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The Future of Swiss Hydropower:
Water Fee-induced Financial Flows in Switzerland

Final Report
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70 NRP Energy Turnaround
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Preamble

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. It particularly 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 2014. During the project the discussion on adjustments of the Swiss water fee framework emerged, leading to an extension of the project to answer the following questions:

4. What are the ***distributional effects*** of different ***water fee reform*** options?
5. What are regional, fiscal and economic ***feedback effects*** of those changes?

This final report provides a summary of the main findings to questions 4 and 5 from a public finance and regional development perspective. It complements the interim report by Betz et al. (2018), entitled "The Future of Swiss Hydropower: Distributional Effects of Water Fee Reform Options", and contributes to the final report of the overall project "The Future of Swiss Hydropower: Realities, Options and Open Questions".

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Executive Summary

Hydropower is a central pillar of the Swiss energy system and of the local economies in many mountain areas, especially in the Swiss Alps. It is to play a key role in mitigating climate change and phasing out nuclear energy, such as envisaged with the Energy Strategy 2050. But, due to market liberalization and low electricity prices on the European market, the profitability of hydropower plants came under pressure in the past decade. As a consequence, the distribution of the water resource rents is politically debated, and no compromise has been found so far among the different stakeholder groups. Those can mainly be separated into representatives from mountain cantons and lowland cantons. As defined in the federal constitution, the former are the 'waterlords' that hold the property rights on the natural resource water. They have the right to grant water-use concessions and receive royalties, the so-called 'water fees', from the hydropower companies. The latter, in turn, are mainly owned by lowland cantons, who are the principal shareholders of Swiss electricity companies.

The water fees constitute an important source of public revenue in many mountain cantons and municipalities. The rules of implementation and the maximum rate the cantons can apply is defined in the federal Water Rights Act (Wasserrechtsgesetz, WRG), which has been established in 1916. Since then, the water fee rate has been increased several times by the federal parliament. Currently, the maximum rate is fixed at CHF 110 per kilowatt installed capacity, while the applied rate is adjusted to hydrological fluctuations. It is physically determined and does not account for economic facts, such as fluctuating electricity prices. This is a political-economic consequence of the original debate at the beginning of the 20th Century and the separation between the owners of the water resources and the capital in the hydropower companies. However, with the ongoing liberalization of the electricity market the producers' and distributers' monopoloy rents partly disappeared. As a consequence, the battle about the distribution of water resource rents has been relaunched.

The current regulation with a fixed maximum rate is extended until the end of 2024, while different options are under consideration to launch a new era of hydropower. These options include, amongst others, flexible water fees fully or partly accounting for electricity price variations, and an integration in the federal and cantonal fiscal equalization schemes. The latter refer to the transfer of fiscal resources across jurisdictions with the aim of reducing fiscal disparities, i.e. the differences in public revenue raising or in fiscal capacity among territorial entities (e.g., cantons, municipalities), and to allow sub-national governments to provide their citizens with similar sets of public goods and services at a similar tax burden. On the national level, fiscal equalization does not account for royalties from natural resources, while the water fees are included in the inner-cantonal schemes in the two mountain cantons of Grisons and Valais. Those two cantons are the largest recipients of water fee payments. In addition, they play a crucial role in the ongoing debate, since municipalities with hydropower plants participate in the water fees. Accordingly, distributional effects of alternative water fee schemes and their feedback

effects on regional economies and public finance must be carefully analyzed. The present study fits into this gap.

Water fees are a means of sharing resource rents – not costs

A resource rent is a surplus resulting from the conversion of a natural resource (waterpower) into a marketable product (electricity). It is defined as the difference between the price of this good and the unit cost of turning the natural resource into the good, which – in the first instance – flows as an income to the holder of the property or use rights in that resource. Though this differs from the return on capital in form of profits, there is no windfall from hydropower without investments that ultimately allow to exploit the power of nature. Accordingly, the value of hydropower is derived from the united application of labour, capital and natural forces and, from a distributional perspective, divided among the employees as well as the owners of the capital and the water resources under the names of wages, profits and royalties (water fees). In addition, some share of the resource rent is generally diverted to the 'public hand' by means of corporate taxes. Altogether, this underlines the role of water fees as an element of sharing resource rents, and thus as an instrument of revenue sharing. This is a distributional concern, rather than a cost factor, and an element of corporate social responsibility.

Water fees are important for public finance in some cantons and municipalities

Given the locations of hydropower plants in the Alps and along the main rivers Aare and Rhine, the water fees are unevenly distributed. Six cantons (VS, GR, AG, TI, BE and UR) receive more than 80% of the total water fees, while Valais and Grisons alone count for roughly 50%. But the importance of water fee receipts for public finance is quite different. In Uri, water fees make up more than 25% when compared to tax revenues and more than 6% of the canton's total revenues. In Grisons, these figures are about 15% and 5%, respectively. Moreover, hydropower and water fees play an important, almost decisive role in many mountain areas, especially in the concession municipalities of Grisons and Valais. They receive revenues in form of water fees, concession levies and partly taxes paid by hydropower companies and their employees, but also benefit from free and preferential energy and other services provided by the companies. Though the situation and potential of the different municipalities are quite diverse, it seems that the majority of these revenues flows into the maintenance of municipal infrastructure and community owned enterprises, as well as into tourist facilities. In addition, some municipalities use water fee revenues to improve their attractiveness with low taxes and other bonuses. This induces indirect effects that exceed the direct value added (income) generated by hydropower operations, especially in peripheral and economically weak areas in the Swiss Alps.

The water fees are ultimately paid by the owners of hydropower companies

Ownership is crucial, when it comes to the analysis of distributional effects induced by hydropower. First, as mentioned above, there are the water fee payments to the cantons and partly municipalities where the hydropower plants are located. Second, there are profits (dividends and retained profits) the ultimate shareholders of hydropower benefit from. However, in recent years, most companies made

losses and did not pay dividends. Moreover, the attribution of dividends to the effective operation of hydropower is not feasible with the current ownership structure with large utilities owning shares in various production units and local hydropower companies ('Partnerwerke'). In contrast, the attribution of the water fee payments to the ultimate shareholders of hydropower production is feasible. It shows, for example, that 35.5% of the water fee payments to Grisons can be attributed to the canton and city of Zurich, who indirectly 'pay' this share in the fees through their shareholdings. The canton of Grisons and its municipalities 'pay' themselves 17.3% of their own water fees. Those are the major shareholder groups in Grisons' hydropower. On the national level, the main shareholders in hydropower are Zurich (canton and city) with almost 15% followed by neighboring countries and private investors with 12% and 9.5%, respectively. The next important shareholders are the cantons and municipalities of Aargau (8.4%) and Bern (7%), followed by Valais (4.7%), Ticino (4.6%) and Grisons (3.9%) as well as the SBB with 4.8%. Based on these facts the prospective profits and the attributed water fee payments must be taken into account when discussing the distributional effects of alternative water fee regimes.

Hydropower and tourist municipalities would be the most affected by lowering water fees in Grisons

In the canton of Grisons, the water fees are equally shared among the canton and the concession municipalities. Moreover, the water fees are accounted for in the inner-cantonal fiscal equalization system, namely through the resource equalization scheme. This aims at reducing disparities that accrue from the uneven distribution of revenue raising potentials, including taxes and water fees, as the latter account for up to almost 80% of the municipal resource potential, in the extreme. However, thanks to the resource equalization and the cantonal waterworks tax (the cantonal share in the water fees) all municipalities in the canton can benefit from water fees. Consequently, all municipalities would suffer from lower and benefit from higher water fees, respectively. Both effects would be transmitted and mitigated by the resource equalization system. Nonetheless, Grisons municipalities would be differently affected by changing water fee regimes. Among the resource-strong municipalities those without other pillars than revenues from hydropower and water fees are the most vulnerable to a substantial reduction in water fee payments. Most of them would lose potential and might become resource-weak if the water fees were totally abolished. In contrast, the resource-strong touristic municipalities would have to pay more into resource equalization in this case. However, one must be aware that these municipalities largely depend on tourism, another industry that is generally considered as structurally weak. This might cause additional pressure on the regional economies in mountain areas that have their comparative advantages in tourism and hydropower.

Resource-strong hydropower municipalities might benefit from flexible water fees

Flexible water fees might also involve periods with payments above the current level of 110 CHF/kW. In such situations, those municipalities that are the most vulnerable to lowering water fees would also be the main beneficiaries with regard to resource equalization and public finance in case of increasing water fees. These municipalities also constitute the group of major water fee recipients in the canton. In

addition, currently resource-weak municipalities receiving water fees could become resource-strong in this case. As a result, they would also have to pay into resource equalization and not being recipients of transfers anymore. All in all, this illustrates the power of solidarity built in the cantonal fiscal equalization system of Grisons.

Water fees and fiscal equalization do not have the same role on cantonal and national levels

When analysing changes in the current water fee scheme in Switzerland, the impact on the local finance and fiscal equalization in the affected cantons must be taken into account. The latter primarily aims at reducing disparities. As a consequence, the principles applied are the same across Switzerland. However, different circumstances and preferences lead to differences in the measurement of the resource potential and cost elements at the national and cantonal levels, and thus to differences in the fiscal equalization schemes. The inclusion of water fees in the resource equalization of the cantons of Grisons and Valais, as well as the request to also include it in the national resource equalization must accordingly be considered against this background. In Grisons and Valais, substantial royalties flow to those municipalities where the hydroelectric power plants are located. The resulting inner-cantonal disparities are mitigated by the cantonal resource equalization. On the national level, water fees seemingly contribute less to the creation of inter-cantonal disparities. Rather, the financial flows within the national resource equalization generally exceed those of water fees substantially, at least for the resource-weak cantons, with the sole exception of Grisons. The latter is a good example to illustrate the role of water fees and fiscal equalization and their impact on municipal and cantonal budgets. But it also reveals that one must expect induced impacts on public expenditure, and thus on the economic development on the cantonal and municipal level. These must additionally be examined in order to draw a complete picture of the prospective impacts from changing the water fee scheme. Indeed, changes in royalties and dividends will have an impact on the economic and social development and employment in peripheral communities. Ultimately, those are social and political issues that require political-economic decisions in the federal system.

Toward a new era of hydropower – and transparency

In this regard, it is also important to notice that the water fees (royalties) represent only a part of the resource rents arising out of the use of hydropower. By focusing on water fees, the dividends mainly flowing to lowland cantons – but also to mountain regions – are neglected. In economically prosperous periods, those are at least equally important as the water fees, and therefore must also be taken into account if the water fees in the national fiscal equalization should be considered. To this end, transparency is required. Together with accountability and responsiveness, it is a core criterion of good governance, both corporate and public. This is a major challenge that must be addressed by the industry and its shareholders on the way to market liberalization and in a new era of hydropower.

Zusammenfassung

Die Wasserkraft ist ein zentraler Teil des Schweizer Energiesystems und eine wichtige Einnahmequelle für die Berggebiete. Im Rahmen der Energiestrategie 2050 soll sie einen verstärkten Beitrag zur inländischen Stromproduktion und Stromspeicherung aus nachhaltigen Quellen leisten.

Streit um die Wasserzinsen

Die Rentabilität der Schweizer Wasserkraft kam aufgrund niedriger Strompreise auf dem liberalisierten europäischen Markt im vergangenen Jahrzehnt stark unter Druck. Dies hat in der Schweiz zu einer politischen Diskussion um die Verteilung der Netto-Erträge (Ressourcenrente) aus der Wasserkraftnutzung geführt. Auf der einen Seite stehen die Vertreter aus Bergkantonen, welche die Eigentumsrechte am Wasser besitzen. Sie können den Betreibern der Wasserkraft Nutzungsrechte gewähren und erhalten dafür eine Entschädigung, die sogenannten Wasserzinsen, welche einem Teil der Ressourcenrente entsprechen. Auf der anderen Seite stehen vereinfacht gesagt die Mittellandkantone, welche die Hauptaktionäre der Schweizer Elektrizitätsunternehmen sind und dadurch auch grosse Anteile an den Wasserkraftwerken in den Alpen besitzen. Mittels Wasserzinsen werden die Netto-Erträge aus der Wasserkraft unter den beteiligten Akteuren verteilt.

Wie oben erwähnt stellen die Wasserzinsen für die Bergkantone und viele ihrer Gemeinden eine wichtige Einnahmequelle dar. Die Höhe des zu bezahlenden Wasserzinses hängt von der installierten Leistung der Kraftwerke ab und ist im Wasserrechtsgesetz (WRG) auf derzeit CHF 110 pro Kilowatt festgelegt. Dieser Höchstsatz wurde im Jahr 1916 zum ersten Mal nach physikalischen Kriterien festgelegt und seither mehrfach erhöht. Entgegen dem Interesse der Elektrizitätsunternehmen in der jüngeren Vergangenheit berücksichtigt er historisch bedingt jedoch keine wirtschaftlichen Fakten wie schwankende Strompreise. Nach einer langen Ära mit guten Gewinnen fordern diese nun eine Flexibilisierung des Wasserzinssystems.

Ein neues Wasserzinsmodell ist frühestens ab 2025 zu erwarten. Dies, nachdem die derzeitige Regelung mit einem fixierten maximalen Wasserzinssatz vom Bund bis Ende 2024 verlängert wurde. Aus Sicht des Bundes sollen die kommenden fünf Jahre dazu genutzt werden, verschiedene Optionen eines neuen Strommarktdesigns zu prüfen. Dazu zählt unter anderem ein flexibles Wasserzinssystem, das Schwankungen bei den Strompreisen teilweise oder ganz berücksichtigt. Eine andere Idee zielt auf die Einbindung der Wasserzinszahlungen in den Finanzausgleich auf nationaler Ebene ab. Gegenwärtig berücksichtigt dieser keine Nutzungsgebühren für natürliche Ressourcen. Ausser in den Kantonen Wallis und Graubünden; hier sind die Wasserzinseinnahmen Teil des innerkantonalen Finanzausgleichs.

Rolle der Wasserzinsen für die öffentlichen Finanzen

Die beiden Kantone Wallis und Graubünden sind aufgrund der zahlreichen grossen Wasserkraftwerke die grössten Empfänger von Wasserzinszahlungen. Da Gemeinden mit eigenen Wasserkraftwerken im Berggebiet ebenfalls Wasserzinsen zahlen und die Wasserkraft vielerorts ein bedeutender

Wirtschaftsfaktor ist, müssen die Auswirkungen alternativer Wasserzinsregelungen sorgfältig untersucht werden.

Aufgrund der Standorte der grössten Wasserkraftwerke in den Alpen entlang der Hauptflüsse Rhone und Rhein sind die Wasserzinseinnahmen ungleich verteilt. Sechs Kantone (VS, GR, AG, TI, BE, UR) erhalten mehr als 80 Prozent der gesamten Wasserzinsen, wobei das Wallis und Graubünden alleine rund 50 Prozent einnehmen. Die Bedeutung der Einnahmen für die öffentliche Hand ist jedoch ganz unterschiedlich. In Uri machen die Wasserzinsen im Vergleich zu den Steuereinnahmen mehr als ein Viertel und im Vergleich zu den Gesamteinnahmen mehr als sechs Prozent aus. In Graubünden liegen diese Werte bei etwa fünfzehn respektive fünf Prozent.

Für viele Konzessionsgemeinden im Wallis und in Graubünden spielen Wasserkraft und Wasserzinsen aber eine wichtige, fast existenzielle Rolle. Sie erhalten Einnahmen in Form von Wasserzinsen und Konzessionsabgaben und an einigen Orten auch einen Teil der von Wasserkraftunternehmen und ihren Mitarbeitenden bezahlten Steuern. Die Gemeinden profitieren aber auch von einem Anteil kostenloser sowie weitere, zu Vorzugsleistungen angebotener Energie samt Infrastrukturleistungen der Elektrizitätsunternehmen.

Ein Grossteil dieser Einnahmen fliesst in vielen Gemeinden in die Instandhaltung der kommunalen Infrastruktur sowie der gemeindeeigenen Unternehmen. Zusätzlich werden mit den Wasserzinsen touristische Einrichtungen finanziert und unterstützt. Einige Gemeinden leisten sich dank den Einnahmen aus der Wasserkraft auch einen tieferen Steuersatz und bieten ihren Einwohnern und Unternehmen etwa vergünstigte Stromtarife, um die Standortattraktivität zu steigern. Dies führt zu indirekten Effekten, die über die direkte Wertschöpfung (Netto-Ertrag) aus der Wasserkraft hinausgehen.

Eigentümer der Wasserkraft zahlen letztendlich die Wasserzinsen

Die Analyse der Verteilungseffekte der Einnahmen zeigt auf, wer die grossen Profiteure der Wasserkraft sind. Aufgrund der komplexen Eigentümerstruktur mit grossen Versorgungsunternehmen, die Anteile an verschiedenen Produktionseinheiten besitzen, sowie lokalen Wasserkraftunternehmen (Partnerwerke), lassen sich die Dividenden gegenwärtig nicht auf die reine Stromproduktion zurückführen. Die Wasserzinszahlungen lassen sich hingegen den einzelnen Aktionären zurechnen.

So lässt sich zeigen, dass rund 36 Prozent der Wasserzinszahlungen, die nach Graubünden fliessen, indirekt von Stadt und Kanton Zürich über ihre Beteiligungen an den Bündner Wasserkraftwerken bezahlt werden. Der Kanton Graubünden und seine Gemeinden kommen mit ihren Beteiligungen selbst für rund 17 Prozent der Wasserzinseinnahmen auf. Die Hauptaktionäre der Schweizer Wasserkraft sind Zürich (Kanton und Stadt) mit fast 15 Prozent, gefolgt von Energieunternehmen aus den Nachbarländern Italien und Frankreich (12 Prozent) und privaten Investoren aus der Schweiz (10 Prozent). Bei der Diskussion um alternative Wasserzinsszenarien sind die Verteilungseffekte aufgrund dieser Fakten zu berücksichtigen.

Verlierer bei sinkenden Wasserzinsen in Graubünden

Im Kanton Graubünden teilen sich der Kanton (mittels Wasserwerksteuer) und die Konzessionsgemeinden die Einnahmen aus den Wasserzinsen zu gleichen Teilen. Zusätzlich fliessen die Wasserzinseinnahmen über den Ressourcenausgleich in die Berechnungen des innerkantonalen Finanzausgleichs mit ein. Der Kanton verfolgt damit das Ziel, Disparitäten aufgrund unterschiedlicher finanzieller Möglichkeiten, die sich durch Unterschiede bei den Einnahmen aber auch bei den Bevölkerungs- und Wirtschaftsstrukturen ergeben, zu verringern. So profitieren letztlich alle Gemeinden von den Einnahmen aus der Wasserkraft. Folglich wären alle Gemeinden von veränderten Wasserzinsen betroffen.

Die effektiven Auswirkungen veränderter Wasserzinsen fallen aber je nach Gemeinde stark unterschiedlich aus. Am anfälligsten bei einer erheblichen Senkung des Wasserzinses wären ressourcenstarke Gemeinden, die neben der Wasserkraft keine weiteren Stützpfeiler haben. Momentan gehören sie zu denjenigen Gemeinden, die in den Ressourcenausgleich einzahlen, im Falle von stark gesunkenen Wasserzinsen jedoch ressourcenschwach und somit unterstützungsberechtigt werden würden. Denn Wasserzinseinnahmen können in gewissen Fällen bis zu 80 Prozent des kommunalen Ressourcenpotenzials ausmachen. Im Gegenzug müssten dann die verbliebenen ressourcenstarken Gemeinden mehr in den Ressourcenausgleich einzahlen. Dies würde hauptsächlich diejenigen Gemeinden betreffen, die in hohem Masse vom Tourismus abhängen, einer anderen Branche, die allgemein als eher strukturschwach gilt. Das könnte zu einem zusätzlichen Druck auf die regionale Wirtschaft in Berggebieten führen, die ihre komparativen Vorteile im Tourismus und in der Wasserkraft haben.

Von flexiblen Wasserzinsen profitieren

In einem flexiblen Wasserzinsmodell wären auch Perioden mit Zahlungen über dem aktuellen Niveau von CHF 110 pro Kilowatt installierter Leistung möglich. Folglich könnten die Gemeinden bei guten Marktverhältnissen am Erfolg der Wasserkraft teilhaben. So könnten Gemeinden, die im Falle einer Senkung am stärksten betroffen wären, umgekehrt auch wieder stärker profitieren.

Alles in allem gilt es bei einer Diskussion um das Wasserzinssystem neben den Wasserzinszahlungen auch die dadurch induzierten Effekte zu erfassen. So wirken sich Änderungen bei der Verteilung der Einnahmen aus der Wasserkraft direkt und/oder indirekt auf die wirtschaftliche und soziale Entwicklung im Alpenraum aus. Somit gilt es, nicht nur eine rein wirtschaftliche, sondern vor allem eine politische Entscheidung im föderalen System der Schweiz zu treffen.

Auf dem Weg zu mehr Transparenz

In diesem Zusammenhang ist weiter zu beachten, dass die Wasserzinsen (Nutzungsgebühren) nur einen Teil der Einnahmen (Ressourcenrenten) aus der Wasserkraft darstellen. Bei einer einseitigen Fokussierung auf die Wasserzinszahlungen werden die Dividenden vernachlässigt, welche hauptsächlich an die Mittellandkantone ausbezahlt werden. In wirtschaftlich guten Zeiten sind diese

mindestens genauso wichtig wie die Wasserzinsen und müssen daher auch berücksichtigt werden, wenn die Wasserzinsen im nationalen Finanzausgleich miteinbezogen werden sollen. Zu diesem Zweck ist bezüglich den effektiven Gewinnen der Wasserkraft mehr Transparenz erforderlich. Dieser Herausforderung muss sich die Schweizer Wasserkraft auf dem Weg zur vollständigen Marktliberalisierung stellen.

Weitere Beiträge aus unserer Wasserkraftforschung:

- ↳ Optimierung von Wasserkraftprojekten durch den Einbezug von Stakeholdern
- ↳ Zur Corporate Social Responsibility von Wasserkraftunternehmen im Alpenraum
- ↳ Welchen Beitrag leistet die Wasserkraft an die nachhaltige Entwicklung?
- ↳ Nachhaltige Planung und Ausbau der Schweizer Wasserkraft: Fallstudie «Lagobianco» GR

Unsere Forschungsprojekte zur Wasserkraft:

- ↳ NFP70 «Zukunft der Schweizer Wasserkraft: Nachhaltigkeitsbeurteilung von Wasserkraftprojekten» (Arbeitspaket 3, HTW Chur)
- ↳ NFP70 «Zukunft der Schweizer Wasserkraft: Revision des Schweizer Wasserzinssystems» (Arbeitspaket 4, HTW Chur/ZHAW Winterthur)

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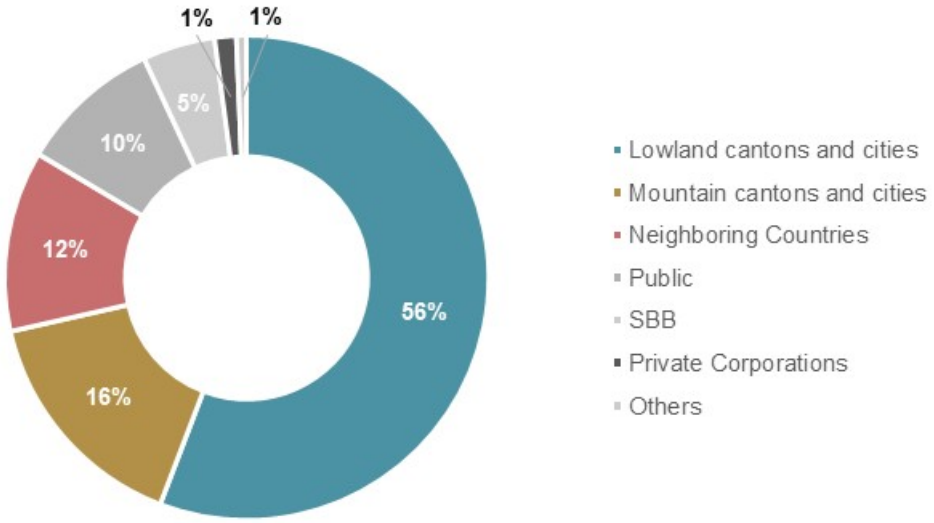
1 Introduction

Given the favorable natural conditions in Switzerland, hydropower is a central pillar of the Swiss energy system. And it shall play a key role in mitigating climate change and phasing out nuclear energy, as envisaged with the Energy Strategy 2050 of the Federal Council (SFOE, 2019). But, due to market liberalization and low electricity prices on the European market, the profitability of hydropower plants came under pressure in the past decade. As a consequence, the distribution of the water resource rents is politically debated, and no compromise has been found so far among the different stakeholder groups. Those can mainly be separated into representatives from 'mountain cantons' (Gebirgskantone) and 'lowland cantons' on the Central Plateau (Mittelandkantone). Defined in the federal constitution, the former are the 'waterlords' that are holding the property rights on the natural resource water in the Alpine areas, where most of the hydropower plants are located (see Appendix A). This is important, since the cantons have the right to grant water-use concessions and receive royalties, the so-called 'water fees', from the hydropower companies. The latter, in turn, are mainly owned by lowland cantons, who are the principal shareholders of Swiss electricity companies, as Figure 1 shows. Those are also the places where most of these companies pay corporate taxes (Filippini & Geissmann, 2014, 2017).

