Zero Emission fossil fuel Power plants
Country profile
Switzerland
May 2008

Introduction

This document contains a short summary of the national current situation with respect to Zero Emission Fossil Fuel Power Plants. It aims to support the taskforces of ETP-ZEP.

Further information sources used for this profile are:

[1] Swiss Federal Office of Energy,
"Overview on the Swiss energy consumption in 2005",
www.bfe.admin.ch/themen

[2] Swiss Federal Office of Energy,
"Swiss electricity statistics 2005",
www.bfe.admin.ch/themen

[3] Axpo "Electricity prospects 2020"
www.axpo.ch/internet/axpo/de/medien/perspektiven

[4] Swiss Federal Assembly, Bulletin Nr. 641.71: „Bundesgesetz über die Reduktion der CO_2-Emissionen" (CO_2-Gesetz), 1999

[5] Swiss Federal Office for the Environment,
"CO_2 emission statistics" (2006),
www.bafu.admin.ch/klima

[6] Swiss Federal Office of Energy,
"Organisation of Energy Research at the Swiss Federal Office of Energy ",
www.bfe.admin.ch/themen

[7] Swiss Federal Office of Energy, "Technology development program Kraftwerk 2020", Annual report, 2006
www.bfe.admin.ch/themen

Chapters 1-5 contain facts and observations, no opinions. Chapter 6 (lessons for ZEP) contains opinions.

1 Background information

Short description of national context

- Short history with respect to zero emission (if any)
- Energy production: energy mix: present and future
- CO2 emissions: present and future
- Storage: possibilities with respect to underground storage
- Energy-related industry (names, not statistics)
    - main utilities
    - main oil, gas, coal industries
    - main energy-intensive industry
- government: main ministries that deal with CCS

BACKGROUND: ELECTRIC POWER SUPPLY & CARBON DIOXIDE EMISSIONS IN SWITZERLAND

As in most other countries worldwide electricity consumption in Switzerland is also increasing at a significant rate on an annual basis (electricity consumption: + 2.1 %; total

energy consumption: + 1.3 % (2004/2005)[1]). Also similar to the situation as in a lot of other highly industrialized countries significant parts of the electricity generation infrastructure (generally large centralized power plants) are in operation since decades and are approaching the end of their operational lifetime. However, Switzerland turns out to be in a very special situation how to cope with these developments because of its highly integrated status of electricity network links with its neighboring countries (France, Germany, Italy, Austria) which is due to its geographic location in the middle of central Europe. In addition, Switzerland provides a lot of pumped hydro-electric storage capacity due to its topography which comprises the central part of the European Alps. Due to these special boundary conditions Switzerland's electricity supply relies heavily on large import/export flows which make use of the seasonal run-off of water from the mountainous regions and the excellent capability for electricity storage via pumped hydropower plants. Historically Switzerland's power generation basis has thus been mainly based on hydropower and nuclear energy.

