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Impacts of the EU and national environmental legislation on tapping hydropower resources in Lithuania – A lowland country

Petras Punys*, Egidijus Kasiulis, Algis Kvaraciejus, Antanas Dumbrauskas, Gitana Vyčienė, Linas Šilinis

Institute of Water Resources Engineering, Aleksandras Stulginskis University, 10 Universiteto str., LT-53361 Akademija, Kaunas distr., Lithuania

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ABSTRACT

This paper briefly discusses the assessment of hydropower resources (mainly, Small Hydropower, SHP) in the light of general methodologies of renewable energy potential, highlighting the particularities of hydropower. A short review of the EU Water Framework Directive (WFD) from the hydropower development perspective is provided, especially focusing on the impact of power plant pre-planning mechanisms whereby rivers or their reaches are listed as exempt from damming (so-called 'no go areas'). The hydropower regulation (for prospective hydropower schemes) in the country is critically reviewed, and the current state of the drafting of river basin management plans is presented. Practically speaking, the national water law does not guarantee a declared statement of sustainable use of water resources because of the introduced list of protected rivers exempt from dam construction. In a number of multipurpose water resource development projects that override public interests, e.g., inland navigation and historic water mills, power generation is a secondary service unable to be implemented, due to on the list of protected rivers. In this paper, based on the geospatial datasets of water streams and their environmental attributes, three pre-planning levels for hydropower development are proposed, and the environmentally compliant potential of the SHP is identified. The remaining SHP potential (117 GWh/year or close to 6% of the gross theoretical potential) is among the lowest ones in the EU. The disproportionate environmental constraints in Lithuania are a key factor preventing the development of hydropower and the multipurpose use of water resources.

1. Introduction

1.1. Hydropower resources assessment

Renewable energy (RE) sources (biomass, wind, sun, water, and so on) are commonly regarded as environmentally friendly. The environment in this case is perceived in a broad sense – in a joint physical, natural, social, and economic way. Despite the bias that RE sources are "clean" sources for electricity generation, studies concerning their impact on the environment have been performed, i.e., assessing their potential to be tapped without detriment to compatibility with the physical, natural and social environment [1–3].

Most RE promoters continually emphasize the large untapped potentials. However, they consider theoretical or, in the best case, geographical or technical potential, which is still quite far from the economic, environmentally compliant, or technically feasible potential. Published estimates for individual RE technical potentials show a wide range of values and vary 100-fold, except for hydropower [4]. However, there are no definitely internationally accepted definitions for measuring renewable energy resource potentials in general [5,6]. The three to six types of RE potential, some of them in combinations, are usually defined and obtained in terms of resource assessment (theoretical, geographical, technical, economic, and realizable/market potentials). A comprehensive review of the types of potential used for RE resource assessment is given in [7].

Hydropower, a mature RE technology, has clearly established the limits between the theoretical, technical, economic and remaining (or realizable) potentials. There has even been an attempt to assess the environmentally compliant potential, which excludes the potential that is incompatible with legal provisions (e.g., environmentally sensitive areas) (Fig. 1). The definitions of potential and identification methodologies are described in [8–12].

Some methodologies applied for other RE resource assessments prefer to determine the geographic potential as a second step after the theoretical potential, accounting for the areas that are suitable for specific RE employment [6].

* Corresponding author.
E-mail address: petras.punys@asu.lt (P. Punys).

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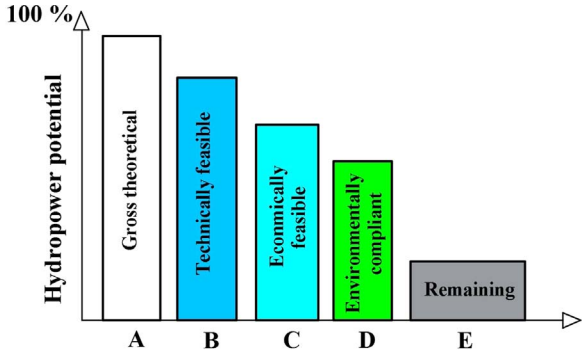

Fig. 1. Decrease of hydropower resources due to various constraints. A-Gross theoretical; B- Technically feasible; C - Economically feasible; D - Environmentally compliant (excludes the potential incompatible with legal provisions); E- Remaining /Realizable (excludes the potential of the hydropower sites already developed).

Although the economic potential is close to reality, it has been overlooked by other RE resource assessment studies because it is commonly known to be less stable than the technical potential, and it is subject to considerable fluctuations, mostly with a decreasing trend over the years. Changing the status of energy support and environmental legislation can greatly alter this.

Landy [5] recommended for the SHP resource assessment to also distinguish between the following: a) the **environmentally compliant** potential which considers the limitations imposed by legal provisions (such as legislation on geographical designations and regulations) and b) the **environmentally compatible** potential which defines environmental best practices in deployment and determines only the resources that can meet that standard (Fig. 2).

