Extended Abstract:

"ÖKOSTROM": A MULTIDISCIPINARY PROJECT TO REDUCE ENVIRONMENTAL IMPACT OF HYDROPOWER GENERATION

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Introduction:

Since the early 1990s, electricity generated in an ecologically sound manner has been available on the market as so called "green power" products or "ÖKOSTROM". As a result of deregulation "green electricity" is meeting with growing demand in the USA and Europe. At present, however, there is still a lack of credible guidelines for the certification of such products. Furthermore, "green electricity" that has been on offer so far has tended to concentrate predominantly on the "new renewables", such as solar, wind and biomass production. The utilisation of hydroelectricity is either generally excluded from "green offers" or it is not treated in a reliable way [1]. Most of the existing concepts for a certification of "green hydropower", meet global terms for an ecological power production. But often the local impact on river systems is not considered and the applied criteria (i.e. power limitation or limitation on construction date) are not founded on ecological facts. Because of this lack of consideration of local environmental impacts, the Swiss Federal Institute for Environmental Science and Technology (EAWAG) started to develop a new concept for a "green hydropower" certification. To support this concept scientifically and with a broad data base a multidisciplinary research project called "ÖKOSTROM" started in 1998 [2]. The scientific objective of this project is to investigate key factors of hydropower production under ecological, economical, political and social aspects. Considering these impacts, the final result will be a certification procedure for "green" or "low impact hydropower" that reduces both: global and local impacts of hydropower production. In the following an overall view of the certification procedure will be given as well as an introduction to some of the associated projects.

"Green Electricity"

The general support mechanism of "green electricity" is quite simple: As the concern for environmental problems increases within the society, more people are willing to pay higher prices for electricity, produced under low ecological impact conditions [3, 4]. Usually this extra money is used to build up new facilities (Fig. 1). Considering solar, wind or biomass production, the extension of renewable capacities supports obviously an increase of sustainable energy production. In opposite to this, there is a need for an alternative support mechanism in the case of hydropower production. Since in the industrialized countries of Europe and North America as much as 53% and 46% of the technical potential of hydropower is already utilized [5], a sustainable electricity system should not mean to build up new hydropower plants. Especially the situation of alpine ecosystems underlines this request. Taking the Swiss situation as an example the situation becomes more clear: more then 80% of the technical potential for hydropower production is already used and about 60% of inland electricity generation is produced in hydropower plants. The effects on the ecological integrity of many alpine river systems are dramatic. Natural or at least free flowing rivers systems have disappeared almost totally. Therefore we propose extra money, paid for “green hydro” should mainly be used to reduce or compensate local impacts in *already* degraded river systems.

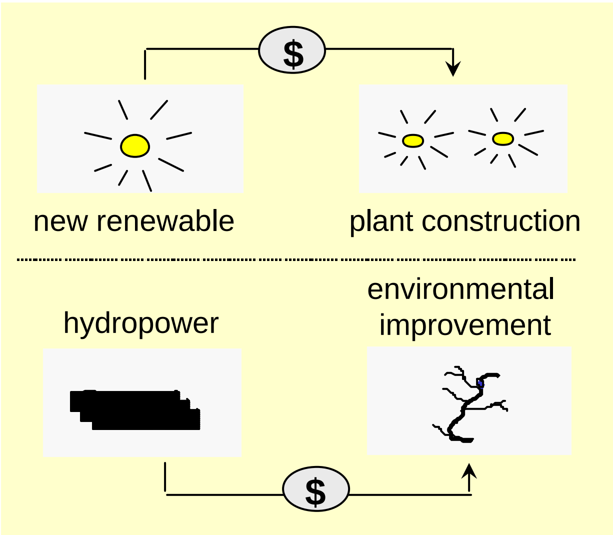

Fig. 1: Support mechanisms for “green electricity”: Usually extra money paid for “green electricity” is used to build up more renewable capacities (solar, wind or biomass production; *upper part*). In contrast to this, extra money paid for sustainable hydropower production should be used to reduce or compensate local impacts caused by existing power plants *(lower part)*.

The Swiss Concept for the Certification of “Green Hydropower” Plants

Regarding existing conditions for “green hydropower” production (Table 1) a common dilemma becomes apparent: Most of the models already used in certification praxis meet the global terms for ecological power production, such as low emission of greenhouse gasses or air pollutants. In contrast to this most of the “green power” labels do not consider any local impact. Defining some simple criteria, (1) hydropower is accepted as “green” in general, (2) only small hydropower plants are considered as “green” or (3) only already existing schemes are allowed to sell their energy for a higher price respectively. However sustainable energy production has to include local impacts as well. Therefore we propose a new classification and certification system especially adapted to “green hydropower” use. According to this classification system each single power plant should meet the following two major criteria: firstly, so called “basic requirements”, to reach a minimum of ecological integrity within the influenced river systems. And secondly additional payments, so called “eco-investments”, from “green power customers” must be invested permanently in environmental improvements in a transparent way.

