The Future of Swiss Hydropower: Is there money left somewhere?

Interim Project Report

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The NRP70 project 'The Future of Swiss Hydropower: An Integrated Economic Assessment of Chances, Threats and Solutions' (HP Future) addresses the challenges Swiss Hydropower faces in the changing electricity market environment. In particular it aims to answer three main research questions:

1. What are ***short-term operational*** options for Swiss HP to cope with the volatile market situation?
2. What are ***long-term investment*** options for Swiss HP and how can ***uncertainty*** be accounted?
3. What are the ***regional impacts*** from a comprehensive ***sustainability perspective***?

The project started in fall 2015 and is projected to be finished early 2018. This interim project report aims to provide a short summary on the main findings so far.

Acknowledgements:

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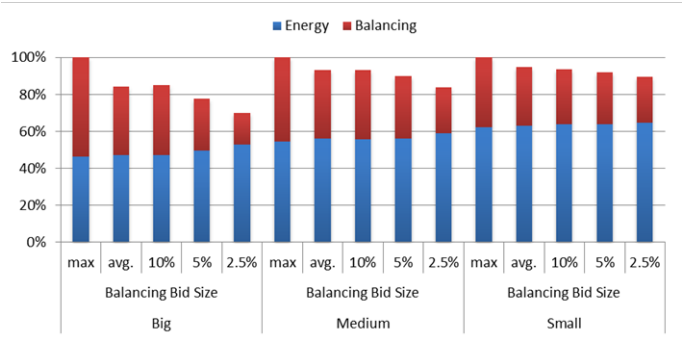
Market Opportunities: Does flexibility pay off?

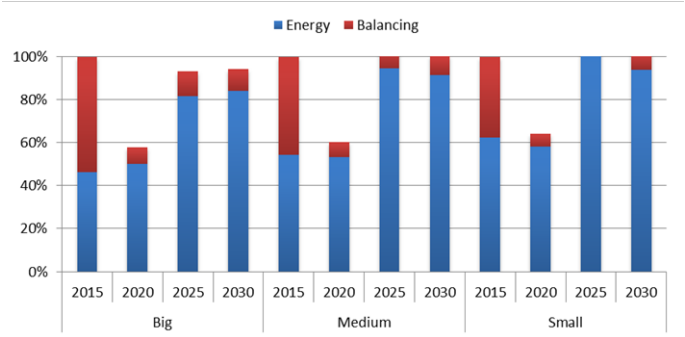
Electricity spot prices decreased over the last years and consequently, also the revenues of HP plants in the spot market dropped significantly. However, it is often assumed that the increase in variable renewable generation can provide new opportunities for highly flexible generation; like hydropower. Within the first Work Package of the project we developed a short-term model framework to analyze market strategies for different hydro plant types (i.e. big seasonal storage plants, small scale run-of-river like plants, and in-between medium sized plants) to increase revenues by trading across energy and balancing markets.

Our ex-post analysis of the last years shows that theoretically there was a high potential for additional revenues. However, accounting for uncertainties, the need for keeping storage reserves, and market characteristics (i.e. the small size of the Swiss balancing markets) the potential for additional revenue generation reduces (see Figure on the right for 2015).

Theoretic Balancing Revenue, 2015



Future Revenue Outlook



This effect is even more pronounced when looking into the future. Applying a model in which the balancing market accounts for the potential of all Swiss hydro plants the obtainable surplus margin greatly reduces (see Figure on the left). Basically, the Swiss balancing market is too small to provide enough value for all plants. The limited role of the Swiss balancing market for filling the revenue gap for a large share of Swiss HP has also been confirmed by stakeholders at our second project workshop in October 2016.

The modeled future forecasts captures a set of varying scenarios including low, modest and high price paths. On average over all scenarios the market price prospects for coming decade are low to modest. As the existing EU capacity structure will likely remain stable the global fuel markets and the carbon price will be the main influences for Swiss HP.

Summarizing, the main findings so far are:

The **current market** environment (i.e. balancing markets) provides **limited pay-off for flexibility** and the **future outlook** has a good chance of a prolonged **low price environment** for several years

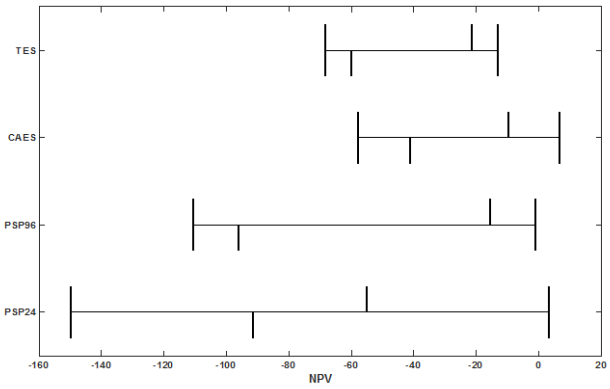
→ If a respective trading and flexibility structure is not already in place, additional **effort for participating** in those 'flexibility' markets is **of limited value**

