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ORIGINAL ARTICLE

Hydropower license renewal and environmental protection policies: a comparison between Switzerland and the USA

Luc Tonka

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Abstract Traditional hydropower creates a number of adverse environmental effects, nowadays largely recognized but still in conflict with rights granted in previous era of development. The Upper Rhone River basin is heavily developed for hydropower generation. As this region undergoes a period of new concession grants, environmental legislation should eventually be implemented to its full extent. This turning point also allows changes in dams' ownership and institutional setting, and these aspects attract much of the political attention. The article compares the US hydropower regulatory framework and the country's experience in dam relicensing to highlight shortcomings in the Swiss regulatory framework and possible outcomes of the concession reversion process in Canton Valais.

Keywords Hydropower relicensing · Rhone River · Hydroelectricity · Valais · Environmental protection policies · Reversion rights

Introduction

Climate change has recently brought attention to the energy-water nexus, showing the interdependencies among these policy sectors and their associated resources. The physical connections between the three domains highlight the potential for counter-productive adaptation and mitigation policies (Pittock et al. 2013). If adopted without paying attention to their indirect effects, policies in these sectors could lead to incoherencies and cancel each other out. A cross-sectoral and coordinated approach is thus called for in order to avoid or limit trade-offs in policy decisions regarding energy and water (Pittock et al. 2013). While often praised for its low GHG emissions, hydropower negatively affects water resources and fresh water sustained ecosystems. As part of carbon lite energy solutions, hydropower's further development could thus potentially increase the pressure on these water resources (Pittock 2011).

Traditional hydropower has indeed a number of adverse environmental effects. By impounding a river and/or diverting its flow, dams dramatically alter the natural regime of a river, hinder or stop fish migration, modify water quality, and change the river bed dynamics and the habitat functions the river plays for fish and wildlife (Collier et al. 2000). Almost all of these impacts arise from the alteration of flow regime in terms of magnitude, frequency, duration, timing, and rate of change (Poff et al. 1997). Yet, altering or taming the natural river flow is often the primary aim of dams—and of hydropower storage dams in particular. Storing water is indeed a convenient way to generate large amount of electricity when it is most needed. The natural flow is thus replaced by an artificial regime as water is released according to electric demand (Graf 1999; Poff et al. 2007, 1997; Rahman et al. 2012). All dams do not affect the environment to the same extent (Frey and Linke 2002:1262), and there are options to mitigate dams' adverse effects. However, because mitigation measures imply production losses, hydropower generation and ecosystem preservation can be considered as rival uses of water resources.

The negative impacts of hydropower on river ecosystems were not necessarily considered in the early stages of its development. Environmental laws now acknowledge

L. Tonka (✉)
Institute for Environmental Sciences, University of Geneva, Geneva, Switzerland
e-mail: Luc.Tonka@unige.ch

this aspect, but their implementation often conflicts with water use rights granted in previous eras. This article presents and compares the regulatory frameworks that have been devised in two regions to limit the adverse environmental impacts of hydropower. In the River basins of the Columbia in the USA and the Upper Rhone in Switzerland, watercourses are heavily developed for hydropower generation which plays a considerable role in the economy and energy supply of both regions. The operation of the dams occurs through the deliverance of licenses or concessions limited in time, but the two systems differ in the duration granted. A maximum of 50 years in the USA has led to an earlier relicensing experience compared with the 80 years standard period in Switzerland.

Since these framework conditions are set for several decades, the coming period of dam relicensure in Switzerland is a turning point. Relicensing poses a number of challenges such as the imposition of new conditions due to environmental policies, possible changes in ownership, unknown aging effects, or long term commitment in a changing economic context with uncertain revenues. Looking at the American experience could thus provide Swiss dam operators, environmental advocates, and administrative agencies at all levels with crucial insights and useful advice.

While all these challenges will bear on the decisions made at the end of license periods, this article focuses on environmental measures and conditions that (should) apply to hydropower as well as on the broader institutional framework that regulates this specific sector. The next section presents the state of hydropower in the Swiss and US cases. The water policies and the specific hydropower regulatory framework of each case are then presented in turn, with a focus on the Canton Valais for Switzerland and on the Pacific Northwest Region in the USA. Finally, the conclusion highlights the main differences between the cases and their possible influence in the Swiss context.

