of 2013, the Climate Cent was replaced by the legally binding obligation for importers of fossil motor fuels to compensate part of the emissions linked to fossil motor fuel use (section 3.4.5). Excess revenues amounting to 150 million Swiss francs, collected by the Climate Cent Foundation until 2012, are to be used by the foundation for the acquisition of international carbon credits. These will be handed over to the government to meet obligations under the international climate regime, as detailed in an agreement between the Climate Cent Foundation and the Swiss Confederation (*Climate Cent Foundation and Swiss Confederation*, 2013).

Estimate of mitigation impact

The Climate Cent was implemented from 2005 to 2012. The ongoing mitigation impact of projects of the Climate Cent Foundation after 2012 is contained in the subsequent measure partial compensation of CO_2 emissions from motor fuel use (section 3.4.5). During the first commitment period of the Kyoto Protocol (2008–2012), the international carbon credits acquired by the Climate Cent Foundation accounted for 16.0 million tonnes of CO_2 equivalents, while domestic reductions achieved by the Climate Cent Foundation during the same time period accounted for 2.7 million tonnes of CO_2 equivalents (*Climate Cent Foundation*, 2013). As the Climate Cent has expired, the mitigation impact for 2020 is indicated as 'not applicable' in Tab. 16 and BR CTF table 3.

3.4.5 Partial compensation of CO_2 emissions from motor fuel use

Based on the second CO_2 Act (section 3.2.3), as of 2014, fossil fuel importers are bound to offset part (at most 40 per cent) of the CO_2 emissions from motor fuel use through investments in domestic emission reduction projects. The offset is financed by a surcharge on imported fuels which shall not exceed 0.05 Swiss francs per litre of fuel. The Swiss Federal Council determined the share of CO_2 emissions from motor fuels to be offset by fuel importers as follows:

- Two per cent in 2014–2015;
- Five per cent in 2016–2017;
- Eight per cent in 2018–2019;
- 10 per cent in 2020.

The revenues and climate change abatement measures are managed by the follow-up organisation to the Climate Cent Foundation, the Foundation for Climate Protection and Carbon Offset (KliK). By the end of 2015, KliK was budgeting for the compensation of a cumulative total of 6.5 million tonnes of CO_2 equivalents for the years 2013 to 2020, achieved by national projects and programmes, as well as the purchase of eligible domestic carbon credits (*KliK*, 2016). The budget estimate corresponds to a surcharge of 0.01 to 0.02 Swiss francs per litre of fossil motor fuel.

For domestic emission reduction projects in order to fulfil the mandatory compensation of CO_2 emissions from motor fuel use, the Swiss Federal Office for the Environment may issue tradable attestations. Domestic emission reduction projects must be registered in advance and the emission reductions achieved must be accounted for annually in a monitoring report. Attestations can only be issued for voluntary measures that go beyond legal requirements and are not already otherwise supported. Those with compensation obligations can initiate domestic emission reduction projects themselves – in a slightly different form – but cannot receive attestations for them. Domestic emission reduction projects cover a variety of different technological areas such as energy efficiency on the supply and demand side, renewable energy, fuel switch, transport, avoidance of emissions of CH_4, N_2O and F-gases, biological sequestration, and

others. A detailed list of domestic emission reduction projects in these various technological areas is available on the website of the Swiss Federal Office for the Environment[29], where the expected and actual emission reductions from currently registered domestic emission reduction projects are presented as well[30].

Planned strengthening

It is planned to continue and strengthen the partial compensation of CO_2 emissions from motor fuel use in the framework of the third CO_2 Act (3.2.4), which is planned to enter into force as of 2021. The proposal by the Swiss Federal Council contains the following cornerstones: (i) the Swiss Federal Council determines the share of CO_2 emissions from motor fuels to be offset by fuel importers at a maximum of 90 per cent and (ii) the Swiss Federal Council determines the share of emissions to be compensated domestically at a minimum share of 15 per cent.

Estimate of mitigation impact

On average over the second commitment period of the Kyoto Protocol (2013–2020), five per cent of CO_2 emissions from motor fuels need to be offset by fuel importers domestically. By 2020, the respective share is 10 per cent, which is expected to correspond to about 1.5 million tonnes of CO_2 equivalents (Tab. 16 and BR CTF table 3). After 2020, the mitigation impact is considered to increase substantially, depending on the pending final decision on the share of emissions from motor fuels to be compensated by importers of motor fuels.

3.4.6 Heavy vehicle charge

Switzerland's freight transport policy is based on Article 84 of the Federal Constitution of the Swiss Confederation (as amended in 1994) which requires transalpine freight transport to shift from road to rail. This goal is to be reached by the so-called heavy vehicle charge, in combination with measures to improve competitiveness of international rail transport. The heavy vehicle charge has been applied to passenger and freight transport vehicles of more than 3.5 tonnes of gross weight since 2001. The fee level is calculated according to three criteria: (i) kilometres travelled on Swiss roads, (ii) vehicle specific maximum authorised gross weight, and (iii) pollutants according to EURO classes. The heavy vehicle charge was implemented in three stages between 2001 and 2008, accompanied by increases in the admissible maximum weight for trucks (40 tonnes instead of 28 tonnes). As of 2017, the charge has been increased, depending on the vehicle class by 11 to 18 per cent (EURO 3/III now at 3.10 Swiss francs per hundred tonne kilometres, EURO 4/IV and Euro 5/V now at 2.69 Swiss francs per hundred tonne kilometres, and EURO 6/VI now at 2.28 Swiss francs per hundred tonne kilometres[31]).

Estimate of mitigation impact

A significant renewal of the truck fleet in the year before the introduction of the heavy vehicle charge was prompted by the fact that the charge depends on the maximum weight and on emissions standards of the individual vehicle. The heavy vehicle charge results in a positive overall environmental balance, in particular thanks to reduced emissions of air pollutants and greenhouse gases from road freight transport. According to model calculations for the year 2005 (*ARE*, 2007), air quality has improved by 10 per cent (particle emissions) and 14 per cent (nitrogen oxides), respectively, and CO_2 emissions have decreased by six per cent compared to a scenario without the introduction of the heavy vehicle charge (and with a weight limit of 28 tonnes). In the absence of more recent estimates, it is assumed that the heavy vehicle charge persistently led to a reduction of CO_2 emissions from road freight transport by six per cent compared to a scenario without its introduction. Applied to the projected emissions of the road freight transport, this assumption suggests a mitigation impact of the heavy vehicle charge of 140 thousand tonnes of CO_2 in 2020 (Tab. 16 and BR CTF table 3).

3.4.7 Mineral oil tax reduction on biofuels and natural gas

The amendment of the Mineral Oil Tax Act of 1 July 2008 provides tax incentives for low carbon fuels. A tax reduction of 0.4 Swiss francs per litre of petrol equivalent is granted for natural and liquefied petroleum gas (LPG). Complete tax

[29] https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/climate-policy/compensation-for-co2-emissions/list-of-registered-compensation-projects.html

[30] https://www.bafu.admin.ch/bafu/de/home/themen/klima/daten-indikatoren-karten/daten/kompensationsprojekte.html

[31] https://www.ezv.admin.ch/ezv/de/home/information-firmen/transport--reisedokument--strassenabgaben/schwerverkehrsabgaben--lsva-und-psva-/lsva---allgemeines---tarife.html

exemption for biogas and other fuels from renewable sources is granted if certain criteria are met. In March 2014, the Swiss Parliament decided to tighten these criteria by amending the Mineral Oil Tax Act as well as the Environment Protection Act. The ecological criteria are: (i) a minimum of 40 per cent greenhouse gas reduction based on life cycle analysis (LCA), (ii) a net environmental burden not significantly exceeding the one of fossil fuels, and (iii) the cultivation of biofuels must not endanger biodiversity, in particular rainforests. Minimum requirements for socially acceptable production conditions are: social legislation applicable at the production location of raw materials and fuels is respected; at least the fundamental conventions of the International Labour Organisation (ILO) are complied with; cultivation of biofuels has to be realised on legally acquired soils. Tax revenue losses are compensated by increasing tax rates on liquid fossil motor fuels. In contrast to other countries, Switzerland has no quotas for biofuels.

The mineral oil tax reduction on biofuels and natural gas will expire in June 2020. The Swiss Federal Council proposed in its draft of the third CO_2 Act to exploit the CO_2 reduction potential of biofuels with the mandatory partial compensation of CO_2 emissions from motor fuel use (see section 3.4.5). Importers of motor fuels shall be bound to compensate five per cent of their emissions by bringing biofuels on the market. At the same time, an initiative from the Parliament requested that the mineral oil tax reduction on biofuels and natural gas shall be extended until 2030. At the time of delivery of this report, discussions are still ongoing.

Estimate of mitigation impact

Until 2020, the mitigation impact of the mineral oil tax reduction on biofuels is estimated at 1.5 per cent of the emissions of the transport sector. This corresponds to roughly 220 thousand tonnes of CO_2 (Tab. 16 and BR CTF table 3).

3.4.8 International exhaust gas regulations (NMVOC)

The first international exhaust gas regulations for motor vehicles started in 1974 and limited the total hydrocarbon emissions for gasoline passenger cars and for light commercial vehicles to 5.1 to 8.2 grams per kilometre. Numerous subsequent regulations followed. The implementation of the three-way catalytic converter led to much lower emissions of NMVOCs from gasoline vehicles. Also for diesel vehicles emission limit values have been introduced.

Estimate of mitigation impact

In 1990, the NMVOC emissions of road traffic amounted to 88 thousand tonnes. In 2020, it is expected to drop below 10 thousand tonnes of NMVOC. Without measures since 1990, it is assumed that the emission factors would have remained constant, resulting in emissions of 70 thousand tonnes of NMVOC in 2020. Lowering NMVOC emissions by 60 thousand tonnes results in lower indirect CO_2 emissions. By 2020, the estimated greenhouse gas mitigation impact is about 200 thousand tonnes of CO_2 equivalents (Tab. 17 and BR CTF table 3), based on a carbon content of NMVOC of 90 per cent for emissions from combustion engines (diesel and gasoline mostly contain hydrocarbons and have a very low content of oxygen, sulphur, nitrogen etc.)[32].

3.4.9 Inclusion of aviation in the emissions trading scheme

Switzerland plans to link its emissions trading scheme with the emissions trading scheme of the European Union. This would imply that the linked emissions trading scheme also includes the Swiss aviation sector (see section 3.2.6 for details).

Estimate of mitigation impact

The mitigation impact will follow the cap-and-trade principle of the new common emissions trading scheme, where the calculation of the cap for the aviation activities covered by the Swiss emissions trading scheme is planned to be based on aviation activities of the year 2018. Due to the planned linking of the Swiss emissions trading scheme with the emissions trading scheme of the European Union, the effective reductions of greenhouse gas emissions may be realised outside Switzerland. For 2020, the mitigation impact is reported as ‘not applicable’ in Tab. 16 and BR CTF table 3, because it is currently open when the mitigation impact of this planned measure will become visible.

[32] In the greenhouse gas inventory, the oxidation factors used to calculate CO_2 emissions from road traffic are assumed to be 100 per cent. Accordingly, indirect CO_2 emissions resulting from the atmospheric oxidation of NMVOCs are already included under direct CO_2 emissions in this case (see section 1.2.4 for more details). The values related to indirect CO_2 emissions provided in chapter 1 and chapter 4 (section 4.3.6) strictly avoid double counting.

3.4.10 CO_2 emissions standards for aircraft

Switzerland helped in the process for the adoption of the first CO_2 emissions standard for civil aircraft by the International Civil Aviation Organisation, which is the world's first global design certification standard governing CO_2 emissions. In Switzerland, the standard will be applicable to Swiss registered new relevant aircraft type designs from 2020. It will also apply to relevant aircraft type designs already in production as of 2023. Those in-production aircraft which by 2028 do not meet the standard will no longer be able to be produced unless their designs are sufficiently modified. The measure is currently adopted.

Estimate of mitigation impact

Because the CO_2 emissions standard for aircraft will develop its mitigation impact after 2020, the mitigation impact for 2020 is reported as 'not applicable' in Tab. 16 and BR CTF table 3.

3.4.11 Carbon offsetting and reduction scheme for international civil aviation (CORSIA)

In 2017 the International Civil Aviation Organisation assembly decided to introduce the so-called carbon offsetting and reduction scheme for international aviation (CORSIA). Under this scheme the CO_2 emissions of international air transport which exceed the levels of the year 2020 will have to be offset by the air traffic operators. Already in 2017, Switzerland has announced its willingness to participate in the scheme together with the 43 other member states of the European Civil Aviation Conference. Applicable standards and recommended practices for the scheme are currently being prepared by the International Civil Aviation Organisation. The pilot phase (from 2021 through 2023) and first phase (from 2024 through 2026) would apply to states that have volunteered to participate in the scheme.

Estimate of mitigation impact

Emissions of international civil aviation activities exceeding 2020 levels covered by the scheme will be offset (carbon neutral growth on the basis of 2020). As the pilot phase is planned to start in 2021, the mitigation impact of this measure will develop after 2020 and is reported, for 2020, as 'not applicable' in Tab. 16 and BR CTF table 3.

3.4.12 Further relevant measures

This section provides a brief overview of further measures with limited direct impact on greenhouse gas emission levels, e.g. measures that may indirectly contribute to climate policy goals (e.g. by reducing precursor gas emissions) and measures focussing on non-greenhouse gas emissions that may have favourable side effects on climate change mitigation.

Further measures to promote rail transport

The ongoing general refurbishment and extension of the rail network increase competitiveness of rail and thus support the shift from road to rail envisaged as part of Switzerland's transport policy. With the openings of the Lötschberg base tunnel in 2007 and the Gotthard base tunnel in 2016 two milestones were reached. With the planned opening of the Monte Ceneri base tunnel in 2020 the capacity of the rail network across the Alps will further increase and travel times will further decrease. On the Lötschberg route, semi-trailers with a 4-metre corner height can already be loaded onto trains and carried as combined transport. The projects to also make the Gotthard route 4-metre capable are well under way, i.e. the 4-meter corridor will be completed by the end of 2020[33].

To further increase productivity and competitiveness of rail transport, Switzerland, in accordance with the relevant European Union directive, has been progressively implementing reforms (Railway Reform). This improves interoperability and the quality of transnational transport. Measures also provide increased flexibility for the railway companies and greater entrepreneurial freedom, making rail transport more productive and attractive.

To bring down slot prices and to provide additional intermodal services (including an efficient truck-on-train service between Germany and Italy), Switzerland is subsidising such services. Thanks to sustained support to truck-on-train

[33] See https://www.bav.admin.ch/bav/en/home/modes-of-transport/railways/expansion-programmes-rail-infrastructure/4-metre-corridor%20.html for more details.

transport, a further shift towards combined transport is expected. Total funding for the modal shift from road to rail amounts to more than 1.6 billion Swiss francs from 2009 to 2018.

The land transport agreement between Switzerland and the European Union secures the Swiss policy and the modal shift efforts in the European context. The European Union respects the Swiss policy objectives and the necessary measures taken (in particular the heavy vehicle charge). Efforts are under way to negotiate a possible introduction of an international transalpine transport exchange market. However, an agreement must include the entire region of the Alps and comply with regulations of the countries involved, the European Union, and Switzerland.

Greenhouse gas emissions from marine bunker fuels

As a landlocked country, Switzerland operates only a small fleet of ships at the international level. Consequently, greenhouse gas emissions from marine bunker fuels are negligible (see Tab. 1) and only include emissions from fuel sold within the borders of Switzerland for international transport on the Lake Geneva, Lake Constance, and the Rhine. Nevertheless, in the framework of its membership to the International Maritime Organisation (IMO), Switzerland supports the introduction and further strengthening of obligations to reduce greenhouse gas emissions from international navigation. Switzerland ratifies, as a basic principle, all environmentally relevant international agreements related to international navigation and implements them, as required, in domestic legislation. On the basis of Article 9 of the Maritime Navigation Act, the compliance with international agreements and domestic legislation is enforced by inspections by the Swiss Maritime Navigation Office or by classification societies accredited by Switzerland.

Air pollution control measures at cantonal and communal level

The cantons are in charge of the implementation of the Ordinance on Air Pollution Control. Within the transport sector, the most important measures include speed reduction in city areas, parking space management and programmes for renewing bus fleets (installation of CRT particle filters). The annual cantonal motor vehicle tax depends on different parameters such as vehicle weight and engine capacity, which provides an incentive to buy and use cars that are more fuel efficient. Moreover, many cantons have adopted rebate and feebate regimes for cars, based on criteria such as the energy label category, fuel or drivetrain type, and specific CO_2 emissions.

Euro emissions standards

Switzerland is following the European path of reducing air pollutants (NO_x, non-methane hydrocarbons, total hydrocarbons, CO, and particulate matter) by introducing stricter Euro emissions standards for new vehicles. Since 2015, the Euro 6/VI standard is mandatory for new vehicles. With regard to reducing particulate matter and diesel soot emissions, particle filter trap systems have been introduced for various types of vehicles.

Gothenburg Protocol

In 2005, Switzerland ratified the Gothenburg Protocol to abate acidification, eutrophication and ground-level ozone (under the Geneva Convention on Long-range Transboundary Air Pollution, United Nations Economic Commission for Europe). The implementation of this protocol and compliance with the prescribed national emission ceilings contributes to the reduction of ozone and secondary particulate precursors. It also contributes to avoiding emissions of indirect greenhouse gases. The Gothenburg Protocol was revised in 2012. The revised version also addresses particulate matter (PM2.5) and black carbon. It contains national emission reduction commitments for sulphur dioxide, nitrogen oxides, ammonia, volatile organic compounds and particulate matter to be achieved by 2020. The obligations of the revised Gothenburg Protocol include the application of best available techniques and emission limit values for industrial and mobile sources, as well as for agriculture. Accordingly, the impact of the Gothenburg Protocol is not limited to the transport sector.

3.5 Industrial processes and product use

3.5.1 Overview

Most greenhouse gas reduction policies and measures in the industry sector are implemented under the CO_2 Act and control CO_2 emissions from fossil fuel use. These policies and measures are presented together with the cross-sectoral policies and measures (section 3.2). The main instruments affecting greenhouse gas emissions from industry are (i) the CO_2 levy on heating and process fuels (section 3.2.5), (ii) the emissions trading scheme (section 3.2.6), and (iii) the negotiated reduction commitments (for exemption from the CO_2 levy) (section 3.2.7).

However, emissions of F-gases and precursor gases – such as NMVOCs – are not tackled by the CO_2 Act. Instead, specific policies and measures have been developed on the basis of the Environmental Protection Act and specified in the Ordinance on Chemical Risk Reduction (*Swiss Confederation*, 2005a), the Ordinance on Air Pollution Control (*Swiss Confederation*, 1985), as well as in the Ordinance on the Incentive Tax on Volatile Organic Compounds (*Swiss Confederation*, 1997). NMVOCs are used as solvents in numerous industries, are contained in many products such as paints, varnishes and various cleaning solutions, and are emitted by industrial processes, product use and by incomplete fuel combustion. If these compounds become airborne, they contribute (together with nitrogen dioxide) to the excessive formation of ground-level ozone (summer smog). In addition, NMVOCs completely oxidise in the atmosphere within days and are, thus, a source of indirect CO_2 emissions. In order to reduce NMVOC emissions, Switzerland has three policies and measures in place: (i) the international exhaust gas regulations for motor vehicles, which are fully implemented in Swiss regulations and where Switzerland is highly involved in the development (reported under the transport sector, see section 3.4.8), (ii) the Ordinance on Air Pollution Control for stationary sources (section 3.5.3), and (iii) the NMVOC incentive fee to reduce diffuse emissions of NMVOCs (section 3.5.4). Regarding the reduction of F-gas emissions, provisions relating to substances stable in the atmosphere (HFCs, PFCs, SF_6, and NF_3) are in place (section 3.5.2).

The policies and measures of the industrial processes and product use sector are summarised in Tab. 17 and detailed in the following sections.

Tab. 17 > Summary of policies and measures in the industry sector. The sector affected is 'industry/industrial processes' for all policies and measures presented in this table. The policy and measure "International exhaust gas regulations (NMVOC)" is now reported in the transport sector (whereas it was reported in the industry sector in previous submissions).

Name of policy or measure [a]	Green-house gas(es) affected	Objective and/or activity affected	Type of instrument	Status of imple-mentation	Brief description	Start year of imple-mentation	Imple-menting entity or entities	Estimate of mitigation impact (not cumulative, in kt CO_2eq)
								2020
Provisions relating to substances stable in the atmosphere (HFCs, PFCs, SF_6, NF_3) *	All F-gases	Reduction in use and emissions of F-gases.	Regulatory	Imple-mented (strength-ening planned)	Regulations relating to, inter alia, refrigerants, aerosol dispensers, plastic foams, solvents containing PFCs, HFCs or HFEs, extinguishing agents, and SF_6 in electrical distribution equipment.	2003	FOEN, cantons	HFCs: 1'087 [b] PFCs: 2 [b] SF_6 and NF_3: 69 [b]
Ordinance on Air Pollution Control *	Indirect CO_2	Improvement of air quality through O_3 abatement.	Regulatory	Imple-mented	Limits for NMVOC emissions of stationary installations, also leading to a reduction of indirect CO_2 emissions.	1986	FOEN, cantons	IE [c]
NMVOC incentive fee *	Indirect CO_2	Improvement of air quality through O_3 abatement.	Economic	Imple-mented	Market-based instrument to reduce NMVOC emissions, also leading to a reduction of indirect CO_2 emissions.	2000	FCA	380

[a] Policies and measures marked with an asterisk (*) are included in the 'with measures' projection.

[b] Values according to *Carbotech* (2020).

[c] The estimate of mitigation impact is included under the 'NMVOC incentive fee'.

IE, included elsewhere
FCA, Swiss Federal Customs Administration; FEDRO, Swiss Federal Roads Office; FOEN, Swiss Federal Office for the Environment

3.5.2 Provisions relating to substances stable in the atmosphere (HFCs, PFCs, SF_6, NF_3)

The three main lines of action in the area of F-gases are: (i) to limit the use of these substances to those applications where there is no alternative at the current state of technology, (ii) when such substances are used, to reduce emissions as far as possible, and (iii) where feasible, to engage in voluntary binding agreements with industry (as implemented in an agreement developed by the industry on SF_6 in high-voltage equipment and other sectors in 2002, revised in 2014).

Under the generic name of 'substances stable in the atmosphere', the Ordinance on Chemical Risk Reduction, in its Annex 1.5, provides for measures to control emissions of persistent substances with high global warming potential values (HFCs, PFCs, SF_6, NF_3, HFEs). Section 8 of Annex 1.5 states that containers and switchgear containing such substances must be labelled, inter alia, with the following text in at least two official languages: 'Contains fluorinated greenhouse gases'.

Moreover, in 2019 provisions have been added to Annex 1.5 of the Ordinance on Chemical Risk Reduction to fulfil Switzerland's obligations under the Kigali Amendment to the Montreal Protocol, in particular the establishment of a licensing scheme for the import and export of the F-gases that were recently included in the Montreal Protocol. Switzerland has ratified the Kigali Amendment in November 2018.

Because emissions resulting from installations/systems working with refrigerants dominate total F-gas emissions, regulations most importantly aim at reducing emissions from such installations/systems. However, further regulations relating to substances stable in the atmosphere are in place.

Refrigerants

Refrigerants containing F-gases have been regulated under the Ordinance on Chemical Risk Reduction since 2003, initially focusing on appliances with such refrigerants. In 2004, the placing on the market of stationary equipment containing more than three kilograms of F-gases has been subjected to a permit, being contingent on the conditions that no alternative at the current state of technology was available and emissions were reduced as far as possible. In 2012, provisions were added to the regulatory system that limit refrigerant charges in certain types of equipment. In 2013, a partial ban has replaced the permit mentioned above. This ban applies to the placing on the market of certain types of stationary equipment containing F-gases, depending on the cooling capacity, the global warming potential of the refrigerant, and the sector of use. The ban has been tightened twice, in 2015 and 2019, respectively. In 2019, additionally a restriction to the servicing of stationary equipment with refrigerants with a high global warming potential has been introduced, along with additional bans on certain types of appliances operating with F-gases. To ensure the transparency and proportionality of the relatively complex system, several technical guidelines relating to the relevant technology and to the implementation of the various measures to improve confinement have been developed in collaboration with cantonal authorities and the sector concerned.

Aerosol dispensers

In the area of aerosol dispensers, emissions of F-gases (mainly HFCs) can only be limited by restrictions on use. Applications for which exemptions are inevitable are medical and pharmaceutical applications, in particular metered dose inhalers. For other applications where these substances may be required, e.g. for safety reasons, the state of technology is changing rapidly, and it seems more appropriate to use the option of granting temporary exemptions based on individual technically justified requests.

Plastic foams

The measures currently implemented in Switzerland (restrictions on use, disposal by incineration and recycling) to limit emissions of F-gases from plastic foams on the one hand and the general tendency of this industry sector in Europe on the other hand have led to the situation where foams without fluorinated gases account for practically the entire Swiss market. F-gases (mainly HFCs) may only be used in plastic insulating foams and under severe restraints: (i) if they offer significant advantages in thermal insulating efficiency in case of spatial constraints and (ii) where non-flammability is required, in agreement with the current state of technology. Rapidly advancing technology requires that the state of technology and application criteria need to be clarified in guidelines developed and updated in collaboration with the producers and professional users, as well as with the cantonal enforcement authorities.

Solvents containing HFCs, PFCs or HFEs

The use of solvents containing HFCs, PFCs or HFEs is currently restricted to surface treatment installations with specific technical characteristics. Exemptions can be given to further uses (in practice almost exclusively within the electronic and precision industry), in cases where sound alternative technology is not available. To reduce emissions, consumer goods containing such solvents have been banned.

Extinguishing agents

Since 1996, the supply and import of extinguishing agents made of F-gases and of appliances or stationary equipment containing such agents are banned. However, temporary exemptions are granted in cases where no viable alternatives are available.

SF_6 in electrical distribution equipment

The use of SF_6 is only authorised in equipment that operates at more than one kilovolt and is hermetically sealed or constantly monitored. This is governed by a voluntary agreement established in 2013 by the high-voltage industry[34]. The level and the volume of annual emissions are limited to one per cent of the total amount used, and to an absolute annual maximum of four tonnes (until 2012, limit is decreasing to 3.6 tonnes in 2020). Further, recovery of SF_6 from decommissioned equipment must be guaranteed.

Other application sectors

The use of PFCs and SF_6 in tyres, insulating windows and sport shoes is banned since 2003. SF_6 as protecting gas in magnesium and aluminium smelting was banned after 31 December 2016. Other uses are authorised insofar as there is no environmentally superior alternative and at minimal emission levels according to the best available techniques.

Furthermore, under Annex I of the Ordinance concerning Lists Regarding the Movement of Toxic Waste, waste containing HFCs counts as special waste. Thus, the movement of such waste is controlled, and it must be treated by licensed enterprises in an environmentally sound manner.

Planned strengthening

In order to fulfil Switzerland's obligations under the Montreal Protocol and its Kigali Amendment (in particular the phase down of HFC consumption to 15 per cent of its baseline until the year 2036), the Ordinance on Chemical Risk Reduction is expected to be revised regularly with a view to further restricting the uses of HFC, where the evolving state of technology provides new alternatives.

Estimate of mitigation impact

For estimating the mitigation impact, emission scenarios were calculated with and without existing policies and measures (see section 4.3.2; *Carbotech*, 2020). The emission scenarios cover metal production, electrical equipment, refrigerants, solvents, aerosols, foam blowing, electrical equipment, and others. The dominating sector is refrigeration, contributing roughly 80 per cent in total CO_2 equivalent emissions of substances stable in the atmosphere. Input data for projecting the development of this key sector are the statistics available on currently installed stationary equipment, as well as assumptions on future market growth and leakage rates during operation and disposal. As shown in Tab. 17 and BR CTF table 3, the emission modelling suggests a total mitigation impact of 1.16 million tonnes of CO_2 equivalents by 2020 (see also Tab. 25 and Fig. 17), thereof 1.04 million tonnes of CO_2 equivalents within the refrigeration sector.

3.5.3 Ordinance on Air Pollution Control

The Ordinance on Air Pollution Control is based on the Environmental Protection Act and entered into force in 1986. It contains – beside other prescriptions – emission limits for NMVOCs for stationary installations. It also prescribes that emissions shall be captured as fully and as close to the source as possible and shall be removed in such a way as to prevent excessive ambient air pollution levels. Furthermore, it gives the possibility to the authorities to limit emissions preventively as far as technically and operationally feasible and economically acceptable.

Estimate of mitigation impact

The estimate of mitigation impact is included under the NMVOC incentive fee (section 3.5.4), and, thus, reported as 'included elsewhere' in Tab. 17 and BR CTF table 3.

3.5.4 NMVOC incentive fee

The NMVOC incentive fee is defined in the Ordinance on the Incentive Tax of Volatile Organic Compounds, which is also based on the Environmental Protection Act and which entered into force in 1997. The incentive fee has been levied since 1 January 2000, amounting to two Swiss francs per kilogram of NMVOC emitted into the air. Since 2003 the fee is three Swiss francs per kilogram of NMVOC. As a market-based instrument in the field of environmental protection, it creates a financial incentive to further reduce NMVOC emissions.

[34] https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/climate-policy/sector-agreements/freiwillige-branchenloesung-fuer-sf6.html

Estimate of mitigation impact

The total anthropogenic NMVOC emissions in Switzerland without road traffic (see section 3.5.3) are projected to drop from 210 thousand tonnes in 1990 to about 64 thousand tonnes in 2020. Using real activity data and keeping the emission factors constant from 1990 onwards, the emissions rise up to 238 thousand tonnes of NMVOC in 2020. The reduction of 173 thousand tonnes of NMVOC is the result of the combination of the Ordinance on Air Pollution Control and the NMVOC incentive fee. Using a carbon content of NMVOC of 60 per cent, about 380 thousand tonnes of CO_2 equivalents result as a greenhouse gas mitigation impact due to the reduction of indirect CO_2 emissions[35].

3.6 Agriculture

3.6.1 Overview

Article 104 of the Federal Constitution of the Swiss Confederation forms the basis for agricultural policy in Switzerland. It mentions sustainability as one of the guiding principles. The Agriculture Act, which came into force in 1999, provides a framework for sustainable development in the agriculture sector. In its Article 2, as amended in 2014, it stipulates that the Swiss Confederation shall, inter alia, take measures to promote the sustainable use of natural resources and animal-friendly and climate-friendly production.

Greenhouse gas emissions in agriculture strongly depend on the portfolio of activities chosen by farmers. An important parameter influencing this decision is the relative economic profit achievable by the different activities. Their attractiveness depends on the price level of agricultural goods and services as well as on the mode and level of agricultural subsidies. Agricultural policy, as it is designed in Switzerland, influences both, prices of agricultural products and subsidies and is therefore an important factor determining the amount of greenhouse gas emissions.

With the revision of Switzerland's agricultural policy since the beginning of the 1990s, support for agriculture has been gradually reduced and decoupled from production. Between 1990 and 2010 total financial aid (price support and budgetary subsidies) was reduced from just over eight billion to 5.6 billion Swiss francs. Furthermore, the proportion of linked financial aid (price support through restrictions on import and other contributions towards market price support including export subsidies) decreased by around 50 per cent over the same period. As compensation, direct payments decoupled from production volume have been considerably increased by 80 per cent.

Tab. 18 gives an overview of the climate-relevant policies and measures in the agriculture sector, while the following sections provide more details and background information on each policy and measure. The values for the mitigation impact of each policy and measure in the agriculture sector are rough estimates.

Tab. 18 > Summary of policies and measures in the agriculture sector. The sector affected is 'agriculture' for all policies and measures presented in this table. Compared to the previous submission, the policy and measure "Further development of the direct payments system (orientation towards targets)" has been renamed to "Agricultural policy 2014–2017 and 2018–2021".

Name of policy or measure [a]	Greenhouse gas(es) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO_2eq)
								2020
Proof of ecological performance to receive direct payments *	CH_4, N_2O, CO_2	Incentives related to ecological goals.	Economic	Implemented	Direct payments are contingent on appropriate soil nutrient balance, suitable proportion of ecological compensation areas, crop rotation system, soil protection, selective application of crop protection agents, and animal husbandry in line with legal provisions.	Early 1990s	FOAG	700
Resource programme (subsidies for a more efficient use of natural	CH_4, N_2O, CO_2	Promotion of efficient use of natural resources.	Economic	Implemented	Subsidising measures for more efficient use of natural resources such as nitrogen, phosphorous and energy, protection and sustainable use of soils, and	2008	FOAG	NE [b]

[35] In this estimate, fossil and biogenic NMVOC emissions are included. In contrast to the estimates presented here, the values related to indirect CO_2 emissions provided in chapter 1 and 4 (section 4.3.6) only consider fossil carbon and strictly avoid double counting. However, in 1990 almost 80 per cent of NMVOC emissions resulted from the use of solvents anyway.

resources)					biodiversity. To qualify for subsidies, measures must go beyond legal requirements or the criteria for other funding programmes.			
Climate strategy for agriculture	CH_4, N_2O, CO_2	Long-term mitigation and adaptation in the sector.	Information, research	Implemented (strengthening planned)	Declaration of intent to reduce emissions by one third by 2050 compared to 1990 with technical, operational and organisational measures and by another third with measures influencing food consumption and production. Framework for the development, testing and implementation of specific future measures in mitigation and adaptation.	2011	FOAG	NE [c]
Agricultural policy 2014–2017 and 2018–2021 *	CH_4, N_2O, CO_2	More targeted use of the direct payments system.	Economic	Implemented (strengthening planned)	Abolition of unspecific direct payments (livestock subsidies, general acreage payments). Additional funds for environment-friendly production systems and for the efficient use of resources, e.g., increase in nutrient efficiency and ecological set-aside areas, reduction of ammonia emissions.	2014	FOAG	200

[a] Policies and measures marked with an asterisk (*) are included in the 'with measures' projection.

[b] The mitigation impact of the resource programme (subsidies for a more efficient use of natural resources) achieved by 2020 cannot be estimated due to the lack of specific information. However, the main mitigation impact will evolve after 2020 as projects with a focus on the reduction of greenhouse gas emissions just started.

[c] Because the measures so far introduced in the framework of the climate strategy for agriculture aim at the exchange and transfer of knowledge, no methodological approaches are available to quantify the mitigation impact.

NE, not estimated
FOAG, Swiss Federal Office for Agriculture

3.6.2 Proof of ecological performance to receive direct payments

Direct payments are tied to ecological standards, i.e. farmers are eligible for payments only if they fulfil the so called proof of ecological performance. This is the case when the nutrient balance is maintained, a suitable proportion of farmland is managed as ecological compensation area, a crop rotation system is in place, soil protection is given due consideration, crop protection agents are chosen and applied selectively, and livestock is kept in accordance with legal regulations and animal welfare requirements. Since direct payments are an essential part of the income for most famers, the diffusion of the proof of ecological performance is widespread.

Estimate of mitigation impact

It is assumed that introduction of the proof of ecological performance was the main driver for the reductions in agricultural greenhouse gas emissions in the 1990s (about 700 thousand tonnes of CO_2 equivalents). The impact of the introduction of the proof of ecological performance to receive direct payments is clearly reflected in substantial decreases of the main drivers of agricultural greenhouse gas emissions in the 1990s. Indeed, total cattle decreased by 14 per cent from 1990 to 2000, while total commercial fertiliser decreased by 23 per cent over the same time period (see also Fig. 23). However, other factors like price signals certainly also have contributed to this trends. Therefore, the estimation may represent an upper limit.

3.6.3 Resource programme (subsidies for a more efficient use of natural resources)

On the basis of an amendment to the Agriculture Act in 2008, a new instrument called resource programme was introduced. Through this programme, the Swiss Confederation is subsidising measures for the more efficient use of natural resources in the agriculture sector. Target areas are resources such as nitrogen, phosphorous and energy, protection and sustainable use of soils, and biodiversity. To qualify for subsidies, measures must go beyond legal requirements or the criteria for other funding programmes. Support is given to measures that need financial support in an introductory phase, but that will run without further payments afterwards. Therefore payments are restricted to six years. The specified targets and measures, as well as the spatial dimension and the participation of the farms can vary considerably between the projects. Until 2015, 24 regional bottom-up projects were initiated and half of them already completed. Two thirds of the projects deal with ammonia emission reduction, the others contain measures with the aim to improve

soil fertility, biodiversity or energy efficiency. In 2016, two new initiatives with the focus on the reduction of agricultural greenhouse gas emissions started. Other projects in relation to greenhouse gas emissions are focusing on humus (start in 2017), nitrogen use efficiency (start in 2018) and use of organic soils (start in 2019). The requirements for projects eligible under the resource programme were slightly revised in 2014. More emphasis is given to innovation and accompanying research. With that, the variety of projects should be enhanced and the transfer of know-how beyond the project improved.

Estimate of mitigation impact

The mitigation impact of the projects which focus on other aspects than the reduction of greenhouse gas emissions cannot be estimated due to the lack of specific information. The two projects on the mitigation of greenhouse gas emissions which started in 2016 have the potential to reduce farm emissions by 10 per cent on nearly 20 per cent of Swiss farms. However, their main mitigation impact will evolve after 2020. Consequently, the mitigation impact for the resource programme (subsidies for a more efficient use of natural resources) is reported as 'not estimated' in Tab. 18 and BR CTF table 3.

3.6.4 Climate strategy for agriculture

The climate strategy for agriculture was published in 2011 by the Swiss Federal Office for Agriculture (*FOAG*, 2011). This strategy is a declaration of intent, guiding agriculture and food production in Switzerland in their efforts to reduce greenhouse gas emissions and adapt to a changing climate. It sets out common guidelines and long-term targets and identifies priorities and possible areas where action can be taken. Greenhouse gas emissions by the agriculture sector are to be reduced by at least one-third by 2050 (compared to 1990 levels) through technical and organisational measures. Further reductions are aspired by influencing production structures as well as consumption patterns. At the same time, agricultural production (nutritional energy) as well as other public and ecological services are to be maintained. Implementing activities in the context of the climate strategy for agriculture include: intensification of agricultural research, development of appropriate legal framework and empowerment of the stakeholders concerned.

Since the publication of the climate strategy for agriculture a platform in the fields of renewable energy, energy efficiency and climate change mitigation was supported with financial aid from the government. The aim of the platform is to facilitate the exchange and transfer of knowledge between research, advisory services, industry and farmers. Congresses and workshops are organised, mitigation options identified and tools developed.

Planned strengthening

It is planned that the reduction target for the agriculture sector set out by the climate strategy for agriculture is made mandatory by including it in the third CO_2 Act (section 3.2.4).

