Hydropower in Switzerland – Situation and Perspectives

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6th meeting of VGB strategic forum «Hydro»
October 2017, Grimsel Hospiz
Profile SWV (1/2)

SWV = Swiss Water Management Association (Water Economies)
Founded 1910 in Zurich; focus on hydropower and flood control; financed by 80% through membership fees; small and efficient office with a staff of 4 people

Structure of memberships SWV by financial contributions

- Broad diversity in membership
- 80% of financial contributions from enterprises with own hydropower
- Representing over 90% of overall Swiss hydropower production
Profile SWV (2/2)

Journal on «Water Management»

- Flexibilisierung Wasserzinsen – eine Chance für alle
- Ausbau Wasserkraft seit 2006
- Aufgelöste Blockrampen
- Antike Hydrotechnik

Website
www.swv.ch

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A lot of Water and Hight Difference = Renewable Energy Source

Electric capacity $P$ is a direct product of water discharge $Q$ ($m^3/s$) and head $H$ (m) – CH with both $Q$ and $H$ as well as with long experience in efficient and reliable utilization.

$$P = \rho \cdot g \cdot Q \cdot H$$

$P$ [kW], $Q$ [m3/s], $H$ [m]
Hydropower CH: Pioneering Achievements in 19th/20th Century

The three phase generator installed at Lauffen am Neckar with first electricity transport over 175 km to Frankfurt, around 1891 (Source: zvg)

Construction of the run-of-river plant «Laufenburg» at the Rhine, the biggest plant in Switzerland at that time, put into operation by 1914 (Source: ED)

Adventurous construction site for the weir of the run-of-river plant «Laufenburg» at the Rhine by 1912 (Source: ED)

Construction site of the dam of «Lago di Lei», the storage lake of the hydropower plant «Hinterrhein», approx. 1957 (Source: KHR)
Hydropower CH: Main Pillar of Electricity Supply

Development of Consumption and Generation 1950–2016
Hydropower until 1965 with a share of 100%, nowadays still approx. share of 60% of annual generation (rest: nuclear and some thermic power, PV/Wind still below 2%)

Quelle: Elektrizitätsstatistik 2015, BFE 2016

Quelle: BFE, Schweizerische Elektrizitätsstatistik 2016 (Fig. 9)
Source: OFEN, Statistique suisse de l'électricité 2016 (Fig. 9)
Hydropower CH: 90/10-Rule regarding Hydropower Plants

Few Large Plants with almost all of the Generation and Capacity
90% of annual generation and 94% of capacity from 14% of plants (186 plants > 10 MW)
[98% of annual generation and 99% of capacity from 30% of plants (416 plants > 1 MW)]
Swiss HPP is an Important Asset within Alpine Region and Europe
Approx. 40% of HPP capacity in EU28 (+CH) is installed in the alpine region, where Swiss HPP is Nr. 1 regarding alpine storage plants and Nr. 3 regarding run-of-river plants.

[Source: Study AGAW, 2017; only plants > 5 MW installed capacity]
Interim Conclusion I: Hydropower as the Main Pillar

1. Hydropower was and still is the main pillar of electricity supply in Switzerland and in fact is its energetic key asset:
   - Domestic energy resource
   - Renewable and climate-friendly
   - High share of annual generation
   - Flexible and storable (minutes to months)
   - Proven and reliable technology
   - Cost-effective and competitive
   - Relevant to national economy
   - Multiple additional benefits
   - Socially accepted

2. Hydropower fulfils all the requirements to remain the main pillar in the future – however, it will not come by itself and needs the right (political) decisions
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Energy Strategy 2050

March 2011: Government decides on exit from nuclear energy ...

... the Swiss population supports the governmental strategy: May 2017
Energy-(Electricity) Strategy: Key Role for Hydropower

Energy Strategy 2050: In Urgent Need of Renewable Generation
Until 2050: Savings through increase in efficiency 24 TWh/y and replacement of nuclear generation 24 TWh/y; Hydropower: preservation of 36 TWh/y and increase by 3.2 TWh/y

[Savings in Consumption]

[Replacement of Nuclear Plants by Renewables]

[Source: Wege in die Stromzukunft, VSE 2012]
Electricity Market: Falling Prices and Spreads

Development of Prices on European Electricity Market 2000-2016
Global and European developments on the energy markets as well as currency exchange rates EUR vs. CHF lead to a massive decline of swissix-prices by –63% since 2008

[Wholesale market prices 2000-2016; Source: BHP, 2017; SWV 2017]
Electricity Market: Partial Liberalisation in Switzerland

Part of Swiss Hydropower has to compete in the Distorted Market

Cyclic behaviour of electricity prices is not a new phenomena, but since the liberalisation of markets, part of hydropower is exposed to a completely distorted European «market».

[Wholesale market prices 2000-2016; Source: BHP, 2017; SWV 2017]
Hydropower CH: Missing Money!

Costs of Swiss HPP can not be covered under «Market Conditions»
Market revenues are not sufficient to cover overall costs, resulting in missing money of approx. 0.6 bn. CHF per year and leading to minimization of maintenance …

Costs vs. Revenues of Hydropower under Market Conditions 2015

Overall costs of HPP in Switzerland (left) vs. revenues on the wholesale market with resulting deficit (right) for 2015; Basis: Generation 37'190 GWh; Average costs 6.3 Rp/kWh; Market revenues 4.7 Rp/kWh [Source: own graph, 2017; Data: BFE, 2016; Study BSG on taxes and charges, 2010; and Study on Rentability of HPP, M. Piot, 2016]
Interim Conclusion II: Hydropower under Pressure

1. The completely distorted European market jeopardizes appropriate maintenance and thus operation of hydropower plants in Switzerland.