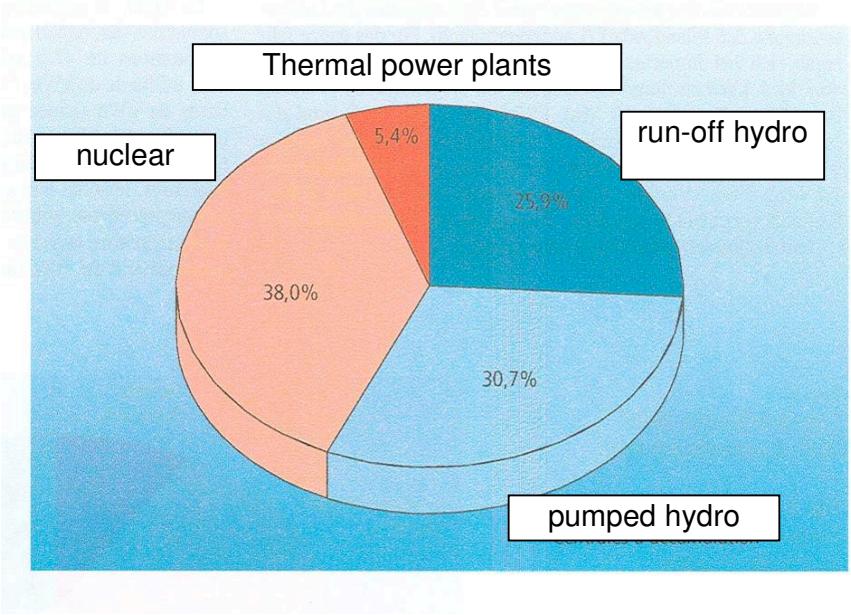

Fig. 1: Electric power generation in Switzerland (2005) [2]

Additional security of supply was achieved via large import contracts with France. Due to the increasing electricity demand, the termination of the import contracts and the shut-down of nuclear generation capacity Switzerland is now facing a potential shortage of electricity supply by the end of the next decade (2015-2020) (Fig. 2).

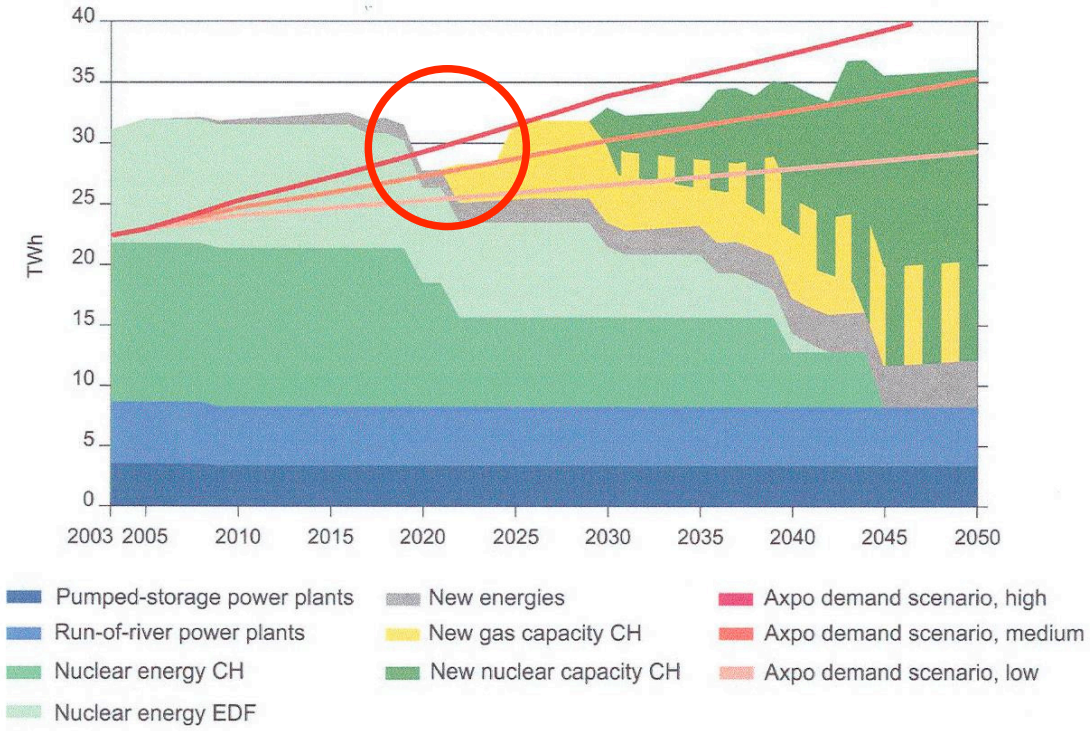

Fig. 2: Electricity supply & demand scenario for Switzerland (2003 – 2050) [3]

In order to cope with the predicted shortage one option being discussed is to build up additional domestic power generation capacity on the order of 1-2 GW_e. Because of the possibility of fast-track installation (less than 5 years between order intake and start of commercial operation) and the high efficiency/low emission potential of gas turbine combined cycle plants fired with natural gas this power generation technology is a prime candidate to fill the gap forecast for the electricity supply. Due to stringent CO_2 emission legislation (see below) and because of security of (gas) supply issues public opinion in Switzerland with respect to natural gas fired combined cycle plants is divided and it is not at all clear with which power generation technology the predicted shortage in electricity supply will be covered.

