EPI WATER

Evaluating Economic Policy Instruments for Sustainable Water Management in Europe

WP3 EX-POST Case studies
Green Hydropower in Switzerland

Deliverable no.: D3.1 - Review reports
15. December 2011

Grant Agreement no. 265213
FP7 Environment (Including Climate Change)

COOPERATION

Deliverable Title	D3.1 - Review reports
Filename	Green Hydropower in Switzerland
Authors	Thomas Dworak (Ecologic Institute)
Date	15 December 2011

Prepared under contract from the European Commission
Grant Agreement no. 265213
FP7 Environment (including Climate Change)

Start of the project: 01/01/2011
Duration: 36 months
Project coordinator organisation: FEEM

Deliverable title: Review reports
Deliverable no. : D3.1

Due date of deliverable: Month 11
Actual submission date: Month 12

Dissemination level

X	PU	Public
	PP	Restricted to other programme participants (including the Commission Services)
	RE	Restricted to a group specified by the consortium (including the Commission Services)
	CO	Confidential, only for members of the consortium (including the Commission Services)

Deliverable status version control

Version	data	Author
1.0	November, 2011	Thomas Dworak (Ecologic Institute)
1.1	December	Thomas Dworak (Ecologic Institute)

Executive Summary

Introduction

Hydropower in Switzerland accounts for about 59% of the electricity supply and has clear advantages in terms of the CO2 balance, but hydropower creates environmental disturbances in river systems. After the Swiss hydropower boom in the 1950s and 1960s, public opinion began to turn against plans to invest in new hydropower plants in the late 1970s and early 1980s due to their negative impacts on ecosystems and landscapes. Grassroots movements against new hydropower projects gained widespread public support and now more people are willing to pay extra for so-called 'renewable electricity'.

The development of the green hydropower standard was initiated by and commissioned to the research team of EAWAG (Swiss research organisation) in the late 90s. It developed the basic scientific concepts and tried to mediate between the different interest positions. At the end of 1999, a private, nonprofit organization (the Association to Promote Environmentally Friendly Electricity (VUE)) was founded to develop a broadly accepted standard of quality for green electricity in Switzerland. In the summer of 2000, the label "Naturemade" was publicly launched.

Definition of EPI and purpose

The concept of the EPI "green hydropower" covers has two main objectives (EAWAG, 2001):

- Economic objective: to have a reliable and objective certification scheme that is trustfully accepted by the consumers and ensures fair competition on the market
- Ecological objective: the improvement of local river conditions by setting an incentive to develop sustainable hydropower

The EPI ("green hydropower") contains two delivery mechanisms. The first one is a standard covering 45 scientifically defined criteria. They allow a supra-regional comparable certification of different power plants, regardless of their age, size, or how they are built or operated. The second delivery mechanism consists of eco-investments defined as a fixed mark-up on every kilowatt-hour sold as green hydropower. On an annual basis, this surcharge must be re-invested in the river system in which the plant is located in the form of river restoration measures adapted to the demands of the individual river system. (EAWAG, 2001).

However, the definition of 'green' is not straightforward and therefore requires a credible certification of high ecological standards. The concept guarantees both general standards for different schemes operating in different types of watersheds and flexibility for local particularities. The Swiss Federal Institute of Aquatic Science and Technology (EAWAG) developed an environmental management matrix that considers basic criteria and eco-investments and covers five environmental areas of concern (i.e., hydrological character, connectivity, morphology, landscape, and biological communities). The ecological perspective is complemented by five management domains.

With this in mind, the EPI can be described using the classification developed in the D 2.2- Toolbox and guidance document as a voluntary instrument which represents a combination of voluntary standards and payments for ecosystem services.

Rationale for choosing the case study

The rationale for choosing this case study is the unique situation that, in a sector that already is considered to produce green energy, the scheme goes even further to become even greener. Instead of using a command and control approach, it is the customer´s choice how green energy production should become.

Legislative setting and economic background

The EPI is a voluntary label that goes beyond the legislative requirements of environmental performance of existing hydropower plants. It is an incentive to invest in environmental protection (i.e., improvement of local river conditions) because green electricity production are estimated to be better marketed. Thereby it clearly contributes to the recovery of costs of water services, in particular to environmental costs due to the second level payments which are earmarked for environmental improvements. However, this contribution is not one of the main aims of this EPI.

Due to the loose relationship to legislative approaches and its voluntary nature, there are no distorting interactions. However, the opposite can also be recognised. The standards set by the label have been gradually turned into legislative requirements. Nowadays, the legal requirements for construction are the same as basic requirements under the EPI.

Brief description of results and impacts of the proposed EPI

Due to the lack of studies and the lack of information, only a few impacts of the EPI could be identified. These are:

- Market impacts: about 3% of the total hydropower production in Switzerland is certified
- Environmental impacts: the eco-payments have created environmental investments for improving hydropower of about 6,5 million Euros (8 million Swiss franc) for the period 2000-2009. The main environmental investments that have been made are the revitalisation/connection and improvement of sediment transport in 24 km of rivers and the creation and restoration of

aquatic and terrestrial ecosystems over an area of 950,000 m2. In addition, several smaller improvements on terrestrial and aquatic ecosystems have also been achieved.

- Educational impacts: Besides using the second-level payments for improving the environmental performance of a plant, the money has also been spent for setting up a youth program „Viva-Riva." This program offers excursions for young people that explain aquatic ecosystems to them. Furthermore, several information campaigns have been held as well as trainings weeks in cooperation with the WWF.
- Due to the only partly liberalised energy market in Switzerland, only limited impacts have been tracked on tariffs and consumption. More tariffs offering green hydropower have been developed, but this does not impact the competition on the market as these tariffs are offered by the same company which has a monopoly to supply households. Energy consumption has not been affected as this is not the aim of the EPI.

No other impacts have been found so far. In particular, the impacts on economic efficiency and social equity have not been sufficiently investigated and could thus not be analysed further due to a lack of time and resources.

Conclusions and lessons learnt

The main lesson learned from the case study is the fact that economic interests and ecological concerns can be combined in one voluntary instrument based on economic and regulatory instruments (standards). In other words, it is possible to combine the demands of different actors and stakeholders in the electricity market and thereby:

- Guarantee quality
- Label sustainable electricity and electricity from renewable energy sources
- Improve the status of the environment on a broader level (basic requirement) but also consider specific local environmental issues (eco-investment payment)
- Establish a competitive advantage for "greener" electricity from renewable energy sources compared to electricity from other renewable (e.g., non-certified hydropower) and non-renewable energy sources (e.g., petrol).

A further enabling factor for this EPI is the fact that environmental stakeholders and energy producers have agreed to use scientific criteria to develop an instrument that provides a win-win situation for both sides. Using scientific criteria as a basis for certification and making them publicly available to consumers is also stated as a factor that ensures public acceptance and uptake (VUE, personal communication).

