Research activities of Verbund with regard to the Water Framework Directive of European Union

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Introduction

Verbund, Austria's leading electricity producing company was founded in 1947. It provides about 50 % of Austrian power requirements by means of its 108 hydro-electric and 4 thermal power plants. The turbine output of hydro power plants is 6.971 MW and the yearly production reaches 27.601 GWh. The four thermal power plants have a turbine output of 1.145 MW. Approximately 90 % of Verbund´s electricity comes from hydro power on an annual basis.

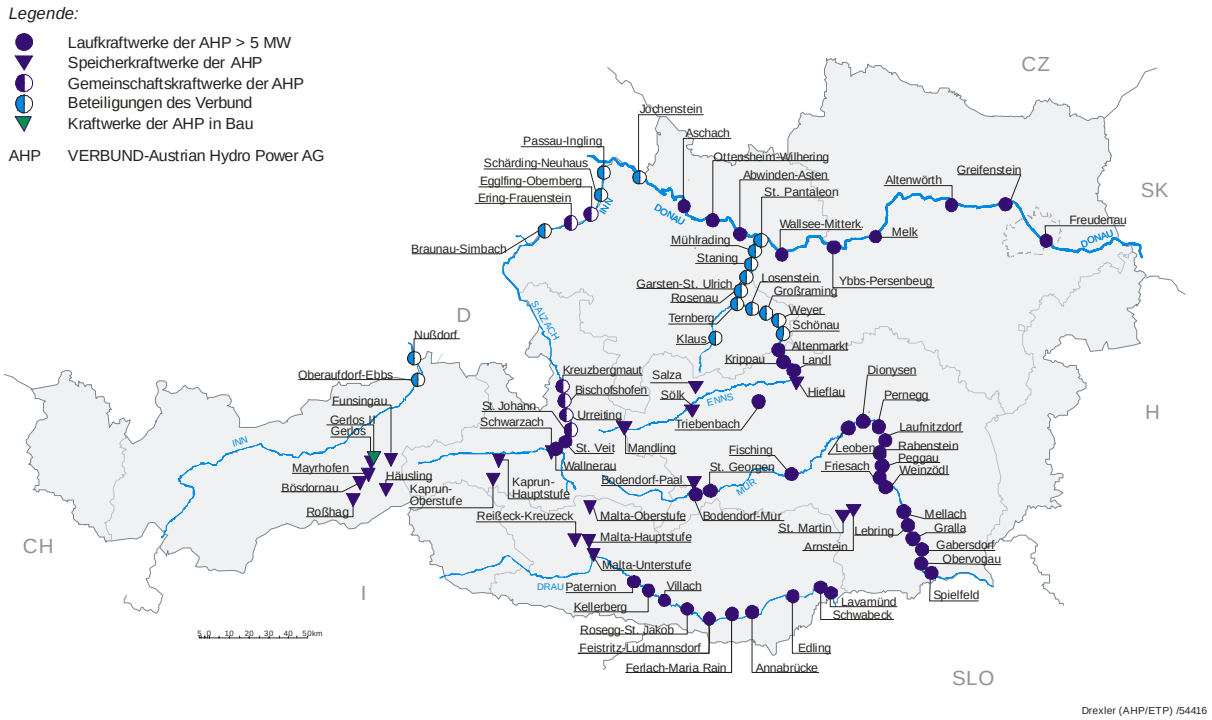

Fig. 1. Hydro power plants of Verbund (greater 5 MW)

VERBUND-Austrian Hydro Power AG (AHP) is the subsidiary of VERBUND, which operates hydro power plants. With its 90 hydropower plants (69 run-of-river plants and 21 storage power plants), AHP has a turbine output of 6.023 MW and produces about 22.800 GWh a year. Half of them are produced in 9 run-of-river plants at Danube River, the most important river in Austria.

Thus, AHP is the largest Austrian producer, by far, of environmentally friendly electricity from hydropower. The power plants are situated in the provinces Carinthia, Upper Austria, Lower Austria, Salzburg, Styria, Tyrol and Vienna.

