Switzerland

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Introduction and Background

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 programs at federal, cantonal, and municipal levels. Efforts to find paths towards a sustainable future energy supply are driven by the so-called “2000-watt society,” a vision in which each person would cut their overall rate of energy use to an average of maximal 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 by far the biggest contributor.

Since 2001, the program “Swiss Energy” aims to promote 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 organizations, 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 programs for different technologies in the field of renewable energies.

Hydrogen R&D&D Specifics

Within the Swiss long-term energy perspectives, hydrogen continues to have major potential as energy carrier that is absolutely essential to addressing storage issues 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 as seed money to coordinate and initiate various activities in national research and demonstration projects. Fostering projects in the field of hydrogen production by renewable energies and hydrogen storage in solid state systems is 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 summed up to $5 million, of which the SFOE directly controls roughly one quarter.
PROGRAMS, PROJECTS, INITIATIVES IN BRIEF

Status and accomplishments

The production of hydrogen by renewable energy sources and the development of effective storage possibilities form the main topics of the R&D program of SFOE. In the following paragraphs some highlights of 2010 are summarized.

National research activities in the field of photo-electrochemical water splitting are concentrated within a competence center “PEChouse” (pechouse.epfl.ch). The same institution also acts as a leading house within the European PEC-project “NanoPEC” that started in 2009. The overall objective of the activities at PEChouse is to design and develop novel semiconductor-based materials capable of harvesting and converting solar energy into chemical energy by oxidation of water into oxygen and hydrogen. Research at PEChouse is focusing on a-iron oxide (hematite) as material for PEC-photoanodes due to its good absorption properties and its high stability.

In 2010 a new breakthrough in the performance of hematite-based PEC photoanodes was achieved, where the Fe$_2$O$_3$ has been modified with IrO$_2$-dopants. The observed photocurrents correspond to a solar-to-hydrogen (STH) conversion efficiency of 4.8% which is the highest value achieved with PEC devices based on oxide materials. With the huge progress made in 2010, the project goal for end of 2011 of 7% STH is within reach. Further breakthrough results have been reported on the photoactivity and stability of a Cu$_2$O photocathodes for hydrogen production (Figure 1). The work is a contribution to Annex 26.
In this reporting year, the solar furnace at the Paul Scherrer Institute for the solar production of Zn and Hydrogen has been successfully upgraded to 100 kW. The furnace will be tested on the Odeillo solar facility in southern France in mid-2011.

The Swiss hydrogen research program will be continued in 2011 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 year, especially demonstrations projects such as the first hydrogen fueling station, which is planned to be opened in end of 2011 for the first hydrogen-driven buses in Switzerland.

**Participation**

The main research institutions in the hydrogen research program are the Swiss Federal Institutes of Technology in Lausanne (EPFL), the Paul Scherrer Institute (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 year. Industrial companies are players in the field of electrolyser-technology (Industrie Haute Technologie IHT, AccaGen) and hydrogen-logistics (PanGas, Linde-Switzerland, WEKA). All participants from research institutes and the industry are organized in the Swiss Hydrogen Association Hydropole (www.hydropole.ch), the national network for hydrogen related matters in Switzerland.
REFERENCES

OTHER IMPORTANT WEBSITES

www.bfe.admin.ch/research/hydrogen
pechouse.epfl.ch

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