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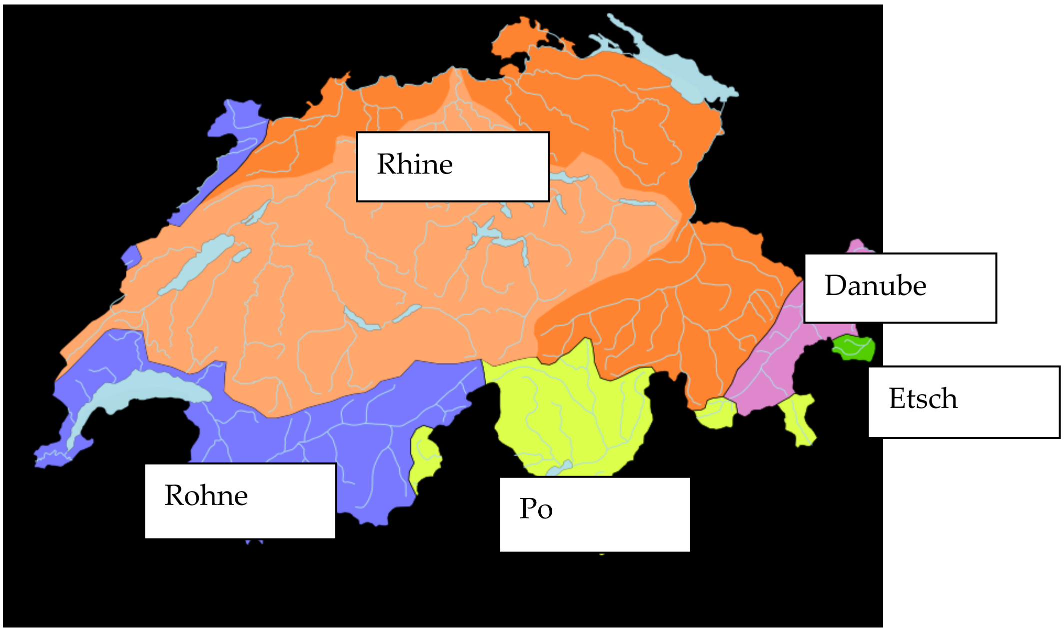
1. Characterisation of the case study area (or relevant river basin district)

Switzerland is a landlocked country geographically divided between the Alps, the Central Plateau, and the Jura, spanning an area of 41,285 km2. While the Alps occupy the greater part of the territory, the Swiss population of approximately 7.9 million people concentrates mostly on the Plateau, where the largest cities are to be found. (Bundesamt für Statistik, 2010). The Swiss economy follows the typical First World model with respect to the economic sectors. Only a small minority of the workers are involved in the primary or agricultural sector (3.8% of the population, in 2006), and a larger minority is involved in the secondary or manufacturing sector (23% in 2006). The majority of the working population are involved in the tertiary or services sector of the economy (73.2% in 2006). While most Swiss economic practices have been brought largely into conformity with the European Union's policies, some trade protectionism remains, particularly for the small agricultural sector.

The Swiss territory is divided into four major types of land use. As of 2001, 36.9% of the land in Switzerland was used for farming. 30.8% of the country is covered with forests and woodlands, with an additional 6.8% covered with houses or buildings. About one-fourth (25.5%) of the country is covered by either mountains, lakes, or rivers and cannot be used (Bundesamt für Statistik, 2010). Agricultural area has decreased 4,8% between 1983 and 2007 while urban areas have increased in the same time by 23%. The overall territory is under nature protection is 4% (Bundesamt für Statistik and Bundesamt für Umwelt, 2011).

Switzerland is a water-rich country with an average precipitation (1961-1990) of 1458 mm (Spreafico and Weingartner, 2005). The territory is covered by 5 river basins, namely the Rhine (68%), the Rhône (18%), the Po (9,3%), the Danube (4,4%), and the Etsch (0,3%) (Bär, 1973).



Map 1-1: River Basins of Switzerland

The total renewable water resources of Switzerland, as of 2005, were 53.3 km3, of which the total freshwater withdrawal was 2.5 km3 per year (Gleick, 2011). This breaks down to a per capita freshwater withdrawal of 370 m3 per year and person (including industry). The main users are domestic (62%) and industrial (17%) (EAWAG, 2009). The estimated irrigation demand reaches 136 to 154 million m3 water per year (Fuhrer, 2010). The share of ground and surface water used for drinking water is 80% to 20% (Bundesamt für Statistik and Bundesamt für Umwelt, 2011).

The main water user in Switzerland is hydropower. Towards the end of the nineteenth century, hydropower underwent an initial period of expansion, and between 1945 and 1970 it experienced a genuine boom during which numerous new power plants were opened in the lowlands, together with large-scale storage plants. At the 1st of January 2011 there are 556 hydropower plants in Switzerland with a capacity of at least 300 kilowatts. The production capacity is on average 35,830 gigawatt hours (GWh) per annum (BFE, 2011). About 47% is produced in run-of-river power plants, 49% in storage power plants, and approximately 4% in pumped storage power plants (Dasen, 2011).
The hydropower market is worth around 2 billion Swiss francs (basis: delivery from power plant at 5 cents per kilowatt hour) and is therefore an important segment of Switzerland's energy industry.

The major water issues in Switzerland are water pollution from the increased use of agricultural fertilizers as well as hydrocarbon pollution from transport and industry. Pesticide thresholds are exceeded at 18% of the monitoring stations. Also, hydro-morphological changes play an important role. Twenty-two percent (14.000km) are heavily modiefied water bodies and around 100,000 barriers limit fish mitigation (Bundesamt für Statistik and Bundesamt für Umwelt, 2011). Since 1800, about 90% of all Swiss wetlands have disappeared. Similarly, it is estimated that the area of floodplains has been reduced by 90%. Only 20% of the floodplains which are left can still be considered actively functioning. (SAEFL, 1998).

2. EPI background

Hydropower in Switzerland accounts for about 59% of electricity production (Dasen, 2011). Its use is responsible for a wide range of environmental disturbances to river systems. At the local level, hydropower construction and operation is associated with a number of serious environmental problems: water diversion, interruption of fish migration, hydropeaking, reservoir flushing and inundation of landscapes, and alterations in bio-geochemical cycling. The mitigation of hydropower impacts on Alpine ecosystems has been a topic of considerable public debate in Switzerland.

"Naturemade" is the quality mark for ecologically produced energy (naturemade star) and energy from renewable sources (naturemade basic). The label is awarded after thorough inspection by the Association to Promote Environmentally Friendly Electricity (VUE). Naturemade covers a broad range of electricity production methods, including bioenergy, solar, wind, and hydropower. In the context of this study, a specific focus is on the hydropower certification scheme ("greenhydro"), which is a combination of a labelling and payments for ecosystem services with the aim of creating an incentive for sustainable hydropower production.

2.1. What was the baseline before the EPI was implemented?

After a hydropower boom in the 1950s and 1960s, public opinion began to turn against plans to invest in new hydropower plants in the late 1970s and early 1980s due to the negative impacts these developments have on ecosystems and landscapes. A number of spectacular grassroots movements against new hydropower projects gained widespread public support. The further expansion of hydropower was criticised as having the potential to destroy the last intact river ecosystems of the Alps. Several attempts to solve these problems have had only limited success but finally resulted in a proposed law which fixed, among other subjects, minimal flow requirements for Alpine streams impacted by reservoirs. In 1991, the revision of the law was accepted in a popular vote, and since then the environmental improvement of hydropower has been a legal requirement. After the law passed, the political debate about the sustainable management of hydropower came to a standstill (Truffer et al., 2003a).
However, the law could only be applied in the context of a renewal of the water use licenses, which typically run over 80 years, and therefore no major changes in operation could be expected before the year 2020. At the same time, the deregulation of electricity markets began shaping expectations and putting pressure on hydropower operators to reduce costs and to act as competitive firms. The prospect of deregulating the electricity market led to a redefinition of incentives for plant operators and local administrations in a way that contradicted more environmentally responsive ways of action but also lead to new

opportunities to deal with environmental concerns. A number of incumbent electric utilities, as well as newly emerging green power marketers, began to develop Green Power products to differentiate themselves from other suppliers (Truffer et al., 2003a).