Estimate of mitigation impact

The climate strategy for agriculture aims at setting out long-term targets to be reached with deduced policies and measures and has, thus, a positive mitigation impact. However, because the measures so far introduced in the framework of the climate strategy for agriculture aim at the exchange and transfer of knowledge, no methodological approaches are available to quantify the mitigation impact. Accordingly, the mitigation impact is reported as 'not estimated' in Tab. 18 and BR CTF table 3.

3.6.5 Agricultural policy 2014–2017 and 2018–2021

In 2013 the Swiss Parliament adopted the agricultural policy 2014–2017. The key element of this quadrennial programme for agriculture is the further development of the direct payments system. Measures with unspecified aims were replaced by specific tools. Subsidies for livestock were converted to subsidies for ensuring food security, dependent on land use. The funds freed by the abolishment of the general acreage subsidy were used, inter alia, for new direct payment types for environmentally-friendly production systems and for the efficient use of resources. Concretely, payments were effected for e.g. organic farming, grassland-based ruminant production, and precise application of fertiliser and plant protection agents, conservative soil cultivation. The legal framework of agricultural policy 2014–2017 has been designed in a way that enables the inclusion of further elements under the new direct payment types by adjusting the corresponding ordinance. In 2017, the Swiss Parliament adopted the continuation of the agricultural policy, setting the financial framework for the period 2018–2021. Further, another two elements were introduced: (i) payments for differ-

entiated feeding of pigs according to age and (ii) nutritional needs and payments for reduced use of plant protection agents in vine and sugar beet.

Planned strengthening

With the agricultural policy as of 2022 (AP22+), the Swiss Federal Council intends to improve the agricultural policy framework conditions in the areas of market, operation and environment. This should enable the Swiss agricultural and food industry to exploit opportunities more independently and more entrepreneurially, increase added value on the market, increase operational efficiency and further reduce environmental pollution and the consumption of non-renewable resources. Planned are measures to promote production with reduced use of pesticides, reduced nutrient and greenhouse gas emissions, as well as measures to build humus, to maintain soil fertility and to enhance the performance of functional biodiversity. Details are currently in development within the Swiss federal administration in collaboration with relevant stakeholders. The Swiss Federal Council plans to submit its draft on the agricultural policy as of 2022 (AP22+) in the course of 2020, launching therewith the debate in the Swiss Parliament.

Estimate of mitigation impact

In a simplified way it can be assumed that, by 2020, the mitigation impact of the further development of the direct payments system corresponds to the difference between the WEM and the WOM scenario (see section 4.3.3 and Tab. 26), i.e. about 200 thousand tonnes of CO_2 equivalents.

3.7 Land use, land-use change and forestry

3.7.1 Overview

There is a long tradition of forest protection in Switzerland. The first Forest Act came into force in 1876. It only covered the Alpine region and its aim was to put a halt to deforestation, to secure the remaining forest area, to manage it in a sustainable way, and to promote afforestation. The Forest Act of 1902 covered the whole country. The forest acts resulted in an increase of the forested area in Switzerland from 0.7 million hectares in the mid-19th century to over 1.3 million hectares today (*FOEN and WSL*, 2015). Switzerland's total forest area is still increasing, although the changes in forest area vary significantly from region to region. The strongest increase in forest area can be observed in the Alps and in the Southern Alps. The forest area in the Central Plateau is virtually stable.

Due to the age structure, large fractions of the Swiss forest are mature for harvesting. Consequently, the levels of harvesting should rise in the near future. On one hand, this contributes to avoiding episodic large quantities of greenhouse gas emissions originating from decay, should the excessive accumulation of carbon stocks be disturbed by drought, fires, storms, or insect attacks. On the other hand, as the forest, its products and services could be broadly affected by climate change there is need to support forests to adapt to climate change. Adaptation processes in forests are best induced through regeneration.

In Switzerland, the climate-related goal of forest policy is to adapt forests by increasing resilience to climate change and – taking into account the high growing stock – to reduce CO_2 emissions by substituting other materials or fossil fuels rather than enhancing sink capacity. The highest possible substitution effect can be achieved through the principle of cascaded use of wood. With the planned step-by-step phasing out of nuclear energy as part of Switzerland's Energy Strategy 2050 (see section 4.3.1), renewable energy sources will play a central role. This is likely to lead to a more intensive use of energy wood and an increase in timber harvesting.

The most recent changes in the Swiss Federal Act on Forest (in force since 1 January 2017) follow this goal and strengthen the measures concerning adaptation and mitigation of climate change. Furthermore, new instruments for the prevention and abatement of harmful organisms have been defined.

Among others, mitigation of climate change is a major objective of the Forest Act and the Forest Policy 2020, which form both part of the legislative arrangements and administrative procedures. At the same time, by applying sustainable forest management practices in Swiss forests, complete use of the wood harvesting potential and conservation of biodiversity are envisaged. The objective of mitigating climate change includes the optimisation of the climate protection services of Swiss forest (*FOEN*, 2007). These climate protection services comprise (i) the sequestration of carbon in the forest, (ii) the carbon fixation in long-living harvested wood products, and (iii) the substitution of fossil fuels by using

fuel wood (energetic substitution) or by replacing energy-intensive construction materials like steel by wood (material substitution). The climate protection services ensure sustainable use of the natural resource 'wood'.

Tab. 19 gives an overview of the most climate-relevant policies and measures in the land use, land-use change and forestry sector, while the following sections provide more details and background information on each policy and measure.

Tab. 19 > Summary of policies and measures regarding land use, land-use change and forestry sector. The sector affected is 'forestry/LULUCF' for all policies and measures presented in this table. Compared to the previous submission, the policy and measure "Forest Act (most recent changes)" has been renamed to "Forest Act (changes due to revision 2017)".

Name of policy or measure [a]	Greenhouse gas(es) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO_2eq)
								2020
Forest Act (sustainable forest management and forest area conservation) *	CO_2	Limiting harvest to size of growth increment in forests, obligation to compensate for any deforestation.	Regulatory	Implemented	Ban on clear-cutting, no deforestation unless it is replaced by an equal area of afforested land or an equivalent measure to improve biodiversity.	First implemented in 1876, main revisions/ extensions in 1902 and 1993	FOEN, cantons	NE [b]
Wood Action Plan *	CO_2	Ecologically and economically effective use of wood.	Information, education, research	Implemented	Policy package implementing Forest Policy 2020 (see above) in the area of better use of the wood harvest potential (the Wood Action Plan is thus meant to help implementing the Forest Policy 2020). Focal areas comprise optimised cascaded use of wood, climate-appropriate building and refurbishment and communication, knowledge transfer and cooperation.	2009	FOEN	IE [c]
Measures within Forest Policy 2020 *	CO_2	Promote the use of wood and the substitution of carbon intensive resources.	Information	Implemented	Improvement of conditions for an efficient and innovative forestry and wood industry. Targets for the consumption of sawn timber and timber products and for CO_2 emission reductions through enhanced use of wood. Long-term target of a CO_2 balance between forest sink, wood use and wood substitution effects. Given the current age structure of Swiss forests, this implies aiming at increased harvesting rates over the coming years.	2011	FOEN, cantons	1'200
Forest Act (changes due to revision 2017) *	CO_2	Promote the use of wood and the substitution of carbon-intensive resources.	Regulatory, Information	Implemented	New legal base for Wood Action Plan (see above) and new legal instrument to promote the use of sustainably produced timber for the construction of federal buildings.	2017	FOEN, cantons	NE [b]

[a] Policies and measures marked with an asterisk (*) are included in the 'with measures' projection.

[b] See the respective sections (3.7.3 and 3.7.5) for a qualitative discussion of the mitigation impact.

[c] The respective effects are included under the measures within Forest Policy 2020. Reductions result from substitution of other materials or fossil fuels (and thus impact emissions outside the land use, land-use change and forestry sector). While these indirect reductions are not included in the modelling of emissions (see section 4.3.4), the figures here do not reflect the corresponding reduction of carbon storage by the forest.

IE, included elsewhere; NE, not estimated
FOEN, Swiss Federal Office for the Environment

3.7.2 Forest Act (sustainable forest management and forest area conservation)

The Forest Act, as revised in 1993, reaffirms the long-standing Swiss tradition of preserving both forest area and forests as natural ecosystems. It prescribes sustainable forest management, prohibits clear-cutting, and bans deforestation unless it is replaced by an equal area of afforested land or an equivalent measure to improve biodiversity. At an average

increment of 10.4 million cubic metres per year, 1.5 million cubic metres remain unlogged annually (values for survey periods of NFI3/2004–2006 and NFI4/2009–2013; *FOEN and WSL*, 2015) – mainly in forests that are difficult to access and in forest reserves. The federal authorities would like to increase Switzerland's annual wood harvest since the forests' sustainable potential for supplying domestic construction and energy wood is not being exploited completely. Specific measures aiming, inter alia, at the better exploitation of the existing potential of wood as a renewable resource are described in the sections below.

Estimate of mitigation impact

There are no quantitative estimates, but the impact is positive (see qualitative evaluation in sections 3.7.3 and 3.7.5). It is difficult or nearly impossible to define scenarios including elements like 'avoiding natural disturbances' or 'adaptation of forests' because these include a lot of speculative assumptions. Moreover, while the mitigation impacts of these elements are quite important for forest ecosystem functioning, they are only of minor importance for Switzerland's national CO_2-budget. Therefore, no quantitative information is provided. The active promotion of wood will have a positive impact on the pool of harvested wood products (more carbon stored), but will have a reverse impact on the carbon stored in the forest. While a quantification is challenging, it is planned to explore ways to quantify the effect in the context of the establishment of the Forest Reference Level, which will be used for accounting of forest land including harvested wood products under the Paris Agreement.

3.7.3 Wood Action Plan

With the Wood Resource Policy (first initiated in 2008, updated in 2014 and 2017; *FOEN/SFOE/SECO*, 2017), the Swiss Confederation formulated a separate Wood Action Plan, which is coordinated with the Forest Policy 2020, climate policy, energy policy and regional policy. As the lead agency in this process, the Swiss Federal Office for the Environment actively promotes the cooperation between these sectoral policy areas, the Swiss forestry and timber sector, and the cantons. The aim of the Wood Resource Policy is to ensure that wood from Swiss forests is supplied, processed and used in a way that is sustainable and resource efficient. By this means, it makes a major contribution to forest, climate and energy policy. With its three priority areas of 'optimised cascade use', 'climate-appropriate building and refurbishment' and 'communication, knowledge transfer and cooperation', the Wood Action Plan serves the implementation of the Wood Resource Policy (*FOEN/SFOE/SECO*, 2017). Upon evaluation of the first (2009–2012) and second phase (2013–2016), the Wood Resource Policy has been updated and the Wood Action Plan extended until 2020.

In 2017, a new programme phase of the Wood Action Plan started (2017–2020). Its focus and relationship to other policy instruments is described above.

Estimate of mitigation impact

There are no quantitative estimates available, but the overall mitigation impact of the Wood Action Plan is positive. The promotion of the 'optimised cascaded use of domestic wood' increases the carbon stored in the pool of harvested wood products. It is a challenge to define and model a scenario including the goal 'optimised cascaded use of domestic wood' because this would include a lot of speculative assumptions. Therefore, only a descriptive and not a quantitative estimate is provided. By aiming to use wood for material purposes and afterwards for energetic purposes, the carbon stored in long-lived harvested wood products will increase and therefore the overall mitigation impact is estimated to be positive. Only mitigation impacts of long-lived harvested wood products would be accounted for in the LULUCF sector. The mitigation impact trough substitution effects would be reflected indirectly in the energy sector.

3.7.4 Measures within Forest Policy 2020

The Forest Policy 2020, which was approved by the Swiss Federal Council in 2011, is a strategic document built on the Forest Act of 1993 and the Forest Ordinance of 1992 and designed to trigger improvements to it. Consequently, the Forest Act and Forest Ordinance have been updated in 2017 (see 3.7.5) based on an intermediate evaluation of the Forest Policy 2020. The Forest Policy 2020 ensures sustainable forest management while creating favourable conditions for an efficient and innovative forestry and wood industry. The policy sets out eleven strategic objectives. It identifies five objectives that pose the greatest challenges: (i) exploiting the potential sustainable wood supply, (ii) contributing to mitigation of, and enhancing resilience to, climate change, (iii) maintaining the protective forest services, (iv) increasing biodiversity by conserving forests as near-natural ecosystems, and (v) conservation of the forest area in its spatial distribution.

The policy contains a comprehensive set of strategic and specific measures, indicators and target values that go with every objective. Some examples related to mitigation are (i) under the Forest Policy 2020, the consumption of sawn timber and timber products should be increased by 20 per cent by 2020 compared to 2006 levels, (ii) at the same time, the substitution effect through enhanced use of wood should be increased by 1.2 million tonnes of CO_2 per year by 2020 compared to 1990, and (iii) in the long term, a sustainable equilibrium between forest sink, wood use and wood substitution effects is sought.

Estimate of mitigation impact

According to the Forest Policy 2020, the mitigation impact by substitution is estimated at 1.2 million tonnes of CO_2 equivalents in 2020 (see page 62 in *FOEN*, 2013). For a qualitative evaluation see sections 3.7.3 and 3.7.5. The estimated mitigation impact of 1.2 million tonnes of CO_2 equivalents in 2020 results from the use of wood for materials and energy and includes the mitigation impacts achieved in other sectors, e.g. when wood replaces fossil fuels or CO_2-intense materials (such as cement and steel) in energy industry, building and housing, industrial processes, etc. This may thus lead to some overlap with the individual estimates of the mitigation impacts for policies and measures affecting these other sectors, however, double counting is carefully avoided for the projections and the estimate of the aggregate effect of policies and measures (as the mitigation impact resulting from substitution of materials and fossil fuels is not accounted for in the WEM and WAM scenarios of the LULUCF sector). The envisaged increase of the consumption of sawn timber and timber products will result in a decrease of carbon stored in the forest, but will in exchange increase the amount of carbon stored in long-lived harvested wood products. While a direct quantification of the Forest Policy 2020 is not available yet, it is being elaborated in the next years in the context of the establishment of Switzerland's Forest Reference Level that will be used for accounting under the Paris Agreement.

3.7.5 Forest Act (changes due to revision 2017)

In 2017 a renewal of the Forest Act entered into force. Article 28a 'Precautionary measures against climate change' is the first legal provision in a federal sector law that explicitly addresses the issue of adaptation to climate change. With this law the Swiss government financially supports adaptation measures with the aim to increase the adaptive capacity of Switzerland's forests (see also section 6.2.7 of Switzerland's seventh national communication). Further, the revised Forest Act allows for taking measures to combat invasive species outside of protective forests. Non-native pests – such as the Asian longhorn beetle, whose numbers have recently increased – will be controlled. The law also foresees measures to promote timber which was produced sustainably and in close-to-nature silvicultural systems. A goal of these measures to promote timber is reducing CO_2 emissions through the use of harvested wood products. Starting in 2017, the Swiss government is required, if suitable, to use wood in its own building projects that complies with the above mentioned criteria.

Estimate of mitigation impact

There are no quantitative estimates available, but overall the mitigation impact of the Forest Act (changes due to revision 2017) is positive:

- In the medium to long term, mitigation cannot be sustained without adaptation: Adaptive forest management in Switzerland aims to avoid major emissions from collapsing forest stands that are not adapted to climate change. The Forest Act prescribes to prepare Swiss forests for future climate conditions by adaptation measures. This means that short-time emissions from forest management can be expected, but positive long-term removals may compensate them. Swiss forests are often characterised by high carbon stocks. To convert these old forests into more stable younger forests, a decrease in biomass is necessary and net emissions may occur if the harvested biomass is not entirely transformed into harvested wood products. Further, specific forest stand types might need a change in species composition because of changing climate and corresponding changing stand characteristics. This exchange in tree species composition is typically spread over decennia. Emissions from these measures are expected to be moderate or small;
- By combating invasive species, emissions from tree mortality caused by insect diseases can be avoided;
- The more active promotion of wood use (e.g., there is a respective commitment for the construction of federal buildings) has a positive mitigation impact because the pool of harvested wood products will be increased.

3.8 Waste

3.8.1 Overview

In general, waste disposal in Switzerland is financed on the basis of the polluter pays principle. In 2011, around 80 per cent of the Swiss residents financed their waste disposal entirely or in part through volume-based charges, and the remaining 20 per cent financed it through taxation or payment of a flat fee. As a matter of principle, all waste should undergo material recycling or thermal treatment. If this is technically not possible or economically not viable, the waste is landfilled following suitable treatment. Since 2000, no untreated municipal solid waste may be landfilled; the capacity of the waste incineration plants was increased accordingly.

The main strategy to reduce emissions from waste incineration is to increase the recycling quantities. Well-developed recycling services exist for many types of waste. In 2015, 53 per cent of the total municipal solid waste was collected separately and recycled (see section 2.9 and Tab. 1 of Switzerland's seventh national communication). The corresponding figure for 2002 was 46 per cent. Recycling rates are particularly high (more than 90 per cent) for glass, aluminium packaging, and waste-paper (see section 2.9 and Fig. 36 of Switzerland's seventh national communication).

Tab. 20 gives an overview of the climate-relevant policies and measures of the waste sector, which are detailed in the following sections. The negotiated reduction commitment of municipal solid waste incineration plant operators is presented in detail together with the policies and measures of the energy sector (section 3.3.7), as their emissions are accounted for in the energy sector.

Tab. 20 > Summary of policies and measures regarding waste management. The negotiated reduction commitment of municipal solid waste incineration plant operators is presented together with the policies and measures of the energy sector (section 3.3.7). The sector affected is 'waste management/waste' for all policies and measures presented in this table.

Name of policy or measure [a]	Greenhouse gas(es) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO_2eq)
								2020
Ban on landfilling of combustible waste *	CH_4	Avoid emissions from solid waste disposal sites, use waste as an energy source.	Regulatory	Implemented	Prohibition on landfilling of combustible waste.	2000 [b]	FOEN	177
Ordinance on the Avoidance and Management of Waste *	CO_2	Optimisation of energy recovery by municipal solid waste incineration plants.	Regulatory	Implemented	Mandatory minimal energy recovery rate.	2016	FOEN	28

[a] Policies and measures marked with an asterisk (*) are included in the 'with measures' projection.

[b] Regulations regarding the installation of technical equipment for the collection and removal of landfill gas were already established in the 1990s.

FOEN, Swiss Federal Office for the Environment

3.8.2 Ban on landfilling of combustible waste

Since 2000, disposal of combustible solid wastes on landfills is banned. All Swiss waste incineration plants use the combustion heat they produce to generate electricity or to supply district heating networks and industrial facilities. Today, Swiss waste incineration plants supply around two per cent of Switzerland's total energy consumption. As a consequence of the ban on landfilling, CH_4 emissions from solid waste disposal sites have declined substantially. In addition, regulations regarding landfilling established in the 1990s led to the installation of technical equipment for the collection and removal of landfill gas (*Consaba*, 2016).

Estimate of mitigation impact

The mitigation impact of the ban on landfilling of combustible waste is estimated by comparing the 'with existing measures' (WEM) and 'without measures' (WOM) scenarios as used for Switzerland's projections of greenhouse gas emissions (for methodological details see section 4.3.5). Accordingly, it is assumed that the mitigation impact of the ban on landfilling of combustible waste corresponds to 177 thousand tonnes of CO_2 equivalents in the year 2020 (this estimate does not include the different evolutions of biogas production which leads to further differences between the two scenarios for the waste sector).

3.8.3 Ordinance on the Avoidance and Management of Waste

In Switzerland, the disposal of waste is regulated by the Ordinance on the Avoidance and Management of Waste (*Swiss Confederation*, 2015). As of 1 January 2016, this ordinance replaced the former Technical Ordinance on Waste. The new ordinance aims in particular at the sustainable use of renewable and non-renewable raw materials, inter alia by promoting closed-loop material flows. At the same time, the reduction of environmental pollution by means of separation and appropriate treatment of hazardous substances and proper disposal of all kinds of waste is to be further improved. The reliability of the waste removal system as a whole is to be strengthened by ensuring adequate structures for collection, transport and treatment of the different types of waste.

The most relevant goal with a direct impact on greenhouse gas emissions of the Ordinance on the Avoidance and Management of Waste is the optimisation of the energy recovery by municipal solid waste incineration plants. This is done by the prescription of a mandatory minimal energy recovery rate of 55 per cent of the energetic content of the waste incinerated (mandatory as of 1 January 2026). All 30 Swiss municipal solid waste incineration plants are supplying energy either in form of electricity or heat for district heating. Whereas many municipal solid waste incineration plants show recovery rates far above the minimal regulatory requirements, there are a few plants which need further technical investments in order to meet the minimal recovery rate.

Estimate of mitigation impact

According to a conservative scenario, municipal solid waste incineration plants with an insufficient recovery rate have to raise their energy efficiency in order to meet the mandatory requirements. Applied to the actual situation in 2016, an additional minimal recovery of 107 gigawatt-hours is needed that all municipal solid waste incineration plants fulfil the legal requirements. Assumed that this additional energy is supplied as heat for district heating and, therefore, replaces fossil heating fuels, a reduction of 28 thousand tonnes of CO_2 can be obtained. On the one hand, this is a very conservative assumption, because an energetic optimisation of a municipal solid waste incineration plant will usually aim at higher energy recovery rate than required by the Ordinance on the Avoidance and Management of Waste. On the other hand, there is a transition period until 2026, i.e. the full mitigation impact may develop after 2020 (but the value of 28 thousand tonnes of CO_2 is still provided as the best estimate for the mitigation impact for 2020 in Tab. 20).

3.9 Costs, non-greenhouse gas mitigation benefits and interactions of policies and measures

Although encouraged by the UNFCCC reporting guidelines on national communications to report on costs, non-greenhouse gas mitigation benefits and interactions of policies and measures, gaining this information is very challenging and Switzerland is not in a position to comprehensively report this information for every single policy and measure. However, information for selected policies and measures as well as a discussion of the challenges regarding the reporting of this information is provided in the following.

Costs of policies and measures

Evaluation of the costs of policies and measures is particularly challenging, e.g. because the definition of costs is ambiguous and because many policies and measures are closely interlinked. Accordingly, Switzerland does not evaluate its policies and measures regarding costs on a regular basis, and no consistent methodology to estimate costs of all individual policies and measures exists. However, the social costs and benefits of the policies and measures are expected to be moderate. For selected policies and measures, the following information is available:

- The economy-wide cost of the CO_2 levy, the most relevant policy and measure in this context, has been analysed in detail (*FOEN*, 2016b). As of 2018, the rate of the CO_2 levy is 96 Swiss francs per tonne of CO_2, resulting in annual revenues of about 1.2 billion Swiss francs. A third of the revenues (at most 450 million Swiss francs) flows into the national buildings refurbishment programme, with which the Confederation and the cantons support energy-efficient renovations. Another 25 million Swiss francs is transferred to the technology fund. Around two thirds of the revenues are available annually for redistribution. The Confederation distributes the funds between the population and the Swiss economy in proportion to the CO_2 levy payed. In 2018, the redistribution to the population was 76 Swiss francs per capita and the redistribution to the Swiss economy was 148 Swiss francs per 100’000 Swiss francs settled old-age and survivor’s insurance payroll of employees. If the CO_2 levy is further increased in the future, households living in poorly isolated buildings that still rely on fossil heating systems would be affected relatively strongly. However, the redistribution of the CO_2 levy on a per capita basis significantly moderates these negative effects and counteracts the regressive nature that carbon taxes generally have. A

hypothetical increase of the maximum rate of the CO_2 levy to 210 Swiss francs per tonne of CO_2 would lead to a reduction of gross domestic product of around 0.4 per cent in 2030, compared to a scenario where the rate is held constant at 96 Swiss francs per tonne of CO_2 (*FOEN*, 2016b) and excluding possible secondary benefits from reducing CO_2 emissions;

- The planned linking of the emissions trading schemes of Switzerland and the European Union would increase Switzerland's gross domestic product by approximately 0.04 per cent in 2030, compared to a scenario where the two emissions trading schemes are operated separately. The inclusion of aircraft operators in the emissions trading scheme would slightly reduce the growth rate of value added of the aviation sector, but this effect would most probably not fully counteract the overall positive impact of the linking;
- The remaining policies and measures are expected to have only a minor or even negligible impact on the overall economy. Additionally, possible secondary benefits of the reduction of emissions (such as lower health costs, lower dependency on fossil fuels, impacts on innovation etc.) are not included in the calculations above. While these benefits are difficult to quantify, it is likely that the overall economic impact of the proposed measures would be positive if their benefits were also considered;
- The costs for the emission reductions outside Switzerland will depend strongly on the corresponding prices. Currently, reductions abroad are a relatively cheap mitigation option when compared to reductions in Switzerland. However, costs for reductions abroad are likely to increase in the future when developing countries will have to fulfil their commitments under the Paris Agreement.

Administrative costs of policies and measures

Because market-based policies and measures such as the CO_2 levy and the emissions trading scheme play a dominant role in Switzerland's climate policy, the administrative costs are generally moderate. For the CO_2 levy, the compensation for implementation expenses is defined in the CO_2 Ordinance (Article 132) and amounts to 1.4 per cent of the receipts (this percentage may be reduced as receipts increase). Non-market-based polices and measures such as the CO_2 emission regulations for newly registered vehicles or the negotiated reduction commitments (for exemption from the CO_2 levy) require more personal and financial resources. The number of exempt firms could increase significantly after 2021, which would lead to a proportional increase of the administrative costs. On the other hand, the Federal Council proposed to fully redistribute the earnings from the CO_2 levy from 2025 onward and to abolish the earmarking for the national buildings refurbishment programme and the technology fund. This would lead to a decrease of administrative costs.

Non-greenhouse gas mitigation benefits of policies and measures

As indicated above, non-greenhouse gas mitigation benefits of policies and measures are generally difficult to estimate. The main benefits come from the reduction of other air pollutants and the corresponding decrease of health and damage costs. Until 2020, these benefits (mainly due to the CO_2 levy on heating and process fuels) are estimated to be 100 million to 200 million Swiss francs per year (*Econcept*, 2008). Policies and measures that increase energy efficiency contribute to energy security and reduce the potential costs of shortages in energy supply. The same holds for policies and measures that lower the demand for fossil fuels. These policies and measures reduce the dependency on fossil energy imports. The dependency on fossil fuels from abroad could be reduced by around 2.7 per cent if the objective of reducing greenhouse gas emissions by 20 per cent by 2020 relative to 1990 is reached. For any other secondary benefits, no robust quantifications are available.

Interactions of policies and measures

Around three quarters of Switzerland's greenhouse gas emissions result from fossil fuel use. Energy and climate policy are therefore closely linked. The main objective of the Energy Strategy 2050 (increasing energy efficiency and the use of renewable energy) also contributes to the mitigation of CO_2 emissions. However, due to the implementation of the Energy Strategy 2050, it is possible that the production of electricity from fossil sources may increase, which would have a negative impact on Switzerland's CO_2 emissions. Fossil thermal power plants are therefore obliged to fully compensate their emissions. The first bundle of measures of the Energy Strategy 2050 also includes measures that require adjustments of the CO_2 Act, most notably the strengthening of the CO_2 emissions regulations for passenger cars from 130 to 95 grams of CO_2 per kilometre, the exemption from the CO_2 levy of operators of fossil combined heat and power plants, and the increase of the maximum amount earmarked for the national buildings refurbishment programme from 300 million to 450 million Swiss francs per year. As detailed in section 4.2.1, *EPFL and Infras* (2016) and *EPFL*

(2017) estimate that in the energy sector the combined effects of policies and measures are responsible for about 12 per cent of the aggregate effect of currently implemented and adopted policies and measures.

3.10 Modification of longer-term trends in greenhouse gas emissions

Switzerland's policies and measures described in section 3.2 to 3.8 are generally set out to modify the short-term and longer-term trends in anthropogenic greenhouse gas emissions and removals (obviously aiming at reducing net emissions of greenhouse gases). In line with the general objectives of the Convention, they aim at promoting efficiency improvements in the energy, transport and waste sectors, give preference to the sustainable use of renewable resources in agriculture and forestry, and set incentives for the use of climate-friendly substances in the industry sector. The modification of the longer-term trend in greenhouse gas emissions achieved by Switzerland's policies and measures becomes obvious when comparing the 'with existing measures' (WEM) and 'without measures' (WOM) scenarios as presented in chapter 4 (and in particular in Fig. 15). Further, emission trends will be modified by measures where the immediate effect on greenhouse gas emission levels is not a priority, but where longer-term contributions to a low-emission economy and society are targeted. Some examples of particular interest are:

- **Masterplan Cleantech**: In 2011, the Swiss government published the Masterplan Cleantech for Switzerland (*OPET*, 2011). This strategy aims at improving resource efficiency and promoting renewable energies. It encourages cooperation among companies, research centres, cantons and the Swiss Confederation. Under its heading, promotional programmes for research and innovation, knowledge and technology transfer, education and advanced training, and export promotion are topics receiving particular attention. The evaluation of the first years of the Masterplan Cleantech shows a highly positive picture, as it is estimated that the clean technology sector contributed an estimated gross value added of 49 billion Swiss francs and employed 530 thousand persons in 2013[36];
- **Technology fund**: In the context of the second CO_2 Act, a technology fund, financed with 25 million Swiss francs per year from the revenue of the CO_2 levy, was established in 2013. This fund provides for loan guarantees for innovative companies in order to ease access to capital for investments in developing new low-emission technologies;
- **Information, training and advisory services**: As of 2013, the second CO_2 Act requests the Swiss Confederation and the cantons to support measures for the integration of elements relevant regarding climate change in communication, education and professional training programmes at all levels. This includes improving knowledge about mitigation of greenhouse gas emissions as well as adaptation to climate change.

3.11 Policies and measures no longer in place

The climate policies and measures developed over the past years are well-established. As described under the respective sections, some of the policies and measures implemented have been adapted and strengthened over time. All policies and measures listed in Switzerland's seventh national communication and third biennial report are still part of the national portfolio[37]. Accordingly, BR CTF table 3 has been updated to a minor degree only to reflect the most recent status of policies and measures in Switzerland.

As mentioned in previous reports, several policies and measures are still in place but no longer listed in BR CTF table 3, due to their nature (legal or strategic frameworks mentioned in the sectoral introductory paragraphs, from which more specific polices and measures emanate) or due to their rather weak link to the achievement of mitigation commitments (policies and measures mainly impacting precursor gases). These policies and measures are, however, briefly described in textual form in section 3.4.12.

[36] For details see *https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-57171.html* and *http://www.swisscleantech.ch*.

[37] Some polices and measures have been renamed in prepration of this report as noted in the captions of the overview tables to the policies and measures of each sector (see e.g. Tab. 15, Tab. 18, and Tab. 19).

3.12 Policies and measures leading to an increase in greenhouse gas emissions

No significant changes have occurred since Switzerland's seventh national communication and third biennial report with regard to Switzerland's commitment under Article 4, paragraph 2(e)(ii), of the UNFCCC to identify and periodically update the policies and practices that encourage activities that lead to greater levels of anthropogenic greenhouse gas emissions than would otherwise occur. In brief, the decision to not replace nuclear power plants at the end of their service life will require other options for power generation, among other likely also gas-fired combined-cycle power plants (see section 3.3.1). While this will potentially lead to additional greenhouse gas emissions, operators of gas-fired combined-cycle power plants are obligated to fully offset the respective emissions (section 3.3.6). Further, as detailed in section 3.13, there are a few tax exemptions and reductions at the federal level providing limited support to users of fossil fuels: Farmers, foresters, fishermen and the fuel use of snow cats are exempt from the mineral oil tax that is normally levied on sales of mineral oils, while public transport companies benefit from a reduced rate. The reasoning for these tax exemptions are to avoid putting a strain on the production within the agriculture sector, to avoid levying taxes which are earmarked for expenditures related to road traffic from users of non-road vehicles (such as snow cats), or to avoid levying taxes from companies which are subsidised because they render services for the public benefit.

3.13 Economic and social consequences of response measures (minimising adverse effects)

Detailed information on the assessment of the economic and social consequences of response measures are requested by paragraph 13 of the revised UNFCCC reporting guidelines on national communications (FCCC/SBI/2016/L.22). Further, paragraph 36 of the guidelines for the preparation of information under Article 7 of the Kyoto Protocol (FCCC/CP/2001/12/Add.3, Annex) requests information on how Parties strive to implement policies and measures under Article 2 of the Kyoto Protocol in such a way as to minimise adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9, of the Convention, taking into account Article 3 of the Convention.

In the following, Switzerland reports the requested information, thereby addressing the actions mentioned in Decision 31/CMP.1, paragraph 8 (FCCC/KP/CMP/2005/8/Add.4). Further information regarding financial support for any economic and social consequences of response measures is provided in section 5.1.5.

Context

Switzerland strives to design climate change policies and measures in a way as to ensure a balanced distribution of mitigation efforts by implementing climate change response measures in all sectors and for different gases. Indirectly, this approach is deemed to minimise also potential adverse impacts on concerned actors (including developing countries). Given Switzerland's size and share in international trade (mainly with the European Union), it is not assumed that Swiss climate change policies have any significant adverse economic, social or environmental impacts in developing countries. Additionally, the policies and measures are very much compatible and consistent with those of the European Union in order to avoid trade distortion, non-tariff barriers to trade and to set similar incentives. All major legal reform projects in Switzerland are to be accompanied by impact assessments, inter alia including evaluation of trade-related issues. This approach strives for climate change response measures which are least trade distortive and do not create unnecessary barriers to trade. Consistently, Switzerland notifies all proposed non-tariff measures having a potential impact on trade to the World Trade Organisation.

Impact assessments of legal reform projects are accompanied by a broad internal and external consultation process, inter alia inviting competent and potentially affected actors to provide advice on economic, social and environmental aspects of proposed policies and measures. The open public consultation process, together with regular policy dialogues with other countries guarantee that domestic and foreign stakeholders can raise concerns and issues related to new policy initiatives, including those concerns about possible adverse impacts on other countries.

Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities

Environmental policy in Switzerland, including climate change policies, is guided by the polluter pays principle, as enshrined in the Swiss Federal Act on the Protection of the Environment (*Swiss Confederation*, 1983). Accordingly, the

internalisation of external costs and adequate price signals are key aspects of Switzerland's climate change policy. Regarding greenhouse gas emissions, market-based instruments – such as e.g. the Swiss emissions trading scheme (section 3.2.6), the supplemental use of international carbon credits from the Clean Development Mechanism (section 2.1.6) or the CO_2 levy on heating and process fuels (section 3.2.5) – are important measures to put a price on emissions of greenhouse gases that are then reflected in market prices and thus internalizing externalities.

Regarding fiscal incentives, tax and duty exemptions and subsidies, price-based measures are recognised as essential instruments for promoting the efficient use of resources and to reduce market imperfections. In 2001, Switzerland introduced a heavy vehicle charge (section 3.4.6). It is applied to passenger and freight transport vehicles of more than 3.5 tonnes gross weight. The impact of the heavy vehicle charge was most clearly reflected by changes in traffic volume (truck-kilometres), but also in reduced air pollution, a renewal of the heavy vehicle fleet and an increase of load per vehicle, i.e. fewer trucks transported more goods. Two thirds of the revenues are used to finance major railway infrastructure projects (such as the base tunnels through the Alps, see section 2.7 of Switzerland's seventh national communication), and one third is transferred to the cantons. The Swiss Federal Office for Spatial Development annually publishes a report analysing all external effects of transport (including costs and benefits). The most recent estimates for 2016 correspond to total external costs of transport of about 2.3 billion Swiss francs (external costs related to climate contributing about 200 million Swiss francs), of which slightly less than one billion Swiss francs are covered by the heavy vehicle charge (*ARE*, 2019).

In 2008, Switzerland introduced the CO_2 levy on heating and process fuel to set an incentive for a more efficient use of fossil fuels, promote investment in energy-efficient technologies and the use of low-carbon or carbon-free energy sources (section 3.2.5). Companies, especially those with substantial CO_2 emissions from use of heating and process fuels, may apply for exemption from the CO_2 levy on heating and process fuels, provided the company commits to emission reductions (section 3.2.7). The company has to elaborate an emission reduction target based on the technological potential and economic viability of various measures within the company. While the proceeds from the CO_2 levy on heating and process fuels were initially to be fully refunded to the Swiss population (on a per capita basis) and to the Swiss economy (in proportion to wages paid), a parliamentary decision of June 2009 earmarked a third of the revenues from the CO_2 levy on heating and process fuels for CO_2 relevant measures in the buildings sector (section 3.3.3). As of 1 January 2018, the funds for the national buildings refurbishment programme are limited to a maximum of 450 million Swiss francs per year (previously 300 million Swiss francs per year).

As analysed in detail in two studies, the overall economic impact of the Swiss climate policy is considered to be very small (*Ecoplan*, 2009; *FOEN*, 2010).

In general, Switzerland does not subsidise fossil fuels. However, depending on the definition, there are some policies in place that may be regarded as fossil fuel subsidies, but these policies are only applicable to small amounts of fossil fuels consumed in Switzerland. At the federal level, a few tax exemptions and reductions provide limited support to users of fossil fuels. Farmers, foresters, fishermen and the fuel use of snow cats are exempt from the mineral oil tax that is normally levied on sales of mineral oils, while public transport companies benefit from a reduced rate. These mineral oil tax exemptions in the specific sectors are listed in appendix 3 of the Swiss Federal Council's subsidy report (*Swiss Federal Council*, 2008). Moreover, the mineral oil tax refunds in the agriculture sector was subject to an examination by the Swiss Federal Audit Office. In the respective report published in August 2018, the Swiss Federal Audit Office recommends the preparation of a legislative revision to abolish the mineral oil tax refunds in the agriculture sector (economic support for agriculture should be provided entirely in the form of direct payments)[38]. Some vehicles are also exempt from the performance-related heavy vehicle charge, e.g. agricultural vehicles, vehicles used for the concessionary transport of persons or vehicles for police, fire brigade, oil and chemical emergency unit, civil protection and ambulances.

Worldwide subsidies for fossil fuels are estimated at 300 billion to 500 billion US dollars per year, depending on the level of energy prices. This huge market distortion does not only produce severe fiscal problems for the countries concerned, it also poses a major obstacle for enhanced investments in energy efficiency measures and renewable ener-

[38] https://www.efk.admin.ch/en/publications/economy-and-administration/economy-and-agriculture/3374-mineral-oil-tax-refunds-in-agriculture-federal-department-of-finance-federal-department-of-economic-affairs-education-and-research-federal-customs-administration-federal-office-for-agriculture.html

gies. Switzerland as a founding member of the Friends of Fossil Fuels Subsidy Reform supports the gradual and sustained phasing out of fossil fuel subsidies and the reduction of unnecessary market distortions. Furthermore, Switzerland contributes to the World Bank development project ESMAP (Energy Sector Management Assistance Program). This programme offers technical assistance for states that want to reform their fossil fuel subsidies. The 2016 Annual Report of ESMAP is also supported by Switzerland and provides the analytical basis for the implementation of such reforms.

