

Roadmap for Hydropower R&D in Switzerland, 2015

Challenges and strategy

According to Energy Strategy 2050, the mean annual hydropower production has to be increased under present framework conditions by 1.53 TWh/a and by 3.16 TWh/a under optimized conditions. In view of environmental and socio-economical constraints, this foreseen increase is extremely challenging and can be reached only by innovative and sustainable solutions for new hydropower plants and by the extension and optimization of existing schemes. The expected increase in power production from small hydropower plants (SHPP) requires the development of criteria for a careful site selection as well as strategies to optimize power production within a river network while at the same time minimizing the negative impacts on stream ecology. The effect of climate change will not only change the availability of water resources in time but also change the behavior of the catchment areas by an increased sediment yield and more frequent natural hazards, and thus considerably endangering waterpower production in the near future. The critical period of energy supply in Switzerland is still the winter half year. For 10 years, Switzerland had to regularly import on average 4 TWh in the winter half year. In order to guarantee a safe energy supply also during critical periods, Switzerland has to increase its storage capacity by new reservoirs where possible and mainly to increase the volumes of existing ones.



Muttssee Gravity Dam



Vieux Emosson Arch Dam

Already today, Switzerland plays, thanks to its storage power plants, an important role in supplying peak energy in the European grid and thus contributes significantly to its frequency control. In the future, this position has to be reinforced with the goal to become one of the main batteries in Europe able to furnish peak energy at any time. The forced and subsidized European production of mainly solar but also wind energy will further increase the need for regulation and peak energy. After reduction of European subsidies and actual market price distortions, and after economic recovery in Europe, the attractiveness of new pumped-storage power plants, the increased reservoir volume by dam heightening as well as the increased installed capacity of existing power plants by adding new parallel waterway systems and powerhouses will be highly attractive again. To make Switzerland's hydropower production more flexible in the future with the purpose to concentrate it at times of high peak demand is a must for guaranteeing a leading position of Switzerland in a highly competitive electricity market in Europe. Such hydropower production focused on peak energy will also have more severe effects on river flow regimes, so-called hydropeaking, which have to be assessed and mitigated by innovative measures.

Key research directions

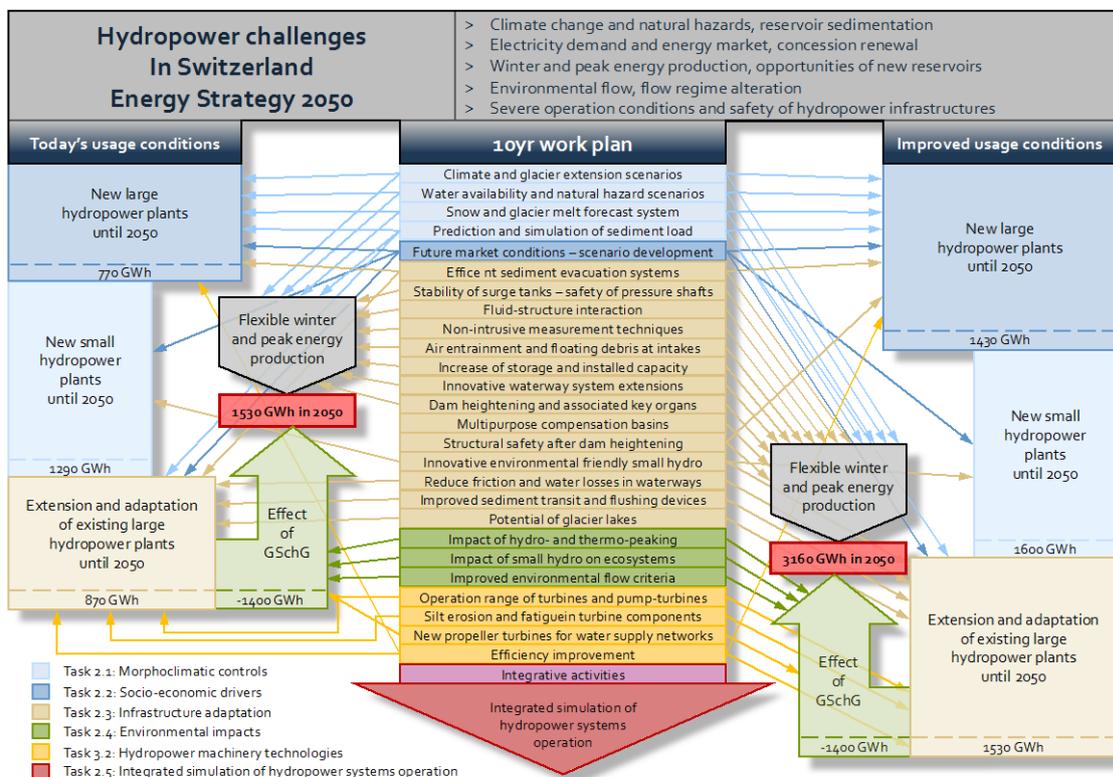
The SCCER funded roadmap develops in the following key research directions:

