Production of renewable energy

Minimising environmental pollution and conserving resources are important aspects of the environmental and energy management of the institutions. Where possible, this also involves utilising waste heat from the infrastructural installations, some of which are very complex, as well as the production of solar energy and cooling and heat output with the aid of water pumps.

Based on the 2050 Energy Strategy, the Federal Council tasked the Swiss Federal Office of Energy (SFOE) on 30 November 2011 with setting up "The Confederation – Exemplary in Energy" (VBE) office and taking on the operational management of the office. The VBE Coordination Group (KG-VBE) was created for the overall control and coordination of "The Confederation – Exemplary in Energy" (VBE) office. It comprises the civil Federal Administration, the ETH Domain, as well as organisations with close links to the Federal Government, namely the Swiss Post, Swiss Federal Railways, Skyguide and Swisscom. In connection with the use of renewable energy in buildings, the Federal Government invited the key players from the VBE to compile individual potential analyses on the use of renewable energy in August 2014. The overall analysis set out to demonstrate the extent to which the Federal Government and the institutions and companies which are closely affiliated to the Confederation managed to utilise waste heat and produce renewable energy (solar, wind and hydro energy, geothermal, wood, district heat and the thermal utilisation of waste) on its sites and in its buildings, and what the associated costs would be. The analysis was presented to the Federal Council at the end of 2016.

The ETH Domain completed its own potential analysis of this in spring 2016. The use of waste heat and ambient heat for heating and cooling purposes in particular, as well as the production of solar energy have already proved to make substantial contributions towards the in-house production of energy in the ETH Domain. The potential of the additional, cost-efficient production of renewable energy on installations and sites in the ETH Domain amounts to almost 3,000 MWh of solar energy and around 64,500 MWh of heat and cooling output per annum. Some of these projects are already at the implementation stage.

The largest energy generators in the ETH Domain include the anergie network for cooling and heat output on the Hönggerberg campus of ETH Zurich, which has current annual production of 1,935 MWh (heat) and an expansion potential of a further 20,000 MWh/a (heat). A project is being undertaken on a similar scale for a gradual replacement of the central cooling plant at the ETH Zurich Centre Campus involving the use of lake water for cooling, with an estimated power rating of 19,700 MWh per annum (ETH Zurich's share). However, the completion of this project remains open-ended, depending on the further development of the Zurich Central University Area. Lake water is also used to cool the mainframe computer system of the CSCS in Lugano with an annual energy output of the cooling system of around 23,385 MWh.

The roofs of the Ecublens Campus of the EPFL are the site of one of Switzerland's largest solar energy installations, operated by Romande Energie. The plant delivered around 2 MWh of solar energy in 2015. Once it is completed, it is expected to produce around 2.2 MWh per annum. Up to now, the EPFL's central heating and cooling plant for the Ecublens Campus has been operated in hybrid mode with a mixture of heating oil (12%) and lake water cooling (88%). The building project approved in December 2016, as part of the 2017 building programme, for the construction of a new central heating and cooling plant for EPFL envisages that 100% of future energy demand will be met using the environmental heating and cooling effect of Lake Geneva.

In order to increase the energy efficiency of the major research plants of the PSI, the waste heat emitted from those plants will increasingly be utilised for heating purposes on the site. The long-term demand for heat is estimated to be approximately 12 GWh per annum, 75% of which is to be covered by waste heat by 2020. The SwissFEL will make an important contribution towards this. AEW Energie AG started up a second photovoltaic system on the roof surfaces of the PSI in 2016. This puts the total nominal power capacity installed in the plants at 173 kWp.

The WSL has been producing energy from photovoltaic cells on the Weissfluhjoch for over 10 years. Together with further systems in Davos Village and in Birmensdorf, there will soon be around 130,000 kWh of photovoltaic energy being produced every year. Through the consistent replacement of fossil-based heating systems, the WSL also anticipates that it will be able to meet about 97% of its heating energy requirements CO_2-free in 2019.

