SWITZERLAND

1.1 Introduction

1.1.1 Objective of the case study

The present case study is developed as part of the European Environment Agency (EEA) project 'Energy Support and Innovation'. The key objective of this case study is to explore in some depth the relationship between support measures applied to all forms of energy and the innovation process in the renewable energy sector. More specifically, the key question addressed in this case study is: How do energy support measures affect the market conditions for renewable energy technologies and hence innovation in the renewable energy sector?

Within this project, the effect on innovation is mainly measured in terms of the market deployment of renewable energy technologies although other indicators have been used to describe the state of play concerning other phases of the innovation process such as research and market development. The structure of the case study is as follows:

Sub-sections 1.1.2 and 1.1.3 provide a brief overview on the key features of the country's economy and energy system as well as overall market conditions for renewable energy technologies. Section 1.2 includes a quantitative overview of the energy support measures in place, distinguishing between conventional energy sources and renewable energy sources (RES) and their development over the period 2005 to 2011. Sub-section 1.3.1 discusses progress concerning the deployment of renewable energy technologies and the 2020 outlook. Because a successful innovation process presupposes that effective and efficient policies are in place, an assessment of the effectiveness and efficiency of renewable policies in place is provided in Sub-sections 1.3.2 and 1.3.3. Subsequent sections provide additional insights on the innovation process in the renewable sector (research and development (R&D), employment, etc.). Finally, for a successful innovation process, the economic, innovation and sector-specific policy objectives need to be coherent and reinforce each other. Therefore, a brief analysis of policy coherence is included in Section 1.5. The analysis covers the period from 2005 to 2011. Relevant developments prior to 2005 and more recent ones are reflected as much as possible.

1.1.2 Key features of the Swiss energy system

In 2012, gross domestic product (GDP) per capita was EUR 44 700, ranking Switzerland third in Europe after Luxembourg and Norway, and well exceeding the EU-27 average of EUR 25 200 (Eurostat, 2013). The unemployment rate was 4 % in 2012 (Eurostat, 2013). Switzerland's economy benefits from a highly developed service sector, accounting for 66 % of gross value added (GVA), followed by the industry sector accounting for 21 % of GVA (Eurostat, 2013).

Table 1 Key economic indicators for Switzerland

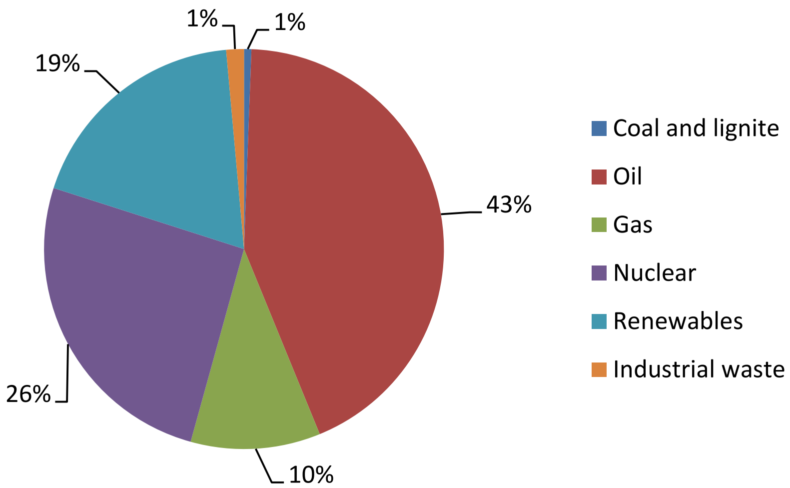
	2005	2006	2007	2008	2009	2010	2011
Energy intensity (gross inland consumption, kg oil equivalent, per €1 000 of GDP)	87	88	81	82	85	80	76
GDP per capita, real (€2 005)	41 300	42 500	43 800	44 200	42 800	44 200	44 600

Unemployment as % labour force	4 %	4 %	4 %	3 %	4 %	5 %	4 %
GDP share agriculture, forestry, fishing, mining (% GVA)	1 %	1 %	1 %	1 %	1 %	1 %	n.a.
GDP share industry (% GVA)	21 %	21 %	22 %	22 %	20 %	21 %	n.a.
GDP share commercial services (% GVA)	66 %	66 %	66 %	66 %	66 %	66 %	n.a.

Source: Eurostat (2013)

In 2011, Switzerland's primary energy consumption was dominated by oil (43 %), followed by nuclear (26 %) and renewables (19 %, mainly large hydropower) (see Figure 2).

Figure 1 Primary energy consumption by share of fuel in 2011



Source: EEA (2013)

Switzerland has a low energy intensity compared to the European average and is entirely dependent on fossil fuel imports.

In May 2011, the Federal Council decided a nuclear phase-out: after their operational lifetime expires, nuclear plants will not be replaced (BFE, 2011a). There is, however, no date set by when nuclear power will be phased out. In order to compensate for the loss of nuclear energy, the Federal Council is elaborating a new Energy Strategy 2050, which places emphasis on 'increased energy savings (energy efficiency), the expansion of hydropower and new renewable energies, and, if necessary, on fossil fuel-based electricity production' ([1]).

1.1.3 Overall market conditions for renewable energy technologies

The feed-in tariff (FIT) system Kostendeckende Einspeisevergütung (KEV) and its predecessor the Mehrkostenfinanzierung (MKF), along with specified targets, are drivers for market demand, although the available budget remained rather limited as compared to market

[1] For further information on the Swiss Energy Strategy 2050, see http://www.bfe.admin.ch/themen/00526/00527/?lang=en online.

demand. The Swiss institutional framework for the support of RES has developed in a way that allowed the sector to grow on a continuous basis with no major disruptions. This process was supported by the SwissEnergy programme, which brought together different stakeholders and stimulated innovation by providing information and advice, accelerating market deployment and supporting cross-sector collaboration (Vatter et al., 2011). With the introduction of the KEV, a national objective for the share of RES in the national energy mix by 2030 was introduced and hence provided a strong signal to the renewable energy sector. The Swiss Energy Act includes the target of an annual additional renewable electricity generation of 5 400 gigawatt-hours (GWh) by 2030 as compared to 2000 and of which 2 000 GWh are to come from hydropower. These long-term targets constitute an important element in the overall framework for RES. The credibility of this target is underlined by the provision in the Energy Act that quota obligations for renewable electricity may be imposed upon electricity suppliers in case the target is missed ([2]). With respect to hydroelectricity, FITs are only for small hydroelectricity below 10 megawatts (MW), as reflected in the MKF and KEV support schemes.

In addition to the financial support mechanisms, non-financial measures such as priority dispatch have provided stable framework conditions for RES. Moreover, the Energy Efficiency and Renewable Action Plans of 2008 led to the implementation of a series of measures aimed at improving market conditions for renewable energy technologies. These measures included financial support for the replacement of existing heating systems with renewable energy (e.g. heat pumps and biomass (via global budgets distributed to the cantons dedicated for supporting measures)) and revision of the building standard for new buildings (minimum share of renewable energy/maximum energy demand):

- financial support for insulation of buildings (via the building programme);
- financial support for renewable heat and waste heat (via global budgets distributed to the cantons dedicated for supporting measures);
- biomass strategy (sustainable use of biomass);
- improve spatial planning instruments for renewable energy technologies;
- strengthen renewable energy research;
- accelerate technology transfer by supporting pilot and demonstration projects for renewable energy;
- improved coordination of education and training.

Based on an assessment of how a FIT for renewable heat could be implemented, it was decided that this would not be pursued further due to, inter alia, high administrative costs related to metering. Instead, financing is made available to the 26 Swiss cantons to support renewable heat projects at the local level.

The Swiss Renewable Energy Index (REIS) ([3]) reflects since 2010 the economic development of the renewable energy and energy efficiency sector in Switzerland based on trends in

[2] Energiegesetz (EnG) (Energy Act) of 26 June 1998 (latest version 1 July 2012), in particular Art. 7a)

[3] The Swiss Renewable Energy Index (REIS) reflects since 2010 the economic development of the renewable energy and energy efficiency sector in Switzerland based on trends in turnover, confirmed contracts, delay in

turnover, confirmed contracts, delay in delivery, employment and exports. For the first quarter 2013, the REIS showed for the first time since its inception a negative perspective with a decrease in turnover and new contracts, whereas for the second quarter 2013 the Index showed that the sector is again on a growth path.

1.2 Quantitative overview of public support to all energy forms ([4])

This section provides a comprehensive overview of the public support available to all energy forms. After briefly describing the different forms of public support available, a quantitative overview is provided in

Table 6.

1.2.1 Direct transfers

Renewable energy sources

Coverage of additional costs for renewable electricity (MKF)

As of 1 January 2005 a system was put in place that allowed operators of renewable electricity power plants to receive a payment for the additional cost of renewable electricity generation (MKF) that was above the wholesale electricity price ([5]). It covered hydropower (< 1 MW), solar photovoltaics (PV), geothermal, wind energy, biomass and biogas. The level of payments is the same for all eligible renewable energy technologies. On average, the payment is 15 Rp/kWh (EUR 12.2 ct/kWh) (the system was therefore also called '15 Räppler'). The costs of the MKF are borne by final electricity consumers.

The MKF system was replaced by the KEV system as of 1 January 2009 for all renewable electricity units that entered into operation after 31 December 2005. Table 2 provides an overview on the MKF payments and additional renewable electricity generation between 2005 and 2011 ([6]).

Table 2 MKF payments and additional renewable electricity generation, 2005–2011

delivery, employment and exports. REIS is published by Credit Suisse and the Agency for Renewable Energy and Energy Efficiency (A EE). For more information, see http://www.aee.ch/de/aee/renewable-energy-index/reis.html#c971 online.

[4] The following exchange rate was used: EUR 1 = CHF 1.2273, based on the European Central Bank's euro foreign exchange reference rates on 7 June 2013 (https://www.ecb.int/stats/exchange/eurofxref/html/index.en.html).

[5] Art. 7 EnG.

[6] No data was available for the years 2005–2007.

Year	2005		2006		2007		2008	
Technology	Additional costs/ payments (TEUR)	Additional generation (MWh)	Additional costs/ payments (TEUR)	Additional generation (MWh)	Additional costs/ payments (TEUR)	Additional generation (MWh)	Additional costs/ payments (TEUR)	Additional generation (MWh)
Biomass	1,804	27,264	2,950	45,356	7,410	93,063	13,658	145,007
PV	988	9,386	851	12,293	1,023	14,391	1,181	17,558
Hydro (< 10 MW)	14,020	228,743	18,176	302,902	23,223	358,086	24,111	361,694
Wind energy	23	359	296	5,195	349	5,705	313	8,584
Geothermal	0	0	2	505	1	159	2	177
Biogas	856	12,933	1,237	19,188	1,348	21,117	1,444	21,797
Total	**17,689**	**278,684**	**23,512**	**385,440**	**33,356**	**492,523**	**40,708**	**554,817**

Year	2009		2010		2011	
Technology	Additional costs/ payments (TEUR)	Additional generation (MWh)	Additional costs/ payments (TEUR)	Additional generation (MWh)	Additional costs/ payments (TEUR)	Additional generation (MWh)
Biomass	2,375	37,510	2,296	33,700	1,916	19,000
PV	703	11,169	627	10,200	753	10,200
Hydro (< 10 MW)	18,709	326,199	18,611	348,100	17,393	265,000
Wind energy	232	4,744	312	5,600	353	5,200
Geothermal	0	0	0	0	0	0
Biogas	1,027	17,356	681	15,400	875	12,000
Total	**23,047**	**396,978**	**22,527**	**413,000**	**21,290**	**311,400**

Note: TEUR represents Additional costs/payments in thousand EUR (TEUR); MWh represents Additional generation (megawatt-hours (MWh)).
Source: KEV (2010) and BFE (2007a)

Feed-in tariff for renewable electricity (KEV)

The ‘feed-in remuneration at cost’ (KEV) ([7]) for electricity generation from RES has been open for applications since May 2008. Feed-in payments started in 2009. Electricity generation from hydropower (< 10 MW), PV, wind energy, geothermal and biomass from waste is eligible for KEV support provided the power plant entered into operation after 1 January 2006. Eligible MKF-funded plants were transferred to the KEV system. ‘Feed-in remuneration at cost’ is guaranteed to the operators for a period of between 20 and 25 years. The KEV FITs are adopted annually based on the generation costs of a reference plant using best available technology for each technology.

