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REGIONAL STRATEGY FOR SUSTAINABLE HYDROPOWER IN THE WESTERN BALKANS

Background Report No. 7

Inventory of planned hydropower plant projects

Final Draft 3

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Contents

List of abbreviations and symbols

Abbr. & Symbols	Description / Meaning
AKBN	Agjencia Kombëtare e Burimeve Natyrore; National Agency of Natural resources in Albania
ALB	Acronym sometimes used in tables and figures for Albania
APP	Application
BR	Background report (refers to reports within this project)
BIH	Acronym used in tables and figures for Bosnia and Herzegovina
BIO	Biosphere
BL	Base load
C/UC	Under construction
CA	Connection approval
CON	Construction
CP	Construction permit
DAM	Type of HPP with machinery room near the dam
DB	Database
DER	Derivative; Type of HPP with machinery room further of dam
DG NEAR	Directorate-General for Neighbourhood and Enlargement Negotiations
DSN	Design
EAF	Ecologically Acceptable Flow
EIA	Environmental impact assessment
ELEM	Elektrani na Makedonija; Macedonian Power Utility
EME	Emerald site
EP	Environmental permit
EPCG	Elektroprivreda Crne Gore; Electric Utility of Montenegro
EPHZHB	Elektroprivreda Hrvatske zajednice Herceg Bosne; Electric Utility of Croatian community of Herzeg-Bosnia
EPS	Elektroprivreda Srbije; Electric Utility of Serbia
ERS	Elektroprivreda Republike Srpske; Electric Utility of Republika Srpska
ESIA	Environmental and social impact assessment
EU	European Union
€	Euro
€/MW	Euro per megawatt
€/MWh	Euro per megawatt-hour
FIT	Feed-in tariff
FBIH	Federation of Bosnia and Herzegovina, entity in Bosnia and Herzegovina
FS	Feasibility study
GF	Greenfield
GIS	Geographic Information System
GW, GWh	Gigawatt, Gigawatt-hour
HME	Hydro mechanical & electrical equipment
HMP-GIS	Hydropower Development Study GIS
HPP	Hydro power plant / project
HPP-DB	Hydro power plant database
HUPX	Hungarian Power Exchange
IDMS	Information and Document Management System
IOLR	Institutional-Organisation Legal-Regulatory
IPF	Infrastructure Project Facility
IPF3	Infrastructure Project Facility –Technical Assistance Window, 3rd contract
JPEP BIH	Javno preduzeće elektroprivreda BIH; Public Enterprise Electric Utility of BIH
KOS	Acronym used in tables and figures for Kosovo

Abbr. & Symbols	Description / Meaning
kV	kilo Volt
m.a.s.l.	meters above sea level
MEPSO	Makedonski Elektroprenosen Sistem Operator; Electricity Transmission System Operator of Macedonia
MCA	Multi-criteria assessment
MD	Main design
MHS	Management areas of habitats/species
MKD	Acronym used in tables and figures for the former Yugoslav Republic of Macedonia
MNE	Acronym used in tables and figures for Montenegro
Mott MacDonald-IPF Consortium	The Consortium carrying out the present project
MW	Megawatt
MWh	Megawatt-hour
N	None
NAT	Natura 2000
NGO	Non-governmental organization
NM	Nature monument
NP	Nature park
NPA	National park
NSP	National/Entity spatial plan
O	In operation
OF	Obtaining financing
OTH	Other
P	Planned
PA	Preliminary assessment
PCA	Preliminary connection approval
PCL	Protected cultural landscape
PD	Preliminary design
PF	Prefeasibility study
PL	Peak load
PNL	Protected natural landscape
RAM	Ramsar site
RES	Reservoir
REV	Reversible
RH	Rehabilitation
ROR	Run-of-river
RS	Republika Srpska, Entity of Bosnia and Herzegovina
RSP	Regional/Cantonal spatial plan
RWE	Rheinisch-Westfälisches Elektrizitätswerk
SEA	Strategic environmental assessment
SEE	South-East Europe
SECI	SECI Energia; Italian electric company
SER	Acronym used in tables and figures for Serbia
SI	Site investigations
SNR	Strict nature reserve
SP	Spatial planning
SS	Support scheme
SSP	Special purpose special plan
ToR	Terms of Reference
TP	Tendering process

