Schweizerisches Talsperrenkomitee
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COMMISSION INTERNATIONALE DES GRANDS BARRAGES
INTERNATIONAL COMMISSION ON LARGE DAMS

ICOLD TC Y – Theme 3
Role of hydropower in climate change and new energy mix

Increasing Swiss hydropower electricity production under climate change conditions

Case study: periglacial reservoirs in the Swiss alps and the new Trift hydropower plant

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Marseille, 28.05.2022

Summary

1. Main issues related to climate change
2. Effects of global warming on swiss rivers runoff regimes
3. Swiss Energy Strategy 2050
4. Finding best suited glacier retreat areas for new hydro schemes in Switzerland
5. Case study: retreat of the Trift glacier, new dam and hydropower plant
6. Challenges and innovation
7. Recommendations and lessons learnt

1. Main issues related to climate change

Tab. 1: Issues emerging due to climate change.

Issue	Solution
Continued glacier retreat	store the water coming from glacier melt
Shifts in the precipitation distribution and pattern	Use the earlier runoff from snow melt
More frequent flood events	improvement of flood protection, multipurpose uses of hydropower reservoirs
Additional or disturbed sediment input and corresponding reservoir sedimentation	Improved sediment control
Remaining risk of natural hazard from glacier ice break-off, snow avalanches and landslides with subsequent wave generation in the lake	Comprehensive natural hazard management

2. Effects of global warming on swiss rivers runoff regimes

- Changes in discharge conditions / production expectations
- More frequent and severe natural hazard events
- Increased sediment input into reservoirs

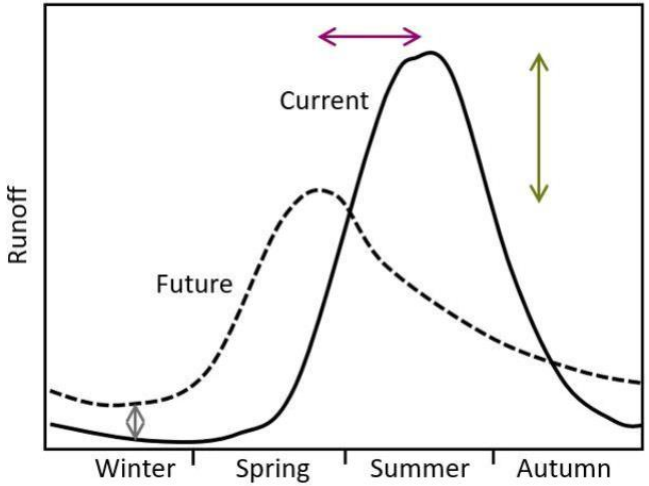


Fig. 1: Main effect of climate change on swiss rivers runoff regimes [1].

3. Swiss Energy Strategy 2050

3 pillars:

– Planned phase out of nuclear power
– Increase renewable energies (excl. hydropower) by 3 times until 2035
– Increase the efficiency of energy consumption (43% less energy per capita consumption until 2035 in respect to 2000)

Role of hydropower

– Total production increase of 2.5 TWh/a is expected by 2050

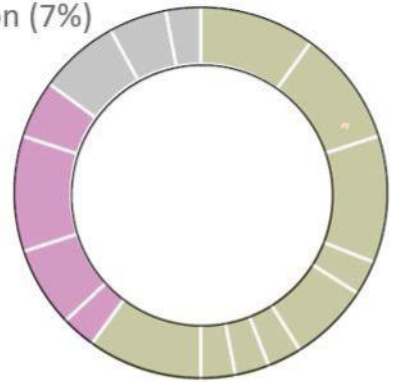
Glaciers will melt by 60% (RCP 2.6), resp. 95% (RCP 8.5) until 2100 in Switzerland

→ Glacier basins can be converted into reservoirs

4. Finding best suited glacier retreat areas for new hydro schemes in Switzerland – multipurpose point of view

SOCIETY (15%)

- Degree of protection (7%)
- Land use (5%)
- Tourism (3%)



ECONOMY (60%)

- Installed capacity (10%)
- Annual electricity production (10%)
- Investment costs (11%)
- Evolution of annual runoff (3%)
- Reservoir sedimentation (7%)
- Earthquake vulnerability (3%)
- Impulse wave vulnerability (3%)
- Flood protection (3%)
- Flexibility and storage capacity (10%)

ENVIRONMENT (25%)

- Visibility from settlements (3%)
- Environmental flow (7%)
- Sediment continuity (10%)
- Hydro- and Thermopeaking (5%)

Fig. 2: Weighting of factors to find best suited glacier retreat areas for new hydro schemes in Switzerland with an RCP 4.5 until 2100 [2].

5. Case study: retreat of the Trift glacier

Glacier in central Switzerland (Canton Bern)

Length: 3.7 km (2013)

Area: 14.5 km^2 (2013)

Annual retreat of about 90 m

Fig. 3: Location of the Trift glacier.