When the Empa building was newly erected in St Gallen back in 1996, a photovoltaic system was integrated into the facade. In 2016, the energy yield was tripled to around 90 MWh per annum by expanding the plant with frameless photovoltaic panels on the flat roofs. Together with Eawag, Empa is creating a new central heating plant for the Dübendorf Campus. When it is completed, the plant is expected to deliver around 3,100 MWh of heating and cooling power from environmental energy every year. As a small but symbolic contribution towards its own production, Eawag acquired outdoor tables for the Dübendorf and Kastanienbaum campuses in 2016, where the surfaces produce photovoltaic electricity which can be used directly in Eawag's own in-house grid.

Environment and energy in the ETH Domain

The ETH Domain provides detailed accounts of its activities in the areas of the Environment and Energy in two publications by the Federal Government: in the annual report entitled "The Confederation: Exemplary in Energy" published by the Swiss Federal Office of Energy (SFOE)[1] and in the biannual[2] report entitled "Resources and Environmental Management of the Swiss Federal Administration" (RUMBA) published by the Swiss Federal Department of the Environment, Transport, Energy and Communications (DETEC). The implementation of measures within "The Confederation – Exemplary in Energy" project is due to run until 2020 and is on course. The institutions are responsible for the operations-led environmental and energy management in the ETH Domain.

ETH Zurich was involved in the implementation of numerous environmental measures in 2016. In addition to focusing on the theme of mobility and on establishing a mobility platform for the coordination of all projects – e.g. by reducing CO_2 emissions in business journeys or in terms of campus mobility and logistics – the primary focus of attention was on energy recovery and efficiency. One example is the preparation of a feasibility study on the use of water from Lake Zurich to supply heating and cooling power to the Zurich Central University Area – not just for ETH, but also for the benefit of the University Hospital and of the University of Zurich. The results of the feasibility study have been available since the end of 2016.

Once the operations improvement expert had started his work in 2015, one of the focuses of attention in 2016 became the implementation of the new operations improvement concept. This contributed to enabling ETH Zurich to meet the targets agreed with the Energy Agency of the Swiss Private Sector (EnAW) once again.

For the first time in Switzerland, the Swiss Society for Sustainable Real-Estate Management (SGNI) standard for the refurbishment of existing laboratories will be applied to the complete refurbishment of the HIF building on Hönggerberg. The preliminary project ran at the end of 2016.

www.umwelt.ethz.ch

As part of the mobility plan at EPFL, a mobility fund has been set up to promote measures for "soft" mobility and for public transport, coupled with a sharp rise in parking charges. Two Act for Change competitions were organised in 2016; one in spring for all students and one in autumn for new undergraduates. Almost 1,000 young people took part in this competition, which was intended to promote sustainability on the campus. It is cooled with water from Lake Geneva. Several projects which were implemented in 2016 sought to reduce water consumption while maintaining the same output. As an example, the control valves for the primary water flow were replaced by a secondary peak flow in four large buildings (INR, ELD, ELE and DIA), with the flow rate reduced from 18 to 9 litres per second. And finally, technical improvements were made to the SwissTech Convention Center and to the SG Building, leading to energy savings of 30% to 40%.

exploitation-energies.epfl.ch/developpement-durable.epfl.ch

As an energy research institution and a major consumer, the PSI attaches special importance to promoting the efficient use of energy. Where possible, efficiency measures are implemented during construction or within the scope of the refurbishment of plants. The PSI was successful in its bid for funding through the SFOE's ProKilowatt programme in 2016 for the planned upgrade to the interior lighting for the SLS, which had been in operation around the clock for 17 years. Replacing the gas-discharge lamps with efficient LED lighting strips (total length of approximately 2.5 km) and their time and light-dependent control will enable existing energy consumption to be halved. The consistent implementation of operational improvements, such as the move implemented in 2016 to switch off magnets on the accelerator systems during short operational breaks, will lead to clearly quantifiable savings in energy consumption without placing any restrictions on users.