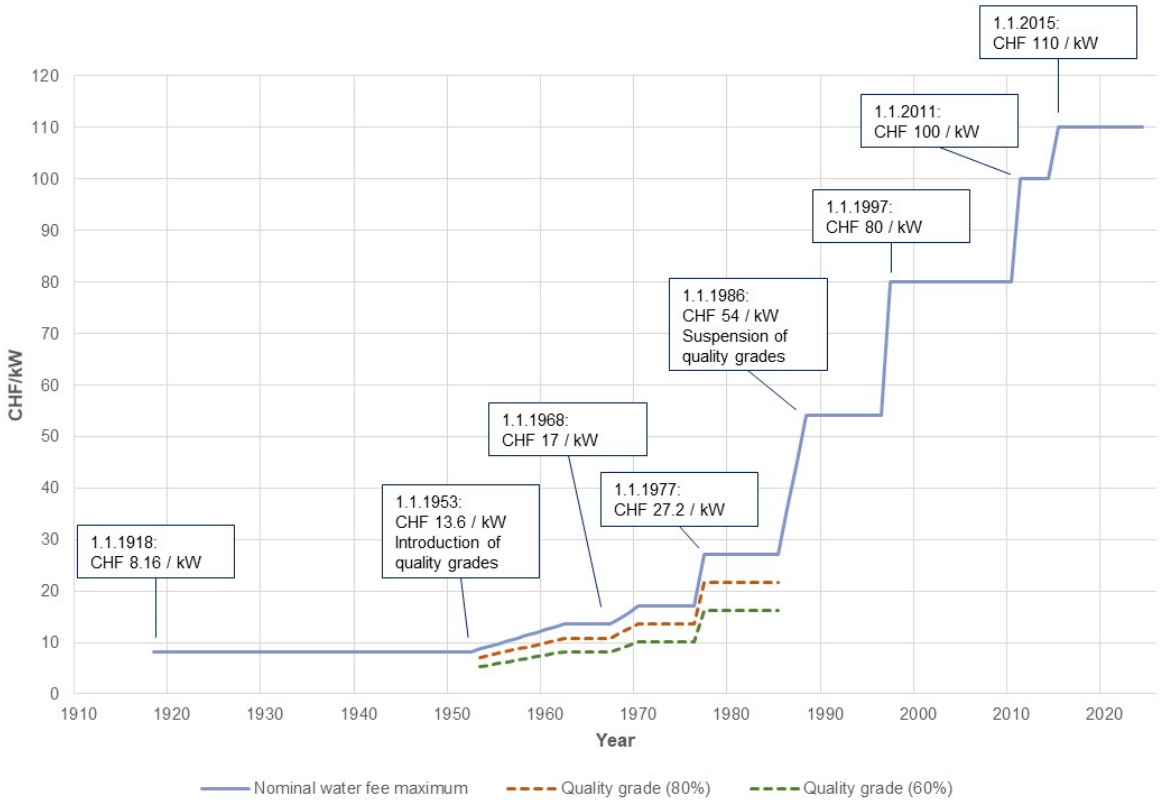
Figure 1. *Shareholdings in Swiss hydropower, 2016*



For details: see Appendix A.

The water fees are regulated by federal and cantonal legislation. The rules of implementation and the maximum rate that can be applied by the cantons is defined in the federal Water Rights Act (Wasserrechtsgesetz, WRG), which has been established in 1916 and currently is under revision in parliament (Bundesrat, 2018a; BFE, 2018a). First introduced in 1918, the maximum water fee rate has been increased several times from initially 8.16 CHF/kW installed capacity to currently 110 CHF/kW (cf. Figure 2).

Figure 2. *The development of the nominal water fee maximum since 1918*



Source: Bundesrat (2018a), created by the authors.

The maximum water fee rate is defined with respect to the installed capacity, while the applied rate is adjusted to hydrological fluctuations. Hence, the current water fees are physically determined. They do not account for economic facts, such as fluctuating electricity prices and site-specific production costs. This was the result of the original political-economic debate at the beginning of the past century, which has been driven by the above mentioned separation between the owners of water resources and the capital owners in the hydropower industry. Furthermore, it accounted for the traditional monopolistic structure of the Swiss electricity system. However, with the ongoing liberalization of the electricity market the historical monopoly rents partly disappeared. As a consequence, the battle about the distribution of water resource rents has been relaunched.

Currently, different options are under consideration (cf. Bundesrat, 2018a; BFE, 2018a; Dümmler & Rühli, 2018). Those include, amongst others, flexible water fees fully or partly accounting for electricity price variations, and an integration in the federal and cantonal fiscal equalization schemes. The latter refers to the transfer of fiscal resources across jurisdictions with the aim of reducing fiscal disparities, i.e. the differences in public revenue-raising or in fiscal capacity among territorial entities (e.g., cantons, or municipalities), and to allow sub-national governments to provide their citizens with similar sets of public goods and services at a similar tax burden (cf. Appendix C). On the national level, fiscal equalization does not account for royalties from natural resources, while the water fees are included in the inner-cantonal schemes in the two mountain cantons of Grisons and Valais. These two cantons are

the largest recipients of water fee payments. In addition, they play a crucial role in the ongoing debate, since in these two cantons municipalities directly participate in the water fees (Betz et al., 2018; Hediger, 2018), and therefore also defend their stake.

The aim of this research is to investigate the distributional effects of different water-fee reform options, and to analyze their regional, fiscal and economic feedback effects. Accordingly, we present our results with respect to those issues. First, in Chapter 2, we introduce the theoretical and institutional background of water resource rents, and elucidate the importance of water fees for public finance in cantons and municipalities. Second, building on the ownership structures of Swiss utilities and using yearly hydropower production data, we calculate the 'attributed' water fee payments according to the shareholdings of cantons and municipalities in the different companies in Chapter 3. This gives us an insight into the effective burden behind the financial flows from hydropower within Switzerland. Furthermore, Chapter 4 provides results from our analysis of water fees and fiscal equalization in the canton of Grisons. This case study particularly reveals the fiscal and some economic feedback effects of different water fee schemes on municipal, regional and cantonal level. Finally, Chapter 5 addresses the idea of integrating the water fee reform into the national system of fiscal equalization and concludes with further considerations and recommendations.

2 Theoretical and institutional background

Since the beginning of the last Century, the use of hydropower has contributed to the economic development of peripheral areas and to a reliable, clean and cheap energy supply in Switzerland. On the one hand, this development has been driven by economic forces, while the regulation of the federal water fee maximum was mainly based on political considerations, rather than on economic grounds. But, in this regard, it is important to consider that the issue of water fees is related to the theoretical concept of resource rents (see also Banfi et al., 2004; Banfi & Filippini, 2010; Hediger, 2018). Accordingly, we briefly sketch the Swiss water fee system (Section 2.1) and introduce the concept of resource rents (Section 2.2), before addressing the importance of water fees for public finance (Section 2.3) and regional development (Section 2.4). In addition, we enter the debate about the inclusion of water fees in fiscal equalization (Section 2.5).

2.1 The Swiss water fee system in brief

In Switzerland, the federal constitution and federal legislation regulate the property rights on water resources. The ultimate decision about the granting of concessions for water resource uses are with the cantons. As mentioned in Chapter 1, the cantons also have the power to set the applied water fee rate up to the legal maximum, which is defined by the federal authorities under the federal Water Rights Act (Wasserrechtsgesetz, WGR).[1] In addition, they have the authority to share the resource rights and thus the water fees with the municipalities and other organizations on their territory. Accordingly, in the cantons of Valais, Grisons, St. Gallen and Schwyz municipalities participate in the water fees, while in three other cantons private landowners and water cooperatives also receive water fees (cf. Table 1).

Table 1. The recipients of water fee revenues in Switzerland

Groups of Cantons	Canton	Districts	Municipalities	Others [a)]
Valais (VS), Grisons (GR), St. Gallen (SG)	X	-	X	-
Schwyz (SZ)	X	X	X	-
Uri (UR), Obwalden (OW), Glarus (GL)	X	-	-	X
The other 19 cantons	X	-	-	-

[a)] Water cooperatives, private landowners, etc.
Source Hediger (2018), based on Sigg & Röthlisberger (2002).

In the cantons of Valais, Grisons and St. Gallen, the water fees are split among the canton and those municipalities that hold the water rights according to cantonal legislation. In Grisons, the related revenue

[1] The effective water fee is calculated by taking location-specific factors into account. Those are the average amount of water that can be used by the plant and the average drop height of the water (Sigg & Röthlisberger, 2002; SWV, 2017). But it does neither account for the actual electricity generation and sales nor for the water resource rents.

is equally shared between the canton and the concession municipalities under the headings of 'waterworks tax' ('Wasserwerksteuer') and 'water fee' ('Wasserzins'). In Valais, the canton takes all water fees from the Rhone river, while the water fees from the side rivers are shared with the eligible communities at a ratio of 60 to 40. The canton of St. Gallen operates a similar system: The canton takes all fees from the Rhine river, two adjacent channels and small hydropower with a maximum installed capacity of 50 PS. In addition, he takes 50% of the fees from large hydropower, which are equally shared with those municipalities where the plants are located. In the canton of Uri, the corporations of Uri and Ursern receive 10% of the water fees (Bundesrat, 2018a; Kanton Graubünden, 2013a; Kanton St. Gallen, 2009; Kanton Wallis, 2017a). Hence, water fees play an important role in public finance for some municipalities and, in some cases, can be a source of inner-cantonal disparities (see also Pfammatter & Piot, 2016; and Chapter 4). As a logical consequence, the water fees are taken into account in the 'inner-cantonal' fiscal equalization scheme in the cantons of Grisons and Valais. These two cantons aim at reducing disparities caused by different revenue-raising or fiscal capacities ('resource potential') and by different costs of providing a standard set of public services due to different geographical and demographic circumstances (cf. Appendix C). Thus, water fee payments have a direct effect on the financial resources available in municipalities granting hydropower concessions, and indirectly affect – through the fiscal equalization mechanisms – the financial situation in other municipalities. As a consequence, one must expect induced impacts of changes in the water fee system upon public expenditures and economic development on cantonal and municipal level (cf. Chapter 4).

The existing water fee system is criticized for not being related to the performance of hydropower plants, since the calculation of water fees is based on average gross capacities and not actual productivity (cf. Bundesrat, 2018a; Dümmler & Rühli, 2018; Piot & Pfammatter, 2017; Pfammatter & Piot, 2016).[2]

As an alternative, several forms of flexibilization have been proposed that would have a stronger link to the actual performance of the hydropower plants (see also Betz et al., 2019; BFE, 2018b; and Appendix D). As a further option, Dümmler and Rühli (2018) propose to abandon the current water fee system and replace it with transfers through the federal fiscal equalization (cf. Appendix C), or more precisely the cost compensation scheme that accounts for disparities due to geographical and topographical circumstances. Their perception of water fees is that of a regional policy instrument, rather than a market-based compensation scheme. In contrast, the Federal Council (Bundesrat, 2018a) concludes that such an approach would be incompatible with the current concept of national fiscal equalization and, therefore, has never been pursued. Important form a fiscal as well as resource-economic point of view is the conceptual linkage of water fees and resource rents (Banfi et al., 2004; Banfi & Filippini, 2010; Hediger, 2018).

[2] Although the federal water fee maximum is exhausted by most cantons – only the Cantons of Bern, Jura, Zug and Vaud currently apply a lower rate – the effective water fee level is variable. It is adjusted to hydrological conditions and accounts for the fact that a more humid year benefits hydropower utilization and thus hydropower companies. Hence, the current water fee mechanism partly adjusts for economic effects of fluctuating production potentials, but not for price variations that could also be an effect of extreme weather situations.

2.2 The theory of water resource rents

A resource rent is a surplus that results when converting a natural resource into a marketable product – here: the conversion of waterpower into electricity. It is defined as "the difference between the price of a good produced using a natural resource and the unit cost of turning that natural resource into the good" (Hartwick & Olewiler, 1997). The relevant costs include the payments for capital, labor, material and other inputs used in the production process; i.e. in the electricity generation from hydropower. After netting-out these factor costs, the remaining value is the natural resource rent. In the first instance, this value flows as an income to the holder of property or use rights on that resource, such as frequently emphasized in the resource economics literature. This income differs from that going to the owners of capital in the form of dividends (distribution of profits).

Ricardo (1817: 40) was first to make a fundamental distinction between rent and profit, since "the laws which regulate the progress of rent, are widely different from those which regulate the progress of profits, and seldom operate in the same direction". Further, Rothman (2000: 5) underlines a fundamental difference between rent and normal profits (return on capital), since rent is a value, "a windfall created by exploiting the bounty of Nature". Ricardo called this a compensation for the use of its original and indestructible powers, which is paid to the owner of that resource. Or, as Rothman emphasizes: "The owner of the natural resource is the owner of the rent." Therefore, capturing resource rents from the resource developers and delivering it back to the owners – often the public – is common practice in resource-based industries, like oil, coal, and mining (Garnault, 2010; Lund, 2009).

However, there is no windfall from hydropower without investments that ultimately allow to exploit the 'bounty' (the power) of nature. Accordingly, holding the exclusive use right on exploiting the power of water, investors also expect some adequate return. Thus, from a theoretical point of view and under consideration of the institutional settings in Switzerland, the water resource rents should go in part to the owners of the property rights (the cantons, etc.) and the holders of the use rights (the hydropower companies and their shareholders). These parts are running under the headings of 'water fees' and 'profits', respectively, such as represented in Figure 3.

Building on a CSR[3] framework (Hediger, 2018), this shows that the value of hydropower is not only determined by the financial performance of the plant and dividends paid out (distributed profits). Rather, the '*total value of hydropower*' also encompasses retained profits for current and future investments, taxes as well as wages and other contributions to or impacts upon the economy, society and the environment. Following Ricardo (1817), the value of hydropower ("the produce of the Earth"), which is derived from using its potential energy by the united application of labor and capital, is divided under the names of rents, profits and wages among the proprietors of the water, the owners of the stock of capital (the investors) and the employees (Hediger, 2018).

[3] CSR = corporate social responsibility.

***Figure 3**. Total value of hydropower and the distribution of the water resource rent*

<table>
<tr><td rowspan="3">Change of reputation capital caused by external contributions and impacts</td><td colspan="3">net revenue (resource rent)
= gross revenue – cost</td><td>additional contributions and impacts:</td></tr>
<tr><td colspan="2">profits</td><td rowspan="2">taxes</td><td rowspan="2">water fees</td><td rowspan="2">(regional) economy, incl. wages
social capital
environment</td></tr>
<tr><td>retained</td><td>distributed</td></tr>
<tr><td colspan="3">internal value</td><td colspan="2">external value</td></tr>
<tr><td colspan="5">total value of hydropower</td></tr>
</table>

Source: own presentation based on Hediger (2018)

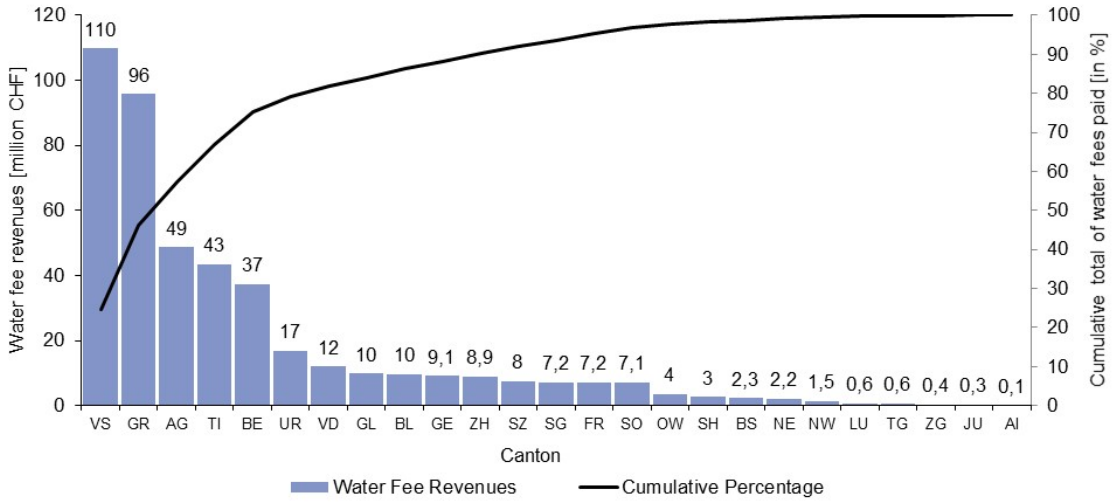
In addition, some share of the resource rent is diverted to the 'public hand' by means of corporate and other taxes. From a theoretical point of view, this implies that profits, water fees and corporate taxes are elements of revenue sharing among different stakeholder groups rather than cost factors, and the regulation of this revenue distribution is an issue of political economics. This is a fundamental issue that must be taken into consideration when designing the future water fee system.

2.3 On the importance of water fees for public finance

Currently, the annual water fees amount to an estimated maximum of CHF 550 million in Switzerland (Bundesrat, 2018a; SWV, 2017). As illustrated in Figure 4, roughly 50% thereof go to the two cantons of Valais (VS) and Grisons (GR). When adding the cantons of Aargau (AG), Ticino (TI), Bern (BE) and Uri (UR), the picture reveals that some 80% of the water fees flow to six cantons only. This is due to the large hydropower production capacities installed in these cantons.

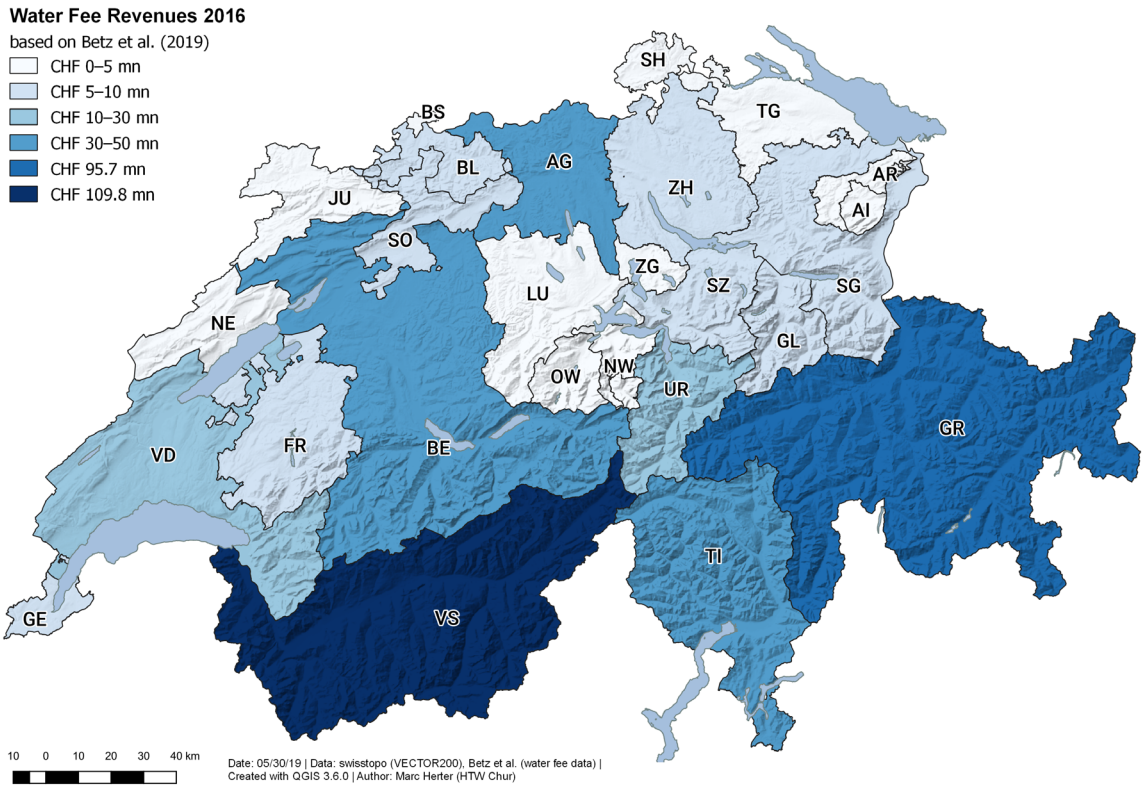
When comparing the amount of water fees to the total budget of the cantons, the picture in terms of financial significance changes. Table 2 shows that the canton of Uri depends the most on its water fee revenues, as it has the highest share of water fees in its total revenue These percentages are even higher when comparing the water fees with tax revenues, only. However, the interpretation of these shares is quite different. The first number reveals the actual fiscal importance of the water fees in the canton, while the second one indicates the hypothetical tax increases necessary to fully compensate the revenue from water fees.

Figure 4. *Distribution of water fee revenues per canton (chart), 2016*



Source: own calculations based on BFE (2017) and (cost) calculations from Betz et al. (2019)[4]*.*

Figure 5*. Distribution of water fee revenues per canton (map), 2016*



Source: own calculations based on BFE (2017) and (cost) calculations from Betz et al. (2019)[5]*;*
Swisstopo (2017) for GIS data; own illustration.

[4] For details, see Appendix A (tables with different shares and production capacities owned by the cantons) and Appendix B (table with complete data, using different cost models, etc).
[5] See footnote 4.

Table 2. Financial importance of water fees for cantons in 2016

Cantons	Total revenue in CHF	Actual water fee revenue in CHF	Actual water fee revenues in % of total revenue	Tax revenue in CHF	Actual water fee revenues compared to tax revenue
Uri (UR)	391'500'000	24'310'632	**6.20%**	91'420'000	**26.59%**
Grisons (GR)	2'393'711'136	112'969'876	**4.70%**	751'823'092	**15.03%**
Valais (VS)	3'810'569'872	102'665'611	**2.70%**	1'260'057'247	**8.15%**
Glarus (GL)	373'178'000	6'083'021	**1.60%**	107'960'559	**5.63%**

Source: Kanton Uri (2017), Kanton Graubünden (2017), Kanton Wallis (2017b), Kanton Glarus (2017).

Thus, the revenues generated by water fees are of substantial importance to many cantons. But they are even more important for numerous municipalities in the Swiss Alps, where water fees partly constitute between 20% and 40% of the total revenues, in some cases even more than 40% (Pfammatter & Piot, 2016). This is particularly true in the cantons of Valais and Grisons (Schweizerischer Gemeindeverband, 2017). The latter is subject to further investigations, given the fact that the municipalities participate in the water fees that, in turn, are included in the cantonal system of fiscal equalization (cf. Chapter 4 and Appendix C). At the same time, water fees constitute a substantial burden for hydropower companies. Most of them have problems to cover their fixed costs when selling electricity on the market at low prices and with small price spreads between peak and off-peak periods, such as experienced in the past decade (Betz et al., 2018). These companies are mainly owned by lowland cantons, which in turn are the major beneficiaries of profits generated by the hydropower companies (cf. Chapter 3 and Appendix B). In addition, and apart from water fees and general taxes, mountain cantons and municipalities benefit from hydropower in various forms, as presented in the following section.