→ Short term **investments to increase** a plant's **flexibility** are likely to be **unprofitable**

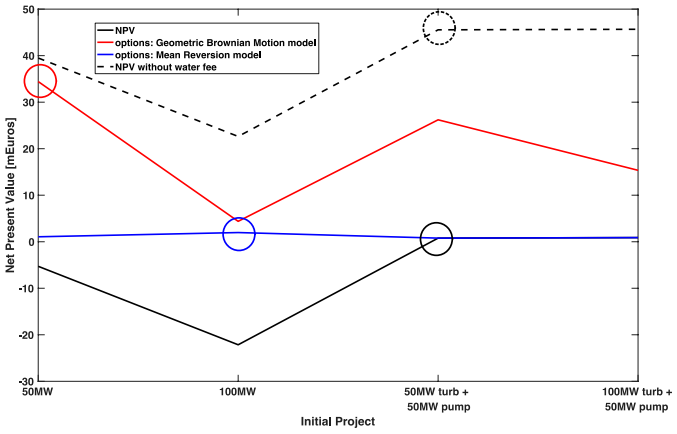
New Investment Strategies: Flexibility in the long run?

As hydropower is one pillar of the Energy Strategy 2050, Switzerland will require significant (retrofitting) investments in the coming decades. However, the difficult market situation due to the low wholesale prices and the decreasing gap between peak and off-peak prices has put most investment plans on hold. In addition to the low value for flexibility in the current markets, also the variance amongst European markets tends to diminish. This means Swiss HP cannot compensate for low energy prices by exporting. Within the second Work Package we aim to assess the impact of long-term drivers on hydropower with a focus on uncertainty and highlight solutions for the corporate and policy makers.

First results show that new energy storage technology, such as compressed air energy storage (CAES) and thermal energy storage (TES), are becoming competitive (see Figure on the right for a net present value comparison). Thus, even if future market designs value flexibility, new storage technologies may capture the profits. Especially, since pump storage is already a mature technology with limited cost reduction potential.



An additional challenge for HP arises due to its low managerial flexibility (i.e. the ability to manage the timing and scale of the project); especially compared to new renewable technologies. Our analysis shows that assuming the same costs, it would be more profitable to invest into new renewable energy in an uncertain market environment thanks to their higher managerial flexibility. Consequently, HP needs to improve its own flexibility, i.e. by planning future investment steps beforehand as implementation ex-post can become too expensive. We show that such an approach tends to privilege smaller investment projects that keep open options being increased later (i.e. “start small, think large”, see Figure on the left). In a context where a utility lacks liquidity, this may be a valid investment strategy. However, decision makers must be ready to pay for implementing the options.



Summarizing, the main findings so far are:

Future market developments pose **threats for HP** as new **storage technologies** are becoming increasingly competitive and **new renewable generation** provide a higher managerial flexibility

→ Large scale **pump-storage investments** are a **high-risk investment**

→ HP needs to **increase** its own **investment flexibility** (including retrofitting) by going in small but **keeping options open** for later adjustments

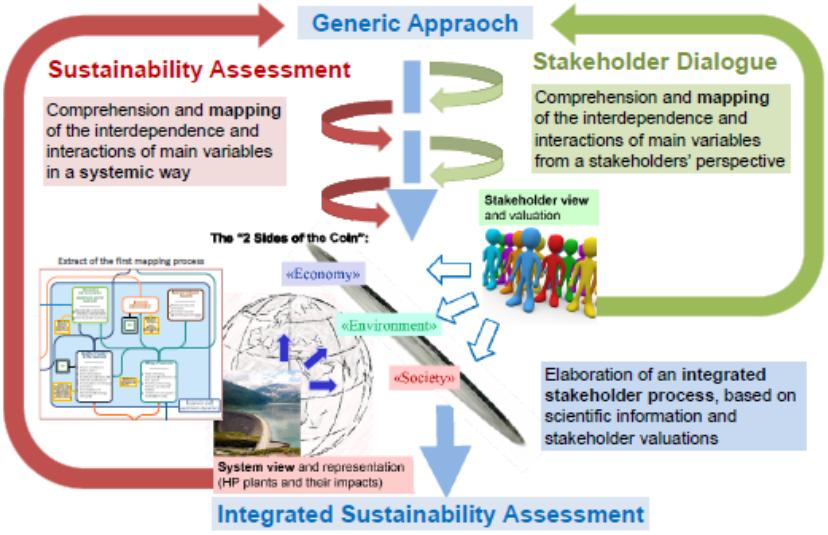
Sustainable Development: Integrating Corporate and Stakeholder Perspectives

