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Hydropower investment profitability under different water fee systems

HP-Future interim project report

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Purpose

The goal of this paper is to assess the profitability of investment in hydropower (HP) under different water fee systems. More precisely, we investigate the investments of 62 existing Swiss HP companies, consisting of 148 installations. By "investments" we mean the remaining capital – equity and debt – to be amortized up to the end of the current concession. Based on the calculated net present value (NPV), we evaluate the profitability of the investments of Swiss HP plants under three water fee systems. The selected water fee systems are the following:

1. **No-fee system**
2. **Fixed-fee system**, which is based on theoretical power combined with annual hydrological conditions (current system).
3. **Semi-flexible** or **fixed and variable fee system**, with 50% based on fixed system and 50 % based on fluctuating electricity prices.
4. **Profit-based imposition system**, which is based on the profit made by companies.

We compare the variations of the NPV for individual facilities, with the inclusion of 4 electricity price scenarios and the 4 water fee systems. We include a 5th water fee system – an equalization found based system, which consists of a solidarity mechanism between facilities – but we do not assess it through our simulation. This system is only mentioned qualitatively to raise the discussion about the pros and cons of various systems.

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70 NRP Energy Turnaround National Research Programme

Introduction

In the past decade, the Swiss power landscape has experienced major changes, starting with a wave of liberalization of the electricity market. The end of the monopoly system resulted in a change in the pricing system, as companies were not as strongly linked to their consumers as they were in the recent past. Major drop in the electricity prices on the open market made it harder for companies to allocate a part of their revenues to the water fees.

Due to its role in the final costs for electricity companies, the water fee system is at the centre of a political debate for its modification or to keep the status quo. Various actors in the electricity scene are debating on the question of what system should be used. The main conflicts seem to arise between the conceding authorities, which benefit from a relatively stable and ensured source of income, and the companies, which suffer from unstable and currently low electricity prices, while still imposed on a steady and rigid fee system. As a result of this debate, various water fee systems have been suggested. We investigate 4 specific system under the scope of the NPV based on existing power facilities, including the currently used mechanism, a price-based semi-flexible system and a profit-based flexible system.

Method and data

We assess the companies' investments on the basis of the NPV. The investment represents the remaining capital, including the equity and debt, to be amortized up to the end of the concession of each facility. To calculate the NPV of each facility, we use a series of data based on the annual report of the concerned facilities for the years 2015 and 2016. In total, the data gather 148 installations of 62 companies. While we do include standard maintenance into our simulations, the latter are based on the assumption that companies proceed no major new investment (e.g. new turbines, increased storage capacity, etc.).

We use the four electricity price scenarios developed by the University of Basel (Schillinger et al., 2017) for our investigations: 1. *Base*; 2. *EU* ; 3. *C++F++* and 4. *C-F-*. Those prices are based on the model *Swissmod*, which optimize the Swiss system, including the HP sector. This model enables the production of list of prices. Those prices are then used to optimize the HP facilities and calculate the revenues for each company. From 2030 and further on, the revenues are considered stable.

Finally, we integrate the water fee based on the data provided in the annual report. The current system used is fixed, equivalent to CHF 110/kW. This corresponds to the current Swiss system, and the value of CHF 110 is the cap imposed at the federal level. Thereafter, we calculate the NPVs with a discount rate of 5% for 3 additional water fee systems: 1. *No water fee*; 2. *CHF 50/kW + Var*, corresponding to a fixed fee of half the past fee and the additional fee being calculated based on the fluctuations of the mean electricity market prices; 3. *Profit-based*, corresponding to a water fee calculated on the profit margin for each company.

Results

The main results of this study are presented in a graphical way in

Figure **1**. First, the scenarios are sorted from the top left to bottom right, from the most to the less profitable one for the HP sector (EU, C++F++, Base, C-F-). For each graph, we compare the current NPV value (based on the current CHF 110/kW system) to the NPV of a new water fee system. The X-axis present the current NPV, while the Y-axis presents the NPV under the new system. For each graph, we add the identity (black line) as a reference. Every dot on that line represents an unchanged NPV, compared to the basis scenario. Each dot above or below the line represents a better or worse situation in the considered scenario, respectively.

The values on the X-axis and Y-axis are normalized based on the highest NPV value overall (highest value from all the scenarios and all HP companies). This choice was driven by the data limitation and to avoid misleading the reader with a risk of difficult interpretation of the numbers.

No fee

This scenario mainly provides us insights in the role played by the imposition of a water fee. Following the results, the imposition of a water fee seems to play an important but not game-changing role for the evaluation of the NPV, as the NPV without fee increases between 0 and 0.1 points in most cases. However, in the worst scenario for the HP sector (C-F-), the presence of the water fee defines whether a NPV turns positive or negative, and can as such play a major role.