Significance of hydropower and federal water policies

There are an impressive number of dams in the USA, over 75,000 according to several estimates (Bowman 2002; MacCully 1998; Graf 1999; USACE 2013). Only 2 % of these are primarily operated to produce electricity (DOE 2001; USACE 2013). Hydropower thus represents about 8 % of the total electricity production in the USA (CRS 2013, USEIA 2013:20). It used to be a much more important energy source in the 1940s after the completion of large federal projects such as the Tennessee Valley Authority or the Grand Coulee Dam—the nation's largest hydropower plant. In fact, federal projects account for about 50 % of the total hydroelectric generating capacity in the USA (Hall and Reeves 2006). The majority of dams were built between 1950 and 1980 (Graf 1999; USACE 2013). Since the potential for hydropower is based on water flow and elevation differential (head), geographic conditions are determinant and hydropower's share in total electricity output varies across regions so that in the Pacific Northwest Region, it reached 56 % in 2012 (NPCC 2013a:6).

The Pacific Northwest's main watercourse, the Columbia River, is heavily developed for hydropower, navigation, and irrigation purposes. The Columbia River Basin—an area roughly equivalent to the size of France—comprises some 400 dams. Among them, 29 dams compose the Federal Columbia River Power System (FCRPS). These federal dams are operated in coordination to maximize flood control and hydropower production, while also providing irrigation water and recreation opportunities. The Columbia River was also home to historically abundant stocks of Pacific salmon, and substantial efforts have been undertaken to enhance and restore this important cultural and economic resource since at least 1980 and the institution of the Northwest Power and Conservation Council (NPCC). With the listing of the first salmon species of the basin as threatened in 1991, these efforts have received additional federal attention and resources have been increasing dramatically—from US$ 3 million in 1981 to 33 million in 1991 to 249 million in 2012 (NPCC 2013b:31).

Switzerland in comparison relies much more heavily on hydropower on a national scale. The 10-year average share of electric production covered by hydropower is 55 % (OFEN 2013a:14). The heydays of dam building in the country took place between 1945 and 1970, and there are now 205 projects listed by the federal administration, 83 % of which are related to hydropower (OFEN 2013b). Two-thirds of the national hydropower production originate from the Alpine region, and 27 % come from the Canton Valais alone (OFEN 2011). There are 31 hydropower dams of 15 m height or more under federal surveillance in this canton (OFEN 2012). Dams and hydroelectric plants are often owned by joint-venture companies (*Partnerkraftwerke*). These were formed to bear the high capital costs of hydropower investments and to insure commercialization of the large quantities of electricity that would reach the market at once upon completion of the plant (Saitzew 1950). Cantons and municipalities are shareholders of local utilities that in turn take part in these joint-ventures. Hence, dams are publicly owned to a large extent, but political control is limited due to these indirect links and because utilities are operated as independent semi-public companies (Canton du Valais 2011). Despite a seemingly fragmented market structure, three regional companies emerged from a concentration trend and now control the capital of 73 % of the national production (AXPO et al. 2010).

In order to approach the hydropower regulation, a brief appraisal of water policies is a useful first step. Indeed, in the USA as well as in Switzerland, hydropower legislation is historically rooted in the water domain: The federal capacity to regulate this sector developed as an extension of flood control and navigation prerogatives.

Hydropower is a telling example of energy and water policies intermingling: While energy policies may set production targets, water policies are more likely to set environmental preservation standards. In line with this sectorally bounded approach, the Swiss Federal Law on Energy of 1998 (LEne, RS 730.0) aims at a 7 % increase in hydropower output by the year 2030, whereas the environmental flow provisions this article focuses on should curtail that production by a similar percentage. Water being the main raw material for electricity generation, one would expect decision making on hydropower to take most directly into account the resources interdependence. But even here, sectoral modifications do not necessarily translate into a broader analysis. A striking example is the lack of attention paid to climate change impacts on water resources availability in relicensure procedures in the USA (Viers 2011). In Switzerland, studies on this topic have been undertaken only recently (e.g., SSHL and CHy 2011; Farinotti et al. 2012) and climate change projections have not yet affected the content of renewed concessions.

The federal structure of the two countries contributes to the complexities of water policies. Water legislation has followed the evolution of water uses, and this development was affected by State–federal government relations. In the two cases, water was first a State or Canton matter and federal jurisdiction only extended over time (Mauch et al. 2000; Rogers 1993). This federal involvement did not grow uniformly with regard to all matters of water policy, especially in the USA. As a result, some aspects are currently firmly established under the purview of federal agencies (e.g., navigation, water quality) whereas others remain under the competence of States (e.g., use rights allocation) (Christian-Smith and Allen 2012a). The Swiss tradition of implementation federalism leads to the translation of legislation at the cantonal level where tasks are carried out by the local administration. While less fragmented than in the US case, this system leads to large cantonal differences in terms of administrative organization and pace of implementation (Mauch et al. 2000:2). Water policies at the federal level in these two countries thus provide a relatively similar picture: a somewhat chaotic sectorial approach to water uses (Christian-Smith and Allen 2012a) quite removed from integrated management. The next sections provide a more detailed analysis of the respective water and hydropower regulation framework.