- a) the change of production potential due to effects of future climate forcing, which are expected to impact water availability (glacier retreat, snow accumulation and melt, streamflow regimes, and sediment production and transport) as well as the operation safety of structures in view of new natural hazards (floods, slope instabilities, etc.);

- b) the efficiency improvement of existing HPPs, which can be achieved by their expansion to allow a more flexible operation to accommodate new and highly fluctuating demands;
- c) the contribution of new technological solutions to adapt existing infrastructures in view of increasing their efficiency of production and achieving higher operation flexibility during seasonal and daily peak demands, while maintaining the same level of (infra)structural safety and supply security;
- d) the assessment of the effects of HPPs new and harsher operation regimes and increased numbers of SHPs on aquatic ecosystems and the development of strategies to reduce these impacts (e.g. by developing innovative strategies of environmental flow releases);
- e) the definition of future boundary conditions for the operation of HPs based on the development of electricity demand and market dynamics under uncertain social, economic and political forcings (e.g. by developing scenarios to force the operation of hydropower systems);
- f) the assessment of multi-objective operation strategies of HP systems, which maximize power production, reliability and flexibility of supply, profitability of operation and ecosystem conservation, under the constraints of a more fluctuating demand – due to higher fraction of renewable production – and an uncertain market.

Roadmap presentation and related work plan 2014-2017

The roadmap and the related work plan 2014 – 2017 is shown in the attached figure. By overcoming the challenges for hydropower in Switzerland shown at the top of the figure, the roadmap of any SCCER research has to focus on achieving the above mentioned objectives of energy strategy 2050 regarding the increase of mean annual hydropower production. The goal is graphically shown on the left and right under today's and future usage conditions, respectively.



As can be seen, new large hydropower plants, new small hydropower plants as well as the extension and adaptation of existing large hydropower plants are the drivers to achieve the objectives of energy strategy 2050. After the end of actual water licenses, the requirements of the Federal Law on the Protection of Waters (GschG) have to be applied, which will result in a reduction of mean annual production as graphically shown. Furthermore, as already mentioned, winter energy is a critical issue for safe electricity supply in the future in

Switzerland. Besides this, energy production of existing and new large hydropower plants in Switzerland has to be made more flexible, which will allow Switzerland to be competitive in a highly volatile energy market. This will not result in an increase in mean annual production but increase the flexible winter and peak energy production as shown above. The planned activities of the work plan 2014-2017 are shown in the middle of the figure. The different colors of activities correspond to the tasks defined in the comprehensive SCCER-SoE work plan. The arrows indicate in a clear way which activity of the work plan will contribute to the achievement of the objectives energy strategy 2050.

Besides disciplinary applied research projects, the roadmap will be developed first (2014-2017) at pilot hydropower systems located in different regions of Switzerland and representative of the hydropower systems across the country. Furthermore, for a complex hydropower scheme representing all technical features and challenges with a promising new dam project related to glacier retreat, a pilot study regrouping large numbers of activities in an interdisciplinary way will be started in early summer 2015. This study will allow determining quantitatively the effect of outcomes of the research activities on energy production of the pilot scheme (x% increase of annual production and flexibility) and consequently the economical position of the latter in a highly competitive market.

Priorities

In principal, all topics mentioned in the work plan are of high significance for any future hydropower development in Switzerland since investments are made on the whole system and not only on single components. The actual market conditions and consequently the investment opportunities will decide which projects will be followed up by a certain hydropower company. These opportunities may be very different from one company to another and one region to another. Therefore, the roadmap work plan has to cover the full range of possible options in order to be prepared to any project opportunity with advanced developments.

Nevertheless, feedback obtained during the roadmap workshop (January 2015) by the hydropower industry revealed the following concerns, which should guide priorities:

- Under today's difficult market conditions, there is a need for innovative solutions to strongly reduce investment costs for any hydropower development. Industry is not looking for the most optimal solutions but for realistic feasible solutions under today's conditions. Risk participation between designers, construction companies and owners is required in order to avoid superposition of safety margins and to obtain economical projects. Projects, which are not developed today, will not be ready when market conditions are again favorable. Thus, reaching the goals of energy strategy 2050 may be endangered if projects are delayed.
- Most of the problems being faced by hydropower development are not technical but related to taxes, water rights and legal issues strongly linked to the concession renewal.
- Simple procedures to carry out structural safety assessments of dams and power plants are required.
- There is urgent need to improve the quality of engineering designs of small hydro schemes, often handled by understaffed, unqualified, purely disciplinary teams. Improved designs should enhance management concepts and public acceptance by properly addressing different stakeholders' interests. Small hydropower plants should be reliable under operation.
- Conflicting interests exist between the extension of small hydropower production and the protection of the remaining near-natural rivers in Switzerland, as well as the river rehabilitation measures required by the waters protection act. The development of new innovative environmental friendly solutions is required to improve public acceptance. More appropriate rules for environmental flows are of high interest, which could reduce the expected energy loss and at the same time sustain ecological conditions.
- There is a need for developing future socio-economic scenarios, similar to the compromise obtained regarding climatic changes expected in the horizon 2050.

Source: www.sccer-soe.ch; March 30, 2015