Table 1: Overview of the well-known requirements for “green hydropower” production, used in some international eco-labeling procedures (own data and modified form [7,8].

Eco-Label (Name, Land and introduction date)	**Requirements for “Green Hydropower Production”**
“Bra Miljöval” Sweden (1995)	*Limitation by construction date:* All facilities accepted that are built before 1995
“SEDA” Australia (1996)	*Limitation by construction date:* Already existing schemes accepted, but no new facilities.
“ECO-Logo” Kanada (1997)	*Power limitation:* All facilities smaller then a maximum capacity of 20 MW are accepted
“Green-e” USA, (1997)	*Power limitation:* All facilities smaller then a maximum capacity of 30 MW are accepted. Some ecologically based criteria are in revision presently [9].
“TÜV” Germany (1999)	*No limitation for hydropower:* All hydropower is accepted to be “green”, however the label includes a support mechanism for new renewables.
“EcoLeader of ReEnergy” Switzerland (under construction)	*Limitation by local environmental impacts:* Certification includes improvement measures to reduce environmental impacts of hydropower production in local catchment sides and river systems.

Certification Procedure for “Green Hydropower” Plants

These two requirements have been transformed into the following four-step procedure for attributing an eco-label to hydropower plants (Fig. 2).

Firstly, within a ***“overview study”*** baseline requirements for “green hydropower” have to be met. These requirements are related to the notion of “ecosystem integrity” and include for instance the potential for natural reproduction of fish, the maintenance of groundwater connectivity and the ecological integrity of protected landscapes, such as wetlands. By defining basic criteria, comparability of the environmental quality between different hydropower plants in different regions may be achieved. Furthermore, it guarantees that no “black sheep” invade the market and create negative publicity for the product. The basic requirements shall be applied in a very rough procedure carried out by a small team of experts in a short time. Basic requirements focus on the ecological impacts of minimum flow, hydropeaking, storage and sites.

Secondly, transparency of the use of additional payments from “green consumers” is achieved by determining a locally adapted set of mitigation measures. These measures should achieve an optimal environmental benefit for the given amount of money, the “eco-investments”. The measures will be identified within a ***“detail study”***. On the basis of a systems overview, single catchment areas will be evaluated. The estimation includes fish and benthos ecology, analyses of water quality and temperature, as well as investigations of sediment transport, suspended particles and groundwater dynamics. Here, sites for potentially profitably measures will be identified. Computer models for discharge, temperature and habitat simulation are used for a locally adapted mitigation program. In the end, a list of mitigation measures will be developed and each measure will be valued by its contribution to various measures to improve the ecosystems’ integrity and the cost of the measure. Potential measures are: dynamically adapted minimum flow regimes, restoration of natural river beds, controlled reservoir flushing, damped forms of hydropeaking, but may also imply the protection of some not yet used rivers.

The third step of the certification procedure includes a ***"decision-making process"***. The selection of an optimized set of measures shall be carried out in the context of a participatory decision process, involving the major local stakeholders of the area. The decision board could be constituted of hydropower plant operators, environmental organizations, government officials, local communities, fishery associations and the like. A priority ranking with mitigation measures will be the final result. The number of measures will be constrained by a determined amount of "eco-investment money" which could be given as a fixed difference in price for the kWh produced. By following such a participatory decision process, local acceptance of the investment could be achieved and a broader set of valuation criteria may be taken into consideration. Thus, the social and economic dimension of sustainability will be taken into account besides the environmental dimension.

If the stakeholders come to an agreement on how to use the eco-investments, an independent organization can finally check the stakeholders suggestions for their ecological credibility. If the proposal meets all ecological requirements mentioned above, then the ***"certification"*** in the narrow sense of the word can be realized.