2.4 The role of hydropower and water fees at the regional level – the case of Grisons

Hydropower plays a very important, almost existential role in mountain areas today, especially for the concession-granting municipalities of Grisons. They receive revenues from water fees, concession levies and to some extent taxes paid by hydropower companies and their employees. Moreover, they benefit from free and preferential energy as well as other services provided by the companies. Acknowledging the historical development and the generally good relations with the power plant companies, hydropower has also played a role in creating a local identity in many places. It is an integral part of the history of many peripheral regions (cf. Gredig, 2007), which are often classified as ‘areas with low potential’ (‘potenzialarme Räume’). The assessment of the regional economic importance of hydropower and water fees must therefore be carried out against this background. This implies, in particular, the importance of hydroelectric energy as an export good and essential input for tourism.

Those are, according to Bätzing (2015), the two industries where many Alpine valleys have their economic potential. Thus, when building on their comparative advantage in tourism and hydropower generation, these regions must no longer be considered as areas with low potential.

Hydropower and the associated water fees have already been important for the peripheral regions and municipalities of Grisons in the past, as they accelerated the economic development in these regions. In addition, there are the jobs created by hydropower companies, as well as the social impact of employees and their families on village life and private and public infrastructures (schools, shops, etc.). This regional economic importance has also been investigated in various studies (AEV, 2009; Banfi & Fetz, 2006; Plaz & Rütimann, 2010; Rieder & Caviezel, 2006). However, the authors of these recent studies made rather positive assumptions about the development of electricity prices and thus the value of hydropower, as the recent development shows.

Plaz and Rütimann (2010), for instance, estimated the value added of Grisons' hydropower in 2008. What they refer to as 'gross value added' includes besides the direct value added of CHF 222 million also the value of inner-cantonal inputs in the construction industry and local commerce amounting to CHF 47 million; but not the inputs purchased in other cantons. The total revenue from hydropower at current prices was CHF 460 million. But 2008 was the peak year for electricity prices on the market, and prices have fallen massively since then (cf. Bundesrat, 2018a: 3427). Thus, on one hand, the above values might be substantially overestimated for methodological and data reasons. On the other hand, the total value added of hydropower in a region or municipality includes, besides the direct value, also values created by indirect and induced effects. Those are caused by the regional economic interconnectedness and by municipal and consumer expenditures enabled thanks to the use of water fee revenues, other charges and taxes as well as services of the power plant companies. In the end, the 'regional value added' corresponds to the income for the primary inputs labor and capital, which remains in the region and municipality, respectively.

Accordingly, the importance of hydropower and the associated charges on the resource rents are even greater than the direct value added indicates, especially in peripheral and economically weak areas of the canton. Indeed, in many regions, hydroelectric power generation (and, in some places, also electricity trading) is often an important pillar of the local economy. At the same time, only a small share of revenues generated by the power plants remains as income in the regions (Plaz and Rütimann, 2010). Due to the prevailing economic structures, many inputs have to be sourced extra-regionally, so that considerable amounts flow from the periphery to the economic centers in the Grisons Rhine Valley, on the Swiss Plateau and abroad. In addition, there is an outflow of profits to the Swiss lowland cantons, which is caused by the ownership of hydropower.

From a regional economic point of view, it is also important how municipalities use the revenues from hydropower. The majority of these revenues flows into the maintenance of municipal infrastructure (roads and trails) and partly into community-owned enterprises (sawmills, forestry, etc.) or the

improvement of tourist infrastructures. In some municipalities, it is also used to improve the attractiveness of the municipality through a low tax rate and other bonuses, or to subsidize deficient tourist facilities (spas, ski lifts, etc.). Moreover, after the last increase of the water fee maximum, the additional proceeds were used in part to balance municipal finances or make necessary investments. This contrasts with the earlier observations by Rieder and Caviezel (2006) that water fee revenues would not be used for investment projects. Finally, municipalities without hydropower indirectly benefit from water fees through the fiscal equalization mechanism in Grisons and the cantonal waterworks tax.

2.5 Water fees and fiscal equalization

In Switzerland's federalist system, the individual cantons and municipalities have a certain degree of financial autonomy, i.e. the power of the respective authorities to solve their tasks independently and to raise the taxes and levies necessary to finance themselves. However, the individual communities do not have financial resources to the same extent. Geographical location, differences in economic development and other causes lead to differences in tax revenue, tax burden and the provision of public goods. To reduce these disparities to a socially accepted level, *fiscal equalization* systems have been developed in the cantons and at the federal level. The inclusion of the water fees in the national fiscal equalization system has recently been proposed by Dümmler and Rühli (2018).[6] They argue that the water fee revenues must be accounted for in the resource equalization, while regional policy goals must be pursued through the cost compensation scheme. But they also acknowledge the 'federalist logic' that entitles a remuneration to the cantons for the use of their natural resource (water and topography). This 'logic' also speaks against the most radical and market-friendly option of completely abolishing the water fees. Another argument in favor of including the water fees into the fiscal equalization comes from the fact that, with the cantons of Grisons and Valais, the two major recipients of water fees already include water fee revenues in their own fiscal equalization schemes. In both cantons, the water fees are split according to a canton-specific rule between the cantonal authority and those municipalities that hold the property rights to the natural resource water. Yet, not all municipalities benefit the same from water fee revenues. In contrast, the impact of water fees on the resource potentials is much smaller between cantons than between municipalities within the cantons of Grisons and Valais.

Hence, the inclusion of water fees in the resource equalization of these two cantons and the request to also include it in the national resource equalization must be considered against the above background. In addition, the impact of alternative water fee reform options upon municipal finance and regional development must be investigated. We first analyze financial flows induced by water fees within Switzerland and their impact on public finance and fiscal equalization in the canton of Grisons (Chapter 4), before addressing the issue of including water fees in the national scheme of fiscal equalization in our conclusion (Chapter 5). The fundamentals of fiscal equalization are presented in Appendix C.

[6] This is also one of the six options suggested by the Federal Council (Bundesrat, 2018a).

3 Financial flows related to ownership structure

The two mountain cantons of Valais and Grisons are the main recipients of water fees, with a share of more than 50% of the total amount of up to CHF 550 million, paid by the hydropower companies. These companies are mainly owned by cantons and municipalities, either directly or through intermediaries, i.e. other companies.[7] Accordingly, the water fees are indirectly paid by intermediaries and finally by the shareholders of the different companies. Thus, linking the water fee payments to hydropower companies and their final shareholders, we refer to this as the ***'attributed water fee payments'***. In order to calculate these values, we identified the ownership structure of Swiss utilities (Section 3.1) and traced the estimated water fee payments for each hydropower plant to its shareholders (Section 3.2).

3.1 Ownership structure of Swiss utilities

To gain a complete picture of the ownership structure in the Swiss hydropower industry with its ultimate shareholders, we use the official WASTA[8] dataset, which is published annually by the Swiss Federal Office of Energy (SFOE). It contains details for each power plant, including geographical and technical information such as the annual energy production (in GWh), the installed production capacity (in MW), and the type of plant (storage, pumped-storage, or run-of-river). This information is available for each central station ("Zentrale"), where the hydroelectric (power-generating) machines are located and that is part of a hydropower plant ("Wasserkraftanlage").[9]

The WASTA dataset[10] for the year 2016 (BFE, 2017) contains a total of 704 central stations and 669 hydropower plants, located in 23 cantons. In a first step, the linkage regarding ownership between central stations and hydropower plants can be derived directly from the WASTA database. However, further investigations are required to gain insights into the final ownership structure (shareholdings) in the Swiss hydropower industry; i.e. to trace back the ownership of each central station and hydropower plant to its ultimate shareholders. Accordingly, the second step is the identification of the owners of the 669 hydropower plants. It shows that each plant has its particular ownership structure with public entities as well as private and public corporations (utilities). To facilitate and structure our analysis, these entities and corporations are summarized under the term "intermediaries" and divided into three groups:

Group A) domestic and foreign utilities (both public and private),

Group B) municipalities and cities, and

Group C) cantons.

[7] A problem is that, hitherto, no official data on the ultimate ownership ('shareholdings') in the Swiss hydropower industry exist.

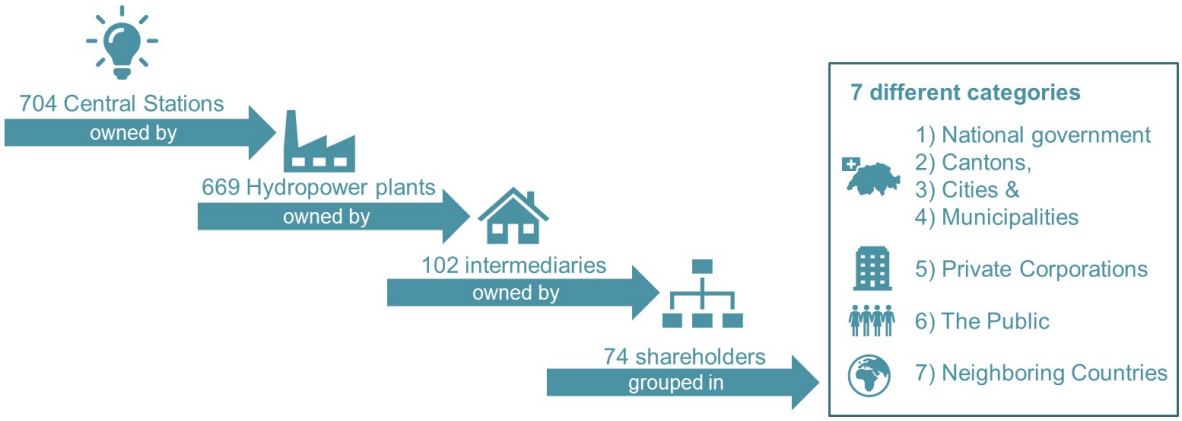
[8] Statistik der Wasserkraftanlagen (WASTA).

[9] Most plants have only one central station. For plants operating with several central stations, each station is listed separately in the statistic that only includes those central stations that are equipped with a maximum possible power provided by the generator of at least 300 kW or with a maximum possible power consumption of the pump motors of at least 300 kW (BFE, 2017).

[10] The cantons Appenzell Innerrhoden (AI), Appenzell Ausserrhoden (AR) and Basel Stadt (BS) had no hydropower plant on their territory by the end of 2016.

In a third step, all intermediaries are scrutinized in terms of their 'true' ownership, which is structured in seven categories of shareholders, such as depicted in Figure 6. These seven categories encompass a total of 74 different shareholders that, in turn, are the owners of 102 intermediaries, which have been identified in our research and cover more than 90% of the total hydropower production in Switzerland. These intermediaries include municipalities and cities, cantons, public and private corporations, as well as domestic and foreign utilities.

Figure 6. *Analytical framework for ownership analysis*



The results of the data collection show that each hydropower plant can have a mixed ownership structure in terms of intermediaries. This means that one single plant can be owned by different intermediaries from each of the three groups defined above.[11] When looking at the ownership structure per group of intermediaries, one can observe the following:

- *Group A* shows the largest variety as it contains different types of corporations, from small local utilities to large international energy corporations.
- *Group B* is rather straightforward, as it only contains Swiss municipalities as well as cities.
- *Group C* is easily distinguishable, as it only contains Swiss cantons.

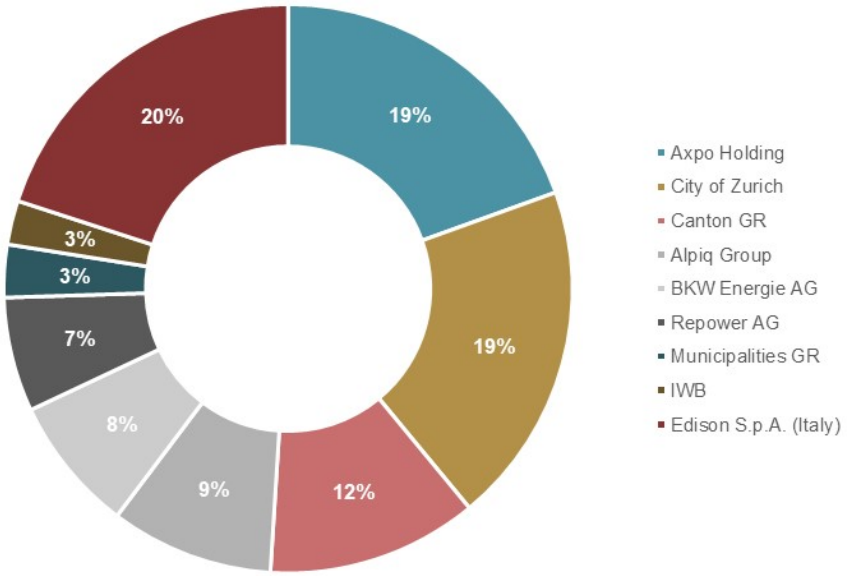
Furthermore, the analysis of the collected data regarding the intermediary structure for each hydropower plant shows that in the case of group-A intermediaries, ownership encompasses up to six different utilities. The data collection for group-B intermediaries reveals up to five different municipalities as intermediary owners of one single hydropower plant.[12] For group-C, the evaluation of the ownership structure shows no case where more than one canton is involved as an intermediary owner of a plant. Thus, a single hydropower plant could theoretically have a diverse ownership structure with as many as twelve different intermediaries, which results when aggregating the maximum numbers of each group A to C. However, none of the analyzed hydropower plants has reached this maximum variety of intermediaries, while up to nine or ten different intermediaries throughout all three groups is common. Altogether, the diversity in ownership structure as highlighted by the three groups of intermediaries,

[11] For the analysis, the direct ownership structure for each hydropower plant was scrutinized and recorded in the dataset.
[12] In some cases, several municipalities are grouped into one organization that represents their interests and is accordingly listed as shareholder of the intermediary, such as in the case of the Gemeindekorporation Hinterrhein that is represented by 'Municipalities GR' in Figure 6.

combined with the total number of 669 plants, underlines the complexity of ownership in the Swiss hydropower industry.

Figure 7 shows an example of the hydropower plant (and central station) Sils im Domleschg., Grisons, that is part of the company Kraftwerke Hinterrhein (KHR), which is owned by nine intermediaries, with the Gemeindekorporation Hinterrhein representing 14 municipalities in the region (cf. Gemeindekorporation Hinterrhein, 2013).

Figure 7. *The ownership structure of the hydropower plant Sils im Domleschg, 2016*

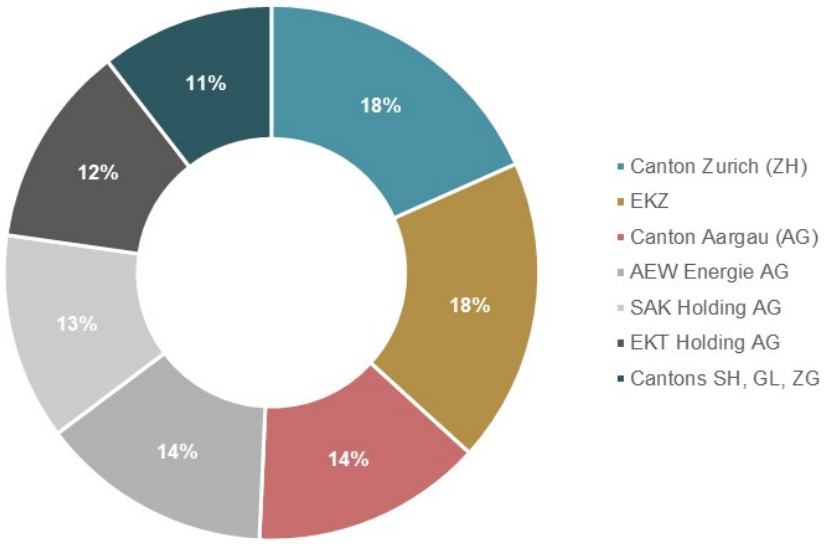


Source: KHR (2016).

Tracing back all intermediaries to the seven categories of shareholders (cf. Figure 6) is straightforward for groups B and C. Referring to categories 3 and 4, the shareholders can clearly be identified as one or more municipalities and cities, respectively, for the former, or one single canton (category 2) for the latter. For Group-A intermediaries, however, additional research had to be conducted. This endeavor proved to be difficult in certain cases, since the ownership structure of these intermediaries can be very complex and is not straightforward. To exemplify Figure 8 depicts the company Axpo Holding AG ('Axpo') in terms of its direct shareholders according to official publications (Axpo, 2016).[13]

[13] Axpo Holding AG, of simply 'Axpo', is 100% owned by the Northeastern Swiss cantons. It assumes strategic responsibility for Axpo Group, which encompasses Axpo Holding AG and its subsidiaries Axpo Power AG, Axpo Solutions AG, Avectris AG and Centralschweizer Kraftwerke AG (CKW) (Axpo, 2019).

Figure 8. *Direct shareholders of Axpo Holding AG, 2016*



Source: Axpo (2016).

The shareholders of Axpo Holding AG can easily be assigned to the three groups of intermediaries and shareholder categories, as defined above. The cantons of Zurich, Aargau, Schaffhausen, Glarus and Zug (ZH, AG, SH, GL and ZG) fall into Group C and thus category 2, while the remaining shareholders (EKZ, AEW Energie AG, SAK Holding AG and EKT Holding AG) belong to Group A. To identify the relevant shareholders the actual ownership of Group-A intermediaries must be further investigated, such as depicted in Table 3.

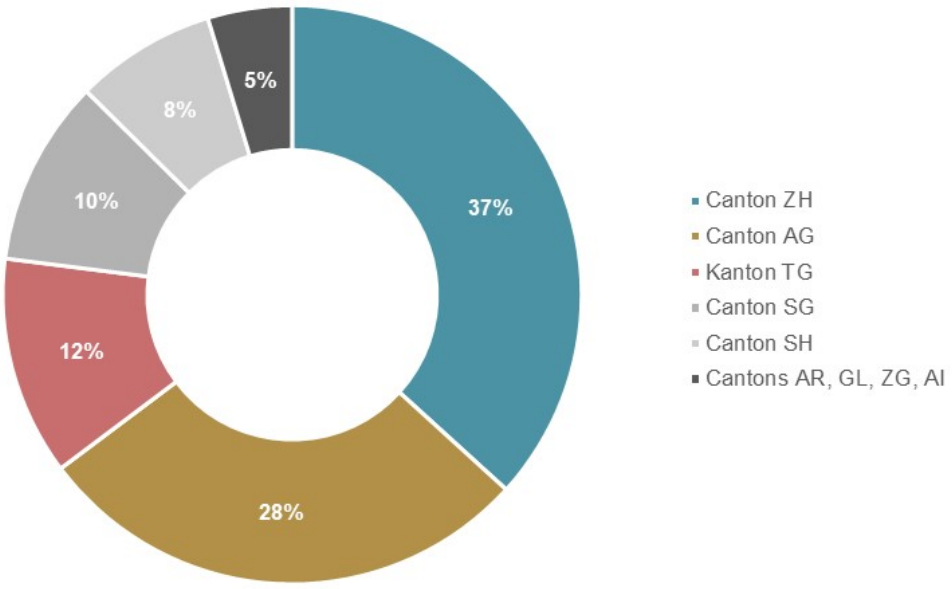
The intermediary EKZ is owned by 100% by the canton of Zurich, and the AEW Energie AG is 100% owned by the canton of Aargau. SAK Holding AG has three shareholders, namely the cantons of St. Gallen, Appenzell-Innerrhoden and Appenzell-Ausserrhoden (SG, AR and AI). Finally, EKT Holding AG is owned by 100% by the canton of Thurgau (TG). Thus, the analysis of intermediaries reveals a different ownership picture, such as present in Figure 9.

Table 3. Identification of shareholders of Axpo Holding AG, 2016

Intermediary	Direct shares in Axpo		Shareholders	Ownership on intermediary	Final shares in Axpo
Canton ZH	18.3%		Canton ZH	100.0%	18.3%
EKZ	18.4%	➔	Canton ZH	100.0%	18.4%
Canton AG	14.0%		Canton AG	100.0%	14.0%
AEW Energie AG	14.0%	➔	Canton AG	100.0%	14.0%
SAK Holding AG	12.5%	➔	Canton SG	83.3%	10.4%
		➔	Canton AR	14.2%	1.8%
		➔	Canton AI	2.5%	0.3%
EKT Holding AG	12.3%	➔	Canton TG	100.0%	12.3%
Canton SH	7.9%		Canton SH	100.0%	7.9%
Canton GL	1.7%		Canton GL	100.0%	1.7%
Canton ZG	0.9%		Canton ZG	100.0%	0.9%
TOTAL	100%				100%

Source: own calculations based on Axpo (2016), Kanton Zürich (2017), Kanton Aargau (2017), Kanton St. Gallen (2017), Kanton Appenzell-Ausserrhoden (2017), Kanton Appenzell-Innerrhoden (2017) and Kanton Thurgau (2017). Acronyms of cantons, see Appendix A.

Figure 9. *Axpo Holding AG shareholders based on ownership analysis, 2016*



Source: own calculations based on Axpo (2016) and annual reports of the cantons mentioned in Table 3.

The example of Axpo Holding AG is a rather simple one with only four Group-A intermediaries that also have a straightforward ownership structure themselves. As an example of a more complex intermediary, the Alpiq Group contains 18 different Group-A intermediaries, including Axpo Holding AG, BKW, Groupe E and Romand Energie. They all are characterized by a diverse ownership structure and intertwined ownership, which increases the level of complexity twofold. Group E, for instance, has shares in both BKW and Romand Energie, while Romand Energie also holds shares of Group E. This level of complexity poses severe limitations to graphical representation, such that no complete picture of the entire ownership structure for Swiss hydropower can graphically be depicted. The example of Axpo Holding AG serves as an approximation to the complexity.

On the national level, the main shareholders in 2016 were neighboring countries with 12.1% in the total shares, followed by the 'public' (i.e. private investors) with 9.5% and the canton of Zurich with 9.0% (cf. Appendix A). When looking at the shares hold by the 'public hand' only, the cantons (including municipalities) account for some 71% of the shares in Swiss hydropower production and the Confederation (through SBB) 4.8%. Among the cantons and municipalities, the largest shares are held by Zurich (canton and city) with 14.65%, followed by Aargau with 8.4% and Bern with 7%. Next are the three mountain cantons Valais, Ticino and Grisons with less than 5%.

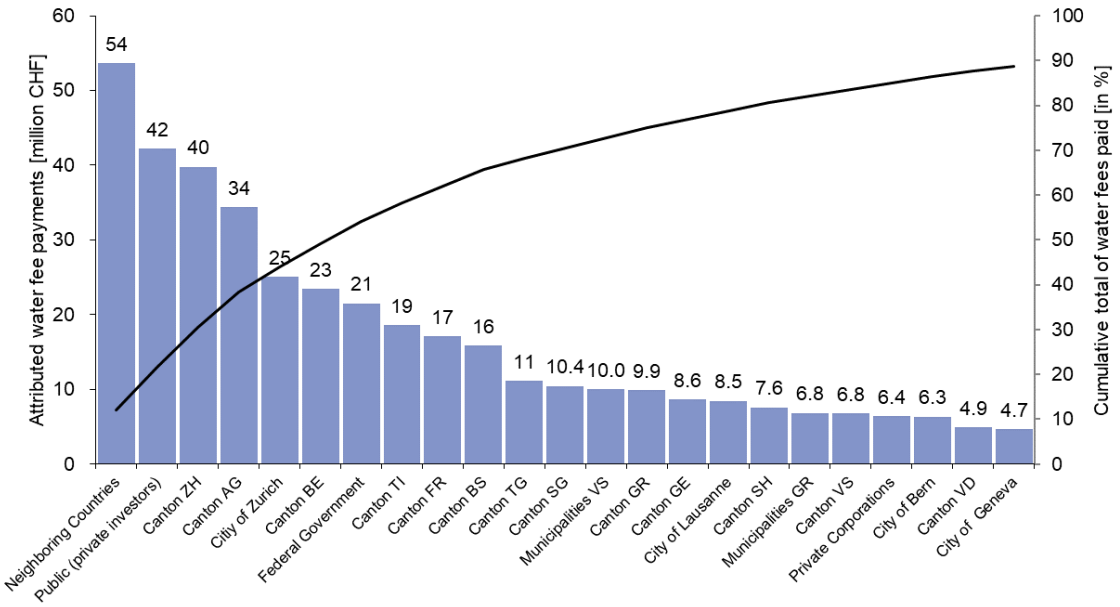
3.2 Attributed water fee payments

The aim of this section is to link the shareholders identified in in the previous one with the financial flows related to water fees. Chapter 2 highlights that the main recipients of water fees are mountain cantons such as Grisons and Valais, and that these fees are paid by the hydropower companies. With the information gained in the previous section, it is possible to trace the financial flows to their origin in terms of the identified shareholders, i.e. to attribute the water fee payments to these shareholders.