As Switzerland's actual power generation base is virtually CO_2-free (Fig. 1) specific attention is paid to the point that any replacement or addition to the generation capacity needs to meet stringent CO_2 emission limits. Currently discussed legislation asks for full compensation of the additional CO_2 emissions of which 70% (min. 50%) need to be accomplished by measures within Switzerland. In general Switzerland has adopted national legislation ("CO_2-Gesetz" [4]) in line with Kyoto protocol targets which call for overall CO_2 emission reductions of 10% by 2010 (based on 1990 emissions). Actual CO_2 emission values miss, i.e. exceed the targeted emission by almost 3 Mt CO_2 (Fig. 3). To reverse this trend a CO_2 tax has been imposed on fossil fuels (as from 2008) which gradually increases from 12 CHF(≈7€)/t CO_2 (2008) to 36 CHF(≈22€)/t CO_2 (2010). The already proposed natural gas fired combined cycle plants (3 projects all with sites in the western part of Switzerland e.g. near Bern) are exempt from this tax but are required to compensate their CO_2 emissions by 100% with accompanying CO_2 emission reduction measures (70% need to be accomplished within Switzerland; max. 30% can be covered on an international basis via permits, joint development projects, etc.). These

legal boundary conditions brought most of the projects to a halt, but discussion on possible compensation measures is ongoing. CCS has not been considered yet as a viable option in this respect.

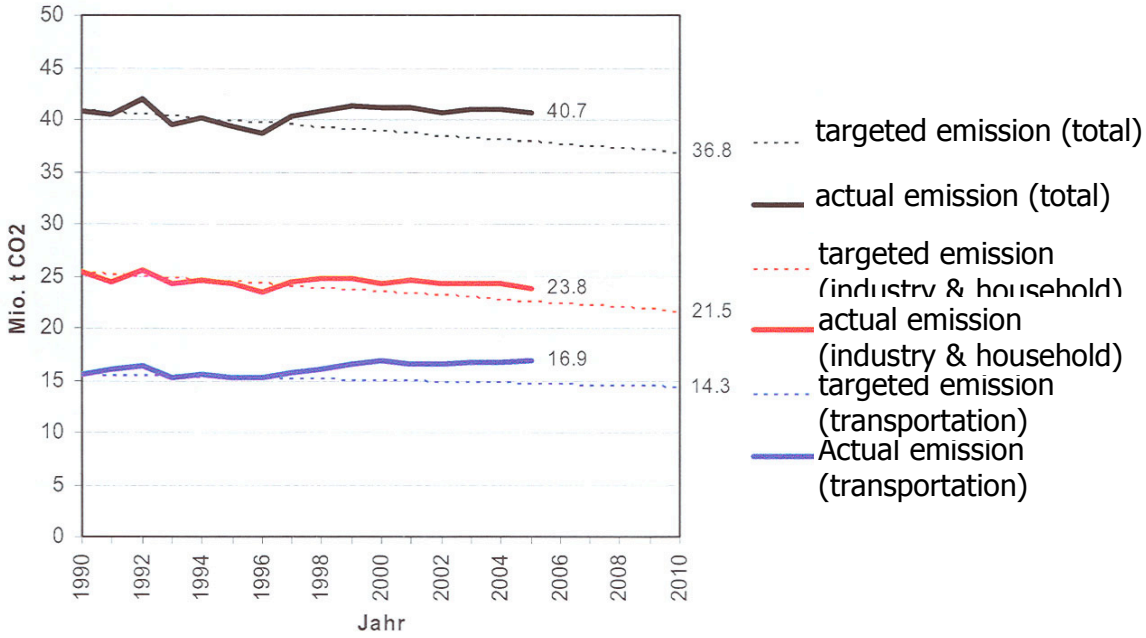

Fig. 3: CO_2 emission development in Switzerland (1990 – 2005) [5]