The Swiss hydropower regulatory framework

The Swiss hydropower sector enters a challenging era with the renegotiation of concessions. This period marks a considerable change because (1) environmental legislation comes into force and (2) changes in ownership of hydropower plants may affect almost every Canton in Switzerland. This process is especially significant in Canton Valais because it concentrate over a quarter of the national hydropower capacity up for a concession renewal between 2015 and 2055 (roughly 3,000 out of 13,500 MW). Furthermore, the Canton and the communes currently own only 20 % of the hydropower produced within the cantonal borders, and the cantonal strategy aims at reaching a minimum of 60 % (Canton du Valais 2011). This expansion would be detrimental to other cantonal and municipal authorities that currently control the capital of the operating companies. The financial stakes are high since in the current exploitation scheme market benefits as well as corporate tax incomes accrue to lowland Cantons. There is thus a distribution issue among the different regions of the country, as well as within the Canton Valais.

Federal water policies

Water policies constitute the most integrated example of natural resource regulation in Switzerland (Knoepfel et al. 2010: 275; Varone et al. 2002). But the historical evolution of water uses regulation makes sectorial boundaries still salient, and an integrated framework has not yet been attained (Knoepfel et al. 2010:256). With regard to property rights, surface waters in Switzerland are generally considered a common property under the purview of the State (Mauch et al. 2000:32). According to the Swiss Constitution (art. 76, al 2, RS 101), Cantons are sovereign over water bodies and streams, and depending on their own legislation, the rights can be passed on to the communes. Water permits are, however, not widespread and concern almost exclusively hydropower plants. The federal State retains authority over boundary streams and rivers, and it is enabled to pass legislation regarding water uses.

Federal water legislation development has been incremental, following a three-phase evolution (Knoepfel et al. 2010; Mauch et al. 2000). It began with flood control issues in the late nineteenth century. The next period was concerned with productive use of the water—including hydropower, from 1908 to 1953. The last phase saw the adoption of policies protecting water resources with an initial focus on qualitative aspects in the 1950s, later extended to quantitative aspects in the 1990s. The Federal Law on the Use of Water Power of 1916 (LFH, RS 721.80) is the main source of regulation over hydropower in Switzerland, while environmental mitigation measures are

set in the Federal Law on the Protection of Waters of 1991 (LEaux, RS 814.20).

The LFH is a framework law encouraging the exploitation of water resources and their rational use through the allocation of use rights. Surface water status as public resources does not preclude their private appropriation (Aubin 2007), and exclusive water rights are established by means of hydropower concessions. According to the LFH, concessions are granted by the Cantons (art. 38 and 60) for a maximum duration of 80 years (art. 38). Public authorities are allowed to collect royalties for the use of their resources (art. 49), and their maximum amount is, however, limited to 100 CHF (~US$ 100) per theoretical kilowatt (kW). The law provides that at the end of the concession period, the public authorities that delivered the concession can either purchase the facilities or receive it for free (art. 67). The existence of this reversion right, however, depends on the specific content of the concession contract itself. In other words, the federal law does not create the reversion right but simply allows this possibility. This notion of reversion is central in the upcoming period of new concession grants because it creates an opportunity for a costless takeover of hydropower plants by local authorities.

While the LFH has set incentives for the rational exploitation of water power since the early 1900s, environmental aspects were first addressed in the last 50 years. The inclusion of a quantitative protection of water resources (i.e., minimum instream flows) has been a long process as it was first introduced in the constitution (1975), then later in legislation (1991), and it is implemented locally only after the concessions have been renewed. Indeed, a concession creates vested rights (LFH art. 43), which means that subsequent legislation may not limit the user's rights without proper compensation.

Instream flows are set in proportion to the natural flow of the stream or river (art. 31). Specific streams can benefit from increased flows if use rights holders are compensated (art. 33); conversely, exemptions from minimum flows provisions are possible (art. 32). The decision to increase or derogate from minimum flows remains with the cantonal authorities. If and when these minimum flows are implemented to their full extent, the national annual hydroelectric output will be reduced by 6 % or 2,000 GWh/year (Kummer 2002). This estimate is based on a sample of facilities which now operate under the new regulation. The sample is, however, not representative of the Swiss fleet of hydropower plants because storage dams—the type of facilities most affected by instream flow provisions—are underrepresented in this statistic. In addition, the sample displays large variation in effective production loss, ranging from 0 to 30 % (Kummer 2002:6). Despite these shortcomings and its probable underestimation of lost generation output, it is the only official quantified assessment available.