The development of the green hydropower standard was initiated by and commissioned to the research team of EAWAG in the late 90s. A working group, was established. A private company (Kiefer & Partners AG), financed by ewz and WWF, was given the responsibility of setting up a business plan for the label. EAWAG developed the basic scientific concepts and tried to mediate between the different interest positions. EAWAG also increased the acceptance of the evaluation procedure in a number of negotiation meetings with all relevant stakeholders. The stakeholder involvement turned out to be essential for the process of standard development. Eco-labelling generally was seen as potential tool leading to a win-win situation for all market actors involved: producers and suppliers as well as consumers and environmental organisations (Wüstenhagen et al., 2000).

At the end of 1999, a private, nonprofit organization (the Association to Promote Environmentally Friendly Electricity (VUE)) was founded to develop a broadly accepted standard of quality for green electricity in Switzerland. In the summer of 2000, the label "Naturemade" was publicly launched.

With this development in mind, the EPI is an additional instrument to a command and control approach and was clearly driven by market forces (differentiation from other suppliers).

2.2. What are the key features of the EPI and what settings made it operational?

The voluntary "greenhydro" concept has two main objectives (EAWAG, 2001):

- Economic objective: to have a reliable and objective certification scheme that is trustfully accepted by the costumers and ensures fair competition on the market
- Ecological objective: the improvement of local river conditions

It consists of two major elements which deal with the key problems associated with the integration of hydropower into green electricity products (Truffer et al, 2003a):

- First, a two-level label was defined as set out in the figure below:

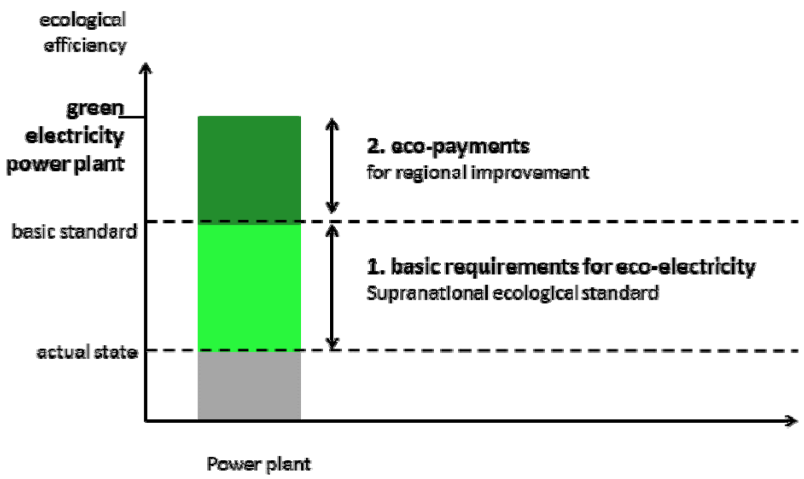


Figure 2-1: The two levels of the label

The first level, naturmade basic, was conceived as a declaration of origin for renewable electricity. Naturemade basic should differentiate conventional hydropower plants from power stemming from nuclear or fossil fuel-fired power plants (which cannot be certified). The second level, naturemade star, was defined for environmentally preferable electricity. Here, plants may be certified that fulfil additional criteria with regard to their lifecycle characteristics and have low local environmental impact. Hydropower plants may achieve this level if they adopt an environmentally optimised operation mode, i.e., by accepting the criteria set forth in the EAWAG project.

- Second, in order to protect the "new renewables" from cost competition of large hydropower plants, a "promotion model" was set up. The marketers of naturemade certified electricity products must guarantee that at least 5% of their sale of certified electricity is covered by "naturemade star" products. Through this, an incentive actively to promote environmentally less disrupting energy systems was installed. However, it was not possible to quantify the strength of this incentive.

The EPI (green hydropower) contains two delivery mechanisms. The first one is a standard covering 45 scientifically defined criteria. They allow a supra-regional comparable certification of different power plants, regardless of their age, size, or how they are built or operated (EAWAG, 2001).

The second delivery mechanism a eco-investment, financed by a fixed mark-up on every kilowatt-hour sold as green hydropower. On an annual basis, this surcharge must be re-invested in the river system in which the plant is located in the form of river restoration measures adapted to the demands of the individual river system. Currently, the eco-investments provide additional money for restoration activities at a rate of 0.08 Eurocent (0.1 Swiss Rappen) per produced kWh and 0.7 Euro cent (0.9 Swiss Rappen) per sold kWh (VUE, 2011). The utilisation of the eco-investments needs to be based on a catchment analysis and are prioritized by round-table decisions with local stakeholders and agencies (Bartrich et al, 2004).

If the hydropower scheme meets both the basic requirements and a defined set of priorities for eco-investment activities, the management concept is reviewed in a formalized audit action plan by an independent inspection of the facility and the river. Once the scheme has been positively evaluated, the eco-label can be granted. Regular monitoring of success will provide the basis for a re-certification after five year. It is then up to the owner of the facility to use the eco-label as a marketing instrument to achieve higher prices for this electricity (Bartrich, et al, 2004).

In order to obtain a naturemade star label for each hydro power plant, the four following steps have to be performed:

- Under step 1, the hydropower scheme wishing to be certified is asked to analyse its ecological performance and estimate the costs for further necessary studies. This screening allows a 'go or no-go' decision and delivers information about serious environmental impacts and upgrading measures needed for certification.

- If the company expects positive economic impacts based on the results form step 1 and decides to apply for the labelling procedure, then it has to develop a management programme based on the two delivery mechanism (basic requirements and eco-investments) mentioned above (step 2).
- As soon as a hydropower scheme meets the basic requirements and a defined set of priorities for eco-investment activities, the management concept is transposed into a formalized audit action plan. This action plan has to be implemented and is accompanied by an independent inspection of the facility and the river. It also requires documentation prepared by an accredited company and by independent expert auditors. Once the scheme has been positively inspected, the eco-label is granted, and the owner of the facility is allowed to use the eco-label as a marketing instrument to gain higher prices for this electricity.
- Step 4 covers regular monitoring of success and is the basis for a re-certification after five years

The "naturemade" label can not only be used by energy producers but also by consumers in the company communication (letters, reports, and marketing) under certain conditions:

- The naturemade star label can be used if 50% or 1GWh of the annual energy consumption is supplied by naturemade star energy
- The naturemade basic label can be used if 95% or 10GWh of the annual energy consumption is supplied by naturemade basic energy

3. Assessment criteria

3.1. Environmental outcomes

One of the EPI´s clear objectives is to improve the environmental performance of hydropower plants. So, the environmental performance of power plants can be assessed from two perspectives:

a) the performance on the plant level

b) the performance on the national (Swiss) level

Performance on the plant level

In order to understand the performance on the plant level, it is essential to assess the basic level of the label (as set out in Figure 2-1). These basic requirements are defined as a general ecological standard for all green hydropower producers. They allow a supra-regional comparable certification of different power plants, regardless of their age, size, or how they are built or operated. The 45 criteria ensure a minimum standard across Switzerland. The green hydro standard covers an extensive range of scientifically based and generally applicable criteria for an ecological assessment of hydropower plants and affected aquatic ecosystems. The certification schemes require consideration of the following set of management criteria (Bartich and Truffer, 2001):

- Minimum flow regulations
- Hydro-peaking
- Reservoir management
- Bedload management
- Power plant design

The scheme further assesses the impacts of each plan on the following environmental aspects with the aim to protect the ecological variability of an ecosystem. These criteria compromise the following areas:

- Hydrological character
- Connectivity of the river system
- Solid material budget and morphology
- Landscape and biotopes
- Biocenoses

By combining ecological impacts and management options, the criteria of the basic requirements were structured in a so-called environmental management matrix. The environmental management matrix with basic goals for certification are set out in Table 3-1.