Abbr. & Symbols	Description / Meaning
UNESCO	United Nations Educational, Scientific and Cultural Organization
UP	Use permit
WA	Wilderness area
WBIF	Western Balkans Investment Framework
WGS 84	World Geodetic system 1984
WB6	Western Balkans consisting of 6 countries: Albania, Bosnia and Herzegovina, Kosovo, the former Yugoslav Republic of Macedonia, Montenegro and Serbia

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0 Preamble

The REGIONAL STRATEGY FOR SUSTAINABLE HYDROPOWER IN THE WESTERN BALKANS[1] — referred to as "the Study" — is a sub-project under the WBIF-IPF3 contract of the IPF Consortium led by Mott MacDonald, with European Commission, DG NEAR D.5, being the Contracting Authority for the WBIF-IPF3 contract.

The six Western Balkans beneficiary countries comprise Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Kosovo*, Montenegro and Serbia - the WB6 region.

The work programme of the Study includes 13 Tasks as stipulated in the Terms of reference (ToR):

- Task 1: Hydropower role (past and future) in the regional and national context;
- Task 2: Assessment of the current situation in the institutional-organisational framework relevant for hydropower development;
- Task 3: Assessment of the current situation in the legal-regulatory framework relevant for hydropower development;
- Task 4: Assessment of hydrology baseline, water-management by country and by river basin with transboundary issues;
- Task 5: Grid connection issues in network development context;
- **Task 6: Identification of HPP projects and acquiring relevant information for the HPP inventory and investment planning;**
- Task 7: Environmental, Biodiversity and Climate Change Analysis on (i) river basin level and (ii) country-level of identified hydropower schemes;
- Task 8: Establishment of the central GIS database;
- Task 9: Development of a web-based GIS application;
- Task 10: Multi-Criteria Assessment (MCA) of prospective hydropower projects;
- Task 11: Drafting of Regional Action Plan on Hydropower Development and compilation of Final report on the Study;
- Task 12: Establishment of IT-supported Information and Document Management System (IDMS);
- Task 13: Training and dissemination of Study results.

The Study deliverables encompass separate Background reports (BR) that focus on specific technical issues in professional areas related with hydropower sector development, e.g.:

- Background report n° 1 (BR-1) – Past, present and future role of hydropower
- Background report n° 2 (BR-2) – Hydrology, integrated water resources management and climate change considerations
- Background report n° 3 (BR-3) – Environment considerations
- Background report n° 4 (BR-4) – Regulatory and institutional guidebook for hydropower development
- Background report n° 5 (BR-5) – Transboundary considerations
- Background report n° 6 (BR-6) – Grid connection considerations
- **Background report n° 7 (BR-7) – Inventory of planned hydropower plant projects**
- Background report n° 8 (BR-8) – Identification of potential sustainable hydropower projects

This Background report no. 7 (BR-7) in the following is the output and deliverable of Task 6.

*This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.

[1] The designated WBIF code of this sub-project is WBEC-REG-EN-01.

Enlargement process

The EU Enlargement process is the accession of new countries to the European Union (EU). It proved to be one of the most successful tools in promoting political, economic and societal reforms, and in consolidating peace, stability and democracy. The EU operates comprehensive approval procedures that ensure new countries will be able to play their part fully as members by complying with all the EU's standards and rules (**the *"EU acquis"***). The conditions of memberships are covered by the Treaty on European Union.

Each country moves **step by step** towards EU **membership as it fulfils its commitment**s to transpose, implement and enforce the Acquis.

The EU relations with the Western Balkans countries take place within a special framework known as the **Stabilisation and Association Process (SAP)** in view of stabilising the region and establishing free-trade agreements. To this end, all WB6 countries have signed contractual relationships (bilateral **Stabilisation and Association Agreements, or SAAs**) which entered into force, depending on the country, between 2004-2016.

The **accession negotiations** are another step in the accession process where the Commission monitors the candidate's progress in meeting its commitments on 35 different policy fields (chapters), such as transport, energy, environment and climate action, etc., each of which is negotiated separately.