Pending the extinction of vested rights, a transitional clause imposes less stringent remedial measures on all intakes (art. 80). These measures are environmental flows set to a level that does not injure existing use rights and hence they do not justify a financial compensation by the Cantons. Implementation was expected within a 15-year period, which was extended to 20 years. About a third (10) of the Cantons has failed to implement the measures by the end of the legal period in 2012 (OFEV 2013). The implementation is likely to undergo further delays as the Federal Tribunal turned down the baseline value used in many cases in a 2012 decision (ATF 139 II 28). The court found residual flows equivalent to a 5 % turnover loss for hydropower companies to be insufficient to meet the law's requirements.

Given the partial implementation of the environmental measures, recreational fishing and environmental groups launched a popular initiative in 2004 to accelerate the process and better mitigate the adverse effects of hydropower. The text asked for an extended procedural right for environmental groups, allowing them to require revitalization measures from Cantonal authorities (Conseil Fédéral 2007:5237). This was seen as highly problematic and was ultimately rejected. It nevertheless provided an important bargaining chip to the environmental organizations who obtained a more thorough mitigation of hydropower's negative impacts (ramping and sediment issues are now taken into account). This revision also entailed further exemptions in high elevation streams (40 % of all hydropower intakes now qualify for an exemption) (CEATE-CE 2008:7307).

Regional-level specificities and financial stakes

The Upper Rhone River basin is mainly comprised within the borders of the Canton Valais, and a focus on its specific situation is thus offered here. The Cantonal Law on Water Power (LFH-VS 721.8) also evolved over time to address preoccupation in line with the development of the hydropower industry. The first law on hydropower in Valais was adopted in 1898 during the sector's initial development and served as a blueprint for the federal legislation (Wyer 2008). The cantonal legislation was then revised in 1957 to further promote investments in an era of large dams building, and the most recent modification occurred in 1990 to better specify the consequences of the end of concessions (Wyer 2008). The 1898 law thus provided a general framework to regulate a nascent industry and laid out some of the principles still in use to date such as the limited duration of concession contracts, an annual fee as a compensation for water use, the beneficial use of water,

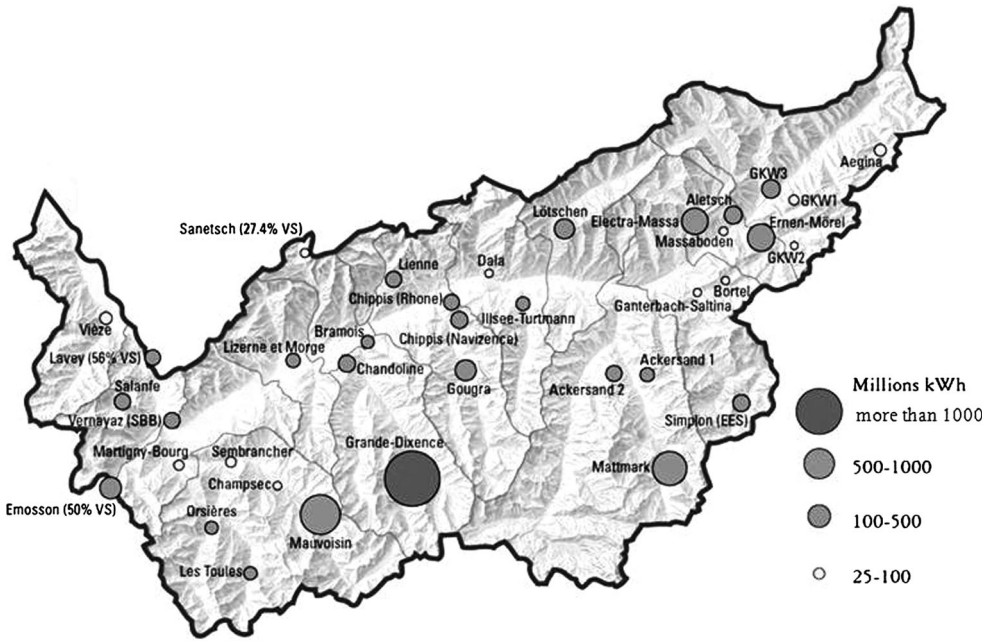

Fig. 1 Main hydropower plants in Canton Valais (production > 25GWh/year). *Source* adapted from Canton du Valais 2011:21

and the free reversion to the public authorities upon termination of the concession (Wyer 2008:16–21). Water rights definition, however, lacked precision, and the absence of quantification makes it difficult to set environmental flows today.