Table 3-1: The environmental management matrix with basic goals for a Green Hydro certification (from Bartrich et al, 2004)

Management field environmental field	Instream flow regulations	Hydropeaking regulations	Reservoir management (storage reservoirs)	Bedload management (run-of-the-river)	Design of power plant structures
Hydrological character	• follows the seasonal changes and the variability of natural discharge patterns.	• is slowed down sufficiently to allow aquatic organisms to migrate to safer areas, • minimizes critical temperature effects.	• assures the timing of reservoir flushing only during high discharge.	• requires minimum flow regimes in diverted river reaches which enable sediment transport, bank erosion and deposition as in the natural case.	• involves control systems to prevent abrupt release of high water flows, • includes technical measures to meet minimum flow regimes at any time.
Connectivity of river systems	• Ensures interconnection with groundwater and lateral tributaries and allows fish migration	• avoids stranding of aquatic organisms outside the main channel.	• allows fish to pass with the headwaters, if they are stocked with a natural fish population.	• ensures that lateral stream inlets retain a functional connectivity.	• ensures unimpeded up- and downstream migration, preferably by creating bypass channels, (technical aids need a record of functionality).
Solid materials regime and morphology	• preserves natural structure of the riverbed and maintains solid transport.		• avoids excessive silting or erosion in the tailwaters during flushing.	• allows for a necessary influx of bedload into tailwaters to prevent the erosion of the riverbed and to develop a typical morphology.	• optimises the weir design for bedload transport in order to maintain an equilibrium bedload level in the tailwaters.
Landscape features and biotopes	• maintains hydraulic characters and preserves inventoried floodplains.	• preserves the specific landscape features of the river and allows safe recreational activities	• preserves habitats requiring conservation, • pays special attention to requirements of migratory birds.	• permits an adequate influx of bedload into the tailwater for maintaining a typical riverine landscape.	• avoids any new buildings in protected areas • optimises bypass channels as substitute habitats for rheophilic organisms.

Biological communities	• preserves natural biodiversity and sustains the reproduction of native fish species • ensures that temperature regime and dilution capacity • remain close to natural level.	• minimizes long-term damage to biodiversity, • maintains the age class distribution of native fish populations, • prevents irreversible drift of organisms and • preserves the diversity of habitats.	• schedules flushing outside critical seasons for the reproduction of important fish species, • ensures that rare and endangered species are not disappearing due to reservoir flushing.	• ensures that typical riverine habitats are forming.	• protects wildlife from harmful contact with installations and machines.

These criteria are chosen in order to ensure that the river system's principal ecological functions are preserved even when they are affected by hydropower generation. The quantification of environmental impacts has to be made on the plant level and is dependent on the level of ecological performance before the certification. No study was found that analyses the improvements on a wider scale. A plant specific example is given in the box below:

Box 3-1: Example for measures taken to improve the environmental performance of a power plant (ewz, n.y.)

In order to get the nature star label for the power plant Wettlingen, and in the context of renewing the concession, the environmental performance was increased. The minimum flow was changed from 0,6 m3/s to 7,5 to 12 m3/s depending on the season. This resulted in a loss of 10% of the production capacity. Due to a new turbine, this production loss was compensated. In addition, a fish pass was established.

The second level (eco-payments) is based on individual measures paid by the additional costs per kw/h. So, it is ensured that environmental mitigation measures are tailored to the specific circumstances involved. They also might be used to remedy environmental shortfalls that have not been primarily caused by the power plant. The only selection criteria required is the optimal cost benefit ratio. The payments are earmarked to the plant they come from and have to be used for mitigation measures directly related to the plant. If all mitigation measures are taken, then investments to improve the wider surroundings of the plant can be made (VUE, personal communication).

The performance on the national level

Currently about 3% of the hydropower plants are "naturemade" certified (VUE, 2011). In absolute terms, for naturemade star 1,099 GWh/a and naturemade basic 7,679 GWh/a are certified, respectively. The total production is 25,835 GWh/a. The level of certification remains rather limited, even if there has been a steady increase of plants certified over the years.

The payments under the second level (eco -payments) have created environmental investments for improving the environmental performance of hydropower plants of 6.4 million Euros (8 million Swiss franc) for the period 2000-2009. The main environmental investments made are:

- Revitalisation/connection and improvement of sediment transport in 24 km of rivers
- Creation and restoration of aquatic and terrestrial ecosystems over an area of 950.000 m2

Further the following specific measures have been taken:

- Improvement of sediment transport (2400 m3)
- New natural hydromorphological structures
- Improvement of fish habitats and other species depending on aquatic ecosystems
- Reducing neophyte
- Bird protection measures
- Demolition of human made hydromorphological structures
- Cleaning and decontamination of land

No (economic) valuation exercise of these benefits was found.

However, even if there is evidence that several measures and actions have been taken to improve the water status, it remains unclear how the actual status of rivers has been improved. In other words it remains unclear how these measures finally improve the status of a water body.[1]

3.2. Economic assessment criteria

In this section, the aim is to evaluate and quantify different (and complementary) economic aspects related to the performance of the EPI. However, it should be noted that the potential for answering these question is rather limited as for most questions no detailed studies have been found and the interviews performed could not close these gaps.

Was this EPI compared with other alternatives? If so, was the chosen one the least-cost alternative? Was a cost-benefit analysis performed? Does it have disproportionate costs?

The evaluation and quantification of different (and complementary) economic aspects related to the performance of the EPI is difficult as no alternative instrument was considered in the design phase (VUE, personal communication). As there was no alternative considered, no CBA was found. The EPI was clearly developed because of political willingness to solve a societal conflict. Disproportional costs have not been identified as the EPI is of voluntary nature and if such costs existed, it would not have been applied by the private sector.

[1] A first attempt to assess these ecological improvements was made in a three-year case study in the catchment of the Brenno River (see Bratrich et al, 2004).

Was there a command-and-control mechanism in place? Did the EPI, when compared to that regulatory alternative, make a clear contribution to increase the economic efficiency with which water resources are used in the economy?

The EPI was developed in addition to a control and command mechanism (Water Act) which aimed to reduce the environmental costs of hydropower plants. However, this water act was only supposed to impact hydropower plants and the efficiency with which water resources are used if a licence is renewed. This renewal process could take up to 2020 for some plants (Truffer, 2003b). In setting up the EPI, there was also the idea to set an incentive to improve the environmental performance (reduction of environmental costs) of the plant quicker. So internalising the environmental costs has increased economic efficiency with which water resources.

Was there a cost-effectiveness analysis to choose and design the EPI? Was the EPI a least-cost alternative?

It can be assumed that due to the participation of the private sector (EWZ) in the development of the label that it is seen as a cost effective approach. This can be underlined by the fact that in the initial phase of the certification each hydropower plant owner who wanted to participant had to do a CBA study investigating whether the benefits of certifying a plant outweighed the costs of complying with the standard.

When comparing the EPI to policy instruments already in place, did the EPI implementation lead to specific cost savings for water users? And for the economy as a whole? Did the EPI deliver additional benefits as well as cost reductions?

No costs savings for water users have been identified. However, the EPI has lead to a reduction of environmental costs as it improves the environmental performance of a hydropower plant.

Who were the winners and losers of the implementation of the EPI?

The main winners of the EPIs are the environmental stakeholders/interest groups that profit from better environmental conditions in certain stretches of certain rivers and the educational programs financed by the eco-payments. The environment itself is also one of the winners; however, it remains unclear how this translates to implications for different social actors.

If energy companies will profit or lose from using or not using the label remains unclear, as the Swiss energy market is still not fully liberalised and customers are not able to select between different products from different providers. At the moment, only shifts between different products within the same company are tracked.

No clear losers have been tracked as the EPI is voluntary.

Who incurred costs for the EPI implementation?