The lack of financial performance caused by the current market situation prevents investments in new and retrofitting HP projects from being undertaken. Yet, for the evaluation of such projects, a wider perspective is required that account for the costs and benefits of a HP plant in the long run. Criticism on traditional economic cost-benefit analyses resulted in alternative approaches that are better suited to evaluate projects with irreversibility under uncertainty, and thus to deal with environmental conservation-versus-development tradeoffs. In several cases, this has resulted in postponing or abandoning HP projects. Yet, under the current circumstances, perspectives might change.

HP's (firm, plant) contribution to society
= total profit prospect (corporate income) of HP activities
+ water fee and tax payments to the public (municipal, cantonal, …)
+ firm's contribution to society, defined from a SD perspective and externally evaluated

From a sustainable development and corporate social responsibility point of view, the general advice is to realize a project whenever the total value of HP is positive; that is, if the sum total of the private (financial) and external (environmental, societal and economic) value is positive (see Figure on the left). It particularly involves the total profit prospects of a plant, water fee and tax payments, as well as other values to society; the latter needs to be evaluated from a societal perspective of sustainable development.

Sustainability assessment provides a comprehensive approach towards this evaluation and the integration of different perspectives. It requires both scientific/technical information and stakeholder involvement (see Figure on the right for a concept how to design a SA for hydropower evaluation).



Stakeholder involvement is not solely an academic invention. Experience from past projects, such as that of Lagobianco (GR), revealed the role different groups can play in optimizing a project and gaining far reaching social acceptance. In addition, a corporate social responsibility (CSR) perspective can bring the water fees and concession discussions under a different light of political economy.

Summarizing, the main findings so far are:

Market benefits (the private value) for HP are **insufficient** to justify investments

→ The **total value** of HP (i.e., the private and external benefit of a plant) must be taken into account **for evaluating investments**

→ This requires an **early and continuous stakeholder involvement** as key element for a successful project and reliable sustainability assessment

Open Points and Challenges Ahead

As is evident from the findings so far there are still open points to be addressed and, especially with a focus on the ongoing debate about Swiss HP within the Energy Strategy 2050 and European market development, policy choices ahead:

1. **Water fees, concessions and governance structure:**

One of the most pressing issues is the question on how to ensure the profitability of Swiss HP. The proposed market premium for large hydro can at best only represent a short term remedy as it does not alter the underlying structural problems. The existing HP governance structure needs to be adjusted to an uncertain market environment: a) the fixed water fees represent a threat for the companies in a cyclic market with (long) periods of low prices while they provide secure financial inflows for cantons and communities; and b) the existing long term water concession regime represents a constraint for a flexible investment design. A trade-off between the involved main actors is needed to reform the overall governance structure and make it fit for the 21st century. The CSR perspective implies that this discussion must involve the governance and ownership structure of HP companies and the fiscal incidence. Consequently, this is a combined economic, fiscal and political challenge.

2. **Retrofitting and Decommissioning:**

Linked to the investment evaluation and governance debate is the aspect of retrofitting efforts. Due to the low market prices and uncertain future prospects many plants currently will be operated on a minimum investment budget. In case of an outage it remains unclear if the needed retrofit effort will be carried out to reactivate the unit. A related point that hasn't entered the discussion so far is the question whether hydro may also be decommissioned pro-actively in certain cases as the overall value has become negative; and if so, how such a process should be structured.

3. **Intraday as last resort?**

While our analysis focuses on the day-ahead and balancing markets the emergence of intraday trading may provide additional revenues for HP. The volatility on intraday market has significantly increased over recent years which flexibly producers like hydro can utilize for short term trading. However, so far the related costs in terms of technical requirements, reduced lifetimes and increased maintenance are largely unknown. Finally, similar to the balancing market also the question remains if the potential revenues diminish if all hydro companies want to benefit from intraday trading.

4. **Seasonal Storage:**

With increasing competition by new storage technologies the question remains whether hydro will be pushed out of the energy market in the long run. An important aspect that needs to be further analyzed in this regard is whether hydro can fill the gap of a seasonal storage provider (beyond the todays structure of storing water inflows across seasons). This hinges on the market value for seasonal transfers, i.e. the price difference between summer and winter which is linked to the European renewable developments, and the available space in storage lakes beyond water inflows.

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The project progress can be traced on the project homepage:

https://fonew.unibas.ch/forschungprojekte/projekte/hp-future/

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