Removing subsidies associated with the use of environmentally unsound and unsafe technologies

Switzerland does not subsidise the use of environmentally unsound and unsafe technologies.

Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end

Switzerland does not support any activities linked to the technological development of non-energy uses of fossil fuels in developing countries.

Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort

Switzerland is an active participant in the negotiations for a plurilateral Environmental Goods Agreement (EGA) at the World Trade Organisation with the aim to liberalise environmental goods, including the diffusion and transfer of less-greenhouse-gas-emitting advanced fossil fuel technologies.

Furthermore, Switzerland is supporting the improvement and refit of inefficient gas-fired power plants in developing countries and advocates the use of the most efficient technologies available. Several Swiss universities conduct research in the field of carbon capture and storage and cooperate with other research institutions, companies and universities primarily in Europe and northern America to further develop the technology. Currently, Switzerland is not supporting any least developed countries and other developing countries in the development of fossil fuel-fired power plants with carbon capture and storage technology, because Switzerland is of the view that the technology is not sufficiently mature and cost effective yet.

Strengthening the capacity of developing country Parties for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities

Switzerland supports through different projects the enhancement of efficiency in industrial production, i.e. ‘cleaner production’. These cleaner production projects promote eco-efficient means of production and better working conditions attained through technological improvements and behavioural changes in both management and staff in industrial companies and services. The resulting rise of economic and environmental efficiency and improved competitiveness is gained through the systematic optimisation of energy use, processing of raw material, more efficient use of resources and thus better protection of the environment.

Furthermore, there is a rising awareness and demand by consumers for environmentally sound products. In order to alleviate potential adverse economic impacts of corresponding national measures, Switzerland promotes and supports the development of international standards, especially with regard to the sustainable use of natural resources (including agricultural commodities), e.g. through the creation of sustainability standards, financial incentives and favourable framework conditions in developing countries.

Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies

Most developing and transition countries have, in recent years, taken important steps towards trade liberalisation, in order to align their trade policies with international trade agreements. The Swiss State Secretariat for Economic Affairs supports these efforts, because a multilaterally acknowledged and respected set of regulations for international transactions not only strengthens trade as such, but also creates more potent and legally secure markets to the benefit of all players.

The measures taken by the Swiss State Secretariat for Economic Affairs are aimed at creating the necessary conditions for earning additional income in the beneficiary countries and thereby contribute directly to the alleviation of poverty. The Swiss State Secretariat for Economic Affairs is focusing on three areas of intervention along the value chain: (i) enabling framework conditions for trade, (ii) international competitiveness, and (iii) improving market access.

Regarding market access, trade between developing and industrial countries is often insufficiently developed respectively not diversified enough. On one hand, in some developing countries there is still a lack of necessary production capacities, quality standards, transport infrastructure and know-how; on the other hand, tariff and non-tariff barriers to trade make direct access to markets more difficult.

Switzerland promotes access to Swiss markets by granting preferential tariffs on products from developing and emerging countries. In addition, the Swiss State Secretariat for Economic Affairs runs programmes for promoting imports to Switzerland and the rest of Europe. Easing market entry for products from disadvantaged countries is an important contribution to the promotion and diversification of trade, the increase of export revenues and thus to the economic development of the partner countries. Switzerland supports developing and transition countries in the following areas:

- Generalised system of preferences;
- Swiss Import Promotion Program[39];
- Promotion and strengthening of private voluntary social and environmental standards based on international multi-stakeholder approaches, such as Better Cotton, 4C (Common Code for the Coffee Community), Roundtable for Sustainable Biofuels, etc.

Finally, Switzerland is a strong supporter of the Extractive Industries Transparency Initiative. Switzerland acts based on the firm conviction that an efficient use of natural resources is an important driving force for sustainable economic growth, contributing to sustainable development and poverty reduction. The sustainable management of natural resources – as supported by the Extractive Industries Transparency Initiative principle and criteria including regular publication and audit of revenues – is key to mobilise the funds for diversification strategies.

Changes compared to the latest submission

There are no fundamental changes compared to the last submission.

3.14 Estimates of emission reductions and removals and the use of units from the market-based mechanisms and land use, land-use change and forestry activities

Detailed information on progress in the achievement of the quantified economy-wide emission reduction targets is provided in BR CTF table 4. The following points are noteworthy:

- Base year emissions (without land use, land-use change and forestry) are indicated in BR CTF table 4 according to the report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of Switzerland (FCCC/IRR/2016/CHE, see also section 2.1.2). Due to recalculations, the relevant base year emissions slightly differ from the respective values provided in Switzerland's most recent greenhouse gas inventory (as presented e.g. in BR CTF table 1);
- Base year emissions include emissions of all greenhouse gases (including indirect emissions of CO_2) from the sectors energy (1), industrial processes and product use (2), agriculture (3), and waste (5). See section 2.1.3 for more details;
- The contribution from LULUCF (i.e. KP-LULUCF for Switzerland) corresponds to the sum of emissions/removals for activities under Articles 3.3 and 3.4, offset against Switzerland's forest management reference level and the technical corrections to the forest management reference level. The forest management cap will be considered for the final accounting at the end of the commitment period;

[39] www.sippo.ch

- Switzerland will account for contributions from market-based mechanisms (including carried-over units as detailed below) at the end of the commitment period, therefore no annual numbers can be provided. However, as recommended by the UNFCCC expert review team during a previous review, Switzerland reports the amount of units from market-based mechanisms on the party holding accounts in the national registry at the end of 2018 as a provisional estimate. Consequently, the contributions from market-based mechanisms for the preceding years are included in the provisional estimate for 2018 and, thus, reported as 'IE' (included elsewhere). For 2018, the total number of 7'736'395 units is composed as follows: (i) number of units on the party holding accounts at the end of 2018 (1'941'872 CERs, see Tab. 11 in this report or Table 4 of RREG1_CH_2018_2_2), (ii) number of carried-over units from the first to the second commitment period of the Kyoto Protocol available on the previous period surplus reserve account (5'794'523 AAUs, see Tab. 11 in this report or Table 4 in RREG1_CH_2018_2_2), and (iii) there are currently no units on the retirement account for the second commitment period.

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4 Projections and total effect of policies and measures

In this chapter, Switzerland's greenhouse gas emission projections under the following three scenarios are reported:

- The 'with existing measures' (WEM) scenario, encompassing currently implemented and adopted policies and measures. The WEM scenario thus reflects the current state of legislation, also taking into account the stipulated strengthening of existing policies and measures (i.e. any strengthening foreseen under current legislation);
- The 'without measures' (WOM) scenario, excluding all implemented, adopted and planned policies and measures to the extent possible. However, autonomous diffusion of technological progress takes place also under the WOM scenario, leading to a gradual improvement of energy efficiency (which is obviously slower than under the WEM scenario);
- The 'with additional measures' (WAM) scenario, encompassing implemented, adopted and planned policies and measures. The WAM scenario thus reflects the target scenarios of the Swiss government up to 2030, taking into account – in addition to all policies and measures considered under the WEM scenario – the planned strengthening of existing policies and measures as well as new policies and measures that have not yet been put in concrete terms but are planned in order to reach the set targets for 2030. Beyond 2030, no concrete policies and measures are planned yet, meaning that the WAM scenario reflects the same emission reductions as the WEM scenario between 2030 and 2035.

Section 4.1 presents Switzerland's total greenhouse gas emissions projected under the WEM, WOM and WAM scenarios from 1990 to 2035, disaggregated by sector and by gas. The projections are presented relative to actual and unadjusted inventory data for the preceding years (*FOEN*, 2019a). An overview of measures considered under the different scenarios and details about the historical and projected key underlying assumptions driving the emission scenarios are provided in this section as well. In section 4.2, the assessment of the aggregate effect of policies and measures is discussed. Information on the methodology applied as well as the underlying assumptions specific to each sector are presented in section 4.3.1 for the energy sector (including transport), in section 4.3.2 for the industrial processes and product use sector, in section 4.3.3 for the agriculture sector, in section 4.3.4 for the land use, land-use change and forestry sector, in section 4.3.5 for the waste sector, in section 4.3.6 for indirect CO_2 emissions, and in section 4.3.7 for international transport. Section 4.3.8 and section 4.3.9 present major changes since Switzerland's last submission and information on the sensitivity analysis, respectively. BR CTF tables 5 and 6(a) to 6(c) provide a summary of Switzerland's updated projections, however, due to technical constraints of the BR CTF platform, the projections could only be reported for the years up to 2030 in these tables.

4.1 Projections

4.1.1 Policies and measures considered under the WEM, WOM and WAM scenarios

Tab. 21 gives an overview of the policies and measures considered under the different scenarios; details regarding each policy and measure are discussed in chapter 2.

Tab. 21 > Policies and measures considered under the WEM, WOM and WAM scenarios (policies and measures marked with a dot are considered under the respective scenario). The bifurcation points for the WEM and WOM scenarios are shown in Tab. 27. Under the WAM scenario, some measures are strengthened compared to the WEM scenario.

Measure	Section in chapter 2	Sector	WEM	WOM	WAM	Remark
First CO_2 Act (1999)	3.2.2	Cross-sectoral	●		●	
Second CO_2 Act (2011)	3.2.3	Cross-sectoral	●		●	
Third CO_2 Act (2021)	3.2.4	Cross-sectoral			●	Planned policy and measure.
CO_2 levy on heating and process fuels	3.2.5	Cross-sectoral	●		●	WAM strengthened compared to WEM.
Emissions trading scheme	3.2.6	Cross-sectoral	●		●	WAM strengthened compared to WEM.
Negotiated reduction commitments (for exemption from the CO_2 levy)	3.2.7	Cross-sectoral	●		●	
SwissEnergy programme	3.3.2	Energy	●		●	The Swiss Federal Office of Energy refrains from estimating the mitigation impact of the SwissEnergy programme (for explanations see section 3.3.2). In contrast, *EPFL and Infras* (2016) include this policy and measure for the calculation

						of greenhouse gas emission projections.
National buildings refurbishment programme	3.3.3	Energy	●		●	WAM strengthened compared to WEM.
Building codes of the cantons	3.3.4	Energy	●		●	WAM strengthened compared to WEM.
Exemption from electricity network surcharge	3.3.5	Energy	●		●	
Obligation to offset emissions from gas-fired combined-cycle power plants	3.3.6	Energy	●		●	
Negotiated reduction commitment of municipal solid waste incineration plant operators	3.3.7	Energy				This policy and measure points at the net emissions of municipal solid waste incineration plants, i.e. it is expected that emission reductions are achieved mainly by indirect savings thanks to the additional production of electricity and heat as well as the recovery of metals from the bottom ash. In particular the latter may indirectly reduce greenhouse gas emissions outside Switzerland. For these reasons, the policy and measure is not considered for the projections (all scenarios).
CO_2 emission regulations for newly registered vehicles	3.4.2	Transport	●		●	WAM strengthened compared to WEM.
Energy label for new motor vehicles	3.4.3	Transport	●		●	
Climate Cent	3.4.4	Transport	●		●	
Partial compensation of CO_2 emissions from motor fuel use	3.4.5	Transport	●		●	WAM strengthened compared to WEM.
Heavy vehicle charge	3.4.6	Transport	●		●	
Mineral oil tax reduction on biofuels and natural gas	3.4.7	Transport	●		●	
International exhaust gas regulations (NMVOC)	3.4.8	Transport	●		●	Relevant for indirect CO_2 emissions.
Inclusion of aviation in the emissions trading scheme	3.4.9	Transport			●	Planned policy and measure.
CO_2 emissions standards for aircraft	3.4.10	Transport			●	
Carbon offsetting and reduction scheme for international civil aviation (CORSIA)	3.4.11	Transport			●	Planned policy and measure.
Provisions relating to substances stable in the atmosphere (HFCs, PFCs, SF_6, NF_3)	3.5.2	IPPU	●		●	WAM strengthened compared to WEM.
Ordinance on Air Pollution Control	3.5.3	IPPU	●		●	Relevant for indirect CO_2 emissions.
NMVOC incentive fee	3.5.4	IPPU	●		●	Relevant for indirect CO_2 emissions.
Proof of ecological performance to receive direct payments	3.6.2	Agriculture	●	●	●	Because the bifurcation point of the WEM and WOM scenarios of this measure is 2011 (Tab. 27), most of the mitigation impact provided in section 3.6.2 and Tab. 18 is reflected in all scenarios (as the mitigation impact reported in Tab. 18 is mostly achieved in the early 1990s).
Resource programme (subsidies for a more efficient use of natural resources)	3.6.3	Agriculture			●	
Climate strategy for agriculture	3.6.4	Agriculture			●	
Agricultural policy 2014–2017 and 2018–2021	3.6.5	Agriculture	●		●	
Forest Act (sustainable forest management and forest area conservation)	3.7.2	LULUCF	●		●	
Wood Action Plan	3.7.3	LULUCF	●		●	
Measures within Forest Policy 2020	3.7.4	LULUCF	●		●	For additional details regarding the accounting of the mitigation impact of this policy and measure see section 3.7.4.
Forest Act (changes due to revision 2017)	3.7.5	LULUCF	●		●	
Ban on landfilling of combustible waste	3.8.2	Waste	●		●	
Ordinance on the Avoidance and Management of Waste	3.8.3	Waste	●		●	

IPPU, industrial processes and product use; LULUCF, land use, land-use change and forestry

4.1.2 Key underlying assumptions

To provide a general overview of the drivers of Switzerland's greenhouse gas emission scenarios, Tab. 22 shows key underlying assumptions used for the modelling of the WEM, WOM and WAM scenarios (the information provided corresponds to the information in BR CTF table 5). Population is assumed to increase considerably over the coming decades. The projected increase in population is dominated by changes in migration, as cases of death will soon be

higher than number of births (details regarding the projection of population are available on the website of the Swiss Federal Statistical Office[40]). The projections of other key underlying assumptions such as the gross domestic product, the energy reference area and transport growth (passenger transport, number of passenger cars, number of other vehicles) are directly related to the projection of population. Indeed, Switzerland's gross domestic product, which also strongly influences energy consumption and greenhouse gas emissions, is assumed to increase considerably over the coming decades. The projection of the energy reference area – i.e. the sum of gross floor areas, above and below ground, which must be heated in order to be used – is also closely related to the projection of population, but also reflects the increasing demand for living area per capita and fewer persons per household (Tab. 22 shows the total energy references area, including household, services and industries). The projection of heating degree days follows the climate scenarios established for Switzerland (see chapter 6 of Switzerland's seventh national communication and third biennial report for additional details, in particular section 6.2.8 on page 172ff). While for historical years the heating degree days reflect the observed natural variability of meteorological conditions (mainly during winter), a smooth trend is assumed for projected years reflecting the expected average meteorological conditions. Accordingly, for future years the greenhouse gas emissions scenarios are based on average meteorological conditions, but actual emissions may vary substantially from year to year. The projections of international energy prices reflect the values used by the International Energy Agency and the European Union.

Tab. 22 > Historical and projected key underlying assumptions used for the modelling of Switzerland's greenhouse gas emission projections (relevant for all scenarios). See section 6.2.8 of Switzerland's seventh national communication for more details about heating degree days.

Key underlying assumptions	Historical							Projected			
	1990	1995	2000	2005	2010	2015	2017	2020	2025	2030	2035
Population (31 December, million inhabitants)	6.75	7.06	7.20	7.46	7.86	8.33	8.48	8.76	9.16	9.54	9.86
Gross domestic product (prices 2015, billion Swiss francs)	443	445	499	537	599	646	668	701	751	799	850
IEA crude oil price (prices 2015, US dollars per barrel)	36.5	25.1	37.6	60.5	84.9	51.0	63.4	82.0	104.5	127.0	137.0
European Union import price for natural gas (prices 2015, US dollars per Mbtu)	4.2	2.9	4.3	6.9	8.2	7.0	7.1	7.3	9.2	11.1	12.1
Energy reference area (in million square meters)	543	588	630	664	697	737	751	799	831	863	886
Heating degree days	3'203	3'397	3'081	3'518	3'586	3'075	3'233	3'244	3'154	3'064	2'974
Passenger transport (billion vehicle kilometres)	42'649	44'131	45'613	48'281	50'949	55'114	55'716	56'618	58'628	60'471	62'032
Number of passenger cars (1000 vehicles)	2'985	3'229	3'545	3'861	4'076	4'458	4'550	4'689	4'824	4'893	4'918
Number of other vehicles (1000 vehicles)	1'046	985	1'030	1'099	1'177	1'326	1'340	1'360	1'389	1'420	1'447

EPFL and Infras (2016); *EPFL* (2017); *Infras* (2017)

4.1.3 Results

Tab. 23 and Tab. 24 provide a general overview of the projections of Switzerland's greenhouse gas emissions under the WEM, WOM and WAM scenarios, detailed by sector and by gas (the tables complement the results presented in BR CTF table 6, in particular they also show the projections up to 2035). For a direct comparison with Switzerland's emissions reduction targets, the total emissions presented in the tables and figures of this chapter are composed as follows:

- Emissions of all greenhouse gases from the sectors 1 'Energy', 2 'Industrial processes and product use', 3 'Agriculture' and 5 'Waste' are included;
- Emissions from sector 6 'Other' are excluded;
- Indirect CO_2 emissions are included (for details see section 1.2.4 and section 2.1.3), with the exception of indirect CO_2 emissions from sector 6 'Other', as this sector is not included at all in Switzerland's emission reduction targets;
- While greenhouse gas emissions and removals from land use, land-use change and forestry are accounted for by an activity-based approach at the end of the commitment period (see section 2.1.5), they are excluded from

[40] https://www.bfs.admin.ch/bfs/en/home/statistics/population/population-projections/national-projections.html

the totals presented in this chapter. However, the evolutions for the different scenarios for sector 4 'Land use, land-use change and forestry' are reported separately and briefly discussed;

- Greenhouse gas emissions from international transport are excluded, but to increase transparency, they are reported separately and briefly discussed;
- To be fully consistent with Switzerland's emission reduction target, the values for Switzerland's base year emissions should actually be taken from the update to Switzerland's second initial report (*FOEN*, 2016d, see also FCCC/IRR/2016/CHE). However, to simplify matters (and because the differences are negligible), relative evolutions in this chapter are provided with regard to the emissions in 1990 according to Switzerland's most recent greenhouse gas inventory submission.

The evolution of total greenhouse gas emissions under the WEM, WOM and WAM scenarios as relevant for Switzerland's emission reduction targets is displayed in Fig. 15, while the various panels in Fig. 16 and Fig. 17 present the disaggregation by sector and gas, respectively. To provide more details for the energy sector and to allow for a distinction of the contribution of transport[41], the evolution of the different source categories of sector 1 'Energy' (1A1, 1A2, 1A3, 1A4, 1A5, and 1B) under the WEM, WOM and WAM scenarios is shown in Fig. 18 and Fig. 19. Finally, Fig. 20 shows the evolution of indirect CO_2 emissions. In brief, the three scenarios (emissions as relevant for Switzerland's emission reduction targets) are characterised as follows:

- **'With existing measures' (WEM) scenario:** By 2020, 2030 and 2035, Switzerland's total greenhouse gas emissions under the WEM scenario are projected to decrease to 85.4 per cent, 77.4 per cent and 74.9 per cent of the emissions in 1990, respectively. While the source category covering residential and commercial/institutional buildings (1A4) dominated total emissions in 1990, its emissions gradually decreased and are projected to continue on a decreasing pathway, reaching a reduction of 31.9 per cent by 2020 compared to 1990 (Fig. 19). Emissions from transport (1A3), on the other hand, increased considerably (by 13.7 per cent) between 1990 and 2008, exceeding emissions from residential and commercial/institutional buildings by 2007. Emissions from the transport sector are largely driven by passenger cars. Only recently, efforts to reduce specific vehicle emissions seem to become effective. Accordingly, thanks to the CO_2 emission regulations for newly registered vehicles stipulated in the second CO_2 Act (section 3.4.2), as well as thanks to the autonomous technological progress, greenhouse gas emissions from the transport sector are projected to decrease over the coming years. The emission reduction projected to be achieved by 2020 is 10.9 per cent compared to the highest level in 2008, meaning that emissions from the transport sector are still 1.3 per cent above the emissions in 1990. Emission reductions from the source categories covering residential and commercial/institutional buildings (1A4) as well as transport (1A3) dominate the projected evolution of total greenhouse gas emissions under the WEM scenario. Emissions from other source categories remain about stable and/or are of minor importance, with the exception of the F-gases, where projections suggest the peaking of emissions before 2020 and a decline thereafter (Fig. 17);
- **'Without measures' (WOM) scenario:** Under the WOM scenario, policies and measures are excluded as of the bifurcation points indicated in Tab. 27, i.e. with a few exceptions as early as 1990. Consequently, emissions under the WOM scenario show an increasing tendency until around 2010, followed by a slow decrease to 4.1 per cent above the emissions in 1990 by 2020 and to 0.5 per cent below the emissions in 1990 by 2030 and 2035. This decreasing trend after about 2010 is a result of autonomous technological progress improving the greenhouse gas efficiency also in the absence of (domestic) policies and measures. Under the WOM scenario (as under the WEM scenario), the source categories covering residential and commercial/institutional buildings (1A4) and transport (1A3) are mainly responsible for the general decrease in total greenhouse gas emissions in the coming years, to some extent also the manufacturing industry (1A2; see Fig. 18 and Fig. 19). In contrast, emissions from energy industries (1A1) are projected to increase, in particular in 2019, 2029 and 2033, i.e. at the time when nuclear power plants are decommissioned and assumed to be replaced by gas-fired combined-cycle power plants (Fig. 21)[42]. Accordingly, greenhouse gas emissions from energy industries (1A1) exceed, by 2030, the

[41] In BR CTF table 6, 'energy' consists of the greenhouse gas emissions from the source categories 1A1, 1A2, 1A4, 1A5 and 1B (which are targeted with the policies and measures presented in section 3.3), while 'transport' consists of the greenhouse gas emissions from source category 1A3 (which are targeted with the policies and measures presented in section 3.4).

[42] In contrast, under the WEM scenario nuclear power plants are replaced by gas-fired combinded-cycle power plants only to a minor extent (Fig. 21). Accordingly, the respective increases in emissions are hardly visible in total emissions of the energy sector, but emerge when looking at emissions of source category 1A1 separately (Tab. 23 and Fig. 18).

emissions in 1990 by about 3.9 million tonnes of CO_2 equivalents. A continuously increasing trend is also projected for emissions from the industrial processes and product use sector, which, driven by emissions of HFCs, increase to 33.2 per cent above the emissions in 1990 by 2020, to 32.2 per cent above the emissions in 1990 by 2030, and to 32.6 per cent above the emissions in 1990 by 2035;

- **'With additional measures' (WAM) scenario:** By 2030 and 2035, Switzerland's total greenhouse gas emissions under the WAM scenario are projected to decrease to 65.3 and 62.0 per cent of the emissions in 1990, respectively. Compared to the WEM scenario, emissions decrease faster, as new policies and measures are introduced and existing policies and measures are strengthened beyond the strengthening already stipulated under current legislation (i.e., under the WEM scenario). While the energy sector (in particular the source categories covering residential and commercial/institutional buildings as well as transport) is mainly responsible for the additional emission reductions, contributions also come from the agriculture sector and from the reduction of emissions of F-gases within the industrial processes and product use sector (Fig. 19). After 2030, the decrease of emissions under the WAM scenario slows down, as additional policies and measures need to be planned yet.

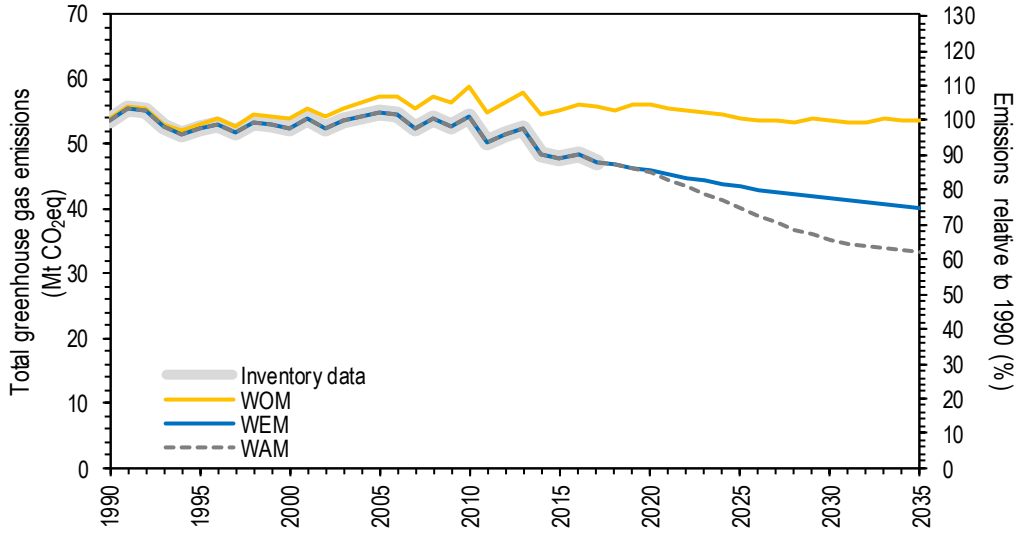
Regarding **land use, land-use change and forestry**, the difference between the WEM and the WOM scenarios results from differing forest management practices, because all other parameters are identical for all scenarios (see section 4.3.4). Under the WEM scenario, harvesting is assumed to increase, making the land use, land-use change and forestry sector a net source, with differences between the WEM and the WOM scenarios of 1.7 million to 2.1 million tonnes of CO_2 equivalents over the period from 2020 to 2030 (after 2030, no significant changes in the evolution of the trends are projected with the current scenarios). However, the low harvesting rates assumed under the WOM scenario lead to an unsustainable forest stand in the long run and, amongst other effects, jeopardise the capacity of forests to adapt to climate change. Therefore, despite the positive (short-term) effect with regard to carbon sequestration, the WOM scenario is not considered a viable policy option. In more detail, the following emissions and removals from the land use, land-use change and forestry sector are projected under the different scenarios (see Tab. 33 for underlying assumptions):

- Under the WEM scenario, forest management leads to net emissions in the order of 0.1 million tonnes of CO_2 equivalents per year in the period from 2020 to 2030. The combined effects of afforestation, deforestation and forest management activities lead to total net emissions in the order of 0.2 million to 0.3 million tonnes of CO_2 equivalents in the period from 2020 to 2030. In total, the land use, land-use change and forestry sector produces net emissions of 0.9 million to 1.0 million tonnes of CO_2 equivalents per year in the period from 2020 to 2030 (Tab. 23);
- Under the WOM scenario, forest management leads to net removals of –1.5 million to –2.0 million tonnes of CO_2 equivalents in the period from 2020 to 2030. The forest category as a whole (i.e. afforestation, deforestation and forest management activities) acts as a net sink of –1.4 million to –1.9 million tonnes of CO_2 equivalents in the period from 2020 to 2030. In total, the land use, land-use change and forestry sector produces net removals of –0.7 million to –1.2 million tonnes of CO_2 equivalents in the period from 2020 to 2030 (Tab. 23);
- Under the WAM scenario, forest management leads to net emissions in the order of 1.1 million to 1.7 million tonnes of CO_2 equivalents in the period from 2020 to 2030. The aggregate effect of afforestation, deforestation and forest management activities leads to total net emissions in the order of 1.2 million to 1.8 million tonnes of CO_2 equivalents in the period from 2020 to 2030. In total, the land use, land-use change and forestry sector produces net emissions of 1.9 million to 2.6 million tonnes of CO_2 equivalents in the period from 2020 to 2030 (Tab. 23).

Regarding **international transport (bunkers)**, virtually all (more than 99 per cent, see Tab. 1) greenhouse gas emissions stem from aviation, while greenhouse gas emissions from navigation are of negligible importance. Greenhouse gas emissions from international transport are assumed to be the same under the WEM and WOM scenarios, while carbon neutral growth for an increasing share of air transport as of 2020 is assumed under the WAM scenario (see section 4.3.7 for details). Although the carbon neutral growth under the WAM scenario may at least partly be reached by emission compensations taking place outside the aviation sector, the full effect is attributed to the aviation sector itself. By 2030 and 2035, emissions from international transport are projected to increase to 132.8 and 136.5 per cent above the emissions in 1990 under the WEM and WOM scenario, respectively (i.e. emissions more than double). Under the WAM scenario, emission are projected to increase to 97.2 and 97.9 per cent above the emissions in 1990 by 2030 and 2035, respectively (i.e. emissions about double).

In this chapter, solely projections of domestic emissions under the different scenarios are provided, in agreement with the target of the second CO_2 Act which is defined as a 20 per cent domestic reduction by 2020 compared to 1990 (chapter 2). While Switzerland's focus indeed lies on domestic emission reductions, international carbon credits will play a subsidiary role in particular cases to reach international commitments (section 2.1.6), but these international carbon credits are not taken into account for the scenarios presented here.

Fig. 15 > Total greenhouse gas emissions under the WEM, WOM and WAM scenarios as relevant for Switzerland's emission reduction targets (i.e. including emissions of all greenhouse gases from the sectors 1, 2, 3 and 5, including indirect CO_2 emissions from these sectors, excluding direct and indirect emissions from sector 6, excluding emissions and removals from land use, land-use change and forestry, and excluding emissions from international transport). Also shown are actual inventory data for the years 1990 to 2017. The vertical axis to the right indicates emissions relative to 1990. Values are provided in Tab. 23 and Tab. 24. Year-to-year variations visible in all scenarios for the years 1990 to 2017 reflect the impact of meteorological conditions on heating demand (see also section 1.2.3). For projections up to 2035, a smooth trend of meteorological conditions is assumed (in line with the heating degree days shown in Tab. 22).



Tab. 23 > Greenhouse gas emissions under the WEM, WOM and WAM scenarios by sector. The total is shown as relevant for Switzerland's emission reduction targets (i.e. including emissions of all greenhouse gases from the sectors 1, 2, 3 and 5, including indirect CO_2 emissions from these sectors, excluding direct and indirect emissions from sector 6, excluding emissions and removals from land use, land-use change and forestry, and excluding emissions from international transport). See footnote 42 for a discussion of the emission trends in source category 1A1. From 1990 to 2017, the WEM and WAM scenarios correspond to actual inventory data.

		1990	1995	2000	2005	2010	2015	2017	2020	2025	2030	2035
		Mt CO_2eq										
Total as relevant for Switzerland's emission reduction targets	**WEM**	**53.6**	**52.4**	**52.5**	**54.8**	**54.2**	**47.9**	**47.2**	**45.8**	**43.4**	**41.5**	**40.2**
	WOM	**53.8**	**53.1**	**53.9**	**57.4**	**58.8**	**55.2**	**55.7**	**56.0**	**54.0**	**53.6**	**53.6**
	WAM	**53.6**	**52.4**	**52.5**	**54.8**	**54.2**	**47.9**	**47.2**	**45.7**	**40.1**	**35.0**	**33.3**
1 Energy	WEM	41.8	41.9	42.2	44.0	43.2	37.1	36.5	35.4	33.4	32.1	31.0
	WOM	42.0	42.3	43.2	45.9	46.7	43.1	43.4	43.9	42.0	41.6	41.6
	WAM	41.8	41.9	42.2	44.0	43.2	37.1	36.5	35.3	30.2	25.9	24.8
1A1 Energy industries	WEM	2.5	2.6	3.2	3.8	3.8	3.3	3.3	3.8	3.7	4.1	4.7
	WOM	2.5	2.7	3.2	3.8	4.0	4.1	4.4	5.1	5.2	6.5	7.7
	WAM	2.5	2.6	3.2	3.8	3.8	3.3	3.3	3.8	3.4	3.3	3.9
1A2 Manufacturing industries and construction	WEM	6.4	6.2	5.9	6.0	5.8	5.0	4.9	4.4	4.3	3.9	3.7
	WOM	6.5	6.2	6.0	6.1	6.0	5.6	5.5	5.6	5.3	5.1	5.1
	WAM	6.4	6.2	5.9	6.0	5.8	5.0	4.9	4.4	3.9	3.2	3.0
1A3 Transport	WEM	14.6	14.3	15.9	15.9	16.3	15.3	14.9	14.8	13.7	12.9	12.1
	WOM	14.6	14.3	16.0	16.2	17.0	16.1	15.9	15.8	15.1	14.7	14.2
	WAM	14.6	14.3	15.9	15.9	16.3	15.3	14.9	14.7	13.3	11.9	11.1
1A4 Other sectors	WEM	17.6	18.2	16.6	17.9	16.8	13.1	13.0	12.0	11.5	10.8	10.1
	WOM	17.8	18.6	17.5	19.4	19.3	16.9	17.2	16.9	16.0	14.9	14.3
	WAM	17.6	18.2	16.6	17.9	16.8	13.1	13.0	12.0	9.3	7.2	6.5
1A5 Military	WEM	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	WOM	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	WAM	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1B Fugitive emissions from oil and natural gas	WEM	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
	WOM	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
	WAM	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
2 Industrial processes and product use	WEM	3.6	2.9	3.1	3.8	4.0	3.9	3.9	3.6	3.2	2.7	2.4
	WOM	3.6	2.9	3.2	4.0	4.6	4.7	4.9	4.8	4.8	4.7	4.7
	WAM	3.6	2.9	3.1	3.8	4.0	3.9	3.9	3.6	3.1	2.5	2.2
3 Agriculture	WEM	6.8	6.5	6.2	6.1	6.2	6.1	6.1	6.0	6.0	6.0	6.0
	WOM	6.8	6.5	6.2	6.1	6.2	6.1	6.0	6.1	6.1	6.1	6.1
	WAM	6.8	6.5	6.2	6.1	6.2	6.1	6.1	6.0	6.0	5.8	5.5
5 Waste	WEM	1.1	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.6	0.7	0.7
	WOM	1.1	1.0	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.7	0.7
	WAM	1.1	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.6	0.7	0.7
Indirect CO_2 (excluding sector 6)	WEM	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	WOM	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
	WAM	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4 LULUCF (not included in the total)	*WEM*	*-2.5*	*-3.8*	*5.6*	*-2.5*	*-2.6*	*-2.2*	*-1.6*	*0.9*	*0.9*	*0.9*	*0.8*
	WOM	*-2.5*	*-3.8*	*5.6*	*-2.5*	*-2.6*	*-2.2*	*-1.6*	*-0.7*	*-1.2*	*-1.2*	*-1.3*
	WAM	*-2.5*	*-3.8*	*5.6*	*-2.5*	*-2.6*	*-2.2*	*-1.6*	*1.9*	*2.5*	*2.4*	*2.3*
International transport (not included in the total)	*WEM*	*3.2*	*3.7*	*4.7*	*3.6*	*4.3*	*5.0*	*5.4*	*5.8*	*6.6*	*7.3*	*7.5*
	WOM	*3.2*	*3.7*	*4.7*	*3.6*	*4.3*	*5.0*	*5.4*	*5.8*	*6.6*	*7.3*	*7.5*
	WAM	*3.2*	*3.7*	*4.7*	*3.6*	*4.3*	*5.0*	*5.4*	*5.8*	*6.1*	*6.2*	*6.2*

Tab. 24 > Greenhouse gas emissions under the WEM, WOM and WAM scenarios by gas. Values are shown as relevant for Switzerland's emission reduction targets (i.e. including emissions of all greenhouse gases from the sectors 1, 2, 3 and 5, including indirect CO_2 emissions from these sectors, excluding direct and indirect emissions from sector 6, excluding emissions and removals from land use, land-use change and forestry, and excluding emissions from international transport). From 1990 to 2017, the WEM and WAM scenarios correspond to actual inventory data. The maximum value for NF_3 is reach in the year 2010 (8.5 kilotonnes of CO_2 equivalents for the WEM and WAM scenarios and 12.7 kilotonnes of CO_2 equivalents for the WOM scenario).

		1990	1995	2000	2005	2010	2015	2017	2020	2025	2030	2035
		Mt CO_2eq										
Total as relevant for Switzerland's emission reduction targets	**WEM**	**53.6**	**52.4**	**52.5**	**54.8**	**54.2**	**47.9**	**47.2**	**45.8**	**43.4**	**41.5**	**40.2**
	WOM	**53.8**	**53.1**	**53.9**	**57.4**	**58.8**	**55.2**	**55.7**	**56.0**	**54.0**	**53.6**	**53.6**
	WAM	**53.6**	**52.4**	**52.5**	**54.8**	**54.2**	**47.9**	**47.2**	**45.7**	**40.1**	**35.0**	**33.3**
CO_2 (excluding LULUCF, excluding sector 6, excluding international transport)	WEM	44.2	43.4	43.6	45.8	45.0	38.7	38.2	37.0	35.0	33.5	32.3
	WOM	44.3	43.8	44.6	47.7	48.5	44.7	45.0	45.4	43.4	42.9	42.8
	WAM	44.2	43.4	43.6	45.8	45.0	38.7	38.2	36.9	31.8	27.4	26.1
CH_4 (excluding LULUCF, excluding sector 6, excluding international transport)	WEM	6.0	5.7	5.3	5.2	5.1	5.0	4.9	4.8	4.8	4.7	4.7
	WOM	6.0	5.8	5.4	5.3	5.3	5.2	5.1	5.1	5.0	5.0	4.9
	WAM	6.0	5.7	5.3	5.2	5.1	5.0	4.9	4.8	4.8	4.6	4.3
N_2O (excluding LULUCF, excluding sector 6, excluding international transport)	WEM	2.8	2.7	2.6	2.5	2.4	2.3	2.4	2.4	2.4	2.4	2.4
	WOM	2.8	2.7	2.6	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4
	WAM	2.8	2.7	2.6	2.5	2.4	2.3	2.4	2.4	2.4	2.3	2.2
HFCs	WEM	0.0	0.2	0.6	1.0	1.3	1.5	1.5	1.4	1.1	0.7	0.6
	WOM	0.0	0.2	0.7	1.3	1.9	2.2	2.4	2.4	2.6	2.6	2.8
	WAM	0.0	0.2	0.6	1.0	1.3	1.5	1.5	1.4	1.0	0.6	0.4
PFCs	WEM	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	WOM	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	WAM	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	WEM	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.1	0.1	0.1	0.1
	WOM	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2
	WAM	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.1	0.1	0.1	0.1
NF_3	WEM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	WOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	WAM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indirect CO_2 (excluding sector 6)	WEM	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	WOM	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
	WAM	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Fig. 16 > Greenhouse gas emissions under the WEM, WOM and WAM scenarios by sector as shown in Tab. 23. Also shown are actual inventory data for the years 1990 to 2017. See Fig. 18 for a more detailed disaggregation within the energy sector, in particular allowing for a distinction of the transport sector. For international transport, the WOM scenario (orange line hidden) is identical to the WEM scenario.