The costs of implementing the EPI are clearly paid first by the company aiming to get a hydropower plant certified. These costs are than partly passed to the end-consumer who pays a higher electricity price. The main costs are:

- The "overview study" (step 1 in the certification process), which defines the basic criteria (comparability of the environmental quality) for different hydropower plants in different locations. This study should be carried out quickly in a very rough procedure by a small team of experts.
- The detailed study (step 2) which outlines the detailed measures to be taken. The measures selected should achieve an optimal environmental benefit for the given amount of money, the "eco-investments."
- Costs for setting up the "decision-making process." The selection of an optimised set of measures shall be carried out in the context of a participatory decision process, involving the major local stakeholders of the area (step 3).
- Implementing the measures. The financing of the measures must be ensured in advance. Additional payments from third parties can be used.
- The lincensing costs, which are set out in the table below:

Table 3-2: Costs for licensing (VUE, 2009)

Fixed certification and licensing fees	Type of fee	Fees in CHF (EUR)			
	Certification fee	Five-yearly			500 (403.1)
	Fixed licensing charge	Annual			200 (161.2)
Variable royalties	Licence	Licensed Quantity			
		Fee in CHF (EUR)	Up to 10 GWh	11 to 100 GWh	more than 100 GWh
	Producers of naturemade basic	Annually per GWh	50 (40.3)	35 (28.2)	20 (16.1)
	Producers of naturemade star	Annually per GWh	70 (56.4)	50 (40.3)	30 (24.2)
	Suppliers of naturemade basic	Annually per GWh	1000 (806.2)	100 (80.6)	40 (32.2)
	Suppliers of naturemade star	Annually per GWh	1500 (1 209.4)	150 (120.9)	60 (48.4)

An example for the costs of a certification are given in the Annex.

Did the EPI contribute to reducing risk when compared with the best command-and-control alternative?

No information could be found.

Did the EPI contribute to the recovery of costs of water services provided to the economy?

The EPI clearly contributes to the recovery of environmental costs of water services as the eco-payments internalise them by paying for measures that mitigate the environmental damage caused by the hydropower plant. However, as the environmental costs are not known yet, it is impossible to estimate the cost recovery rate.

Did the EPI provide the right incentives?

Designed in a voluntary manner, the EPI provides the right incentives compared to its set target. It stimulates the uptake of environmental measures by creating an incentive to better market green electricity.

3.3. Distributional effects and social equity

It is very difficult to assess the distributional consequences and the social equity of the EPI due to its voluntary nature and the low uptake rate. Due to the mandatory participation process when selecting the measures, it can be assumed that distributional consequences and social equity issues are discussed and considered on the plant level. However, no evidence for this was found.

According to the personal communication with the WUE and the EWZ, the certification scheme has lead to a customer shift in the case of major customers. However these shifts are mainly between different energy products offered by the same company and not between different companies. This can be explained by the fact that the Swiss energy market is not fully liberalised. Only since 2009 have major customers such as industry faced a liberalised market. Private costumers should follow by 2014 (see StromVG, 2007). Due to the partly liberalised energy markets, no real competition between producers exists. As such, the impacts on income and profits of companies are marginal. However, according to personal communication with the EWZ, it is expected that a fully liberalised energy market will have the main impact on profits and income in the future. Therefore, green hydropower producers spent quite some effort on marketing their product in order to make sure that the price is not the only signal the costumer recognises. Companies seem to be more open to green hydropower because they can better their image in terms of "corporate social responsibility." Private customers are expected to follow mainly the price signal, as the location of improving the environment is far away (upstream Zurich) from the use of energy (city of Zurich). Only a few specific customers are expected to be willing to pay for such improvements.

Furthermore, in rural areas no big impact was recognised while in urban areas (e.g., city of Zurich) the willingness to pay higher prices for green hydropower is increasing and major customers follow this trend.

Besides using the second level payments for improving the environmental performance of a plant, the money has also been spent for setting up a youth program „Viva-Riva." This programme offers excursions for young people that provide insight into aquatic ecosystems. Further information campaigns have been held as well as training weeks in cooperation with the WWF.

Table 3-3. Summary of results table

Energy Producers	Type of measure	Direction of Change
Material living standards	Quantitative	+
Health	Qualitative	0
Education	Qualitative	+
Personal Activities	Qualitative	0
Employment	Quantitative	?
Environment	Qualitative	++
Insecurity	Qualitative	0
Political Voice	Qualitative	0
Social connections and relationships	Qualitative	++

Notes: + represents a positive change from base scenario to implementation of EPI;

0 represents no discernible change from base scenario to implementation of EPI

- represents a negative change from base scenario to implementation of EPI

3.4. Institutions

As already indicated in section 2, the public discourse about hydropower in Switzerland went through a number quite clearly demarcated phases. In a first phase (1880 and 1914), the electrical utopia based on the "white coal" facilitated a national consensus to develop alpine hydropower plants (Gugerli, 1997). Due to technical limitations, the majority of currently running large-scale hydropower plants in the Swiss Alps were constructed in the 1950s and 1960s. This resulted in negative impacts on ecosystems, landscapes, and local communities; national and public opinion began to turn against plans to invest in new hydropower plants in the late

1970s and early 1980s. As a result, a number of spectacular grassroots movements against new hydropower projects gained widespread public support.

This change in public perception culminated in a political struggle over the renewal of the Swiss Water Protection Law that aimed to fixe, among other subjects, minimal flow requirements for Alpine streams impacted by reservoirs. In 1991, the revision of the law was accepted in a popular vote but led to a strong political opposition between several parties: environmental
organisations struggled for the protection of the last untouched river stretches in the Alpine mountain valleys, while electric utilities lobbied against "unproductive" water running down the river. The debate was strongly conditioned by the institutional form of the electricity sector where public authorities held some 75% of the shares of electric utilities. Conflicts also arose between federal authorities, supporting the Water Protection Law, and regional (cantonal) authorities in their role as shareholders and taxation authorities of hydropower plants. These conflicts gained also momentum as regional authorities are also responsible for enforcing the new Water Protection Law (Truffer, et al 2003b). Given the complexity of this task and the lack of trust between the parties on all sides, the Swiss Federal Institute for Environmental Science and Technology (EAWAG), with the aim to develop scientifically based criteria for sustainable hydropower (Wüstenhagen, et al, 2000), was seen as a mediator.

The process to create the label was then initiated and supported by pioneers from both sides: the municipal utility of Zurich (EWZ) and the World Wide Fund for Nature (WWF). Decisive was the awareness that the success of a label can only be achieved by mutual cooperation. The initiative was backed up by a research project. The creating institutions in detail:

- EWZ (municipal utility of Zurich): In the late 1990s, when market liberalisation gained increasing attention in the political debate, and a significant expansion of the green power market in Switzerland took place, a number of committed municipal utilities, like the EWZ, decided to take a more marketing-oriented approach to promoting green electricity. EWZ became an important actor on the supply side when developing the label. EWZ has been supplying the city of Zurich and parts of the Grisons with power since 1892 and offers a comprehensive range of energy services. EWZ produces roughly a third of the energy it supplies in its own 14 hydroelectric power plants. Two of them (Höngg and Wettingen) are certified with the naturemade star label, while the others are certified as naturemade basic.
- WWF (World Wildlife Fund), an environmental NGO in Switzerland
- EWAG (Swiss Federal Institute of Aquatic Science and Technology) is a Switzerland-based aquatic research institute that combines natural and social scientists and engineers. It permits a wide range of water research, across the continuum from relatively unperturbed aquatic ecosystems to fully

engineered wastewater management systems. Their main role in the development of the naturemade label was the development of the scientific base for the label.

- A private company (Kiefer & Partners AG), financed by the municipal utility of Zurich (EWZ) and WWF. It was given the responsibility to set up a business plan for the label.