The law of 1898 also attributed the jurisdiction over the Rhone River to the Canton and over smaller streams to the communes. This explains why the municipalities nowadays have the authority to issue concession contracts and are entitled to reversion rights on tributaries to the Rhone River—where most of the projects are located (Fig. 1). This attribution of rights has deprived the cantonal authorities of important revenues, a matter first addressed by the introduction of a special tax in 1923 that initially rerouted about 25 % of the annual fees to the cantonal treasury, and today represents 60 % of these fees (Wyer 2008:25–34). However, this solution did not modify the property and disposition rights structure, and, as it turns out, the Canton is not entitled to the financial benefits of the forthcoming reversion processes.

The concession contract, as a legal act mixing decisional and contractual clauses, takes precedence over the framework laws. Hence, according to Wyer (2008:21), the interpretation of the concession relies first on the contract itself, then on the content of the cantonal law in force when the concession was delivered, and finally on the federal law. In other words, the content of the concession contract is of the utmost importance and may be enforced even if it runs against provision of the law (such has for instance, renunciation to reversion rights). The concession is at the same time an exclusive water use right and an authorization to exploit the plant (although not a construction permits). In order to obtain a concession, the operator must present a detailed project as well as an environmental impact statement (EIS) to the concession-granting authority (Canton or municipality) (LFH-VS art. 12). The project is subject to public inquiry for 30 days (art. 16). The concession must provide information about the head and amount of water used, the minimum flows, the duration of the concession, the royalties paid and other economic compensations (e.g., free electricity or water supply), and whether or not a reversion right exists (art. 25). The Canton's executive body has to approve concession contracts delivered by the municipalities (art. 9).

The large implementation of the hydropower industry in Valais also generates public revenues. Including royalties and taxes at the cantonal and municipal level, the current annual estimate amounts to US$ 160 million (Canton du Valais 2011) and municipal budgets rely heavily on hydropower contribution, which sometimes reaches up to 40 %. In comparison, the industry's turnover generated from regional plants' output is estimated to US$ 2 billion annually (Canton du Valais 2011).

The Canton Valais is at a crossroads: In the years 2015–2055, the free reversion right could change the ownership structure of a quarter of the country's hydropower capacity. Several options are available to the public authorities as they could simply sell the dams back to their current operators, form joint companies with the latter, or become full owner of the facilities. Given the time spread and the split jurisdiction on water courses, there is no guarantee of a uniform solution and the cantonal authorities are currently trying to convince municipalities to follow the ownership option. Municipalities are facing a dilemma as

some of them have small population and tax revenues but must cope with important charges due to their remote location. The first option would provide an estimated 15 billion CHF in the short run to a limited number of communes. In contrast, in the third option, all public authorities in the canton would share yearly revenues estimated to 700 million (Canton du Valais 2011). The latter entails significant risks and uncertainties as it involves direct marketing of the electric production.

Thus, as the period of concessions renewals nears, the local debates revolve exclusively around the distribution of financial benefits and the defense of disposition rights. This term will also mark the implementation of environmental protection measures which could possibly impact the economic viability of hydropower plants, especially in a context of receding prices on the European market and of uncertain availability of the water resources due to climate change. While the Cantonal Law on Water Power has been revised to ensure continued investments in and operations of hydropower dams, the possible end of these infrastructures' life cycle is not prepared.

The USA's regulatory framework for federal and licensed hydropower

The USA have a dual system of hydropower authorization: Federally owned facilities require congressional approval, whereas a system of licenses exists for other plants. With its fragmented water regulation, its longer experience in relicensure, and its differentiated regulatory solutions, the USA example could be invaluable to the Swiss hydropower relicensing process.

Federal and State water legislation

Water regulation in the USA is very fragmented as a result of the evolution of water uses and of the relation between States and the federal government (Rogers 1993; Gerlak 2006). Much like in the Swiss case, the federal role in water management was initially limited and grew over time. Water was a States' subject in the first place (Rogers 1993:219), and water rights and allocation issues remain at this level (Wright 1990; Gillilan and Brown 1997:35–38; Christian-Smith and Allen 2012a:37). The situation is characterized by a lack of national water policy and a piecemeal approach to water issues (Christian-Smith and Allen 2012a; Gerlak 2006; Rogers 1993). There are thus about 30 agencies in 10 departments with federal responsibilities over water (Christian-Smith and Allen 2012a:28) and Rogers (1993:16) counted 184 subcommittees in Congress dealing with some aspect of water resources. A brief overview of the evolution of the Federal Energy Regulatory Commission (FERC) licensing authority illustrates these general trends.