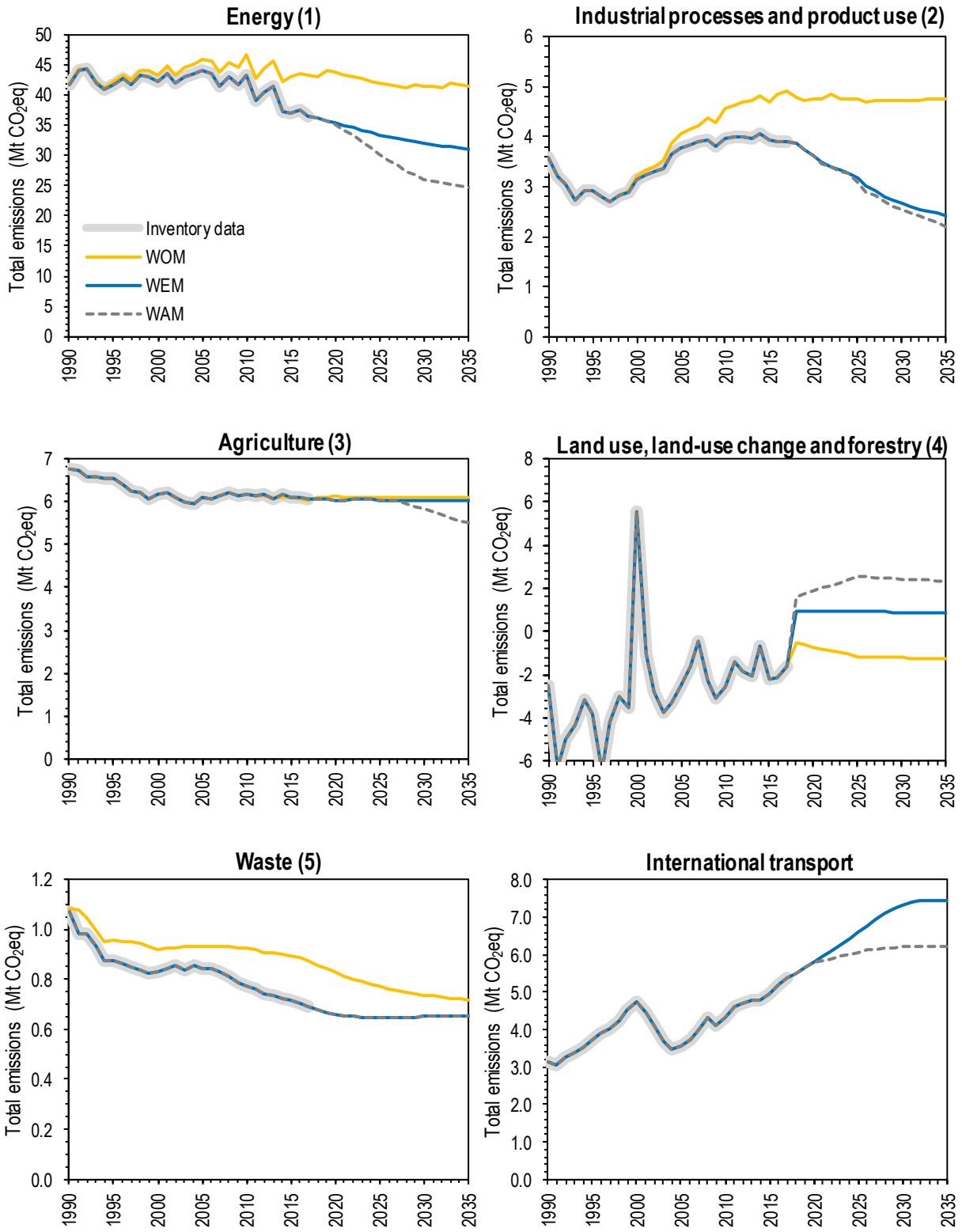


Fig. 17 > Greenhouse gas emissions under the WEM, WOM and WAM scenarios by gas as shown in Tab. 24. Also shown are actual inventory data for the years 1990 to 2017. The panel for SF_6 and NF_3 shows the sum of the two gases (SF_6 strongly dominates, see Tab. 24 for the individual contributions).

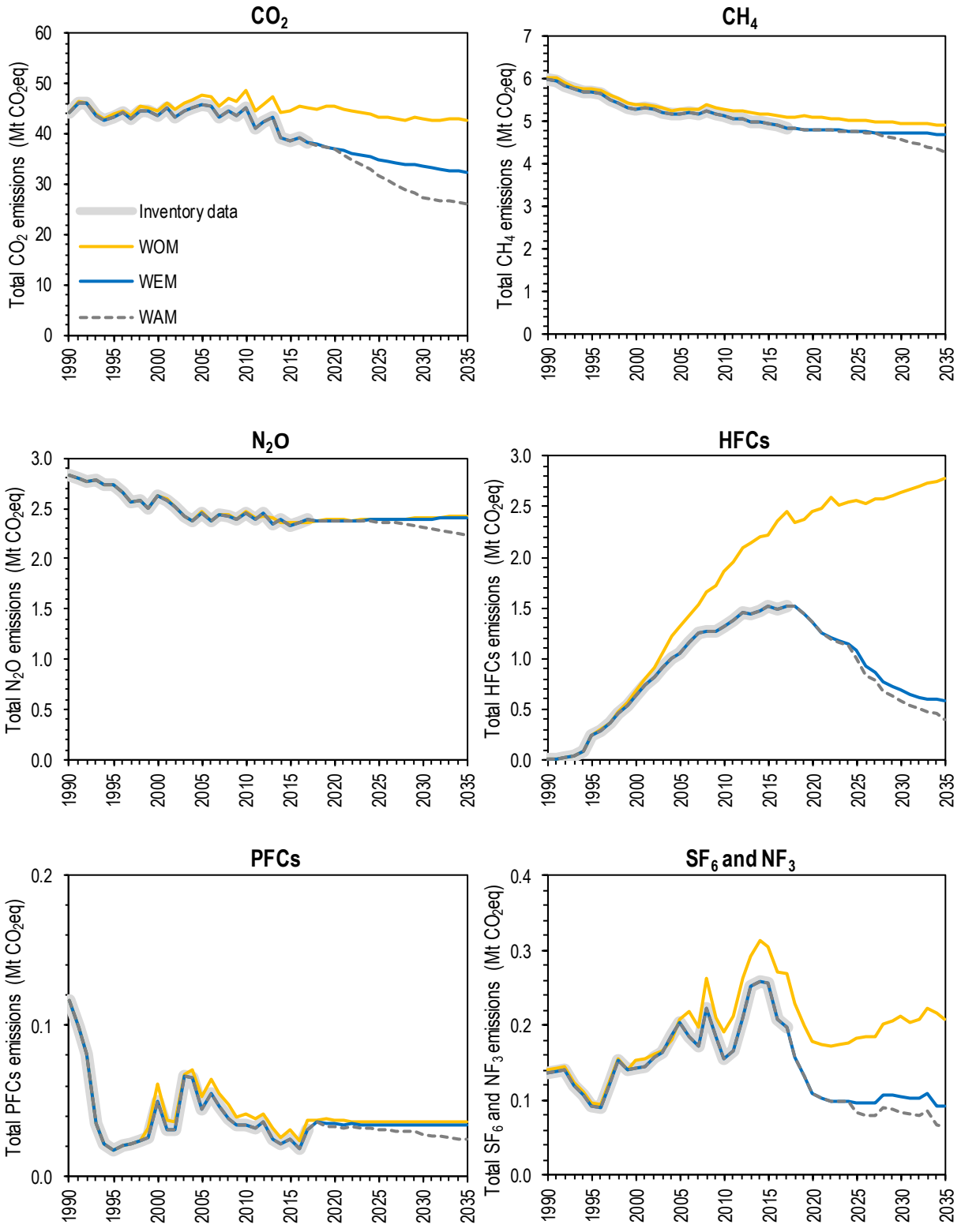


Fig. 18 > Greenhouse gas emissions in the different source categories of the energy sector under the WEM, WOM and WAM scenarios as shown in Tab. 23. Also shown are actual inventory data for the years 1990 to 2017. 'Transport' corresponds to source category 1A3. Source category 1A4 is dominated by greenhouse gas emissions from residential and commercial use of fossil fuels, while source category 1A5 covers greenhouse gas emissions from non-road military vehicles including military aviation (see section 1.2.3 for more details). For the source categories 1A5 'Other' and 1B 'Fugitive emissions from oil and natural gas' the WOM scenarios (hidden orange lines) are identical to the WEM scenarios.

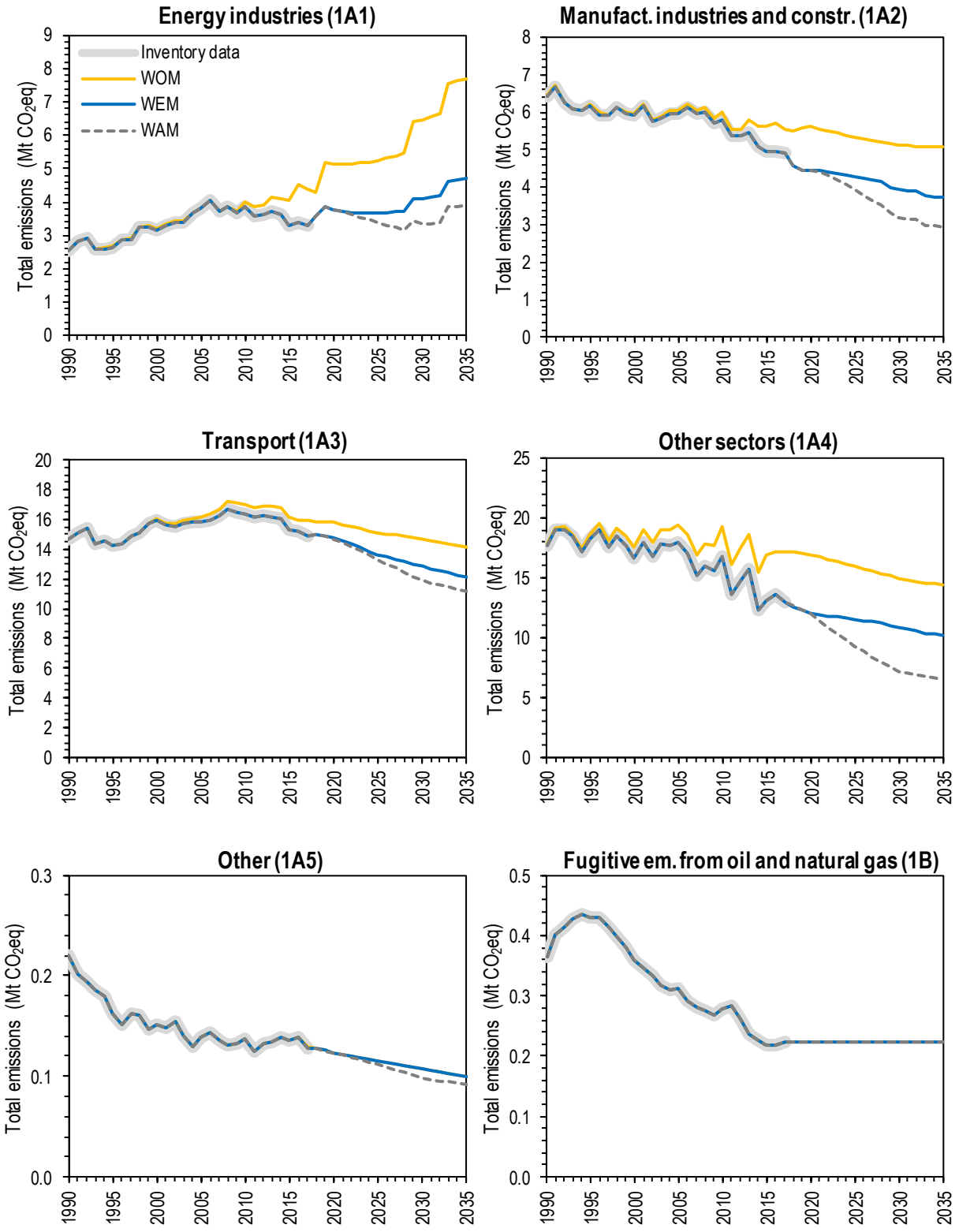


Fig. 19 > Contribution of the different sectors to the evolution of total greenhouse gas emissions under the WEM, WOM and WAM scenarios. Emissions are considered as relevant for Switzerland's emission reduction targets (i.e. including emissions of all greenhouse gases from the sectors 1, 2, 3 and 5, including indirect CO_2 emissions from these sectors, excluding direct and indirect emissions from sector 6, excluding emissions and removals from land use, land-use change and forestry, and excluding emissions from international transport). Contributions from the energy sector are further disaggregated to illustrate the most important source categories (1A1, 1A2, 1A3, 1A4, 1A5, and 1B).

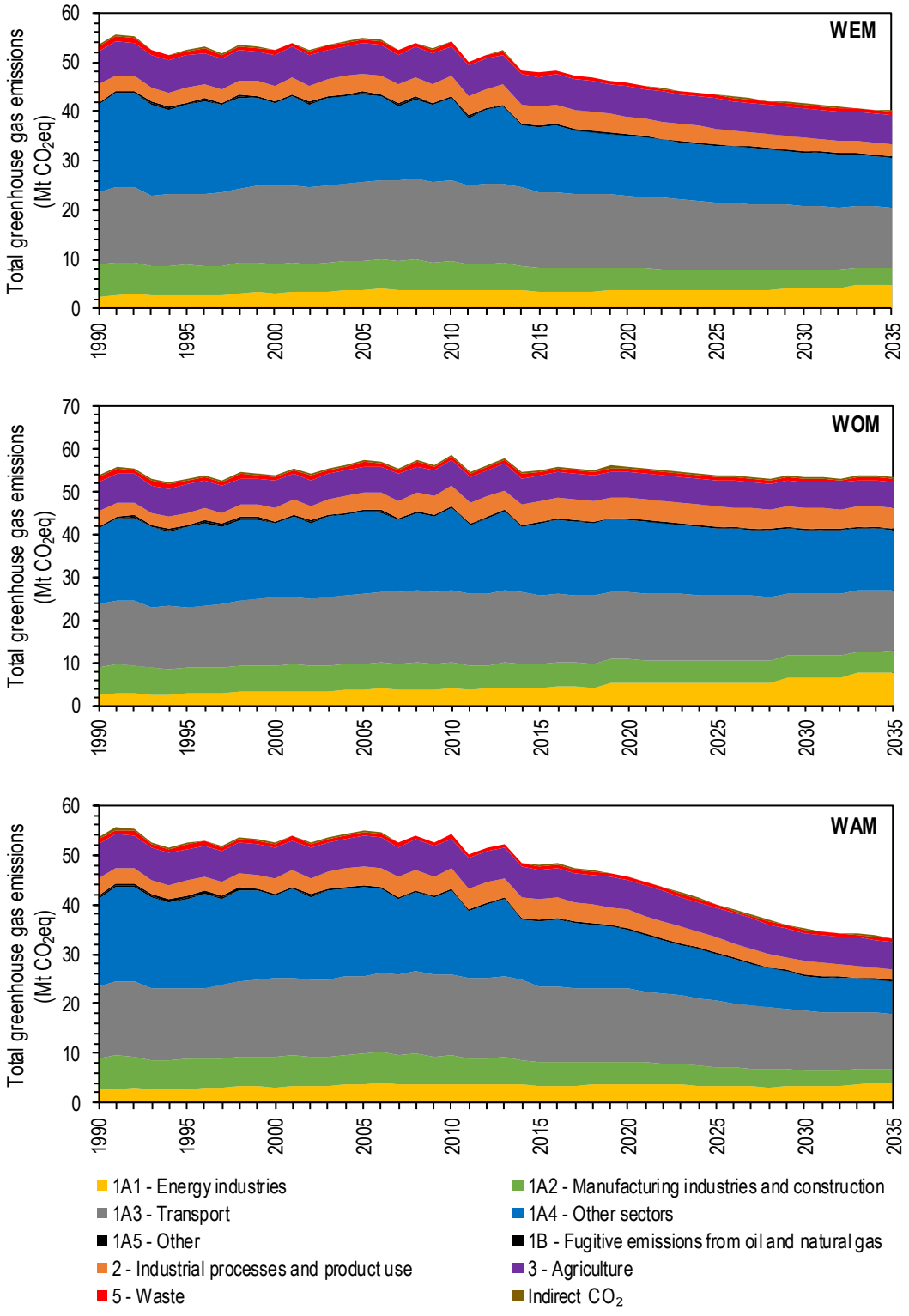
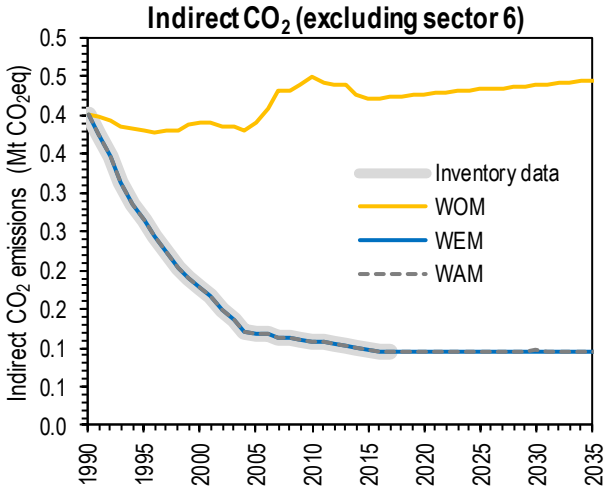


Fig. 20 > Indirect CO_2 emissions under the WEM, WOM and WAM scenarios (excluding sector 6) as shown in Tab. 23. Also shown are actual inventory data for the years 1990 to 2017.



4.2 Assessment of aggregate effect of policies and measures

4.2.1 Total effect of currently implemented and adopted policies and measures

The total effect of currently implemented and adopted policies and measures – calculated based on the difference between the emissions under the WOM and WEM scenarios – is presented in Tab. 25 by gas and in Tab. 26 by sector. For 2020, the total effect of currently implemented and adopted policies and measures is estimated at a reduction of 10.2 million tonnes of CO_2 equivalents (annual reduction, not cumulative). This estimate depends on the assumptions regarding the evolution of the underlying drivers and contains considerable uncertainties (see sensitivity analysis in section 4.3.9). Further, the total effect of currently implemented and adopted policies and measures also depends on the bifurcation points of the WEM and WOM scenarios, which are shown in Tab. 27. The contributions of each sector are discussed in the following. Importantly, the total effect of policies and measures as presented in this chapter does not necessarily correspond to the sum of the mitigation impacts of individual policies and measures as reported in chapter 3. Among the reasons are (i) differences in the policies and measures considered as well as in the bifurcation points, (ii) differences in the methodologies applied, and (iii) interactions of policies and measures only considered when estimating the total effect but not the individual mitigation impact.

Tab. 25 > Total effect of currently implemented and adopted policies and measures by gas. Emissions are considered as relevant for Switzerland's emission reduction targets (i.e. including emissions of all greenhouse gases from the sectors 1, 2, 3 and 5, including indirect CO_2 emissions from these sectors, excluding direct and indirect emissions from sector 6, excluding emissions and removals from land use, land-use change and forestry, and excluding emissions from international transport). Shown are the differences between the WOM and WEM scenarios as presented in Tab. 24.

	1990	1995	2000	2005	2010	2015	2017	2020	2025	2030	2035
	Mt CO_2eq (annual reduction, not cumulative)										
CO_2	0.2	0.4	1.0	1.9	3.5	6.0	6.9	8.4	8.4	9.4	10.5
CH_4	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.2	0.2
N_2O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HFCs/PFCs/SF_6/NF_3	0.0	0.0	0.1	0.3	0.6	0.8	1.0	1.16	1.6	2.1	2.3
Indirect CO_2	0.0	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
Total as relevant for Switzerland's emission reduction targets	**0.2**	**0.7**	**1.4**	**2.5**	**4.6**	**7.3**	**8.4**	**10.2**	**10.6**	**12.0**	**13.4**

Tab. 26 > Total effect of currently implemented and adopted policies and measures by sector. Emissions are considered as relevant for Switzerland's emission reduction targets (i.e. including emissions of all greenhouse gases from the sectors 1, 2, 3 and 5, including indirect CO_2 emissions from these sectors, excluding direct and indirect emissions from sector 6, excluding emissions and removals from land use, land-use change and forestry, and excluding emissions from international transport). Shown are the differences between the WOM and WEM scenarios as presented in Tab. 23.

	1990	1995	2000	2005	2010	2015	2017	2020	2025	2030	2035
	Mt CO_2eq (annual reduction, not cumulative)										
1 Energy	0.2	0.4	1.0	1.9	3.5	6.0	6.9	8.4	8.5	9.5	10.6
2 Industrial processes and product use	0.0	0.0	0.1	0.3	0.6	0.8	1.0	1.2	1.6	2.1	2.3
3 Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
5 Waste	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1
Indirect CO_2	0.0	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
Total as relevant for Switzerland's emission reduction targets	**0.2**	**0.7**	**1.4**	**2.5**	**4.6**	**7.3**	**8.4**	**10.2**	**10.6**	**12.0**	**13.4**

Tab. 27 > Bifurcation points of the WEM and WOM scenarios for the individual sectors. For the WEM and WAM scenarios, historical data from the greenhouse gas inventory are used for all available years, i.e. until 2017. The WEM and WAM scenarios thus start after 2017, with the WAM scenario increasingly deviating from the WEM scenario as planned policies and measures (or the planned strengthening of implemented policies and measures) come into force.

Sector	Bifurcation points of the WOM and WEM scenarios
Energy sector (including transport)	The bifurcation point is 1990. Some policies and measure in the energy sector already have a minor mitigation impact in 1990 (see *EPFL and Infras* (2016) and *EPFL* (2017) for details).
Industrial processes and product use sector	No measures specifically targeting process emissions of CO_2, CH_4 and N_2O are considered under any of the scenarios. Regarding F-gases, the bifurcation point is 1990.
Agriculture sector	The bifurcation point is 2011 (first calculation with different assumptions for the WEM and WOM scenarios for the following year, see section 4.3.3 for more explanations).
Land use, land-use change and forestry sector	The bifurcation point is 2017 (first calculation with different assumptions for the WEM and WOM scenarios for the following year, see section 4.3.4 for more explanations).
Waste sector	The bifurcation point is 1990.
Indirect CO_2	The bifurcation point is 1990.

Energy (including transport)

For 2020, the aggregate effect of currently implemented and adopted policies and measures in the energy sector (including transport) is estimated at 8.4 million tonnes of CO_2 equivalents (Tab. 26), i.e. the energy sector is expected to contribute about 83 per cent to the aggregate effect of currently implemented and adopted policies and measures. For 2030 and 2035, the aggregate effect of currently implemented and adopted policies and measures in the energy sector (including transport) is estimated at 9.5 and 10.6 million tonnes of CO_2 equivalents, respectively. As required by the reporting guidelines, the estimated and expected effects of individual policies and measures are addressed in chapter 2. Importantly, the model for the calculation of the scenarios in the energy sector as applied by *EPFL and Infras* (2016) and *EPFL* (2017) (see section 4.3.1 for details) does not simply sum up the effects of individual policies and measures, but also considers the interactions and, thus, the combined effects of policies and measures. *EPFL and Infras* (2016) and *EPFL* (2017) estimate that in the energy sector the combined effects of policies and measures are responsible for about 12 per cent of the aggregate effect of currently implemented and adopted policies and measures. The aggregate effect of currently implemented and adopted policies and measures in the energy sector is strongly modulated by the introduction of renewable energy sources and the potential need for gas-fired combined-cycle power plants as a replacement for nuclear power plants (Fig. 21).

Industrial processes and product use

As no policies and measures affecting process emissions of CO_2, CH_4 and N_2O from industry are considered, all scenarios are identical and, thus, no aggregate effects of policies and measures are expected for these gases. However, policies and measures with regard to F-gases substantially influence emissions of HFCs, PFCs, SF_6, and NF_3 from the industrial processes and product use sector. In particular, the phase-out of fluorinated refrigerants assumed under the WEM scenario leads to a substantial reduction of total greenhouse gas emissions of 1.2 million tonnes of CO_2 equivalents in 2020, 2.1 million tonnes of CO_2 equivalents in 2030, and 2.3 million tonnes of CO_2 equivalents in 2035 compared to the WOM scenario (Tab. 25 and Tab. 26; annual reduction, not cumulative).

Agriculture

For 2020, the aggregate effect of currently implemented and adopted policies and measures in the agriculture sector is estimated at 0.1 million tonnes of CO_2 equivalent, remaining about constant for each year up to 2035 (Tab. 26). Both CH_4 and N_2O emission reductions contribute about equally to the aggregate effect of currently implemented and adopted policies and measures in the agriculture sector. The bifurcation point of the WEM and WOM scenarios is 2011 and not 1990 as for other sectors (Tab. 27), because retrospectively it is impossible to elaborate meaningful WOM scenarios for this sector (see also section 4.3.3).

Waste

For the waste sector, the aggregate effect of currently implemented and adopted policies and measures can almost completely be attributed to the ban on landfilling of combustible waste (section 3.8.2), which is considered for the WEM and the WAM scenarios, but not for the WOM scenario (section 4.3.5). The effect of the ban on landfilling of combustible waste is slightly reduced due to incentives for increasing biogas production, which lead to somewhat increased fugitive CH_4 emission under the WEM and WAM scenarios, compared to the WOM scenario. Overall, emissions under the WOM scenario exceed emissions under the WEM scenario by 0.2 million tonnes of CO_2 equivalents in 2020 and by 0.1 million tonnes of CO_2 equivalents in 2030 and 2035 (Fig. 16).

4.2.2 Total additional effect of planned policies and measures

The total additional effect of planned policies and measures – calculated based on the difference between the emissions under the WEM and WAM scenarios – is presented by gas in Tab. 28 and by sector in Tab. 29. The starting points of the various planned policies and measures are detailed under the respective sections in chapter 2. For 2030, the total additional effect of planned policies and measures is estimated at a reduction of 6.5 million tonnes of CO_2 equivalents (annual reduction, not cumulative), where the main contribution comes from the energy sector. For the 2035, the total additional effect of planned policies and measures is estimated at a reduction of 6.9 million tonnes of CO_2 equivalents. Between 2030 and 2035, the additional effect of planned policies and measures comes from agriculture and F-gases (no planned policies and measures are so far considered for the energy sector).

Tab. 28 > Total additional effect of planned policies and measures by gas. Emissions are considered as relevant for Switzerland's emission reduction targets (i.e. including emissions of all greenhouse gases from the sectors 1, 2, 3 and 5, including indirect CO_2 emissions from these sectors, excluding direct and indirect emissions from sector 6, excluding emissions and removals from land use, land-use change and forestry, and excluding emissions from international transport). Shown are the differences between the WEM and WAM scenarios as presented in Tab. 24.

	1990	1995	2000	2005	2010	2015	2017	2020	2025	2030	2035
	Mt CO_2eq (annual reduction, not cumulative)										
CO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.2	6.1	6.1
CH_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4
N_2O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
HFCs/PFCs/SF_6/NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
Indirect CO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total (excluding LULUCF, including indirect CO_2)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**3.3**	**6.5**	**6.9**

Tab. 29 > Total additional effect of planned policies and measures by sector. Emissions are considered as relevant for Switzerland's emission reduction targets (i.e. including emissions of all greenhouse gases from the sectors 1, 2, 3 and 5, including indirect CO_2 emissions from these sectors, excluding direct and indirect emissions from sector 6, excluding emissions and removals from land use, land-use change and forestry, and excluding emissions from international transport). Shown are the differences between the WEM and WAM scenarios as presented in Tab. 23.

	1990	1995	2000	2005	2010	2015	2017	2020	2025	2030	2035
	Mt CO_2eq (annual reduction, not cumulative)										
1 Energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.2	6.2	6.2
2 Industrial processes and product use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
3 Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5
5 Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indirect CO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total as relevant for Switzerland's emission reduction targets	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**3.3**	**6.5**	**6.9**

4.3 Methodology

The methodologies applied to calculate Switzerland's greenhouse gas emission scenarios are tailored to the particular characteristics of each sector, always ensuring consistency with actual data of the greenhouse gas inventory. To provide a basic understanding of the models and approaches used, details relevant for each sector are summarised in Tab. 30 and discussed in the following sections.

Tab. 30 > Overview of models and approaches used to project Switzerland's greenhouse gas emissions from different sectors.

	Gases	Type and characteristics of approach or model	Original purpose of approach or model	Strengths and weaknesses	Accounting of overlaps and synergies
1 Energy	CO_2, CH_4, N_2O	Computable general equilibrium model for CO_2, for CH_4 and N_2O constant ratio to CO_2.	Assessment of planned climate and energy strategies at global and regional levels (no fundamental adjustments needed).	Comprehensive simulation of Switzerland's economy, considering interactions of policies and measures. Need for reliable assumptions regarding the future evolution of exogenous variables. The recursive dynamic nature of the model somewhat impacts the results.	Accounts for interactions between the effects of different policies and measures, direct and indirect rebound effects, as well as spill-over effects in all economic sectors.
2 Industrial processes and product use	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3	Bottom-up estimates according to the 2006 IPCC guidelines for national greenhouse gas inventories.	Greenhouse gas inventory (no fundamental adjustments needed).	Calculations at the level of single processes, requiring a full set of projections of activity data and emission factors.	Policies and measures are assumed to target distinct sources of greenhouse gases, i.e. overlaps and synergies are considered negligible.
3 Agriculture	CO_2, CH_4, N_2O				
4 Land use, land-use change and forestry		Stochastic empirical single tree forest management scenario model (MASSIMO3) for CO_2, simple assumptions for CH_4 and N_2O.	Projections of the development of forest resources.	Specifically designed to reflect the characteristics of Swiss forests, based on data from the national forest inventories.	
5 Waste		Bottom-up estimates according to the 2006 IPCC guidelines for national greenhouse gas inventories.	Greenhouse gas inventory (no fundamental adjustments needed).	Calculations at the level of single processes, requiring a full set of projections of activity data and emission factors.	
Indirect CO_2	Indirect CO_2				
International transport	CO_2, CH_4, N_2O	Projection of emissions based on assumed rates for demand and technological progress.	Projection of the development of the energy sector.	Simple approach, taking into account the capacity limits of Swiss airports.	

4.3.1 Energy

For Switzerland's fourth biennial report, the projections for the energy sector are based on the same computable general equilibrium model as for Switzerland's seventh national communication and third biennial report. However, as mentioned above, projections are now presented up to 2035. The used approach has various strengths. It not only takes into account the full spectrum of policies and measures tackling energy use and greenhouse gas emissions related to the energy sector, but also accounts for interactions between the effects of different policies and measures, direct and indirect rebound effects, as well as spill-over effects in all economic sectors. Such a comprehensive investigation would not be possible based on bottom-up impact assessments of policies and measures alone. The approach, however, also suffers from the usual weaknesses of economic models, in particular provoked by the need for reliable assumptions regarding the future evolution of exogenous variables (such as energy prices, gross domestic product, population, etc.). An overview of the key steps performed to establish the WEM, WOM and WAM scenarios for the energy sector, including information on underlying assumptions, is provided in the following[43].

[43] The computable general equilibrium model does not cover emissions from the source category 1B, which are of minor importance regarding total emissions from sector 1 'Energy'. The projections for source category 1B are thus calculated based on the results of *Prognos* (2012) for 2035, with interpolated values between the last inventory year and 2035. Identical emissions are assumed from the source category 1B for all scenarios over the full time period from 1990 to 2035.

Calculation of CO_2 emissions for the WEM scenario

In a first step, the computable general equilibrium model, GEMINI-E3 from the Swiss Federal Institute of Technology in Lausanne, is used to calculate CO_2 emissions from the energy sector for the WEM scenario (*EPFL and Infras*, 2016; *EPFL*, 2017). For many aspects, the assumptions used in the model are based on the energy perspectives of *Prognos* (2012), but underlying scenarios have been updated to follow the observed and anticipated trends where needed. Key underlying assumptions – in particular population, gross domestic product and energy prices – have been updated as well (see Tab. 22). The WEM scenario takes into account currently implemented and adopted policies and measures (Tab. 21), generally assuming that the policies and measures will be continued in a similar manner, i.e. without any strengthening or weakening, up to 2035. Only in cases where implemented or adopted regulations already stipulate a (possible) strengthening, e.g. in the case of the partial compensation of CO_2 emissions from motor fuel use (section 3.4.5), a future strengthening is considered under the WEM scenario. For the most important policies and measures the assumptions going beyond the descriptions in chapter 3 are as follows (for details regarding all policies and measures see *EPFL and Infras*, 2016 and *EPFL*, 2017):

- **Emissions trading scheme** (section 3.2.6): The cap is reduced by a rate of 1.74 per cent per year until 2020 and held constant thereafter;
- **Negotiated reduction commitments (for exemption from the CO_2 levy)** (section 3.2.7): The emissions reduction targets of companies exempt from the CO_2 levy are not further enhanced after 2020;
- **National buildings refurbishment programme** (section 3.3.3): 300 million Swiss francs or at maximum one third of the revenues from the CO_2 levy on heating and process fuels are earmarked for the national buildings refurbishment programme up to 2017, while 450 million Swiss francs or at maximum one third of the revenues from the CO_2 levy on heating and process fuels are available as of 2018. Under the WEM scenario, it is assumed that the national buildings refurbishment programme is stopped as of 2020[44];
- **Building codes of the cantons** (section 3.3.4): Until 2020 it is assumed that the annual incremental CO_2 savings remain constant thanks to the revision of the regulations in 2014 (*EnDK*, 2014), which will gradually come into effect between 2016 and 2020. Beyond 2020, it is assumed that the annual incremental CO_2 savings decrease by two per cent per year due to erosion of the attributable impact by technological progress;
- **CO_2 emission regulations for newly registered vehicles** (section 3.4.2): It is assumed that the set targets, 95 grams of CO_2 per kilometre by 2020 for new passenger cars and 147 grams of CO_2 per kilometre by 2020 for new light commercial vehicles, are reached by 2023 (the delay is caused by temporary arrangements such as e.g. double counting of highly-efficient electric vehicles or similar). No further strengthening of the CO_2 emission regulations for newly registered vehicles is assumed afterwards;
- **Partial compensation of CO_2 emissions from motor fuel use** (section 3.4.5): The share of CO_2 emissions from motor fuel use to be offset by fuel importers increases as prescribed in the CO_2 Ordinance (two per cent in 2014–2015, five per cent in 2016–2017, eight per cent in 2018–2019, and 10 per cent in 2020), and is held constant at 10 per cent after 2020.

While a brief overview is given in the following, details about the methodologies used to calculate CO_2 emissions from the energy sector for the WEM scenario are provided in the respective project reports (*EPFL and Infras*, 2016; *EPFL*, 2017). GEMINI-E3 is a multi-country, multi-sector, recursive dynamic computable general equilibrium model, which has been extensively used to assess planned climate and energy strategies at global and regional levels during the last 20 years. It is based on the assumption of total flexibility in all markets, both macroeconomic markets such as the capital and the exchange markets (with the associated prices being the real rate of interest and the real exchange rate, which are then endogenous), and microeconomic or sector markets (goods, factors of production). Simulations start from a statistically observed bundle of consumer goods, i.e. the Swiss input-output table 2008 (*Nathani et al.*, 2011), and then changes in relative prices provoke deviations from this bundle through substitutions between alternative goods. Thereby, a representative household uses its disposable income to purchase the bundle of goods that gives greatest satisfaction, and the choice is affected (and affects) relative prices. For instance, when fossil fuels become more expensive, e.g.

[44] While the national buidlings refurbishment programme is open-ended under the current legislation, a limitiation is planned under the third CO_2 Act. As a limitiation to as early as 2020 cannot completely be excluded, this date is used under the WEM scenario.

due to the CO_2 levy on heating and process fuels, the representative household replaces some fossil fuel by electricity (mostly heat pumps) and invests more for heat insulation of buildings. A calibration ensures that the model is able to reproduce the economic development with the associated energy consumptions and CO_2 emissions for the historical years, i.e. the model is calibrated to the observed historical growth rates and emission pathways. Key parameters for calibration are the elasticities of substitution which reflect the degree to which inputs to production (labour, capital, energy) or goods in consumption may be substituted, and the rates of autonomous technological progress, which define the rates of improvement in efficiency that occurs independently of political intervention. The model results were obtained in 2017, meaning that the calibration is based on historical emissions up to 2015. A recalibration with most recent inventory data, i.e. historical emission up to 2017, is considered to lead to negligible adjustments only. Accordingly, Switzerland refrained from a repetition of the costly modelling exercise in preparation of its fourth biennial report, considering the available set of scenarios as up-to-date.

Where possible, measures are directly implemented in the model. This is the case for measures with regard to price such as the CO_2 levy on heating and process fuels and the price of emission allowances in the emissions trading scheme. Further, for companies which are exempt from the CO_2 levy on heating and process fuels (section 3.2.7) a shadow price on emissions is introduced. However, an estimate of the CO_2 savings and related economic data are required for each measure that cannot be directly implemented in the model, such as equivalent subsidies, taxes and abatement costs. Additionally, the model requires information on the share of different energy sources that are affected by a specific measure. The data needed to calibrate the model is derived from (bottom-up) impact assessments. Thereby, double counting of effects is carefully avoided, i.e. for overlapping measures only the additional impact is considered (*EPFL and Infras*, 2016).

As mentioned above, the model includes technological progress, which may evolve autonomously or driven by polices and measures. In particular, where policies and measures cannot be directly implemented in the model by means of a price, the effect of policies and measures are translated into a policy-induced technological progress. For instance, this is the case for the building codes of the cantons (section 3.3.4) or the CO_2 emission regulations for newly registered vehicles (section 3.4.2).

