Enhancing transparency in hydropower development– a strategic approach to balance conflicting aims of energy provision and conservation

L'amélioration de la transparence dans le développement de l'hydroélectricité - une approche stratégique pour concilier les objectifs contradictoires de fourniture d'énergie et de conservation

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RÉSUMÉ

L'hydroélectricité est considérée comme une source importante d'énergie renouvelable. Toutefois, elle est également associée avec des dégradations des écosystèmes, compromettant ainsi les objectifs de la Directive-cadre sur l'eau (DCE) et de la Directive sur les habitats. Sur la base de la Directive européenne sur les énergies renouvelables, la stratégie énergétique autrichienne a défini des objectifs pour accroître la production de l'hydroélectricité de 3.5TWh d'ici 2015. Un outil d'aide à la décision a été développé pour identifier les projets d'hydroélectricité à fort potentiel économique offrant le moins de conflits en matière de conservation sur les sections en question. Les résultats ont montré qu'en Autriche, il n'existe qu'un petit nombre de projets hydroélectriques sans conflits de conservation. La mise à niveau des installations hydroélectriques est prévue en ciblant les impacts écologiques les plus faibles, alors que les réservoirs d'hydroélectricité sont préférés aux centrales hydroélectriques. Les projets de taille plus réduite ont été évalués comme moins attrayants et très en conflit avec les besoins de conservation. L'instrument mis au point pour les décisions futures dans l'expansion de l'hydroélectricité pourrait contribuer à une méthode transparente d'harmonisation des besoins de fourniture d'énergie et de protection des paysages fluviaux écologiquement sensibles et de leurs biotes.

ABSTRACT

Hydropower (HP) is considered as an important renewable energy source. However, HP is also associated with ecosystem degradations which jeopardize the aims of the EU Water Framework- and Habitats Directive (WF-D, FFH-D). Based on the EU Renewable Energy Directive (RES-D), the Austrian Energy Strategy defined goals to further increase HP production by 3.5TWh until 2015. A decision support tool was developed to identify those hydropower projects (HPPs) with high economic potential combined with least conservation conflicts for the river stretches concerned. The results showed that, in Austria, only a minor number of projects is without conservation conflicts. Upgrading of existing HPPs was associated with least ecological impacts, while HPPs with reservoirs are favoured against run-of-river plants. Small projects were evaluated as least attractive but were highly in conflict with conservation needs. The instrument developed for future decisions in hydropower expansion might contribute to a transparent way of harmonizing the needs of energy provision and protecting ecologically sensitive riverine landscapes and their biota.

KEYWORDS

Decision support, hydropower, Renewable Energies Directive, Water Framework Directive

1 INTRODUCTION

Running waters in Europe are under severe stress. Hydro-morphological alterations due to hydropower production and flood protection measures can be addressed as the key pressures already for decades. In Alpine countries about 70-90 % of the hydro-electrical potential is already used. The remaining potential can be found at the still unutilized river stretches, which often are close to a natural state and which have - at the same time - become increasingly rare (e.g. Muhar et al. 2000). Due to the unexploited hydroelectric potential of rivers on the one hand and the important value of the remaining healthy aquatic ecosystems on the other hand, the generation of hydropower results in a conflict of interests between the use of renewable energy and the protection of the aquatic environment. This in particular becomes important as the European Renewable Energy Directive (RES-D; 2009/28/EC) came into force in 2009 and defines as key objective to increase the share of energy from renewable sources until 2020. Since then, numerous hydropower plants have already been built in Austria or are under construction and about 100 additional projects are planned. On the other hand, the EU Water Framework Directive (WFD; 2000/60/EC) aims for the “good ecological status” of water bodies across Europe until 2015-2027. Therefore, the need of an integrative approach to allocate “favourable” and “not favourable” sites for the upcoming hydropower use became obvious

2 METHODS

The aim of our study was to develop a strategic instrument to identify those hydropower projects with the highest energy economic value combined with least conservation concerns. We collected information on 102 planned hydropower plants all over Austria. The hydropower plants were then evaluated on the basis of energy economic criteria with regard to (1) economic attractiveness, (2) security of supply, (3) quality of supply and (4) climate protection. The ratings of each criterion were combined to an overall assessment ranging from 0 (low hydropower attractiveness) to 5 (very high hydropower attractiveness). Furthermore, the identification and evaluation of ecologically valuable and sensitive river stretches based on 39 single criteria grouped into the categories (1) ecological status, (2) hydro-morphological status, (3) length of free flowing river sections and migration corridors, (4) key habitats, (5) key species, (6) floodplain forests, (7) legal and (8) other designated protected areas. The criteria used are largely based on an official document of the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW 2012), the Austrian Water Catalogue (AWC) - a guideline for the evaluation of sustainable hydropower development. To discuss the conservation need in more detail we developed a set of six conservation scenarios (S1: maximal conservation, S2: WWF energy revolution S3: moderate conservation, S4: minimal conservation, S5: AWC and S6: WWF eco-master-plan). The conservation conflict of a hydropower project was classified by defining a conflict rating for each ecological criterion depending on the scenario. The highest rating was given to so-called “exclusion criteria” which indicated the presence of conservation values incompatible with HP development. Furthermore, non-exclusion criteria received scenario-specific scorings on the basis of their assigned relevance (i.e. very high, high, medium or low conservation value).