The Commerce and Property clauses of the Constitution are at the root of the federal involvement in water issues (Christian-Smith and Allen 2012a; Kenney 2008; Rogers 1993). They have been interpreted broadly and construed as allowing, respectively, federal management of all navigable waters of the USA and of those waters that pertain to federal land Reservation. It is under the Commerce Clause that the Federal Power Act of 1920 (FPA 16 U.S.C. §§792–892) authorized the predecessor to the FERC to license non-federal dams affecting navigable waters. The FPA was adopted during a period of strong federal involvement in natural resource management and has provided FERC with broad powers (Gerlak 2006; Kenney 2008:118–119; Pollack 2007). The States' opportunities to intervene in hydropower licensing have been enhanced by court decision as a consequence of the passage of subsequent legislation.

In spite of the almost exclusive role played by FERC in the licensing process, State water policies and laws also matter for hydropower environmental regulation since a water right is required in addition to the federal license. The first difference in States' water code relates to the established water rights doctrine. While there is some hybridization between the two systems (e.g., Lux v. Haggin, 69 Cal. 255; 10 P. 674), Eastern States have initially followed the riparian doctrine and the more arid Western States have adopted the prior appropriation doctrine (Gillilan and Brown 1997; Wilkinson 1992; Wright 1990). Since this study focuses on the Columbia River Basin, a very simplified description of the prior appropriation doctrine is offered here.

The main difference between the two systems of water allocation is the link with real estate ownership. In the riparian doctrine, water rights are acquired with the ownership of land adjacent to the stream whereas the prior appropriation rationale was developed precisely to allow diversions to places of use remote from the stream (Wright 1990). Water in the riparian context is shared equally among riverine land owners, and water rights are not quantified. The prior appropriation doctrine requires such quantification, but permits may allocate water beyond the available resources. In cases of water shortage, senior appropriators are served before junior right holders—the famous "first in time, first in right" principle. Water rights must be put to beneficial use, which traditionally only included activities generating direct economic benefits. Thus, instream flows for fish or recreation were not recognized and could not be guaranteed by a water permit. Water rights are granted in perpetuity unless a prolonged absence of beneficial use can be demonstrated, in which case the right is lost. Under the prior appropriation

doctrine, water rights are transferable even to different uses and to different intake places as long as they do not harm other rights. In any case, water rights are not equivalent to ownership of the water but constitute only use rights (Gillilan and Brown 1997; Wilkinson 1992; Wright 1990).

To illustrate some effects of the rights system on hydropower, the case of Oregon is provided here as an example. Whether a given use is considered "beneficial" depends on State legislation. Oregon was the first State to adopt an instream water flows program in 1955, but it was not until 1987 that instream flows were systematically enforced. To insure that instream flows are not transferred to other uses, water rights are held in trust by the State. The prior appropriation doctrine still applies and instream water rights tend to have a junior status (Christian-Smith and Allen 2012b:153). The incentive received by the State to develop its water courses also matters. In Oregon, rights for hydropower generation are different from storage and live flow rights as a fee is collected in return for the right of use. The principle of an annual fee not exceeding US$ 1 per theoretical horsepower (US$/HP) is set in Oregon water code [ORS 543.300(5)], and the current amount is of 0.405 US$/HP or 0.30 US$/kW [ORS 543.078(2)].

With regard to hydropower production, there is generally a dual system of regulation in place in the USA depending on the ownership of the dam. Dams federally owned are authorized by Congress; otherwise, it is the FERC that issues licenses under FPA's authority. FERC's license system operates much like the Swiss concession contracts, except for water rights which are not granted with the license. The main cross-country differences are summarized in Table 1 below. With both US systems of regulation, the main environmental laws that affect hydropower are the National Environmental Protection Act of 1969 (NEPA), the Endangered Species Act of 1973 (ESA), the Clean Water Act of 1972 (CWA), the Wild and Scenic Rivers Act of 1968, and, in the Northwest's specific case, the Pacific Northwest Power Planning and Conservation Act of 1980 (Northwest Power Act).