Using the detailed ownership structure identified with the procedure described in Section 3.1, it is possible to link the production volume in kWh of each central station through the intermediaries to the different shareholders. The result of this calculation are the so-called '*attributed water fees*' per shareholder, such as presented in Figure 10.

When combining the recipients of water fees and the shareholders, a more detailed picture emerges. In order to exemplify the effects of the complex ownership structure on water fee-based financial flows the relationships between the two cantons of Grisons and Zurich are visualized in Figure 11. In this regard, it is important to notice that the numbers presented in the visualization are only an approximation, based on the ownership analysis of Section 3.1 and the estimation of the water fee payments per kWh according to Betz et al. (2019). This approximation has the limitation that it cannot depict the actual water fee amounts received by the canton and municipalities of Grisons. Furthermore, the hydrological component in terms of availability of water is not included, since the WASTA-based approximation is based on average production values in kWh per central station and hydropower plant, respectively.

Figure 10. *Attributed water fees per shareholder in million CHF, 2016*



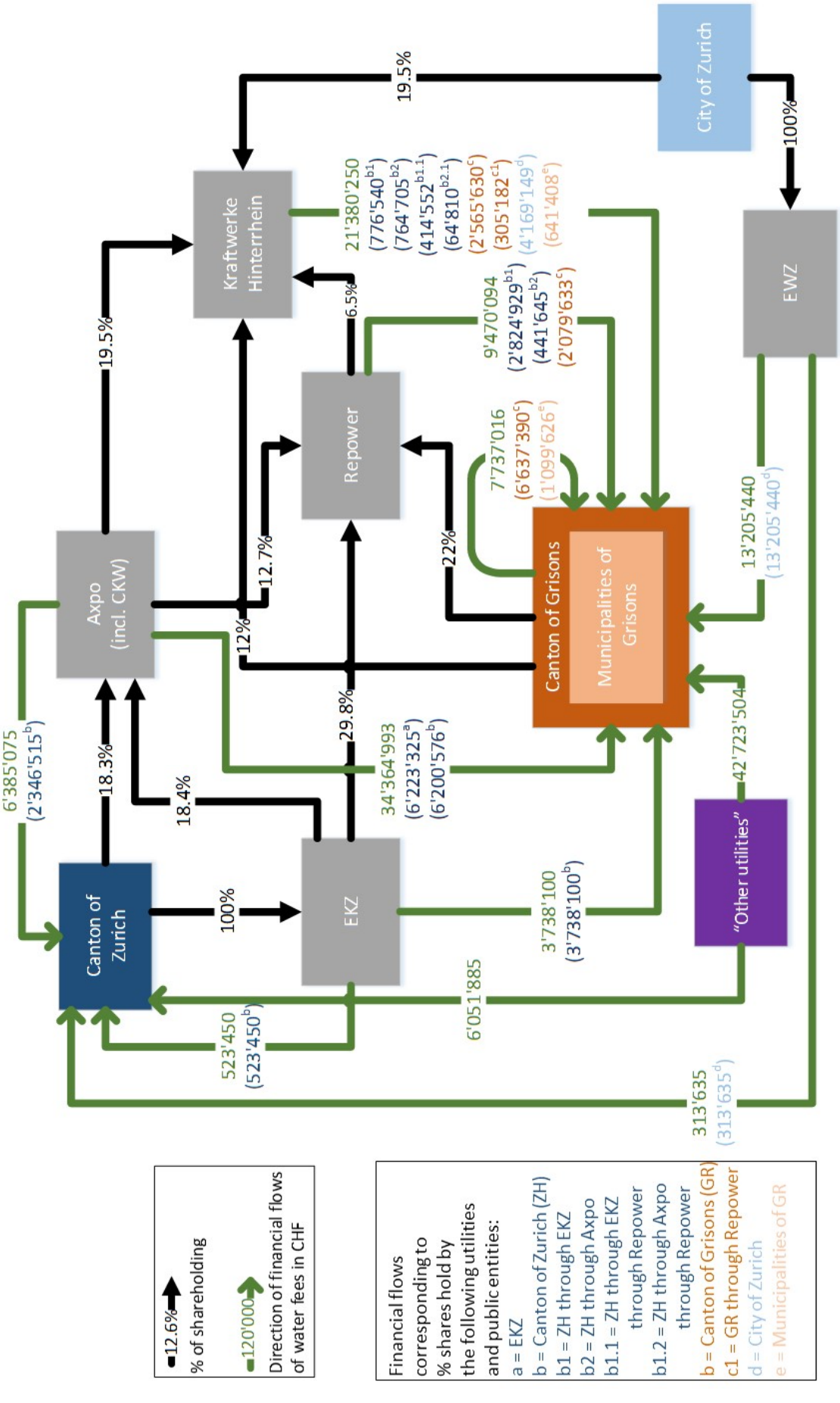
Data: see Appendix B (also for the complete data adding up to 100%).

From a shareholder perspective, the most relevant actors are the canton and the city of Zurich as well as the canton and concession-granting municipalities of Grisons. The actor 'other utilities' encompasses mainly other cantons, particularly those with shares in Axpo Holding AG.

The actors depicted in Figure 11 by grey boxes are intermediaries, whith some of those intermediaries, such as Axpo Holding AG or Repower AG (subsequently referred to as Axpo and Repower, respectively), hold shares of other intermediaries. The black arrows show the percentage of shares for each shareholder or intermediary, respectively. The green arrows characterize financial flows and the corresponding numbers in green represent the amount of water fees. The total values (numbers in green) are based on the approximation of water fee payments using the cost calculation of 0.0124 CHF/kWh by Betz et al. (2019).[14] For each financial transfer, the partial amounts attributed to a single actor are depicted in brackets.

[14] Cf. Appendix B for details.

Figure 11. *Attributed financial flows between Zurich und Grisons, 2016*



Example: As illustrated in Figure 11 by black arrows, 64.5% of the shares of Repower are hold by EKZ, Axpo and the Canton of Grisons, while the rest is held by UBS Clean Energy Infrastructure KGK and in free float (Repower, 2019). Repower paid in the year 2016 a total of CHF 9.47 million water fees to the canton and municipalities of Grisons, as indicated by the green number on the green arrow from Repower to Canton of Grisons. The additional figures in parenthesis depict the attribution of this amount to Repower's main shareholders in Grisons. Those are the Canton of Zurich with an attributed amount of CHF 2.82 million through EKZ and CHF 0.44 million through Repower (b1 and b2) as well as the Canton of Grisons with CHF 2.08 million with its direct shareholding in Repower (c).

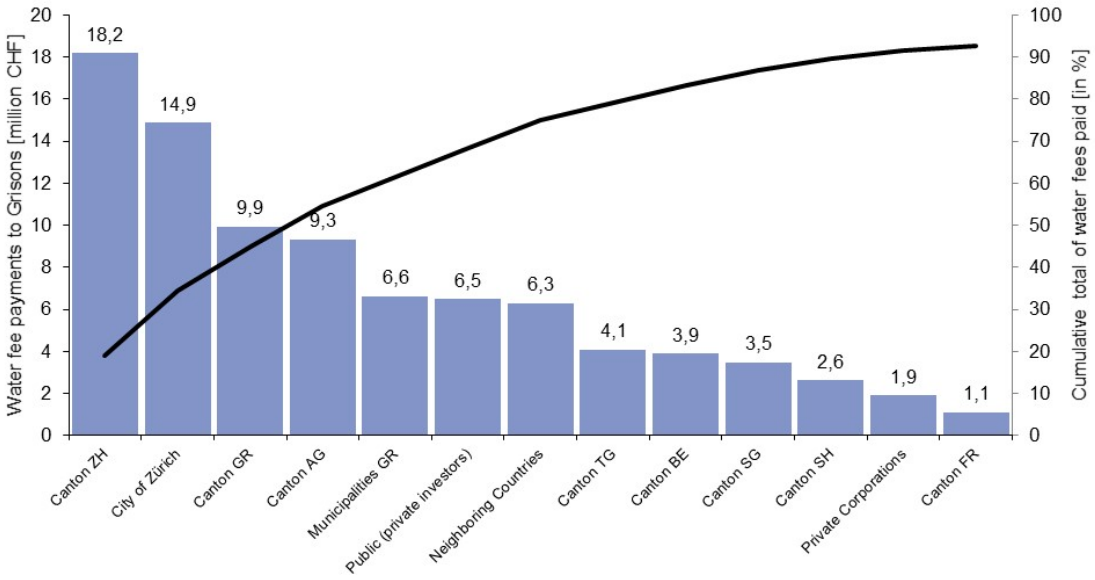
The visualization reveals that more than 10% of the water fee payments can be attributed to the canton of Grisons and some 6% to the municipalities of Grisons themselves. Furthermore, a large part of the attributed water fees can be traced back to the canton and the city of Zurich, which cover approximately 19% and 16%, respectively, given their shareholdings in hydropower plants and intermediaries acting in Grisons. Table 4 and Figure 12 show the distribution of the attributed water fee payments flowing to the canton of Grisons and its municipalities structured according to the seven categories of shareholders defined in the analytical framework of Section 3.1.

Table 4. Percentage of attributed water fee payments in Grisons for 2016

Shareholders	**Attributed % of water fee payments**§)
Canton ZH	19.0%
City of Zurich	15.5%
Canton GR	10.4%
Canton AG	9.7%
Municipalities GR	6.9%
Public	6.8%
Neighboring Countries	6.6%
Canton TG	4.3%
Canton BE	4.1%
Canton SG	3.6%
Canton SH	2.7%
Private Corporations	2.0%
Canton FR	1.2%

§) For reasons of clarity, water fee payments below 1% have been excluded from this table. The total amount therefore represents only 92% of all water fee payments attributed to GR. (For the acronyms of cantons, see Appendix A)

Figure 12. *Attributed water fee payments for Grisons, 2016*



Source. Own calculations (cf. Table 4), using the cost structure provided by Betz et al. (2019).

Regarding the financial situation of cantons receiving water fees, the approximation based on the calculated cost factors – such as the one taken from Betz et al. (2019)[15] – reveals different results than the actual water fees that have been collected and reported by the respective cantons. Table 2 in Chapter 2 shows the actual amounts of water fees received by the cantons UR, GR, VS and GL. The same analysis, based on the analytical framework and the concept of attributed water fees presents a different picture as Table 5 shows.

Table 5. Financial importance of water fees for cantons in 2016, using estimated data

Cantons	Total revenue in CHF	Estimated water fee revenue in CHF	Estimated water fee revenues in % of total revenue	Tax revenue in CHF	Estimated water fee revenues compared to tax revenue
Uri (UR)	391'500'000	16'858'296	**4.31%**	91'420'000	**18.44%**
Grisons (GR)	2'393'711'136	95'723'485	**4.00%**	751'823'092	**12.73%**
Valais (VS)	3'810'569'872	109'755'936	**2.88%**	1'260'057'247	**8.71%**
Glarus (GL)	373'178'000	9'779'880	**2.62%**	107'960'559	**9.06%**

Source: Kanton Uri (2017), Kanton Graubünden (2017), Kanton Wallis (2017b), Kanton Glarus (2017).

[15] See also Appendix B.

The comparison of both tables (Table 2 in Chapter 2 and Table 5 above) highlights that the cost calculation of 0.0124 CHF/kWh taken from Betz et al. (2019), such as described in Appendix B, produces different results for both the comparison of the estimated water fees with total revenues as well as tax revenues. On the one hand, regarding the total revenues, for Uri (actual = 6.2% vs. approx. = 4.3%) and Grisons (actual = 4.7% vs. approx. = 4.0%) the estimated data are lower than the reported ones, while for Valais (actual = 2.7% vs. approx. = 2.9%) and Glarus (actual = 1.6% vs. approx. = 2.6%) they are higher. On the other hand, the information on tax revenue also changes when comparing the last two columns of Table 2 in Chapter 2 and Table 5. For Uri and Grisons the estimated water fee revenues compared to tax revenue decreases (actual = 26.59% vs. approx. = 18.44%), while in the case of Valais it remains almost at the same percentage (actual = 8.15% vs. approx. = 8.71%) and for Glarus we see an increase between the actual amount received and our approximation (actual = 5.63% vs. approx. = 9.06%).

The concept of attributed water fees delivers insightful information, as it enables to link both shareholders and water fee receiving cantons through attributed water fee payment. But the above results also indicate limitations going along with the approximation using production cost per kWh. However, there is no alternative, as long as no official data on water fee payments are available. There is still a lack of clarity in terms of water fee payments on a national level. As transparency in terms of cost structures of utilities is important to shed more light on the complexity of financial flows related to water fees, it is equally important that the cantons and municipalities that receive water fee payments make those financial flows transparent. Driven by the needs of fiscal equalization, the canton of Grisons and its municipalities follow this need for transparency, while it is still lacking on the level of hydropower plants and central stations.

Another limitation to this analysis is the exclusion of financial flows in forms of dividends to the shareholders. A decade ago, the utilities as shareholders of hydropower plants received substantial amounts of dividends from their investments in these companies. Nevertheless, parallel to the decline of energy prices, the steady flow of dividends was gradually reduced and came to an end by 2016 (Derungs, 2016). However, the profit from each utility on which the dividends are based, is a result of the combined performance of the entire utility that also undertakes many other activities besides hydropower. Thus, hydropower itself has only a limited impact on the overall dividends of any utility and therefore including dividends would be conceptually incoherent, when solely analyzing the part of hydropower.

4 Water fees and fiscal equalization in the canton of Grisons

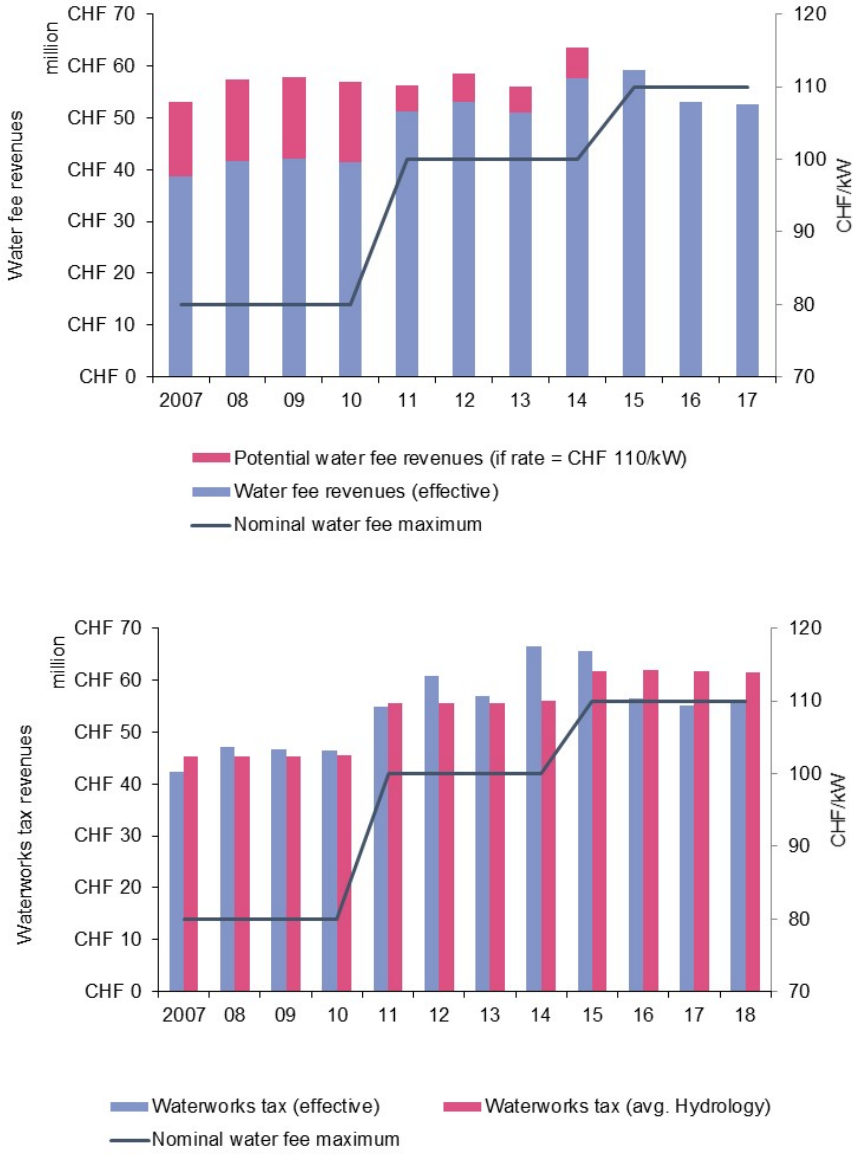
Currently, hydropower companies pay in Grisons about CHF 110 million on water fees annually. The hydropower municipalities and the canton share these revenues under the headings of water fees, on municipal level, and waterworks taxes, on the cantonal level, as illustrated in Figure 13. In order to mitigate the resulting disparities among municipalities, water fees are included in the inner-cantonal scheme of fiscal equalization (cf. Appendix C). Thus, a change in water fee payments affects public finances of all municipalities and the canton, and therefore needs careful consideration in any reform of the current water fee scheme. Accordingly, this chapter first looks at the current financial flows of transfer payments through the resource equalization system between resource-weak and resource-strong municipalities in Grisons and then offers a scenario-based analysis of the impacts of different water fee levels on public finance in the year 2018. This was the first year fully covering water fee revenues associated with the current maximum rate of 110 CHF/kW, as the calculation of each municipality's resource strength uses water fee revenue data from two and three years before (see Appendix E).

4.1 Water fee revenues of municipalities in Grisons

The actual revenues from water fees depend on the maximum water fee rate, as regulated by the law, as well as the natural water availability and further agreements made in the concession contracts.[16] It particularly depends on the average drop heights of the plant and the available quantity of water, which finally relies on natural factors such as the amount of precipitation. The effective water fee revenue a municipality is eligible to receive is not fixed. Rather, it varies from year to year and across the different regions and valleys of the canton. This is illustrated in Figure 13 for the years 2007 to 2017/18. It shows the maximum water fee rate (black line) as well as the potential and actual water fees revenues of Grison municipalities and the canton's waterworks tax revenues, respectively (purple and blue bars).

[16] The concession agreement between the operating company/corporation and the municipality settles the exact details of the amount and form of the water fee to be paid. It may also include agreements about the delivery of electricity at reduced prices or infrastructure services as part of the water fee payments. Accordingly, the concession contracts tend to be unique and tailored to the hydropower plants and municipalities they apply to. In addition, some partners have agreed on a fixed rate or a price bandwidth, such that that fluctuations in water availability do not have a direct impact on the water fee revenues, especially since the contracts usually stand for eighty years. Altogether, this makes plant-to-plant comparisons difficult, if not impossible.

Figure 13. *Water fee and water works tax revenues in Grisons, 2007–2018*



Data source: Amt für Energie und Verkehr (AEV) Graubünden.[17]

This illustration reveals the combined effects of the two-step increase of the water fee maximum in 2011 and 2015 as well as the hydrological variations over the years. First, the water fee revenues of municipalities in Grisons increased from CHF 40.9 million (2007 to 2010 average) to CHF 53.2 million (2011 to 2014 average), and reached a peak in 2015 with CHF 59.2 million. This is partly due to the upsurge in the maximum water fee rate, which has been 80 CHF/kW until the end of 2010, 100 CHF/kW from 2011 to 2014, and 110 CHF/kW since 2015, such as illustrated in Figure 13. In line with the increment of 25% from 80 to 100 CHF/kW, the total water fee revenues of eligible municipalities raised on average by 30%, while the last increase of the maximum water fee rate in 2015 did not (yet) have the same effect as the previous one in 2011.

[17] Beat Hunger, Amt für Energie und Verkehr Graubünden (AEV), personal communication on 14.02.2019.

The over-proportional effect of the first increase is also due to more favorable hydrological conditions, which benefited hydropower utilization. To illustrate this effect, we compare the 'potential water fee revenues' with a constant water fee maximum of 110 CHF/kW over the entire period (purple bars from 2007 to 2014). It shows that 2014 was an extremely good year for hydropower utilization, while the potential was more or less constant from 2008 to 2013; only 2007 was clearly below average. Despite the additional 10% increase of the water fee maximum, the water fee revenues of Grison municipalities in 2015 were slightly above those of 2014, only (CHF 59.2 million compared to CHF 57.7 million). Afterwards, these revenues even dropped below the 2014 level, with only CHF 52.9 million in 2016 and CHF 52.6 million in 2017. Compared to other years, those were hydrologically less favorable for hydropower generation, as illustrated by the potential water fee proceeds in Figure 13.

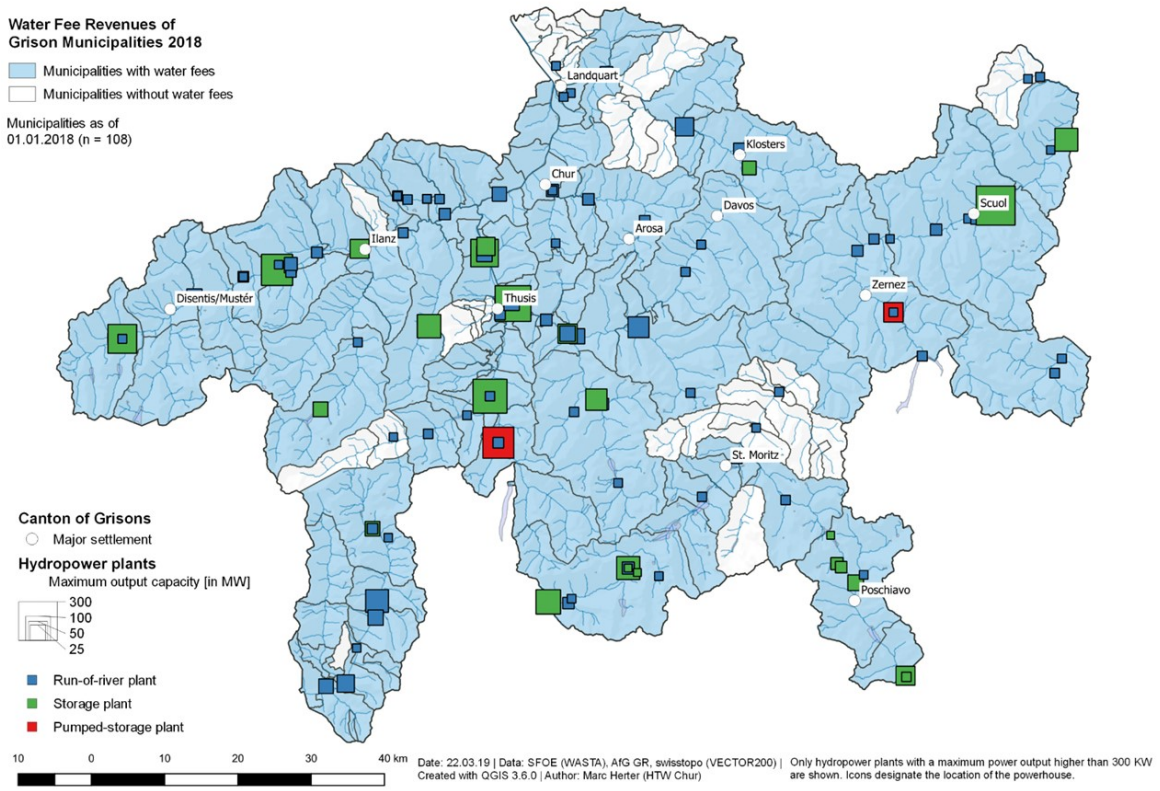
4.2 Municipal finance and resource equalization 2018

As of January 1st, 2018, almost 50% of the municipalities in the canton (53 out of 108) were the location of a hydropower station, and 86 municipalities received water fees as a compensation for the deviation of water on their territory (cf. Figure 14).[18] These municipalities received water fee payments of around CHF 57 million in 2018 (see above). According to the principle of the calculation of a municipality's resource potential, these proceeds are treated equally to tax revenues: With a delay of two and three years, revenues from water fees enter the calculation of a municipality's resource potential, in addition to their tax revenues of natural and legal persons and land and real estate taxes, and consequently are taken into consideration in the inner-cantonal resource equalization (cf. Appendix C). Accordingly, municipalities without hydropower facilities can indirectly benefit from water fees. But they are also affected by changes in the water fee revenues of other municipalities.