CHF 110/kW

Compared to the system without fees, the fixed fee tends to charge more the facilities with a high NPV value, and therefore tends to flatten the differences between the lowest and highest NPV values. On the other side, the comparison between the four price scenarios shows that the fixed fee has a higher influence on the definition of the NPV, leading to an increased vulnerability of the HP sector to price scenarios and therefore worst financial years.

CHF 50/kW + Var

The system is calibrated at CHF 100/kW over the last 10 years. Under this calibration, the changes between a fixed and a fixed-variable fee seem marginal. The fixed-variable tends to increase the charged fee in the best scenarios and decrease it when the situation worsens, therefore increasing the income of conceding authorities during the best years and decreasing it during the worst ones. However, this system seems unable to change the rules of the game by turning yet unprofitable investments into profitable ones.

An important point to highlight is the calculation of the variable part, as the latter is based on the mean electricity price on the market. This system is likely to advantage storage HP facilities with low discharge duration and able to quickly produce relatively large amount of electricity, as such facility may strategically target to take financial advantage of peak prices.

Finally, an additional consequence of this system is that it increases the sharing of the financial risk between the company and the conceding authority. Indeed, accordingly to our scenarios, the revenues

of the conceding authorities from water fees fluctuate between +31% to -21%. This aspect is closely linked to an indirect effect that we don't consider in our simulation. By diminishing the risk taken by companies (due to the increased sharing of risk between companies and conceding authorities), the discount rate is likely to decrease as well. As HP facilities are characterised by capital-intensive assets, this decrease of the discount rate could constitute a critical change for the sector.

Profit-based

By imposing a fee based on the profit, this system benefits to the companies in the worst situation, while disadvantages those in the best situations. Related to economic theory, the value of the fee should be directly linked to the value of the resource (Amundsen et al. 1992). In the HP sector, the quality of the resource – and therefore its value – largely varies between cases, leading to large differences in the benefits realized between the companies, which do not benefit from the same quality of the resource. To the contrary of fixed fee systems, the profit-based system enables to balance those differences. As a result, our simulation shows that a profit-based system tends to increase the financial robustness of HP facilities in the worst scenarios, compared to the fixed-variable system. Another consequence lies mainly with the conceding authority, which has to carry a larger risk, as the income from water fees can fluctuate from +400% to -60%. For this system, we consider a profit taxed at 40 %. This rate is, of course, arbitrary, and its level should be discussed.

Equalization found system

We do not assess this system through this analysis, as it would require setting a series of parameters that are not accessible currently – they could be developed for instance with stakeholder processes. However, this system is presented here because it can foster a fruitful discussion about its advantages and disadvantages.

The principle is rather simple, as it implies an extra fee imposed on facilities in good situations to subsidize facilities that are in critical financial situations. As the liberalization of the market has drastically changed the rules of the game, some investments made by companies decades ago have turned into stranded assets. Furthermore, due the fixed fee system imposed up to now, companies with the most valuable resources have benefits from a relatively low imposed fee, as this aspect was not considered. However, it is worth mentioning that a few companies proceeded to a series of investments during the controversial discussion about market liberalization, which shows that investors didn't perceive it as a threat. Finally, this system could provide an emergency fund for the worst years, as the contribution to the fund would be reduced, and less profitable companies could still benefit from subsides.