Table 1 Summary table of licenses and licensing processes differences between Switzerland and the USA

	Switzerland (Valais)	USA (Oregon)
Usual duration	80 years	30–50 years, depending on investment
Royalties	100 US$/kW	0.30 US$/kW (OR)
Reversion right	Licensing authority	None
Burden of decommissioning costs	Unspecified	Licensee
Water rights	Included	Not included
Information burden in opposition procedure	Affected interest	Licensee
Authority in charge of relicensure	Canton or communes (VS) Confederation (transboundary waters)	FERC (primarily) State Regulatory federal agencies

Environmental measures in FERC's hydropower license system

Federal Energy Regulatory Commission's jurisdiction extends to project located on navigable waterways and projects that affect the interstate commerce of electricity. Given the broad interpretation of the Commerce Clause, FERC licensing process extends to virtually all non-federal hydropower projects. The FPA allows FERC to issue licenses for 30–50 years (Pinchot 1945), and the same periods are applicable to relicensing. FERC, however, grants renewed licenses of a duration commensurate with the investment consented by the licensee (FERC 2001:100). The licensing process necessitates numerous permits and authorization from a wide array of State and federal agencies, and consultation with the interested parties falls under the duties of the license applicant (Manahan and Verville 2005:46).

Historically, FERC has enjoyed a large autonomy regarding the conditions under which licenses were granted (Blumm and Nadol 2001: 81–90). New Acts, Amendments to the FPA, and Court rulings have changed the latitude FERC has in (re)licensing processes and imposed some restrictions (see gen. Blumm and Nadol 2001; Becker 2006; Pollack 2007). Hence, on some 200 watercourses protected under the Wild and Scenic River Act, new licenses grant are limited to relicensure of existing projects. Since licensing occurs through a federal agency, NEPA requires an EIS and opens way to the intervention of environmental groups and other affected interests. The Electric Consumer Protection Act of 1986 amended the FPA so that FERC now has to give equal consideration to non-development interests such as recreation, fish and wildlife, or instream flows. FERC is thus required to consider recommendation from Indian Tribes or federal agencies managing resources affected by the project (Bryant 1999:104).

Court cases also played an important role in compelling FERC to incorporate conditions from other agencies in the license. Hence, in Escondido Water Co v. La Jolla Indians [466 U.S. 765 (1984)], the supreme court stated that under Section 4(e) of the FPA when the project is located on a federal reserve, conditions issued by the land management agency are mandatory (Blumm and Nadol 2001). More recently, in its decision in SD Warren v. Main Board of

Environmental Protection [547 U.S. 370 (2006)], the Supreme Court ruled that a State certification under Section 401 of the CWA was required to issue a license effectively allowing State Agencies to impose conditions on the licensees (Pollack 2007).

Taken together these provisions of the CWA and the FPA allow for increased environmental conditions imposed on licensees, which ultimately raise costs of operation for hydropower plants. Along safety reasons, environmental and economic factors become more prevalent rationales for dam removal (Pohl 2002). FERC issued a policy statement in 1994 asserting its authority to order dam decommissioning and to impose its costs on the licensee (Bryant 1999). Dam removals have, however, been mostly conducted under settlement agreements, which sometimes incurred costs on third parties as well (Becker 2006; Bryant 1999).

Federal hydropower regulation

The federal government controls the largest hydropower projects in terms of capacity, mostly through the US Army Corps of Engineers, the Bureau of Reclamation, and the Tennessee Valley Authority (Hall and Reeves 2006). These are projects directly authorized by Congress through ad hoc legislation, and they typically entail multipurpose dams. Electric power produced at federal hydro plants is marketed by the Power Market Authorities, and energy sales revenues are returned to the federal treasury to cover the share of the project's building costs associated with hydropower.

Federal agencies that operate these dams are subject to Section 7 of the ESA. The Fish and Wildlife Service (FWS) or the NOAA Fisheries are required to issue a Biological Opinion assessing the impacts of proposed federal actions on listed species. If an action puts listed species in jeopardy, reasonable and prudent alternatives (RPAs) are proposed. The NOAA or the FWS cannot impose these RPAs on the action agency but negotiates them in order to respect the initial purposes of the action. Hence, the full protection of listed species is not guaranteed by this process, and Federal Courts may be seized to further alter the planned action, as it is the case with the FCRPS Biological Opinion since 2000.

In the Pacific Northwest, since the 1980s and the passage of the Northwest Power Act, another layer of regulation has been added through the establishment of the NPCC. The Council's purpose is to balance fish and wildlife and hydropower interests. To achieve that balance, the NPCC establishes a 20-year forecasting Power Plan for consumption and production in the region as well as a Fish and Wildlife Program to mitigate adverse effects and enhance habitat. While the program addresses both anadromous and resident fish as well as wildlife issues, the majority of its spending is concentrated on the salmons and steelhead listed species.