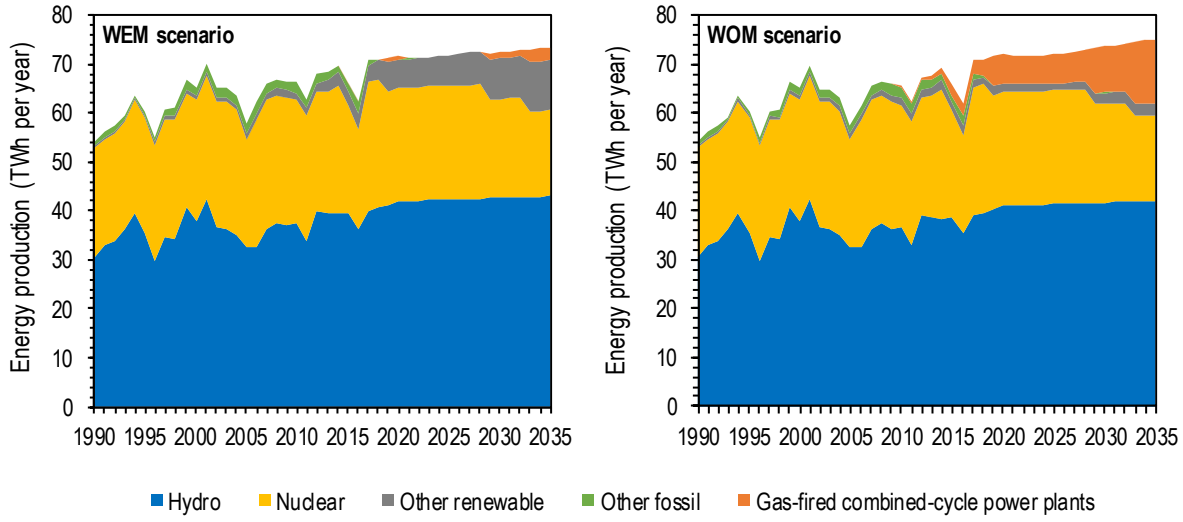
The model takes into account domestic compensation required by policies and measures such as the partial compensation of CO_2 emissions from motor fuels use (section 3.4.5) or the obligation to offset emissions from gas-fired combined-cycle power plants (section 3.3.6). Methodological details regarding the implementation of domestic compensation are provided in *EPFL and Infras* (2016). In brief, domestic compensation is either represented by an increase in energy efficiency at a cost based on the experience from existing compensation projects (data provided by the Foundation for Climate Protection and Carbon Offset (KliK), see also section 3.4.5) or by subsidies for additional emission reductions by firms (as KliK buys domestic carbon credits at a price exceeding the rate of the CO_2 levy on heating and process fuels). Accordingly, domestic compensation is fully contained in the model results, and, thus, cannot be reported separately.

Crucial for the CO_2 emissions under the different scenarios is the electricity production projected by the model. In the wake of the nuclear incident in Fukushima in 2011, the Swiss Federal Council and the Swiss Parliament decided to decommission the existing nuclear power plants at the end of their service life (section 3.3.1). This decision has a major impact on future electricity generation as decommissioning of nuclear power plants is compulsory under all scenarios, and, thus, prescribed in the model (a first reactor is decommissioned in 2019, a second in 2029, a third in 2033, while all others operate beyond 2035). However, apart from this constraint regarding nuclear power plants, the computable general equilibrium model chooses the most economical way to generate the required electricity, taking into account all direct and indirect effects of policies and measures in place under the respective scenario. This results in the operation of gas-fired combined-cycle power plants, with an annual energy output of 1.1 terawatt-hours by 2030 and 2.7 terawatt-hours by 2035 under the WEM scenario (for an overview of the resulting energy mixes for electricity generation under the WEM scenario see Fig. 21, left). Under the WEM scenario the model completely takes into account the required compensation of emissions from gas-fired combined-cycle power plants (section 3.3.6), with a share of 50 per cent domestic compensation and the price for international carbon credits fixed at 10 Swiss francs per tonne of CO_2 (however, the compensation using international carbon credits is of course not considered in Switzerland's national totals).

Regarding the evolution of the transport sector, the computable general equilibrium model relies on inputs from the road traffic model primarily used for the greenhouse gas inventory (see section 3.2.9 in *FOEN*, 2019a). The road traffic

model is based on a bottom-up approach, taking into account the composition of the Swiss vehicle fleet and differentiating various vehicle classes, fuel types and emissions standards. For past and future years, energy consumption is then calculated based on parameters such as the composition of the fleet, the distances travelled, the fuel types used, and the specific fuel consumption. As the differences in fuel prices between Switzerland and neighbouring countries levelled as a consequence of a substantial change in the exchange rate for the Swiss franc to the Euro in January 2015, the so-called 'tank tourism' was declining and, for gasoline, ceased completely (for details see *Keller*, 2015). In the absence of justifiable estimates for the future exchange rate for the Swiss franc to the Euro, it is assumed that 'tank tourism' remains constant for projected years (*EPFL*, 2017). The road traffic model directly targets vehicle kilometres, i.e. passengers per vehicle are not quantified for this exercise. Regarding the use of biofuel in the transport sector, the road traffic model has been revised and now projects a much more moderate contribution of biofuel to total fuel consumption in the transport sector. By 2030, it use assumed that the share of biofuels is two per cent with regard to the total consumption of gasoline and diesel (*Infras*, 2017).

Fig. 21 > Energy mixes for electricity generation under the WEM (right) and WOM (left) scenarios as deduced with the computable general equilibrium model (GEMINI-E3). The decommissioning of nuclear power plants at the end of their service life is compulsory in each scenario (a first reactor is decommissioned in 2019, a second in 2029, and a third in 2033, while all others operate beyond 2035).



EPFL (2017)

As briefly addressed in *EPFL* (2017), the computable general equilibrium model does not account for the possibility that firms in the emissions trading scheme may save excess emission allowances for later use. This implies that some of the emission reductions (in particular those resulting from the closure of one of the two Swiss refineries in 2015) are achieved 'on credit' only, as firms will make use of the available excess emission allowances at some point in the future. To reflect these circumstances in the mid-term and long-term evolution of projected greenhouse gas emissions, the emissions avoided by the closure of the refinery are again added to the total emissions within the emissions trading scheme, as they are still 'available' in the cap. Adding the 0.5 million tonnes of CO_2 to the emission levels of all projected years leads to a somewhat artificial increase of emissions in source category 1A1 'Energy industries' from 2017 to 2018 (see Fig. 18, emissions further increase from 2018 to 2019 due to the decommissioning of a nuclear power plant in 2019).

Further, the recursive dynamic nature of the computable general equilibrium model has, to some extent, an impact on the model results. In particular, the energy prices (crude oil and gas) are assumed to be lower in *EPFL* (2017) compared to *EPFL and Infras* (2016) for the present due to recent developments in the energy market, but (according to the forecasts used) reach about the same values in 2030. This implies that in *EPFL* (2017) prices have to rise at a higher rate, which sets a stronger price signal. Due to the recursive dynamic set-up of the computable general equilibrium model – where foresight of the agents (households, firms) is limited to the next period – this leads to additional reductions of emissions compared to *EPFL and Infras* (2016). In 2030, this effect amounts to approximately 0.4 million tonnes of CO_2. In a model with perfect foresight where agents would optimise over the entire period and take the projected development of energy prices into account, this effect would be much smaller. The 0.4 million tonnes of CO_2 are therefore a reduction triggered mostly by the inherent dynamics of the model and only to a smaller extent by the fact that energy prices were lower than projected in 2015. While the complete effect of the model dynamics on the mid-term

to long-term CO_2 emissions can only be estimated partially based on the sensitivity analysis (section 4.3.9), the scenarios provided by *EPFL* (2017) are adjusted by +0.4 million tonnes of CO_2 in 2030 to at least account for the minimal effect. The adjustment is applied to one third to source category 1A4a and to two thirds to source category 1A4b, linearly increasing from zero in 2016 to +0.4 million tonnes of CO_2 in 2030, and remaining constant thereafter.

Overall, the simulations with the computable general equilibrium model provide the optimised use of goods including energy, thereby reflecting the effect of policies and measures in place at any time (see Tab. 21). As a final step, the CO_2 emissions resulting under the modelled energy demand and energy efficiency are calculated for the energy sector.

Calculation of CO_2 emissions for the WOM scenario

In the computable general equilibrium model, the implemented policies and measures can be 'switched off' in a rather simple way, allowing for a model run corresponding to the WOM scenario. For this purpose, the effects of policies and measures on prices as well as all policy-induced technological progress are omitted. The resulting WOM scenario has a bifurcation point as early as 1990 and is driven by key underlying assumptions (such as energy prices and population), as well as autonomous technological progress spreading regardless of the absence of policies and measures (*EPFL and Infras*, 2016; *EPFL*, 2017). Under the WOM scenario, an annual energy output of 9.4 terawatt-hours by 2030 and 12.9 terawatt-hours by 2035 by gas-fired combined-cycle power plants is needed (for an overview of the resulting energy mixes for electricity generation under the WOM scenario see Fig. 21, right). As the WEM scenario, the WOM scenario provided by *EPFL* (2017) is adjusted for the effect caused by the inherent dynamics of the model.

Calculation of CO_2 emissions for the WAM scenario

The WAM scenario uses the same underlying assumptions regarding growth of population, gross domestic product, energy prices, and autonomous technological progress as the WEM scenario. In addition to the WEM scenario, the WAM scenario takes into account the impact of the strengthening of the existing policies and measures and of new instruments as proposed in the third CO_2 Act (section 3.2.4) for the time period up to 2030 in most cases. The following adjustments of the most important measures are considered under the WAM scenario:

- **CO_2 levy on heating and process fuels** (section 3.2.5): Linear increase of the rate of the CO_2 levy on heating and process fuels from 96 Swiss francs per tonne of CO_2 in 2020 to the proposed maximum rate of 210 Swiss francs per tonne of CO_2 in 2030;
- **Emissions trading scheme** (section 3.2.6): Linking with the emissions trading scheme of the European Union, reduction of the cap at a rate of 2.2 per cent per year from 2021 to 2030 (see section 3.2.6 for details);
- **Negotiated reduction commitments (for exemption from the CO_2 levy)** (section 3.2.7): The emission reduction targets of companies exempt from the CO_2 levy on heating and process fuels are enhanced and strengthened, leading to a total reduction of the emissions of exempt companies of 10 per cent in 2030 compared to 2020;
- **National buildings refurbishment programme** (section 3.3.3): Increase of the maximum amount of the revenues from the CO_2 levy on heating and process fuels earmarked for the national buildings refurbishment programme from 300 million to 450 million Swiss francs per year in 2018. Financing of the programme is terminated in 2025, leading to a gradual phase out of the additional impact after 2025;
- **Building codes of the cantons** (section 3.3.4): Widespread application of the 2014 standard of the model ordinances in all cantons, also beyond 2020 (no decrease of the impact as assumed for the WEM scenario). It is further assumed that emission reduction achieved thanks to cantonal measures are enough to avoid the introduction of the emissions standards at the federal level;
- **CO_2 emission regulations for newly registered vehicles** (section 3.4.2): Further (linear) decrease of the emissions limit for new passenger cars from 95 to 68 grams of CO_2 per kilometre and for new light commercial vehicles from 147 to 105 grams of CO_2 per kilometre from 2025 until 2029. These targets are based on an earlier proposition in the European Union that has been replaced in the meantime. Because the new propositions cannot be translated into quantifiable targets yet, targets of 68 and 105 grams of CO_2 per kilometre have been used to quantify the possible mitigation impacts of a further strengthening from 2025 onwards;
- **Partial compensation of CO_2 emissions from motor fuel use** (section 3.4.5): Increase of the domestic compensation rate from 10 per cent in 2020 to 15 per cent in 2030;

- **Biofuels:** Increase of the shares of biofuels to five per cent (bio-ethanol) and seven per cent (bio-diesel) respectively (*Infras*, 2017) until 2030.

These adjustments are provisional in the sense that they reflect the propositions of the Swiss Federal Council that are discussed in the Swiss Parliament since 2018. The mitigation impacts of the measures are generally calculated individually using bottom-up approaches. Where available (e.g. for the CO_2 levy on heating and process fuels or for the CO_2 emission regulations for newly registered vehicles), model simulations have been used to estimate the mitigation impacts. For other measures (e.g. the national buildings refurbishment programme), projections are calculated based on existing ex-post analyses. The estimation of the additional reduction of the emissions trading scheme is based on the reduction of the cap. The planned adjustments of the negotiated reduction commitments (for exemption from the CO_2 levy) and of the partial compensation of CO_2 emissions from motor fuel use are interpreted as reduction objectives; the mitigation impact of these measures then corresponds to these objectives. Finally, the WAM scenario is constructed using the estimated additional mitigation impacts with respect to the WEM scenario of the relevant measures up to 2030. Beyond 2030, no concrete policies and measures are planned yet. Therefore, it is assumed that the WAM scenario decreases in parallel to the WEM scenario between 2030 and 2035[45].

CH_4 and N_2O emissions for all scenarios

The methodologies for the WEM, WOM and WAM scenarios described above were exclusively established for CO_2 emissions from the energy sector, as CH_4 and N_2O emissions – with a share of just above one per cent in total greenhouse gas emissions from the energy sector (Tab. 1) – are of minor importance. Hence, CH_4 and N_2O emissions in the energy sector are derived based on the following assumptions:

- For years covered by the greenhouse gas inventory (1990–2017), CH_4 and N_2O emissions of the WEM scenario are available from inventory data. While for the years 1990 to 2017 the WAM scenario corresponds to the WEM scenario, CH_4 and N_2O emissions of the WOM scenario are calculated out of the CO_2 emissions of the WOM scenario by application of the same ratios of CH_4 to CO_2 and N_2O to CO_2 as in the WEM scenario (i.e. of inventory data) in each individual year;
- For projected years (2018–2035), CH_4 and N_2O emissions of the WEM, WOM and WAM scenarios are calculated out of the CO_2 emissions of the corresponding scenario by application of the same ratios of CH_4 to CO_2 and N_2O to CO_2 as in the WEM scenario in the year 2017 (i.e. the latest year with inventory data).

4.3.2 Industrial processes and product use

Greenhouse gas emission scenarios for the industrial processes and product use sector were calculated following exactly the same methodology as used for the greenhouse gas inventory, i.e. bottom-up estimates according to the 2006 IPCC guidelines for national greenhouse gas inventories (*IPCC*, 2006). Details about the methodologies, including relevant emission factors, are documented in *FOEN* (2019a). The strength of this approach is that greenhouse gas emission scenarios are calculated at the level of single processes. This, however, requires a full set of projections of activity data and emission factors (which may potentially be considered a weakness of the approach).

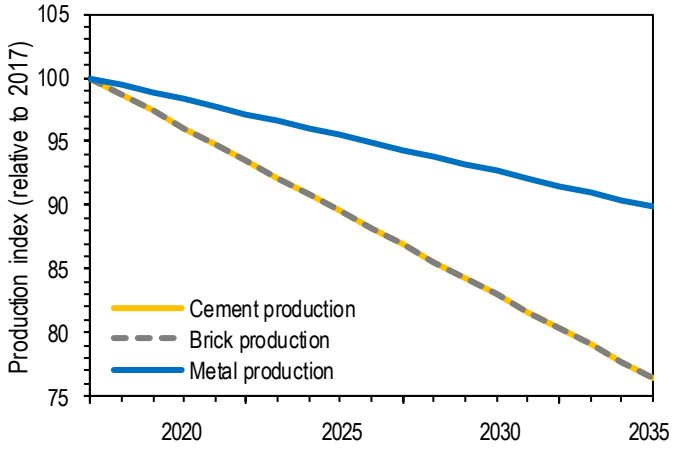
In Switzerland, there are few industrial branches that release relevant amounts of process-related greenhouse gases. The dominant part of process-related greenhouses gases emitted from the industrial processes and product use sector stems from the cement industry, followed by emissions of F-gases from the use as refrigerants and by emissions of CO_2 from the thermal cracking process (production of ammonia and ethylene). With the exception of F-gases, measures in the industry sector are primarily targeting energy-related emissions (section 3.3), which are included under the energy sector (for the respective projections see section 4.3.1). However, the emissions trading scheme (section 3.2.6) also covers process-related emissions, permitting companies to reach their reduction obligations not only by more efficient use of energy, but also by optimisation of their production processes leading to reduced process-related emissions of greenhouse gases (for instance, in a plant producing nitric acid, a new catalyst led to a substantial reduction of N_2O emissions). Nevertheless, for most emitters of process-related greenhouse gases covered by the emissions trading

[45] Therewith, the decrease rate for the WAM scenario is lower from 2030 to 2035 compared to the years before. Assuming a parallel decrease of the WEM and WAM scenarios after 2030 implies that under the WAM scenario, some policies and measures are 'reset' to the level of implementation as under the WEM scenario. The models for emissions from agriculture and of F-gases contain some further reductions under the WAM compared to the WEM scenario between 2030 and 2035.

scheme (in particular for the cement industry, the major emitter) this possibility hardly exists due to physical/chemical limits regarding further reductions of the emission factors. As described in section 4.3.1, it is thus assumed that all companies within the emissions trading scheme reach their full reduction obligations by reductions of energy-related emissions (or acquisition of emission allowances). As the Ordinance on Air Pollution Control (section 3.5.3) and the NMVOC incentive fee (section 3.5.4) are exclusively considered regarding the scenarios for indirect CO_2 emissions, provisions relating to substances stable in the atmosphere (section 3.5.2) represent the only policy and measure leading to differences between the WEM, WOM and WAM scenarios for the industrial processes and product use sector.

The relevant activity data for industrial production are inferred from the energy perspectives of *Prognos* (2012). Production of mineral products (cement, bricks and tiles) and metal production are assumed to decline over the coming decades (Fig. 22), leading to a reduction of total greenhouse gas emission from these branches of about 45 per cent by 2030 compared to 1990. For other industrial processes whose emissions are of minor importance and for which detailed production projections are unavailable, it is assumed that the activities remain constant at the level of past years (depending on the process, mean values over the last ten years or over the full time period since 1990 are used). Where projections are deduced from *Prognos* (2012), values are calculated based on the results for 2035, with linear interpolation between the last inventory year and 2035.

Fig. 22 > Production indices for cement, bricks and metal until 2035 (relative to 2017). Identical production indices are used for the WEM, WOM and WAM scenarios.



Prognos (2012)

Regarding emissions of F-gases, which strongly depend on the scenario, projections are based on a well-established bottom-up model (see *Carbotech*, 2020). This model, described in detail in *FOEN* (2019a), is not only used to derive the emission estimates for the annual greenhouse gas inventory, but also serves to project future emissions. From 1990 up to the most recent inventory year, i.e. currently 2017, the model is based on the most recent import statistics, supplemented by available information from the branch associations and companies concerned. The model makes assumptions about product life time as well as emission factors relevant for assembly, operation and disposal of appliances. For the projections, the two most important applications of fluorinated gases – refrigeration and electrical equipment – are considered in detail, while emissions from other applications are mostly hold constant over time regarding the WEM and WOM scenarios. The WAM scenario contains additionally a more restrictive handling of exclusions remaining in different applications. The main factors defining the scenarios are the phase-out of HFCs, decreasing emission factors in refrigeration, and the limit set on SF_6 emissions following the provisions relating to substances stable in the atmosphere (HFCs, PFCs, SF_6, NF_3) (section 3.5.2). As visible in Fig. 17, emissions of HFCs show a substantial change to a faster decrease rate at around 2025 under the WEM and WAM scenarios. The reason is that the model assumes that HFCs with relatively high global warming potentials are disposed at this time as the respective appliances reach their end of life. Therewith, emissions from the remaining appliances (in operation as well as at their disposal) are lower. The large changes reflect past changes of filling amounts, as the lifetimes are assumes to be a fixed number without smoothening over several years. All scenarios have been updated to be consistent with the most recent evolutions in the relevant policies and measures.

Tab. 31 provides an overview of assumptions in the industrial processes and product use sector with regard to the WEM, WOM and WAM scenarios. Regarding F-gases, *Carbotech* (2020) provides further details about underlying assumptions and methodologies.

Tab. 31 > Assumptions used for the projections of emissions from the industrial processes and product use sector under the WEM, WOM and WAM scenarios.

	WEM	WOM	WAM
Industrial production	In close correspondence with the assumptions on industrial production used in the energy perspectives of *Prognos* (2012), the cement, brick, tile and steel production are assumed to decline over the coming decades. For other processes, which are of minor importance, it is assumed that activities remain at the level of past years.	As there are no policies and measures affecting the production rates, the evolution is identical for all three scenarios.	As there are no policies and measures affecting the production rates, the evolution is identical for all three scenarios.
HFCs	Existing restrictions on the use of F-gases (in concert with technological progress) are assumed. This leads to a gradual replacement of HFCs used as refrigerants (*Carbotech*, 2020). Further, measures to reduce leakage (secure handling of refrigerants, monitoring etc.) are continuously introduced.	The WOM scenario assumes no forced phase-out and replacement of fluorinated gases and therefore emissions of HFCs keep increasing (*Carbotech*, 2020).	Similar but faster replacement of HFCs as refrigerants compared to the WEM scenario and more restrictive handling of exclusions in further applications is assumed. It is further assumed that optimisation of disposal leads to additional prevention of emissions (*Carbotech*, 2020). Overall, the implemented measures assure compliance with Switzerland's commitment under the Kigali Amendment to the Montreal Protocol.
SF_6	Agreements with relevant sectors, leading to reduction of emissions.	Constant use of SF_6 and higher emission factors compared to the WEM and WAM scenarios.	Stepwise prohibition of SF_6, leading to a replacement for use in electrical equipment.
Gases from other industrial processes and solvent use	Other process-related emissions (e.g. from ammonia/ethylene production, nitric acid production) and emissions from solvent use are assumed to maintain the level of past years.	Identical evolution for all three scenarios.	Identical evolution for all three scenarios.

4.3.3 Agriculture

Greenhouse gas emission scenarios for the agriculture sector are based on projected activity data, e.g. livestock numbers, crop production data (amount of crops harvested, areas of crop cultures, meadows and pastures) and use of synthetic fertilisers and recycling fertilisers (such as sewage sludge, compost, as well as liquid and solid digestate) from different agricultural policy evaluation models. Most other model parameters for emission calculation (e.g. nitrogen excretion rates, emission factors) are kept constant throughout the projection time frames. An important exception is the productivity of dairy cows (i.e. milk yield), which is projected to develop according to the respective scenarios.

Generally, time series beyond 2017 (WEM, WAM) and 2011 (WOM) respectively are extended by continuing the time series according to the development of the respective parameters in the scenario models used. Some data such as e.g. crop yields may exhibit considerable year-to-year variability and this may lead to somewhat arbitrary projections due to an arbitrary starting point. However, observing the overall behaviour of the projections, no indication that this would lead to a systematic misalignment is found. Hence, it is concluded that the eventual offsets of individual time series projections cancel out each other.

In the following, considerations regarding different aspects relevant under the WEM, WOM and WAM scenarios are presented.

Animal livestock population

The development of livestock population is dependent on price scenarios and consequently on policies concerning market price support and free trade agreements with the European Union as well as consumer demand (*Peter et al.*, 2009; *Peter et al.*, 2010; *Zimmermann et al.*, 2011; *Möhring et al.*, 2015). Furthermore, the modalities for agricultural subsidies and direct payments are an important driver for the development of livestock population.

Feeding regimes

Feeding regimes are generally assumed to remain unchanged with the single exception of dairy cows whose energy intake depends on milk production. An important political measure in this regard could be the governmental promotion

of grassland-based milk and meat production (*Swiss Federal Council*, 2012). Some respective incentives were already implemented in the agricultural policy 2014–2017 and 2018–2021 and will continue in the agricultural policy as of 2022 (AP22+).

Manure management

Different modes of (financial) incentives might influence the livestock management and subsequently the type of manure management. Manure management is governed by the stable system which is again mainly influenced by requirements for animal-friendly livestock husbandry and the respective incentives and label programmes. Furthermore, the need for low-emission stables and manure management systems might have a certain influence in the future. A separate report by the Swiss Federal Office for the Environment and the Swiss Federal Office of Agriculture regulates the respective requirements (*FOEN and FOAG*, 2012).

Nitrogen excretion by animals

Nitrogen excretion rates determine the amount of manure nitrogen managed and applied to soils and hence govern N_2O emissions. Nitrogen excretion rates varied in the past due to changing production modes and particularly due to the feeding of protein-reduced animal feeds. It is most likely that nitrogen excretion rates will continue to change in the future although there are no clear indications of directions of future trends. For cattle, the federal programme for grassland-based milk and meat production (*Swiss Federal Council*, 2012) might be decisive, while for monogastrics environmental regulations as well as financial constraints and subsidy systems may be most influential. *Sollberger et al.* (2013) found that there is still an unexplored potential to increase nitrogen efficiency in pig fattening.

Crop cultures

An important driver for the future development of the cropping areas and the respective agricultural portfolio is the mode of future direct payments. Accordingly, trends in the development of different crop cultures may differ due to differential governmental incentives. The current system of direct payments contains several mechanisms to incentivise more sustainable production such as support for environmental-friendly production systems (e.g. organic agriculture), promotion of ecological compensation areas (biodiversity) or advancement of extensive crop management (*Möhring et al.*, 2016). In addition to the governmental subsidy system, macroeconomic price levels particularly related to possible free-trade agreements as well as the need for animal fodder will determine the portfolio of crop cultures in the future.

Fertilisers and fertiliser management

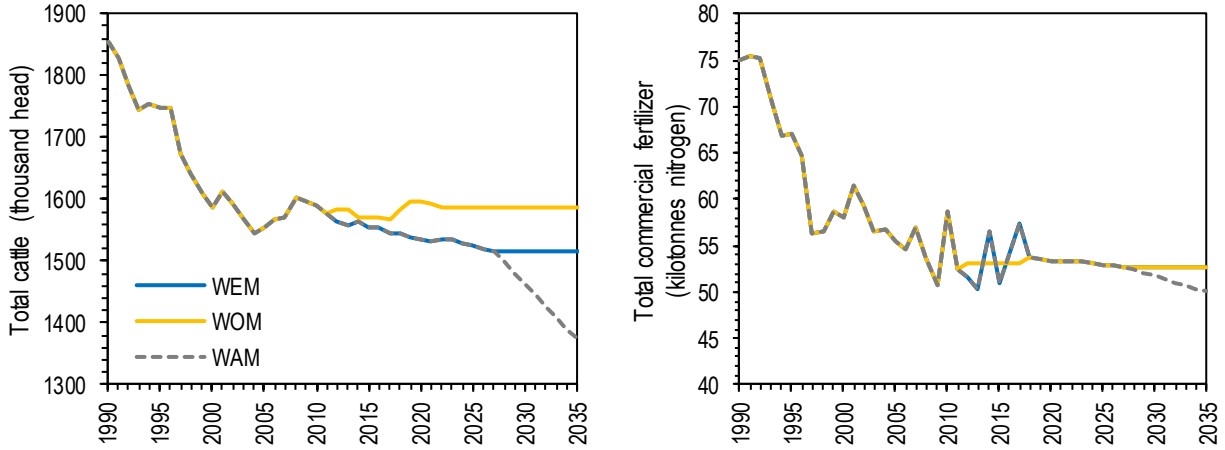
Fertiliser management depends on the standards of the Suisse-Bilanz (fertiliser management plan) that have to be observed in order to fulfil the proof of ecological performance and to get access to direct payments (*Swiss Federal Council*, 2009; *Herzog and Richner*, 2005). The Suisse-Bilanz might be a convenient tool to promote nitrogen use efficiency in the future by altering the level of maximum fertiliser allowances. For the agricultural policy as of 2022 (AP22+) it is planned to revise the nutrient balance tool (Suisse-Bilanz). More stringent provisions for maximum surplus allowances and a stronger enforcement of the standards defined in the new tool can have substantial effects on fertiliser management and nitrogen use efficiency.

Nitrogen use efficiency

Nitrogen use efficiency is strongly related to agricultural greenhouse gas emissions and nitrogen surplus can be used as proxy for N_2O emissions (e.g. *Schils et al.*, 2007). Parameters determining the nitrogen surplus and hence the nitrogen use efficiency are primarily the ammonia emission factors and the share of nitrogen lost as nitrate (leaching and runoff). Nitrogen use efficiency will be mainly affected by the programmes for resource efficiency (e.g. *Swiss Federal Council*, 2009), the Ordinance on the Promotion of Quality and Sustainability in the Agrifood Sector (*Swiss Confederation*, 2013) as well as by the general requirements under the proof of ecological performance (Suisse-Bilanz and possible follow-up tools). The breeding of new crop varieties with higher nitrogen use efficiencies might be another aspect to consider.

In the following, the circumstances and sources of information relevant for the WEM, WOM and WAM scenarios are discussed. Fig. 23 shows the evolution of the most relevant key parameters under the different scenarios.

Fig. 23 > Evolution of the most relevant key parameters under the WEM, WOM and WAM scenarios for agriculture: Total cattle (left) and total commercial fertiliser (right).



Based on *FOEN* (2019a), *Möhring et al.* (2018), *FOAG* (2011) and *Peter et al.* (2010)

WEM scenario

The basis of the WEM scenario is the continuation of the agricultural policy 2018–2021 (section 3.6). In general, no major changes were implemented compared to the previous agricultural policy (2014–2017). Specifically, the decoupling of the direct payments from the amount of animals living on the farms was maintained, reducing incentives for intensification in the livestock sector that would lead to negative environmental impacts (*Swiss Federal Council*, 2009). *Möhring et al.* (2015) investigated the repercussions of the agricultural policy 2014–2017 with the multi-agent model SWISSland and later explored the impact of the new agricultural budget and adjusted policies for 2018–2021 (*Möhring et al.*, 2016). In 2018, *Möhring et al.* (2018) elaborated new projections based on the unaltered continuation of the current agricultural policy. Projections are thus based on data and information available by 2018 on the development of the macroeconomical variables (gross domestic product, population, crop yields) and the expected development of the domestic producer prices. The possible effects of an eventual market liberalisation (depletion of international trade tariffs) was not considered.

Development of animal populations, productivity of dairy cows (milk yield), development of cropping areas and fertiliser use are projected until 2027. For the subsequent years, all values are kept constant at the levels projected for 2027.

WOM scenario

The WOM scenario for agriculture is based on the continuation of the agricultural policy 2011. The great number of drivers that influenced the development of agricultural structures since 1990 (e.g. technological progress, breeding programmes, macro-economic framework, agricultural policy, etc.) does not allow to distinguish the specific mitigation impacts of individual political measures retrospectively. Accordingly, 2011 was chosen as bifurcation point since concrete projections were made for the agricultural policy 2011 at this time. The fundamental assumption is that the scheme of the direct payments and the requirements under the proof of ecological performance would not have been adjusted and will not be adjusted in the future. Greenhouse gas emissions are projected according to *Peter et al.* (2010), as expected after the implementation of the agricultural policy 2011. *Peter et al.* (2010) projected the future development of the agricultural portfolio according to calculations made with the S-Integral model. The S-Integral model is a comprehensive agricultural supply model which simultaneously takes into account economic, agronomic and ecological aspects and interrelationships (*Peter et al.*, 2008). Projections were made for three agricultural price scenarios of which the high price level scenario is presented here. The portfolio of agricultural operations (i.e. the production levels of the individual livestock animals and crop cultures) develops according to the macroeconomic development that was given exogenously as model input. Technical, organisational and structural framework conditions were assumed to remain largely unchanged. The time horizons of the projections reach in most cases until 2022, and all values are kept constant for subsequent years.

WAM scenario

Up to 2027, emissions follow the same course as under the WEM scenario, i.e. the development according to an unaltered continuation of the agricultural policy 2018–2021 (*Möhring et al.*, 2018). After 2027, emissions are projected to decline according to the target scenario in the climate strategy for agriculture (*FOAG*, 2011). A substantial reduction of agricultural greenhouse gas emissions until 2050 is aspired. Technical and organisational measures shall reduce greenhouse gas emissions by at least one third. By influencing consumption patterns as well as the respective production structures further reductions of similar scale are aspired (*FOAG*, 2011). The envisaged decrease of emissions is in line with the roadmap of the European Commission for moving to a competitive low carbon economy in 2050 (*EC*, 2011).

The climate strategy for agriculture is rather a declaration of intent and encompasses only some general hints on the future roadmap of a climate-friendly agriculture. Up to date, very few concrete measures are available that could be readily implemented. However, tools and measures are being established and consolidated at the moment such as the AgroCleanTech platform that will support farmers and other related stakeholders in the fields of renewable energy, energy efficiency and climate change mitigation. *Peter et al.* (2009) and *Peter et al.* (2010) as well as publications from the Animal Nutrition Group of the Swiss Federal Institute of Technology in Zurich (e.g. *Kreuzer*, 2012) or the IP-Suisse programme (*Mieleitner et al.*, 2011; *Alig et al.*, 2015) list various potential mitigation measures that will be pursued in such a context. Two measures intended to financially support relevant projects by agricultural stakeholders, namely the resource programme (section 3.6.3) and the Ordinance on the Promotion of Quality and Sustainability in the Agrifood Sector (*Swiss Confederation*, 2013), were implemented by the Swiss Federal Office for Agriculture. Under these voluntary programs several pilot projects were financed that intent to implement technical greenhouse gas reduction measures on the farms. Experiences and insights from these projects may be used to guide the further development of the agricultural policy framework in the future.

Tab. 32 provides an overview of specific assumptions in the agriculture sector with regard to the WEM, WOM and WAM scenarios.

Tab. 32 > Assumptions used for the projections of emissions from the agriculture sector under the WEM, WOM and WAM scenarios.

	WEM	WOM	WAM
Animal livestock population	The agricultural policy 2018–2021 influences animal population as predicted by *Möhring et al.* (2016). The scenario currently used in this report assumes a more or less unaltered continuation of this policy and is based on projections from *Möhring et al.* (2018). Direct payments are decoupled to a certain degree from cropping area and particularly from the amount of animals living on the farms, reducing incentives for intensification that would lead to negative environmental impacts (*Swiss Federal Council*, 2009). Consequently, animal populations more directly depend on price levels. The cattle population is projected to decline slightly, whereas the number of swine and poultry increases. Dairy cows are projected to exhibit a further increase in milk yield. Beyond 2027 (the time horizon of *Möhring et al.*, 2018) animal populations are assumed to be constant for all animal categories.	Overall, *Peter et al.* (2010) expected rather constant livestock populations until 2022. Beyond 2022, constant populations are assumed for most animal categories.	Until 2027 the same projections as for the WEM scenario are used. After 2027 livestock populations are projected to decrease until overall agricultural greenhouse gas emissions reach the minimum reduction target set in the climate strategy for agriculture in 2050 (*FOAG*, 2011), i.e. one third of the level of 1990. This means that livestock populations have to fall by more than 27 per cent between 2027 and 2050. A reduction of the consumption of animal products should accompany the reduction of the livestock populations in order to prevent the imports of greenhouse gas-intensive animal products.
Feeding regime	With the exception of mature dairy cows, energy intake and CH_4 rates remain constant at the value of 2017, i.e. no technical measures concerning animal diets are implemented. Milk yield and hence gross energy intake of mature dairy cattle are assumed to slightly increase until 2027 (*Möhring et al.*, 2018). Accordingly, the CH_4 emission factor for both enteric fermentation and manure management increases proportionally. An important political measure could be the promotion of extensive milk and meat production based on grassland diets (*Swiss Federal Council*, 2012). It is planned that the respective incentives implemented during the agricultural policy 2018–2021 will be maintained and eventually developed further. The associated effects in the WEM and WAM scenarios are roughly reflected in the projected developments of milk yields, grassland areas and other feed crops (*Möhring et al.*, 2016; *Möhring et al.*, 2018).	With the exception of mature dairy cows, energy intake and CH_4 rates remain constant at the value of 2011, i.e. no technical measures concerning animal diets are implemented. Milk production and hence gross energy intake of mature dairy cattle level off approximately around 2011 (*Peter et al.*, 2010). Accordingly, the CH_4 emission factors for both enteric fermentation and manure management of mature dairy cows also remain more or less at the level of 2011.	Energy intake as well as all other related feeding parameters are assumed to be equal to those under the WEM scenario. New scientific developments such as e.g. the findings of the Animal Nutrition Group of the Swiss Federal Institute of Technology in Zurich (e.g. *Kreuzer*, 2012) might help to define alternative feeding strategies with low emission intensities in the future. However, scientific results are not yet in the state to allow widespread implementation. Accordingly, the respective emission reductions are not yet included in the inventory model scenario.
Manure management	The current tendency towards more animal-friendly livestock husbandry might continue with a steady trend towards loose housing systems and more manure excreted on pasture. This would also be in line with the programme for grassland-based milk and meat production (*Swiss Federal Council*, 2012). However, due to the lack of tangible projections, the shares of	Manure management system distribution is assumed to remain constant (distribution as in 2011).	The same assumptions are implemented as under the WEM scenario.

	manure excreted on pasture, range and paddock as well as the shares of the individual manure management systems cannot be predicted satisfactorily and are thus left constant at the level of 2017.		
Nitrogen excretion by animals	All nitrogen excretion rates are assumed to remain constant at the level of 2015 (last census of farm management techniques; *Kupper et al.*, 2018).	Nitrogen excretion rates of all animal except mature dairy cattle are assumed to remain constant at the level of 2011. Nitrogen excretion rates of mature dairy cattle depend on milk production and are assumed to level off around 2011 as no further increase of milk yield is projected (*Peter et al.*, 2010).	The same assumptions are implemented as under the WEM scenario. Eventual programmes that might lead to higher excretion rates for cattle (e.g. grassland-based milk and meat production) or lower excretion rates (e.g. further promotion of nitrogen-reduced feeds for swine) are not modelled due to the lack of tangible projections.
Crop cultures	Targeting of direct payments is improved, particularly for the promotion of common goods and the securing of a socially acceptable development (*Swiss Federal Council*, 2009; *FOAG*, 2010). Direct payments are divided into contributions for an open cultivated landscape, contributions for security of supply, contributions for biodiversity and contributions for landscape quality. Furthermore, macroeconomic price levels as well as the need for animal fodder determine the portfolio of crop cultures in the future. Taking into account these aspects, *Möhring et al.* (2016) and *Möhring et al.* (2018) projected the future development of the individual crop cultures. In general, arable crop production is projected to slightly decline whereas feed production from grasslands will slightly increase. Beyond 2027, constant yields and areas are assumed.	Development of crop cultures between 2011 and 2022 is calculated according to *Peter et al.* (2010). Areas of arable crops are slightly declining while land use for meadows and pasture is slightly increasing. Between 2022 and 2050, areas and yields are assumed to remain constant.	For crop yields the same projections are used as under the WEM scenario. In Switzerland, an increase of the agricultural area is not possible and a substantial decrease is very unlikely because inland food supply security is an important target of agricultural policy.
Fertilisers and fertiliser management	Use of commercial fertilisers is projected to decrease by 8.1 per cent between 2017 and 2027 (*Möhring et al.*, 2018). Beyond 2027, constant fertiliser use is assumed.	After 2011, the total amount of applied commercial fertiliser is assumed to remain constant as total agricultural area and total dry matter production is not changing significantly.	The same projections are used as under the WEM scenario until 2027. Afterwards, consumption of commercial fertilisers is projected to further decline by 15 per cent until 2050 due to further promotion of nitrogen use efficiency.
Nitrogen use efficiency	Further development of the scheme of direct payments with adjustments in the proof of ecological performance is aspired (*Swiss Federal Council*, 2009). Programmes for resource efficiency in agriculture will be further developed and shall be designed to increase nutrient use efficiency in order to fulfil the environmental goals for agriculture (*FOEN and FOAG*, 2008). Consequently, the agricultural policy as of 2022 (AP22+) plans to address the above mentioned issues. However, due to the lack of specific indications, ammonia emission factors and nitrogen loss rates are projected to remain constant at the level of 2017 in the inventory model.	Since total amount of applied commercial fertiliser as well as total nitrogen available from animal manure are assumed to remain constant, no increase in nitrogen use efficiency is achieved.	Falling commercial fertiliser levels combined with more or less stable crop yields immediately implies that nitrogen use efficiency must substantially increase. This could be reached through crop breeding, more efficient use of synthetic fertilisers or increasing the nitrogen use efficiency of manure fertilisers by reducing losses of ammonia and nitrate. However, due to the lack of specific information, the fractions of nitrogen lost as ammonia and nitrate are kept constant in the calculation model, which might lead to a somewhat unrealistic situation. *Kupper and Menzi* (2011) studied the possibility of reductions of ammonia. The respective findings might be used to refine the projections under the WAM scenario in the future.