For the above reasons (gap in electricity supply, excessive CO_2 emissions) a technology development program (called "Kraftwerk 2020"; more details see chapter 2) has been put in place to support all efforts needed to provide the required technologies for introducing highest efficiency (> 60%) natural gas fired combined cycle plants with the potential for further CO_2 emission reduction via co-firing of biomass derived syngas and/or process modifications for CO_2 capture.

Specifically suited storage sites for CO_2 with significant capacity have not been identified within the territory of Switzerland even though the pre-alpine low lands (northern & western part bordering France and Germany) might be generally geologically suited. Although these potentially suited regions coincide with potential sites for large point sources of CO_2 in the future, they are also heavily populated and thus public acceptance for CO_2 storage will be a very sensitive issue. Today CO_2 storage within the territorial boundaries of Switzerland is generally not considered a viable option.

The main Swiss manufacturing industry in the energy business consist of very few large size companies with subsidiaries in Switzerland such as ALSTOM (large gas turbines), MAN Turbo (gas/air compressors; industrial turbines), Sulzer (high temperature materials & coatings) and hundreds of small & medium size companies supplying parts and services for the (international) power generation market.
There is not a dominant single largest energy consuming industry in Switzerland even though major industrial energy consumption (in 2005) came from chemical industries (23%), pulp & paper (13%) and food industries (13%).

The Swiss electricity market is highly fragmented with about 80 electricity producers and 900 utilities including 7 consortia (ATEL, BKW, CKW, EGL, EOS, NOK) which handle the majority of the Swiss international electricity exchange.
Governmental organisations related to energy issues and greenhouse gas emissions (CO_2 & others) are the Swiss Federal Office of Energy (Bundesamt für Energie, BFE) and the Swiss Federal Office for the Environment (Bundesamt für Umwelt, BAFU) which both report to the Swiss Federal Department (equivalent to a Ministry) of the Environment, Traffic, Energy and Communication (Department für Umwelt, Verkehr, Energie und Kommunikation UVEK).

2 R&D

This chapter is directed at the taskforce on technology. One of their main tasks is to give input to 7FP, to get an overview over european R&D-activities and to identify the R&D-gap. The following issues should be described:

- private research:
    - which are the main industries with R&D-activities
        - oil&gas, coal industries?
        - Utilities?
        - equipment manufacturers?
    - What is the estimated size of private research (rough indication FTE, financial resources)
    - What is their focus, main topics of research
- public research
    - main R&D-organizations and groups, number of researchers (FTE), director
    - General government policy with respect to CCS/clean fossil
    - Main R&D programmes, size of programmes, duration of programmes
    - Focus, topics of research

TECHNOLOGY DEVELOPMENT PROGRAM "KRAFTWERK 2020"

The technology development program "Kraftwerk 2020" (which is part of the portfolio of R&D programs [6] of the Swiss Federal Office of Energy (BFE)) is centered around activities suitable to allow the installation of new electric generation capacity without jeopardizing CO_2 emission reduction targets Switzerland has committed to in national legislation ("CO_2-Gesetz" [4]) in line with Kyoto protocol targets. As renewable energy sources, additional hydropower stations and new nuclear power plants cannot meet the required timeline (2020) the power generation technology option being followed is based on natural gas fired combined cycle plants.
The technology development projects of the program (Fig. 4) contribute to advancements in minimum CO_2 emissions per MWh_e by maximization of the electric efficiency, by allowing co-firing of biomass derived syngas and by adopting process modifications for CO_2 capture. The following projects have been initiated in 2006 and are currently being executed:

maximization of the electric efficiency

Turbogenerator with highest electrical efficiency (> 99%)
Coatings for steam turbine components
High-efficiency steam turbine blading