The KEV is financed through a levy on transmission costs of up to 0.6 Rp/kWh (0.9 Rp since 2013) (EUR 0.49 ct/kWh and EUR 0.73 ct/kWh, respectively). The cap of 0.6 and 0.9 Rp implies that there is an overall cap on the available KEV fund for each year equivalent to around CHF 350 million (EUR 285 million) and CHF 530 million (EUR 432 million), respectively, based on an annual electricity consumption of around 59 terawatt-hours (TWh) in 2011 (BFE, 2013b). In addition to this overall cap there are technology-specific caps that can be adjusted each year. Hydropower can receive up to 50 % of the KEV fund, PV — depending on the required KEV payment — between up to 5 and 20 %, and other technologies up to 30 %. The payment for tendering procedures cannot exceed 5 % of the KEV payments. The caps shall ensure that there is no over-spend on the available fund and that individual technologies are not supported too much. A special provision exists for PV for which the cap is set based on the costs not covered on the market ([8]). In order to ensure that these caps are respected, potential operators of renewable electricity plants need to register and apply for KEV payments. This implies that there are a limited number of projects that can be financed per technology category and year.

[7] Energiegesetz (EnG) (Energy Act) of 26 June 1998 (latest version 1 July 2012), in particular Art. 7a.
[8] Energiegesetz (EnG) (Energy Act) of 26 June 1998 (latest version 1 July 2012), Art. 3f EnV.

The KEV levy is collected by the Swiss transmission grid operator Swissgrid AG and paid by the final electricity consumers. An overall cap is fixed in the legislation that stipulates that the levy cannot exceed 1 Rp/kWh for final consumers. Large electricity consumers or consumers whose competitiveness may be affected by the levy can benefit from reductions ([9]). A foundation (KEV Stiftung) was set up to manage the KEV fund. The revenues from the KEV levy cover the gap between the generation costs, as determined based on the reference plant, and the market price for electricity in the relevant quarter (until 30 September 2011 it was the previous quarter). The KEV transfer payments between 2009 and 2011 are summarised in Table 3.

Table 3 KEV transfer payments and annual renewable electricity generation (in EUR)

Year	2009				2010				2011			
Technology	Annual generation (MWh)	KEV payments (TEUR)	Market price (TEUR)	Total payment (TEUR)	Annual generation (MWh)	KEV payments (TEUR)	Market price (TEUR)	Total payment (TEUR)	Annual generation (MWh)	KEV payments (TEUR)	Market price (TEUR)	Total payment (TEUR)
Biomass	203,597	17,072	13,789	30,860	172,415	23,800	11,800	35,600	223,418	29,875	16,914	46,789
PV	15,434	7,974	961	8,936	17,248	10,540	1,209	11,749	27,804	15,889	2,072	17,961
Hydro (> 10 MW)	166,350	11,454	10,798	22,252	211,419	20,446	14,492	34,938	300,784	24,587	22,488	47,075
Wind energy	5,138	434	344	778	10,551	1,257	704	1,961	36,143	3,946	2,747	6,694
Geothermal	0	0	0	0	0	0	0	0	0	0	0	0
Total	**390,519**	**36,935**	**25,892**	**62,827**	**411,632**	**56,043**	**28,205**	**84,248**	**588,149**	**74,296**	**44,221**	**118,518**

Sources: KEV (2010, 2011 and 2012)

While the overall capacity cap and the technology-specific capacity caps help to keep control over the premium payments, they constitute a limitation for market demand. Moreover, they can lead to a volatile market with demand peaks to avoid being ‘left out’ after the peak has been reached. This was the case for solar PV in particular, which resulted in a temporal halt to any new power plants being supported in 2009. At the end of 2010, a total of 8 629 renewable energy projects with a projected annual electricity generation of 3 800 GWh were on the waiting list for KEV approval (KEV, 2011). Overall, the KEV support scheme stimulated the construction of new renewable electricity generation capacity as well as the upgrading and expansion of existing renewable power plants. This trend in increased market demand for KEV support was reinforced in 2011 and continued in 2012. In 2011 alone, there were 9 229 KEV applications, compared to 2 999 applications in 2010. By the end of 2011, a total of 21 122 KEV applications had been submitted, out of which 4 867 were approved and 15 606 were put on the waiting list (KEV, 2012). Due to the cap on total annual revenues there is not much scope to remove plants off the waiting list and hence the market demand cannot be met under the KEV support scheme. Approval under the KEV system relates only to financing; all other relevant permits are subject to separate procedures.

The strong increase in market demand in 2011 was also described as the ‘Fukushima effect’ (KEV, 2012) and shows the importance that external events can have on creating demand for new technologies.

In 2013, the Swiss Parliament supported changes to the KEV system, which envisage increasing the cap on the levy from 1 Rp/kWh to 1.5 Rp/kWh for final consumers as of 1 January 2014. Moreover, small PV installations (< 10 kilowatts (kW)) should no longer

[9] For final consumers whose electricity costs are higher than 10 % of their gross added value, the contribution to the KEV is limited to 3 % of their electricity costs (Art. 15b of the Energy Act). Final consumers with electricity costs of at least 8 % may benefit from the same cap.

benefit from KEV payments but from installation grants of up to 30 % of installation costs. In addition, energy-intensive industry whose electricity costs are higher than 10 % of their gross value added (GVA) should be exempted from the levy but in turn be obliged to invest a certain share of the saved money in energy efficiency measures (BFE, 2013c).

Promotion of renewable energies in buildings

Revenues from the carbon dioxide (CO_2) tax have been partly earmarked for modernisation and promotion of renewable energies in buildings since 2010 and disbursed via cantonal programmes, mostly in the form of investment grants.

Climate Cent for transport fuels

The Climate Cent existed between 2005 and 2012. It was based on a voluntary agreement under which a surcharge of CHF 0.015 (EUR 0.012) per litre was collected by mineral oil importers on imports of both gasoline and diesel. Revenues were invested into CO_2-reduction projects both in Switzerland and abroad via the Climate Cent Foundation. Between 2005 and 2012, the Climate Cent raised around CHF 105 million (EUR 86 million) per year and CHF 720 million (EUR 587 million) in total (Stiftung Klimarappen, 2012). Between 2005 and 2009, CHF 182 million (EUR 148 million) was allocated to a buildings renovation programme under which grants were made available (BFE, 2010). The Climate Cent was based on a voluntary agreement between 2005 and 2012, which was concluded as a condition for an exemption under the future CO_2 tax ([10]).

As of 1 January 2013, the voluntary Climate Cent has been replaced by a legal obligation on oil importers to directly offset a part of the CO_2 emissions from transport fuel use by supporting climate-related projects inside or outside Switzerland.

Stabilisation programme

A stabilisation programme worth CHF 710 million (EUR 579 million) in total was adopted in March 2009 in support of the Swiss economy. As part of this programme, CHF 60 million (EUR 49 million) was allocated to the energy sector. Out of this amount, CHF 20 million (EUR 16 million) was available for PV plants that were on the KEV waiting list. Also, CHF 10 million (EUR 8 million) was available for the support of the replacement of electric heating systems, and CHF 30 million (EUR 24 million) was available for district heating projects using at least 80 % heat waste and RES (BFE, 2009).

1.2.2 Fiscal preferential treatment

Fossil fuels

CO_2 tax exemption for large consumers (coal, gas, petroleum)

[10] Since it is not possible to specify how much funding was used in support of renewable energy sources, it is not counted as support for renewable energy sources.

Since 2008 certain large consumers (i.e. energy-intensive companies) are exempt from Switzerland's CO_2 tax on heating and process fuels. Companies exempted from the CO_2 tax must, however, commit to legally binding CO_2 reduction targets.

<u>Excise tax refund for farming, forestry and fishing</u>

The use of fuel for farming, forestry, natural stone extraction and fishing purposes is entitled to a partial refund from the excise tax that normally applies to mineral oils consumed in Switzerland ([11]).

<u>Excise tax exemption for certain transport companies</u>

This tax provision allows companies that have been granted a concession for the transport of persons to benefit from a reduction in the rate of the excise tax that normally applies to mineral oils consumed in Switzerland. Tax reductions are granted at different levels according to soot particle filter emission technology applied.

<u>Excise tax refund for public interest</u>

The use of fuels is in certain cases of public interest entitled to a refund of the excise tax that normally applies to most sales of mineral oils in Switzerland. Fossil fuels used in power plants for electricity generation get a refund of the excise tax. However, they are taxed according to the CO_2 Act[12].

<u>Reduced mineral oil tax for natural and liquid gas</u>

Since mid-2008, a reduced tax rate applies to natural and liquid gas to reduce greenhouse gas (GHG) emissions in the transport sector.

<u>Exemption from performance-related heavy vehicle fee</u>

The heavy vehicle fee (HVF), which has been in force since 2001, is a federal tax levied on the basis of total weight capacity, emissions level and the distance (in kilometres) travelled within Switzerland. Some vehicles exempt from the HVF include: some of the agricultural vehicles (differentiated by purpose), vehicles used for the concessionary transport of persons, vehicles used by emergency services and military vehicles.

Renewable energy sources

<u>Mineral oil tax exemption for biofuels</u>

Until 1 July 2008, the mineral oil tax exemption was applicable only to domestically produced biofuels. As of 1 July 2008, an amendment of the law was enacted. Biofuels (e.g. biogas, bioethanol, biodiesel, and plant and animal oils) are partly or totally exempt from the

[11] For details, see http://www.ezv.admin.ch/zollinfo_firmen/04020/04256/04263/04521/04524/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCDdIJ5hGym162epYbg2c_JjKbNoKSn6A--online.

[12] For details see http://www.bafu.admin.ch/klima/00493/index.html?lang=de

mineral oil tax if they comply with a set of environmental and social criteria[13]. This can lead to a tax reduction of up to CHF 0.72 per litre. These measures have to maintain budget neutrality, which is why the taxing of gasoline was raised.
The total exemptions in support of the production and consumption of biofuels amounted to CHF 65 million (EUR 53 million) between 2005 and 2011 (CHF 46.3 million (EUR 37.7 million) for biodiesel, CHF 12.0 million (EUR 9.8 million) for ethanol and CHF 6.7 million (EUR 5.4 million) for used oils) (see Table 4) ([14]).

Table 4 Tax exemptions for biofuels, 2005–2011 (in EUR)

(x1000l)	Biodiesel			Bioethanol			Used oils (national)			TOTAL TAX EXEMPTION (EUR)
	National production	Imports	TAX EXEMPTION (EUR)	National production	Imports	TAX EXEMPTION (EUR)	National production	Imports	TAX EXEMPTION (EUR)	
2005	6180	181	3,628,541	901	0	529,015	529	0	310,598	4,468,154
2006	8717	116	5,118,121	1060	0	622,371	845	0	496,135	6,236,628
2007	9756	113	5,728,162	3188	0	1,871,810	1846	0	1,083,865	8,683,838
2008	11915	12	7,103,917	3284	0	1,956,004	849	158	599,786	9,659,707
2009	6837	679	4,476,653	0	1438	856,496	808	1418	1,325,842	6,658,991
2010	6945	2380	5,554,123	0	2593	1,544,433	869	950	1,083,426	8,181,982
2011	7161	3101	6,112,215	0	4047	2,410,460	641	229	518,186	9,040,861
TOTAL 2005-2011 (EUR)			37,721,732			9,790,590			5,417,839	52,930,161

Source: Own calculations and GSI (2008)

Climate Cent exemption for biofuels

An additional form of support given to the use of biofuels is exemption from the Climate Cent equivalent to CHF 0.015 (EUR 0.012) per litre of diesel and gasoline to fund projects for CO_2 reduction, amounting to CHF 1.35 million (EUR 1.1 million) over the period 2005–2011 (see section 1.2.1 above).