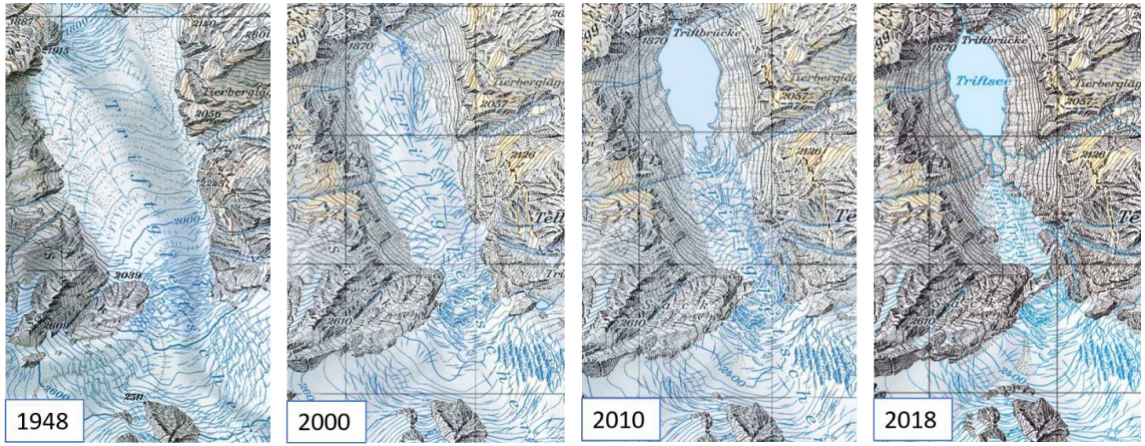


Fig. 4: Retreat of the Trift glacier between 1948 and 2018 © swisstopo.

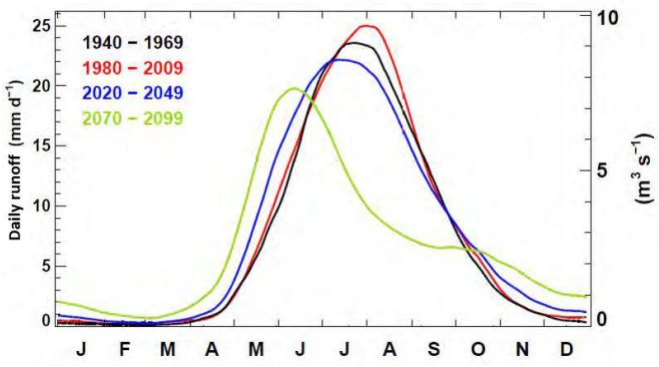


Fig. 5: Runoff forecast until 2100 for the Trift glacier [3].

5. Trift Glacier – Project overview

Construction of a new reservoir (85 mio. m^3)

Predicted annual production: 145 GWh

Dam height ~170 m

Construction time ~8 years with commission in 2035

Investment cost: 361 mio. EUR

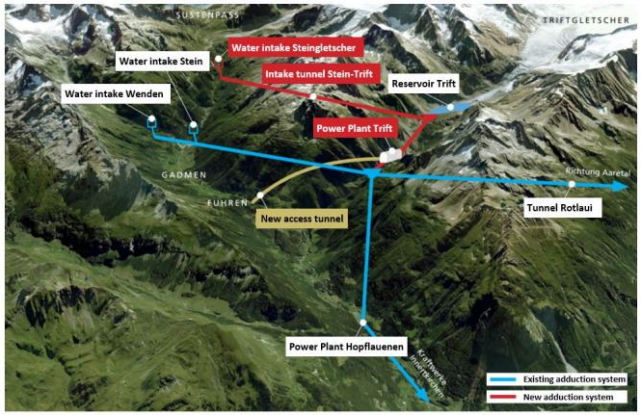


Fig. 6: Existing and new hydraulic components of the Trift storage plant [4].

Fig. 7: Visualisation of the future Trift dam and periglacial reservoir [4].

6. Challenges and innovation

- ✓ New strategies for hydro systems are needed to meet the swiss energy strategy 2050: new reservoirs can replace the storage function of melting glaciers

- ✓ Glacier retreat can increase erosion and sediment transport: comprehensive sediment management is essential

- ✓ Climate change modifies hydrological patterns: new head reservoirs improves flood routing

7. Recommendations and lessons learnt

- Conception of new multipurpose reservoirs must consider multiple effects (economics, societal and environmental)

- In addition to the construction of new hydropower plants, the extension (heightening of existing dams) and optimisation (pumped-storage plants) of the existing hydro project offer alternatives

- New strategies for hydro systems are necessary to meet the needs of power generation, reliability and flexibility of supply, operational profitability, and ecosystem protection under conditions of more fluctuating demand

Thank you for your attention

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Bibliography

[1] Boes R. M. (2018). *Wasserkraftpotential in den (vergletscherten) Schweizer Alpen.* SCCER-SoE Annual Conference 2018.

[2] Ehrbar, D. (2018). *Hydropower potential and reservoir sedimentation in the periglacial environment under climate change*. VAW-Mitteilung 248 (R. Boes, ed.), Laboratory of Hydraulics, Hydrology and Glaciology, ETH Zurich.

[3] SCCER-SoE (2019). *Climate change impact on Swiss hydropower production – Synthesis Report*. Swiss Competence Center for Energy Research – Supply of Electricity. Zürich, Switzerland.

[4] https://www.grimselstrom.ch