www.psi.ch/about/psi-energy-concept

www.psi.ch/about/psi-environmental-concept

The WSL refurbished two 1950s-era buildings in Birmensdorf to comply with the Minergie-P-Eco standard. In terms of plumbing, the very latest spray taps, which are particularly water-efficient, have been installed. Both buildings are now covered with solar roofs. The 600 m² or so of solar panels will produce about 100,000 kWh of renewable electricity every year. This will enable the building to even outperform the Minergie-P-Eco standard: they are the first in the canton of Zurich to be awarded the "Minergie-P-A-Eco" standard. The WSL Environmental Group has been newly set up and expanded upon the instructions of the directorate.

www.wsl.ch/umweltmanagement

Two important beacon projects at Empa were demonstrated to the general public in the form of the NEST research platform and the 'move' multifunctional filling station. The planning for the expansion of the mid-temperature network on the site has been completed. Energy efficiency can be increased through the construction of heat ring lines and a geothermal energy store (commencement of construction in 2017 and 2018). The construction of a combined heat pump/cooling machine at the St Gallen Campus led to a clear saving in energy and to a reduction in power peaks. The environmental management system has been optimised through an updated environmental, energy and mobility concept, as well as with a new Environmental Committee.

www.empa.ch/web/resources-environment

Eawag will now be free to choose its energy supplier at its Kastanienbaum site in Lucerne. After inviting tenders, it opted for 100% hydropower from the Elektrizitätswerke Obwalden utility company. It will also continue to buy certificates for naturemade star ecopower for this share of its energy requirements; this is a label that is based on research conducted at Eawag in the preservation of aquatic habitats. Eawag commissioned ewz to carry out an energy consumption analysis for its site in Dübendorf in 2016. One of the pavilions on the Eawag site which performs poorly in energy efficiency is to be replaced by an energy-saving building (construction work commences in 2018).

www.umwelt.eawag.ch

[1] Published in July 2016 by the Swiss Federal Office of Energy (SFOE).
[2] The next RUMBA report is due to appear in September 2017.