In the fiscal year 2018, 38 resource-strong municipalities deposited around CHF 18.7 million into the resource equalization scheme whereas 68 resource-weak municipalities were eligible to receive around CHF 27 million in disbursements thereof (see Figure 16). In addition, the canton made balancing payments of CHF 8.3 million to cover for the difference between the total deposits and disbursements. As mentioned above, the water fee revenues of 2015 and 2016 entered the calculations for the resource equalization 2018 (see Table 6 and Table 7).

[18] At the beginning of 2018, 108 hydropower plants with an installed capacity of at least 300 kW operated in the canton of Grisons, whereof 84 were run-of-river plants, 22 storage plants, and 2 pumped-storage plants (BFE, 2018c; AEV, 2018). Together, these plants provided an installed capacity of 2.8 MW and an expected annual output of 7,9 GWh in 2018. In addition, there existed 17 small hydropower plants with a capacity of less than 300 kW and 129 drinking-water power plants with an installed capacity of 8.9 MW and an average production of 44.7 GWh per year in the canton, as well as 8 pumped-storage plants with an installed power of 161 MW and an average pump consumption of 139.8 GWh per year (AEV, 2018).

Figure 14. *Hydropower and water fee-receiving municipalities in Grisons, 2018*



Source: AfG (2018) for public finance data; Swisstopo (2017) for GIS data; own illustration.

Figure 14 illustrates the territorial distribution of hydropower in the canton of Grisons: first, regarding the locations of hydropower stations by type (run-of-river, storage and pumped-storage plants) and size; second, with regard to the distribution of water fee-receiving municipalities. It elucidates the majority of municipalities in Grisons directly receive water fee payments (highlighted in blue), while only few (white coloured) do not.

Table 6. Financial contributions to the resource equalization system in Grisons, 2016–2018

(*all data in million CHF*)	**2016**	**2017**	**2018**
Total disbursements to resource-weak municipalities	26.4	27.1	27.0
Total deposits by resource-strong municipalities	17.9	18.4	18.7
Balancing payments by the canton	8.5	8.7	8.3
Total resource potential of all municipalities in Grisons	713.4	746.5	758.4
Total water fees accounted for in the resource potential[§)]	55.4	59.6	57.3
§) water fees considered from the years …	2013–2014	2014–2015	2015–2016

Source: Data provided by Amt für Gemeinden, Departement für Finanzen und Gemeinden, Kanton Graubünden.

Compared to the years before, the ratio of resource-weak to resource-strong municipalities as well as the level of deposits and disbursements are currently more or less constant (see Table 6).

Water fee revenues account for a large amount of the total resource potential of many sparsely populated municipalities in the periphery. For the fiscal year 2018, these revenues contributed between 30% and nearly 80% to those municipalities' resource potentials, as illustrated in Figure 15. However, due to the merger of municipalities and the variations in water fee revenues caused by hydrological fluctuations (see also Figure 13), more detailed year-to-year comparisons must be exercised with caution. Nonetheless, the pattern of resource-strong and resource-weak municipalities as well as the underlying drivers are important when analyzing the effects of alternative water fee mechanisms through fiscal equalization (see Figure 16, Table 7).

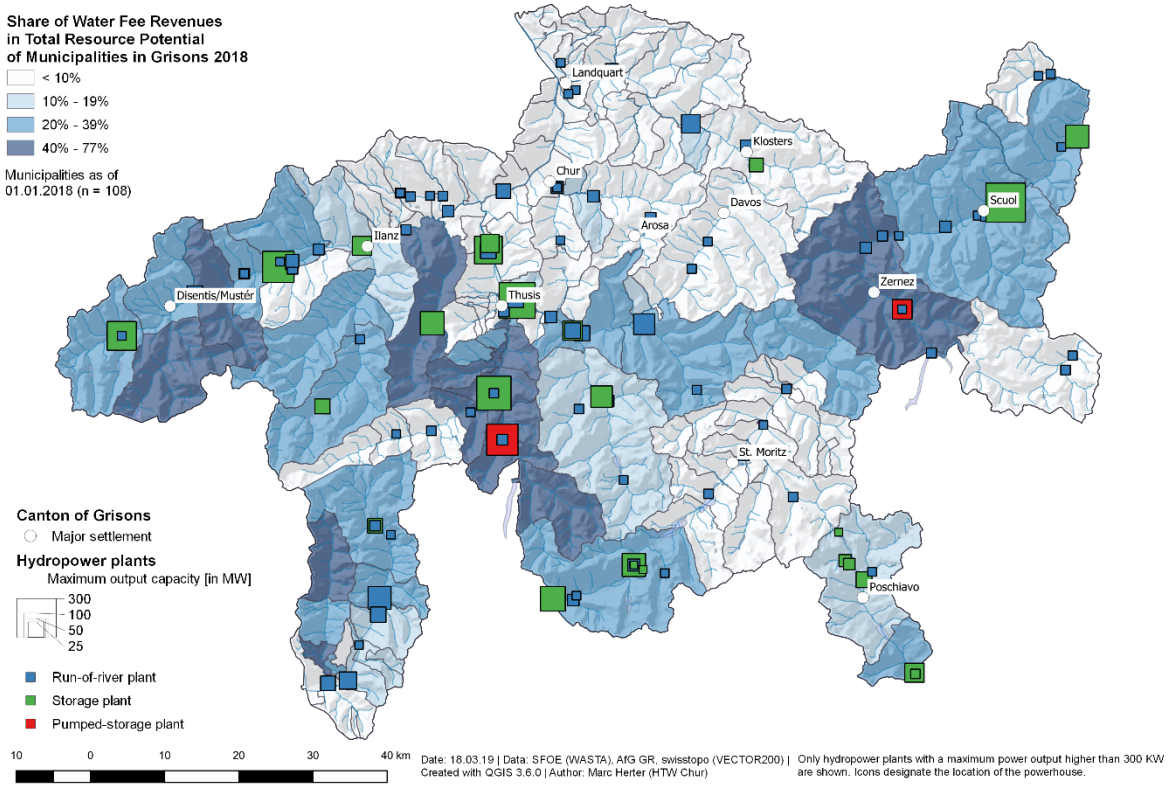
Table 7. Resource-strong and resource-weak municipalities in Grisons, 2016–2018

	2016		**2017**		**2018**	
Number (and share) of resource-strong municipalities	39	*(34%)*	42	*(37%)*	38	(35%)
Number (and share) of resource-weak municipalities	75	*(65%)*	70	*(61%)*	68	(63%)
Municipalities excluded from resource equalization	2	*(2%)*	2	*(2%)*	2	(2%)
TOTAL number of municipalities	**116**		**114**		**108**	

Source: Data provided by Amt für Gemeinden, Departement für Finanzen und Gemeinden, Kanton Graubünden.

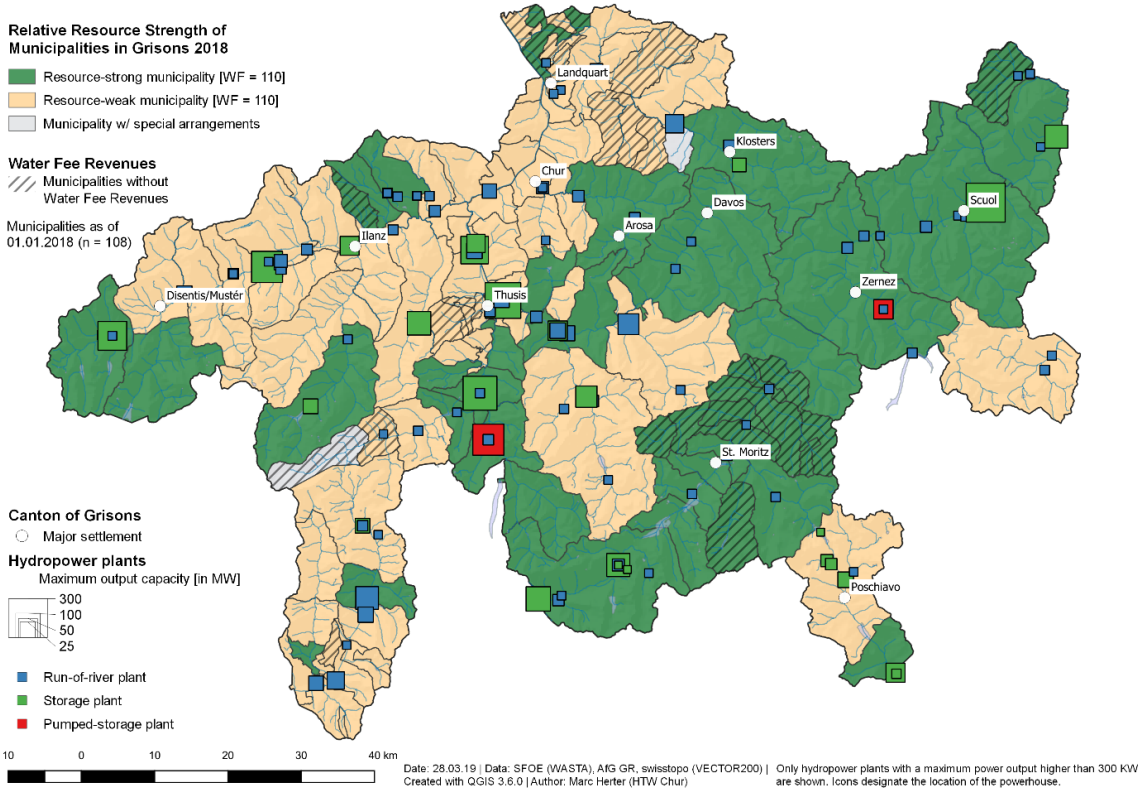
Tourism and hydropower utilization are economic backbones of the canton of Grisons, as the characteristics of the resource-strong and resource-weak municipalities in 2018 indicate. The 38 resource-strong municipalities are mainly located in regions with either a strong tourism industry (e.g. Upper Engadine, Davos-Klosters, Vaz/Obervaz, Arosa, Flims-Laax, Upper Surselva) or in key regions of hydropower utilization (e.g. Bregaglia, Brusio, Viamala, Lower Engadine). On the contrary, the 68 resource-weak municipalities are mostly located in more peripheral regions (such as Mesolcina or Val Müstair) and in the main industrial belt between Ilanz/Thusis-Chur-Landquart-Prättigau. These patterns are mainly caused by two effects: First, the relatively high revenue from tourism and hydropower in some regions, and second, the calculation principles of a municipality's resource potential (see Appendix C). The latter imply that the per-capita resource strength (the resource index) of a municipality in a more populous, industrial region is, in general, lower than that of a small peripheral village municipality with substantial water fee revenues.

***Figure 15**. Shares of Water Fee Revenues in the Resource Potential of Grison Municipalities, 2018*



Source: AfG (2018) for public finance data; Swisstopo (2017) for GIS data; own illustration.

***Figure 16.** Resource-strong and resource-weak municipalities in the canton of Grisons 2018*



Source: AfG (2018) for public finance data; Swisstopo (2017) for GIS data; own illustration.

4.3 The impact of changing water fees on resource equalization in Grisons

With the aim of highlighting the fiscal effects of different water fee schemes on municipal and cantonal level, we present the following results of our scenario-based analysis on the interface between water fees and resource equalization within the canton of Grisons.[19] We based our calculations on

a) the methodology that is based on the cantonal legislation, which is in force since 2016 (cf. AfG, 2016; 2018), as described in Appendix C, using fiscal data for the year 2018 provided by the Amt für Gemeinden (AfG) (cf. Hediger & Herter, 2019), as well as
b) water fee scenarios (cf. Table 8) that are based on different energy price scenarios (Betz et al., 2018) and different options (variants) of water fee schemes, as described in Appendix D.

Taking five distinct water fee scenarios, we investigate the hypothetical effects that these would have had on municipal finances and resource equalization in Grisons in the year 2018. Thus, we do not provide any forecast, but a scenario-based sensitivity analysis. The scenarios range from a high water fee maximum of more than twice the current rate that could result with a flexible fee in a high price scenario (case i) to a complete abolition of the water fee system (case v), as listed in Table 8.

Table 8. Water fee scenarios (cases) used in this analysis

Case	Water fee	Remarks
(i)	230 CHF/kW	scenario C++F++ with WF1/WF2 (2030)
(ii)	130 CHF/kW	small increase due to flexibilization, only
(iii)	110 CHF/kW	status quo (WFC)
(iv)	80 CHF/kW	minimum level of WF2; as applied from 1997 to 2010
(v)	0 CHF/kW	no water fees (WF0)

For details: see Appendix D, and Hediger & Herter (2019).

Out of eleven scenarios in total (Hediger & Herter, 2019), we chose five for a more detailed analysis: (i) 230 CHF/kW as the highest suitable maximum if we see a linear increase in carbon and fuel prices until 2030 (cf. Appendix D), (ii) 130 CHF/kW as a more realistic approximation of future electricity prices, (iii) 110 CHF/kW as the current status quo, (iv) 80 CHF/kW as a popular fallback idea onto a former rate, and (v) 0 CHF/kW corresponding to the abolition of the water fee system. The main effects of these assumptions on the inner-cantonal resource equalization are summarized in Table 9.

[19] The scenarios and the fiscal equalization system are described in more detail in Appendix D.

Table 9. Simulated impacts of water fee scenarios on the resource equalization in Grisons, 2018

Water fee:	**230 CHF/kW**	**130 CHF/kW**	**110 CHF/kW**	**80 CHF/kW**	**No water fees**
Scenario case:	(i)	(ii)	(iii)	(iv)	(v)
Total municipal water fee receipts (million CHF/year)	120	67	57	42	0
Sum total of net resource equalization = balancing payments by the canton (million CHF/year)	10.9	8.6	8.3	7.9	9.1
Number of resource-strong municipalities paying into the cantonal resource equalization	44	39	38	38	26
Number of resource-weak municipalities receiving transfers from the cantonal resource equalization	62	61	68	68	80
Sum total of waterworks tax revenues (million CHF/year) (*canton only*!)	117	67	56	40	0

Source: own calculations as described in Hediger & Herter (2019).

In general, one must acknowledge that all municipalities in Grisons would benefit from higher water fee payments, either directly with higher water fee receipts or indirectly through lower payments into or higher disbursements out of the resource equalization. The opposite would apply in case of lower water fees: all municipalities would lose. The inner-cantonal resource equalization fosters this effect of solidarity (Hediger & Herter, 2019).

A first comparison on the cantonal level elucidates how more extreme scenarios would go along with more extreme results, as illustrated in Table 9. The total water fee revenues of municipalities in Grisons could rise to over CHF 100 million (case i) or fall to zero (case v) in our two extremes. The net resource equalization, which corresponds to the difference between deposits and disbursements and equals the canton's annual balancing payment into the resource equalization, is also the highest in these two cases. Moreover, a substantial increase in water fee revenues could boost the resource potential of water fee-receiving municipalities and alter the relative resource potentials among municipalities to an extent that municipalities that have been resource-strong so far could become resource-weak and therefore eligible to receive disbursements from the resource equalization (see Figure 17, below).

Interestingly, there is a slightly negative difference between the status quo (case iii) and the 'old water fee rate' (case iv) in terms of net resource equalization. That is because the resource-strong, water fee-receiving municipalities would lose some 27% of their water fee proceeds, which to a certain degree

would also reduce the spread of resource potentials among all municipalities and lower the balancing payments required by the canton. In addition, the canton would lose about CHF 15 million on revenue from waterworks taxes.

A substantial change in the water fee rate could also affect the ratio between resource-weak and resource-strong municipalities. As represented in Table 9, those are currently split at a ratio of about two to one (68:38, case iii). This ratio would not change if we rolled back to the former rate (case iv). However, looking at the scenarios with a higher maximum water fee rate (cases i & ii), Table 9 shows that the ratio would shift towards having more resource-strong municipalities, as up to six formerly resource-weak municipalities would become resource-strong. On the contrary, the abolition of the water fee system (case v) would further increase the imbalance between the number of resource-weak and resource-strong municipalities to the disadvantage of the latter.

Thus, any change in water fee payments would have distributional consequences. It would affect water fee-receiving municipalities directly and all other municipalities indirectly. The direct effect regards an increased (for higher water fee rates) or reduced (for lower water fee rates) resource potential of those municipalities that receive water fees. Depending on the scenario, all other municipalities would indirectly be affected through their payments into and disbursements out of the resource equalization system, respectively (see Table 10).

Table 10. Direct impact of alternative water fee scenarios on municipalities in 2018

Water fee:	**230 CHF/kW**	**130 CHF/kW**	**110 CHF/kW**	**80 CHF/kW**	**No water fees**
Scenario case:	(i)	(ii)	(iii)	(iv)	(v)
Average resource potential per person* among all municipalities [CHF/year]	3'987	3'734	3'683	3'607	3'405
Average resource potential per person* among water fee-receiving municipalities [CHF/year]	4'041	3'760	3'704	3'620	3'395

* This refers to the decisive number of inhabitants ("massgebende Personenzahl"), which is defined as the number of inhabitants 2015 plus 20% of the taxable persons that exceed the number of inhabitants (see AfG, 2016).

The fact that the average per person resource potential among water fee-receiving municipalities is currently above the average resource potential of all municipalities in Grisons (case iii,) underlines the importance of water fee revenues and the resource equalization for public finance. A higher water fee rate would invariably lead to an increase in the average resource potential, further benefitting the water fee-receiving municipalities in particular (cases i & ii), such as illustrated in Table 10. This effect would switch to the contrary if the water fee rate was reduced to a point at which the average per person

resource potential of water fee-receiving municipalities fell below the per person average among all municipalities, such as illustrated in Table 10 for the scenario without water fees (case v).

Table 11. Indirect impact of changing water fees on the avg. resource potential in 2018

Water fee:	**230 CHF/kW**	**130 CHF/kW**	**110 CHF/kW**	**80 CHF/kW**	**No water fees**
Scenario case:	(i)	(ii)	(iii)	(iv)	(v)
Average resource potential per person* among all municipalities [CHF/year]	131	137	139	135	173
Average resource potential per person* among water fee-receiving municipalities [CHF/year]	48	43	42	42	31

* This refers to the decisive number of inhabitants ("massgebende Personenzahl"), which is defined as the number of inhabitants 2015 plus 20% of the taxable persons that exceed the number of inhabitants (see AfG, 2016).

The above analysis supports the suggestion that, under *ceteris paribus* conditions, an increased water fee maximum would lead to a win-win situation whereas a decrease would result a lose-lose situation regarding the average per person deposits into and disbursements out of the resource equalization system (see Table 11). A higher water fee rate (cases i & ii) would lower the average per person deposits while increasing the average per person disbursements, while resulting in a win-win situation for all municipalities. Reduced water fee rates (cases iv & v) would have the contrary effect by increasing the average per person deposit and simultaneously decreasing the average per person disbursement.

Hence, lowering the water fee payments would indirectly affect all municipalities negatively, regardless of whether or not they receive water fees. In contrast, all municipalities in the canton would benefit from higher water fees. This is an expression of mutual solidarity and fairness, which has been established with the new fiscal equalization system in 2016. However, the exposition to changes is quite different, as the following analysis and classification provided in Table 12 shows.

Table 12. Typology of Grison municipalities regarding resource-strength and changes in water fees

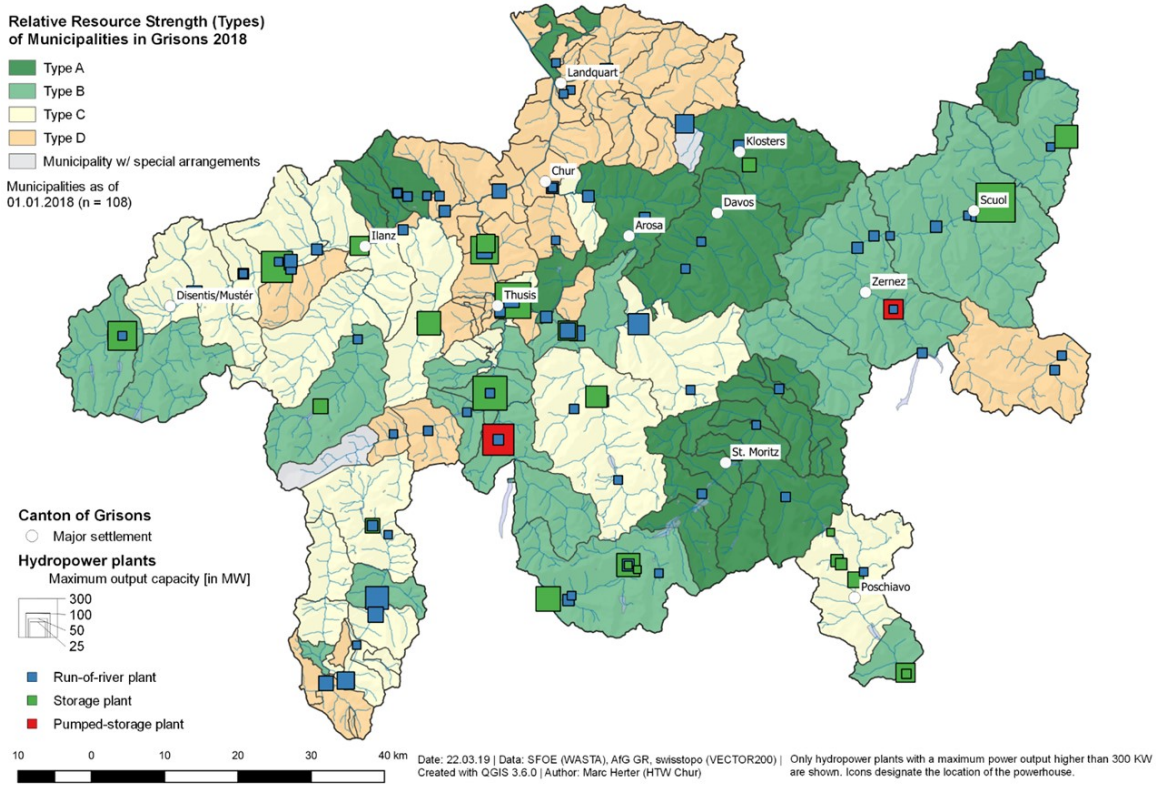
Typology		Number of municipalities (fiscal year 2018) with water fees	without water fees	TOTAL
Type A	***resource-strong municipalities*** that would have had to *pay more* into resource equalization (RE) if the water fee level had been lower and *pay less* if it was to increase	11	8	19
Type B	***resource-strong municipalities*** that would have had to *pay less* into RE if the water fee level had been lower and *pay more* if it was to increase	19	-	19
Type C	***resource-weak municipalities*** that would have *received more* out of RE if the water fee level had been lower and *received less* if it was to increase	25	-	25
Type D	***resource-weak municipalities*** that would have *received less* out of RE if the water fee level had been lower and *received more* if it was to increase	30	13	43
not classified *		1	1	2
TOTAL		86	22	108

*excluded from resource equalization for special reasons.

This analysis gives us a differentiated picture on the effect a change in water fees would have on both resource-strong and resource-week municipalities in Grisons. First, the 21 municipalities without water fees would all be worse off within the resource equalization in case of lower water fees; i.e. they would have to pay more or would receive less. The opposite applies in case of higher water fees. Second, the 11 resource-strong water fee-receiving municipalities classified as Type A are all 'tourism municipalities' with a ratio of overnight stays to inhabitants larger than five and more than 40'000 overnight stays per year.[20] The 8 municipalities without water fees in the same category are all located in touristic regions, though they do not fulfil the above criterion on overnight stays. Figure 17 illustrates the spatial pattern of this typology. Altogether, this underlines the importance of tourism on the resource potential of municipalities in the canton of Grisons.

[20] As defined by BFS (2017).