Project members of EAWAG increased the acceptance of the evaluation procedure in a number of negotiation meetings with all relevant stakeholders. As set out earlier, the stakeholder involvement turned out to be essential for the process of standard development. Eco-labelling generally was seen as a potential tool leading to a win-win situation for all market actors involved: producers and suppliers as well as consumers and environmental organisations (Wüstenhagen, et al; 2000). After another year of mediation and research concerning the criteria to be applied for hydropower plants, a new organisation was created (Wüstenhagen, et al, 2000). The newly created organisation was called the Association to Promote Environmentally Friendly Electricity (VUE). It aims to:

- Fund renewable energies and ecological energy products. This is mainly done through the development and the promotion and the application of certification schemes and labels for ecological and renewable energy products. It also promotes the funding of its own label.
- Develop scientific criteria for the assessment of ecological energy products
- Co-operate with other organisations in Switzerland and outside

VUE is an interesting example of an intermediary as an "organisation of organisations" (Ahrne et al, 2007), as Swiss electricity companies (and their industry organisations) and advocacy organisations of renewable electricity generators have been included directly in the labelling organisation along with the green NGOs and consumer organisations. In this context, the board of directors covers

- hydropower producers and their organisations,
- "new renewable energy producers" and their organisations,
- energy suppliers and traders and their organisations,
- environmental NGOs,
- small customers' organisations, and
- large customers and their organisations.

The development process of the label and the role of the different institutions have been described in Kiefer (n.y) as presented in the table below.

Year and phase	Discussion process and results	Most important actors
1997 Phase I	• A team from EAWAG develops the research idea for eco-electricity from hydro power. First talks with WWF Switzerland and EWZ take place. → Research project "Eco-electricity from hydropower" at EAWAG • In relation with the marketing of solar power the need for quality assurance rises.	• EAWAG • EWZ – Elektrizitätswerk der Stadt Zürich • WWF Switzerland
1. half of 1998 Phase II	• On the initiative of WWF Switzerland the working group "Eco-electricity label" is established. Important economical and political actors of the Swiss electricity market are represented in the group. • The EAWAG research project "Eco-electricity from hydro power" is started. →Discussion about the requests for a label Kiefer & Partners AG presents the idea of a two level label, a concept, that is similar to the one presently applied.	• WWF Switzerland • Govermental Department of renewable energies E2000 • Different economical and political actors on the electricity market • EAWAG
2. half of 1998 Phase III	• From the working group "eco-electricity label" a body responsible for a business plan "Association Eco- Electricity Label" is established. WWF Switzerland and EWZ are represented in the body. → Kiefer & Partners AG prepares a draft of a business plan • Parts of the VSE are opposed to the concept of a two level label → The concept is changed into a basic label for electricity from renewable energy sources ("SwissReEnergy") and an additional label for "eco-electricity" ("EcoLeader"). • The EAWAG research project is to be	• EWZ • WWF Switzerland • Kiefer & Partners AG • VSE

	speeded up, since some exponents of the electricity market urge a decision for hydro power. At the same time EAWAG gets resistance from the water economy section.	
1. half of 1999 Phase IV	• The business plan draft is discussed with the different actors. The presented solution for the label is welcomed by VSE. The resistance against EAWAG is transformed into support. Surprisingly resistance against the label solution now rises from environmental organizations. They fear an "erosion of ecological standards" because of the possibility of being awarded a basic label. → The label concept is reconsidered. Instead of the two level labels an "eco-label" and a declaration for electricity from renewable energy sources are taken into the new concept. • Preparation for the foundation of the Association	• VSE • Environmental organisations • EWZ • WWF Switzerland
IX and X 1999	• The members of the Association agree on the present solution → The Association is founded (VUE)	• Members of the Association

3.5. Transaction costs

The assessment of transaction costs in detail is very difficult, as no information was found in the literature. Furthermore, when studying the development phase of the EPI, no indication on a discussion of the issue was found. However, the following transaction costs have been identified but cannot be quantified:

- Costs of developing the certification scheme and criteria. An indication that these costs were high is given in Wustenhagen, et al. (2000) in the statement: "Especially the basic and the final design phase may require a lot of time and financial resources."
- Costs for developing a guidance provided to decision makers
- Costs for setting up the VUE
- Costs for maintaining the EPI in the frame of the VUE

However, even if transaction costs might have played a role, they seem to be no argument for not setting up the EPI *(Only annual turnover + costs figures for the VUE available, but nothing on the EPI in particular).*

3.6. Policy implementability

The assessment of the policy implementability has to consider this voluntary approach. Main aspects to be considered are: i) flexibility of the instrument, ii) public participation/acceptance and cooperation and coordination between the other stakeholders, iii) budgetary constraints, and iv) links to other policies.

Flexibility

As the situation is different for each hydropower plant, the application of the EPI requires a flexible approach. The instrument is intended to support an individual upgrading process of the hydropower schemes in their distinct catchment areas. Due to the implementation being part of a case by case-based certification process, it allows adaptation to different local conditions. Local adaptation refers to the deadlines by which the new green hydropower standards (level one) have to be made and also to which environmental investments under the second level have to be made and by when.

Due to the re-certification process that is required every 5 years, the EPI is adjusted following a post-implementation review. The costs of this re-certification are different for each plant, as they depend on local conditions. The general rules (environmental matrix criteria as set out in Table 3-1) for the EPI have not been further developed over the years, as the certification rules from 2001 are still valid.

Public participation/cooperation and coordination between the other stakeholders

In the context of public participation, two aspects have to be considered:

- **Developing the EPI**: There is clear evidence that public participation played a major role in the development of the EPI. Public opinion and public protest movements (in the 1980s) against new dam projects facilitated the development of the EPI. Also, the renewal of the Swiss Water Protection Act in 1991—backed by a popular vote—set up more severe requirements for the use of hydropower, creating a market for the EPI. When ecological standards are considered, environmental organisations have a highly credible image in the Swiss public. So, the importance of the inclusion of the WWF in the development of the EPI became obvious. As stated in Wustenhagen (2000), the Swiss experience highlights the need to address different stakeholders early in the process and to explicitly integrate the relevant groups in the standard development process. As soon as major interests are partly neglected or violated, there is a danger of either small uptake of the label or even a counterproductive development of alternative and then competing certification schemes, as occurred in the German market (Markard, et al, 2000).

- **Implementation of the EPI**: In stage 3 (see section 2.2) of the certification process, a consultation with local stakeholders is performed. This mainly means that those interest groups should be involved that either benefit from the mitigation measures or are carrying out their own measures and could be used for support. Such an involvement should not only increase the acceptance but should also ensure that the funds are used effectively.

Public acceptance

The EPI was driven by a societal concern for environmental problems reflected by the fact that more people are willing to pay higher prices for electricity produced with low ecological impact. This concern has lead to the 2009 Energy Act that stimulates electricity production from renewable energy. It sets a target of at least 5.4 billion kilowatt hours by 2030. This corresponds to around 10% of current electricity consumption (2008: 58.7 billion kilowatt hours). In addition, the slow but continuous increase of certified hydropower plants can be seen as an indication of public acceptance.

Budgetary constraints

In stage 1 of the certification process (see section 2.2), the power plant owner has to carry out an overview study that estimates the cost of the certification process. If these economic costs are considered too high for the plant owner, he can drop out of the certification process. In other words, budgetary contains might hamper the implementation of the EPI.