The electricity is generated with the greatest possible consideration for the environment. Thus, scientific investigations, especially in aquatic and semi-aquatic living space, have a

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long tradition in Verbund. These investigations get a new dimension in 2000, when the Water Framework Directive of European Union (EU-WFD) was putting into effect.

The Water Framework Directive of european union (EU-WFD)

The EU-water framework directive (EU-WFD 2000) from the 23rd of October 2000, was implemented into national right in 2003. It aims to reach at a throughout Europe comparable level a „good ecological status" of our water bodies up to 2015, besides, also exceptions are discussed for some rather specific situations.

The consequences on the Austrian water power use will depend on

- in which extent water bodies are expelled as " heavily modified water bodies " (HMWB) and
- how demandingly the criteria are formulated for the reaching of the " good ecological status " as well as the " good ecological potential " in the relevant national ordinances.

Possible operation and production restrictions for water power users result from the following ecological deficits in network of running waters:

- the continuum of the lotic network
- effects of water extraction
- impacts of "hydro-peaking"

In Verbund, together with authorities and national communities of interests, estimations to minimize the influences were carried out. In following will be shown, what initiatives were taken place and what advances Verbund could bring into the actual discussions. With presentation of studies and pilot-projects the efforts under regulations of EU-WFD were documented, to minimize the effects to guarantee the further full operation of power plants, especially at Danube river system.

Consequences

The constructions fulfil beside her most original task – the production of regenerative electric energy from water power – within the scope of their multiple purposes other essential tasks, as for example a unsubstantial contribution to flood control or to the improvement of navigation. Additionally, numerous infrastructural facilities have been constructed with the power stations, like water supplies, sewerage facilities, traffic developments as well as landscape architecture for recreational purposes. Also a high value was always attached to the consideration of ecological and landscape values in connection to the project realization.

All together the Verbund is using about 1,100 km of Austrian running waters. The usable volume of the reservoirs for power production amounts with a maximum water surface area of about 15.6 km² about 692 mil. m³. The residual flow distances downstream the barriers reach in length about 232 km. Approx. 73 km are influenced by hydro-peaking.

About 870 km of running waters are influenced by run-of-river power stations. Of these areas bout 639 km are converted to reservoirs, 142 km are impacted by river bed degradation, 99 km are residual flow stretches and 21 km are altered by other impacts, such as hydro-peaking.

These figures make clear that the introduction and implementation of the WFD will have massive effects on the AHP and the business environment. Nevertheless, the AHP was and is encouraged to meet actively the challenges of the WFD.

Cooperative initiatives

Within the scope of the stakeholder processes, the need was formulated for an investigation of the energy-economic consequences of the WFD on the Austrian economy of electricity production. Besides, the achievement of the defined ecological targets of the WFD should be compared with the sustainable use of the national water power. Prof. Stigler (Technical University Graz) was in charge to do the research according to these requirements.

In form of a scenario model the consequences of different residual flow and flood water regulations were examined and valued. Also the financial expenditure for the measures to establish the flow continuum again was estimated. The results of the study (Stigler et al. 2005) in which the AHP introduced extensive base data material were presented in autumn, 2005 to the general public.

The essential results are:

The nation-wide re-establishment of the **flow continuum** could require investment costs up to 234 mil. €.

The **residual flow stretches** concerns exclusively run of river plants with diversion channels (10 – 32% small water power plants, 5 – 20% large run-of-river plants (> 10 MW) and 3 – 10% storage power plants).

With regard to the **whole water power production** the possible losses of mean annual output might be between 2 and 7%.

A special problem above all from view of the supply security shows the subject of the operational **reduction of hydro-peaking** in storage power stations. Single plants could lose up to 87% of their control and reserve capacity.

The study should support to find an ecological-economic optimization for the implementation of the WFD with which the most significant primary energy source of Austria will be obtained, while also the environmental requirements are reached and thus, a sustainable management of the water bodies is guaranteed.