Figure 17. *Typology of Grison municipalities regarding resource strength and water fees, 2018*

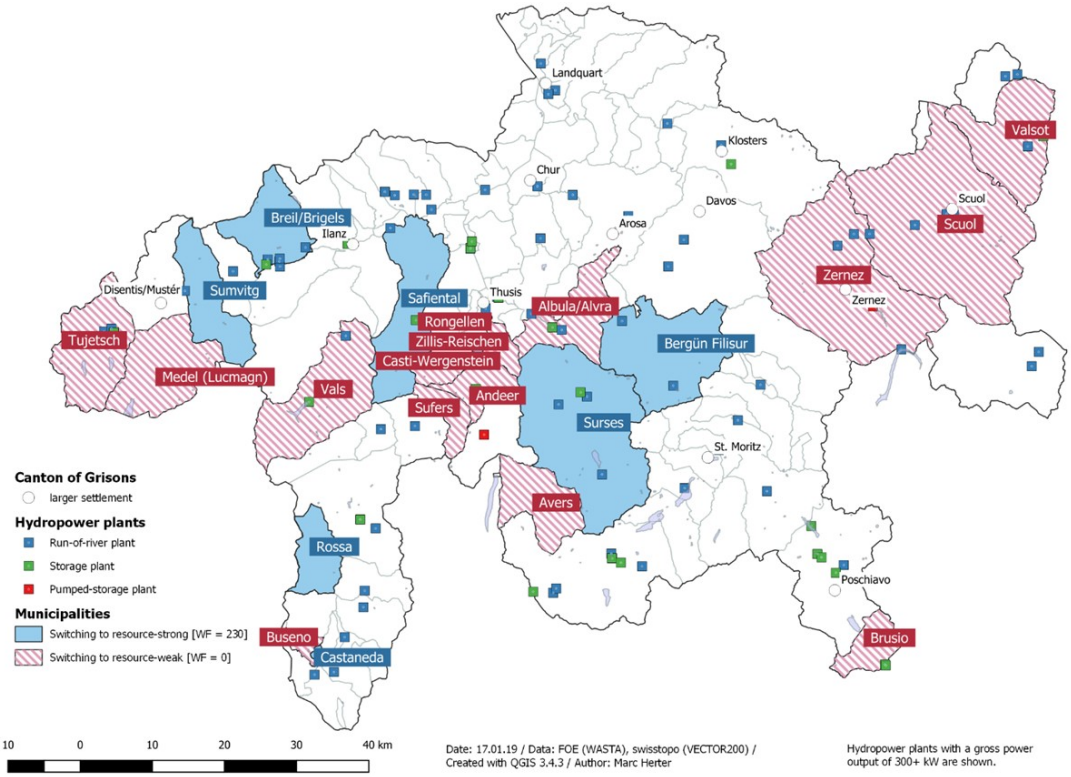


Source: AfG (2018) for public finance data; Swisstopo (2017) for GIS data; own illustration.

Moreover, some municipalities might shift from resource-strong to resource-weak, and vice versa, depending on the level of water fees: Out of the 19 resource-strong municipalities of Type B, 4 would have been resource-weak with a water fee of 50 CHF/kW, and even 15 would have been resource-weak if no water fees had been paid at all in 2018. In contrast, 1 of the resource-weak municipalities of Type C would have been resource-strong in case of a water fee level equal to 130 CHF/kW. This number would increase to 3 and up to 8 with water fee levels of 150 CHF/kW and 230 CHF/kW, respectively. Altogether, this illustrates the sensitivity of the relative resource-strength of Grison municipalities with respect to the applied water fee level, and thus to changes in the water fee scheme. Figure 18 depicts those municipalities that would become resource-strong under the most extreme scenario (case i) in blue, and those municipalities that would become resource-weak if the water fee system was to be discontinued (case v) in red stripes.[21]

[21] A sensitivity analysis with more details is provided in Appendix E.

Figure 18. *Sensitivity of the resource equalization system in Grisons on changes in water fees*



Source: AfG (2018) for public finance data; Swisstopo (2017) for GIS data; own illustration.[22]

The municipalities in blue are currently classified as resource-weak and could become resource-strong if the water fee rate went up. Water fees constitute an important part of public revenue for these municipalities. Additionally, the red-striped municipalities are currently categorised as resource-strong but would be on the list of resource-weak municipalities if the water fee system was discontinued. For these municipalities water fees form an important part of public revenue too. Taking a closer look at the other municipalities (in white in Figure 18), we see that most of them are either located in the main industrial valley along the river Rhine (Ilanz-Thusis-Chur-Landquart) and in the Prättigau, or are major tourist destinations, such as Klosters-Davos, Lenzerheide-Arosa, Upper Engadine, and Flims-Laax.

4.4 First learnings about fiscal feedback effects induced by changes in water fees

Hydropower utilization has played an important role in generating revenues in Grisons ever since it first started over 100 years ago (cf. Chapter 2). This refers to direct economic effects from hydropower plants during the construction and operation phases as well as to indirect effects through water fees and fiscal equalization payments. As one form of public revenue, water fees directly play an important role for some municipalities. But they are also a potential source of disparities. In consequence, the resource equalization mechanism aims to balance out the different income-raising capabilities between

[22] Note: As the definite sum of water fee revenues may vary strongly from year to year depending on hydrological conditions, this representation must be interpreted with caution. As illustrated in Figure 11, these variabilities may be as high as 20%.

municipalities and indirectly redistributes a share of the total amount of water fee revenues to resource-weak municipalities. A change in the applicable water fee rate would thus affect every municipality – some directly, others indirectly.

A higher water fee rate would directly benefit the water fee-receiving municipalities through higher revenues and all other municipalities indirectly through increased average disbursements out of the resource equalization system. A reduction of the water fee rate, on the contrary, would reduce public revenues for all water fee-receiving municipalities and lower their respective resource potential, thus gradually causing a shift of resource-strong towards resource-weak municipalities. This would not only imply that the average disbursements to an increasing number of resource-weak municipalities would decrease but also that the remaining resource-strong municipalities would be required to increase their deposits into the resource equalization system. Altogether, this would put more pressure on those municipalities with a strong tourist industry, which is the other economic backbone in Grisons apart from hydropower utilization. They would have to generate revenue in a time, when the number of tourist arrivals is falling and climate change emerges as another threat to winter tourism (see also Credit Suisse, 2015). Altogether, this underlines the contemporary importance of water fees for the economic development of the diverse regions of Grisons. Similar effects might be expected in other mountain regions. Accordingly, modifications of the water fee system must be made with caution and only on the basis of careful evaluations.

5 Conclusions

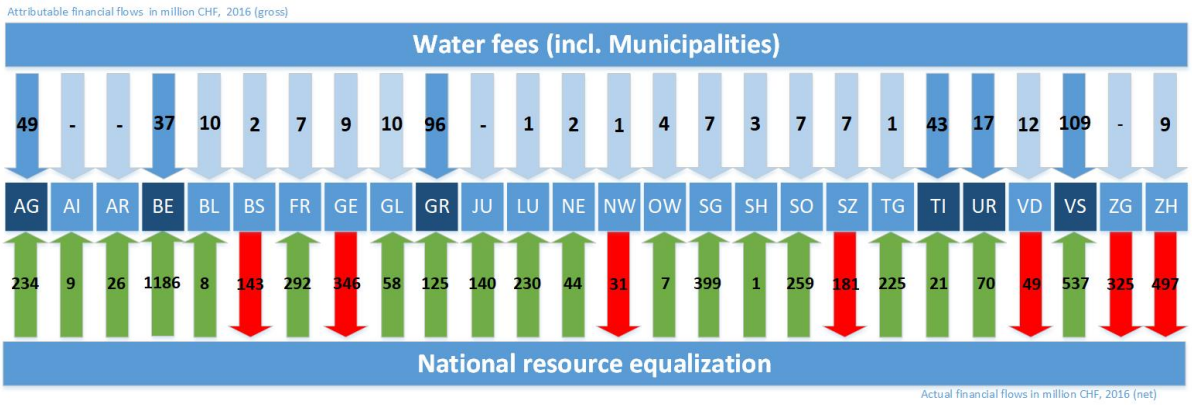
Water fees are the remuneration for the exclusive use of hydropower (use right) to be paid by the hydropower companies to the concession-granting cantons and municipalities that are the legal holders of the property rights to the water resources, according to the federal constitution and legislation. This system has been in place for more than 100 years, with a maximum rate that is fixed by the federal parliament and that has been augmented several times since its introduction in 1918. However, the system is currently being debated for various reasons. On the one hand, the water fee revenues are an important source of fiscal revenue to mountain cantons and municipalities. On the other hand, they are considered as a decisive cost factor by the representatives of hydropower companies that are mainly in the possession of 'lowland cantons', i.e. cantons located on the Central Plateau. Finally, it is criticized that the water fees currently account for physical facts only, but not for economic realities. They are seen as a subsidy for regional development by some commentators, while others defend the current system with the argument that water fees are neither a subsidy nor a cost element. The first group emphasizes the lack of competitiveness of Swiss hydropower under the current system, at least on the international market. The second group stresses the importance of water fees and hydropower for public finance and economic development in remote areas, especially in the mountain cantons. In this context, fiscal equalization also plays an important role, as it aims to mitigate disparities between cantons (national level) and between municipalities (inner-cantonal levels), respectively. Thus, when analyzing prospective changes of the current water fee scheme in Switzerland, the distributional effects caused by water fees and the ownership structure of hydropower companies as well as the impact on public finance and fiscal equalization in the affected cantons must be taken into account.

First, the annual water fees currently amount to between CHF 450 million and CHF 550 million.[23] About 50% thereof go to the cantons of Valais (VS) and Grisons (GR), and another 30% to Aargau (AG), Ticino (TI), Bern (BE) and Uri (UR). This is due to the large hydropower production capacities installed in these cantons, where water fee revenues constitute a considerable contribution to the cantonal budget. In Uri, the water fee revenues amount to about 30% of the tax revenues (Dümmler & Rühli, 2018), but only about 6.2% of the canton's total revenues (own calculations, see Chapter 2). Furthermore, a look at the resource-weak cantons (indicated by green arrows in Figure 19) shows that the financial flows from the national fiscal equalization scheme[24] (resource equalization) substantially exceed those of water fees. In the year 2016, only Schaffhausen (SH), Ticino (TI) and Basel-Land (BL) had water fee receipts exceeding the transfers from the national resource equalization.

[23] CHF 550 million is the theoretical maximum (Bundesrat, 2018a), given the installed capacities of the hydropower plants, while the effective payments are subject to hydrological fluctuations. Since these fluctuations also affect hydropower generation, production data published annually by the SFOE in the WASTA statistics (e.g. BFE, 2017) must be used for estimations that further rely on approximated cost factors (cf. Chapter 3 and Appendix B).

[24] Figure 17 does not include the financial flows from the cost compensation scheme, which also forms part of the national fiscal equalization.

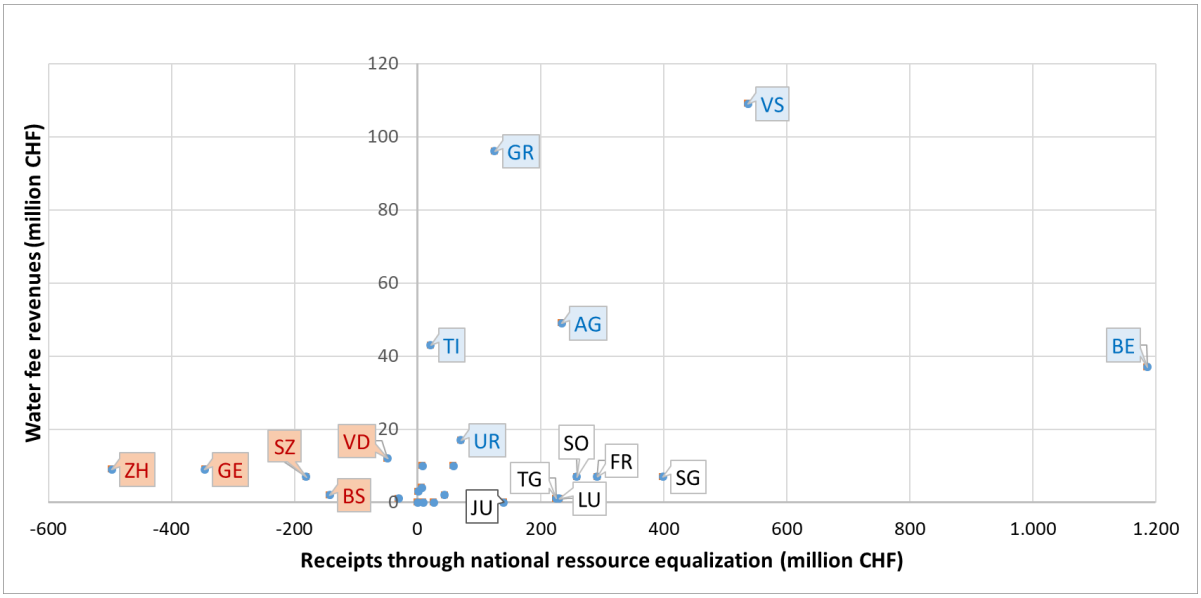
Figure 19. *Comparison of financial flows from water fees and fiscal equalization in 2016*



Source: own calculations based on Betz et al. (2019) and BFE (2017), as well as official data provided by the Federal Finance Administration (EFV, 2017).

Though, the six main recipients of water fees (VS, GR, AG, TI, BE and UR) are all resource-weak, no clear relationship can be found between the levels of resource equalization and water fees, such as depicted in Figure 20. It cannot be concluded that the major hydropower cantons are resource-weak, as a rule. Rather, in 2016, the lowland cantons SG, FR, LU, SO, TG and AG together with BE and VS are the main beneficiaries of the national resource equalization, each receiving more than CHF 200 million through this scheme. In contrast, the two main 'donors' in the national resource equalization – Zurich (ZH) and Geneva (GE) – had higher water fee receipts than the group of lowland cantons above. Thus, as in the canton of Grisons (cf. Chapter 4), other drivers determine the economic and fiscal prosperity of a region (canton or municipality).

Figure 20. *Water fees and national resource equalization, 2016*



Source: own calculations based on Betz et al. (2019) and BFE (2017), as well as official data provided by the Federal Finance Administration (EFV, 2017).

Second, the resource rents generated by the exploitation of the natural potential of hydropower are theoretically split into dividends and retained profits, on the one side, and water fees and corporate taxes, on the other. Accordingly, they are shared among capital owners (investors), on the one side, and the holders of the property rights on the natural resource water, on the other. Thus, from an (national) economic point of view, water fees are an element of distributing (sharing) resource rents, rather than a cost element. The regulation of this distribution is an issue of fairness and political economy, and cannot exclusively be based on cost considerations (Hediger, 2018; 2019). It must ensure, over time, sufficient returns on investment to the owners of the hydropower companies and, at the same time, adequately compensate the owners of the water rights. Accordingly, it must be carefully designed, under consideration of the various effects in the corporate, economic and societal spheres. In the end, it must contribute to the Energy Strategy 2050 and the constitutional goal of sustainable development. In this regard, one must recognize that social responsibility, transparency and accountability are core principles of sustainability and corporate governance. The latter involves the classic problems of the ownership-management separation, but also problems among owners and stakeholders (cf. Beltratti, 2005; Shleifer and Vishny, 1997; Tirole, 2001). Thus, the ownership structure of Swiss hydropower must be taken into account when designing the future water fee scheme.

A comprehensive analysis of financial flows from hydropower utilization to the different cantons must consequently encompass all the above forms of participating in the resource rent. This is particularly relevant when investigating the distributional effects of alternative water fee schemes and electricity price scenarios. However, dividends cannot be calculated with the information currently available. Nonetheless, the attribution of water fee payments according to the shareholdings of different actors in the different companies can be calculated, such as presented in Chapter 3, and they remain constant, as long as the shareholdings do not change. Our analysis particularly shows that, through their direct and indirect shareholdings in the different hydropower companies, public and foreign investors, the cantons of Zurich, Aargau and Bern as well as the City of Zurich ‘pay’ about 60% of the total water fees in Switzerland. But the mountain cantons and municipalities also cover some share of the water fee bill, through their shareholdings in mostly local hydropower companies.

Third, in Grisons and Valais, substantial royalties flow to those municipalities where the hydroelectric power plants are located. The resulting inner-cantonal disparities are mitigated by the cantonal resource equalization in these two cantons. In general, fiscal equalization systems exist on the national and cantonal levels, and they all aim at reducing disparities. Accordingly, the principles applied are more or less the same across Switzerland. However, different circumstances and preferences lead to differences in the measurement of the resource potential and cost elements at the national and cantonal levels, and thus to differences in the fiscal equalization schemes. Hence, the inclusion of water fees in the resource equalization of the cantons of Grisons and Valais, as well as the proposal to include it in the national resource equalization must be considered against this background.

On the national level, water fees seemingly contribute less to the creation of inter-cantonal disparities. Rather, the financial flows within the national resource equalization generally exceed those of water fees substantially, at least for the resource-weak cantons, such as shown in Figure 19 and Figure 20. The canton of Grisons, which shows a comparably small difference between both flows, is also a good example to illustrate the role of water fees and fiscal equalization and their impact on municipal and cantonal budgets. But it also reveals that one must expect induced impacts on public expenditure, and thus on the economic development on the cantonal and municipal level. These effects must additionally be examined in order to draw a complete picture of the prospective impacts from changing the water fee scheme. Indeed, changes in royalties and dividends will have an impact on the economic and social development and on jobs available in peripheral communities. Ultimately, those are social issues that require political-economic decisions in the federal system. In this regard, it is also important to remember that the water fees (royalties) represent only a part of the resource rents arising out of the use of hydropower, such as underlined above. Thus, dividends, retained profits and corporate taxes should also be taken into account if one considers including water fees in the national fiscal equalization.

Finally, transparency is a major issue that needs to be addressed. As far as transparency of actual costs is concerned, Betz et al. (2019) provide useful insights. However, the approximation of attributed water fees based on the cost structure assessed by Betz et al. and the ownership analysis in Chapter 3 reveal substantial differences between the actual water fee payments and our approximations. Nonetheless, the ownership analysis underlines that hydropower companies are owned mainly by cantons. This ultimately raises the issue of public (corporate) governance, and thus of the ownership strategies of each canton, including financial standards. In this respect, the information that is provided by the utilities regarding their cost structures is highly dependent on the applied accounting standards and the quality and level of detail of information that has to be provided based on these standards. Thus, in order to shed more light on the discrepancies between estimated and actual cost of water fees, the requirements for publicly-owned hydropower companies in terms of accounting information require further investigation. Only fully transparent cost information (at best on hydropower plant level) would provide a solid basis for policy decisions regarding a new water fee regime. In addition, full information of the effective water fees received by the cantons and other communities is essential to complete the picture and provide a solid data basis for further analyses, and finally for informed decision-making. Altogether, solving these issues of transparency is crucial for the analysis of the impacts alternative water fee systems would have on corporate profits, public finance and regional development, particularly in mountain areas.

Appendix

A. Ownership of Swiss Hydropower

The major production capacities of Swiss hydropower located in the Alps and along the main rivers, while the effective owners of these plants are the lowland cantons through their shareholdings in the large utilities. Figure A1 shows in the upper part the location of large Swiss hydropower plants (with a minimum power of 300 kW) and in the lower part the final ownership ("shareholdings") in these plants among the Swiss cantons, including cities, municipalities, and other organizational units. The source of information used for these representations are described in the following, whereby one must notice that, hitherto, no official data on the ultimate ownerships ('shareholdings') exist. With this research, we also fill this gap, such as described in Chapter 3 and Appendix B. Table A2 shows the shareholders with their shares and owned capacities in Swiss hydropower production, while Table A1 gives the official signs of the Swiss cantons.

Table A1. The Swiss cantons and their shareholdings in Swiss hydropower

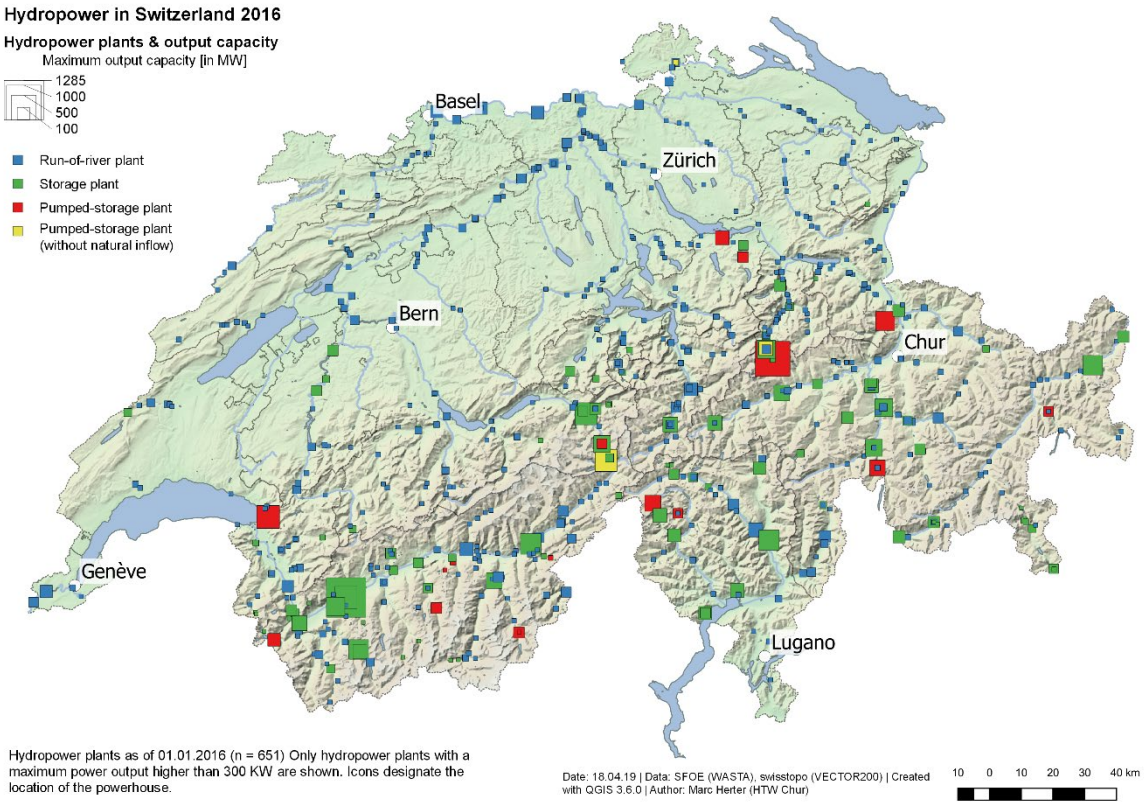
Sign	Canton	Shares	Sign	Canton	Shares
AG	Aargau	8,41%	NW	Nidwalden	0,38%
AI	Appenzell Innerrhoden	0,07%	OW	Obwalden	0,39%
AR	Appenzell Ausserrhoden	0,40%	SG	St. Gallen	3,09%
BE	Bern	6,98%	SH	Schaffhausen	1,95%
BS	Basel-Stadt	3,57%	SO	Solothurn	0,65%
BL	Basel-Land	0,50%	SZ	Schwyz	0,64%
FR	Fribourg	3,86%	TG	Thurgau	2,58%
GE	Geneva	3,53%	TI	Ticino	4,64%
GL	Glarus	0,69%	UR	Uri	0,95%
GR	Grisons	3,90%	VD	Vaud	3,47%
JU	Jura	0,00%	VS	Valais	4,70%
LU	Lucerne	0,71%	ZG	Zug	0,23%
NE	Neuchâtel	0,50%	ZH	Zürich	14,65%

Note: These shareholdings include those of the cantons themselves and of their municipalities.