At the time of writing (November 2017), there are four WB6 countries that have been granted **Candidate Country** status: the former Yugoslav Republic of Macedonia, Montenegro, Serbia and Albania, while Bosnia and Herzegovina and Kosovo have the status of **Potential Candidate** countries at this date. With two countries, Montenegro and Serbia, the **accession negotiations** have already started and several of the chapters of the EU *acquis* have been opened.

To benefit from EU financing for projects, each country **should respect the EU legislation relevant to that project,** even if the national legislation has not been yet fully harmonised with the EU acquis.

The "Regional Strategy for Sustainable Hydropower in the Western Balkans" aims to set guidelines for a sustainable development of hydropower in the Western Balkans.

EU Acquis relevant to the Study

In the context of this Study, **the most relevant thematic areas are spread mainly over two Acquis Chapters** (15 on Energy and 27 on Environment) relating to water resources, energy, hydropower development and environmental aspects including climate change.

- Chapter 15 Energy Acquis consists of rules and policies, notably regarding competition and state aid (including in the coal sector), the internal energy market (opening up of the electricity and gas markets, promotion of renewable energy sources), energy efficiency, nuclear energy and nuclear safety and radiation protection.
- Chapter 27 relates to 10 sectors / areas: 1 - Horizontal Sector, 2 - Air Quality Sector, 3 - Waste Management Sector, 4 - Water Quality Sector, 5 - Nature Protection Sector, 6 - Industrial Pollution Sector, 7 - Chemicals Sector, 8 - Noise Sector, 9 - Civil Protection Sector, and 10 - Climate Change Sector.

Commission President Juncker said in September 2017 in his State of the Union address that: *"If we want more stability in our neighbourhood, then we must also maintain a credible enlargement perspective for the Western Balkans".* To Serbia and Montenegro, as frontrunner candidates, the perspective was offered that they could be ready to join the EU by 2025. This perspective also applies to all the countries within the region. This timeline also corresponds to the period for preparing such major infrastructures and their lifetime. Consequently, WB6 countries have to demonstrate now that they are and will develop sustainable hydropower according to EU rules.

Relevant pieces of EU legislation and international agreements

Hydropower development should be done while respecting relevant EU legislation and international agreements to which the WB countries are Parties. This includes:

- Renewable Energy (Renewable Energy Directive 2009/28/EC)
- Energy Efficiency Directives (2012/27/EU; 2010/30/EU; 2010/31/EU)
- Environmental Impact Assessment Directive (Directive 2011/92/EU as amended by Directive 2014/52/EU) and Strategic Environmental Assessment Directive (Directive 2001/42/EC)

- Water Framework Directive (Directive 2000/60/EC)
- Habitats Directive (Directive 92/43/EEC) & Birds Directive (Directive 2009/147/EC)
- Floods Directive (Directive 2007/60/EC)
- Paris Agreement on climate change
- Aarhus Convention (the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters)
- Espoo Convention (the UNECE Convention on Environmental Impact Assessment in a Transboundary Context)
- Berne Convention (the Berne Convention on the Conservation of European Wildlife and Natural Habitats)

The framework conditions and legal obligations for hydropower development stem from the EU acquis and international obligations, the implementation of which should be supported through the Energy Community Treaty (to which all of the WB6 countries are signatories) as well as International River Basin Organisations.

As **Contracting Parties (CPs) to the Energy Community Treaty (ECT),** the WB6 countries have obligations and deadlines to adopt and implement acquis closely related to the energy sector / market development and environment such as:

- Electricity (Directive concerning common rules for the internal market in electricity (Directive 2009/72/EC); Regulation on conditions for access to the network for cross-border exchanges in electricity (Regulation (EC) 714/2009); Regulation on submission and publication of data in electricity markets (Regulation (EU) 543/2013))
- Security of supply (Directive concerning measures to safeguard security of electricity supply and infrastructure investment (Directive 2005/89/EC)
- Infrastructure (Regulation on guidelines for trans-European energy infrastructure (Regulation (EU) 347/2013)
- Energy Efficiency Directives (2012/27/EU; 2010/30/EU; 2010/31/EU)
- Renewable Energy (Renewable Energy Directive 2009/28/EC)
- EIA Directive (Directive 2001/92/EU);
- SEA Directive (Directive 2001/42/EC);
- Birds Directive (Directive 79/409/EEC);
- Directive on environmental liability with regard to the prevention and remedying of environmental damage (Directive 2004/35/EC as amended by Directive 2006/21/EC, Directive 2009/31/EC)
- Large Combustion Plants Directive 2001/80/EC

Note: We recognise that close coordination between the energy, environment and climate change legislation and policies is necessary in the context of sustainable hydropower development.