Program costs are entirely covered by Bonneville Power Administration (BPA) rate payers. BPA markets the power produced by the federal hydropower system (FCRPS) and sells it at cost to public utilities. The electricity rates remain low in national comparison despite the sizeable financial efforts made to offset hydropower's environmental impacts. In 2012, the program budget totaled US$ 249 million in direct spending. If additional capital costs, power purchase, and forgone revenue linked to the fish and wildlife program are taken into account, the 2012 costs rise to US$ 644 million. Cumulated costs from 1978 to 2012 total US$ 13 billion, with the three largest posts being power purchase (4 billion), had forgone revenue (2.9 billion) and direct spending (2.8 billion) (NPCC 2013b:6–7). These figures are a clear illustration of the direct trade-offs between hydropower and environmental protection. In spite of the important financial efforts consented by BPA's rate payers in the last 30 years, the Pacific salmon species have not yet recovered and remain listed under the ESA.

Conclusion

The USA's experience in dam regulation can provide insights for the Swiss forthcoming period of new concessions grants. Indeed, the US non-federal regulatory framework is very similar to the concession system. Additionally, the public ownership option studied in Valais could resemble the federal hydropower system. However, some discriminating factors are worth mentioning here as they presumably weight on the fate of dam facilities. Given the length of concession periods, the relicensing process represents a unique opportunity to alter the allocation of costs and benefits.

With regard to procedural aspects of FERC (re)licensing process, an important difference lies in the consultation of the affected parties. Whereas the burden of the American procedure rests on the licensee, in Switzerland the affected interests have to monitor administrative processes and to manifest their opposition in time. An earlier inclusion of affected interests in the relicensing process could possibly shorten procedures, especially with regard to environmental mitigation. Indeed, the environmental groups active on hydropower issues dispose of a legally sanctioned opposition right. In case their appeal of the mitigation plans is upheld, preliminary studies have to be redrawn, incurring important delays.

There are striking differences in the financial distribution of hydropower benefits. The Swiss system provides strong incentives for local communities to develop their

resources to the maximum extent possible. In comparison, the annual hydropower fee in Oregon seems anecdotal. When it comes to sharing the costs of hydropower mitigation measures (mostly through lost revenues), the Swiss regulatory framework works against the improvement of rivers ecological quality. Indeed, the production losses also diminish public revenues and instream flows above the statutory minimum must be compensated by the Cantons. As they are the authorities in charge of delivering the authorizations and ordering mitigation measures, the system does not lean toward enhanced environmental measures. A possible way out would be to finance increased minimum instream flows by a rate surcharge, sharing the costs among all consumers at the national level.

This resembles the funding scheme of the NPCC fish and wildlife program. Despite the large financial commitment to this program, the FCRPS provides virtually every electricity consumer at affordable rates. Public utilities served by BPA are likely to oppose more stringent actions such as dam decommissioning. The position of both BPA and the FCRPS is strengthened by the large number of beneficiaries of this system. The cantonal authorities' strategy to gain a controlling majority in hydropower plants in Valais is not likely to receive the same support. Indeed, the aim is clearly to maximize market benefits for the State and communes and not to provide affordable rates. This aspect should be kept in mind in the current context of growing environmental public concern. A more direct link between hydropower companies and public authorities would likely convey an expectation of proactive implementation of environmental laws.

Public ownership of dams and hydropower plants is not new in both selected cases. The involvement of the Canton Valais and of the communes as a result of the reversion process would, however, completely alter the political equilibrium between lowland and mountain Cantons. The economic and political center leans toward the lowland region, and the efforts deployed by peripheral regions might have repercussions in the future, such as a change in environmental legislation or a more profound alteration of jurisdiction in water policy.

With the end of concession contracts, 80 years after they were signed, comes a new era. Environmental measures resulting from better knowledge of dams impact and value change in society are coming into force. They will probably have a considerable effect on the economic profitability of dams. The high capital costs of dam building were a central ground in granting long authorization periods. Despite the amortization of existing facilities, changes in concessions' length are not foreseen rendering future environmental adaptation difficult. Moreover, the extent of environmental measures' implementation will also depend on the future of energy policy. As a new national energy strategy is being discussed, profitability concerns may be replaced by issues of electric supply security. This new framing could reshuffle the cards in energy-water nexus issues.

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