Strategies of the AHP

How does the AHP meet now this possible time-target conflict to minimize the consequences on the production capacities? Which alternatives exist? Does the principle of the commensurability find its application?

The AHP always placed on an optimized operation and a sustainable maintenance of its facilities. Applied innovations as well as ecological and economic optimization of each plant contributed to the positioning of the water power as an “ecologically friendly” form of energy. Recent developments and knowledge are implemented in collaboration with universities, research institutions and other partners to meet actively the challenges of the market.

recent activities

Applied research

From view of the WFD are the following applied research areas important:
- Improvement of the environmental impact or consequences on humans, fauna and flora as well as
- Improvement of operational optimization and energy efficiency.

Today, numerous results can be introduced in the running discussions, above all the results of specific research projects focused on ecology which support the clarification of knowledge deficits as partial aspects within the scope of the necessary monitoring programmes. The recent investigations which are to be assigned to the research fields of hydromorphology in relation to biotic indicators dealt with

- the macrophyte development in artificial shore line structures (Janauer & Schmidt 2005),
- benthic microcrustaceans benthischen Mikrocrustaceen (Gaviria-Melo & Waidbacher 2006)
- the function of fish migration facilities (Eberstaller et al. 2001, Petz-Glechner & Petz 2002)
- ecosystem studies of whole power plant areas (Petutschnig et al. 2002)

Running projects about improvements of fish populations or mappings of the water molluscs are to be assigned to the same subject area, as well as the sediment management in reservoirs or the river basin management of a closed chain of hydro power stations.

Re-establishment of the flow continuum

For fish and zoobenthos are dams or weirs interruptions flowing continuum. These migration obstacles are also limitations for achieving of the good ecological potential of reservoirs. Therefore, the restoration of the flow continuum is one of the substantial demands of the WFD.

Within the recently established run of river power station projects fish migration facilities were already built as a fixed project component. Accompanying investigations delivered interesting results, not only about the functionality, but also valuable knowledge and planning support for future project realizations (Eberstaller et al. 2001, Petz-Glechner & Petz 2002). This knowledge on optimized fish migration facilities for example will used for the following projects: run of river power station in Leoben at the River Mur or for the planning of the plant along the Salzach in Werfen/Pfarrwerfen.

A by far larger challenge is the continuum re-establishment within existing hydro power plants, because these measures intervene with existing infrastructures and installations. Here, the only approach is to develop individual solutions. During the past years on this basis several hydro power stations along the River Mur have been equipped with fish bypasses and at the moment projects are under the way for the stretches of the lower River Mur and the River Drau.

At the moment the realization of a fish migration facility is built at the Danube run of river power station Melk, which is realized as a part of the EU project LIFE „ Interlinking the Danube and the Ybbs River“ in cooperation with the ministry for water, agriculture and environment. This project has construction costs of 2.2 mil. € (50% financed by EU within the LIFE II program) and is an important measure for the future achievement of the WFD. The fish migration facility is designed as a bypass channel connected to a backwater. An accompanying monitoring program until 2009 will deliver new insights in the fish migration behavior for the 80 km long permanently connected bypass channel.

Summary

The efficient implementation of the WFD is an explained purpose of the Austrian water policy. River basin management plans will fix how the target conditions of each river basin are to be reached. From energy-economic standpoint substantial interventions will bring above all the restoration of the flow continuum, reduction of hydro-peaking and changes in the residual flow condition also for the production capacities of electricity.

The implementation of the EU-WFD is a process which will significantly impact hydro power operators, such as Verbund, in the coming decade. The first implementation steps concerned the leading positioning in national, but also international committees. Farsighted research projects for the processing of knowledge deficits, above all in the area of river geomorphology and aquatic habitats are to be called further initiatives. The realization of measures already fulfilling future requirements also contributes to improve existing knowledge. These foresighted activities will lead to a valuable knowledge gain for the future implementation, especially under time confined conditions.

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