4.3.4 Land use, land-use change and forestry

To project greenhouse gas emissions from the land use, land-use change and forestry sector, the stochastic empirical single tree forest management scenario model (MASSIMO3), which is based on data from the three successive national forest inventories, was used. The model was specifically designed to reflect the characteristics of Swiss forests. MASSIMO3 is also used for the calculation of the Swiss forest management reference level for accounting for forest management under the Kyoto Protocol for the second commitment period (2013–2020). The model mainly consists of a single tree growth component, a wood harvesting component, and a component on natural regeneration. These model components as well as in-growth and mortality rates are empirically derived from data of the national forest inventory (*Kaufmann*, 2011), as detailed in the following:

- **Single tree growth** is estimated using a single tree model. It depends on the diameter at breast height, on the basal area of the stand under consideration, on a competition index, on site fertility, on the elevation, and on the stand age. The estimation of stand age is based on a model that has been derived from tree ring analysis on the sample plots of the national forest inventory. In-growth rates are considered as well;
- **Wood harvesting component**: To calculate annual clear-cut areas in even-aged forest (80 per cent of the forest area), the following rotation periods are assumed: 90–110 years on very good sites, 110–130 years on good sites,

130–150 years on medium sites, and 180 years on poor sites in alpine regions. Mature stands are harvested within a time span of 20–30 years in order to promote natural regeneration. This is common practice in the Swiss forestry sector and is also reflected in the data of the national forest inventory. Stands are thinned as soon as their basal area has increased by 10 per cent since the last thinning event. This criterion guarantees that a stand reaches the development stage of mature timber during a rotation period. The thinning techniques implemented in the model runs are derived from the national forest inventories;

- Information for plots with **natural regeneration** is extracted from a database containing regeneration plots according to the national forest inventories;
- **Mortality rates and management strategies** are considered as observed in the last few years, since MASSIMO3 is based on data of the three national forest inventories covering the time period 1985–2005, comprising all management activities with significant impact during that period.

MASSIMO3 produces a time series of carbon stocks, harvest rates, and gross growth for Swiss forests per decade starting in 2006. The model thus gives information on changes in carbon stored in forests. Changes in emissions or removals from non-CO_2 gases are not calculated by the model. Accordingly, it is assumed that, until 2035, the non-CO_2 gases stay at the mean value of the emissions between 1990 and 2007 since no changes are expected in the occurrence of wildfires nor in afforestation and deforestation. As greenhouse gas emissions in the land use, land-use change and forestry sector are dominated by activities in source category 4A1 'Forest land remaining forest land', projections are focussing on this source category, assuming that all other source categories remain at their current level. Source category 4A1 is closely related to the forest management activity under the Kyoto Protocol. Using MASSIMO3 and defining future harvesting rates to derive forest management scenarios, greenhouse gas balances under the WEM, WOM and WAM scenarios were calculated. The scenarios presented here show net emissions and removals as reported under the UNFCCC. For accounting purposes under the Kyoto Protocol, the net emissions from selected activities are considered in relation to the forest management reference level. The characteristics of the WEM, WOM and WAM scenarios, which correspond to the scenarios presented in Switzerland's last submission, are detailed in Tab. 33.

Tab. 33 > Assumptions used for the projections of emissions from the land use, land-use change and forestry sector under the WEM, WOM and WAM scenarios.

	WEM	WOM	WAM
Forest area, afforestation, deforestation	The forest area as well as the changes in forest area (afforestation, deforestation) are calculated using an extrapolation of the trend 1990–2009 (values derived from the Swiss land use statistics AREA, *SFSO*, 2012).	Afforestation and deforestation activities are identical for all scenarios.	Afforestation and deforestation activities are identical for all scenarios.
Forest management, political measures	In order to reach the optimal combination of the objectives identified in Switzerland's Forest Policy 2020 (section 3.6.5), it is important that Swiss forests are stable and managed in a sustainable way. The WEM scenario, in accordance with the Forest Policy 2020, is defined as a scenario where the living biomass pool remains constant at the level of 2006 (growing stock from NFI3/2004–2006), meaning that gross growth equals cut and mortality.	No political measures considered.	Compared to the WEM scenario, a different approach for forest management is taken into account. Switzerland's wood resource policy (*FOEN/SFOE/SECO*, 2017; section 3.7.3) promotes higher harvesting rates in Swiss forests. With the excellent image of sustainably produced Swiss wood, the future demand for wood products is expected to increase.
Harvesting rates	To reach constant biomass, harvesting rates have to increase by 16 per cent until 2025 compared to 1995–2006 (harvesting rate for the periods of NFI2/1993–1995 and NFI3/2004–2006; *Kaufmann*, 2011). Without increase of harvesting rates, standing volume in Swiss forests would further increase and lead to unstable forests not fulfilling the objectives of sustainable forest management. After 2025, harvesting rates are assumed to stay at this level.	Without political measures, Swiss forests would act as a considerable CO_2 sink because growing stock in Swiss forests would further increase, thereby leading to an unsustainable forest structure. Under the WOM scenario, harvesting rates stay at the level of 1995–2006 (periods of NFI2/1993–1995 and NFI3/2004–2006; *Kaufmann*, 2011) until 2035.	As the aim of Switzerland's wood policy under the WAM scenario is to increase wood production by 2025 in the interest of harvesting the potential sustainable wood supply, harvesting rates have to increase by up to 30 per cent compared to 1995–2006 (harvesting rate for the periods of NFI2/1993–1995 and NFI3/2004–2006; *Kaufmann*, 2011). After 2025, harvesting rates are assumed to stay at this level. The feasibility of such an increase in harvesting was determined in a scientific study, 'Switzerland's potential sustainable wood supply' (*FOEN*, 2011).
Other source categories and greenhouse gases	As greenhouse gas emissions in the land use, land-use change and forestry sector are dominated by activities in source category 4A1 'Forest land remaining forest	Identical assumptions for all scenarios.	Identical assumptions for all scenarios.

	land', projections are focussing on this source category, assuming that emissions from all other sources (including emissions of CH_4 and N_2O) remain constant.		

Planned improvements

For this submission, there were no recalculations or improvements compared to Switzerland's last submission, because updated results for all three scenarios are not yet available. Until 2020 profound improvements to the modelling work will have been carried out. Results of the projections for all three scenarios will be in line with the methodological improvements related to the forest management reference level, i.e. with the technical corrections already implemented for the calculation of the forest management reference level (see section 11.5.2.4 in *FOEN*, 2019a), with the technical corrections planned for the next years (see section 11.5.2.4 in *FOEN*, 2019a) and with the methodological developments already identified for the forest reference level, which is still being calculated (not published yet).

4.3.5 Waste

Greenhouse gas emission scenarios for the waste sector were calculated following exactly the same methodology as used for the greenhouse gas inventory, i.e. bottom-up estimates according to the 2006 IPCC guidelines for national greenhouse gas inventories (*IPCC*, 2006). Details about the methodologies are documented in *FOEN* (2019a). The strength of this approach is that greenhouse gas emission scenarios are calculated at the level of single processes. This, however, requires a full set of projections of activity data and emission factors (which may potentially be considered a weakness of the approach). The underlying assumptions used under the different scenarios to project greenhouse gas emissions are described in Tab. 34. As in the waste sector policies and measures are rather limited, the WEM, WOM and WAM scenarios are largely based on the same underlying assumptions, with differences for the WOM scenario regarding landfilling of combustible waste and emissions from biogas production. For all scenarios, it is assumed that waste generation per capita remains the same.

Tab. 34 > Assumptions used for the projections of greenhouse gas emissions from the waste sector under the WEM, WOM and WAM scenarios. In consistency with the greenhouse gas inventory, greenhouse gas emissions from waste incineration facilities are reported under public heat and electricity generation in the energy sector.

	WEM	WOM	WAM
Landfilling of combustible waste	As landfilling of combustible waste was only of secondary importance and is prohibited completely since the year 2000 (section 3.8.2), greenhouse gas emissions from solid waste disposal sites are small, further decreasing, and only result from waste deposited before the implementation of the ban on landfilling of combustible waste. The WEM scenario is thus based on a continuation of the model for landfilling of combustible waste until 2035 (*IPCC*, 2006; *FOEN*, 2019a). The share of CH_4 flared reaches a value of 10 per cent by 2030 (current value nine per cent), and then declines to zero by 2050 as the remaining emissions are getting to small to be flared.	It is assumed that the ban on landfilling of combustible waste was not implemented. Consequently, the amount of waste disposed of at waste disposal sites under the WOM scenario follows the same evolution as under the WEM and WAM scenarios until 1999, but then only decreases to 10 per cent of this value by 2020, remaining constant thereafter[46]. It is further assumed that the share of CH_4 recovered for power production (on total CH_4 produced) is the same under the WOM scenario as under the WEM and WAM scenarios (the share decreases disproportionately as the cost-income ratio is changing for the worse with decreasing CH_4 production of the waste disposal site). Finally, it is assumed that the share of CH_4 flared remains constant at 3.5 per cent from 1990 to 2030, and then declines to zero by 2050.	Same as for the WEM scenario.
Wastewater handling	Emissions from wastewater handling are assumed to scale with the evolution of population.	Same as for the WEM scenario.	Same as for the WEM scenario.
Biogas production	It is assumed that increased demand for biogas leads to the construction of additional biogas facilities (*Prognos*, 2012). Accordingly, the total number of biogas facilities reaches 209 by 2020 and 461 by 2030, remaining constant thereafter. The	It is assumed that the amount of biogas upgraded under the WOM scenario compared to the amount of biogas upgraded under the WEM and WAM scenarios corresponds to about half of the amount by 2020 and to about one third of the amount	Same as for the WEM scenario.

[46] The reasoning for this assumption is a decreasing public acceptance of waste disposal sites (odour, need of space, pollution, etc.), leading to the closing of waste disposal sites (where practicable) even without an official ban.

	additional biogas facilities lead to a related increase of fugitive emissions over the coming years.	by 2030 and 2035 (*Prognos*, 2012). The total number of biogas facilities under the WOM scenario is then derived assuming the same amount of upgraded biogas per facility as under the WEM and WAM scenarios. Consequently, reduced fugitive emissions from biogas facilities – from upgrading of biogas to natural gas quality and from flaring – result under the WOM scenario compared to the WEM and WAM scenarios.	

4.3.6 Indirect CO_2 emissions

For the WEM and WAM scenarios, projections of indirect CO_2 emissions are based on the same assumptions and methodologies as the projections of direct greenhouse gas emissions in the respective sectors (see above). For the WOM scenario, it is assumed that due to the absence of policies and measures the emission factors for NMVOC emissions do not improve over time and, thus, remain constant at the values in 1990 (see section 3.5.4). The same activity data as under the WEM and WAM scenarios are then used to derive NMVOC emissions and subsequently indirect CO_2 emissions under the WOM scenario. For all scenarios, only fossil emissions and only emissions not already included elsewhere are considered (see section 1.2.4 for more details).

4.3.7 International transport

The scenarios for international aviation are based on the following assumptions:

- For international aviation, a constant growth rate of passenger numbers of 3.2 per cent per year is assumed. This value is based on the growth rate for scheduled and charter flights estimated by *Intraplan* (2015) and serves as an indicator for fuel consumption. Due to capacity limits of Swiss airports, the constant growth rate is gradually transferred, between 2027 and 2033, to a growth rate connected to the projected population increase (with values below one per cent per year, see also Tab. 22);
- The growth rate as mentioned above is superimposed by an increase in efficiency by 0.57 per cent per year, based on scenario 5 in *ICAO* (2016). This increase in efficiency also reflects the effect of the CO_2 emissions standard for aircraft (section 3.4.10)[47]. Therewith, overall fuel consumption is assumed to increase by 2.63 per cent per year up to 2027, slowing down its growth rate as Swiss airports reach their capacity limits. The role of biofuels in aviation is assumed to remain negligible up to 2035, but may become relevant thereafter;
- For the WEM and WOM scenarios – where apart from the CO_2 emissions standard for aircraft no policies and measures are in place – the increase rate as described above is directly applied to project emissions[48];
- Under the WAM scenario, the planned inclusion of aviation in the emissions trading scheme (section 3.4.9) as well as the planned carbon offsetting and reduction scheme for international civil aviation (CORSIA; section 3.4.11) overall enforce a carbon neutral growth on the basis of 2020. As the carbon neutral growth does not right away cover the complete fuel consumption of global aviation (some countries may join later), it is assumed that the carbon neutral growth is achieved for 66 per cent of total fuel consumption for the years 2021 to 2026, increasing to 80 per cent of total fuel consumption for the years 2027 to 2035[49]. Although emission compensations may take place outside the aviation sector, all effects resulting from efforts related to the policies and measures within the aviation sector are fully considered within the sector itself.

For Switzerland, emissions from international transport are dominated by international aviation. The minor emissions from international navigation are assumed to remain constant (at the level of emissions in 2017) up to 2035.

[47] As this policy and measure is of global significance, it is assumed that it does not lead to differences between the WEM, WOM and WAM scenarios.

[48] While CO_2 and N_2O emissions are assumed to increase in concert with the estimates for fuel consumption, CH_4 emissions are assumed to remain constant under all scenarios. This is based on the trends reported in the greenhouse gas inventory, where – for more than the last decade – CH_4 emissions have remained about constant despite increasing fuel consumption.

[49] See *https://www.edf.org/climate/icaos-market-based-measure* for more background information.

4.3.8 Main differences compared to previous submissions

Compared to the greenhouse gas emission scenarios presented in Switzerland's last submission (i.e. Switzerland's seventh national communication and third biennial report), the following most important changes and improvements regarding methodology and assumptions were implemented in the calculations for the different sectors:

- Switzerland's greenhouse gas emission scenarios have been extended to the end year 2035 (compared to 2030 in Switzerland's seventh national communication and third biennial report). While the BR CTF tables do currently not foresee the reporting of greenhouse gas emission projections going beyond 2030, the tables and figures in Switzerland's fourth biennial report now show greenhouse gas emission scenarios up to 2035;
- For the energy sector, the scenarios for CH_4 and N_2O slightly differ from the scenarios of the last submission. This because CH_4 and N_2O emissions of the WEM, WOM and WAM scenarios are calculated out of the CO_2 emissions of the corresponding scenario by application of the same ratios of CH_4 to CO_2 and N_2O to CO_2 as in the WEM scenario in the latest year with inventory data (see section 4.3.1). Compared to the last submission, the latest year with inventory data is now 2017 (compared to 2015 in Switzerland's seventh national communication and third biennial report);
- In the industrial processes and product use sector, the modelling of emissions of F-gases has been updated to be consistent with the most recent development of legislation, in particular reflecting Switzerland's commitment under the Kigali Amendment to the Montreal Protocol under the WAM scenario (see section 3.5.2);
- Projections for the agriculture sector have been updated with new scenarios from *Möhring et al.* (2018) and adjusted to the latest emission estimates from the greenhouse gas inventory submitted in 2017. Differences to the previous submission are small since *Möhring et al.* (2018) assume a more or less unaltered continuation of the current agricultural policy;
- The scenarios for international transport have been revised. They now take into account the latest changes in legislation as well as the recently observed development and updated projections for emissions from international aviation.

The overall effect of updated assumptions and changes to the methodology used to prepare the projections is shown in Fig. 24. Compared to the previous submission, the most recent WEM scenario is 0.5 per cent and 0.6 per cent lower by 2020 and 2030, respectively. The most recent WOM scenario is 0.2 per cent and 0.5 per cent lower by 2020 and 2030, respectively. The most recent WAM scenario is 0.1 per cent and 0.1 per cent higher by 2020 and 2030, respectively. The overall differences are of minor importance, as recent changes with relevant impacts were the extension of projections to 2035 and the update of emissions from international transport (not shown in Fig. 24, but see Fig. 25).

Fig. 24 > Total emissions without LULUCF: Changes in projections as reported in Switzerland's fourth biennial report (coloured lines) and Switzerland's seventh national communication and third biennial report (black dotted lines). The overall differences are of very minor importance.

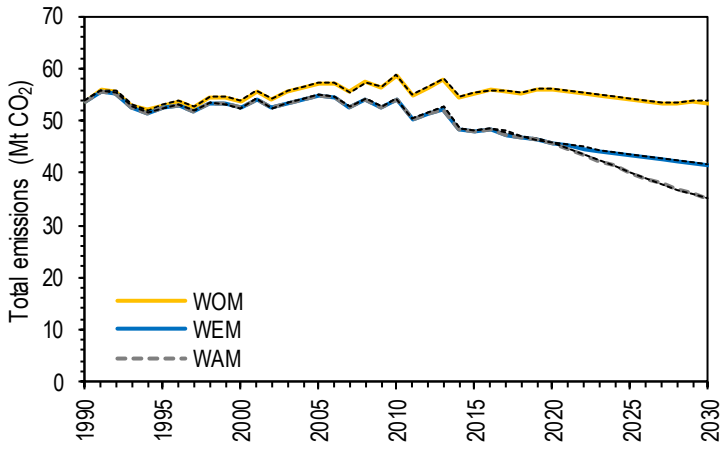
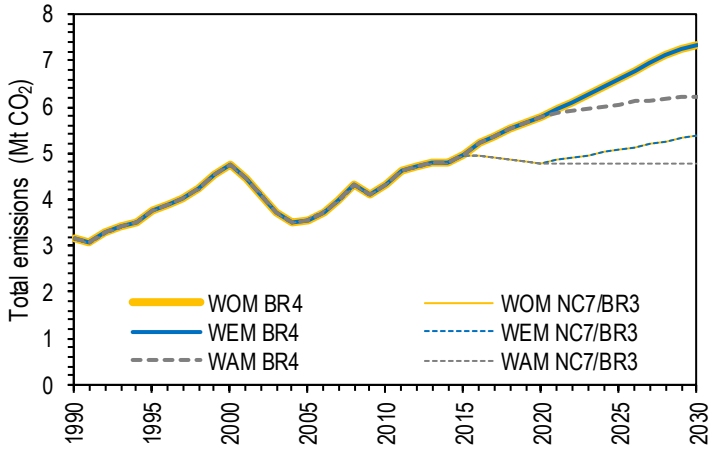


Fig. 25 > International transport: Changes in projections as reported in Switzerland's fourth biennial report (thick lines) and Switzerland's seventh national communication and third biennial report (thin lines). By 2020, the WEM, WOM and WAM scenarios are 21.1 per cent higher compared to the previous submission. By 2030, the WEM and the WOM scenarios are 36.4 per cent higher and the WAM scenario is 29.7 per cent higher compared to the previous submission.



4.3.9 Sensitivity analysis

In the context of the development of the greenhouse gas emission scenarios for the energy sector (including transport), the computable general equilibrium model was also used to perform a sensitivity analysis (*EPFL and Infras*, 2016). In brief, for the CO_2 emissions from the energy sector (including transport), which contribute the dominant part to Switzerland's total greenhouse gas emissions, so-called 'sensitivity scenarios' were analysed for the WEM scenario. Thereby, the following key underlying assumptions, which may introduce the largest amount of uncertainty into the model calculations, were altered within reasonable limits (i.e. increased and decreased with regard to their reference value):

- Gross domestic product;
- International price of oil;
- International price of gas;
- Technological progress;
- Bottom-up estimates of the mitigation impacts of non-price policies and measures used for the simulations with the computable general equilibrium model.

A low and a high scenario were then produced by combining the altered key underlying assumptions in such a way that the new sets of key underlying assumptions either favoured low emissions or high emissions. For the low and high scenario, the altered key underlying assumptions were selected as shown in Tab. 35. The resulting emission scenarios are shown in Fig. 26 for the WEM scenario and in Fig. 27 for the WOM scenario. *EPFL and Infras* (2016) had to restrict the sensitivity analysis to a very limited number of scenarios (i.e. resulting emission pathways calculated with a set of altered key underlying assumptions), rather than performing analyses in which all the main assumptions of the models are altered over a range of plausible values. This is because back-casting different paths requires recalibration of the model, a task that cannot be performed for ranges of plausible values (for more details see section 5.1 of *EPFL and Infras*, 2016).

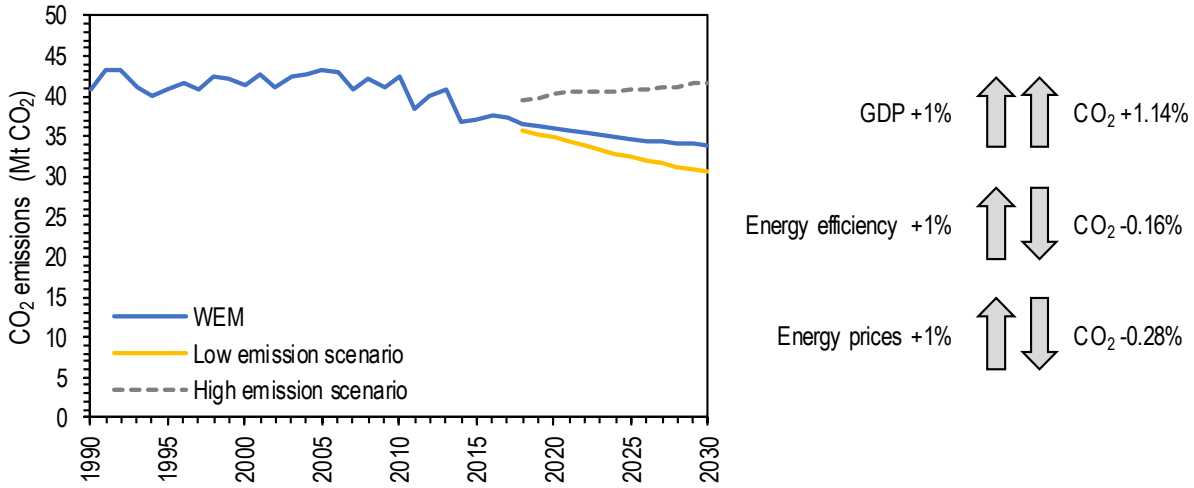
Tab. 35 > Key underlying assumptions used for the sensitivity analysis under the low and high emission scenarios for 2030.

Key underlying assumption	Low emission scenario	Reference	High emission scenario
Gross domestic product in 2030	96%	100%	104%
International price of oil	100%	100%	50%
International price of gas	100%	100%	50%
Technological progress	75%	100%	125%
Bottom-up estimates	70%	100%	130%

The main results of the sensitivity analysis are as follows:

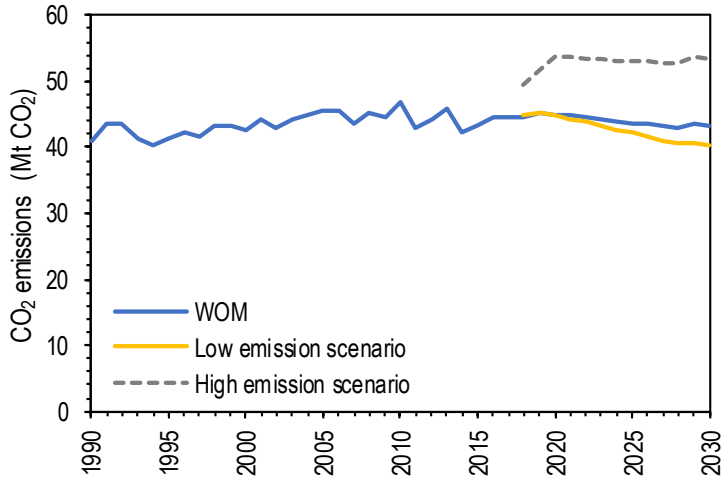
- For the WEM scenario, CO_2 emissions from the energy sector (including transport) cover a range (relative to the scenario calculated with the reference values for the key underlying assumptions) from –3 to +12 per cent by 2020. By 2030, the range increases to –9 to +23 per cent;
- An increase of the gross domestic product by one per cent leads to an increase of CO_2 emissions from the energy sector (including transport) by 1.14 per cent;
- An additional improvement of energy efficiency by one per cent leads to a decrease of CO_2 emissions from the energy sector (including transport) by 0.16 per cent;
- An increase of the international price of oil by one per cent leads to a decrease of CO_2 emissions from the energy sector (including transport) by 0.28 per cent.

Fig. 26 > Sensitivity analysis for the WEM scenario (CO_2 emissions from the energy sector, based on *EPFL and Infras*, 2016[50]). Left: Low and high emission scenarios produced by combining the altered key underlying assumptions in such a way that the new sets of key underlying assumptions either favour high emissions or low emissions (see Tab. 35). Also shown is the WEM scenario as the reference. Right: Stimulated changes in CO_2 emissions from the energy sector by a change of one per cent in a particular key underlying assumption (for 2030).



[50] The sensitivity analyses of *EPFL and Infras* (2016) are based on the data available at the time of the publication of the report. Therefore, the reference scenarios (WEM and WOM) in Fig. 26 and Fig. 27 may sligthly differ from the scenarios provided elsewhere in Switzeraland's fourth biennial report. However, this does not impair the interpretation of the sensitivity analyses, but enures that the low and high emission scenarios are fully consistent with the respective reference shown in the same figure.

Fig. 27 > Sensitivity analysis for the WOM scenario (CO_2 emissions from the energy sector, based on *EPFL and Infras*, 2016[50]). Low and high emission scenarios produced by combining the altered key underlying assumptions in such a way that the new sets of key underlying assumptions either favour high emissions or low emissions (see Tab. 35). Also shown is the WOM scenario as the reference.



Further methodological details as well as additional figures and tables are available in chapter 5 of *EPFL and Infras* (2016); to make the information available to a broad readership, this report was written in English rather than in one of the official languages of Switzerland.

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5 Financial, technological and capacity-building support

5.1 Finance

5.1.1 Introduction

The Federal Constitution of the Swiss Confederation stipulates that Switzerland be committed to the long-term preservation of natural resources and to a just and peaceful international order. Furthermore, it states that Switzerland shall in particular promote global sustainable development and protect the natural resource base in view of alleviating poverty in the world. Support for international climate action – through a variety of channels and instruments, such as dedicated multilateral climate funds, specific multilateral and bilateral climate programmes and projects, as well as integrating low-carbon development and climate resilience into Switzerland's development assistance – has thus been a cornerstone of Switzerland's international engagement since the early 1990s. Regarding international climate financing, three government entities – the Swiss Agency for Development and Cooperation, the Swiss State Secretariat for Economic Affairs, and the Swiss Federal Office for the Environment – have specific roles and dedicated budgets. They cooperate closely to ensure the overall effectiveness and coherence of Swiss support for climate change adaptation and mitigation activities in developing countries and countries in transition.

Building on decades of climate-relevant work in developing countries in different areas such as energy efficiency, renewable energy, agriculture and forestry, land-use planning, disaster risk management and technology transfer, Switzerland has played an active role since the early days of international climate policy. In the international climate change arena, Switzerland underscores the relevance of a fair and equitable burden sharing among Parties, while stressing the importance of a sound regulatory framework and an attractive investment environment to achieve a low-carbon and climate-resilient development. Through its multilateral and bilateral cooperation and its membership in the governing bodies of various multilateral institutions (inter alia multilateral development banks, the Green Climate Fund, the Global Environment Facility, the Adaptation Fund, United Nations agencies) Switzerland attaches great importance to increased coherence and effectiveness in the mandate of the above mentioned multilateral climate finance institutions. Furthermore, the establishment of strategic partnerships at all policy levels and the strengthening of dialogue among all stakeholders, including the private sector and other non-governmental institutions, are key principles guiding Switzerland's international climate change engagement.

Switzerland's public climate finance has seen a steady increase over the past years. Standing at 175 million US dollars in 2012 the respective amount grew to 299 million US dollars in 2014, 330 million US dollars in 2016, and 340 million US dollars in 2018. The increase between 2012 and 2014 was partly fuelled by the decision of the Swiss Parliament in 2011 to raise the level of official development assistance to 0.5 per cent of gross national income by 2015. In addition, Switzerland's development assistance has gradually shifted to place an enhanced focus on climate change, thus pushing the envelope of climate-relevant and climate-proofed programmes and projects in developing countries. These strategic decisions lead to a remarkable progression compared to previous efforts. Switzerland therefore considers its provided climate finance as new and additional. It represents furthermore Switzerland's highest possible effort under budget constraints that currently also affect official development assistance spending (currently at 0.45 per cent of gross national income) and is therefore considered adequate by the Swiss government pursuant to Article 4, paragraph 3 of the Convention. Through its contributions to multi-annual multilateral funds, such as the Green Climate Fund and the Global Environment Facility, Switzerland is committed to providing predictable climate finance. In addition, Switzerland's bilateral support for climate action is based on a cooperative, bilateral dialogue with the various recipient countries. Every four years the Swiss cooperation offices engage in a demand driven planning dialogue, where, contingent on the available resources, the needs and priorities of the recipient country are assessed. This programmatic procedure ensures country ownership and provides increased predictability for the partner countries, pursuant to Article 4, paragraph 3 of the Convention.

The decision adopted by the Conference of the Parties to the UNFCCC in 2010 in Cancun refers to a variety of sources including the private sector. In contrast to this decision, the financial resources reported in this section relate to financing from public sources attributable to official development assistance only. Current Swiss public investments for climate change adaptation and mitigation measures in developing countries can be found in section 5.1.6. All public funding was provided in the form of grants (no loans).

This biennial report does include bilateral, but not multilateral mobilised private climate finance. It also does not include the outflow data of public climate finance provided and mobilised by multilateral institutions. The rationale for omitting this data is informed by Switzerland's view that bilateral reporting of mobilised private finance through multilateral channels as well as bilateral reporting of the outflow data from multilateral institutions would not do justice to the complexity and the joint effort of all partners involved in multilateral institutions. However, Switzerland considers multilateral mobilised private climate finance as well as the full face value of the climate finance outflow of multilateral institutions as climate finance accountable towards the 100 billion US dollars goal. Switzerland remains very much committed to increasing its share of mobilised private finance as part of its climate finance spending. It is also keen to advance efforts at the international level to collectively capture and report on private climate finance mobilised through multilateral channels and to fully capture the outflow of public climate finance by multilateral institutions.

Switzerland has added its data on mobilised private climate finance outside of this report and the UNFCCC reporting to (i) the joint report of the OECD and the Climate Policy Initiative on Climate Finance 2013–2014 and the 100 billion US dollars goal and (ii) the report of the OECD Climate Finance Provided and Mobilised by Developed Countries in 2013–2017 (*OECD*, 2015; *OECD*, 2019). Switzerland was part of the donor group, which provided significant methodological input to the report to measure and report mobilised private climate finance in a transparent, comparable and aggregate manner. Switzerland, together with the other donors, followed a robust methodology for the assessment of the mobilised private sector investments (*TWG*, 2015). In developing the methodology, the donor group was guided by the following principles: (i) to ensure that only finance mobilised by developed country governments is counted towards the 100 billion US dollars goal, (ii) that, where multiple actors are involved, the resulting finance is only counted once in tracking the progress, and (iii) to ensure that the reporting framework encourages and incentivises the most effective use of climate finance. The 2015 report came to the conclusion that all developed countries have jointly mobilised 12.8 billion US dollars in 2013 and 16.7 billion US dollars in 2014 from private sources. In 2016, 48.5 billion US dollars have been mobilised by all developed countries compared to 56.7 billion US dollars in 2017. While the 2016 and 2017 totals cannot be directly compared with estimates for earlier years due to improvements in data and methodology relating to private finance (*OECD*, 2019), mobilised private finance overall is increasing steadily.

5.1.2 Multilateral activities

Switzerland has made financial contributions to the UNFCCC secretariat, to the operating entities of the financial mechanism of the Convention, to other multilateral institutions and to international financial institutions such as the World Bank and other multilateral development banks that fund climate change adaptation, mitigation, disaster risk management, capacity building and technology cooperation programmes in developing countries. Among the international financial institutions, the largest contributions goes to the International Development Association, a substantial share of which is allocated to finance climate change action. Switzerland's total contribution to the 18th replenishment of the International Development Association was a total of 645 million Swiss francs. Moreover, many international organisations, such as the United Nations Development Programme and the Consultative Group on International Agricultural Research, whose operations are co-funded by Swiss core contributions, are increasingly generating important climate benefits.

Tab. 38 and Tab. 39 highlight Switzerland's contributions to these multilateral institutions, organisations and associated programmes. Where possible, Switzerland calculated the climate relevant part of the Swiss multilateral official development assistance contributions using the climate relevant share of the portfolio for the respective organisation according to the OECD Development Assistance Committee methodology. Switzerland also cooperates with a number of multilateral institutions as implementing agency of bilateral and regional programmes and projects. The funds invested in those specific programmes are included in Tab. 40 and Tab. 41.

Green Climate Fund

As an operating entity of the financial mechanism of the Convention the purpose of the Green Climate Fund is to make a significant and ambitious contribution to the global efforts towards attaining the goal agreed by the international community to keep global warming well below two degrees Celsius. In the context of sustainable development, the Fund promotes a paradigm shift towards low-emission technologies and climate-resilient development with a focus on the most vulnerable countries. From 2015 to 2018 Switzerland contributed in total 100 million US dollars to the Green Climate Fund. Switzerland announced to contribute 150 million US dollars to the first formal replenishment period,

increasing its contribution by 50 per cent compared to the Initial Resource Mobilization Period (2019–2022), subject to approval by the Swiss Federal Council and the Swiss Parliament.

Global Environment Facility

The Global Environment Facility addresses global environmental issues while supporting national sustainable development initiatives. The Global Environment Facility provides support for projects related to climate change, biodiversity, land degradation, forests, the ozone layer, persistent organic pollutants and international waters. Switzerland has supported the Global Environment Facility since its inception in 1991. To the Fifth Replenishment of the Global Environment Facility (2010–2014) Switzerland contributed roughly 114 million US dollars. Besides the 32 per cent of funds allocated for the climate change focal area in the Fifth Replenishment of the Global Environment Facility, including mitigation and adaptation measures, capacity building and technology transfer, the Global Environment Facility incorporates climate change considerations into broader programmes of the other focal areas. For the Sixth Replenishment of the Global Environment Facility (2014–2018) Switzerland contributed roughly 133 million US dollars. The contributions by Switzerland for the fifth and sixth replenishment are paid over a period of ten years. Switzerland has never been in arrears with its payments.

Least Developed Country Fund and Special Climate Change Fund

The Global Environment Facility also features two dedicated climate change funds under the UNFCCC, i.e. the Least Developed Country Fund and the Special Climate Change Fund.

The Least Developed Country Fund was established to address the special needs of the least developed countries with regard to the negative impacts of climate change. The least developed countries identified adaptation as their top priority, which is why the Least Developed Country Fund is thus far the only fund under the Climate Convention tasked specifically with financing the preparation and implementation of National Adaptation Programmes of Action (NAPAs). Unlike the Least Developed Country Fund, the Special Climate Change Fund is open to all developing country Parties to the UNFCCC, supporting adaptation measures and technology transfer. Between 2015 and 2018, Switzerland's contributions to both funds amounted to roughly 9.3 million US dollars.

Adaptation Fund

The Adaptation Fund was established to finance concrete adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol and are particularly vulnerable to the adverse effects of climate change. Financing for the Adaptation Fund comes mainly from a two per cent levy on CERs and other units from the market-based mechanisms under the Convention. In addition, the Fund receives voluntary contributions from governments, the private sector and individuals. In 2013, Switzerland provided a supplemental contribution of 10.79 million US dollars to the Adaptation Fund in line with Article 12 of the Kyoto Protocol. Switzerland has not made any voluntary contributions to the Adaptation Fund from 2014 to 2018.

Global Facility for Disaster Reduction and Recovery

The Global Facility for Disaster Reduction and Recovery is a growing global partnership among contributing and recipient countries and several international organisations hosted by the World Bank since 2006. Its mission is to mainstream disaster risk management and climate adaptation into development strategies. The facility carries out a range of activities to support countries to build resilience, structured around five pillars of action: (i) risk identification, (ii) risk reduction, (iii) preparedness, (iv) financial protection, and (v) resilient recovery. Working as a grant-making facility, the Global Facility for Disaster Reduction and Recovery supports countries to develop capacity, generate new knowledge, and apply it to policy reforms and investments for disaster risk management. Switzerland contributed 20 million US dollars to the Global Facility for Disaster Reduction and Recovery from 2013 to 2016 with a particular focus on resilience to climate change.

Addressing the needs of developing country Parties

Relating to multilateral programming – likewise the bilateral programming – Swiss delegates always advocate for country ownership (implying country need-based programming) and impact oriented programming in the various multilateral funding institutions and governing bodies of multilateral climate finance funding schemes, in which Switzerland participates as a contributor.

All multilateral activities mentioned above ensure that their activities are endorsed by the recipient countries to ensure the projects fit within the recipient countries' priorities and that the funded interventions are sustainable.

In addition, most multilateral institutions, which are active in the area of climate finance, have started initiatives for a better integration and alignment of their portfolio with the communicated nationally determined contributions of developing countries. The more detailed and precise the nationally determined contributions are formulated, the easier it will be for agencies to align their investments and initiatives with the national priorities of developing countries. In the past, this has been very challenging since the Biennial Update Reports, which could be used to communicate the needs and priorities of developing countries, have not been submitted on time by multiple Parties or have not been submitted at all.