Table 5 Climate Cent exemption for biofuels, 2005–2011 (in EUR)

(x1000l)	Biodiesel			Bioethanol			Used oils (national)			TOTAL TAX EXEMPTION (EUR)
	National production	Imports	TAX EXEMPTION (EUR)	National production	Imports	TAX EXEMPTION (EUR)	National production	Imports	TAX EXEMPTION (EUR)	
2005	6180	181	77,744	901	0	11,012	529	0	6,465	95,221
2006	8717	116	107,956	1060	0	12,955	845	0	10,328	131,239
2007	9756	113	120,618	3188	0	38,964	1846	0	22,562	182,144
2008	11915	12	145,771	3284	0	40,137	849	158	12,308	198,216
2009	6837	679	91,860	0	1438	17,575	808	1418	27,206	136,641
2010	6945	2380	113,970	0	2593	31,692	869	950	22,232	167,893
2011	7161	3101	125,422	0	4047	49,462	641	229	10,633	185,517
TOTAL 2005-2011 (EUR)			783,341			201,797			111,733	1,096,871

Source: Own calculations and GSI (2008)

[13] More information is available here:
http://www.internationallawoffice.com/newsletters/detail.aspx?g=8576f04b-113b-46f0-99b8-ad08c1b5c600, accessed on 10.04.2014
[14] Biogas for transport is not included here
(http://www.ezv.admin.ch/zollinfo_firmen/04020/04256/04263/04521/04524/index.html?lang=de).

1.2.3 Transfer of risk to government

Risk-sharing guarantee scheme for geothermal projects

For the promotion of geothermal projects, the Energy Act ([15]) provides for the possibility to provide a risk-sharing guarantee scheme for geothermal projects. Risk guarantees can cover up to 50 % of the investment costs of a geothermal project. The guarantee scheme is funded from the KEV levy. In 2011, the first guarantee with a financial volume of CHF 8.8 million (EUR 7.2 million) was approved (KEV, 2012).

1.2.4 Other fiscal measures

Guaranteed grid access

The Energy Act stipulates that grid operators need to provide access to the grid to third parties (independently of the energy source) and remunerate the renewable electricity fed into the grid according to the regulated tariffs for renewable electricity. The network operator can refuse grid access if additional renewable electricity generation capacity would endanger the stability of the grid.

Renewable energy sources

Priority dispatch for renewable electricity

Renewable electricity benefits from priority dispatch ([16]).

EnergieSchweiz

The EnergieSchweiz programme ([17]) provides a platform for voluntary measures in support of the transition to a low-carbon energy system including the deployment of RES. It brings together all relevant stakeholders to ensure sharing of information and best practices. The current EnergieSchweiz (2011–2020) builds on the previous EnergieSchweiz (2000–2010) and its predecessor programme Energie2000 (1990–2000). It aims to stimulate innovation by providing information and advice, accelerate market deployment and support cross-sector collaboration. The annual federal budget contribution was CHF 23.2 million (€28,6 million) in 2011.

Public support to energy sources

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[15] Art. 15a.

[16] Art. 13 StromVG. This implies that renewable energy sources have priority access to the grid and provides renewable energy operators with an assurance that they will be able to sell and transmit the electricity from renewable energy sources in accordance with connection rules at all times, whenever the source becomes available.

[17] See http://www.energieschweiz.ch/de-ch/home.aspx online.

Table 6 provides a quantitative summary overview of public support to all energy sources. It shows that direct transfers are the main form of support for RES in the form of FITs, earmarked revenues from the CO_2 tax for renewables in buildings and a one-off payment from the economic stabilisation programme ([18]). For biofuels, fiscal preferential treatment is a common form of support. For conventional sources, the main form of support is fiscal preferential treatment.

1.2.5 Summary

Table 6 Quantitative overview on support measures for all energy sources, 2005–2011 (*million EUR*)

	2005	2006	2007	2008	2009	2010	2011
Direct transfers							
Renewable energy sources							
MKF	17.7	23.5	33.3	40.7	23.0	22.5	21.3
KEV	-	-	-	-	36.9	56.0	74.3
EnergySchweiz and RES in buildings (via cantonal harmonised programmes) ([a])	12.8	14.8	17.4	22.8	43.6	50.3	46.7
Fiscal preferential treatment							
*Conventional sources ****							
CO_2 tax exemption for large consumers (coal)	-	-	-	3.3	7.3	15.5	25.3
CO_2 tax exemption for large consumers (gas)	-	-	-	6.5	13.0	26.9	44.0
CO_2 tax exemption for	-	-	-	4.1	8.1	15.5	26.1

[18] The Climate Cent is not included here although its buildings renovation programme, whose main focus was on emission reductions, may also have supported renewable energy technologies.

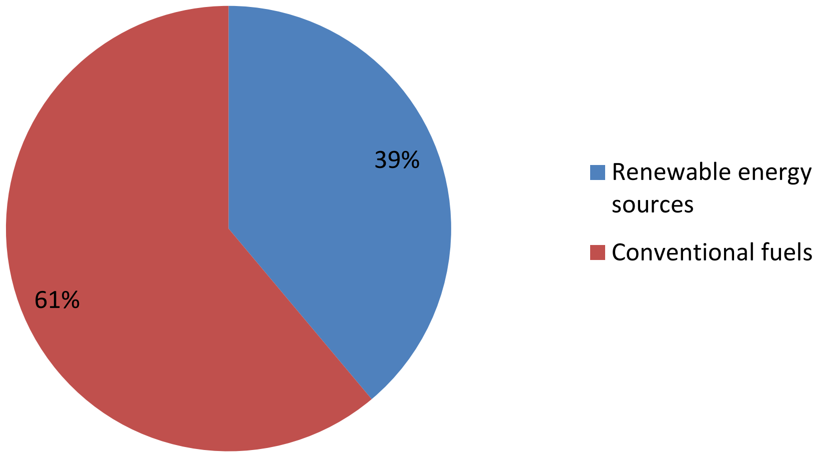
large consumers (petroleum)							
Excise tax refund for agriculture, forestry, natural stone extraction and fishery)	57.9	58.7	57.9	57.0	56.2	55.4	55.4
Excise tax exemption for concessionary transportation	57.9	58.7	57.9	57	56.2	54.6	50.5
Excise tax refund for public interest (e.g. electricity production)	4.3	5.0	4.4	4.3	4.2	3.7	4.8
Reduced mineral oil tax for natural and liquid gas for transportation	n.a.	n.a.	n.a.				
Renewable energy sources							
Mineral tax exemption for biofuels	4.5	6.3	8.7	9.7	6.7	8.1	9.0
Climate Cent tax exemption for biofuels	0.1	0.1	0.2	0.2	0.1	0.2	0.2
Risk transfer mechanisms							
Renewable energy sources							
Risk-sharing guarantee scheme for geothermal					(16.3)*	(89.6)*	7.2**

Note: * Funds available; ** Funds committed; *** Tax expenditures for any given country are measured with reference to a benchmark tax treatment that is generally specific to that country. Consequently, the estimates contained in the table above are not necessarily comparable with estimates for other countries. In addition, because of the potential interaction between them, the summation of individual measures for a specific country may be problematic. The allocation of particular measures across fuel types was done by the OECD Secretariat based on the IEA's Energy Balances.
([a]) The cantonal programmes provide direct investment support for energy efficiency and renewable energy sources buildings. In addition, they provide indirect support in the form of information and advice. The numbers reported in the table refer to the investment grants for renewable energy sources only. This includes CHF 60 million allocated to energy efficiency and renewable energy sources under the stabilisation programme in 2009.

Source: OECD: Inventory of estimated budgetary support and tax expenditures for fossil fuels – 2012

Total public support between 2005 and 2011 was EUR 971 million for fossil fuels and EUR 618 million for RES. Hence, in this period, 61 % of support for energy sources went to fossil fuels whereas 39 % was allocated to RES (see Figure 2).

Figure 2 Split of energy support measures between fossil fuels and renewable energy sources in the period 2005–2011



Source: EEA

While all support measures for conventional sources were funded directly from the state budget, the most important support measure for RES, the KEV, is funded via a levy on final electricity consumers.

1.3 Effectiveness and efficiency of national support schemes for the deployment of renewable energy technologies

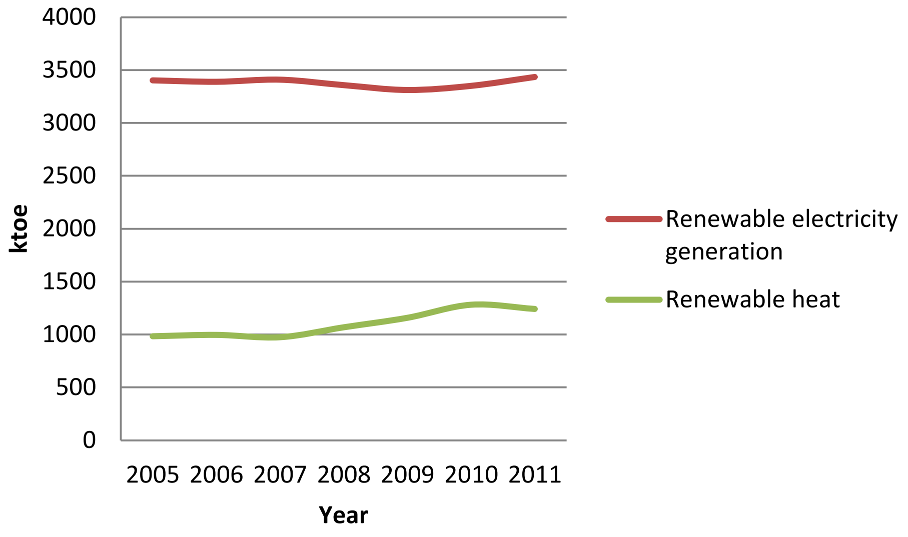
Before analysing the effectiveness and efficiency of the national support schemes for renewable energy, the following sub-section outlines key developments in renewable energy deployment between 2005 and 2011 as well as the potential for future renewable energy deployment.

1.3.1 Development in renewable energy deployment

Renewable energy generation in the power and heating sector increased marginally from around 4 400 thousand tonnes of oil equivalent (ktoe) in 2005 to 4 674 ktoe in 2011. While renewable electricity output remained stable at around 3 400 ktoe, renewable heat generation increased from below 1 000 ktoe in 2005 to above 1 200 ktoe in 2011 (see Figure 3).

Figure 3 Renewable energy generation, 2005–2011 (*ktoe*) ([19])

[19] Data for transport not available.



