

Renewal of alpine hydroelectric plants according to the spatial and temporal scales of analysis

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Introduction

Since the adoption of the "Energy Strategy 2050" by the Federal Council in 2017, Switzerland has been looking for new energy alternatives to the nuclear sector and ways to reduce its greenhouse gas emissions, in particular by promoting the development of renewable energies. The national hydroelectric park, which represents 59% of total energy production, has an essential place in this context of upheaval in electricity supply. In the coming years, more and more existing power plants will come to the end of the concession. In this transitional period, they must be the subject of interventions to adapt their installations and operations to future economic, energy, legislative and environmental contexts. The main objective of the project is the development of a methodology to identify and promote technical solutions to increase winter energy production and operating flexibility. It consists of a first step of diagnosing the installations reference state and then a second step of generating and analysing renewal variants. It is then applied to the case study of the Forces Motrices de Conches (GKW) and the Forces Motrices Valaisannes (FMV) power plants in Haut-Valais.

Methodology

The general methodology followed in this work consists of three main steps. First of all, the establishment of the existing system reference state aims to study the existing power plants and their environment in order to choose the spatial and temporal scales of analysis and to identify the potential for optimising operation. Renewal variants are generated according to the identified intervention possibilities. These variants are then compared using multi-criteria analysis, modelling and pre-dimensioning to produce final recommendations.

The choice of the spatial scale of analysis is intended to limit the scope of investigations for the generation of renewal variants. The approach of choice proposes to evaluate at different scales the additional potential of existing facilities and their environment in order to achieve the project objectives. If large-scale surveys are required, a simplified cost calculation of an extension of storage capacity should allow for a comparison of construction costs and potential winter production gains.

Preselection is carried out to evaluate and compare the variants using criteria on energy, technical, environmental and social aspects. Finally, a second comparison based on the results of this in-depth analysis should lead to recommendations for final solutions.

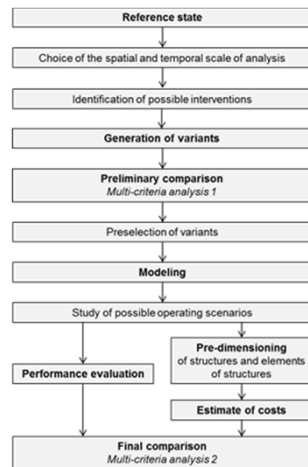


Figure 1: General approach for a hydroelectric facilities renewal project

Case study

The project applies to the Heiligkreuz (GKW), Ernen and Mörel (FMV) power plants located on the left bank of the Rhône in Haut-Valais, Switzerland.

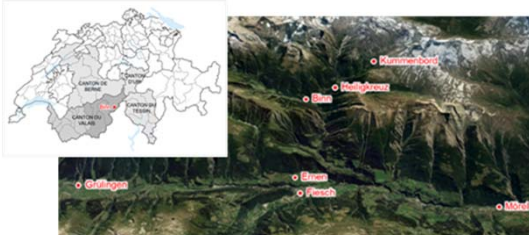


Figure 2: Geographical location and topography of the case study region

The system has an installed capacity of 119.5 MW for an annual production of 448 GWh. Seasonal transfer of inputs is not feasible in the current state of the facilities and winter production represents between 1/10 and 1/4 of the annual production depending on the plant.

Rivers and intakes in the study area are not instrumented and the required hydrological data are only partially available. The operating data from the Heiligkreuz, Ernen and Mörel power plants and the Rhone flow measurements at Reckingen provided by the FOEN are therefore used to reconstitute the water inflow curves at the intakes.

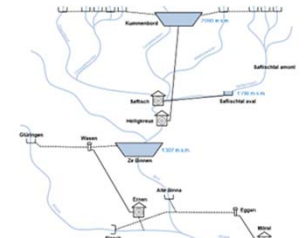


Figure 3: General scheme of the current facilities

Results

The procedure for generating adaptation concepts enables the development of 18 local variants and sub-variants based on the intervention types identified in the previous step. They can be divided into two main groups according to whether they aim to specifically optimize the use of Lentalwasser inflows or whether they propose to exploit the potential of the Saffischthal. The three of them that are preselected provide an increase in production thanks to two new power plants and seasonal storage possibilities thanks to a large capacity reservoir upstream of Kummembord and new pumping systems between Ze Binnen and Kummembord.

Hydraulic modelling of operating scenarios and energy performance assessment show an increase in the annual production of the three main power plants.

	Variant n°2		Variant n°4		Variant n°6	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
Heiligkreuz	+8.53%	+8.53%	+6.65%	+5.40%	+4.29%	+1.46%
Ernen	+6.78%	+6.71%	+6.55%	+6.47%	+6.47%	+5.82%
Mörel	+6.12%	+6.16%	+5.81%	+6.07%	+5.77%	+5.69%

Figure 4: Rate of increase in annual production from existing plants

The development of scenarios based on the seasonal transfer of inputs also provides an opportunity to rebalance the annual distribution of production by increasing winter supply.

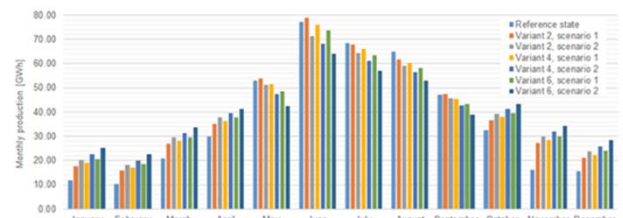


Figure 5: Monthly total production of the system in the different scenarios

The economic evaluation of the variants shows a decrease in the profitability of the largest variants due to high construction costs. A balance must therefore be found between the advantages of winter supply and the expected financial benefits.

Conclusions

The application of the methodology to a case study in Upper Valais provided different variants to achieve the objectives of increasing energy production and developing operational flexibility and seasonal storage for winter supply. It has been established that the GKW and FMV power plants in the Conches Valley have a real potential for optimization. Variants with large storage capacities have been selected and submitted for further study. Finally, modelling and pre-dimensioning steps demonstrated their relevance to the project objectives.

One of the avenues for continuing the project could be the instrumentation of strategic points of the system in order to ensure better monitoring of the available hydrological inflows and to consider optimising operation up to the limits of the current and future concession.

References

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