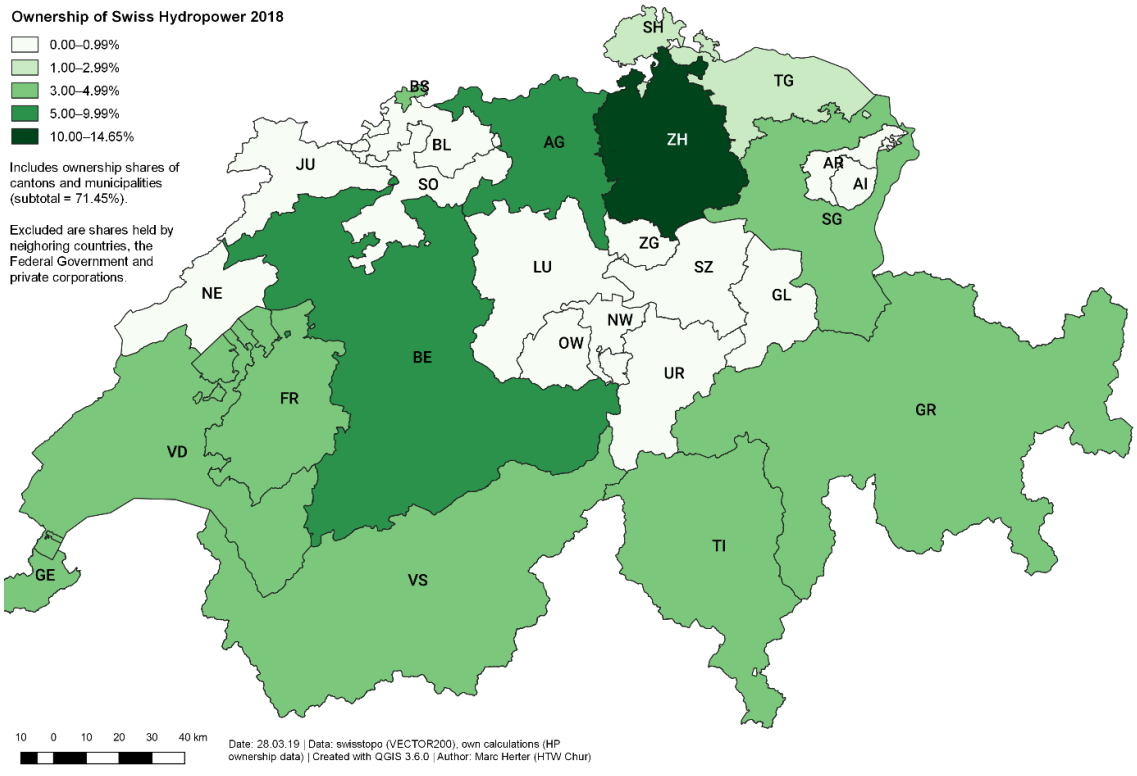
Source: Table A2.

Figure A1. *Location and ownership of hydropower plants in Switzerland, 2016*

a) Location



b) Shareholdings



Source: BFE (2017) for hydropower data, Table A2 for ownership structure, and Swisstopo (2017) for GIS data; own illustration.

Table A2. The shareholdings in Swiss hydropower, 2016

Shareholder	*Appropriated production in kWh*	*Share of total production volume*
Canton AG	2'774'009'191	7.743%
Canton AI	25'105'850	0.070%
Canton AR	142'601'207	0.398%
Canton BE	1'893'797'444	5.286%
Canton BL	179'250'000	0.500%
Canton BS	1'279'604'272	3.572%
Canton FR	1'381'553'829	3.856%
Canton GE	696'406'645	1.944%
Canton GL	196'819'468	0.549%
Canton GR	800'281'656	2.234%
Canton LU	78'650'774	0.220%
Canton NE	37'190'466	0.104%
Canton NW	135'800'000	0.379%
Canton OW	74'087'000	0.207%
Canton SG	841'862'366	2.350%
Canton SH	611'263'418	1.706%
Canton SO	234'172'782	0.654%
Canton TG	896'871'902	2.503%
Canton TI	1'500'930'500	4.190%
Canton UR	114'185'000	0.319%
Canton VD	393'761'806	1.099%
Canton VS	549'078'266	1.533%
Canton ZG	65'922'887	0.184%
Canton ZH	3'207'855'002	8.954%
City of Aarau AG	182'954'828	0.511%
City of Arbon TG	26'315'400	0.073%
City of Baden AG	56'640'000	0.158%
City of Bern BE	511'035'120	1.426%
City of Biel BE	77'200'000	0.215%
City of Buchs SG	15'600'000	0.044%
City of Davos GR	45'614'520	0.127%
City of Geneva GE	379'858'140	1.060%
City of Gossau SG	650'000	0.002%
City of La Chaux-de-Fonds NE	39'056'001	0.109%
City of Lausanne VD	682'454'123	1.905%
City of Locarno TI	71'659'500	0.200%
City of Le Locle NE	16'632'312	0.046%
City of Lugano TI	88'910'509	0.248%
City of Luzern LU	176'249'200	0.492%

Shareholder	*Appropriated production in kWh*	*Share of total production volume*
City of Martigny VS	37'332'391	0.104%
City of Montreux VD	1'806'922	0.005%
City of Neuchâtel NE	59'446'405	0.166%
City of Rapperswil-Jona SG	8'187'013	0.023%
City of Rorschach SG	38'011'133	0.106%
City of Schaffhausen SH	86'875'000	0.242%
City of Siders VS	101'824'200	0.284%
City of Sion VS	188'857'940	0.527%
City of St. Gallen SG	99'847'067	0.279%
City of Vevey VD	2'466'204	0.007%
City of Zug ZG	13'415'047	0.037%
City of Zurich ZH	2'020'697'620	5.640%
District of Schwyz SZ	140'581'000	0.392%
Municipalities BE	16'804'180	0.047%
Municipalities GE	189'929'107	0.530%
Municipalities GL	49'706'867	0.139%
Municipalities GR	552'059'964	1.541%
Municipalities NE	15'376'490	0.043%
Municipalities OW	64'913'000	0.181%
Municipalities SG	104'170'000	0.291%
Municipalities SH	1'660'000	0.005%
Municipalities SZ	65'868'250	0.184%
Municipalities UR	226'669'000	0.633%
Municipalities VD	163'491'182	0.456%
Municipalities VS	806'248'449	2.250%
Municipalities ZG	4'695'266	0.013%
Municipalities ZH	20'467'533	0.057%
Municipality Schwyz SZ	23'507'750	0.066%
Municipality Val-de-Travers NE	12'067'438	0.034%
Neighboring Countries	4'326'199'509	12.076%
Private Corporations	519'672'741	1.451%
Public (private investors)	3'406'310'536	9.508%
SBB (Federal Government)	1'733'685'000	4.839%
“Miscellaneous”	190'694'964	0.532%
“Residual Value”	49'932'560	0.139%
Total	**35'825'369'114**	**100.00%**

Source: BFE (2017) and ownership analysis, such as described in Chapter 3 and Appendix B.

B. Estimation of Water Fees and 'Attributed Water Fees'

For the analysis of financial flows from water fees, we develop and apply the concept of 'attributed water fees'. This requires detailed information regarding the ownership structures from the central stations to the final shareholders (cf. Chapter 3 and Appendix A, below) and about water fee payments. Unfortunately, no official data are available on the effective water fee payments from each hydropower plant. Therefore, water fees must be assessed for each plant first, which is not a trivial exercise, either. From a technical perspective, water fees are calculated based on the following formula (Pfammatter & Piot, 2016), with kW denoting a plant's gross production capacity:[25]

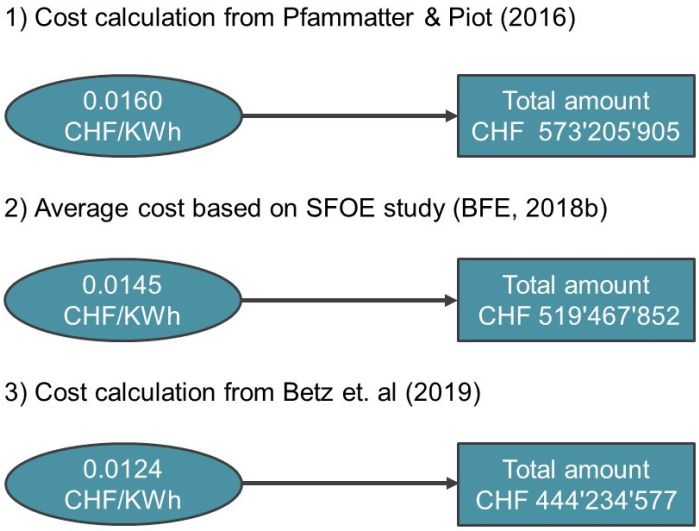
$$water\ fees\ [CHF] =$$
$$max.water\ fee\ rate\ [CHF/kW_{br}] \times average\ gross\ production\ [kW_{br}]$$

The maximum water fee rate is defined through national legislation (cf. Chapter 2) and is the same rate for all cantons. Average gross production, however, is an individual value for each central station. It is based on the utilizable slope and the availability of hydrological resources, and can accordingly vary from year to year. Again, this information is not available.

Nonetheless, individual water fee payments can be assessed on the basis of production data for each central station, such as provided in the WASTA database (e.g. BFE, 2017). Still, this leaves some degree of ambiguity, which becomes evident when studying the current literature regarding the 'cost of water fees' in CHF per kWh.[26] The literature shows substantial differences regarding this value. Pfammatter and Piot (2016) calculate for the average hydropower plant the cost of water fees amounting to 0.0160 CHF/kWh. The Swiss Federal Office of Energy (BFE, 2018b) presented the results of a survey conducted among 27 owners of hydropower plants,[27] revealing that, based on the participants' calculation, the average cost for water fees ranged between 0.0131 CHF/kWh and 0.145 CHF/kWh for the years 2011 to 2016. For reasons of comparability with the results of Pfammatter and Piot (2016), the 2016 value is used in this study, which is 0.0145 CHF/kWh. Another estimation stems from Betz et al. (2019). Their evaluation of the cost structure of 60 hydropower plants shows that water fee payments amount to 0.0124 CHF/kWh. At a first glance, these differences might not seem significant. However, when calculating the total amount of water fee payments for the entire country, the differences are quite substantial as depicted in Figure B1.

[25] Note that we use throughout this paper the scientific notation kW instead of kW_{br}.
[26] Although, we underline in Chapter 2 that water fees are an element of sharing resource rents among different constituencies, rather than a cost factor, we apply this approach based on the terminology used by the SFOE (BFE, 2018c) and by Betz et al. (2019).
[27] Regarding the definitions established in Chapter 3 such owners of hydropower plants can be qualified as intermediaries.

Figure B1. *Comparison of cost calculations for water fees*



In our calculations of water fees per canton (see Table B1) and of the attributed water fees (see Table B2 and Chapter 3), we use the cost factor of 0.0124 CHF/kWh estimated by Betz et al. (2019). This decision is based on the structure and scope of the analysis undertaken by Betz et al., which is believed to give a state-of-the-art picture about the current cost structure for hydropower utilities. Nonetheless, in some cases, the estimation of water fees per canton shows substantial deviations, either when using the cost factor from Betz et al. (2019) or that of the Federal Office (BFE, 2018b). In most cases, the official figures are above the estimations (GL, GR, JU, NW, OW, UR), in two cases they are below (GL, VS), and in one case (AG) it is in between. The reasons for these deviations are not clear, and need further investigations. But this also reveals that more transparency on the effective water fee data is required.

Table B1. Water fees per canton, 2016

Cantons	**Water fees (CHF)**		
	Official data	Estimation using cost calculation from Betz et al. (2019)	Estimation using cost estimation of BFE (2018b)
Canton AG	49'334'000.00	48'648'399.19	56'887'240.98
Canton AI	n.a.	95'480.00	111'650.00
Canton BE	approx. 43'000'000[(a)]	37'309'109.83	43'627'588.11
Canton BL	n.a.	9'568'460.00	11'188'925.00
Canton BS	n.a.	2'269'200.00	2'653'500.00
Canton FR	n.a.	7'212'211.99	8'433'634.99
Canton GE	n.a.	9'083'620.00	10'621'975.00
Canton GL	6'083'021.00	9'779'880.00	11'436'150.00
Canton GR	112'969'876.00	95'723'484.76	111'934'720.08
Canton JU	486'430.35[(b)]	306'528.00	358'440.00
Canton LU	n.a.	639'220.00	747'475.00
Canton NE	n.a.	2'191'439.04	2'562'569.85
Canton NW	1'710'913.75	1'450'800.00	1'696'500.00
Canton OW	4'900'000[(c)]	3'568'720.00	4'173'100.00
Canton SG	n.a.	7'214'568.00	8'436'390.00
Canton SH	n.a.	2'669'100.00	3'121'125.00
Canton SO	n.a.	7'108'795.82	8'312'704.79
Canton SZ	n.a.	7'511'300.00	8'783'375.00
Canton TG	n.a.	565'192.00	660'910.00
Canton TI	n.a.	43'447'119.90	50'805'099.88
Canton UR	CHF 24'310'632	16'858'296.00	19'713'330.00
Canton VD	n.a.	12'013'616.13	14'048'180.15
Canton VS	CHF 102'665'611	109'755'935.57	128'343'634.33
Canton ZG	n.a.	360'716.00	421'805.00
Canton ZH	n.a.	8'883'384.80	10'387'829.00
Total	**n.a.**	**444'234'577.03**	**519'467'852.16**

Note: (a) No detailed information available in the annual report; (b) «Droits d'eau et conessions hydrauliques» (République et canton du Jura, Compte 2016, p. 209) ; (c) "Abrechnung Wasserzinsen" [Forderungen] (Geschäftsbericht des Regierungsrats 2016, Kanton Obwalden, p. 264); n.a = not available (no data available). Source : Annual reports of the cantons, own calculations based on WASTA database (BFE, 2017) and cost factors provided by Betz et al. (2019) and BFE (2018b), respectively.

Table B2. Total of attributed water fees per shareholder, 2016

Shareholders	Attributed water fees (CHF)	Shareholders	Attributed water fees (CHF)
Canton AG	34'397'713.97	City of Lugano TI	1'102'490.31
Canton AI	311'312.54	City of Luzern LU	2'185'490.08
Canton AR	1'768'254.97	City of Martigny VS	462'921.65
Canton BE	23'483'088.30	City of Montreux VD	22'405.83
Canton BL	2'222'700.00	City of Neuchâtel NE	737'135.42
Canton BS	15'867'092.98	City of Rapperswil-Jona SG	101'518.97
Canton FR	17'131'267.49	City of Rorschach SG	471'338.05
Canton GE	8'635'442.40	City of Schaffhausen SH	1'077'250.00
Canton GL	2'440'561.41	City of Siders VS	1'262'620.08
Canton GR	9'923'492.54	City of Sion VS	2'341'838.46
Canton LU	975'269.60	City of St. Gallen SG	1'238'103.63
Canton NE	461'161.78	City of Vevey VD	30'580.93
Canton NW	1'683'920.00	City of Zug ZG	166’346.58
Canton OW	918'678.80	City of Zurich ZH	25’056’650.49
Canton SG	10'439'093.34	District of Schwyz SZ	1’743’204.40
Canton SH	7'579'666.39	Municipalities BE	208’371.83
Canton SO	2'903'742.50	Municipalities GE	2’355’120.93
Canton TG	11'121'211.59	Municipalities GL	616’365.15
Canton TI	18'611'538.20	Municipalities GR	6’845’543.55
Canton UR	1'415'894.00	Municipalities NE	190’668.48
Canton VD	4'882'646.40	Municipalities OW	804’921.20
Canton VS	6'808'570.50	Municipalities SG	1’291’708.00
Canton ZG	817'443.80	Municipalities SH	20’584.00
Canton ZH	39'777'402.02	Municipalities SZ	816’766.30
City of Aarau AG	2'268'639.87	Municipalities UR	2’810’695.60
City of Arbon SG	326'310.96	Municipalities VD	2’027’290.65
City of Baden AG	702'336.00	Municipalities VS	9’997’480.76
City of Bern BE	6'336'835.49	Municipalities ZG	58’221.30
City of Biel BE	957'280.00	Municipalities ZH	253’797.41
City of Buchs SG	193'440.00	Municipality Schwyz	291’496.10
City of Davos GR	565'620.05	Municipality Val-de-Travers	149’636.23
City of Geneva GE	4’710’240’94	Neighboring Countries	53’644’873.91
City of Gossau SG	8'060.00	Private Corporations	6’443’941.99
City of La Chaux-de-Fonds	484'294.41	Public (private investors)	42’238’250.65
City of Lausanne VD	8'462'431.12	SBB (Federal Government)	21’497’694.00
City of Locarno TI	888'577.80	“Miscellaneous”	2’364’617.56
City of Le Locle NE	206'240.67	“Residual Value”	619’163.74
		TOTAL	**444’234’577.03**

Source: own calculations, using the cost factor from Betz et al. (2019); cf. Table B1.

C. The Essentials of Fiscal Equalization in Switzerland and in Grisons

Federalism and subsidiarity are fundamental principles of the Swiss Confederation. They are built on the promise that a federal structure with smaller administrative units moves decision-making processes closer to the population, making their voice heard better than would be the case in a central state (EFD, 2007, 2018; EFV, 2018; Hausner, 2005). Accordingly, state tasks should only be assigned to an overarching state level (confederation, canton) if they are able to perform the tasks better than the subordinate state levels (cantons, municipalities). This gives the individual cantons and municipalities a certain degree of autonomy, involving the power of the authorities of the three levels to solve their assigned tasks independently and to raise the taxes and levies necessary to finance them themselves. However, financial resources and the potential to raise them varies among individual communities. Geographical location, differences in economic development and other causes lead to differences in tax revenue. In order to reduce the related disparities in tax burden and public goods provision to a socially accepted level, fiscal equalization systems have been developed in the cantons and at the federal level. In principle, they aim to reduce gaps in financial strength due to unalterable (dis-)advantageous location factors, which a local authority can hardly manage unilaterally (Rühli, 2014).

The Swiss Federal Constitution regulates which tasks the federal government and the cantons must perform. The cantons, for their part, specify the competencies for the communes on their territory (ch.ch, 2019). Tasks that the Federal Constitution does not explicitly assign to the federal government fall under the jurisdiction of the cantons. The latter, for their part, establish the competencies for the municipalities on their territory. The federal government, in turn, takes the potential impact of its actions on the municipalities into consideration, explicitly accounting for the special situation of cities and agglomerations as well as mountain areas. Fiscal equalization is an important instrument in this federalist system.

In the following sections, we briefly describe the fiscal equalization systems of the Confederation and of the canton of Grisons, as this is used for in-depth analysis in this project, and conclude with a final view on fiscal equalization.

The federal level: Fiscal equalization between the cantons

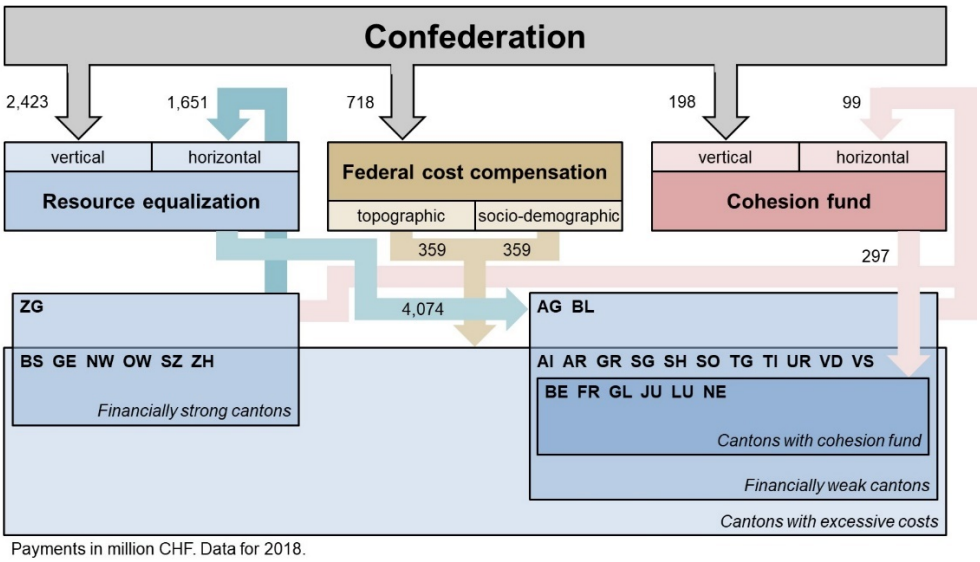
As a result of the recent reform of the financial equalization and the division of tasks between the Confederation and the cantons (Neugestaltung des Finanzausgleichs und der Aufgabenteilung zwischen Bund und Kantonen, NFA), the current fiscal equalization between the cantons has been in force since the beginning of 2008. It starts with two levers of finances (*fiscal equalization in the narrow sense*) and tasks (*fiscal equalization in the broader sense*), and aims to achieve two main objectives (EFD, 2007; EFV, 2018):

(1) The reduction of cantonal differences in the supply of public goods and tax burden, and

(2) an increase in the efficiency of government services.

This intends to improve cooperation between the cantons as well as between the Confederation and the cantons and to relieve the Confederation, so that it can concentrate more on its core competencies and tasks, accurate to the principle of subsidiarity. Accordingly, *fiscal equalization in the broader sense* aims at (a) the clear allocation of tasks to the Confederation and the cantons, (b) appropriate forms of cooperation between these two levels, and (c) the inter-cantonal cooperation within the framework of burden-sharing. In addition, the core elements of *fiscal equalization in the narrow sense* are resource and burden equalization. For these two compensation instruments, the Confederation and the cantons provided CHF 3.75 billion in the year 2008, and CHF 4.8 billion in 2018 (cf. Figure C1; EFD, 2018; NFA-Geberkantone, 2019).

Figure C1. *Financial flows under the national fiscal equalization for the year 2018*



Source: own illustration based on EFD (2018).

The resource equalization ("Ressourcenausgleich") is based on a measure of the cantons' financial performance, their so-called 'resource potential'. The latter corresponds to the value of its fiscal revenues and is determined on the basis of taxable incomes and assets of natural persons as well as taxable profits of companies.[28] As a result, it is not the effective tax returns but the corresponding potentials that are decisive for resource equalization. Based on these potentials, the cantons are divided into resource-strong and resource-weak cantons (cf. Figure C1). Resource-weak cantons receive funding from the resource-strong cantons (horizontal resource equalization) and the federal government (vertical resource equalization). The recipients can freely dispose of these revenues.

The cost compensation ("Lastenausgleich") accounts for special geographic-topographic and socio-demographic burdens incurred in the provision of government goods and services, and the fact that, for

[28] As a fundamental principle of fiscal equalization, it is not the entire value added (GDP) of a canton but only the fiscal value that should be taken into account. Those components of the value added that cannot be taxed by the canton, i.e. that cannot be exhausted, should be deliberately omitted (EFV, 2007). Effectively, the resource potential corresponds to the average of the aggregate tax base ("aggregierte Steuerbemessungsgrundlage", ASG) of the last three years available. Example: the resource potential 2018 is determined by the average of the ASGs of 2012, 2013 and 2014 (NFA-Geberkantone, 2019).

structural reasons, the affected communities face higher costs in their provision. Mountain cantons, for example, bear higher costs in terms of infrastructure, winter service or school services (e.g., school buses), while cantons with a more urban structure often have an above-average share of elderly people, poorer people, and poorly trained migrants.

As an additional element, a cohesion fund ("Härteausgleich") was introduced to reduce the financial losses of financially weak cantons when switching from the old to the new fiscal equalization system. The Confederation finances two thirds, with the rest coming from the cantons based on the number of inhabitants. It is exclusively dedicated to the financially weak cantons, has been declining by 5% annually since 2016, and is temporary until 2036, at the latest.

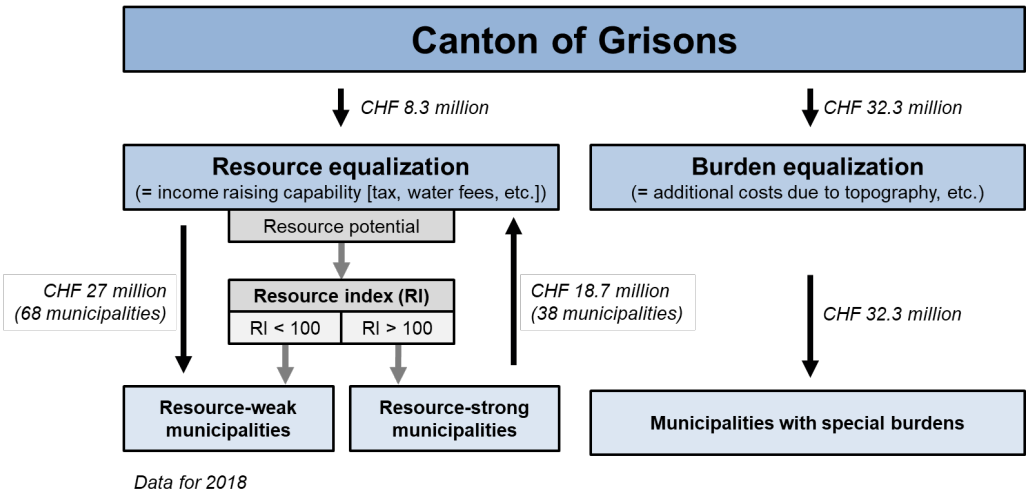
The cantonal level: Fiscal equalization in Grisons

Similar to the national fiscal equalization, the cantons have schemes to achieve an internal balance between the municipalities. This is different from canton to canton, and subsequently illustrated for the canton of Grisons, which is particularly interesting as a mountain and hydropower canton.