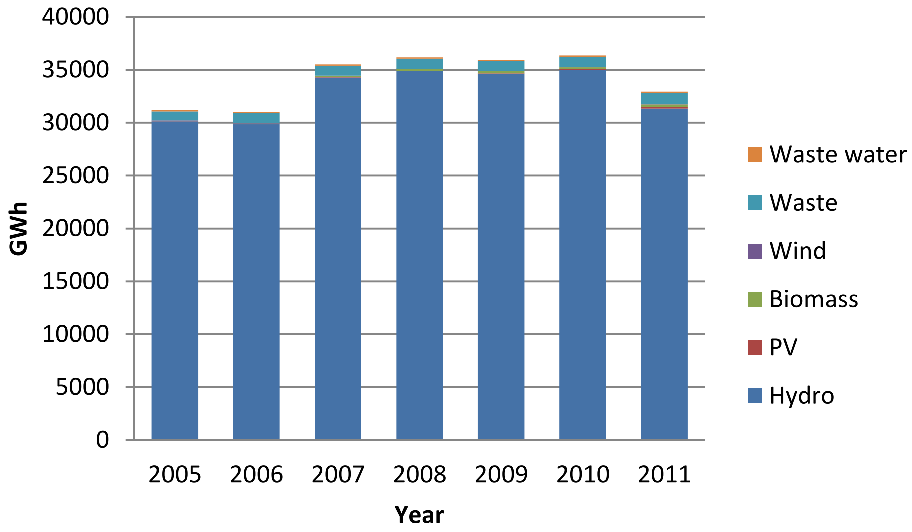
Source: EEA (2013)[20]

The renewable electricity output was dominated by hydropower with an output of between 30 130 GWh in 2005 and 31332 GWh in 2011, with some variations over the interval due to annual weather conditions. Between 2005 and 2011, wind energy, solar PV and biomass showed the strongest increase. Starting from low levels of electricity generation, their output increased from around 8 GWh, 19 GWh and 42 GWh in 2005 to 70 GWh, 149 GWh and 244 GWh, respectively in 2011(see

Figure 4).

Figure 4 Development of renewable electricity generation between 2005 and 2011 (in GWh)

[20] CH has not reported to ESTAT under the SHARES2011 application. The values/data for CH in this report come from EEA bottom-up calculation based on data Switzerland has submitted to Eurostat (low level data) on energy and data from EurObserv'Er (http://www.eurobserv-er.org/).

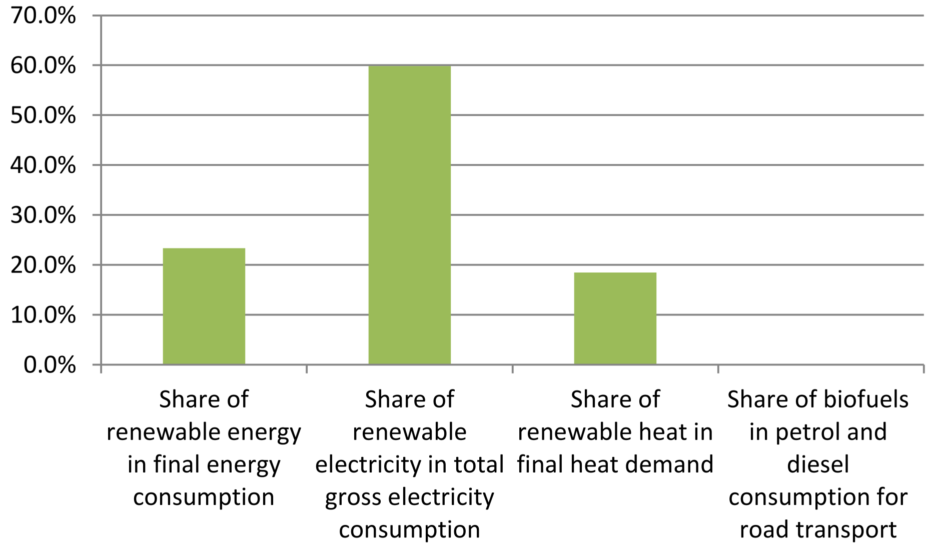


Source: BFE (2012)

Note: This data is based on national data and is not directly comparable with data presented in Figure 3 above because the hydro and wind output has not been normalised according to the methodology used for Figure 3 above.

In 2011, the renewable energy share in final energy consumption was 23.4 %, the share of renewable electricity in total gross electricity consumption was around 60 %, and the share of renewable heat in final heat demand was 18.5 % (see Figure 5). The share of biofuels in the transport sector was virtually zero, which was also due to concerns on the environmental sustainability of biofuels at that time.

Figure 5 Share of renewable energy in final energy consumption for each sector, 2011



Source: EEA (2013)

Switzerland does not have a binding target for renewables for 2020. However, as part of the revision of the Swiss Energy Act in 2007, Switzerland adopted a target of an annual additional renewable electricity generation of 5 400 GWh by 2030 as compared to 2000 and of which 2 000 GWh are to come from hydropower. The Renewable Energy Action Plan aims to increase the share of RES in total energy consumption from 16.2 % in 2008 to 24 % by 2020.

Despite the preferential fiscal treatment for biofuels (see Sub-section **Error! Reference source not found.**), the total share of biofuels in the Swiss transport sector has remained marginal. The reason for this is that ever since the introduction of the mineral oil tax exemption for biofuels there has been a critical political debate on the ecological and social benefits of biofuels production. In fact, concerns about biofuels' ecological and social impacts had hence led to the introduction of minimum criteria in the tax exemption framework, which are quite strict. Therefore, the current political view in Switzerland is that other measures or instruments are more effective in achieving the goals in climate and energy policy than the promotion of biofuels. Currently, parliamentary debate aims at introducing even more criteria and possibly market access regulation concerning biofuels ([21]).

1.3.2 Policy effectiveness

The Policy Impact Indicator (PII) shows to what extent the remaining gaps to a set future target for RES have been reached per year. It is defined as follows:

Policy Impact Indicator = additional generation in a given year divided by the difference between the generation in 2005 and the potential defined by the policy target.

As the generation in 2005 is used as a basis to calculate the remaining gap against the target set for 2030, an average yearly policy impact of 4 % during the 25 years between 2005 and 2030 would be required to meet the 2030 target. If the PII is below 4 %, more efforts are needed in future years to close the gap for reaching the 2030 target. On the other hand, if the PII is well above 4 %, less effort is needed in the future or, in the case of continued high policy impact, the target will be overachieved.

For Switzerland, the PII is calculated on the basis of the 2030 target for renewable electricity as included in the Swiss Energy Act. This foresees an additional renewable electricity generation of 5 400 GWh by 2030 as compared to the year 2000 and of which 2 000 GWh are to be sourced from hydropower.

For the calculation below (see Figure 6), it is assumed that an additional 3 400 GWh of electricity is expected to come from non-hydropower renewable electricity sources. The PII in 2006 was 7.2 % but dropped to below 0 % in 2007. In the following 3 years, the PII fluctuated between above 3 % and 0 %, and reached 17.2 % in 2011 (see Figure 6). The annual changes may be mainly explained by the transition from the MKF to the KEV system in 2008 and the cap on payments. Overall, the policy effectiveness achieved since 2007 is not sufficient to reach the 2030 target as the PII remained below 4 %, unless the recent increase to 17.2 % is not a one-off increase but indicates an upwards trend in renewable electricity generation.

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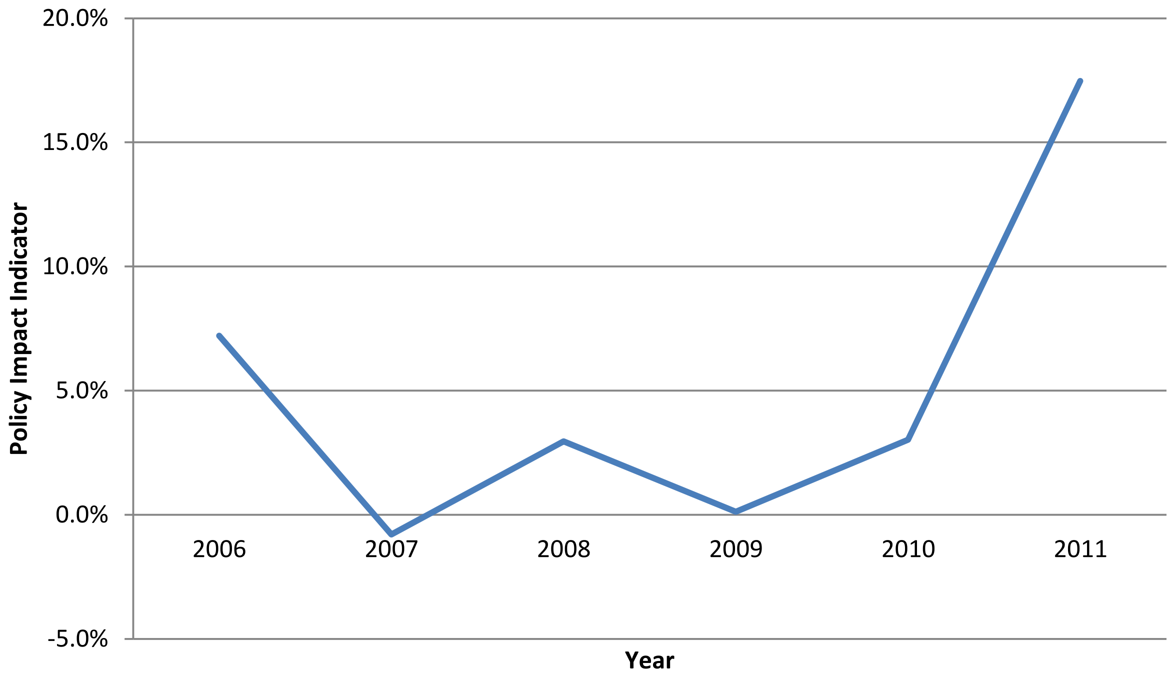
[21] Further reading is available at http://www.ezv.admin.ch/zollinfo_firmen/04020/04256/04263/04530/index.html?lang=en&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1ad1IZn4Z2qZpnO2Yuq2Z6gpJCDeoF2g2ym162epYbg2c_JjKbNoKSn6A-- online.

Figure 6 Policy Impact Indicator for renewable electricity (excl. hydropower), 2006–2011



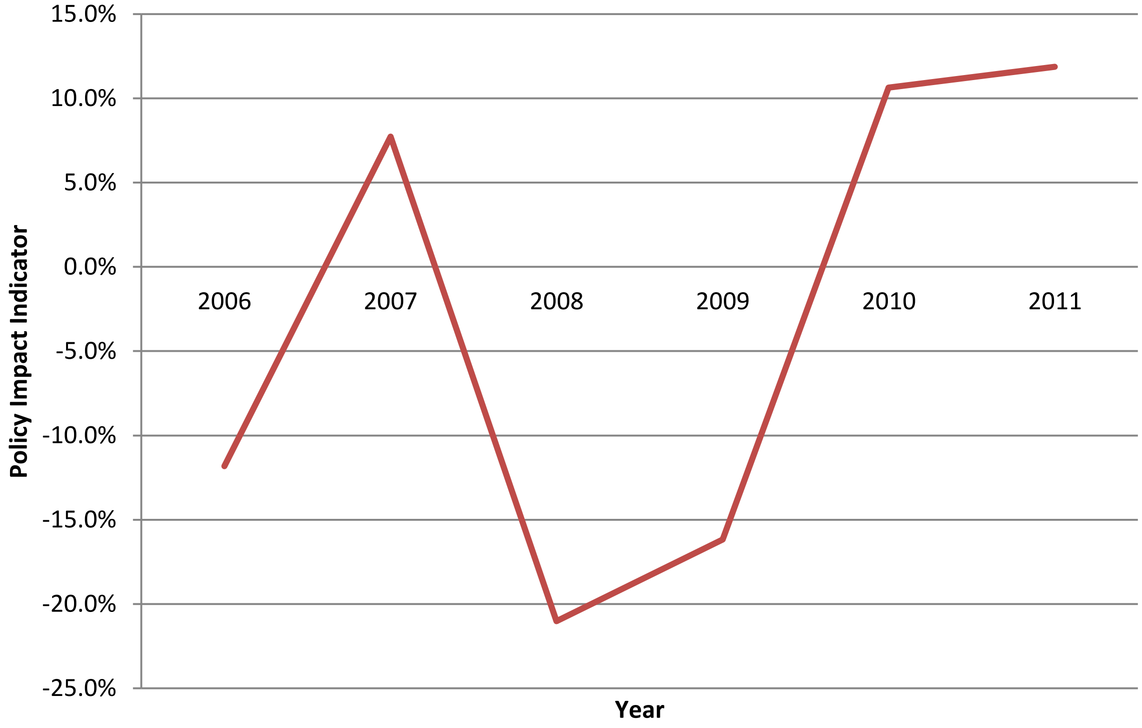
Source: EEA

As for normalised hydropower[22], the calculations of the PII show a strong fluctuation between 2006 and 2011, reflecting the variation in hydropower output despite normalisation (see

Figure 7). The average PII was – 6.1 % and it is clear that the 2030 target would not be reached if this development was to continue. Based on this indicator, the policy therefore appears to be ineffective.

