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ScienceDirect

Energy Procedia 95 (2016) 81 – 88

Energy Procedia

International Scientific Conference "Environmental and Climate Technologies", CONECT 2015, 14-16 October 2015, Riga, Latvia

Strategies for mitigating the impact of hydropower plants on the stocks of diadromous species in the Daugava River

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Abstract

The Daugava River is the largest river in Latvia. Daugava Hydro Power Plants built in 1939 – 1974 are Latvia's most important renewable resource in generation of electricity. The absence of fish passage structures excludes upstream migration of diadromous species. Compensatory stocking activities are introduced annually. The need for studying alternative or additional impact mitigation measures is based on biodiversity conservation aspects and possible changes in EU legislation. The case study of solutions for improving the Daugava River connectivity is introduced and further strategies for mitigating the impact of HPP are proposed in the paper.

Peer-review under responsibility of Riga Technical University, Institute of Energy Systems and Environment.

Keywords: hydropower; fish migration; fish passage; environmental impact; renewable energy

1. Introduction

From the ecological point of view hydropower plants significantly and sometimes irreversibly modify existing ecosystem. There are very few truly natural free flowing rivers left in the world [1]. The life cycle of diadromous species takes place partly in fresh water and partly in sea water. Dams and hydropower plants that prevent passage have a fundamental effect on migrating fish populations [2]. Dams can block or delay fish migration and thus

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Peer-review under responsibility of Riga Technical University, Institute of Energy Systems and Environment.
doi:10.1016/j.egypro.2016.09.027

contribute to the decline and even the extinction of species that depend on longitudinal movements along the stream continuum during certain phases of their life cycle. Mortality resulting from fish passage through hydraulic turbines or over spillways during their downstream migration can be significant. Habitat loss or alteration, discharge modifications, changes in water quality and temperature, increased predation pressure as well as delays in migration caused by dams are significant issues affecting diadromous fish stocks [3].

At the same time the use of hydropower is a significant contribution to mitigation of climate change and reduction of greenhouse gas emissions. 2030 Climate and Energy Framework agreed by EU leaders in 2014 aims to reduce greenhouse gas emissions by 40 % below 1990 levels as well as achieve 27 % share of renewable energy sources following 2020 targets (–20 % of GHG emissions and 20 % of RES). Latvia is one of the leading EU member states in the use of renewable energy. This achievement is mostly based on Daugava HPPs which produce at least 50 % of the total electricity generated in Latvia.

Co-existence of hydropower and river system biodiversity is always a challenge which requires complex sustainable solutions taking into consideration economic, social and environmental aspects. Two environmental science areas – biodiversity conservation and climate change mitigation come to a conflict at this point. Compromise should be found without neglecting the importance of the use of RES for electricity generation (thus reducing emissions of GHG) as well as preserving natural resources of the river system which have not only economic (commercial and recreational fishery), but also biological (rare, protected species) and social (keeping the nature as it is for the next generations) value.

The Daugava River is the largest river in Latvia and originates from the Valdaja plateau. It flows 1020 km through Russia, Belarus and finally empties into the Gulf of Riga, in the Baltic Sea. Within Latvia, the Daugava River flows 357 km before reaching the Gulf. The river basin is 24 700 km^2, including approximately 40 tributaries in Latvia [4]. The annual mean discharge in Daugava River is 601 m^3/s (1971–2014). The two major tributaries within the Latvian territory are the River Ogre and Aiviekste, situated about 50 and 120 km from the river mouth, respectively [2]. Daugava hydro power plants (HPPs) built in 1939 – 1974 and owned by power supply company Latvenergo AS are Latvia's most important renewable resource in generation of electricity with a total installed capacity of 1,56 GW.

The electricity generation capability of the Daugava HPPs depends on the Daugava River discharge. Therefore, with the exception of the spring flooding season, the Daugava HPPs operate on a cascading principle to cover peak loads. This allows the accumulation of water and generation of electricity during periods of increased demand (daytime peak hours). During the spring flooding season, which lasts for one to two months each year, the Daugava HPPs operate at full capacity. It is possible to satisfy the demand of all Latvian electricity consumers in this period [5]. The HPPs also perform the role of the power system's emergency reserves – they are able to quickly start electricity generation in the event of emergency, thus preventing electrical network overload and protect disconnection of consumers from power supply.

Plavinas HPP, located 107 km from the Gulf of Riga, forms the third stage of the Daugava HPP cascade. Plavinas HPP is the largest hydropower plant by installed capacity in the Baltics and one of the largest in the European Union. The power plant started operation in 1968 with ten Francis type hydropower units. The current capacity of the plant is 894 MW, maximum head 40 m.

Kegums HPP forms the second stage of the cascade. Located 70 km from the Gulf of Riga, it consists of two separate power plants on the left and on the right banks of the Daugava River. Kegums HPP is the oldest of the Daugava HPPs – it was constructed between 1936 and 1939. Currently the total capacity of Kegums HPP is 264 MW, maximum head 14 m, 7 Kaplan type hydropower units are installed.

Located 35 km from the Gulf of Riga, Riga HPP forms the lowest stage of the Daugava HPP cascade. Riga HPP was commissioned in 1974. Current capacity of the plant is 402 MW, maximum head 18 m, 6 Kaplan type units are installed [5].

Changes in the Daugava ichtyofauna have taken place as a result of natural as well as anthropogenic factors. The greatest impact on river ichtyofauna has been observed from the construction of the HPP cascade, determining an unpassable obstacle to fish migration and a change into a lentic system which substantially altered the distribution of some species in this river basin.

Before the construction of Kegums HPP Atlantic salmon, sea trout, vimba bream and other species migrated all over the Daugava and its tributaries, reaching Belarus [6]. Although the Kegums HPP was historically equipped with a fish passage facility, fish migration was significantly limited. Studies showed that a small fraction of fish at the dam,