Links to other policies

In the context of this EPI, two main policies have to be considered:

- The 2009 Energy Act contains a package of measures aimed at promoting renewable energies and energy efficiency in the electricity sector, the mainstay of which is the cost-covering remuneration scheme for electricity generated from renewable energies. The maximum surcharge of 0.6 cents may only be levied once the registered plants with a positive decision have been certified, are feeding electricity into the grid, and are already receiving the cost-covering remuneration. The Federal Office of Energy decided that the 2010 surcharge is to remain at 0.45 cents per kilowatt hour. Since the latest revision of the Act in summer 2011, there is also the possibility to use the surcharge also for re-naturation of rivers impacted by hydropower.

- With the revision of the Water Protection Act in January 2011, a legal basis has been created for maintaining natural conditions in streams and rivers below hydropower plants. This base is very similar to the requirements set in the basic requirements of the "greenhydro" certification scheme. Only building measures, which, in contrast to operational measures, do not affect electricity production, have to be applied by the power plants. This can be the construction of equalising basins or underground channels to a lower lake. In addition to dampening the effects of turbine-related surges, the aim here is to overcome various other ecological problems, such as the build-up of silt and debris in the vicinity of dams and the interruption of fish migration routes by weirs, machinery buildings, etc.

  The problem that the authorities are unable to impose any new regulations on electricity companies during the period of validity of a licence can be solved in the form of a special provision in the Water Protection Act, which stipulates a retrofitting requirement for all existing hydropower plants, regardless of the duration of the operating licence but at the same time provides for the payment of full compensation to the operator for the required structural measures.
  The funding of around 0.8 Billion Euros (1 billion Swiss francs), which will be required during the coming 20 years for the construction of equalising basins, bypass watercourses, fish ramps, and other structures, is to be financed via an electricity surcharge of 0.1 cents per kilowatt hour. Thus, in keeping with the "user pays" principle, the costs of these measures are to be borne by the consumer (Kampa, et al, 2011).

The links and interdependencies of both legal acts with the EPI are given and explained in the table below:

Table 3-4: Link between the EPI and legal system.

EPI: Objective	Economic objective: To have a reliable and objective certification scheme that is trustfully accepted by the costumers and ensures fair competition on the market Ecological objective: the improvement of local river conditions	
	EPI delivery mechanism	
	Delivery mechanism 1: Basic criteria	Delivery mechanism 2: Eco Investment payment
Energy Act	+/- The eco-payment sets an additional incentive to support renewable energy which uses the customers' willingness to pay beyond legal requirements. However, with the forthcoming liberalisation of the Swiss energy market energy, prices are expected to drop, which might hamper the implementation of the EPI, as customers will only react to low price signals.	

<table>
<tr><td rowspan="2">Water Protection Act</td><td>+++
The basic requirements go beyond the legal requirements of the Act, as the basic certification criteria also focus on management issues and not only on constructive ones. The label also supports the implementation of restoration measures at an earlier stage as they would be foreseen by the legal Act (which requires them only at the end of the concession).</td><td>+++
The payment supports hydrological mitigation and restoration measures to tackle the impacts of hydropower. The label also supports the implementation of restoration measures at an earlier stage as they would be foreseen by the legal Act (which requires them only at the end of the concession).</td></tr>
<tr><td colspan="2">However as there is an overlap between the standards required under the Water protection Act and those of the EPI, the entry point for certification is lower.</td></tr>
</table>

Notes: + represents a positive synergy between the objectives of the EPI and the other policy; 3 levels: + (low positive interaction), ++ (medium), +++ (high positive interaction), 0 represents no discernible interaction, - represents a negative effect between the objectives of the EPI and the other policy; 3 levels: - (low negative interaction),-- (medium),--- (high negative interaction)

3.7. Uncertainty

There were no clear quantified targets set for the EPI on the Swiss level. This refers to economic targets as well as for environmental objectives. This can be explained by its voluntary nature. Therefore, it is difficult to assess the uncertainty. Filling the pedigree diagram, the following picture can be drawn:

Table 3-5: Pedigree table addressing uncertainty

	Policy target (how much)	Policy deadline (when)	Reference
Green hydropower	No information	No information	No information
Pedigree	(3)	(3)	(2)

Policy target: (1) quantifiable and clearly stated, (2) measurable in principle, qualitative levels of achievements (e.g. weak, substantial), (3) vague and hardly quantifiable.

Policy deadline: (1) clearly stated; (2) stated in qualitative terms (short, medium, long term); 3) no statement

Reference: (1) clearly stated in quantitative terms and with specific reference; (2) not stated

On the plant level the targets are set individually. In this context, two main uncertainties exist:

- Uncertainty related to the environmental performance of certain mitigation measures applied at the plant level: effectiveness of hydrological mitigation measures was mentioned one of the biggest concerns in a recent expert workshop on hydropower and the WFD (Kampa, et al 2011).
- There is no uncertainty related to recertification. If a hydropower plant is certified once, it remains certified (VUE, personal communication).

4. Conclusions

The assessment of the Swiss EPI on green hydropower has clearly some strengths and weakness. While the rational for the EPI, its development process, and the environmental and educational impacts are rather well documented and analysed, other aspects such as transaction costs, economic impacts, and issues of social equity are not. This can be explained by the fact that the developers of the EPI have published quite a lots of papers, but no external review was performed so far. With regard to the environmental and educational outcomes, the VUE has also published quite some material for marketing reasons. Another reason for this asymmetric information availability is the fact that transaction costs, economic impacts, and issues of social equity are not so important from a business point of view and therefore not considered as much by practitioners working on a day-to-day basis with the EPI. These limitations of the assessment have to be taken into account when reading the following conclusions, which are clearly based on a limited set of information.

The green hydropower certification scheme can be seen as a successful instrument. Even if the uptake by the sector is limited (3% of the total hydro power production), it has found its place in the market. Second, the concept is considered in other places (see King, et al, 2007) of the world as well and often used as a good example in the ongoing discussions about implementation of the WFD across Europe (see, e.g., Ecologic, 2007; Vovk-Korže et al., 2010). In the latter it is stated: "*The most comprehensive and in depth* ("sic") *set of best practices for hydropower sustainability carried out at European level is probably that included in the Greenhydro procedure for hydropower certification, later adopted by the label Naturemade*".

4.1. Lessons learned

The main lesson learned from the case study is the fact that economic interests and ecological concerns can be combined in one voluntary instrument. In other words, it is possible to combine the demands of different actors and stakeholders in the electricity market and thereby:

- Guarantee quality
- Label of sustainable electricity and electricity from renewable energy sources
- Improve the status of the environment on a broader level (basic requirement) but also consider specific local environmental issues (eco-investment payment)
- Establish a competitive advantage for "greener" electricity from renewable energy sources compared to electricity from other renewable (e.g., non-certified hydropower) and non-renewable energy sources (e.g., petrol).

In the context of EPI-Water, the following lessons for work package 2 are that the assessment framework does not take into account all types of EPIs assessed. Some of the questions and indicators are not applicable or are difficult to translate to the current situation (e.g., issues of social equity). It would be good to consider these problems in detail when developing the framework further.

4.2. Enabling / Disabling factors

The main enabling factor for this EPI is the fact that environmental stakeholders and energy producers agreed to used scientific criteria to develop an instrument that provides a win-win situation for both sides. After a two-year discussion process, which aimed to achieve a consensus between different economic and political actors in the electricity business, the VUE was created to respect the interests of both sides.

Using scientific criteria as a basis for certification and making them publicly available to energy consumers is also recognised as a factor that ensured the public acceptance and uptake of the label (VUE, personal communication).

These criteria determine the basic ecological standards for green electricity and reflect the direct impact of HPP on river ecosystem and its riparian landscape. In order to determine more easily these relationships, the criteria were structured in a simple way. Five management fields describe operational issues of construction relating to HPP, and five environmental fields were selected to cover most important aspects relevant to ensuring the ecological viability of a river ecosystem. This approach ensures transparency and clarity for non-environmental experts.