[22] The same methodology has been applied as in the Renewable Directive 2009/28/EC.

Figure 7 Policy Impact Indicator for normalised hydropower, 2006–2011



Source: EEA

For Switzerland it was not possible to calculate technology-specific PIIs since there are no technology-specific targets in place.

For the renewable heating sector, PIIs could not be calculated since there is no long-term renewable heating target in place (and consequently no technology-specific targets).

1.3.3 Policy efficiency

The Total Cost Indicator (TCI) shows the cost for a specific renewable energy support scheme. It is defined as follows:

Total Cost Indicator = how much a country spends in addition to the market price for energy to get an x amount of additional generation from a renewable technology.

For this purpose, the amount of annual FIT payments is compared to the wholesale value of the total annual electricity generation. For Switzerland, the payments under the MKF and KEV systems between 2008 and 2011 (see Table 2 and Table 3) are compared to the wholesale value of total annual electricity generation in each year. The yearly average wholesale price varied quite strongly over the period (see Table 7). This variation affects the calculations of the TCI with respect to the value of total annual electricity generation and has an impact on FIT expenditure.

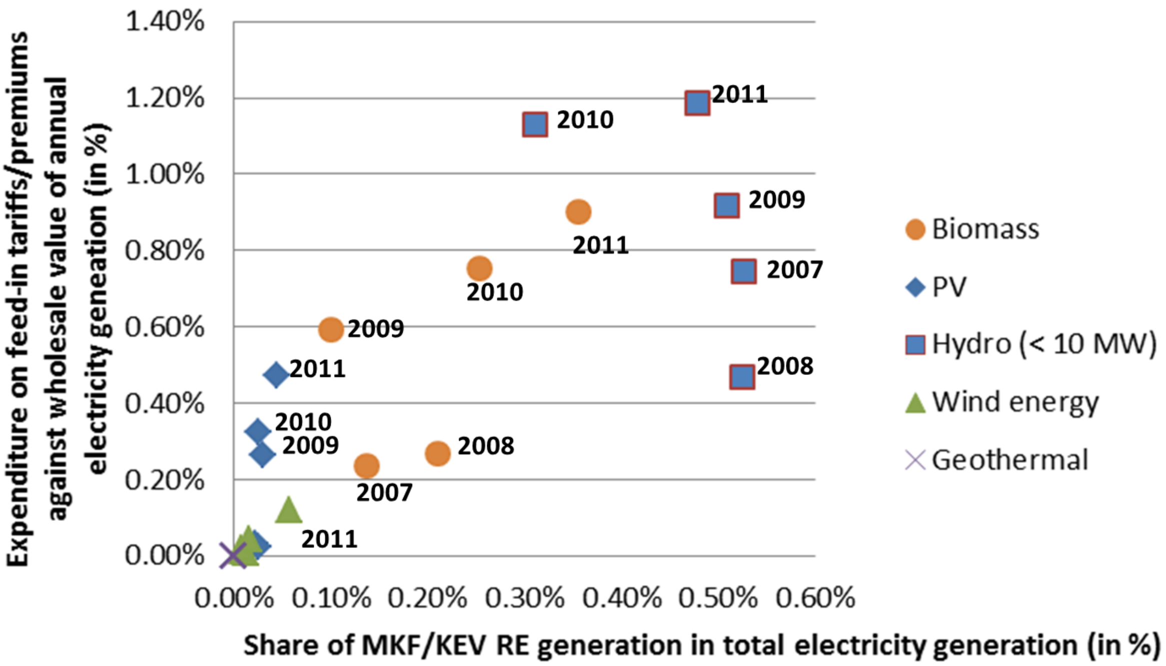
Table 7 Average wholesale price (€ nominal prices) per MWh, Market: EPEX-CH.

2008	2009	2010	2011
74.38	47.92	51.02	56.18

Source: EMOS (DG ENER, 2013)

The calculated TCI shows that both the share of the MKF- and KEV-supported renewable electricity compared to total electricity generation was very low in 2011: 0 % for geothermal, 0.04 % for solar PV, 0.06 % for wind energy, 0.36 % for biomass and 0.48 % for small hydropower (< 10 MW). Similarly, total costs for MKF and KEV payments in per cent of the wholesale value of total electricity generation were relatively low, representing 0.12 % for wind energy, 0.47 % for solar PV, 1.19 % for small hydro and 0.90 % for biomass in 2011 (see Figure 8). This shows that the KEV system with its cap on available funding helped to keep costs under control and hence the total expenditure on each technology. However, this has also resulted in low effectiveness for some years, as measured in terms of the PII (see discussion above).

Figure 8 Total Cost Indicator for MKF and KEV renewable electricity in Switzerland, 2007–2011 ([23])



Source: EEA

Box: National practice for policy evaluation

[23] The years 2005 and 2006 are not included due to data gaps on average wholesale price per MWh.

An evaluation of the KEV was commissioned by the Swiss authorities in 2012. It covered the first three years of its operation (2009–2011). The evaluation was based on the following five criteria:

- conception, e.g. objectives, instruments and control mechanisms;
- implementation, e.g. involved actors and efficiency of implementation;
- outputs, e.g. number of registered and funded power plants and their annual production, efficiency of the procedures;
- impacts, e.g. direct positive/negative impacts among (potential) plant operators, innovation effect, effectiveness in relation to the objectives of the KEV among the target groups;
- outcomes, e.g. additional renewable electricity generation, contribution to reach the 2030 target, costs compared to initial objectives.

The evaluation concludes that the system fulfils nearly all criteria of a 'good' FIT system, but points to the following shortcomings:

- no interim targets between 2008 and 2030;
- no inflation adjustment for the feed-in tariffs;
- no incentives to sell the KEV remunerated electricity at the spot market;
- no 'one-stop-shop' for administrative procedures.

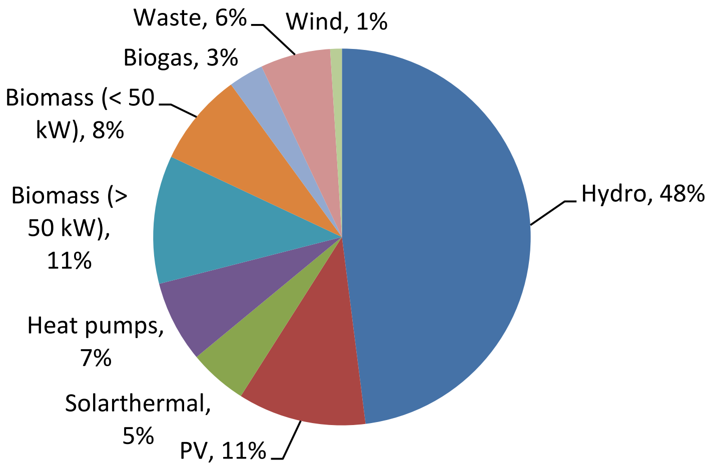
The evaluation considers the KEV is an effective tool as the objectives will be met under the current conditions. The analysis showed that PV is most expensive per kWh (77 Rp), compared to small hydropower (13.5 Rp), wind energy (16 Rp) and biomass (18.5 Rp) (Interface, 2012).

1.3.4 Impact on the renewable energy sector

Over the last decade a sizeable renewable energy industry has developed in Switzerland. While support policies for renewable energy technologies have played a role, a major reason for this success is related to the well-established national innovation system that reacted well to overall demand in Asia and Europe for Swiss goods and services.

Despite a rather low share of new RES (excluding hydro) in total electricity generation, a sizable renewable energy sector has developed in Switzerland. On the supply side, in 2010 CHF 7.26 billion or €5.3 billion) was spent on renewable energy technologies, of which CHF 4.7 billion or €3.4 billion) was spent on goods and services (Nathani et al., 2013). Most of these goods and services (CHF 3.1 billion or €2.2 billion) were provided by the Swiss renewable energy sector and the remainder (CHF 1.1 billion or €0.8 billion) were imported (mainly wind energy installations, solar cells and modules as well as biomass heating and heat pumps). At the same time, Swiss exports were worth CHF 3.2 billion (€2.3 billion) in 2010, mainly consisting of products relevant to the solar PV industry, although PV deployment had only recently started to take off in Switzerland. Altogether, the renewable energy sector was worth CHF 10.4 billion (€7.5 billion) in 2010. The Swiss renewable energy sector's direct contribution to GVA was around CHF 4.8 billion (EUR 3.9 billion), contributing 0.9 % to Swiss GDP (Nathani et al., 2013). Whilst hydropower makes the highest contribution (48 %), solar PV (11 %) and solar thermal (5 %) make a remarkable contribution compared to the low level of deployment of these technologies in Switzerland (see Figure). The indirect contribution to GVA was around CHF 3.2 billion (EUR 2.6 billion), which makes a total contribution of 1.5 % to Swiss GDP ([24]).

Figure 9 Direct contribution per technology to gross value added of renewable energy sector in 2010

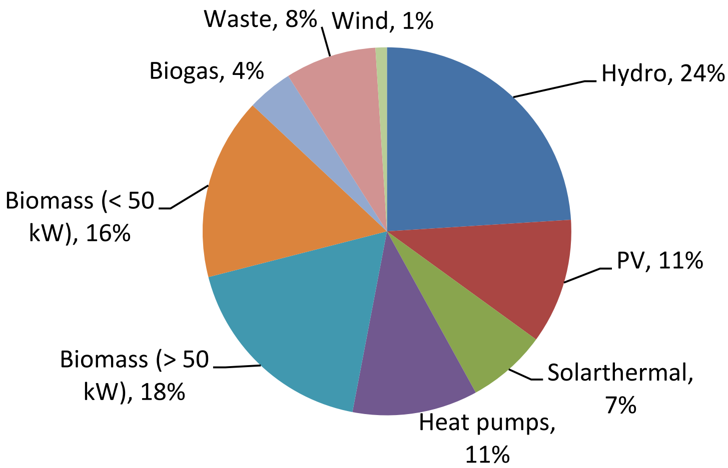


Source: Nathani et al. (2013: 77)

In 2010, 22 800 people were employed in the renewables sector (Nathani et al., 2013). Most employment is related to hydropower and biomass, followed by solar PV and heat pumps (see Figure 8). Indirect employment was 23 390, which brings total sector-specific employment to 46 200 in Switzerland.

Figure 8 Share in total employment in the renewable energy sector per technology in 2010

[24] Nathani et al. (2013) consider as direct contribution all activities related to the construction and operation of a renewable energy power plant, including manufacturers, suppliers and service providers, while indirect contribution includes all indirect effects stimulated in the economy.



Source: Nathani et al. (2013: 77)

1.4 Assessment of innovation processes in the renewable energy sector

1.4.1 Rationale and objectives of innovation policies

According to the Innovation Union Scoreboard (IUS), using a composite of separate innovation indicators, Switzerland continuously outperforms all EU-27 countries, holding the position of overall innovation leader (EC, 2013). Research intensity measured by gross domestic expenditures on R&D (GERD) was nearly 3 % of GDP in 2008 and GERD per capita was 1 365 (in current USD purchasing power parity (PPP)) in 2008 (the only year for which data is available) (OECD, 2012). Switzerland had a considerably higher R&D budget relative to GDP than most European Union (EU) Member States, which had an average R&D expenditure of 2.03 % in 2011 (Eurostat, 2013).