3 RESULTS

3.1 Economic criteria

Considering all investigated projects, they constitute an annual production of 4,304GWh/a and an installed capacity of 4,742MW. Overall, 35 projects were rated with medium, 22 with high and only five with very high attractiveness, while the remaining 40 hydropower plants were considered as not attractive from an energy-economic point of view (rating low or moderate). The results of the energy-economic analysis showed that storage HPPs with additional pump-capacity were most attractive. Furthermore, run-of-river HPPs reached high ratings if they were equipped with a small-storage. If this was not the case, less pronounced summer discharges were prerequisite for a high rating of run-of-river HPPs. Pure pumped-storage HPPs were located in the midfield, since they do not contribute to the annual production. In general, large/medium HPPs tend to be rated higher than small/very small HPPs which are least attractive with regard to the considered criteria.

3.2 Ecological criteria

The HPPs were also rated on the basis of the ecological criteria and their awarded relevance in six ecological scenarios. With regard to exclusion criteria, 65 HPPs were considered as exclusion projects in S1, while this number declines to 57 HPPs in S6, 50 HPPs in S2, 34 HPPs in S3 and zero HPPs in

S4 and S5, which did not apply exclusion criteria.

3.3 Combined results

The evaluation-results of energy economic and conservation needs were combined and plotted in Figure 1. The dashed line divides HPPs considered as attractive (≥2.5) with regard to energy economic characteristics from unattractive projects (<2.5). Considering only attractive hydropower plants the number of HPPs is reduced by the half (from 102 to 54), while the installed capacity decreases only slightly (2.3 %) and the annual production decreases by 12 %. The results show that due to the high rate of exploitation until now, only a very limited number of projects might cause no or only minor conservation conflicts. Even in the least strong scenario (S4) more than 20 % of the projects were classified with high conservation concern. Small projects were evaluated as least attractive but were highly in conflict with conservation needs.

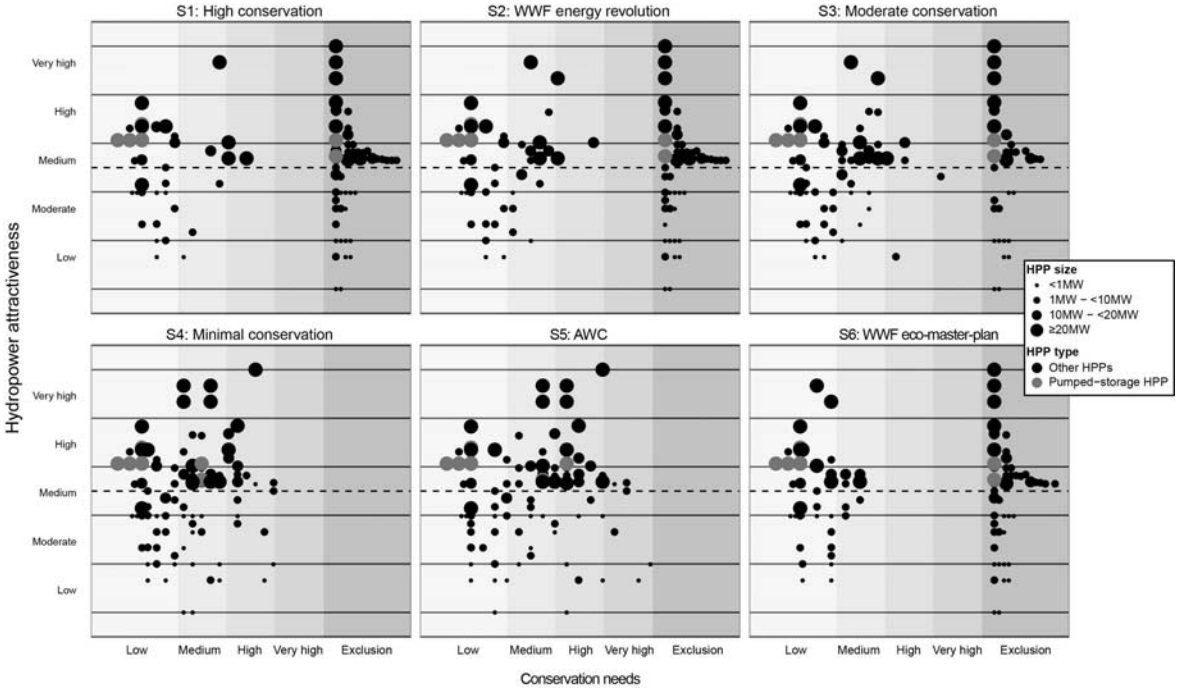

Figure1: Hydropower attractiveness and conservation needs in six scenarios

4 DISCUSSION

The here presented approach supports decision makers in the implementation of both the RES-D and the WF-D in a transparent way, while also avoiding conflicts and stranded investments. A high share of the analysed projects is in conflict with conservation needs in almost all scenarios. Furthermore, half of the projects are not attractive from the energy-economic point of view, (i.e. ratings <2.5) and therefore their implementation cannot be recommended, especially since a dismissal of these projects causes only a slight production loss. This suggests that many HP-projects are small HPPs, which marginally contribute to the aims of the RES-D, but counteract the achievement of the WF-D and FFH-D obligations. This is in line with Schmutz et al. (2010) who showed that SHPs waste much more river-km with regard to the production of 1GWh/a (i.e. 200m) than large run-of-river HPPs (i.e. 42m). This study has shown that strategic planning on a larger scale under consideration of conservation needs and energy-economics is possible and desirable for sustainable hydropower development.

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