However, to avoid duplications in the BRs, issues related to the WFD and Floods Directives are addressed in more detail in BR-2 (Hydrology, integrated water resources management and climate change considerations) and BR-5 (Transboundary considerations), respectively while all other Directives (in addition to the WFD and Floods Directives) comprising the EU environmental legislative package (Habitats, Birds and SEA/EIA) are addressed in more details in BR-3 (Environment considerations)

Small Hydropower Plants in the Regional Strategy for Sustainable Hydropower in the Western Balkans

While the 390 small hydropower plants in the Western Balkans 6 region represent almost 90% of all hydropower plants, they only produce 3-5% of the total hydropower generation and constitute 7% of the total hydropower capacity, most of hydropower energy and capacity in the region being delivered by the large hydropower plants.

This raises the question of the role of small hydro power plants and the pertinence of further developing such infrastructures. Their contribution to the global energy production and security of supply, or to the renewable energy sources targets, is extremely limited. In parallel, their impacts on the environment are severe, as they create multiple interruptions in water flows and fish passages, increase habitat deterioration and require individual road access and grid connections. Furthermore, while most of these small hydropower plants were commissioned after 2005, when the state-support schemes – mainly feed-in tariffs – which will be phased out after 2020 and hence it is expected that the private sector interest in developing small hydropower plants will diminish significantly.

Due to the large number of small hydropower existing plants and projects, and due to the questions on their role and pertinence, the Regional Strategy for Sustainable Hydropower in the Western Balkans focused on major hydropower contributors to the power system, that is to say large hydropower plants of a capacity above 10 MW. Nevertheless, wherever possible, small hydropower plants have also been addressed in the study.

1 Introduction

This report presents the methodology used in the development of the Hydro Power Plant database (HPP-DB), an essential register of planned HPPs developed within the framework of this project. In addition, data and analysis on plans to rehabilitate and refurbish existing HPPs are presented. Further the results and analysis of the collected data on HPPs in WB6 are presented. Finally, recommendations and conclusions are given.

This report also presents the GIS system which is used to present locational and other salient data on HPP sites, together with the Information and Document Management System (IDMS) that was developed to support the project.

1.1 Background

A fundamental concept of the Study is to assess the remaining hydropower potential in WB6 based on the development prospects of actual HPP projects - a "bottom-up" approach. A key tool to support that process is the establishment of the database of HPP projects (HPP-DB).

Hydropower has a long tradition and history in WB6 countries. While the status of the existing HPPs and its development over the last 60 years are analysed in BR-1, many plans for additional HPP projects have been proposed, particularly in the period 1960-1990. A legacy of that extensive study work done in the second half of the 20th century is a number of hydropower project ideas. Many of these project ideas are still appearing in various documents and strategic plans - even though some of them are outdated in terms of the technical solution proposed, changing environmental considerations or are outdated in that the land is already used (or intended to be used) for other purposes.

The "bottom-up" approach for the assessment of hydro potential was chosen in this BR to avoid a common pitfall of the "top-down" approach (which commences from hydrology and geographical assessments) which can be too general. The top-down approach usually results in very large and unrealistic estimations of the remaining hydro potential, because it fails to consider the many practical obstacles to successful HPP project delivery. The bottom-up approach, in its essence, relies on decades of investigative work and hundreds of studies already undertaken to study the technically available hydropotential. It also provides a list of projects which already have a certain development history, some of them also with quite advanced project documentation, and are therefore possible to implement in the medium term. The HPP-DB and the HPP projects identified therein therefore provide the remaining (or additional) technically exploitable hydropower potential for construction of greenfield HPPs of greater than 10 MW of installed capacities – probably the maximum HPP development potential that could be theoretically exploited in the medium- (next 10-15 years) to long-term future (to 2050 and beyond) should there be no environmental, financing and other barriers. Considering the long history of HPP development in the WB6 countries and the Study findings, it is not likely that significant additional larger HPP projects would be identified in the future and implemented in the medium-term run on new locations not already identified within the course of this Study.