In Switzerland, public R&D in general focuses on basic and long-term research in universities with no particular thematic focus of the R&D budgets, reflecting the bottom-up principle in Swiss research and innovation policy (OECD, 2006). Swiss innovation policies generally target small and medium-sized enterprises (SMEs) and their cooperation with universities, the most important priority being to create favourable conditions for firms. This includes a strong focus on knowledge transfer, but almost no direct policy support measures (ERAWATCH, 2011). In 2012, the Federal Council defined as a priority to 'consolidate the high level of grant funding awarded on a competitive basis and further strengthen Switzerland's internationally competitive position' (ERAWATCH, 2011).

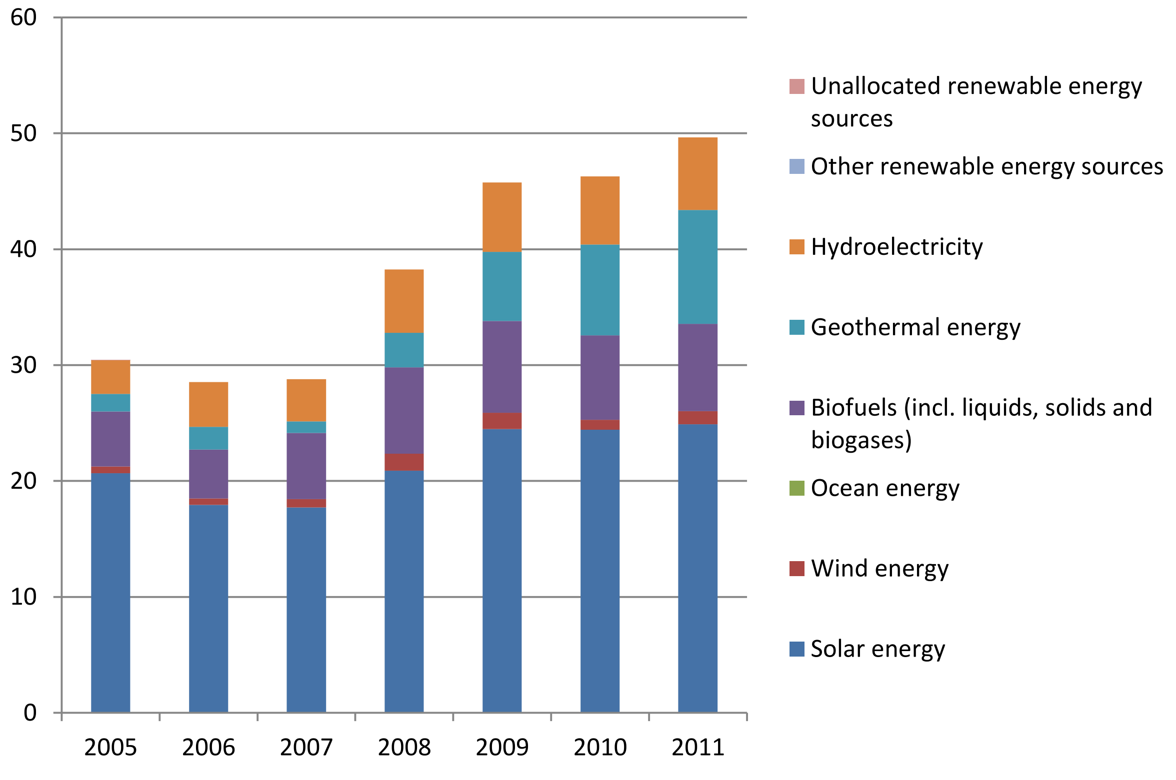
Specific budgets for energy-related research have always been considered an integral part of the Swiss energy policy. This is reflected in tri-annual federal energy research masterplans that outline key priorities for energy research. The latest masterplan published in 2012 for the period 2013–2016 (DETEC, 2012) integrates recent changes to the Swiss energy policy, namely the phase-out of nuclear power, and puts even more emphasis on energy efficiency and renewable energy technologies as well as applied research than the previous masterplan for the period 2008–2011 (BFE, 2007b) (see also Sub-section 1.5.3). This strengthened focus of the specific research budget is expected to also be reflected in the general research budget and hence to increase the contribution of energy-related research, development and demonstration (RD&D) expenditure to reach Swiss energy policy objectives.

1.4.2 Drivers for innovation in the RES sector

In the period 2005–2011, the R&D expenditure for renewable energy technologies increased from around EUR 30 million in 2005 to nearly EUR 50 million in 2011. For each year, the highest share was allocated to solar energy, followed by biofuels until 2011. Funding for geothermal energy experienced a very strong increase from EUR 1.5 million in 2005 to nearly EUR 10 million in 2011 and made it the second most important technology to receive R&D funding in Switzerland (see

Figure 9).

Figure 9 Total R&D budget for renewable energy technologies, 2005–2011 (*million EUR*, 2012 prices and exchange rates)



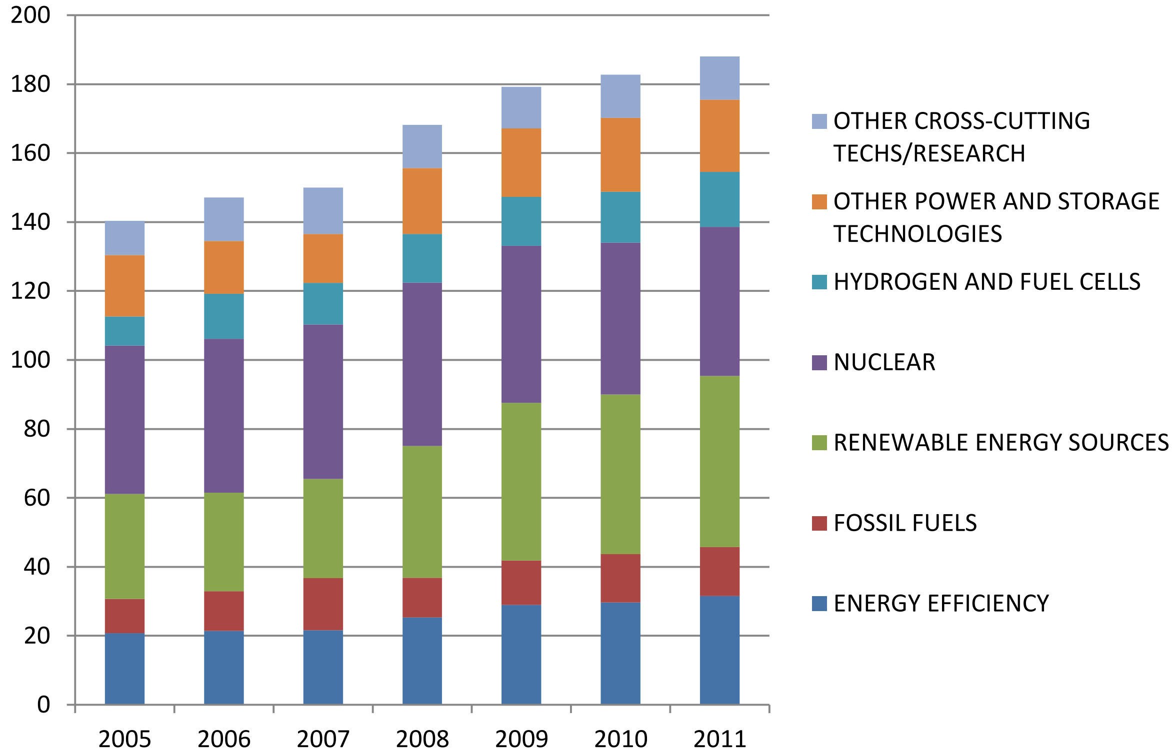
Source: IEA (2013)

To assess the extent to which renewable energy technologies are a particular focus in Swiss energy technology R&D, the budget allocated for these technologies is compared to the R&D budget allocated to other energy areas (see

Figure 10). Nuclear received the highest share of the total budget between 2005 and 2008. Since 2009, RES have the highest share (25 %) although closely followed by nuclear (22 %) and energy efficiency (18 %) (see

Figure 10).

Figure 10 Total energy R&D budget per technology group, 2005–2011 (*million EUR*, 2012 prices and exchange rates)

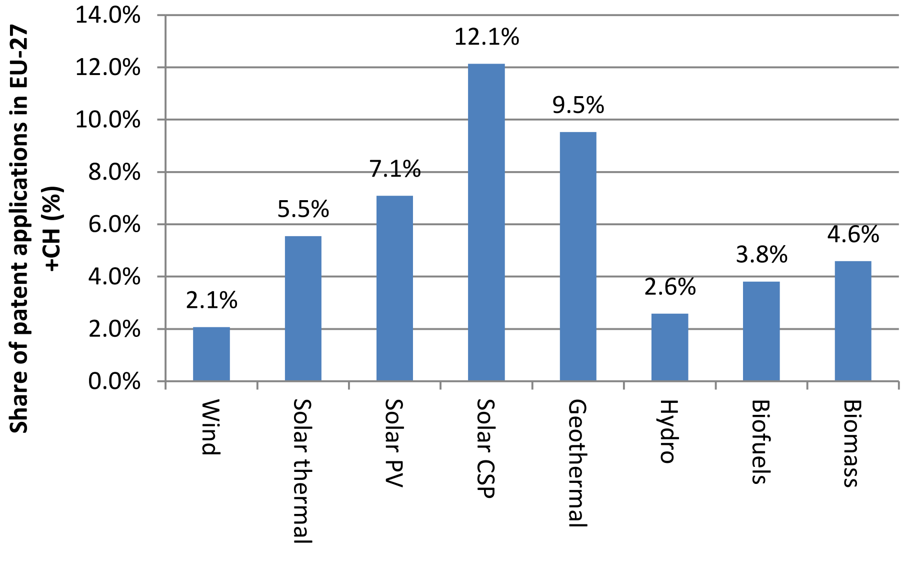


Source: IEA (2013)

Looking at the Swiss share of renewable energy technology patent applications, the share is highest for concentrated solar power (CSP) and geothermal, followed by solar PV (see

Figure 11). Given the low level of deployment for solar technologies in Switzerland, there seems to be no link between domestic deployment and R&D activity. R&D activity in geothermal may be explained by the high geothermal potential in Switzerland.

Figure 11 Share of renewable energy technology patent applications in EU-27 +Switzerland, 2006–2010 (in %) ([25])



Source: OECD patents database

The strong role of the renewable energy sector in the Swiss economy compared to the still relatively small role of 'new' RES (excluding large hydropower) in the energy mix indicates that the domestic deployment of new renewable technologies was not the main driver for innovation in the sector. This is in particular true for solar PV, where Swiss companies exported mainly to other European countries but also to Asia (mainly equipment) (Nathani et

[25] Patent applications filed under the Patent Cooperation Treaty (PCT). 2010 is the latest year for which data were available.

al., 2013). However, the hydropower sector, where Switzerland has a high domestic deployment rate, does play an important role in the Swiss renewable energy sector, which otherwise is strongly export-oriented. The innovation in renewable energy technologies (R&D level) builds on the strong national innovation system and the strength of the relevant industries in terms of their technological capabilities.

On the domestic deployment side, the KEV support scheme certainly constitutes one of the key drivers in Switzerland for new renewable electricity technologies. Although the capacity caps constitute a limitation to market demand, these can also be an important driver for innovation, in particular for technologies that have a strong cost-reduction potential, such as solar PV. As for specific innovation effects, it was argued that the heterogeneity of small hydropower and biomass plants led to new innovative solutions and technological improvements when developing and implementing new projects (Interface, 2012).

The development of a long-term strategy that foresees a strong role for RES (and energy efficiency) for Switzerland also affects investment decisions. According to a survey of 23 Swiss electricity utilities, 78 % have developed an investment strategy for the renewable energy sector and 18 % are developing such a strategy (Windisch et al., 2011). In seven of the larger companies, dedicated subsidiaries were established to develop and implement renewable energy projects. Based on their responses, it is expected that total investments will be CHF 4.66 billion (€3.8 billion) resulting in additional installed capacity of 3 085 MW by 2015 with an annual renewable generation of 6 300 GWh. By 2020, total investments would amount to CHF 6.93 billion (€5.6 billion) and installed capacity of 5 086 MW generating 10 600 GWh.