In the national fiscal equalization, the canton of Grisons is a net recipient (see Figure C1). With a resource index of 83.2 points, Grisons receives payments from the resource equalization scheme. Due to its high geographic-topographic loads, it further receives payments as part of the cost compensation scheme to an amount that corresponds to 38% of the national cost compensation paid out in Switzerland (EFV, 2017). All in all, the canton received 2018 about CHF 270 million (or CHF 1'322 per inhabitant) from the national fiscal equalization, which amounts to around 5.6% of the total amount transferred. These compensation payments to the canton of Grisons come almost equally from resource equalization and cost compensation. In addition, the canton can benefit from around CHF 120 million in water fee *revenues* annually that are shared equally between the canton and those municipalities that hold the property rights to water. This, in turn, causes disparities among communities in Grisons that are mitigated through fiscal equalization.

The new fiscal equalization scheme in the canton of Grisons has been in force since 2016. It aims to strengthen the municipalities and reduce disparities within the canton. Resource-weak municipalities usually in the periphery receive the most support and are typically characterized by many fractions and scattered settlements and tend to have high tax rates (AfG, 2016). Figure C2 schematically shows the functioning of the fiscal equalization and its two instruments in the canton of Grisons.

Figure C2. *The pillars of fiscal equalization in the canton of Grisons*



Source: own translation, based on AfG (2016).

Though the fiscal equalization within Grisons is based on the same instruments as the national system – namely resource equalization and cost compensation – the methods of calculation are different. At the national level, the resource potential is based on the sum of the taxable income and assets of natural persons and the taxable profits of companies, but does not correspond to the effective tax revenues of the cantons. In the canton of Grisons, the resource potential of the municipalities includes in addition to the fiscally exploitable resources also the water fee revenues of the individual municipalities. In contrast to the national level, water fees contribute substantially to disparities among municipalities in Grisons, despite the fact that legally up to 50% of the revenues directly go to the canton (cf. Chapter 4).

The resource equalization serves to align the financial potentials of the municipalities. It supports all resource-weak municipalities and is financed by the canton and the resource-strong municipalities (see Figure C2). Whether a municipality pays money into or receives money from the resource equalization depends on its resource potential (RP) and the related resource index (RI). The RP of a municipality is calculated such as to account for its most important sources of revenue (AfG, 2016):

- Taxes of natural and legal persons, at 100% according to simple cantonal tax (average values of 3 and 4 years prior to the equalization year);
- Land and real estate taxes, at a maximum rate of 1.5‰ (average values of 3 and 4 years prior to the equalization year);
- Water fees (including compensations of losses in the use of hydropower[29]), at 100% (average value of 2 and 3 years prior to the equalization year).

[29] The so-called 'Landschaftsrappen' that is paid as a compensation for the preservation and protection of a landscape of national importance against hydropower development (Art. 22 of the Water Rights Act, Wasserrechtsgesetz WRG; Regulation on the Compensation of Losses in the use of Hydropower, VAEW, SR 721.821).

The average resource potential of all municipalities per person[30] corresponds to the resource index (RI) of 100 points. Municipalities with an RI of more than 100 points are considered to be resource-strong, while those with less than 100 points are considered to be resource-weak. Resource-strong municipalities pay between 15% and 20% (currently 17.5%) of their RP surplus to finance the resource equalization system each year. In turn, resource-weak municipalities have their resource potential raised to at least an index value of 65 points. For the other resource-weak municipalities, the compensation is progressive, i.e. the greater the difference between their own RP and the cantonal average, the higher the compensation contribution. This does not change the order of resource strength of the municipalities.

The cost compensation (Lastenausgleich, LA) mitigates excessively high costs due to topographical situations, population structure, pupil numbers or social support services. It is financed exclusively by the canton. The LA consists of the three vessels: the mountain and school load compensation (Gebirgs- und Schullastenausgleich, GLA), from which only resource-weak municipalities can benefit, the social support cost compensation (Soziallastenausgleich, SLA), and the individual excessive burden balancing for special loads (individueller Härteausgleich, ILA).

A final remark on fiscal equalization and water fees

At both the federal and the cantonal level of Grisons, fiscal equalization is based on a separation between resource equalization and cost compensation, and it primarily aims at reducing disparities. However, different circumstances and preferences lead to differences in the measurement of resource potential and cost elements at the national and cantonal levels. The inclusion of water fees in the resource equalization of the canton of Grisons and the request to also include it in the national resource equalization must be considered against this background.

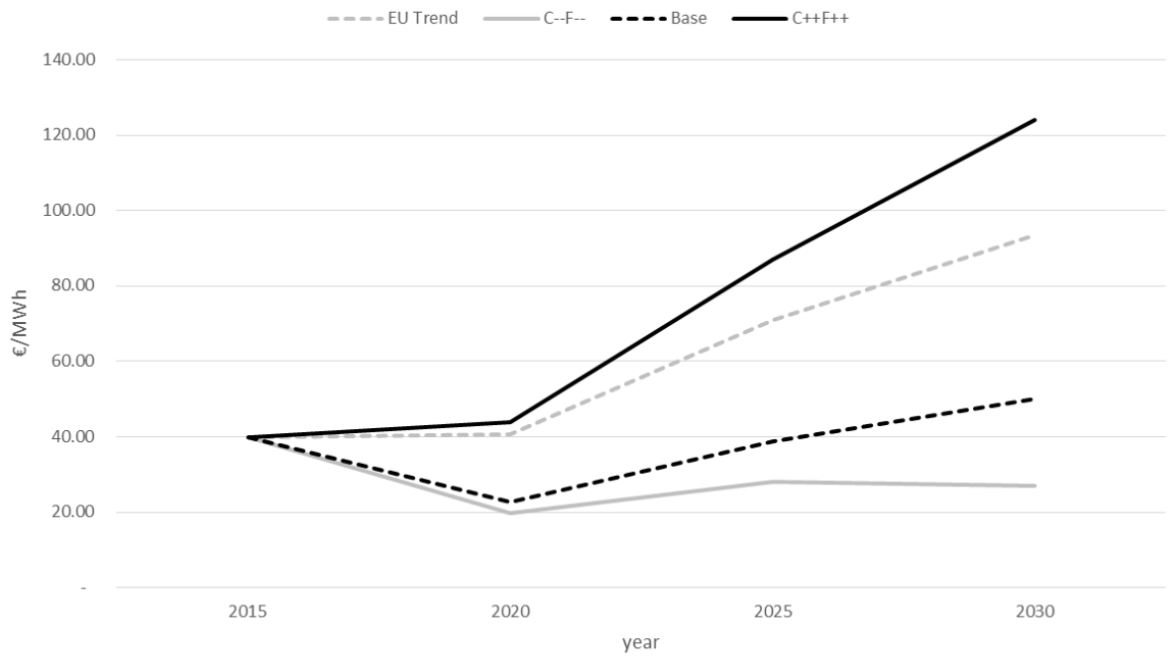
Consequently, when changing the current water fee system, for which there is only a legal basis until the end of 2024 and whose core elements are currently politically discussed, the impact on municipal finances and fiscal equalization within the cantons concerned must be taken into consideration. This is not only about cantonal and municipal finance. Rather, it is about impacts on economic and social development and jobs in peripheral regions. Finally, those are social and political issues that require decisions in the federalist system. Moreover, it should be noted, that water fees only account for one part of the resource rents resulting from hydropower use. The returns on investment from the power plants that mainly flow to the lowland cantons, who are the main shareholders in the hydropower companies, are neglected. This must particularly be taken into account if water fees should be included in the national fiscal equalization system.

[30] This refers to the decisive number of inhabitants ("massgebende Personenzahl"), which is defined as the number of inhabitants 2015 plus 20% of the taxable persons that exceed the number of inhabitants (see AfG, 2016).

D. Price and Water Fee Scenarios

Based on calculations with Swissmod (Schlecht & Weigt, 2014), Betz et al. (2018) present four different price scenarios for the years 2020, 2025 and 2030 that capture a range of possible market developments (cf. Figure D1). Starting from the base year 2015, these scenarios are formulated in real terms. They involve different assumptions about the development of carbon and fuel prices on the European market and refer to a complete liberalization of the Swiss electricity market, including a trend scenario that corresponds to the EU reference scenario (European Commission, 2016) but does not represent an estimation of the most likely development (Betz et al., 2018).

Figure D1. *Average simulated day-ahead market price by scenario*

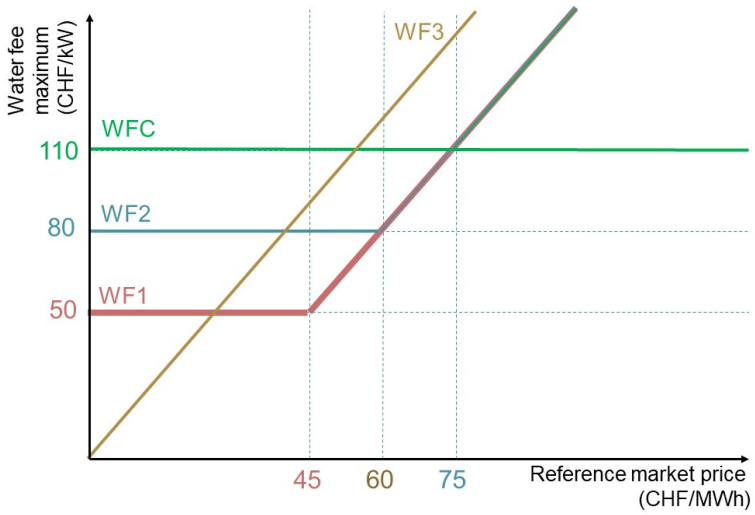


Scenario	Fuel and carbon price development
Base	Fuel and carbon prices as in 2015
EU Trend	Fuel and carbon prices as in EU Reference Scenario (European Commission, 2016)
C++F++	Fast linear increase in carbon price (50€/t in 2030) and fuel prices (+100% until 2030)
C--F--	Linear decrease in carbon price (4€/t in 2030) and fuel prices (-50% until 2030)

Source: Betz et al. (2018).

Different variants have been defined for the water fee maximum, encompassing the status quo with a water fee maximum of 110 CHF/kW (scenario WFC), and three scenarios (WF1 to WF3) with a flexible water fee maximum, such as illustrated in Figure D2. The flexible scenarios with a fixed (WF1, WF2) alternatively assume a fixed part ('Sockel') of 50 and 80 CHF/kW, a starting point of the variable part at the reference market price of 45 and 60 CHF/MWh, respectively, and a slope of the variable part of 2 CHF/kW per increase of the reference price (CHF/MWh). In addition, we use a completely flexible version with a slope of 2, as above, but without a fixed part.

Figure D2. *Different water fee schemes*



Source: Betz et al. (2019).

By combining these variants of alternative water fee schemes with the above price scenarios, we gained a set of possible outcomes for the water fee maximum that would result in different settings, such as presented in Table D1.

Table D1. Water fee rates resulting for the different water fee regimes and price scenarios

Price scenario	Water fee scheme	Reference price (CHF/MWh)				Water fee rate (CHF/kW)			
		2015	2020	2025	2030	2015	2020	2025	2030
BASE	WF1	44	25.30	42.90	55	50.00	50.00	50.00	70.00
	WF2	44	25.30	42.90	55	80.00	80.00	80.00	80.00
	WF3	44	25.30	42.90	55	88.00	50.60	85.50	110.00
	WFC	44	25.30	42.90	55	110.00	110.00	110.00	110.00
C++F++	WF1	44	44	95.70	136.40	50.00	56.80	151.40	232.80
	WF2	44	44	95.70	136.40	80.00	80.00	151.40	232.80
	WF3	44	44	95.70	136.40	88.00	96.80	191.40	272.80
	WFC	44	44	95.70	136.40	110.00	110.00	110.00	110.00
C--F--	WF1	44	22	30.80	29.70	50.00	50.00	50.00	50.00
	WF2	44	22	30.80	29.70	80.00	80.00	80.00	80.00
	WF3	44	22	30.80	29.70	88.00	44.00	61.60	59.40
	WFC	44	22	30.80	29.70	110.00	110.00	110.00	110.00
EU trend	WF1	44	45.10	78.10	103.40	50.00	50.20	116.20	166.80
	WF2	44	45.10	78.10	103.40	80.00	80.00	116.20	166.80
	WF3	44	45.10	78.10	103.40	88.00	90.20	156.20	206.80
	WFC	44	45.10	78.10	103.40	110.00	110.00	110.00	110.00

The result is a wide range of possible outcomes between 44 CHF/kW in scenario C--F--/WF3 (2020) to 272.8 CHF/kW in scenario C++F++/WP3 (2030); i.e. for the water fee variants with complete flexibility. If this scheme had been applied in 2015, the water fee maximum would have been 88 CHF/kW. In contrast, the water fee maximum would vary in a smaller range for the two schemes with a floor (i.e., WF1 and WF2) compared to the fully flexible scheme WF3. Building on this background, we selected five different water fee scenarios for our analysis on the impact of the resource equalization in Grisons in Chapter 4.

For the in-depth and sensitivity analysis (cf. Hediger & Herter, 2019, and Appendix E), we use in total 11 scenarios with different water fee levels, ranging from 0 to 230 CHF/kW.

E. Sensitivity analysis: different water fee rates and the resource potentials in Grisons

In order to investigate the fiscal feedback effects of changing water fee payments within Grisons this appendix provides a sensitivity analysis, using hypothetical water fee levels in the range of 0 to 230 CHF/kW, resulting from the policy and energy price scenarios presented in Appendix D. It encompasses the analysis of hypothetical changes of the water fee level upon the resource potential and equalization scheme in Grisons for the fiscal year 2018. The analysis includes the effects on different types of municipalities and their exposition to changes in water fees, both directly and indirectly through fiscal equalization within the canton. The current water fee rate of 110 CHF/kW is used as the case of reference, and therefore highlighted in the subsequent tables.

Table E1. Effect of diff. water fee levels on resource potential & financial flows in Grisons, 2018

Water fee level (CHF/kW)	Resource potential of all muni-cipalities (million CHF)[a]	Total receipts by municipalities (million CHF/year)			Financial flows to the canton (million CHF/year)	
		Water fee revenues	Deposits into resource equalization [b]	Disburse-ment out of resource equalization [c]	Balancing payment into resource equalization	Waterworks tax revenue for the canton
230	820.9	119.7	-22.7	33.7	10.9	117.8
190	800.1	98.9	-21.2	31.1	9.9	97.3
150	779.2	78.1	-19.8	28.8	9.0	76.8
130	768.9	67.7	-19.2	27.8	8.6	66.6
110	758.4	57.3	-18.7	27.0	8.3	56.3
100	753.2	52.1	-18.5	26.6	8.2	51.2
80	742.8	41.6	-18.1	26.1	8.0	41.0
50	727.2	26.0	-17.6	25.6	8.0	25.6
35	719.4	18.2	-17.4	25.6	8.2	17.9
25	714.2	13.0	-17.3	25.7	8.4	12.8
0	701.2	0.0	-17.7	26.9	9.2	0.0

(a) Note: the resource potential consists of taxes of natural and legal persons at 100%, land and real estate taxes at a reduced rate, as well as water fee and compensation payments for losses in the use of hydropower at 100%, calculated with a delay of 2 to 4 years (cf. Appendix C).

(b) Paid by resource-strong municipalities.

(c) Received by resource-weak municipalities.

Source: own calculations (cf. Hediger & Herter, 2019).

Table E1 reveals the direct relationship between the water fee level, the water fee revenues of the municipalities and their resource potential: the higher the water fee level, the higher the water fee revenues and the resource potential. However, the picture gets more differentiated when it comes to the resource equalization payments – i.e. deposits by the resource-strong municipalities and disbursements to the resource-weak ones, plus balancing payments by the canton (cf. Appendix D): These three figures reach a minimum around the water fee level of 50 CHF/kW. Thus, the equalization scheme does not respond in a linear way to changes in water fees. Striking is that the canton would have to bear the highest balancing payments in the extreme cases with zero and very high water fees, respectively. In the former case, it would also suffer from zero waterworks taxes, whereas in the opposite case the canton could easily cover the additional payments with high waterworks tax revenues.

Table E2. Effect of different water fee levels on municipal resource strength in Grisons, 2018

Water fee level (CHF/kW)	Number of resource-strong municipalities			Number of resource-weak municipalities			Shifts between types of municipality
	Type A°	Type A	Type B	Type C	Type D	Type D°	
230	6*°	11	27*	17*	30	15*°	*°: A° → D° *: C → B
190	8	11	25*	19*	30	13	
150	8	11	22*	22*	30	13	
130	8	11	20*	24*	30	13	
110	8	11	19	25	30	13	Current level
100	8	11	19	25	30	13	No change
80	8	11	19	25	30	13	
50	9**°	11	15**	29**	30	12**°	**: B → C **°: D° → A° ***: D → A
35	9**°	11	11**	31**	30	12**°	
25	9**°	11	9**	35**	30	12**°	
0	9**°	13***	4**	40**	28***	12**°	

Type A: municipalities paying more (less) into resource equalization with lower (higher) water fees.

Type B: municipalities paying less (more) into resource equalization with lower (higher) water fees.

Type C: municipalities receiving more (less) from resource equalization with lower (higher) water fees.

Type D: municipalities receiving less (more) from resource equalization with lower (higher) water fees.

Type A°: Type A municipalities without water fees.

Type D°: Type D municipalities without water fees.

Source: own calculations (cf. Hediger & Herter, 2019).

The non-linear effect within the resource equalization scheme is mainly driven by the changes in the relative resource potential and thus the resource strength of some municipalities, such as illustrated in Table E2. First, it shows that the current pattern with resource-strong and resource-weak municipalities is stable within the rage of a maximum water fee rate between 80 and 110 CHF/kW; i.e. the ones that represent the recent past and the present situation. Apparently, the new equalization scheme has been designed and parametrized for these cases. Second, it shows that the relative resource strength and weakness of some municipalities could be affected by changes in water fee levels.

Indeed, with the water fee level falling to 50 CHF/kW and below, an increasing number of municipalities would shift from resource-strong to resource-weak. Those are municipalities of Type B that would first benefit from lower water fees, as they would have to pay less into resource equalization in this case (see also Table E3). However, they would lose more in terms of foregone water fees at 50 CHF/kW and below than they could 'benefit' from lower deposits into resource equalization, such that they would turn into resource-weak municipalities; i.e. they might shift from Type B to Type C. In the extreme case without water fees (water fee = 0 CHF/kW), 15 of the 19 municipalities would be affected by this shift (cf. Figure 18, Chapter 4).[31] On the other side, municipalities of Type C might shift to Type B with increasing water fee levels.[32] These shifts are due to the fact, that the resource strength of each municipality is defined in relative terms; i.e. each municipality's resource potential per capita compared to the average resource potential per capita of all municipalities (cf. Appendix C). For the same reason, our sensitivity analysis also shows municipalities shifting from resource-weak (Type D) to resource-strong (Type A) with low water fees,[33] and from resource-strong (Type A) to resource-weak (Type D) in the extreme case with a water fee level of 230 CHF/kW.[34]

Altogether, this indicates that the water fee-receiving municipalities of Type B and Type C are the most exposed to changes in water fees, as far as their resource potential and thus public finances are concerned. This could be an indication of vulnerability of these communities.[35] However, the above results also indicate that the resource equalization scheme in the canton of Grisons is quite well designed to balance the most severe effects of changes in water fee receipts. Table E3 and Table E4 give additional insights in this regard. First, it shows that, in sum, the municipalities of Type B are by far the major recipients of water fee revenues in Grisons, followed by Type C. It is therefore not surprising that the municipalities of these two types would be suffering the most from falling water fee payments, while potentially benefiting the most from flexible water fees with increasing energy prices, such as described in our scenarios in Appendix D. Finally, the strength of the resource equalization scheme in Grisons is

[31] These municipalities are: Albula/Alvra, Andeer, Avers, Buseno, Brusio, Casti-Wergenstein, Medel (Lucmagn), Rongellen, Scuol, Sufers, Vals, Valsot, Zernez, and Zillis-Reischen, in alphabetical order.
[32] Those are, in alphabetical order: Bergün Filisur, Breil/Brigels, Castaneda, Donat, Rossa, Safiental, Sumvitg, and Surses.
[33] Those were Malans (if the water fee fell to 50 CHF/kW and below), as well as Bonaduz and Chur (in case of zero water fees).
[34] Falera and Maienfeld.
[35] An effective analysis on the vulnerability and resilience of municipalities or entire regions to changes in water fee regimes and energy policy would require further investigations on the interconnection between public finance, energy prices and economic development on national and regional level. This goes beyond the scope of this study.

the solidarity involved among the different groups of municipalities. In good times, those benefiting most from high water fee payments would bear a higher burden in the equalization scheme, either through higher payments or lower disbursements. Other municipalities would see a similar situation at times with low water fees. However, in the latter case, mainly those municipalities would have to pay more into resource equalization that have fiscal strength thanks to tourism, which is also considered a structurally weak industry in Grisons (cf. Credit Suisse, 2015). On the other side, resource-weak municipalities with low or without water fee revenues would receive less compensation out of the resource equalization in the same case. Hence, substantial reductions in water fee payments could seriously affect the regional economies in Grisons. The sensitivity analysis regarding the fiscal feedback effect gives only a first indication in this respect.

Table E3. Effect of different water fee levels on resource equalization in Grisons, 2018

Water fee level (CHF/kW)	Payments (million CHF/year) into resource equalization …						
	… by municipalities of …						… by the canton GR
	Type A°	Type A	Type B	Type C	Type D	Type D°	
230	0.803	12.098	9.844	-3.373	-24.822	-5.730	10.933
190	0.925	12.629	7.599	-3.820	-22.210	-5.047	9.923
150	1.099	13.159	5.549	-4.394	-19.778	-4.634	8.999
130	1.185	13.425	4.590	-4.765	-18.634	-4.435	8.634
110	1.272	13.710	3.704	-5.210	-17.541	-4.242	8.306
100	1.316	13.866	3.288	-5.470	-17.014	-4.147	8.161
80	1.402	14.178	2.478	-6.089	-16.001	-3.961	7.994
50	1.555	14.648	1.348	-7.291	-14.588	-3.692	8.020
35	1.636	14.887	0.860	-8.061	-13.932	-3.561	8.172
25	1.688	15.046	0.599	-8.697	-13.513	-3.474	8.351
0	1.820	15.709	0.283	-11.090	-12.531	-3.261	9.151

Type A: municipalities paying more (less) into resource equalization with lower (higher) water fees.

Type B: municipalities paying less (more) into resource equalization with lower (higher) water fees.

Type C: municipalities receiving more (less) from resource equalization with lower (higher) water fees.

Type D: municipalities receiving less (more) from resource equalization with lower (higher) water fees.

Type A°: Type A municipalities without water fees.

Type D°: Type D municipalities without water fees.

Source: own calculations (cf. Hediger & Herter, 2019).

Table E4. Water fee revenues in Grisons by type of municipality, 2018

Water fee level (CHF/kW)	Water fee receipts (million CHF/year) by municipalities of …			
	Type A	Type B	Type C	Type D
230	7.626	84.327	20.200	7.361
190	6.300	66.408	19.942	6.081
150	4.974	49.719	18.452	4.801
130	4.311	39.474	19.606	4.161
110	3.647	31.069	18.923	3.521
100	3.316	28.244	17.203	3.201
80	2.653	22.595	13.762	2.560
50	1.658	12.283	10.440	1.600
35	1.161	6.536	9.370	1.120
25	0.829	4.028	7.334	0.800
0	-	-	-	-

Type A: municipalities paying more (less) into resource equalization with lower (higher) water fees.

Type B: municipalities paying less (more) into resource equalization with lower (higher) water fees.

Type C: municipalities receiving more (less) from resource equalization with lower (higher) water fees.

Type D: municipalities receiving less (more) from resource equalization with lower (higher) water fees.

Source: own calculations (cf. Hediger & Herter, 2019).

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