CO_2 emission reduction

High-efficiency compression of fuel gas from biomass
Combustion of syngas

Gas turbine process with CO_2 mitigation

Basic research

Laser diagnostics in extremely lean flames
Optimized casting process for gas turbine components

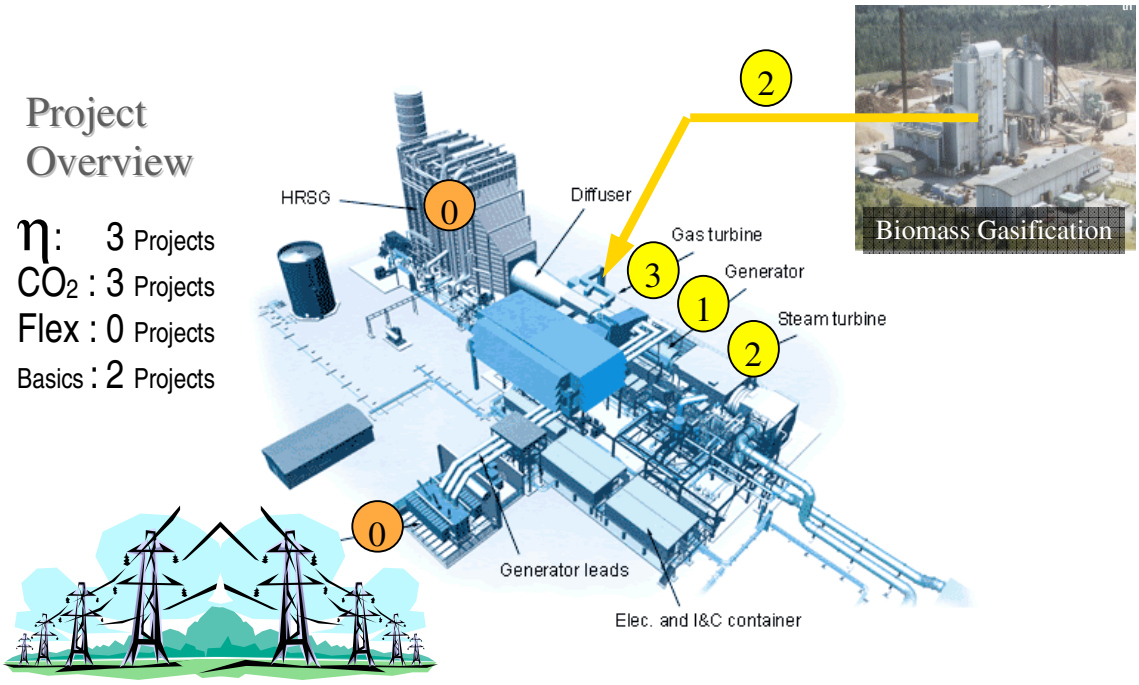

Fig. 4: Project overview of the technology development program "Kraftwerk 2020" [7]

Main industrial participants in the program projects are ALSTOM and MAN Turbo, supported by a number of SME's and research institutes (e.g. Paul Scherrer Institute, PSI). Current funding volume per year (5.5 MSFr. ≅ 3.3 M€) is provided by the industry partners (approx. 70%) and public agencies such as BFE and the Commission for Technology & Innovation (CTI). The annual funding volume is planned to grow to up to 15 MSFR (9 M€) with additional funding from local authorities, EU FP7, SwissElectric (funding pool from Swiss utilities) and the Swiss gas industry.

Main research organizations active in various fields related to ZEP are comprised in the ETH domain (Swiss Federal Institution for Higher Education) which consist of the Technical Universities in Zurich (ETHZ) and Lausanne (EPFL) and mainly government funded national research institutes such as the Paul Scherrer Institute, PSI.

3 Implementation

- Industry:
  - General attitude of industry towards ZEP
  - Which national ZEP-related projects/initiatives/demos have been announced? Which are expected to be announced?