Another important enabling factor is the certification process itself. On one hand, it allows an early assessment of the economic viability of a certification case. On the other hand, it also contains the public participation mechanism which should ensure that the measures taken are accepted by the affected stakeholders.

The simple concept and the scientific criteria, which can easily be adapted to other ecosystems in the world, make this EPI easily transferable. Ruf and Bratich (2007) have shown that the EPI also complies with the requirements of the EU Water Framework Directive, which is the main water legislation in Europe. However, a precondition for a successful transfer is the willingness of the energy sector and the environmental stakeholders to cooperate.

5. References

Ahrne, G., Brunsson, N., Tamm Hallstrom K, 2007. *Organizing organization*

Bär, O., 1973. *Geographie der Schweiz*

Bartich, C. and Truffer, B. 2001. *Green Electricity certification for Hydropwer Plants Concept, Procedure, Criteria* – Green Power Publications Issue 7, ISBN 3-906484-06-4

Bratrich, C., Truffer, B., Jorde, K., Markard, J., Meier, W., Armin, P., Schneider, M., Wherli, B. 2004. *Green Hydropower - A new assessment procedure for river management*, available at http://homepages.eawag.ch/~wehrli/papers/Bratrich_GreenHydro_RiverRes_04.pdf

Bundesamt für Energie, 2011. *Stand der Wasserkraftnutzung in der Schweiz am 1. Januar 2011*, available at http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_237113070.pdf&endung=Stand%20der%20Wasserkraftnutzung%20in%20der%20Schweiz%20am%201.%20Januar%202011

Bundesamt für Statistik and Bundesamt für Umwelt, 2011. *Umweltstatistik Schweiz in der Tasche 2011.*

Bundesamt für Statistik, 2010. available a http://www.bfs.admin.ch/bf

Bundesgesetz vom 23. März 2007 über die Stromversorgung (Stromversorgungsgesetz, StromVG)

Dasen, G., 2011. *Statistik der Wasserkraftanlagen der Schweiz*, available at http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_811816381.zip&endung=Statistik%20der%20Wasserkraftanlagen%20der%20Schweiz

Eawag, 2009. *Wasserversorgung 2025 – Vorprojekt*. available at http://www.bafu.admin.ch/wassernutzung/02792/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCFe4N5fmym162epYbg2c_JjKbNoKSn6A--

EAWAG, 2001. *Ökostrom-Zertifizierung für Wasserkraftanlagen - Konzepte, Verfahren, Kriterien*

Ecologic, 2007. *Water Framework Directive & Hydropower*, Issues Paper for the Common Implementation Strategy Workshop, Berlin, 4-5 June 2007, http://www.umweltbundesamt.de/wasser/themen/downloads/issue_paper.pdf

Ewz, n.y. Ökostrom aus Wasserkraft. Die ewz Kraftwerke an der Limmat

Fuhrer, J. 2010. *Abschätzung des Bewässerungsbedarfs in der Schweizer Landwirtschaft*, available at http://www.blw.admin.ch/dokumentation/00018/00112/00504/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCEdn17fWym162epYbg2c_JjKbNoKSn6A--

Gleick, P. 2011. *The World's Water Volume 7 - The Biennial Report on Freshwater Resources*

Kampa, e.; Weppen von der, J.; Dworak, T., 2011. *Water management, Water Framework Directive & Hydropower* - Common Implementation Strategy Workshop, Brussels, 13-14 September 2011 -Issue Paper

Kiefer, B. (n.y): *Creating an Eco-label for Electricity in Switzerland – The Art of mediating between diverging interests*

King, P., Bird, J., Haas, L. 2007. *The Current Status of Environmental Criteria for Hydropower Development in the Mekong Region - A Literature Compilation*

Markard, J., Rothenberger, D., Truffer, B. 2000. *Analysing market mechanism of third party eco-labelling: The case of Green Power certification*. European society for ecological economics (ESEE), 3rd biennial conference, Vienna.

Ruf, A. and Bratrich, C., 2007. Integration of the EU´s Water Framework Directive and the greenhydro Standard. Improving the Aquatic Environment in River Systems affected by Hydropower Generation, Eawag, 8600 Duebendorf, Switzerland, available at http://www.greenhydro.ch/veroeffentlichungen/greenhydro_WFD_final_May07.pdf

SAEFL, 1998. *National Report to the Convention on Biological Diversity*, available at http://www.cbd.int/doc/world/ch/ch-nr-01-en.pdf

Spreafico, M. and Weingartner, R., 2005. *Hydrologie der Schweiz Ausgewählte Aspekte und Resultate* Berichte des BWG, Serie Wasser – Rapports de l'OFEG, Série Eaux – Rapporti dell'UFAEG, Serie Acque Nr. 7 – Bern 2005, available at http://proclimweb.scnat.ch/portal/ressources/109.pdf

Bundesversammlung der Schweizerischen Eidgenossenschaft, 2011. *Bundesgesetz vom 8. Oktober 1999 über die Reduktion der CO2-Emissionen (CO2-Gesetz)* In English: *Swiss Federal Energy Act.* available in German at: *http://www.admin.ch/ch/d/sr/641_71/index.html*

Gugerli, D. 1997. *Redeströme. Zur Elektrifizierung der Schweiz 1880–1914*. Chronos. Zürich.

Truffer, B., Bratrich, C., Markard, J., Armin, P., Wuest, A. Wehrli, B. 2003a. *Green Hydropower: The contribution of aquatic science research to the promotion of sustainable electricity* available at http://homepages.eawag.ch/~wehrli/papers/98_03/Truffer_GreenHydro_AqSci03.pdf

Truffer, B., Bratrich, C., Markard, J., Armin, P., Wuest A., Wehrli, B 2003b. *Green Hydropower: The contribution of aquatic science research to the promotion of sustainable electricity*, in Aquatic Sciences Vol. 65, 2003 available at http://homepages.eawag.ch/~wehrli/papers/98_03/Truffer_GreenHydro_AqSci03.pdf

Verein für umweltgerechte Energie (VUE) 2009. *naturemade scale of fees - For electricity, heat/cooling energy and bio-methane*

Verein für umweltgerechte Energie (VUE), 2011. *Jahresbericht 2010*

Vovk-Korže, A, Korže, D., Goltara, A. Conte, G., Toniutti, N. Smolar-Žvanut, N. 2010. Review of best practices/guidelines for compensation measures for hydropower generation facilities, available at http://www.ch2oice.eu/download/public/CH2OICE_D2-2.pdf

The Federal Assembly of the Swiss Confederation, 2011. *Bundesgesetz vom 24. Januar 1991 über den Schutz der Gewässer (Gewässerschutzgesetz, GSchG)* In English: *Federal Act of 24 January 1991 on the Protection of Waters (Waters Protection Act, WPA)*, available in German at http://www.admin.ch/ch/d/sr/814_20/index.html

Wüstenhagen, R., Markard, J., Truffer, B., 2000. *Green Electricity in Switzerland Insights in market development and eco-labelling*. -Paper prepared for the conference on "Consumer-driven green electricity in competitive electricity markets", Copenhagen, May 22-23rd, 2000

6. Interviews

Personal Interview with Rita Gnehm Wohlwend and Ursula Stocker (VUE naturemade) 22.11.11

Personal Interview with Gerhard Emch (EWZ) 05.12.11

7. Annex 1: Ecological criteria

See
http://www.naturemade.ch/Dokumente/zertifizierung/GreenHydro/Issue_7_English.pdf
See Part III

8. Annex 2: Example of a costs estimate for the certification of green hydropower.

See
http://www.naturemade.ch/Dokumente/zertifizierung/GreenHydro/Issue_7_English.pdf
See page 107