Fig. 34: Environment and energy data

		ETH Domain 2014	ETH Domain 2015	ETH Zurich Total	EPFL Total	PSI Total	WSL Total	Empa Total	Eawag Total	ETH Domain Trend 2016[1]
Basic data										
Energy reference area (ERA)[2]	m^2	1,416,238	1,434,194	679,599	429,223	146,486	28,965	121,821	28,100	1,471,509
Full-time equivalent[3]	FTE	33,030	34,827	19,774	10,813	2,015	632	966	627	35,310
Energy[4]										
Final energy, net[7]	**kWh/a**	**424,363,562**	**436,876,537**	**176,929,147**	**96,474,394**	**136,958,127**	**5,083,482**	**16,845,242**	**4,559,145**	**430,943,167**
Electricity, net (not incl. self-produced)	**kWh/a**	**360,356,537**	**365,894,796**	**138,043,690**	**79,964,917**	**130,392,447**	**3,121,610**	**11,055,265**	**3,316,867**	**360,766,157**
Consumption of uncertified electricity	kWh/a	73,477,017	56,008,759	16,763,000	0	29,698,573	64,519	10,069,740	0	–
Consumption of certified electricity	kWh/a	292,683,761	317,551,399	121,280,690	85,213,264	100,693,874	3,057,091	3,402,540	3,316,867	–
– Electricity (without naturemade star)	kWh/a	278,775,510	303,244,322	117,280,690	78,328,774	100,693,874	2,951,371	3,402,540	0	–
– Photovoltaic naturemade star	kWh/a	2,159,919	2,135,781	0	2,000,000	0	52,860	0	82,921	–
– Hydro power naturemade star	kWh/a	11,693,332	12,171,296	4,000,000	4,884,490	0	52,860	0	3,233,946	–
– Wind naturemade star	kWh/a	55,000	0	0	0	0	0	0	0	–
Sale of electricity	kWh/a	–5,804,241	–7,665,362	0	–5,248,347	0	0	–2,417,015	0	–
Heat	**kWh/a**	**60,903,802**	**68,494,879**	**37,995,000**	**16,135,387**	**6,266,680**	**1,448,575**	**5,545,496**	**1,103,741**	**–**
Fuel oil	kWh/a	2,268,480	3,468,116	2,000	2,866,800	350,960	248,238	0	118	–
Natural gas	kWh/a	53,021,591	57,795,344	38,477,000	13,107,225	0	0	6,194,707	16,412	–
Natural gas BHKW	kWh/a	0	0	0	0	0	0	0	0	–
District heating	kWh/a	28,796,711	31,108,657	23,256,000	411,726	5,915,720	0	438,000	1,087,211	–
Woodchip	kWh/a	1,162,248	1,520,337	320,000	0	0	1,200,337	0	0	–
Sale of heat	kWh/a	–24,345,228	–25,397,575	–24,060,000	–250,364	0	0	–1,087,211	0	–
										–
Fuels (own vehicles)	**kWh/a**	**2,941,223**	**2,486,862**	**890,457**	**374,090**	**326,000**	**513,297**	**244,481**	**138,537**	**–**
Energy: additional information										
Energy costs, electricity and heat[5]	CHF/a	45,620,448	50,046,943	25,649,844	9,050,972	12,507,406	573,911	1,698,688	566,122	49,002,062
Self-generated renewable electricity	kWh/a	450,788	520,813	217,100	0	102,550	28,000	29,159	144,004	–
Total sale to third parties	kWh/a	–30,149,469	–33,062,937	–24,060,000	–5,498,711	0	0	–3,504,226	0	–
Water (drinking water)	**m^3**	**618,123**	**630,749**	**335,697**	**171,616**	**88,466**	**8,613**	**21,210**	**5,147**	**647,254**
Materials										
Paper	**kg**	**393,591**	**341,961**	**173,000**	**103,652**	**35,541**	**10,619**	**11,753**	**7,396**	411,591
Paper, new fibre	kg	213,173	120,462	87,150	18,642	10,992	3,498	0	180	173,722
Paper, recycled	kg	180,418	221,499	85,850	85,010	24,549	7,121	11,753	7,216	237,870
Key figures: environmental impact[8]										
Primary energy[6]	**kWh/a**	**765,075,488**	**625,358,315**	**233,673,708**	**117,700,819**	**216,682,452**	**11,422,118**	**39,909,299**	**5,969,918**	**–**
Proportion of renewable energies	**%**	**31.5**	**62.8**	**52.5**	**67.5**	**80.3**	**24.2**	**12.3**	**66.2**	**–**
CO_2 emissions	**t CO_2/a**	**57,115**	**36,820**	**16,394**	**7,158**	**8,144**	**733**	**3,933**	**458**	**–**

[1] Provisional figures for the year under review (trend) as at the beginning of March 2016.
[2] The energy reference area is the sum of all gross floor areas, above and below ground, which must be heated or air-conditioned in order to be used.
[3] The FTE (full-time equivalent) value listed here was supplemented by the number of students with an FTE value of 0.68 to produce the consumption per person.
[4] The key indicator "energy consumption" shows the total consumption of heat and electricity for buildings as well as for teaching and research activities.
[5] The key indicator "energy costs" shows all expenditure (cash out) for the provision of energy (heat and electricity).
[6] In energy economics one refers to primary energy as the energy that is available using the originally occurring forms or resources of energy, such as fuel (e.g. coal or natural gas), as well as energy carriers such as sun, wind or nuclear fuels.
[7] Final energy is the portion of the primary energy that is left after losses due to energy conversion and transmission, after it is supplied via the consumer's domestic connection. The final energy essentially corresponds to the energy that is purchased.
[8] In 2015 the environmental factors for purchased, certified electricity from hydropower Switzerland were corrected, which contributed to a clear improvement in the key figures. The 2014 figures have been taken over from the Annual Report 2015 unchanged. The corrected figures for 2014 are: primary energy 627,985,232 kWh/a, renewable 50.6% and CO_2 36,753 t/a.