    - Short description of each initiative like in the dynamis overviews and source of information
- Reported national barriers to implementation

Besides the technology development program "Kraftwerk 2020" there are currently no other programs in place or announced which directly relate to the implementation of ZEP technologies.
As there are already a couple of commercial projects for large combined cycle plants (based on natural gas) in an advanced planning status, which have all been required by recently passed legislation to fully compensate their CO_2 emissions, there might be increasing interest by the utilities developing these projects to implement ZEP technology in their power plants. No public announcement has yet been made how CO_2 compensation is proposed to be achieved in these projects. Project developers have declared that the projects are economically not viable if the imposed legislation cannot be applied in a flexible way.
As Switzerland's actual power generation base is virtually CO_2-free it is a paradigm shift in energy policy to discuss seriously about large scale power plants based on fossil fuels (even being natural gas). Natural gas combined cycle plants are only considered because they are the only technically available solution to close the predicted shortage in the electricity supply in the time frame given (operational within the next 5-10 years). In order to gain public acceptance official government policy statements picture the natural gas based power plants as temporary – but indispensable - solution for the next few decades.

4 Public acceptance

- Level of awareness with respect to CCS
- Which public organizations deal with public acceptance?
- Specific initiatives directed at public acceptance

How to secure future electricity supply in Switzerland has been in the spotlight of public discussion since about a couple of years with a spikes in attention as important related legislation (compensation of CO_2 emission, CO_2 tax on fuels for stationary power generation) has been put into action by the main governmental bodies (Nationalrat, Ständerat) in 2007. The decision has been taken that CO_2 emission from large power plants need to be compensated 100% but carbon capture & storage has not been specifically discussed in this respect. General public opinion is that CCS is not a viable option within Switzerland. Extension & renewal of nuclear power plants has been considered seriously in recent months and specific project proposals have been announced for the near future.
The Swiss Federal Department (equivalent to a Ministry) of the Environment, Traffic, Energy and Communication (Department für Umwelt, Verkehr, Energie und Kommunikation UVEK) is the governmental body responsible for the Swiss energy policy guidelines supported mainly by the Swiss Federal Office of Energy (Bundesamt für Energie, BFE).

5 Government policy

- Government policy on R&D in the field of CCS
- Government policy on implementation
    - The investment phase: Tax incentives and subsidies, early mover incentives
    - The operational phase
    - National CO2 allocation plan
- Is there a policy directed at public acceptance?

Government policy is mainly directed to foster energy savings and to avoid/minimize use of fossil fuels as Switzerland's actual power generation base is virtually CO_2-free. There are – and will be – no tax incentives and subsidies for the energy - or any other industry – sector as the general Swiss policy is to keep taxes (and in turn also subsidies) at a minimum level. There is a major governmental program in place ("Energie Schweiz") which supports and drives all kind of efforts related to energy efficiency & savings with a special emphasis on the buildings and transport sector.

6 Lessons for ZEP

- What can we learn from this member state?
- What opportunities does this member state offer to ETP-ZEP?
- Which problems in this member state that need to be addressed by ETP-ZEP?

Because Switzerland's actual power generation base is virtually CO_2-free all CO_2 related power generation technologies are regarded as very sensitive issues and (100%) compensation of any additional CO_2 emissions will be required. If CO_2-free power generation (renewable energies, nuclear energy) cannot cover all the additional electricity demand this provides a specific opportunity for CCS technologies. Proposed projects for large combined cycle plants (based on natural gas) might be suited as ZEP demonstration projects for certain CCS technology – as part of the Flagship Program - but project developers (utilities) have not been expressing interest in this respect (so far) as these units have been evaluated on a purely commercial basis. The Swiss Federal Office of Energy (BFE) is planning to make utilities specifically aware of the Flagship Program and to initiate discussion on how Swiss industries could participate. As CO_2 storage within the territorial boundaries of Switzerland is generally not considered a viable option any such CCS projects would need to be agreed on at least on a bi-national level (e.g. with French partners).