1.5 Coherence of renewable energy policies with other relevant policies

In this section we discuss the coherence of energy policies with other relevant policies. Coherence is assessed in terms of the degree to which there is an absence of major conflicts between policy areas concerning objectives/targets and the degree to which policies reinforce their effects (i.e. synergies) and minimise negative trade-offs.

A slightly different approach was taken for the consideration of policy objectives in the Swiss case study. Instead of the respective National Reform Programmes (NRPs) submitted in the framework of the European Semester being one of the main elements for comparison, the Swiss case study focuses on policy objectives as presented in federal laws and, where available and like in the other case studies, other policy documents by public authorities.

1.5.1 Energy and renewable energy policy objectives

The Swiss Energy Law (Assemblée fédérale de la Confédération suisse, 2012a: Article 1) states three objectives:

1. To ensure a production and a distribution of energy that is economical and compatible with the imperatives of environmental protection;
2. To promote the economical and rational use of energy;
3. To encourage the use of domestic and renewable energy.

It further specifies a set of principles to be respected by the authorities, energy providers, designers and manufacturers of installations, vehicles and energy-consuming devices, as well as by consumers (Assemblée fédérale de la Confédération suisse, 2012a: Article 3). These principles establish that all energy will be used in the most economical and rational manner possible, and that the use of renewable energy needs to be increased. In relation to the first principle, the Swiss Energy Law further clarifies that the meaning of 'energy use in the most economical and rational manner possible' is consuming the least energy possible, using energy the best possible way, investing the least energy possible to achieve a given result and using residual heat.

The Swiss Energy Efficiency Action Plan (Office fédéral de l'énergie, 2008a: 1) defines three objectives as well:

1. To reduce the consumption of fossil energy by 20 % between 2010 and 2020;
2. To limit the increase in electricity consumption to maximum 5 % between 2010 and 2020 by aiming at a continued reduction of growth rates as of 2015 at the latest;
3. To pursue a 'best practice' strategy for buildings, vehicles, industrial equipment and processes; and measures incentivising investors, buyers and users of these items to consider energy efficiency in their decisions.

The Swiss Renewable Energy Action Plan (Office fédéral de l'énergie, 2008b) includes the objective to increase the renewable energy share in total energy consumption to 24 % by 2020. Moreover, the Swiss CO_2 Law to 2012 (Assemblée fédérale de la Confédération Suisse, 2012b) entered into force in 2000 and foresaw to reduce CO_2 emissions that are due to energy use of fossil fuels. This objective also covered a contribution to reducing other environmental impacts, to an economical and rational use of energy, and to an increased use of renewable energy (ibid.). Since 2013, a new law is in force (Assemblée fédérale de la Confédération suisse, 2013a) aiming at GHG emissions reductions, in particular CO_2 emissions from using fossil fuels, and to contribute to keeping the increase of global average temperature below 2 °C.

Overall, there is no incoherence between the objectives of the Swiss energy and renewable energy policy objectives. The objectives point to support schemes for rational and economic energy use, technologies aiming at the reduction of CO_2 emissions from fossil fuels, the promotion of renewable energy and energy efficiency.

1.5.2 Coherence (renewable) energy and economic policy objectives

According to the Swiss economic growth policy 2012–2015, increasing the growth rate of labour productivity is at the heart of the Swiss economic policy (Conseil fédéral, 2012: 7). The policy defines seven areas of action (Conseil fédéral, 2012: 8 et seqq.) and related objectives:

1. promoting competitiveness on the internal market;
2. promoting external openness of the economy;
3. maintaining labour participation at a high level;
4. promoting education, research and innovation (human capital) is an objective of both education and labour market policies;
5. ensuring 'good health' of public finances;
6. creating a legal framework encouraging entrepreneurial initiative;
7. guaranteeing the perpetuity of resources extracted from the environment is a seventh, new objective.

There is no incoherence between the economic policy objectives as presented in the Swiss economic growth policy 2012–2015 and policy objectives related to energy and renewable energy. The economic policy objectives point towards support schemes that would favour the preservation of natural resources and the fostering of innovation.

1.5.3 Coherence (renewable) energy and innovation policy objectives

The Swiss Law to Promote Research and Innovation defines various principles (Assemblée fédérale de la Confédération suisse, 2013b). Research organisations should keep close links between education and research, and contribute to the sustainable use of natural resources as well as to international cooperation in the areas of science, technology and innovation. Consideration should also be given to a contribution to competitiveness and added value for employment (ibid.).

The Swiss Federal Commission for Energy Research, a federal consultative body on energy research, elaborates specific energy research plans. The energy research plan 2008–2011 refers to the vision of a '2 000 watts society' with the following objectives (Commission fédérale pour la recherche énergétique, 2007: 4):

- reduce energy demand by factor 2.5;
- cap the CO_2 production at 1 tonne CO_2 per person per year;
- further decrease pollutant emissions;
- diminish material fluxes linked to energy production.

R&D is an essential element of the Swiss energy policy, allowing for innovation in the areas of energy efficiency, promoting the use of renewable energy and ultimately reinforcing the competitiveness of the Swiss economy.

The latest energy research plan (Commission fédérale pour la recherche énergétique, 2013), valid for the years 2013–2016, presents a vision according to which Swiss energy research should promote secure energy provision that is economically and ecologically sustainable at national and international levels.

According to the 2013–2016 energy research plan, energy research should be reinforced in line with the energy policy of the Swiss Federal Council in five areas (Commission fédérale pour la recherche énergétique, 2013: 5):

- efficiency technologies;
- energy systems;
- networks (including electricity transmission);
- energy storage;
- electricity supply;
- socio-economic and legal issues.

The Swiss Federal Commission for Energy Research stresses, however, that increased effort in these areas should not be at the expense of areas of action that are not directly linked to the energy policy, such as combustion and issues related to living, working and mobility.

Finally, the Swiss Masterplan Cleantech (Département fédéral de l'économie, de la formation et de la recherche et al., 2011) identifies specific, cleantech-related objectives, including the objective that Switzerland should become a leader in cleantech production by 2020.

There is no incoherence of principles and objectives of Swiss innovation policy and legislation with the objectives of energy and renewable energy policy. The objectives of the

Swiss innovation policy, and in particular of the latest energy research plan, point towards support schemes that would support the broad lines of the Swiss energy policy, such as in the area of energy efficiency and clean technologies.

No potential incoherence of the Swiss energy, renewable energy, economic and innovation policy objectives could be found.

1.6 Conclusions

Renewables, particularly the new technologies (apart from hydropower), are making a slow but stable progress in Switzerland. In 2011, the renewable energy share in final energy consumption was 23.4 %, the share of renewable electricity in total gross electricity consumption was around 60 %, and the share of renewable heat in final heat demand was 18.5 %. The specific design of the Swiss FIT for renewables, namely that the payments are financed through a levy on the transmission costs that is capped, means that there is a limited amount of funds available each year for the deployment of renewable energy. This leads on the one hand to a stop-and-go approach but, on the other hand, it helps keep in check the costs of various technologies that have still significant potential for cost reduction.

In 2011, 61 % of total support allocated to the energy sector was spent on conventional sources and 39 % on RES. Conventional sources benefit mainly from tax exemptions, therefore having a direct impact on public budgets as forgone revenue ([26]). Renewable electricity, on the other hand, receives mainly direct transfers in the form of FIT payments (except for large hydropower) financed by final electricity consumers.

Unlike other European countries reviewed, regular policy evaluations are required under Swiss law and constitute an important opportunity to adapt the policy framework over time to ensure its effectiveness and efficiency.

Because of the specific design of the Swiss renewable policy (2030 perspective, lack of technology-specific targets), it was not possible to assess the policy effectiveness and policy efficiency in the same manner as for the other EU member countries reviewed. Therefore, there is no direct comparison between Switzerland and the other three countries reviewed under this project (the Czech Republic the Netherlands and Spain).

The Swiss renewable policy effectiveness was affected by the introduction in 2008 of the new FIT scheme (KEV) and after initial fluctuations between 3 and 0 %, reflecting the stop-and-go approach of the funding scheme, the PII jumped to 17 % in 2011, far above the 4 % threshold necessary for the policy for 2030 to be met. However, it is not clear whether this recent development will be sustained over time.

In terms of policy efficiency, the TCI remains rather low for all technologies, meaning that a relatively low level of deployment took place but it did come at a relatively low cost.

Despite new RES still having a small share in the overall electricity mix in Switzerland, the sector contributed 1.5 % to Swiss GDP in 2010. Innovation in the renewable energy sector built on the overall strengths of the Swiss R&D framework and benefited from the strong market demand in Asia and other European markets. Before the rather recent growth in PV deployment in Switzerland, the Swiss renewable energy sector had developed important business in PV building on the strengths of existing industries. The strong performance of the Swiss renewable energy sector also seems to be related to a relatively high R&D budget. Switzerland spent almost 3 % of its GDP on R&D for renewable technologies in 2008.

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[26] However, there are efficiency targets for big companies according to cantonal energy acts. For further information, see http://www.endk.ch/media/archive1/fachleute/vollzugshilfen/VoHi_EN15_de.pdf online.

Swiss renewable energy policy is currently at a crossroads, facing the need to cater for a much stronger domestic deployment of RES technologies, pushed by long-term targets for 2030 and, more recently, a long-term strategy until 2050. Besides energy efficiency, RES will have to play a key role in filling the gap of nuclear power. This constitutes an important driver for the renewable energy sector but requires a more effective policy framework resulting in higher deployment rates.

For the period under consideration, there was no incoherence among policy objectives of the Swiss energy, renewable energy, economic and innovation policies. The elements identified in official documents considered point towards energy support schemes that would promote rational and economic energy use, technologies contributing to the reduction of CO_2 emissions from fossil fuels, clean technologies, renewable energy, energy efficiency and innovation.

References

Assemblée fédérale de la Confédération suisse, 2012a, *Loi sur l'énergie (LEne) du 26 juin 1998 (Etat le 1er juillet 2012)* (http://www.admin.ch/opc/fr/classified-compilation/19983485/index.html) accessed 19 July 2013.

Assemblée fédérale de la Confédération suisse, 2012b, *Loi fédérale sur la réduction des émissions de CO2 (Loi sur le CO2) du 8 octobre 1999 (Etat le 1er mai 2012)* (http://www.bafu.admin.ch/klima/00493/00494/index.html?lang=fr&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1ae2IZn4Z2qZpnO2Yuq2Z6gpJCGfYF,fWym162epYbg2c_JjKbNoKSn6A) accessed 22 July 2013.

Assemblée fédérale de la Confédération suisse, 2013a, *Loi fédérale sur la réduction des émissions de CO2 […] (Loi sur le CO2) du 23 décembre 2011 (Etat le 1er janvier 2013)* (http://www.admin.ch/opc/fr/classified-compilation/20091310/201301010000/641.71.pdf) accessed 22 July 2013.

Assemblée fédérale de la Confédération suisse, 2013b, *Loi sur l'encouragement de la recherche et de l'innovation (LERI) du 7 octobre 1983 (Etat le 1er janvier 2013)* (http://www.admin.ch/opc/fr/classified-compilation/19830263/index.html) accessed 19 July 2013.

BFE, 2007a, *Faktenblatt Mehrkostenfinanzierung 2005/2006*, Bundesamt für Energie (BFE) (http://www.news.admin.ch/NSBSubscriber/message/attachments/10036.pdf) accessed 10 July, 2013.

BFE, 2007b, *Konzept der Energieforschung des Bundes 2008 bis 2011*, Bundesamt für Energie (BFE).

BFE, 2009, *Stabilisierungsprogramm 2: Riesenerfolg für Energieförderprogramme*, Bundesamt für Energie (BFE) (http://www.bfe.admin.ch/energie/00588/00589/00644/index.html?lang=de&msg-id=27864) accessed 29 July, 2013.