5.1.3 Bilateral activities

Next to the important multilateral engagement, the bilateral programmes and projects build a key element of Switzerland's climate change cooperation. Switzerland works closely with bilateral partners to deliver effective global responses to climate change and tangible results on the ground. All activities are implemented by one of the two Swiss development agencies – the Swiss Agency for Development and Cooperation or the Swiss State Secretariat for Economic Affairs – in close cooperation with government institutions, non-governmental organisations, private sector entities and research institutions. Switzerland's bilateral and regional climate-relevant activities are: (i) generate new and relevant knowledge on climate policy, (ii) technology and implementation, (iii) harness and replicate successful practices, (iv) develop the skills and capacities of partner countries for their engagement in the international debate on climate change issues, and (v) the implementation of climate action.

In order to effectively tackle the double challenge of addressing climate change mitigation and climate change adaptation in a complementary manner, the climate change activities of the Swiss Agency for Development and Cooperation consists of four main components: (i) climate change processes and funds, (ii) climate change mitigation, (iii) climate change adaptation, and (iv) knowledge management. In total the Swiss Agency for Development and Cooperation spent roughly 470 million US dollars between 2015 and 2018 for bilateral climate change programmes (for further details see Tab. 40 and Tab. 41).

With the aim to foster climate-friendly growth in developing countries, the climate change portfolio of the Swiss State Secretariat for Economic Affairs is structured mainly along three areas of intervention: (i) sustainable urban management (e.g. energy, mobility and disaster risk reduction), (ii) resource efficiency in industrial production and sustainable management of natural resources, and (iii) framework conditions for green financing mechanisms.. The Swiss State Secretariat for Economic Affairs provided approximately 332 million US dollars between 2015 and 2018 for its global, regional and bilateral programmes and projects in climate change as well as through the Swiss Investment Fund for Emerging Markets. In addition, it mobilised in 2017–2018 roughly 64.3 million US dollars from the private sector among others through the Swiss Investment Fund for Emerging Markets and the Private Infrastructure Development Group and the Climate Investment Funds, up from 3.7 million US dollars in the reporting period 2013–2014[51].

Addressing the needs of developing country Parties

Switzerland's approach to offering bilateral support is oriented towards the needs and priorities of the receiving countries. Country-ownership is thus a key requirement. Assistance for climate action is based on a clear demonstration of demand and need by the partner country. As a general rule, all bilateral projects have to be endorsed by the partner country.

Switzerland's bilateral climate mitigation and adaptation activities are based on national strategies and priorities and are ideally reflected in the partner countries' national climate change and/or sustainable development policies. Over the next years, Switzerland endeavours to work closely with its partner countries to support the implementation of the Paris Agreement and align the partner countries' national policies, activities and needs with the Paris Agreement.

[51] The Swiss Investment Fund for Emerging Markets is Switzerland's development finance institution and a cornerstone of Swiss development cooperation (see http://www.sifem.ch). The mobilisation figure for 2013 and 2014 were reported to the OECD and the Climate Policy Initiative for their aggregate report.

Switzerland has for example supported the Capacity Building Initiative for Transparency with half a million Swiss francs in 2016 and half a million Swiss francs in 2017. The Capacity Building Initiative for Transparency finances the build-up of institutional and human capacities in developing countries, which are committed to implement the Paris Agreement and scale-up their efforts for increased transparency. The initiative will support these in defining their needs and gaps to comply with the increased transparency framework and to fill those in an efficient and effective manner. The application procedures are the same as for the Global Environment Facility funds and ensure country ownership.

Adaptation

Switzerland has undertaken a broad range of activities to support developing countries in reducing their vulnerability to the unavoidable consequences of climate change, while also minimizing the social and economic costs by:

- Maintaining or increasing productive capital of land (forest, agriculture) and maintaining or increasing water availability at a local level;
- Reducing vulnerability to natural hazards in highly endangered areas at the local/regional level;
- Supporting countries in defining their national and sub-national adaptation strategies and plans;
- Increasing capacity-building, technology transfer and innovation in the field of adaptation in developing and middle-income countries;
- Increasing understanding and awareness about adaptation at different levels and promoting south-south learning processes.

Besides supporting developing countries in adapting to the impacts of climate change, Switzerland has been active for many years in the prevention and reduction of disaster risks. For instance, it developed methods and tools to better integrate disaster risk reduction into project planning and project management[52].

After a slight reduction between 2013 and 2016, Switzerland increased its specific support for bilateral adaptation activities from 102 million US dollars in 2016 to 153 million US dollars in 2018.

Through its bilateral and multi-bilateral development cooperation, Switzerland supported several climate change adaptation related projects, such as the Indian Himalayas Climate Adaptation Programme (see Tab. 36) and:

- **Cryospheric Climate Services for Improved Adaptation (CICADA):** The mountain cryosphere in Central Asia is a core determinant for water management and disaster risk management: the mountain glaciers and snow packs serve as water towers in the arid region and glacier retreat can trigger disastrous events such as glacier lake outburst floods or debris flows. Co-financed by the Swiss Agency for Development and Cooperation, the CICADA project is improving cryospheric climate services in Central Asia in order to support the region in better adapting to climate change. It is establishing a modern glacier monitoring system in Central Asia, creating high quality data which are fed in openly accessible databases managed by the World Glacier Monitoring Service. The project is increasing the capacities of national hydro-meteorological services and universities in cryosphere monitoring through field campaigns and summer schools. In two pilot regions, the project assessed the impact of glacier retreat on the regional water balance and the formation of additional glacier lakes;
- **Can Tho Urban Development and Resilience Project:** Co-financed by the Swiss State Secretariat for Economic Affairs together with the World Bank, the project aims to increase the resilience of Can Tho City, Vietnam, to adverse climate change-related events by proactively addressing the two biggest threats to its socioeconomic development: flooding and uncontrolled urbanisation. Situated in the middle of the Mekong Delta, Can Tho is susceptible to flooding caused by Mekong overflow, high tides, and extreme rainfall events. The objective of the Can Tho Urban Development and Resilience Project is to reduce flood risk in the city of Can Tho, guide urban development in a risk informed way, improve connectivity between the city centre and the new low risk urban development areas, and enhance the capacity of city authorities to manage disaster risk sustainably;

[52] https://www.eda.admin.ch/deza/en/home/themes-sdc/disaster-reduction-relief-reconstruction/disaster-risk-reduction.html

- **Green Gold Project in Mongolia**: Regional climate models predict an increase in the annual air temperature of 3.5 to 4 degrees Celsius in Mongolia over the next 100 years and declining precipitation in all parts of the country, accompanied by decreasing soil moisture due to increased temperatures and dryness. Livestock herders have already started repeatedly expressing their concerns about lakes, streams and rivers drying up and declining pasture productivity. This, in turn, starts to affect pastoral land use patterns by increasing conflicts over scarce water and pasture resources. The past two decades also witnessed two severe winters when millions of livestock perished with devastating effects on the livelihoods of thousands of herder households. In response to these challenges, the Green Gold Project supported community-based rangeland management initiatives of herders aiming at reducing pasture conflicts and prevent rangeland from degradation, as well as to increase resilience and climate change adaption capacity of herders by strengthening the self-regulating feedback of socio- economic and environmental system of pastoral livestock. The project helped to strengthen the capacities of Mongolian herders who are currently discussing via novel associations joint rules for pasture management with the local governments. The respective autonomous associations are, in fact, increasingly recognised by local Mongolian authorities who give them permission to manage pastures, and provide them with technical advice and financial support. Preserving and maintaining ecosystems provides the essential basis for creating sustainable income for herders. The project thus contributed to the improvement of the livelihood of 100 thousand semi-nomadic herder families in western Mongolia;
- **Tapping resilience for a stronger future:** The Pan Africa Bean Research Alliance (PABRA) is a regional bean research partnership coordinated by the Center for Tropical Agriculture covering 31 countries in sub-Saharan Africa. PABRA's focus is to improve the livelihoods of smallholder bean farmers by delivering on improved food security, nutrition security, increased trade and gender equality. This is achieved through enhanced networks of stakeholder, sound research and improved seed systems through which farmers get good quality seed of new crop varieties. These new varieties are high-yielding, more resilient to drought and environmental stress and biofortified with iron ad zinc. In Burundi for example, through PABRA's multiple interventions bean yield has doubled in the intervention areas due to new bean varieties that are high yielding and drought tolerant. This also triggered increased trade and income especially for women, and the development of small and medium enterprises in the seed and processing business – generating additional local jobs;
- **Ensuring food security for smallholder farmers with micro insurance and microcredits:** The Rural Resilience Initiative combines four climate risk management tools, which are all aimed at preventing or reducing the impact of climate change on the population by rehabilitating irrigation systems, improving soil water retention, promoting sustainable farming practices in the fields, constructing access roads, etc. The Swiss Agency for Development and Cooperation supported project activities in Malawi, Zambia and Zimbabwe. The project provides smallholders who are most at risk from drought or floods with agricultural micro insurance. An innovative measure is that the project allows farmers to pay their insurance premiums by taking part in community work. The project also includes the installation of new weather stations in Zambia and Malawi – an important prerequisite to calculate the price of insurance premiums and better anticipate bad harvests. As a parallel measure, the project trains microcredit agencies in limiting the debt risk. The combination of micro insurance and microcredit is intended to encourage farmers to invest in agricultural activities (inputs, equipment) without fear of losing their farm the following year.

Tab. 36 > Promotion of climate change adaptation in the Indian Himalayas.

Project/programme title:
Indian Himalayas Climate Adaptation Programme.

Goal:
The project aims at strengthening the resilience of vulnerable communities in the Himalayas and to enhance knowledge and capacities of research institutions, communities, and decision-makers.

Recipient country	Sector	Total funding	Years in operation
India	Adaptation	5.6 million Swiss francs	2012–2018

Description:
The project helped to build capacity and enhance knowledge related to three pillars:

- Scientific and technical knowledge cooperation between Indian and Swiss scientific institutions;
- Adaptation measures for vulnerable communities;
- Mainstreaming adaptation policies for improved action in the Indian Himalayan Region.

The Indian Himalayas Climate Change Adaptation Programme was initiated by the Swiss Agency for Development and Cooperation in collaboration with the Department of Science and Technology, Government of India. Implementing partners included a consortium of Swiss (Geneva, Bern, Fribourg, Zurich) and Indian (Jawahrlal Nehru University, G.B. Pant National Institute of Himalayan Environment and Sustainable Development, Doon University, Himachal Pradesh Agricultural University Palampur, Birbal Sahni Institute of Palaeobotany, Lucknow) universities.

Key achievements (complementary to the paragraphs below):

- 1200 sector experts and policy makers in Himalayan states sensitised on various issues related to climate change and spring-shed management
- An innovative joint research work (India and Switzerland) on vulnerability, risks and hazard assessment in Kullu district in partnership with the Department of Science & Technology, government of Himachal Pradesh was carried out;
- A common framework for integrated vulnerability, and risk assessment for all Himalayan states was developed; through the project climate vulnerability maps of all 12 Indian Himalayan States have been made available for the first time, using a standardised common framework.
- Results of joint research and common framework help enable planning and implementation of adaptation action at state level;
- Media capacity building workshops were conducted in different Indian Himalayan states with 74 journalists trained;
- Knowledge management and outreach were addressed through policy briefs with an outreach to more than 26 thousand individuals;
- Co-funding support was generated to universities/institutions for promoting a scientific dialogue on climate change impact, vulnerability & adaptation in the Himalayas;
- Technical assistance for the preparation of climate change adaptation projects was provided to Jammu Kashmir and Himachal Pradesh for National Adaptation fund on Climate Change;
- The revival of multi-stakeholder 'Himalayan Sustainable Development Forum' fostered cooperation on sustainable development across the Himalayan region.
- Technical contributions were made to the working group on inventory and revival of springs in the Himalayas for water security

Technology transferred/capacity building:

The Indian Himalayas Climate Adaptation Programme mainly focused on capacity building of Indian researchers, universities and institutions as well as government representatives in the field of glaciology and related areas. The project helped develop an Indo-Swiss Capacity Building Programme on Himalayan Glaciology through which 52 researchers were trained. The programme was then further developed into a full-fledged 'glaciology course' as part of a Master's curriculum in order to secure the sustainability of the efforts and achievements jointly with the two selected Indian Kashmir and Delhi Universities. Course content was put on an online portal with currently 240 registered users, and is also mainstreamed through the Himalayan University Consortium. The project also conducted an Indo-Swiss Collaborative Research in Kullu district. As a result of this collaborative research a synthesis report was produced (*IHCAP*, 2016).

Impact on government targets:

Through the Indian Himalayas Climate Adaptation Programme the Swiss Agency for Development and Cooperation collaborated with the Department of Science & Technology, Government of India. Indian Himalayas Climate Adaptation Programme was designed to work with existing country systems at national and state levels and directly contributed to the implementation of India's National Mission on Sustaining the Himalayan Environment. It also contributed to the implementation of the State Action Plans and to gaining access to climate finance by supporting the preparation of climate change adaptation projects for the National Adaptation Fund on Climate Change.

Swiss Agency for Development and Cooperation

Mitigation

Greenhouse gas emissions responsible for warming the planet originate from multiple sources. Therefore Switzerland's support of climate change mitigation activities in developing countries is cross-cutting, building on a variety of sectors and actors. Switzerland focuses its activities on access to modern energy infrastructure, including renewable energies, rural electrification, energy efficiency in the industry and in the building/construction sector, cleaner industrial production, and sustainable use of natural resources, namely forests and grassland. In addition, Switzerland supports its partner countries in the development and use of innovative financing and market mechanisms in climate protection such as emissions trading schemes or carbon taxes. Switzerland also assisted selected countries in developing a scientific basis for planning mitigation activities (Mitigation Action Plans and Scenarios, MAPS) – namely Peru, Chile and Brazil –, which ultimately informed the governments on the elaboration of their nationally determined contributions. Switzerland further supports developing countries in the design and implementation of ambitious policies to mitigate climate change such as clean air policies or policies to mitigate black carbon emissions. Switzerland increased its bilateral support for mitigation activities from 100 million US dollars in 2016 to 186 million US dollars in 2018.

Through its bilateral development cooperation Switzerland supports multiple climate change mitigation projects, such as the Vinnitsa Energy Efficiency Project (see Tab. 37) and the following:

- **The Transformative Carbon Asset Facility** is co-financed by the Swiss State Secretariat for Economic Affairs and supports different types of direct and indirect carbon pricing efforts by paying for verified carbon assets that result from these actions. The results-based payments could be used to support the implementing country government to enhance sectoral planning, strengthen low-carbon policy coordination and implementation, and monitor sector performance on greenhouse gas emissions. All these are necessary conditions to create a conducive environment for increasing private sector investment in low carbon technologies. Transformative Carbon Asset Facility will support the measuring, reporting and verification of nationally determined contributions by developing baselines and monitoring performance of the programmes. This support to move from carbon pricing readiness to implementation builds on the work done by the World Bank's Partnership for Market Readiness and other readiness initiatives. Piloting will also inform the international process to develop standards and agreements for future carbon crediting instruments and the transfer of mitigation assets;
- **The Pilot Auction Facility for Methane and Climate Change Mitigation** is an innovative mechanism co-financed by the Swiss State Secretariat for Economic Affairs that pioneers the use of auctions to allocate public finance for climate action efficiently. The facility demonstrates a new pay-for-performance mechanism that

takes advantage of existing tools and experience developed at the multilateral level under the Clean Development Mechanism and related carbon markets to deliver financing, in the form of a price guarantee, to projects that combat climate change;

- **Climate Investment Funds**: The Climate Investment Funds support transformational, scaled-up climate action in developing countries that has the potential to leverage significant co-financing from the private sector as well as multilateral development banks and achieve strong climate and development outcomes. The Climate Investment Funds support mitigation, adaptation, and technology transfer activities and are composed of the Clean Technology Fund and the Strategic Climate Fund with its three targeted programmes: (i) the Forest Investment Programme, (ii) the Pilot Programme for Climate Resilience, and (iii) the Scaling Up Renewable Energy in Low Income Countries Programme. Switzerland contributed 26 million US dollars to the Scaling Up Renewable Energy in Low Income Countries Programme. This programme's mandate is to scale up the deployment of renewable energy solutions in low income countries to increase energy access and economic opportunities. It currently supports 27 pilot countries, including one regional programme. Through its contribution to the Scaling Up Renewable Energy in Low Income Countries Programme Switzerland mobilised a total of five million US dollars in private finance during the period 2015–2018.

Tab. 37 > Vinnitsa Energy Efficiency Project.

Project/programme title:
Vinnitsa Energy Efficiency Project.

Goal:
Improving the municipal infrastructure and its energy efficiency in the City of Vinnitsa, Ukraine.

Purpose:
To promote energy efficiency and water conservation during the use of buildings in a cost-effective way.

Recipient country	Sector	Total funding	Years in operation
Ukraine	District Heating	20.6 million Swiss francs	2011–2019

Description:
The programme consists of the following components (related to district heating):
- Support to the municipality of Vinnitsa with the introduction of the European Energy Award system for sustainable energy management at municipal level;
- Capacity building for the district heating utility MTE;
- Rehabilitation of district heating networks through the replacement of old pipes with pre-insulated system elements and through the introduction of individual heat substations at building level in four districts;
- Rehabilitation of existing gas-fired boiler stations and building of wood-fired boiler stations in two districts.

Strategic partners at the national level is the Ministry for Communities and Territories Development of Ukraine.

Expected added value of the programme:
- Demonstration effect and replication in other Ukrainian cities;
- Support to the introduction of the European Energy Award at the national level in Ukraine;
- Strengthen awareness raising on energy efficiency and sustainable energy management at the municipal level.

Technology transferred:
Not applicable.

Impact on greenhouse gas emissions/sinks:
Reduction of greenhouse gas emission in the rehabilitated district heating systems up to 48 per cent (tonnes of CO_2 per gigacalorie of delivered heat) compared to the baseline.

Swiss State Secretariat for Economic Affairs

5.1.4 Multiple benefits of forestry

Agriculture, forestry and other land use contribute 24 per cent to total global greenhouse gas emissions. 9.5 to 10.0 per cent of total global emissions are due to land use change and forest cover loss (*IPCC*, 2014). By absorbing and storing CO_2 from the atmosphere, tropical forests are therefore of critical importance in mitigating climate change. In addition, stronger ecosystems often provide important climate adaptation benefits for livelihoods and hazard protection. However, Switzerland's activities in the field of sustainable management of forests, grasslands and soil do not only focus on mitigation and adaptation effects, but are also geared towards yielding multiple environmental, economic and social benefits. Natural resources are key for the fight against poverty, especially when forests, grasslands and soils are protected and used as a sustainable source of income for local communities. .

Through its bilateral, regional and multilateral development cooperation Switzerland supports multiple sustainable forest management and climate change-related projects, such as:

- **Forest Carbon Partnership Facility:** Through the Forest Carbon Partnership Facility at the World Bank, Switzerland supports the development and piloting of REDD+ and thus preparations for a results-based payment

scheme to sustainably manage and protect forests as important carbon stocks and sinks. Apart of the financial contribution, Switzerland supported the development of Carbon Fund activities with relevant expertise;

- **Andean Forests Programme *('Bosques Andinos')*:** Andean forest ecosystems are fragile landscapes and particularly vulnerable to the combined effects of climate change, deforestation and forest degradation. At the same time, forest ecosystems potentially contribute to climate change mitigation, restoration of key ecosystem functions and reduced vulnerability of the people living in forested landscapes. In spite of their paramount importance for both human development and ecosystem stability, the Andean forests do not yet receive the necessary attention and recognition in national and international policy processes. Changing this situation is the declared goal of the Andean Forests Programme, which highlights the role of Andean montane forests for adaptation and mitigation of climate change and promotes knowledge development to address information gaps that prevent a more robust set of policies to ensure sustainable management and conservation of the mountain forests. The programme seeks to spark regional political interest in the conservation of Andean forests and shares the experiences made at the global level;
- **Macedonia Nature Conservation Programme:** Switzerland assists Macedonia in the sustainable management of natural resources through practical application of conservation measures such as regional protected areas and integrated forest management in the Bregalnica region. Furthermore, framework conditions are improved and support is provided in implementing national legislation and the Strategy on Nature. By promoting ecologically and sustainably produced products and services, economic benefits for the local population are generated. The aim of the project is to safeguard the natural values and to promote socio-economic development that is sustainable and inclusive in the Bregalnica region;
- **Support to Forestry and Fisheries Communities in Cambodia:** Switzerland contributes to the initiative Partnership for Forestry and Fisheries implemented by a consortium of four non-governmental organisations, led by WWF Cambodia. The programme supports rural communities to secure their access to forestry and fishery resources, to improve income and food security through enhanced production practices, and to advance public dialogue on sustainable natural resource management in four least-developed provinces in the northeast of Cambodia. The aim of the project is to increase the incomes of rural and indigenous communities and households and to improve their resilience to economic and natural shocks by engaging in sustainable community-based livelihood approaches that protect their ecosystems and reduce pressure on their communal natural resource base.

5.1.5 Financial support for any economic and social consequences of response measures

Switzerland supports developing countries in the economic diversification and transformation, the creation of decent work and sustainable alternative livelihoods. For example, projects in the forest and energy sector are designed together with partner countries in order to ensure the diversification of livelihoods of local communities and local industries. Project activities usually include a policy dialogue at the local, national and regional level, striving for a sustainable transition to a low-carbon economy and sustainable development. For example the second phase of the Sustainable Recycling Industries programme of the Swiss State Secretariat for Economic Affairs, with a lifespan from 2019–2023, is developing knowledge partnerships in the area of e-waste in Columbia, Peru, Ghana, Egypt and South Africa. The programme supports these countries in their efforts to improve e-waste management systems. The Sustainable Recycling Industries programme focuses on a sustainable integration and participation of small and medium size enterprises from developing and transition countries in the global recycling of secondary resources. The programme organisation includes experts and builds strong local partnerships with governmental organisations, industry and the civil society. Through these and other strong capacity-building components at all levels – from local communities to government officials – Switzerland directly supports and fosters alternative livelihoods and the necessary capacities for the workforce to be ready for a transition to a low-carbon future.

5.1.6 Provision of financial resources (including under Article 11 KP)

Switzerland's climate-related development cooperation has steadily increased over the last years. Tab. 38 to Tab. 41 give an overview on multilateral and bilateral climate-related public contributions of Switzerland. Overall, Switzerland disbursed 340.2 million US dollars in the form of grants through bilateral, multi-bilateral and multilateral channels in 2018 (up from 330.1 million US dollars in 2016). In addition, there was a total of 112 million US dollars bilaterally/multi-bilaterally mobilised private finance in 2018 (up from 8.5 million US dollars in 2016). This substantial increase in mobilised private finance was achieved in part through activities of the Swiss Export Risk Insurance, amounting in 2018 to 68.5 million US dollars mobilised private finance.

Of the bilateral climate finance disbursed in 2018 a share of 153 million US dollars or 45 per cent went to adaptation and a share of 186 million US dollars or 55 per cent to mitigation (compared to 102 million US dollars or 50.5 per cent to adaptation and 100 million US dollars or 49.5 per cent to mitigation in 2016). More details are provided in the BR CTF tables.

The data in Tab. 38 and Tab. 39 is based on support provided and the climate-specific part of the inflows is calculated based on the climate-specific imputed shares published on a year-by-year basis by the OECD Development Assistance Committee.

All contributions included in Tab. 40 are provided climate-specific and grant-based public financial contributions from Switzerland. The contributions included in Tab. 41 are climate-specific mobilised private financial contributions and provided climate-specific and grant-based public financial contributions from Switzerland. The climate-specific share of each activity is assessed based on the Rio-marker methodology and reduction factors are applied. A reduction factor of 50 per cent will be applied for activities with an indirect impact on climate change adaptation or mitigation (significant marker) and a reduction factor of 85 per cent will be applied for activities with a direct impact on climate change adaptation or mitigation (principal marker). Double counting between adaptation and mitigation specific activities is excluded by netting out potential overlaps between the climate change adaptation and mitigation Rio markers. Following such an approach is necessary as the same activity may target multiple objectives and can be marked against several Rio markers, thereby reflecting the intertwined nature of the three Rio Conventions but at the same time avoiding double counting of efforts within one convention.

Tab. 38 > Switzerland's financial contributions to multilateral institutions and programmes, 2015 and 2016.

	2015		2016		2015–2016
	Core contribution	Climate-specific contribution	Core contribution	Climate-specific contribution	Average imputed share
	US dollars				%
Multilateral climate change funds					
1 Global Environment Facility	31'433'728	22'003'610	31'250'866	21'875'606	70%
2 Least Developed Countries Fund	1'039'132	1'039'132	1'776'425	1'776'425	100%
3 Special Climate Change Fund	1'298'914	1'298'914	507'550	507'550	100%
4 Adaptation Fund	0	0	0	0	100%
5 Green Climate Fund	30'017'704	30'017'704	34'210'745	34'210'745	100%
6 UNFCCC Trust Fund for the core contribution	219'499	219'499	210'127	210'127	100%
7 Intergovernmental Panel on Climate Change	103'913	103'913	101'510	101'510	100%
8 UNFCCC Voluntary Trust Fund	270'174	270'174	253'775	253'775	100%
9 Capacity Building Initiative for Transparency	0	0	507'550	507'550	
Sub-total	**64'383'064**	**54'952'946**	**68'818'548**	**59'443'288**	**85%**
Multilateral financial institutions, including regional development banks					
1 World Bank (including IDA and IBRD)	273'455'646	49'349'219	254'705'488	45'846'988	18% IDA 19% IBRD
2 International Finance Corporation	0	0	0	0	
3 African Development Bank	73'913'420	15'396'575	77'218'231	16'094'113	19% AfDB 21% AfDF
4 Asian Development Bank	14'840'813	2'404'376	12'181'199	2'070'804	12% AsDB 17% AsDF
5 European Bank for Reconstruction and Development	0	0	0	0	34% EBRD
6 Inter-American Development Bank	1'137'231	193'329	1'367'979	232'556	17% IADB, 8% IDB Special Fund
Sub-total	**363'347'110**	**67'343'500**	**345'475'897**	**64'244'460**	**19%**
Specialised United Nations bodies					
1 United Nations Development Programme	62'347'891	NA	60'905'995	NA	NA
2 United Nations Environment Programme	4'449'977	NA	4'412'233	NA	NA
Sub-total	**66'797'868**	**0**	**65'318'228**	**0**	**NA**
Other					
1 United Nations International Children's Emergency Fund	22'860'893	NA	22'332'198	NA	NA
2 United Nations Convention to Combat Desertification	721'841	NA	159'467	NA	NA
3 United Nations Office for Disaster Risk Reduction	779'349	NA	951'656	NA	NA

4 Consultative Group on International Agricultural Research	16'106'538	NA	17'053'679	NA	NA
5 International Fund for Agricultural Development	9'871'749	6'910'225	15'314'107	10'719'875	70%
5 Multilateral Fund for the Implementation of the Montreal Protocol	1'959'087	1'959'087	1'913'780	1'913'780	100%
Sub-total	**52'299'457**	**8'869'312**	**57'724'887**	**12'633'655**	**17%**
Total	**546'827'499**	**131'165'758**	**537'337'560**	**136'321'403**	**24%**

NA, not applicable
IBRD, International Bank for Reconstruction and Development
IDA, International Development Association
AfDB, African Development Bank
AfDF, African Development Fund
AsDB, Asian Development Bank
AsDF, Asian Development Fund
EBRD, European Bank for Reconstruction and Development
IADB, Inter-American Development Bank
IDB Special Fund, Inter-American Development Bank Special Fund

Tab. 39 > Switzerland's financial contributions to multilateral institutions and programmes, 2017 and 2018.

	2017		2018		2017, 2018
	Core contribution	Climate-specific contribution	Core contribution	Climate-specific contribution	Average imputed share
	US dollars				%
Multilateral climate change funds					
1 Global Environment Facility	31'624'365	21'504'569	31'196'319	20'589'571	68%, 66%
2 Least Developed Countries Fund	2'015'127	2'015'127	1'641'207	1'641'207	100%
3 Special Climate Change Fund	507'614	507'614	511'247	511'247	100%
4 Adaptation Fund	0	0	0	0	
5 Green Climate Fund	34'215'076	34'215'076	0	0	100%
6 UNFCCC Trust Fund for the core contribution	361'422	361'422	366'423	366'423	100%
7 Intergovernmental Panel on Climate Change	472'081	472'081	102'249	102'249	100%
8 UNFCCC Voluntary Trust Fund	1'065'990	1'065'990	460'123	460'123	100%
9 Capacity Building Initiative for Transparency	507'614	507'614	0	0	100%
Sub-total	**70'769'289**	**60'649'493**	**34'277'568**	**23'670'820**	
Multilateral financial institutions, including regional development banks					
1 World Bank (including IDA and IBRD)	254'737'732	43'305'414	220'390'695	48'485'953.00	IDA: 17%, 22% IBRD: 20%, 25%
2 International Finance Corporation	0	0	0	0	
3 African Development Bank	65'009'794	8'856'648	65'475'099	13'726'716	AfDB: 10%, 11% AfDF: 14%, 22%
4 Asian Development Bank	7'113'926	995'950	7'164'844	1'504'617	AsDB: 14%, 21% AsDF: 11%, 15%
5 European Bank for Reconstruction and Development	0	0	0	0	
6 Inter-American Development Bank	0	0	0	0	
7 Asian Infrastructure Investment Bank	23'899'099	6'213'766	28'317'791	14'725'252	26%, 52%
Sub-total	**350'760'551**	**59'371'778**	**321'348'429**	**78'442'538**	
Specialised United Nations bodies					
1 United Nations Development Programme	60'913'706	NA	49'079'755	NA	NA
2 United Nations Environment Programme	4'456'954	NA	4'488'855	NA	NA
Sub-total	**65'370'660**	**0**	**53'568'610**	**0**	**NA**
Other					
1 United Nations International Children's Emergency Fund	22'335'025	NA	21'472'393	NA	NA
2 United Nations Convention to Combat Desertification	393'361	NA	94'793	NA	NA
3 United Nations Office for Disaster Risk Reduction	1'827'411	NA	996'933	NA	NA
4 Consultative Group on International Agricultural Research	17'055'838	NA	14'928'425	NA	NA
5 International Fund for Agricultural Development	15'228'426	10'050'761	15'337'423	7'055'215	66%, 46%
5 Multilateral Fund for the Implementation of the Montreal Protocol	1'914'022	1'914'022	2'927'510	2'927'510	100%
Sub-total	**58'754'083**	**11'964'783**	**55'757'477**	**9'982'725**	
Total	**545'654'585**	**131'986'055**	**464'952'085**	**112'096'083**	

NA, not applicable
IBRD, International Bank for Reconstruction and Development
DA, International Development Association
AfDB, African Development Bank
AfDF, African Development Fund
AsDB, Asian Development Bank
AsDF, Asian Development Fund
EBRD, European Bank for Reconstruction and Development
IADB, Inter-American Development Bank
IDB Special Fund, Inter-American Development Bank Special Fund

Tab. 40 > Switzerland's financial contributions through bilateral and multi-bilateral channels, 2015 and 2016.

	2015		2016	
	Swiss francs	US dollars	Swiss francs	US dollars
Adaptation activities of the Swiss Agency for Development and Cooperation				
Programmes and projects in Africa	14'647'646	15'220'830	18'088'331	18'361'463
Programmes and projects in Asia	24'422'062	25'377'734	19'233'872	19'524'302
Programmes and projects in Europe	622'448	646'805	680'768	691'047
Programmes and projects in Latin America	20'214'621	21'005'650	22'523'954	22'864'064
Programmes and projects in the Middle East and North Africa	1'170'610	1'216'417	1'667'029	1'692'201
Global programmes and projects	9'147'897	9'505'868	9'903'974	10'053'524
Sub-total	**70'225'284**	**72'973'304**	**72'097'927**	**73'186'000**
Mitigation activities of the Swiss Agency for Development and Cooperation				
Programmes and projects in Africa	5'991'167	6'225'610	4'660'709	4'731'086
Programmes and projects in Asia	9'076'765	9'431'952	9'070'758	9'207'726
Programmes and projects in Europe	0	0	0	0
Programmes and projects in Latin America	7'154'598	7'434'568	6'414'756	6'511'618
Programmes and projects in the Middle East and North Africa	149'554	155'406	342'959	348'138
Global programmes and projects	3'883'827	4'035'807	4'918'065	4'992'327
Sub-total	**26'255'910**	**27'283'344**	**25'407'247**	**25'790'895**
Adaptation activities of the Swiss State Secretariat for Economic Affairs				
Programmes and projects in Africa	1'361'384	1'414'657	211'761	214'959
Programmes and projects in Asia	5'034'322	5'231'323	10'649'599	10'810'407
Programmes and projects in Europe	4'846'303	5'035'946	5'960'352	6'050'353
Programmes and projects in Latin America	4'270'783	4'437'905	4'366'585	4'432'520
Programmes and projects in the Middle East and North Africa	309'258	321'360	329'744	334'723
Global programmes and projects	7'025'982	7'300'919	6'479'690	6'577'533
SIFEM adaptation programmes and projects	0	0	0	0
Mobilised private adaptation finance	0	0	0	0
Sub-total	**22'848'032**	**23'742'110**	**27'997'731**	**28'420'494**
Mitigation activities of the Swiss State Secretariat for Economic Affairs				
Programmes and projects in Africa	7'055'836	7'331'942	4'475'887	4'543'473
Programmes and projects in Asia	8'660'748	8'999'656	10'873'670	11'037'862
Programmes and projects in Europe	5'377'784	5'588'225	11'506'873	11'680'626
Programmes and projects in Latin America	7'678'211	7'978'671	4'953'429	5'028'225
Programmes and projects in the Middle East and North Africa	2'057'128	2'137'627	1'674'503	1'699'788
Global programmes and projects	14'571'013	15'141'199	16'580'959	16'831'330
SIFEM mitigation programmes and projects	0	0	14'333'564	14'550'000
Mobilised private mitigation finance	1'443'513	1'500'000	8'373'560	8'500'000
Sub-total	**46'844'233**	**48'677'319**	**72'772'445**	**73'871'303**
Adaptation activities of the Swiss Federal Office for the Environment (Global)				
Sub-total	**281'885**	**292'916**	**435'531**	**442'107**
Mitigation activities of the Swiss Federal Office for the Environment (Global)				
Sub-total	**252'213**	**262'082**	**525'659**	**533'597**
Adaptation activities through other government entities (Global)				
Sub-total	**0**	**0**	**48'750**	**49'486**
Mitigation activities through other government entities (Global)				
Sub-total	**0**	**0**	**26'250**	**26'646**
Sub-total bilateral adaptation	**93'355'201**	**97'008'331**	**100'579'939**	**102'098'688**
Sub-total bilateral mitigation	**71'908'843**	**74'722'745**	**98'731'602**	**100'222'441**
Sub-total bilateral mobilised private climate finance	**1'443'513**	**1'500'000**	**8'373'560**	**8'500'000**
Sub-total bilateral public climate finance	**165'264'044**	**171'731'076**	**190'937'981**	**193'821'128**
Total public and mobilised private climate finance	**166'707'557**	**173'231'075**	**199'311'541**	**202'321'129**

SIFEM, Swiss Investment Fund for Emerging Markets

Tab. 41 > Switzerland's financial contributions through bilateral and multi-bilateral channels, 2017 and 2018.

	2017		2018	
	Swiss francs	**US dollars**	**Swiss francs**	**US dollars**
Adaptation activities of the Swiss Agency for Development and Cooperation				
Programmes and projects in Africa	33'775'039	34'289'379	28'099'543	28'731'639
Programmes and projects in Asia	23'148'580.36	23'501'097	22'240'170	22'740'461
Programmes and projects in Europe	633'718.00	643'369	972'764	994'646
Programmes and projects in Latin America	21'399'057.78	21'724'932	19'078'156	19'507'317
Programmes and projects in the Middle East and North Africa	5'914'303.34	6'004'369	1'111'143	1'136'139
Global programmes and projects	13'691'062.50	13'899'556	32'165'191	32'888'743
Sub-total	**98'561'760**	**100'062'701**	**103'666'967**	**105'998'944**
Mitigation activities of the Swiss Agency for Development and Cooperation				
Programmes and projects in Africa	4'930'393	5'005'475	8'213'991	8'398'763
Programmes and projects in Asia	7'800'246	7'919'032	9'333'401	9'543'355
Programmes and projects in Europe	272'273	276'419	391'689	400'500
Programmes and projects in Latin America	2'676'865	2'717'630	6'178'235	6'317'214
Programmes and projects in the Middle East and North Africa	288'326	292'716	241'081	246'504
Global programmes and projects	8'913'296	9'049'032	14'085'828	14'402'687
Sub-total	**24'881'400**	**25'260'304**	**38'444'225**	**39'309'024**
Adaptation activities of the Swiss State Secretariat for Economic Affairs				
Programmes and projects in Africa	1'470'537	1'492'931	953'011	974'448
Programmes and projects in Asia	12'421'098	12'610'252	8'617'539	8'811'390
Programmes and projects in Europe	5'062'735	5'139'833	6'621'537	6'770'487
Programmes and projects in Latin America	3'894'832	3'954'144	6'631'957	6'781'142
Programmes and projects in the Middle East and North Africa	507'265	514'990	82'448	84'302
Global programmes and projects	5'022'454	5'098'938	5'093'463	5'208'040
SIFEM adaptation programmes and projects	0	0	0	0
Mobilised private adaptation finance	9'366'500	9'509'138	17'892'848	18'295'346
Sub-total	**37'745'421**	**38'320'225**	**45'892'802**	**46'925'156**
Mitigation activities of the Swiss State Secretariat for Economic Affairs				
Programmes and projects in Africa	6'077'160	6'169'705	6'861'471	7'015'819
Programmes and projects in Asia	12'780'563	12'975'191	11'735'564	11'999'554
Programmes and projects in Europe	8'818'096	8'952'382	11'127'825	11'378'144
Programmes and projects in Latin America	6'348'860	6'445'543	5'986'493	6'121'158
Programmes and projects in the Middle East and North Africa	823'836	836'381	76'500	78'221
Global programmes and projects	19'348'114	19'642'755	12'424'773	12'678'340
SIFEM mitigation programmes and projects	3'447'500	3'500'000	2'550'000	2'607'362
Mobilised private mitigation finance	13'852'966	14'063'925	91'820'810	93'886'309
Sub-total	**71'497'094**	**72'585'882**	**142'583'436**	**145'764'908**
Adaptation activities of the Swiss Federal Office for the Environment (Global)				
Sub-total	**729'566**	**740'676**	**830'477**	**849'158**
Mitigation activities of the Swiss Federal Office for the Environment (Global)				
Sub-total	**1'082'926**	**1'099'417**	**1'047'367**	**1'070'928**
Adaptation activities through other government entities (Global)				
Sub-total	**76'250**	**77'411**	**42'500**	**43'456**
Mitigation activities through other government entities (Global)				
Sub-total	**23'750**	**24'112**	**410'666**	**419'903**
Sub-total bilateral adaptation	**137'112'998**	**139'201'013**	**150'432'747**	**153'816'714**
Sub-total bilateral mitigation	**97'485'169**	**98'969'715**	**182'485'694**	**186'564'763**
Sub-total bilateral mobilised private climate finance	**23'219'466**	**23'573'062**	**109'713'659**	**112'181'655**
Sub-total bilateral public climate finance	**211'378'700**	**214'597'665**	**223'204'782**	**228'199'822**
Total public and mobilised private climate finance	**234'598'167**	**238'170'728**	**332'918'441**	**340'381'477**

SIFEM, Swiss Investment Fund for Emerging Markets

Fig. 28 > Swiss international public climate finance, including bilateral contributions and climate specific contributions disbursed to multilateral institutions, 2015 and 2016.

