# SWITZERLAND

**Stefan Oberholzer**

Swiss Federal Office of Energy

## SWISS ENERGY FRAMEWORK

**Energy policies of the federal government and the local regions (cantons) are based on regularly updated energy perspectives for Switzerland as well as on strategies and implementation programmes at federal, cantonals and municipal levels. Efforts of finding paths towards a** sustainable future energy supply are driven by the so called **"2,000-watt society", a vision in which each person would cut their over-all rate of energy use to an average maximum of 2,000 by the middle of the century without lowering their standard of living.**

**Due to the geographical location in the** core of the Alps, **Switzerland's most important source of renewable energy is hydropower. Other renewables including solar, biomass, wind, geothermal, and ambient heat also play an increasingly important role in today's Swiss energy mix. The long-term potentials of domestic renewable energy indicate that, for all forms, the prospects for electricity and heat are very sound. With the introduction of remuneration at cost for input into the grid in 2009, one of the goals of Switzerland's energy policy is to increase the proportion of electricity produced from renewable energy by 5,400 GWh, or 10% of the country's present-day electricity consumption, by 2030. Today, 56% of Switzerland's overall electricity production comes from renewable sources, with hydropower as by far the biggest contributor.**

**Since 2001, the programme "Swiss Energy" aims at promoting energy efficiency and the use of renewable energy. Its main strength lies in close co-operation between the federal government, the cantons and municipalities, and numerous partners from trade and industry, environmental and consumer organisations, and public and private agencies.**

**The energy research carried out in the public sector is based on the energy research concept of the federal government, which is updated every four years by the Swiss Federal Energy Research Commission (CORE). The Swiss Federal Office of Energy (SFOE) is responsible for the implementation of this concept and coordinates various national research and demonstration activities in collaboration with other public and private funding institutions. The overall public funding for energy related research amounts to $147 Million. In order to fulfill its coordinative task, the SFOE runs 24 research programmes for different technologies in the field of renewable energies.**

## VITAL STATISTICS

Sweden is a member of the EU but not EMU.

### Population

7'870'100 (2010)

### Territory

41'285 km2

### Capital

Bern

### GDP/capita

CHF 69'887 (2010)

($ 74'395)

### Average Annual GDP Growth 1.9 % (1997-2007)

### *Primary Energy Structure*

### Production

*235'040 Terajoule (2008)*

| | |
|---|---|
| *Wood:* | *15 %* |
| *Waste:* | *22 %* |
| *Hydro:* | *58 %* |
| *Others:* | *5 %* |

### Imports

*1'138'110 Terajoule (2008)*

| | |
|---|---|
| *Coal:* | *1 %* |
| *Oil:* | *19 %* |
| *Petrol:* | *29 %* |
| *Gaz:* | *10 %* |
| *Nuclear fuel:* | *25 %* |
| *Electricity:* | *16 %* |

### Exports

*212'610 Terajoule (2008)*

| | |
|---|---|
| *Electricity:* | *87 %* |
| *Petrol:* | *13 %* |

### Demand/Consumption

*900'040 Terajoule (2008) (final consumption)*

| | |
|---|---|
| *oil* | *55 %* |
| *electricity* | *24 %* |
| *natural gas* | *12 %* |
| *coal* | *1 %* |
| *wood* | *4 %* |
| *others* | *4 %* |

**Electricity Production**

66'967 GWh (brutto 2008)

| | |
|---|---|
| Hydro: | 56 % |
| Nuclear: | 39 % |
| Fossil: | 5 % |
| Biomass: | 119 GWh (0.17 %) |
| PV: | 34 GWh (0.05 %) |
| Wind: | 19 GWh (0.02 %) |

**Imports**

50'300 GWh (2008)

**Exports**

51'400 GWh (2008)

**Total Demand/ Consumption**

58'729 GWh (2008)

| | |
|---|---|
| Households | 31 % |
| Agriculture | 2 % |
| Industry | 32 % |
| Services | 27 % |
| Transport | 8 % |

# HYDROGEN R,D&D PROGRAMME

Within the Swiss long-term energy perspectives, hydrogen continues to own a major potential as energy carrier that is absolutely needed when facing storage problems in a future energy supply based on renewable energy sources. The funds available in the Swiss Hydrogen Program (www.bfe.admin.ch/research/hydrogen) lead by the SFOE are used to as seed money to coordinate and initiate various activities in national research and demonstration projects. The fostering of projects in the field of hydrogen production by renewable energies and hydrogen storage in solid state systems constitutes the long term strategy of the SFOE hydrogen research program. The overall funding by public institutions for the hydrogen and solar chemistry activities in 2009 was $5 million, of which the SFOE directly controls roughly one quarter.