BFE, 2010, *Evaluation des Gebäudeprogramms der Stiftung Klimarappen*, Bundesamt für Energie (BFE) (http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_696447409.pdf&endung=evaluation%20des%20geb%e4udeprogramms%20der%20stiftung%20klimarappen) accessed 17 July 2013.

BFE, 2011a, *Bundesrat beschliesst im Rahmen der neuen Energiestrategie schrittweisen Ausstieg aus der Kernenergie*, Bundesamt für Energie (BFE) (http://www.bfe.admin.ch/energie/00588/00589/00644/index.html?lang=de&msg-id=39337) accessed 25 July, 2013

BFE, 2011b, *Schlussevaluation EnergieSchweiz 2001-2010*, Bundesamt für Energie (BFE) (http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_641262605.pdf&endung=Schlussevaluation%20EnergieSchweiz%202001-2010) accessed 24 July, 2013

BFE, 2012, *Schweizerische Statistik der erneuerbaren Energien*, Bundesamt für Energie (BFE), Ausgabe.

BFE, 2013b, *Electricity consumption up 0.6% in 2012*, Bundesamt für Energie (BFE) (http://www.bfe.admin.ch/energie/00588/00589/00644/index.html?lang=en&msg-id=48529) accessed 30 July, 2013.

BFE, 2013c, *Bundesrat befürwortet Ausbau der erneuerbaren Stromproduktion und Entlastung der stromintensiven Unternehmen*, Bundesamt für Energie (BFE) (http://www.bfe.admin.ch/energie/00588/00589/00644/index.html?lang=de&msg-id=47948) accessed 30 July, 2013.

Commission fédérale pour la recherche énergétique, 2007, *Plan directeur de la recherche énergétique de la Confédération pour les années 2008 à 2011*, Office fédéral de l'énergie (OFEN) (http://www.bfe.admin.ch/php/modules/enet/streamfile.php?file=000000009543_01.pdf&name=000000270099) accessed 13 July 2013.

Commission fédérale pour la recherche énergétique, 2013, *Plan directeur de la recherche énergétique de la Confédération 2013–2016*, Commission fédérale de la recherche énergétique (CORE) (http://www.bfe.admin.ch/php/modules/enet/streamfile.php?file=000000010938_01.pdf&name=000000290705) accessed 13 July 2013.

Conseil fédéral, 2012, *Politique de croissance 2012-2015* (http://www.news.admin.ch/NSBSubscriber/message/attachments/27193.pdf) accessed 23 July 2013.

Département fédéral de l'économie, de la formation et de la recherche et al., 2011, *Masterplan Cleantech – Une stratégie de la Confédération en matière d'efficacité des ressources et d'énergies renouvelables*, Office fédéral de la formation professionnelle et de la technologie (OFFT). (http://www.cleantech.admin.ch/cleantech/index.html?lang=fr&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1ae2IZn4Z2qZpnO2Yuq2Z6gpJCDdIJ9fGym162epYbg2c_JjKbNoKSn6A) accessed 23 July 2013.

DETEC, 2012, *Federal Energy Research Masterplan 2013–2016*, Federal Department of the Environment, Transport, Energy and Communications (DETEC), Federal Energy Research Commission (CORE).

EC, 2013, *Innovation Union Scoreboard 2013*, European Commission (EC) (http://ec.europa.eu/enterprise/policies/innovation/files/ius-2013_en.pdf) accessed 14 June, 2013.

EEA, 2013, ENER 28, based on data extracted from Eurostat on 28 February 2013.

ERAWATCH, 2011, *Erawatch Country Reports 2011: Switzerland*, European Commission Joint Research Centre (http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/reports/countries/ch/report_0006) accessed 10 July, 2013. .

Eurostat, 2013, *Europe 2020 indicators*, Eurostat, European Commission (http://epp.eurostat.ec.europa.eu/portal/page/portal/europe_2020_indicators/headline_indicators) accessed 30 July, 2013.

GSI, 2008, Biofuels – At what cost? *Government support for ethanol and biodiesel in Switzerland: 2008 Update*, Global Subsidies Initiative (GSI). (http://www.iisd.org/gsi/sites/default/files/switzerland2008update.pdf) accessed 29 July, 2013.

IEA, 2013, *R&D Budget*, International Energy Agency Energy Technology R&D Statistics (database) (accessed 18 July 2013). doi: 10.1787/data-00488-en

Interface, 2012, *Evaluation der kostendeckenden Einspeisevergütung (KEV)*, Interface Politikstudien Forschung Beratung, Ernst Basler + Partner AG, Université de Genève, report prepared for Bundesamt für Energie (BFE), July (http://www.bfe.admin.ch/themen/00526/00541/index.html?lang=de&dossier_id=05417) accessed 10 July 2013.

KEV, 2010, *Geschäftsbericht 2009*, SwissGrid, Frick, Switzerland. .

KEV, 2011, *Geschäftsbericht 2010*, SwissGrid, Frick, Switzerland..

KEV, 2012, *Geschäftsbericht 2011*, SwissGrid, Frick, Switzerland..

Nathani, C., et al., 2013, *Volkswirtschaftliche Bedeutung erneuerbarer Energien in der Schweiz*, final report for Bundesamt für Energie (BFE).

OECD, 2006, *OECD Reviews of Innovation Policy: Switzerland*, November (http://www.oecd.org/switzerland/oecdreviewsofinnovationpolicyswitzerland.htm) accessed 10 July 2013.

OECD, 2012, *Science, Technology and Industry Outlook 2012*, Organisation for Economic Co-operation and Development, Paris. (http://www.oecd.org/sti/oecdsciencetechnologyandindustryoutlook.htm) accessed 11 July 2013.

OECD: Inventory of estimated budgetary support and tax expenditures for fossil fuels – 2012.

Office fédéral de l’énergie, 2008a. Aktionsplan "Energieeffizienz", "Best-practice-Strategie", Faktenblatt 5, http://www.bfe.admin.ch/themen/00526/02577/index.html?lang=en&dossier_id=02578. Accessed 24 July, 2013.

Office fédéral de l’énergie, 2008b. Aktionsplan "Erneuerbare Energien“. Faktenblatt 6, http://www.bfe.admin.ch/themen/00526/02577/index.html?lang=en&dossier_id=02579. Accessed 24 July 2013.

Stiftung Klimarappen, 2012, *Kennzahlen der Stiftung Klimarappen*, Stiftung Klimarappen, Climate Cent Foundation (http://klimarappen.ch/fileadmin/Downloads/Medienmitteilungen/Kennzahlen_SKR_DE.pdf) accessed July 25, 2013.

Vatter, A., et al., 2011, *Schlussevaluation EnergieSchweiz 2001-2010*, final report for Bundesamt für Energie (BFE).

Windisch, R., Friederich, E., Wanner, A. and Wüstenhagen, R., 2011, *9,7 Milliarden Franken für Strom aus erneuerbaren Quellen: Analyse der Investitionsstrategien Schweizer Energieversorger bei der regenerativen Stromproduktion*, Schweizer Stromkongress, Electrosuisse Bulletin (12s/2011) 20–23.

Annex I Inventory of energy, renewable energy, economic and innovation policy objectives

<table>
<tr><th>Thematic area</th><th>Policy objective</th><th>Coherence between policy objectives</th><th>Source</th></tr>
<tr><td colspan="4">'internal' coherence between different energy policy objectives</td></tr>
<tr><td rowspan="8">Energy</td><td>- to ensure a production and a distribution of energy that is economical and compatible with the imperatives of environmental protection;</td><td>+</td><td rowspan="3">Assemblée fédérale de la Confédération suisse, 2012a</td></tr>
<tr><td>- to promote the economical and rational use of energy;</td><td>+</td></tr>
<tr><td>- all energy shall be used in the most economical and rational manner possible, i.e. consuming the least energy possible, using energy the best possible way, investing the least energy possible to achieve a given result and using residual heat;</td><td>+</td></tr>
<tr><td>- to reduce the consumption of fossil energy by 20 % between 2010 and 2020;</td><td>+</td><td rowspan="3">Office fédéral de l'énergie, 2008a</td></tr>
<tr><td>- to limit the increase in electricity consumption to maximum 5 % between 2010 and 2020 by aiming at a continued reduction of growth rates as of 2015 at the latest;</td><td>+</td></tr>
<tr><td>- to pursue a 'best practice' strategy for buildings, vehicles, industrial equipment and processes; and measures incentivising investors, buyers and users of these items to consider energy efficiency in their decisions;</td><td>+</td></tr>
<tr><td>- to reduce CO_2 emissions that are due to energy use of fossil fuels;</td><td>+</td><td>Assemblée fédérale de la Confédération suisse, 2012b</td></tr>
<tr><td>- greenhouse gas emissions reductions, in particular CO_2 emissions from using fossil fuels, and to contribute to keeping the increase of global temperature below 2 °C.</td><td>+</td><td>Assemblée fédérale de la Confédération suisse, 2013a</td></tr>
<tr><td colspan="4">coherence with energy policy objectives</td></tr>
</table>

Renewable Energy	- the use of renewable energy needs to be increased;	+	Assemblée fédérale de la Confédération suisse, 2012a
	- to encourage the use of domestic and renewable energy;	O/+	
	- to increase the renewable energy share in total energy consumption to 24 % by 2020;	([27])	Office fédéral de l'énergie, 2008b
	- contribution to reducing other environmental impacts, to an economical and rational use of energy, and to an increased use of renewable energy.	+	Assemblée fédérale de la Confédération suisse, 2012b
coherence with energy and renewable energy policy objectives			
Economic policy	- increasing the growth rate of labour productivity;	O	Conseil fédéral, 2012
	- the aim of competitiveness policy is promoting competitiveness on the internal market;	O	
	- the aim of external economic policy is the external openness of the economy;	O	
	- the aim of labour market policy is to maintain labour participation at a high level;	O	
	- promoting education, research and innovation (human capital) is an objective of both education and labour market policies;	+	
	- the objective of finance policy is to ensure good health of public finances;	O	
	- legislative activities should focus on creating a legal framework encouraging entrepreneurial initiative;	O	
	- guaranteeing the perpetuity of resources extracted from the environment.	+	
coherence with energy and renewable energy policy objectives			
Innovation	- scientific quality of research;	O	Assemblée fédérale de la Confédération suisse, 2013b
	- close links between education and research;	O	
	- a contribution to the sustainable use of natural resources;	+	
	- international cooperation in the areas of science, technology and innovation;	O	

[27] Objective not assessed as a more detailed study of ambition level would be necessary.

	- contribution to competitiveness;	O	
	- added value for employment;	O	
	- a ‘2000 watts society’ with the following objectives: • reduce energy demand by factor 2.5; • reduce energy demand by factor 2.5; • cap the CO_2 production at 1 tonne CO_2 per person per year; • further decrease pollutant emissions; • diminish material fluxes linked to energy production.	+	Commission fédérale pour la recherche énergétique, 2007
	- innovation in the areas of energy efficiency and promoting the use of renewable energy and ultimately reinforcing the competitiveness of the Swiss economy;	+	
	- Swiss energy research should promote secure energy provision that is economically and ecologically sustainable at national and international levels;	+	Commission fédérale pour la recherche énergétique, 2013
	- it should support effective energy policy;	+	
	- energy research should be reinforced in line with the energy policy of the Swiss Federal Council in five areas (Commission fédérale pour la recherche énergétique, 2013: 5): • efficiency technologies; • energy systems; • networks (including electricity transmission); • energy storage; • electricity supply; • socio-economic and legal issues.	+	
	- Switzerland should become a leader in cleantech production by 2020;	+	Département fédéral de l’économie, de la formation et de la recherche et al., 2011
	- maintain efforts in areas of action that are not directly linked to the energy policy, such as combustion and key issues related to living, working and	O	Commission fédérale pour la recherche

	mobility.		énergétique, 2013