Usually, in practice, the environmentally compliant hydropower potential is assessed by reducing the technical potential in the rivers that flow through the designated areas or are situated in the areas where damming is precluded due to the existing legislation. There is no doubt that the environmentally compliant hydropower potential can be clearly and quantitatively identified. However, the real potential would be reduced even more because of the additional environmental factors that could be assessed only during the project design stage.

Most widely used is the technical potential [9–13]. However, the producers and owners of these data do not account for the impact of environmental restrictions to the hydropower potential. SHP resources are scarcely singled out except for the data from the European Small Hydropower Association (ESHA) [14].

United Nations Industrial Development Organization and International Center on Small Hydropower (UNIDO/ICSHP) has recently launched the World Small Hydropower Development Report providing mostly SHP capacities. It considered neither the economic potential nor the environmentally compliant hydropower potential

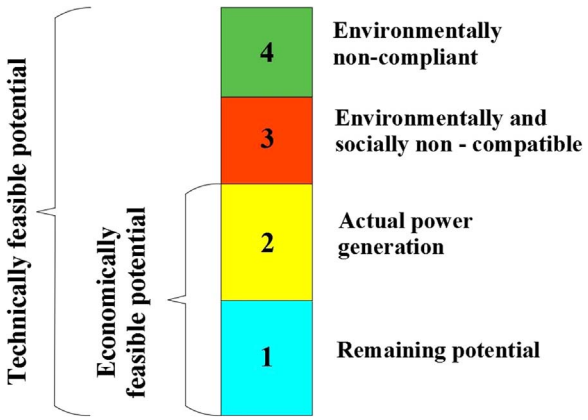

Fig. 2. Diagram of the technically and economically feasible potential for hydropower.

[15].

A realizable small hydropower (P < 10 MW) resource, determined by expert judgments in 2001, was 20% – 35% on average of the theoretical potential in the EU [16]. Approximately 10 years later an update for the 27 EU member countries found the environmentally compliant potential to be 27% [14].

Currently, advanced methodologies using GIS tools for screening out environmentally sensitive areas for hydropower potential assessment are becoming a common practice [17–22].

1.2. WFD and hydropower

With the enactment of the EU Water Framework Directive (WFD), hydropower has been identified as one of several drivers for hydromorphological alterations resulting in a significant risk of degradation and loss of biodiversity of the river systems. However, the WFD does not directly preclude the construction of dams and hydropower development [23]. Nevertheless, its provisions note that new hydropower projects can deteriorate the water status and conflict with the WFD "no deterioration principle". The WFD emphasizes ecology more, especially river continuity, in the hydropower planning and designing process. Hydropower is observed as an integral unit – without distinguishing between large and small hydropower plants. For the latter, further exploitation is possible but much more difficult. The higher secondary costs, e.g., research, expertise etc. and the reduction of plant sizes e.g., head and discharge are common issues [24,25].

A number of guiding principles for sustainable hydropower based on EU policy documents and recommendations have been published [26–29]. The impact of the WFD on hydropower and the experience of the implementation of the water projects under this directive were examined in [30–32]. The substantial losses of electricity generation in hydropower plants under operation as implemented under the WFD requirements have been highlighted [9,33–35].

Some flexibility was also established in the WFD when addressing water infrastructure projects. Heavily modified water bodies may be designated for the rivers extensively used for navigation, hydropower, and flood protection facilities. For these water bodies, reduced environmental objectives can be applied. Furthermore, Article 4.7 outlines provisions in which the failure to achieve certain WFD objectives is permitted, e.g., new sustainable development activities. For a new hydropower project that is likely to result in the deterioration of the water body status, effects on the water environment should be considered properly using the Article 4.7 test. However, there has been little consideration to date of the implications of this WFD exemption test for hydropower assessment processes and appraisal criteria [5,36,37]. The analysis for applying exemptions should be as simple as possible but as detailed as necessary, i.e., proportionate to the risk posed by a project. If a project fails the Article 4.7 test, it cannot be implemented [32].

1.3. Rivers excluded from damming

Hydropower development is associated with dam construction, which usually results in water stream physical modifications. Therefore, the WFD documents highlight the advantages of preplanning mechanisms to facilitate the locations of suitable areas for new hydropower projects considering the environmental criteria as well as socioeconomic aspects, including other water uses. These mechanisms include some extremities from a blanket ban in the „no go" or non-favourable areas to the less favourable („maybe-go") or even suitable („go") areas [26,38]. By doing so, it is intended to protect certain rivers or their reaches that possess remarkable ecological and aesthetic values as free-flowing.

It should be noted that in some EU countries (e.g., Sweden, Finland, and France) this ban to prevent the impoundment of large water streams areas was implemented before the WFD was enacted.