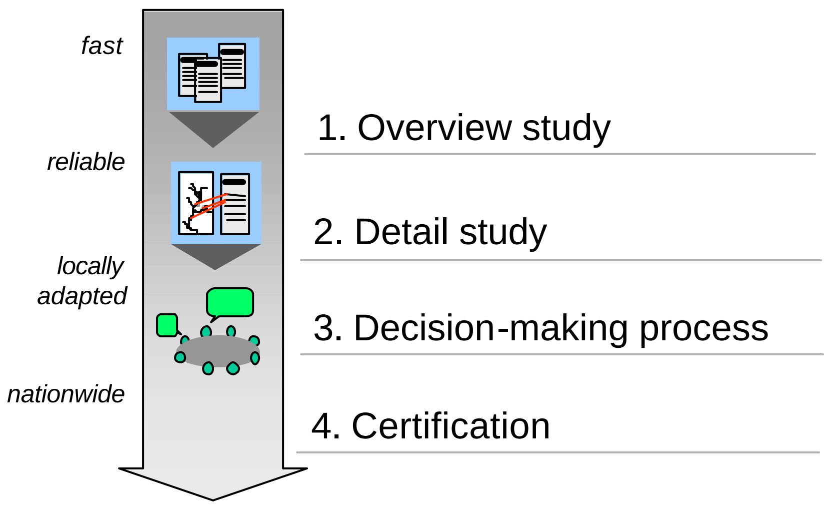

Fig. 2: Swiss concept of a four-step procedure for the certification of "green" hydropower plants.

The multidisciplinary project ÖKOSTROM

During the last years, "green pricing" experiments received a lot of attention and were in general quite successful. Studies of the market potential for "green power" show that about 20% of the private households would be ready to pay a price of 20% or more above the current electricity prices [10]. However, it has been shown that credibility of the products is the key factor for a successful marketing [4]. Considering both, global *and* local impacts of hydropower use, a need for scientifically based criteria becomes obvious. In order to develop a credible certification procedure, EAWAG started a multidisciplinary project on this topic. Almost 20 research projects are coordinated in four working groups:

- The *assessment group* is working on the conceptual procedure for a certification of "green hydropower" plants.

- The *residual water* group is concentrating on determining environmentally sound minimum flow regulations.
- The *floodplain group* is focusing on the amount of water a floodplain needs to sufficiently maintain its basic ecological function.
- The *marketing and politics group* is investigating the basic questions of management and energy policies for a successful launching of the product "green electricity" on the market.

The research activities cover the entire spectrum from the development of the certification process to market analyses to research on fish and benthos biology; from chemical and morphological surveys to simulations of discharge and habitat suitability. The empirical work is concentrated on a catchment area of the Brenno river (Southern Switzerland). In spite of the diverse investigations each group's results support not only the contents of the individual research but contribute actively in the development of the certification procedure - this being the really new aspect of this multidisciplinary project. In the following lectures a representative selection of the activities will give a more detailed impression of the present state of the scientific investigations:

1. A systems overview of the morphology and fish biology providing an indication for ecological improvement potentials in the catchment area of the Brenno.
2. Groundwater data which show the importance of aquatic habitats for biodiversity of alpine floodplain dynamics.
3. Data on the temperature regime, benthos and fish biology which permit the use of simulation models for determining environmentally sound minimum flow regulations.

References

[1] Bratrich C., B. Truffer & K. Jorde (1999): *Neue Perspektiven der Wasserkraftnutzung;* Wasserwirtschaft (in press).

[2] Truffer, B., J. Bloesch, C. Bratrich & B. Wehrli (1998): *“Ökostrom”: Transdisziplinarität auf der Werkbank*. GAIA 7(1), 26-35.

[3] Farhar, B.C. & H.H. Ashley (1996): *Willingness to pay for electricity form renewable energy.* National Renewable Energy Laboratory, Golden Colorado. September 1996.

[4] Truffer, B. (1998): *Market potentials for green power products.* In: Proceeding of the Greening of Industry Network Conference, Rome, November 15th-18th.

[5] Fouquet, R. (1998): *The United Kingdom demand for renewable electricity in a liberalised market.* Energy Policy, 26(4), 281-193.

[6]Gleick, P.H. (1993): *Water in crisis*. New York, Oxford University Press.

[7] Buhl, T., M. Cordes-Kraft, C. Cornejo, J.-M. Degen, E. Sandmeier (1998): *Ein Zeichen setzen: Das Ökostromlabel*. Diploma Thesis, University of Zurich, Nachdimplomstudium Umweltwissenschaften.

[8] Twidell, J.W. (1999): *Grüner Strom auf Großbritaniens offenem Strommarkt.* In: Der Markt für grünen Strom. EOROSOLAR (Ed.), 38-44.

[9] American Rivers & Green Mountain Energy Resources (1999): *Low Impact Hydropower Certification*. Draft for Public Comment. South Burlington VT, Washington DC.

[10] Wortmann, K. 1996. *Grüner Tarif - Klimaschutz durch freiweillige Kundenbeiträge zum Stromtarife. Akzeptanz, Umsetzung, Verwendung.* Energiestiftung Schleswig-Holstein, Studie 2, Kiel, June 1996