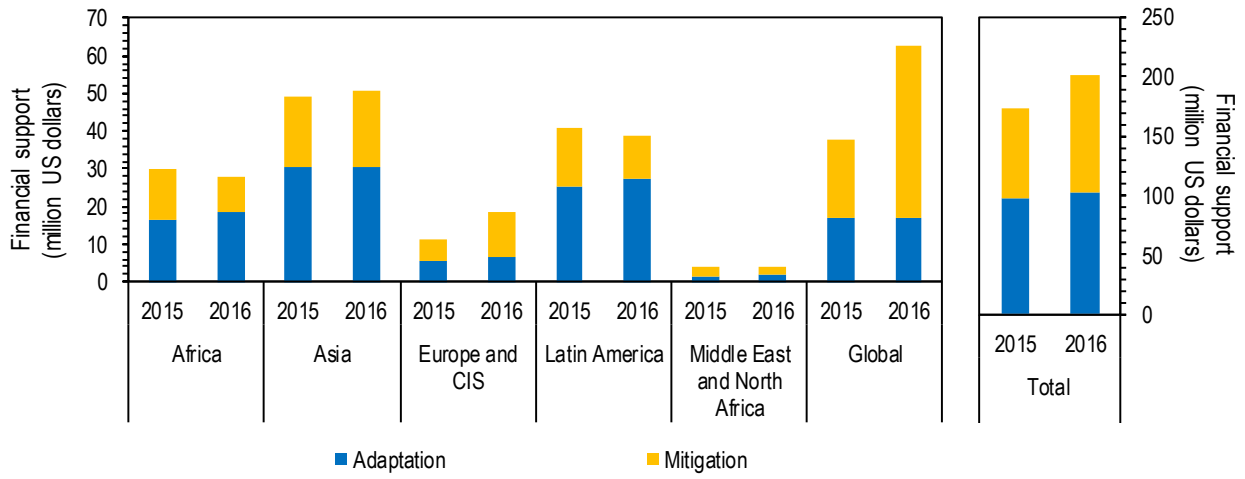
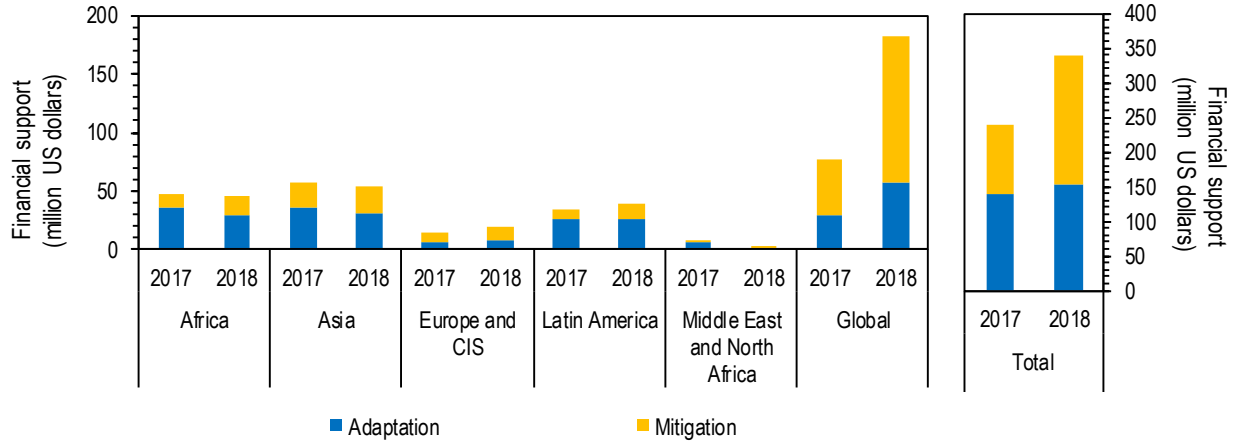


Fig. 29 > Swiss international public climate finance, including bilateral contributions and climate specific contributions disbursed to multilateral institutions, 2017 and 2018.



Tab. 40 and Tab. 41 include aggregated data per region. The BR CTF tables contain more disaggregated data on the country level, where possible. Switzerland does not provide activity-level information in the BR CTF tables. An additional administrative burden would arise and a high risk of errors when entering the data manually. In addition, Switzerland is of the view that activity-level data within the national communication and the BR CTF tables (with the current technical set-up) is difficult to read and interpret. However, given the relevance of increased transparency and to illustrate the diversity of projects, programmes and regions of Swiss support for climate action in developing countries, a full list of all climate-relevant projects is provided in a supplementary document named ‘List of all Swiss projects and programmes to support climate action in developing country Parties (activity level, 2015–2018)’. The table also indicates in detail all sectors, which have benefitted from each of the activities, since it is not possible to give a clear indication of sectors in the BR CTF tables due to aggregation.

5.2 Technology development and transfer

Numerous Swiss programmes and projects, which support developing countries in their endeavours to mitigate and adapt to climate change, contain a technology development and/or transfer component. Technology development and transfer are critical means of implementation to ensure the sustainability of a project or programme. This is particularly true in the area of infrastructure financing and the development of local markets and products.

Switzerland provides support for technology development and transfer through the below mentioned activities and measures in line with its commitment under Article 10, paragraph c, of the Kyoto Protocol as well as Article 4, paragraphs 3 and 5, of the Convention.

5.2.1 Importance of and measures to promote private sector initiatives for technology transfer

Technology transfer and innovation are crucial for any economic development. Technologies are mostly developed and owned by the private sector. In various areas of environmentally sound technologies, Swiss companies are leading in the development, diffusion and implementation of state-of-the-art solutions. Switzerland is an important hub in terms of R&D, foreign direct investment and technology exports. Some of these climate relevant Swiss private sector activities are supported by the Swiss export promotion agency 'Switzerland Global Enterprise' (*www.s-ge.com*) through its Swiss business hubs in strategic export markets. 'Switzerland Global Enterprise' is mandated by the Swiss Confederation to make information on Swiss Cleantech companies available in a publicly accessible database (*www.s-ge.com/cube*). This database may be used to identify the Swiss partners for environmentally sound solutions. Many companies registered in the database are active in developing countries. 'Switzerland Global Enterprise' is also contributing to some long-term cooperation projects aiming at the same time to add value for developing country Parties and for exporting Swiss companies. Examples of such long-term cooperation projects are described in a brochure published by the Swiss Federal Office of Energy, the Swiss Federal Office for the Environment, and the Swiss State Secretariat for Economic Affairs[53].

Another important service for private technology suppliers is the Swiss Export Risk Insurance (*www.serv-ch.com*). The Swiss Export Risk Insurance is traditionally very important for Swiss exports e.g. in the context of new hydropower schemes. Through the support of the export of climate friendly technologies by Swiss companies to developing countries, Switzerland contributes to the commitment of Parties under Article 4, paragraph 5, of the Convention. In 2018, the mobilisation of private finance has increased drastically in part due to the finance mobilised by the Swiss Export Risk Insurance (68.5 million US dollars).

5.2.2 Role of the public sector in technology transfer

Successful technology transfer uses the know-how, innovation and financing capacity of the private sector. Switzerland is supporting various initiatives in the area of technology development and transfer, targeting developing and transition countries as part of its development cooperation. Switzerland is convinced that the following elements need to be taken into consideration by governments to foster technology transfer and development:

- Creating a sound trade framework: Reduce custom tariffs and non-tariff barriers;
- Creating an enabling investment framework: Protect private property, intellectual property rights (IPR), reduction of administrative hurdles for companies, fight against corruption; legal stability, security, appropriate energy tariff setting, etc.;
- Strengthening financial markets: Improve access to finance particularly for SMEs and strengthen the risk management of financial intermediaries in its partner countries including capacity building in addressing environmental and social risks;
- Capacity-building and sharing of information in order to prepare industry and corporations in developing countries to deal with the challenges of global production chains and new technologies;
- Realising pilot and demonstration projects.

5.2.3 Measures promoting the transfer of, access to and deployment of climate-friendly technologies

In line with the above mentioned elements, Switzerland has implemented several measures to promote, facilitate and finance the transfer of, access to and the deployment of climate-friendly technologies for the benefit of developing country Parties and for the support of the development and enhancement of endogenous capacities and technologies of developing country Parties. Several of these measures are highlighted below.

Platform for the promotion of renewable energy and energy efficiency in international cooperation (REPIC)

The interdepartmental platform on Renewable Energy, Energy and Resource Efficiency Promotion in International Cooperation (REPIC)[54] is specifically targeting technology transfer and development in renewable energy, energy

[53] *https://www.s-ge.com/sites/default/files/cserver/publication/free/cleantech-broschuere-s-ge.pdf*

[54] *http://repic.ch/repic-en*

efficiency and resource efficiency. Beyond enhancing knowledge and coherence, REPIC offers seed money, capacity building and technical advice for promising climate change initiatives during the pre-competitive phases of project development, for technology and market testing. REPIC mobilises currently private funds for climate. Further reflections are undergoing to see how REPIC could mobilise more private funds for climate activities. A project example is depicted in Tab. 42.

Tab. 42 > Platform for the promotion of renewable energy, energy and resource efficiency in international cooperation (REPIC).

Project/programme title:
Pyrolysis Based Coffee Drying in Vietnam (funded with REPIC seed money).

Purpose:
This project aimed at introducing pyrolysis plants in Vietnam's agricultural sector; first targeting coffee cherry drying.

Recipient country	Sector	Total funding	Years in operation
Vietnam	Resource efficiency	150'000 Swiss francs	2016–2018

Description:
Pyrolysis technology can efficiently valorise organic agricultural waste, while generating two main products: clean heat, which can be used for drying, and biochar which can be used for soil enrichment. A first plant was built and commissioned in a farmer cooperative in Vietnam. 100 kilograms of pulp can be processed per hour; with production of about 30 kilograms of biochar and 250 kilowatt of thermal power. This is enough to dry four tons of coffee cherries in 20 hours, in a four-tonne dryer. The smoke emissions meet Swiss standards. The Swiss experts worked closely with a Vietnamese manufacturer (Viet Hien Mechanical Ltd.) to test the pyrolysis plant and adapt it to local needs and conditions. Know-how transfer for local production has been carried out and a business model developed. The international integration of pyrolysis is under way, in cooperation with the main coffee trade actors.

Factors that led to project/programme's success:
Both Swiss partners (Sofies-Emac and Ökozentrum Langenbruck) have strong expertise in the area of clean production technologies for developing countries. A close cooperation with the Vietnamese partner has enabled an adequate adaptation to local requirements.

Technology transferred:
State-of-the-art pyrolysis technology – turning coffee husks into biochar and energy for mechanical coffee drying – is a climate smart solution to enhance coffee quality and soil fertility, while mitigating CO_2 emissions.

Impact on greenhouse gas emissions/sinks:
When producing biochar on the basis of coffee husks and working the biochar into soils, the pyrolysis technology becomes climate positive. By integrating biochar in the soil, carbon is withdrawn from the atmosphere and stored in the soil. For every ton of biochar produced, 3.6 tonnes of CO_2 are sequestered for several hundred or thousand years. This makes pyrolysis a carbon positive technology contributing significantly to decreasing the carbon footprint of coffee production. Following the implementation of this project, pyrolysis technology is being replicated in other countries, notably in Cambodia, Serbia and Brazil.

Cleaner production and resource efficiency in the construction sector

The building and construction sector has a large potential for climate change mitigation and adaptation measures. Switzerland has been active in this area domestically and is engaged in the transfer of technology and capacity building for multiple years.

Tab. 43 > Low Carbon Cement Project.

Project/programme title:
Low Carbon Cement Project.

Purpose:
Limestone Calcined clay cement (LC3) is established as reliable, viable and green cement, suitable for general production and construction.

Recipient country	Sector	Total funding	Years in operation
India, Cuba, Global	Building	5.074 Mio Swiss francs	2014–2018

Description:
The project aims to enable the recognition of a new low carbon cement type (Limestone Calcined Clay Cement – LC3) as suitable for general construction and initiate its establishment in the market. It has three components:

- Scientifically investigate and validate the technical, economic and ecological viability of LC3;
- Pioneering cement companies produce and showcase LC3 cement in representative construction projects in India and select other countries;
- A conducive regulatory environment is created for upscaling the production and application of LC3 through standards, policies and certification.

Implementing Partners of the project include: Swiss Federal Institute of Technology in Lausanne, Switzerland; CEMENTIS, Switzerland; Indian Institute of Technology, Delhi; Indian Institute of Technology, Madras; Technology and Action for Rural Advancement, India; Centro de Investigación y Desarrollo de Estructuras y Materiales, Cuba.

Factors that led to the success of the project/programme:

- Trilateral collaboration between Indian, Swiss and Cuban universities;
- Close collaboration with public and private stakeholders; the project was able to put the subject of Low Carbon Cement on the agenda of governments as well as global cement companies;
- Strong presence at international conferences: The project introduced LC3 prominently at several national and international conferences (e.g. UNFCCC COPs, Global and regional CEMTECH conferences);
- Collaboration with different global initiatives and programmes. Cement Sustainability Initiative of the World Business Council on Sustainable Development and the Global Alliance for Buildings and Construction hosted at the United Nations Environmental Programme;
- Contribution to a United Nations Environment Programme Report (2016) on Eco-efficient Cements, available at *http://www.nanocem.org/fileadmin/nanocem_files/documents/misc/2016-UNEP_Report.pdf*.

Technology transferred:
A new low carbon cement type (LC3) was researched and tested jointly between the different involved universities and institutions.

Impact on greenhouse gas emissions/sinks:
During the production process of LC3, up to 30 per cent of CO_2 emissions can be saved in comparison to ordinary Portland Cement.

Climate Technology Centre and Network

The Climate Technology Centre and Network is part of the UNFCCC Technology Mechanism. The Mechanism consists of two complementary bodies: the Technology Executive Committee, whose focus is to develop technology policies and recommendations to support country efforts, and the Climate Technology Centre and Network, which provides technology implementation at the request of developing countries. The Climate Technology Centre and Network ensures its accountability to the UNFCCC Conference of Parties through the oversight of the Climate Technology Centre and Network Advisory Board.

Tab. 44 > Climate Technology Centre and Network.

Project/programme title:
Climate Technology Centre and Network.

Purpose:
The Climate Technology Centre and Network promotes the development and transfer of climate technologies at the request of developing countries for energy efficient, low carbon and climate-resilient development.

Recipient country	Sector	Total funding	Years in operation
Global	Multi sector	4 million US dollars	2016–2019

Description:
The Climate Technology Centre and Network fosters technology development and transfer across numerous adaptation and mitigation sectors by providing three key services:

- Technical Assistance: The Climate Technology Centre and Network provides technical assistance and capacity building in response to requests submitted by developing countries via their National Designated Entities. Upon receipt of such requests, the Centre mobilises its global Network of climate technology experts to design and deliver a customised solution tailored to local circumstances;
- Knowledge Sharing: Through regional forums, publications, an online portal, and its Incubator Programme, the Climate Technology Centre and Network creates environments for capacity building and knowledge sharing on climate technology solutions. The Centre engages its Network and NDEs in highlighting technology best practices, south-south transfer examples, and learning from existing technical assistance experiences;
- Collaboration and Networking: The Climate Technology Centre and Network brings together a diverse global community of climate technology users and providers, decision makers, and funders to identify barriers, share best practices, and identify matchmaking opportunities. Under the umbrella of the UNFCCC Technology Mechanism, Network members gain the opportunity to showcase relevant technologies, policies and practices, and to facilitate their deployment in developing countries.

Factors that led to project/programme's success:
Key factors for programme success are the well-established and still growing network of climate technology experts which will help developing countries to design and develop mitigation and adaptation activities with a strong focus of technology implications. Furthermore the demand driven, bottom-up approach strengthens ownership on the side of the beneficiaries.

Technology transferred:
The main purpose of the Climate Technology Centre and Network is the provision of technical assistance, capacity building and knowledge sharing within the sphere of climate technologies. For more information see the description of the project.

Impact on greenhouse gas emissions/sinks:
The impact on greenhouse gas emissions cannot be calculated. Climate Technology Centre and Network is a mechanism that helps to design and develop projects and does not finance the concrete project implementation.

Resource Efficient and Cleaner Production

The Global Eco-Industrial Parks Programme (GEIPP) aims at strengthening the capacity of the management of selected existent industrial parks regarding resource efficient and cleaner production methods and at supporting governments and administrations in their effort to enhance/design the necessary institutional settings**.** Furthermore the programme works together with enterprises located in the selected industrial parks and enhances their international competitiveness by increasing their (resource-) productivity.

Tab. 45 > Global Eco-Industrial Parks Programme.

Project/programme title:
Global Programme on Resource Efficient and Cleaner Production in developing and transition countries (RECP).

Purpose:
The GEIPP aims at enhancing the resource productivity, competitiveness and environmental performance of selected existing industrial parks in participation countries.

Recipient country	Sector	Total funding	Years in operation
Egypt, Colombia, Peru, Ukraine, Vietnam	Multi sector	14.5 million Swiss francs	2019–2023

Description:
The development objective of the Global Eco-Industrial Parks Programme (GEIPP) is to demonstrate the viability and benefits of greening industrial parks by improving resource productivity and economic, environmental and social performances of businesses and thereby contributing to inclusive and sustainable industrial development in the participating countries.
GEIPP focusses on contributing to the following outcomes:

- Eco-Industrial Parks (EIP) incentivised and mainstreamed in relevant policy and regulations leading to an increased role of EIP in environmental, industry and

other relevant policies at the national levels in the participating Programme countries;
- EIP opportunities identified and implementation started, with environmental (e.g. resource productivity) economic and social benefits achieved by enterprises confirmed. The implementation of EIP opportunities by enterprises and other organisations will be supported by the EIP services providers, and will lead to reduction of the environmental footprint and operational and compliance costs of businesses, and an increase in their - natural - resource productivity;
- EIP tools developed, services delivery capacity enhanced and lessons learnt properly capturing and effectively exchanged. EIP tools developed and made applicable beyond the context of the individual parks or countries (via description how to apply tools locally).

Factors that led to project/programme's success:
- In-plant assessments of the different resource streams offer opportunities for improvement and learning;
- Buy-in and ownership of the host country;
- Strengthened implementation capacities of national stakeholders;
- Strengthened awareness of resource efficiency issues.

Technology transferred:
Technology transfer in the context of the RECP global programme encompasses know-how and services as well as organisational and managerial procedures. Furthermore, the programme supports recipient countries to develop an institutional framework that enables the transfer of climate-related technologies. The main focus lies on technical assistance and the build-up of local know-how and expertise.

Impact on greenhouse gas emissions/sinks:
Programme has just started in 2019; no emissions reductions so far.

Multilateral engagement of Switzerland in the area of technology transfer and development

Besides its bilateral projects that oftentimes contain an integrated technology development and transfer component, Switzerland also contributed to specific technology development and transfer funds such as the Climate Technology Centre and Network (4 million Swiss francs, see Tab. 44), the Special Climate Change Fund (2.8 million Swiss francs between 2015 and 2018) as well as several other funds and multilateral organisations, which are active in the area.

5.2.4 Quantification of all activities related to technology transfer

Due to the integrated character of the bilateral technology development and transfer support measures of Switzerland, it is not possible to single out and quantify the respective components. In addition, it would not do justice to the integrated approach underpinning Switzerland's climate change interventions. Therefore, the technology development and transfer components of Swiss-funded projects are not systematically identified in this report.

There is internationally no clear understanding and no consensus on how Parties should quantify their technology transfer components within climate-relevant projects. The lack of consensus prevents a comparison of quantifiable data. Switzerland is of the opinion that qualitative information therefore provides much more content to exchange on lessons learnt and improve the technology transfer and overall development support.

If Switzerland were to isolate the technology transfer components of its climate-related activities, it would need to fundamentally redesign its entire national reporting system. An important corollary would be that all project managers both at the headquarters and in the field offices would have to estimate the technology transfer components in the planning phase of their projects. This would considerably increase the administrative burden and reduce the resources available for project implementation, ultimately diminishing the climate impact on the ground.

Based on concrete project examples (see section 5.2.3), Switzerland will therefore continue to report on its technology transfer activities in qualitative terms by emphasising their integrative character.

5.3 Capacity building

Capacity building is an essential component of almost all Swiss programmes and projects, which support developing countries in their endeavours to mitigate and adapt to climate change. Capacity building is critical for the successful and effective implementation of climate measures and helps to ensure the sustainability of any project or programme. However, in order to scale up, appropriate set-ups and corresponding tools are needed. Switzerland therefore strives to promote a cooperative model among different actors and has invested considerable efforts in developing a user-friendly tool that helps in mainstreaming climate change both at the strategic as well as at the operational level.

Due to the highly integrated character, it is not possible for Switzerland to single out the capacity-building components of all its development cooperation projects and programmes. Moreover, it would not do justice to the integrated approach underpinning Switzerland's climate change interventions. Therefore, capacity-building components of Swiss-funded projects are not systematically identified in this report. Nevertheless – and for illustrative purposes – various project examples given below showcase how the integrated approach plays out.

Environment and Social Risk Management in Sub-Saharan Africa

In most countries, businesses and individuals do not pay for the negative environmental and social effects they cause. Hence, social and environmental risks do usually not inform the development of business plans as well as daily operations. The Environmental and Social Risk Management Programme of the International Finance Cooperation aims to address this problem. The programme is based on the assumption that financial institutions can play a key role when it comes to pushing change in the market because financial institutions are in a position to influence business behaviour through their ability to allocate capital by lending money to companies.

Tab. 46 > Environment and Social Risk Management in Sub-Saharan Africa.

Project/programme title:
Environmental and Social Risk Management for financial institutions in Sub-Saharan Africa.

Purpose:
The overall objective of the programme is to increase the uptake of environmental and social standards by financial institutions in the Sub-Saharan Africa region. This is expected to lead to an improvement in environmental and social performance of local businesses in the long term.

Recipient country/region	Targeted area
Sub-Saharan Africa (Ghana, Nigeria, South Africa)	Adaptation

Description:
The programme has just started, hence an overview of the planned capacity building support is provided:

- Training and advisory services make the regulator (mainly the central bank) more effective in dealing with environmental and social issues. In particular, the regulator will be supported in revising existing and designing new environmental and social risk management policies and procedures;
- Development of material and manuals which can be used for environmental and social risk management training;
- Development of sector specific guidelines that fit the relevant country context;
- Provision of country specific environmental and social information to the public, mainly through the development of country specific portals of the FIRST for Sustainability website (*www.firstforsustainability.org*).

It is expected that those activities will lead to:

- The development of effective regulatory policies, procedures and standards in order to create an environment which is conducive to the uptake of ESRM systems;
- The build-up of relevant environmental and social expertise of local consultants in the markets of the programme countries. This expertise can be used/ purchased by financial institutions in order to implement their own Environmental and Social Risk Management Programme systems;
- Increased awareness on environmental and social risks, increased level of publicly available information on environmental and social issues as well as improved information dissemination among financial institutions and other stakeholders.

Environment and Social Risk Management in Asia

The objective of the programme is to promote the adoption, implementation and enforcement of internationally agreed environmental and social standards with a focus on boosting the corresponding audit performance and thus increase climate-friendly investments in the East Asia Pacific region. A special focus is given to Vietnam and Indonesia. The programme supports these countries in their endeavours to develop, implement and enforce a set of practical risk management guidelines applicable to financial institutions. Specific knowledge and capacity building is provided in order to develop, implement and enforce a set of practical environmental risk management guidelines, to individually assist financial institutions and to ramp up the environmental and social risk management consulting and training capacity.

Tab. 47 > Environment and Social Risk Management in Asia.

Project/programme title:
Environment and social risk management for financial institutions in Asia.

Purpose:
The purpose of the programme is to develop the capacities of financial regulators and institutions in order to create effective policies as well as sound, efficient, and responsive financial institutions that are environmentally and socially sustainable, thus helping to achieve substantial business benefits.

Recipient country/region	Targeted area
East Asia Pacific with focus on Indonesia and Vietnam	Adaptation

Description:
The programme primarily provides capacity building support for financial regulators and institutions as well as other stakeholders:

- Training and advisory services make the financial regulators more effective in dealing with environmental and social issues. In particular, the financial regulators are supported in revising existing and designing new environmental and social risk management policies and procedures;
- Within the banking sector, the programme supports the development of material and manuals for the E&S risk management training;
- For the public, specific E&S information and for consultants, in-depth advisory services are provided;
- Sector and country specific guidelines are developed.

The activities shall lead to:

- The development of effective regulatory policies, procedures and standards in order to create an environment which is conducive to the uptake of ESRM systems;
- Relevant environmental and social expertise within the banking sector, including to the benefit of consultants;
- In general, increased awareness on environmental and social risks, increased level of publicly available information on environmental and social issues as well as improved information dissemination within the banking sector and other stakeholders.

Climate, Environment and Disaster Risk Reduction Integration Guidance (CEDRIG)

While global aspirations to effectively tackle climate change both via mitigation and adaptation measures are high, the related concrete expectations appear more difficult to be met. This situation is also due to a lack of 'do-how' by many actors. This is why Switzerland has undertaken considerable efforts to develop, test and now disseminate and apply a user friendly tool that helps to mainstream climate change in strategies, programmes and projects of different concerned sectors. Moreover, acknowledging the close interlinkages between climate change, disaster risk reduction and the environment (natural resources), the Swiss Agency for Development and Cooperation has developed a comprehensive tool that integrates all three aspects. With the recent decision of the directorate that all the investments of the Swiss Agency for Development and Cooperation need to be 'climate-proofed' in the future, the instrument has gained further importance for mainstreaming climate, environmental and natural disaster aspects in both programming and operational work.

Tab. 48 > Climate, Environment and Disaster Risk Reduction Integration Guidance (CEDRIG).

Project/programme title:
Climate, Environment and Disaster Risk Reduction Integration Guidance (CEDRIG).

Purpose:
To help integrate aspects of climate change, environmental degradation and disaster risk reduction into development cooperation at strategic, programmatic and operational levels.

Recipient country/region	Targeted area
Global	Multiple areas

Description:
CEDRIG is a practical and user friendly tool developed by the Swiss Agency for Development and Cooperation. It is meant to systematically integrate climate, environment and disaster risk reduction into development cooperation and humanitarian aid in order to enhance the overall resilience of systems and communities. CEDRIG helps to reflect whether existing and planned strategies, programmes and projects are at risk from climate change, environmental degradation and natural hazards, as well as whether these interventions could further exacerbate greenhouse gas emissions, environmental degradation or risks of natural hazards. The tool is open source, multilingual and offers three independent modules.
CEDRIG follows an integrated approach to assess the risks for and the unintended potential negative impacts of a new strategy, programme or project. By its application, existing or planned interventions will become more climate, environment and risk smart. CEDRIG is divided into three parts: (i) CEDRIG Light helps to decide whether a detailed risk and impact assessment must be conducted or not, (ii) in case of a 'yes', CEDRIG Strategic is used to analyse strategies and programmes, and (iii) CEDRIG Operational is applied for projects.
A series of CEDRIG workshops have been carried out in different countries such as e.g. in Benin, Bosnia-Herzegovina, Burkina Faso, Bolivia, Morocco, Myanmar, Nepal, Nicaragua, Peru, Tajikistan and Zambia. In most instances, interested and concerned actors from neighbouring countries were invited to participate, too. Fostering a systematic application of CEDRIG-type process in all projects in the future, regional CEDRIG champions from different parts of the world have been trained to become facilitators that will support the application in their respective region. As a result people and institutions were trained and respective strategies, programmes and projects revised by including aspects to address climate change, disaster risk reduction and the environment.

One UN Climate Change Learning Partnership (UN CC:Learn)

Tab. 49 > UN CC:Learn.

Project/programme title:
One United Nations Climate Change Learning Partnership (UN CC:Learn).

Purpose:
At the global level, the partnership supports knowledge sharing, promotes the development of common climate change learning materials, and coordinates learning interventions through collaboration of United Nations agencies and other partners. At the national level, UN CC:Learn supports countries in developing and implementing national climate change learning strategies.

Recipient country/region	Targeted area
Global with selected partner countries	Multiple areas

Description:
The UN CC:Learn is a collaborative initiative involving more than 30 multilateral organisations. It supports countries in designing and implementing country-driven, results-oriented and sustainable learning to address climate change. The initiative was launched at the 2009 Copenhagen Climate Change Summit with substantial funding from the Swiss Agency for Development and Cooperation. UN CC:Learn is included in the 'One United Nations Climate Change Action Framework' of the United Nations System Chief Executives Board for Coordination. The Chief Executives Board for Coordination framework aims at maximizing existing synergies, eliminating duplication and optimizing the impact of the collective effort of UN organisations in combatting climate change. As such UN CC:Learn directly contributes to the implementation of Article 6 of the UNFCCC on education, training and public awareness, as well as the Doha Work Programme.
So far, UN CC Learn has supported nine pilot countries in developing and implementing their climate change learning strategies (Benin, Burkina Faso, Dominican Republic, Ethiopia, Ghana, Malawi, Niger, Indonesia, and Uganda). It has further developed a free introductory online course on climate change which is now available in English, French, Spanish, Portuguese, Khmer, Thai and Mandarin. So far over 80 thousand people have registered and more than 10 thousand have successfully completed the training with a certificate. Additional courses and training materials have been developed linked to the following thematic focus areas: Climate change science, climate finance, international climate negotiations, adaptation planning, climate change and health, climate change and forests, and climate change education for children.

5.3.1 Reporting of activities related to capacity building

As mentioned above, due to the integrated character of the bilateral capacity-building support measures of Switzerland, the necessary data to single out and quantify the respective capacity-building components is not available. In addition, a reporting of these components in isolation would not do justice to the integrated approach underpinning Switzerland's

climate change interventions. Therefore, the capacity-building components of all Swiss-funded projects are not in isolation systematically identified and quantified in Switzerland's national communication or biennial report (nor in the corresponding BR CTF tables).

If Switzerland were to isolate the capacity-building components of all its climate-related activities, it would need to fundamentally redesign its entire national reporting system.

Switzerland will therefore continue to report on its capacity building activities in qualitative terms, by emphasising the integrative character based on concrete project examples.

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6 Other reporting matters

6.1 Self-assessment and local action against domestic non-compliance

Switzerland's domestic arrangements established for the process of the self-assessment of compliance with emission reductions in comparison with emission reduction commitments are addressed in section 3.1. This section also presents the establishment of national rules for taking local action against domestic non-compliance with emission reduction targets (sector-specific interim targets, proposition of additional policies and measures, automatic increase of the CO_2 levy on heating and process fuels, sanction mechanisms for various policies and measures, etc.).

6.2 Any other information

Switzerland reported on all information that it considers relevant to the achievement of the objective of the Convention in the chapters 1 to 5 above, as well as in its BR CTF tables.

Annex A Responses to recommendations and encouragements

Tab. 50 and Tab. 51 list all recommendations and encouragements from the 'report of the technical review of the third biennial report of Switzerland' (FCCC/TRR.3/CHE) as well as from the 'report of the technical review of the seventh national communication of Switzerland' (FCCC/IDR.7/CHE). To each of the recommendations and encouragements a brief response is provided, with reference to the respective section in Switzerland's fourth biennial report where appropriate.

Tab. 50 > Responses to recommendations of previous reviews.

Recommendation	Response	Reference to chapter/section of Switzerland's fourth biennial report
'Report of the technical review of the **third biennial report** of Switzerland' (FCCC/TRR.3/CHE)		
Table 11, No. 1: The ERT noted that Switzerland did not provide information in CTF table 8 on the provision of technology development and transfer support, although it referred to the relevant information provided in the NC7. In the NC7, and referenced in the BR3, Switzerland explained that owing to the integrated character of the bilateral technology development and transfer support provided by the Party, it is not possible to single out and quantify the respective components of technology transfer. During the review, Switzerland confirmed its difficulty in providing specific information and that it did not complete CTF table 8 because the individual projects, programmes and activities it supports involve various technologies and include technology-transfer and capacity-building components. The ERT reiterates the recommendations made in the reports on the technical reviews of the BR1 and BR2 that Switzerland provide information on the provision of technology development and transfer support, to the extent possible, in CTF table 8 in its next BR. The ERT considers that the provision in CTF table 8 of at least qualitative information on activities and measures for technology transfer support could improve the completeness of the reporting by the Party.	Switzerland responds to this issue in the same way as in its seventh national communication and third biennial report: Due to the integrated character of the bilateral technology development and transfer support measures of Switzerland, it is not possible to single out and quantify the respective components. In addition, it would not do justice to the integrated approach underpinning Switzerland's climate change interventions. Therefore, the technology development and transfer components of Swiss-funded projects are not systematically identified in this report. There is internationally no clear understanding and no consensus on how Parties should quantify their technology transfer components within climate-relevant projects. This lack of consensus would therefore also not allow for a comparability of quantified data. Switzerland is of the opinion that qualitative information provides much more content and potential to exchange on lessons learnt and improve the technology transfer and development support overall. If Switzerland were to isolate the technology transfer components of its climate-related activities, it would need to fundamentally redesign its entire national reporting system. Switzerland will therefore continue to report on its technology transfer activities in qualitative terms, by emphasizing the integrative character based on concrete project examples. Therefore, Switzerland has not completed BR CTF table 8.	5.2.4
Table 12, No. 1: The ERT noted that Switzerland did not provide information in CTF table 9 on its provision of capacity-building support but referenced the BR3 for the relevant information. In the BR3, the information provided in the NC7 is referenced. The ERT reiterates the recommendations made in the reports on the technical reviews of the BR1 and BR2 that Switzerland, in its next BR, fill in, to the extent possible, CTF table 9. The ERT considers that the provision in CTF table 9 of at least qualitative information available on projects and programmes on capacity-building support could improve the transparency of the reporting by the Party.	Switzerland responds to this issue in the same way as in its seventh national communication and third biennial report: Due to the integrated character of the bilateral capacity-building support measures of Switzerland, it is not possible to single out and quantify the respective components. In addition, it would not do justice to the integrated approach underpinning Switzerland's climate change interventions. Therefore, the capacity building components of all Swiss-funded projects are not systematically identified in this report. If Switzerland were to isolate the capacity-building components of all its climate-related activities, it would need to fundamentally redesign its entire national reporting system. Switzerland will therefore continue to report on its capacity building activities in qualitative terms, by emphasising the integrative character based on concrete project examples. Therefore Switzerland has not completed BR CTF table 9.	5.3.1
'Report of the technical review of the **seventh national communication** of Switzerland' (FCCC/IDR.7/CHE)		
No recommendations were made in the 'report of the technical review of the seventh national communication of Switzerland'.		

Tab. 51 > Responses to encouragements of previous reviews.

Encouragement	Response	Reference to chapter/section of Switzerland's fourth biennial report
'Report of the technical review of the **third biennial report** of Switzerland' (FCCC/TRR.3/CHE)		
Table 8, No. 1: Through its reference to the NC7, Switzerland reported limited information on the results of its sensitivity analyses in its BR3, although it did conduct a sensitivity analysis on the projections for various assumptions such as GDP and international oil and gas prices. During the review, Switzerland provided an amendment to the NC7, in which the Party explained that the sensitivity analyses conducted were for comparing sensitivity scenarios. The ERT commends Switzerland for this supplementary information. However, as the details have to be obtained from a technical report (EPFL and INFRAS, 2016), it remains difficult to circumscribe the underlying assumptions and it is not always straightforward to analyse the linkages between the underlying assumptions and the reported projections. For example, the non-price bottom-up PaMs are listed in table 1 in the executive summary of EPFL and INFRAS (2016), whereas the sensitivity analysis is to be found in chapter 5 of this publication, which made it difficult for the ERT to assess the underlying assumptions on bottom-up estimates of the impact of non-price PaMs. The ERT encourages Switzerland to enhance the transparency of the reporting in its next BR by reconsidering ways of presenting the information, notably to better explain the implication of underlying assumptions on the projections.	In response to the encouragement raised by the expert review team during the review of Switzerland's seventh national communication and third biennial report, Switzerland enhanced its reporting of the sensitivity analyses. The additional information provided facilitate a general understanding without the need to consult the corresponding technical reports.	4.3.9
'Report of the technical review of the **seventh national communication** of Switzerland' (FCCC/IDR.7/CHE)		
Table 9, No. 1: Switzerland reported limited information on the results of its sensitivity analyses in its NC7, although it did conduct a sensitivity analysis on the projections for various assumptions such as GDP and international oil and gas prices. During the review, Switzerland provided an amendment to the NC7, in which the Party explained that the sensitivity analyses conducted were for comparing sensitivity scenarios. The ERT commends Switzerland for this supplementary information. However, as the details have to be obtained from a technical report (EPFL and INFRAS, 2016), it remains difficult to circumscribe the underlying assumptions and it is not always straightforward to analyse the linkages between the underlying assumptions and the reported projections. For example, the non-price bottom-up PaMs are listed in table 1 in the executive summary of EPFL and INFRAS (2016), whereas the sensitivity analysis is to be found in chapter 5 of that publication, which made it difficult for the ERT to assess the underlying assumptions on bottom-up estimates of the impact of non-price PaMs. The ERT encourages Switzerland to enhance the transparency of the reporting in its next NC by reconsidering ways of presenting the information, notably to better explain the implication of underlying assumptions on the projections.	This encouragement is identical to the encouragement 'Table 8, No. 1' made in the 'report of the technical review of the third biennial report of Switzerland'. Accordingly, see above for Switzerland's response.	