## ACTORS

The main research institutions in the hydrogen research program are the Swiss Federal Institutes of Technology in Lausanne (EPFL), the Paul Scherrer Institut (PSI), the Swiss Materials Science & Technology Center (EMPA), as well as Cantonal Universities (Geneva, Basel) and Universities of Applied Sciences (Fribourg, Winterthur). The establishment of a national center of competence in photo-electrochemistry (PEC) at the EPFL with additional activities at EMPA and the University of Basel allowed for a concentration of research activities in this subfield to take place within the past years. Industrial players are companies in the field of electrolyser-technology (Industrie Haute Technologie IHT) and hydrogen-logistics (PanGas, Linde-Switzerland, WEKA). All actors from research and industry are organised in the Swiss Hydrogen Association Hydropole (www.hydropole.ch), the national network for hydrogen related matters in Switzerland.

## ACCOMPLISHMENTS 2011

The production of hydrogen by renewable energy sources and the development of effective storage possibilities form the main topics of the Swiss hydrogen programme. Some highlights of 2011 are summarized in the following paragraph.

Research activities at the Solar Technology Laboratory at the Paul Scherrer Institut (PSI) and the Institute of Energy Technology at ETH Zurich are focused on concentrated solar energy technologies, especially on the investigation of high-temperature solar thermochemical processes for the production of hydrogen and synthetic fuels. Over many years 2-step thermochemical cycles based on metal oxide redox reactions are developed to split water and/or CO2 to and produce hydrogen and carbon monoxide. In a first solar endothermic reaction, a metal oxide is reduced into a reduced-valence metal oxide and O2. The non-solar exothermic oxidation of the reduced metal oxide with water and/or CO2 yields hydrogen and/or syngas together with the initial metal oxide, which is recycled to the first step. Of special interest is the solar thermal dissociation of ZnO. Here, the PSI developed a new 100 kW pilot (see figure 1). A first experimental campaign was conducted in summer 2011 at the 1 MW Solar Furnace (MWSF) in Odeillo, France (figure 2). More than 60 hours of on-sun testing in the MWSF were recorded, each experiment lasting between three and seven hours.

*Figure 1: 1 MW solar furnace (MWSF), Odeillo, France, consisting of heliostat field, parabolic concentrator, and tower with experimental platform, which is used with the 100 kW solar pilot reactor to produce Zn.*

All systems of the solar pilot plant have been tested and qualified. A second experimental campaign planned for 2012 aims at optimizing the reactor performance by implementing a modified quench unit and by operating the reactor at higher temperatures using improved high-temperature wall materials. The goal will be to reach a Zn yield exceeding 50% and a solar-to-chemical energy conversion efficiency approaching 10 %. The results from this research will extent the ability to store solar energy as a fuel – such as Zn, H2, or syngas – in a manner that increases the chances of having a sustainable solution to the current world problem of being dependent on a limited supply of fossil fuels.

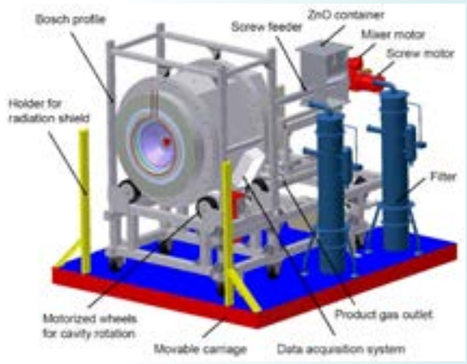


Figure 2: 3D schematic view of the 100 kW solar pilot plant mounted on the movable carriage for operation at the 1 MW solar furnace in Odeillo (France): solar reactor, dynamic screwfeeder, and filter system.

Since end of 2011, the first five fuel cell buses are in regular operation at PostBus (PostAuto Schweiz AG). PostAuto is the largest public transport operator in Switzerland with a fleet by approximately 2000 buses covering approximately 100 million km per year. Hydrogen for the five buses is provided by water electrolysis using electricity from hydro power. The project is part of the European CHIC (Clean Hydrogen In European Cities) with 26 hydrogen FC powered buses in five major European regions. The focus in the Swiss part of the CHIC project is on gaining experience with hydrogen buses on hilly ground.

The Swiss hydrogen research program will be continued in 2012 in collaboration with the R&D programs of the IEA-HIA and with additional funding from the European Union. New projects will be launched within the next years, especially demonstration projects such as the first hydrogen fueling station for buses, which is planned to be opened in spring of 2012.

Figure 3: Since end 2011 the first hydrogen buses (Citaro FuelCELL-Hybrid) in Switzerland are operational.

## CONTACT

Dr. Stefan Oberholzer
Swiss Federal Office of Energy, Section Energy Research,
Hydrogen & Fuel Cells, Photovoltaics, CSP
3003 Bern, Switzerland
Tel: +41 (0)31 325 89 20

stefan.oberholzer@bfe.admin.ch

www.bfe.admin.ch/research/hydrogen