As will be elaborated in more detail, in the following sections as well as in BR-1, this study evaluated only the projects with a capacity larger than 10 MW for the following reasons: detailed information on smaller prospective HPP projects are often unavailable (unclear hydropower potential on a large number of tributaries that are the typical locations for such HPPs); HPPs smaller than 10 MW are at present still eligible for RES state-support schemes (however, this situation is likely to change after 2020 when more market-based schemes should be introduced according to EU guidelines), and are thus competing on a different market basis and to a certain extent face different issues then larger plants; smaller plants have a limited contribution to the overall hydropower capacity and generation compared to HPPs larger than 10 MW (in 2016 - 7% in capacity and during 2021-2015 - approx. 3% in generation); and the vast number of possible smaller HPPs in WB6[2] would make it very difficult to conduct this Study within the assigned resources and timelines.

[2] DB available on *http://balkanrivers.net/en/content/studies* (RiverWatch DB) reports on possible construction of 970 small HPPs in WB6 of approx. 1,500 MW capacity in total.

IRENA report "Cost-Competitive Renewable Power generation, Potential across South East Europe", January 2017, reports on approx. 1,900 MW of possible additional cost-competitive small HPPs in the future, which could represent approx. 20% of total capacities in large and small HPPs (approx. 9,800 MW).

The HPP Database allows for both a collective and individual analysis of the potential hydropower projects, as will be presented in the following sections.

In addition to the greenfield HPP projects (that are accounted for in the HPP-DB), this report also deals with existing HPPs which are candidates for rehabilitation and refurbishment. It has been generally well-recognised that hydropower rehabilitation projects are both essential for the extension of the lifetime of the existing aging HPPs, the potential to introduce for environmental mitigation measures and, in some cases, rehabilitation projects also present a means for increasing the capacity and electricity generation from these plants, where environmental damage or water body modification has already taken place.

1.2 Objectives of this background report

In assessing the sustainable potential for hydropower development in WB6, this report aims considers “sustainable development” with respect to economic, environmental and social perspective. Adding HPP generation capacity is envisaged in national renewable energy action plans. WB6 countries see new HPP development as beneficial from economic and social perspective (additional electricity generation capacity, reduction of reliance on imported electricity, significant investments that create jobs, flood protection/irrigation infrastructure). On the other hand, many stakeholders are concerned regarding negative environmental and social aspects of hydropower (adverse impact on habitats, flooding of significant areas and related resettlements, etc.)

Throughout the course of the study, the general approach has been (i) assessing the existing plans in the WB6 countries for further hydropower potential development, and (ii) performing a Multi-Criteria Assessment (MCA) of these greenfield HPP candidates, to identify, compare and group HPP candidate projects according to their assessed potential for successful development and implementation in WB6 – which then provides an assessment of the entire sustainable hydropower potential for the WB6 countries. As an initial step, a comprehensive database containing all available information on individual prospective HPP projects (referred to as “HPP-DB”) was developed.

The HPP-DB is also used to integrate findings of tasks dealing with hydrology, integrated water resources management and climate change considerations (BR-2), Environment (BR-3), and Grid Connections (BR-6) and to communicate with the GIS system.

This BR aims to describe the following:

- The organisation of the database and relevant categories of information that were collected;
- The methodology used to collect the information and comments regarding the accuracy and the sources of information; and
- The main findings regarding the identified HPP projects.

Brief information on Tasks 8-9 (GIS) and Task 12 (IDMS) are provided in Annexes 2 and 3, respectively.

In addition to the greenfield projects which are contained within the HPP-DB, this report also presents the findings of the analysis on the rehabilitation plans and requirements for the existing large HPPs (i.e. more than 10 MW) in WB6, based on data provided by the power utilities, who are the operators of the existing HPPs. In some cases, HPP rehabilitation may also present a good opportunity to improve/implement the environmental protection measures.