2. The quality of electricity supply in Switzerland, however, highly depends on reliable domestic hydropower generation and flexibility.

3. The few measures within Energy Strategy 2050 (mainly the “market bonus”) are necessary but not sufficient. There is need for improvements of the economic framework:
   - A new market design which compensates the many benefits of domestic hydropower (revenues)
   - Reduction of the burden of charges and taxes, particularly by a reform of the water tax (costs)
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Main Challenges of the Future

Profitability / Market Design

Renewal of Concessions

Maintenance

Hydropower in Switzerland

Climate Change

Environment
Maintenance

[Rehabilitation of the Illsee-Dam, Foto: Axpo, 2012]
Challenge 1: Maintenance of Existing Plants

Preservation of Existing Hydropower Generation needs Investments
 Maintenance of existing plants is estimated to need 1 bn. CHF/y and solution to technical challenges such as concrete swelling, hydro abrasion and reservoir sedimentation.
Climate Change

2050 Model
Bruno Nedela (ETH)
Challenge 2: Effects of Climate Change I

Change of the Hydrological Regimes (Quantity and Distribution)
Example of a forecast for the development of discharge in the catchment area of Aletsch until 2090 (mean scenario): first an increase, than reduction and shift in season

Annual hydrograph at the station Massa-Blatten, mean scenario
[Source: SGHL, 2011, and Alpiq, 2015]
Challenge 2: Effects of Climate Change II

New Lakes through the Retreat of Glaciers bring Opportunities and Threats

According to scientific models, hundreds of new lakes will arise in the Swiss Alps in the next decades, approx. 40 with considerable volumes > 10 Mio. m$^3$ (~ volume of Gelmersee)

Example

Lake Corbassière
New dam
50 Mio. m$^3$, 500 MW

Example

Lake Trift
New dam, Height 167 m
Volume 85 Mio. m$^3$
Energy content 215 GWh
Add. Generation 145 GWh/y

Excerpt of model for potential new lakes due to retreat of glaciers
[Own illustration; Source of information: Häberli, / UNIZ, 2012]
Environmental Requirements
Challenge 3: Increasing Environmental Requirements I

Very High Standards regarding Protection of Water Courses
Revised Law on Water Protection demands the minimization of negative effects regarding fishpassage, hydropeaking and bedload until 2030 for approx. 1 bn. CHF (grid charge)

Fishpassage
~1'000 hot spots

Hydropeaking
~100 hot spots

Bedload
~200 hot spots

(Revitalisation)
~4'000 km (80 years)

Handlungsbedarf Sanierungen Gewässerschutz gemäss Strategischen Planungen der Kantone
[Quelle: Bericht «Renaturierung Schweizer Gewässer», BAFU, 2015]
Challenge 3: Increasing Environmental Requirements II

Increasing Conflicts regarding Protection of Landscape/Nature Heritage
Expl.: Federal inventory of landscapes and natural monuments covers approx. 20% of the country, impeding extensions of existing plants and/or even renewal of concessions.
Renewal of Concessions
Ending of Concessions for Hydropower Plants brings Uncertainties

From 2017 to 2050 the concessions of around 70% of total annual HPP generation are to be renewed, bringing a lot of uncertainties

Effects:
- More stringent requirements re: residual water
- Open questions re: future ownership
- Open questions re: ensuring operation
- Claims for dismantling of plants
- ...
- etc.
Locations of Hydropower Plants vs. Locations of Main Shareholders
Approx. 80% of Swiss hydropower generation are located in five mainly alpine cantons, while the shareholders and their investments come from the cities and cantons in the plains.

Challenge 4: Renewal of Concessions II
Profitability / Market design
Challenge 5: Uncertain Profitability I

Falling Electricity Prices vs. a Lot of Costly Challenges in HPP
In the short run: no prospect of real improvement regarding wholesale market prices; in the long run: increasing prices likely but uncertain, depending also on «market design»

Short- and middle-term (until 2020):
No prospect of real improvement

Long-term (until 2050):
Increasing prices, mainly in winter?

Szenarien für die möglichen Entwicklungen der Strompreise in EUR/MWh bis 2050
[Quelle: Pöyry-Studie zur flexiblen Erzeugung, VSE 2012]

Main Requirement: Cost Reduction for International Competitiveness

In view of the typical cost structure of HPP in Switzerland two main measures: 1) cost reduction o+m; 2) reform of water tax with market-based approach and relief of producers.
Interim Conclusion III: Profitability as Key Factor

1. Hydropower in Switzerland is facing a lot of interesting challenges:
   - Expensive maintenance, complex technical problems
   - Climate change as opportunity and threat
   - Increasing environmental requirements
   - Renewals of concessions with uncertainties
   - Profitability as key-factor

2. In order to be able to meet the challenges and cope with the tasks, hydropower in Switzerland has to be made competitive for its survival in the international market.
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Conclusion I: Disbalance

very high expectations

no economic incentives, increasing demands
Conclusion II: Need for Action

1. Short-term:
   o Further reducing costs for operation and maintenance
   o Making use of the «market bonus» as urgent help
   o No additional demands without compensation

2. Middle-term:
   o Reform of water tax system (market-based approach)
   o Market design which benefits Swiss hydropower
   o European policy on reducing greenhouse gases

3. Long-term:
   o Reasonable ecological rehabilitation of plants
   o Increase capacity and flexibility, incl. storage volumes
   o Adapting hydropower plants to climate change
Thank you for your attention!

[Grimselsee; Photo: KWO / R. Bösch]