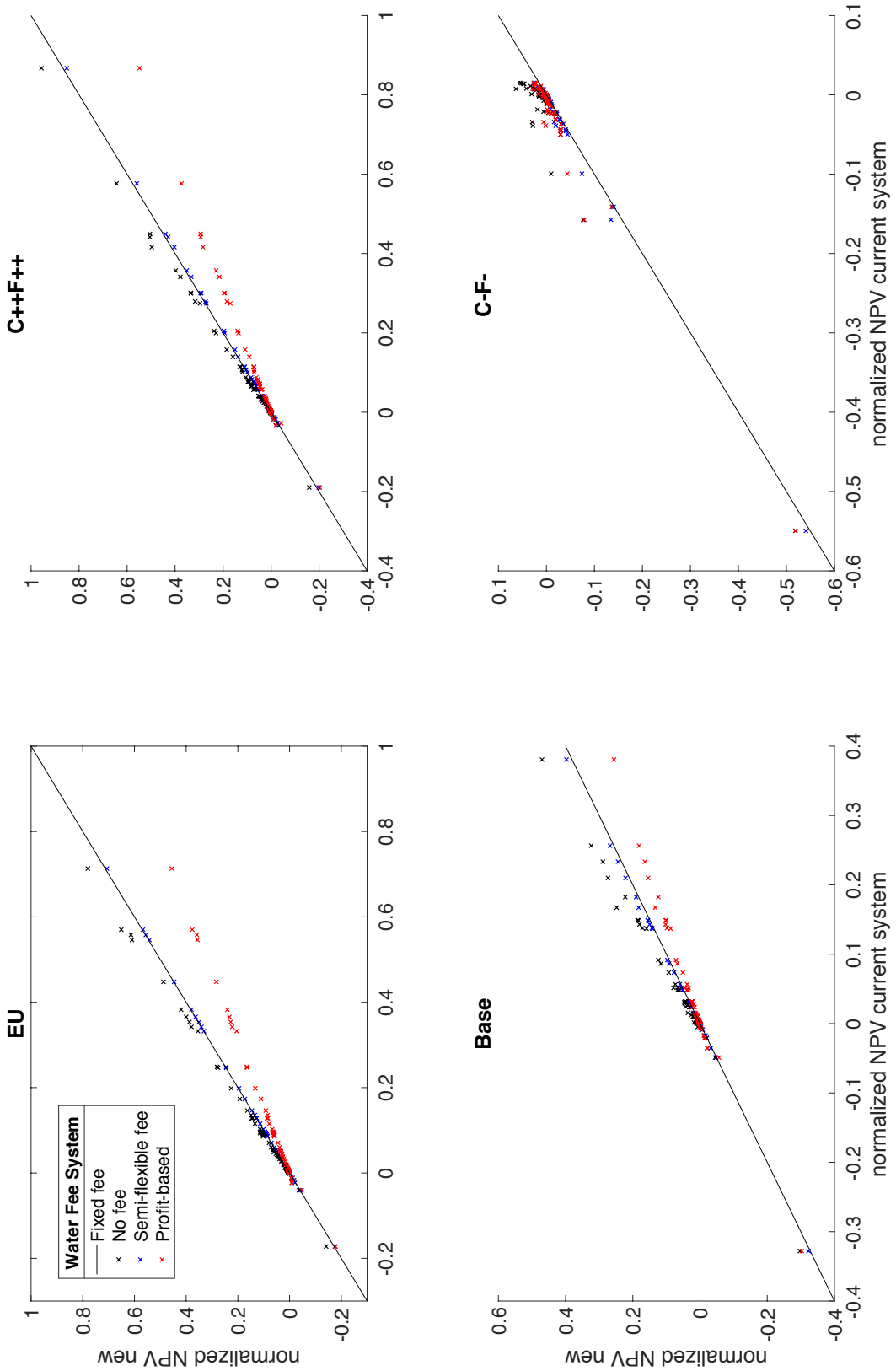

Figure 1: Variation of normalized NPV accordingly to the four water fee systems and electricity price scenarios

Discussion

As mentioned already, the used data suffers from some limits, notably due to the limited years available (2015 – 2016), used for our simulation. A larger period would have enabled us to benefit from a steadier basis for our estimations. Also, we have analyzed 3 different systems – four with the inclusion of no-fee system -, without any modification in the parameters (e.g. change in the amount of the fixed fee, the part between fixed and variable fee or the imposed tax rate for the profit-based system). Changing some of those parameters could fine-tune the results in order to select the most adapted system to meet the most challenging aspects of the current financial context faced by the HP sector. Finally, all the results are intrinsically linked to the price scenario considered. Yet, the latter should not be considered as forecasting material.

It is essential to keep in mind that this report only aims at highlighting some critical questions related to water fee systems, rather than providing the actual parameters that must be considered. Those questions include the system for risk distribution between conceding authorities and companies involved, criteria for the calculation of the fee (theoretical power, value of the resource, price on the electricity market) and the level of solidarity that must be reached within the HP sector.

Conclusion

With this study, we present a series of 4 systems (no-fee, fixed system, fixed-variable system, profit-based system) and include some discussion aspects for an additional system based on the equalization principle. Currently, the fixed system is used through the Swiss cantons, with a maximal cap set at CHF 110/kW, calculated on the theoretical power. The no-fee system is presented mainly for emphasizing the role played by the current water fee in the financial situation of the Swiss HP sector. Besides, innovative systems (profit-based, equalization found) have been analyzed and discussed, and enlightens the discussion about the pros and cons of alternative systems, compared to those mainly discussed for future applications in the Swiss system (fixed and fixed & variable).

As shown, a profit-based fee reaches a fairer imposition system relative to the variability of the quality and value of the resource exploited by companies. Fixed systems do not allow such flexibility and impose a fee based on the theoretical power. This situation leads to high disparities between financial situations of studied facilities.

However, it is clear that essential aspects are not discussed in this study, such as the political challenges of each system, notably the issues they can raise between concerned parties and the opposition they can face between miscellaneous interests.

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