1.3 Activities undertaken under specific Tasks

Within **Task 6**, an extensive data collection campaign was undertaken. The following data sources were used to collect, evaluate, and analyse the data:

- Publicly available data;
- Data acquired from questionnaires sent to relevant national institutions and companies – specifically the power generation utilities;
- Data obtained from WB6 national project experts deployed by the Consultant;
- Data created from own analysis; and
- Data received from the execution of other tasks within this Study

Throughout the execution of this task, the relevant institutions from each WB6 country were involved. This typically included the following:

- Line ministries in charge of energy, water resources, spatial planning and environmental protection;
- Energy regulators;
- NGO and CSO organisations, bilateral, EC or IFIs' supported projects; and
- Power utilities and where appropriate other (non-state) project developers.

Expert team missions were undertaken throughout the WB6 with the aim to:

- Present the project, its objectives and aims;
- Facilitate communication and cooperation, to collect and validate the data; and
- Discuss and comment on open issues and intermediate findings.

The expert team performing the activities within Task 6 included:

- The hydropower generation expert (task leader);
- 5 national HPP development experts, one in each WB6 country;
- A junior HPP development engineer in support of the HPP-DB development and its maintenance;
- Support from and cooperation with other task experts and national WBIF representatives.

Data sources that were used are listed in Annex 4 to this report.

Institutions directly contacted within the execution of this task are listed below. Note that this is not an exhaustive list, as information was also gathered by other project Tasks/experts. In other Tasks, additional institutions have been consulted, as is detailed in their respective BRs.

Institutions/subjects directly contacted within the execution of BR-7:

Albania

Albanian Power Corporation (KESH)

National Agency of Natural Resources (AKBN)

Ministry of Energy and Industry

Albanian Transmission System Operator

Bosnia and Herzegovina

Power Utility of Republic of Srpska (ERS)

Ministry of Industry, Energy and Mining of Republic of Srpska

Ministry of Environment, Construction and Spatial Planning of Republic of Srpska

Energy Regulatory Commission of RS

Power Utility of Federation of Bosnia and Herzegovina (EP BIH)

Energy Regulatory Commission of FBIH

Hidroinvest d.o.o. Sarajevo

Intrade Energija d.o.o. Sarajevo

Power Utility of HZ HB (EP HZ HB)

Operator for Renewable Energy Sources and Efficient Cogeneration

The Former Yugoslav Republic of Macedonia

ELEM Macedonian Power Plants (ELEM)

Ministry of Economy

Ministry of Environment and Physical Planning

Kosovo

Kosovo Energy Corporation (KEK)

Ministry of Economic Development

Energy Regulatory Office

Montenegro

Power Utility of Montenegro (EPCG)

Ministry of Economy

Ministry of Sustainable Development and Tourism

Environmental Protection Agency

Montenegrin Electricity Market Operator

Energy Regulatory Agency

Serbia

Power Utility of Serbia (EPS)

Serbian European Integration Office

Ministry of Mining and Energy

The HPP data and information collection campaign was at times difficult - due to several misunderstandings regarding the aim and purpose of this study, especially with the power industry institutions from the WB6 countries involved in the Study. The initial Study name "Regional Master Plan" caused several problems in communication and cooperation with the beneficiaries, as the term "Master-Plan" implies a mandatory nature and binding study results. This caused considerable caution and high sensitivity with some WB6 representatives. A commonly-held notion on the side of the beneficiaries was a fear that the Study would give too much weight to typically constraining environmental issues relating to further HPP development and that its results would stop or delay their ongoing activities in the development of their national HPP projects. On the NGOs' side, however, their concern was completely the opposite: fearing that the Study would restore the foundations for rapid and uncontrolled development of HPP projects without giving enough attention to the environmental issues, consequently promoting devastation of the environment.

In some cases, the issue of data confidentiality was raised, with fears being expressed that information disclosure could negatively impact relations with potential strategic partners in the pipeline, resulting in the requested data not being delivered to the consultant. In other cases, the requested data was simply not available, in many cases due to non-existence of (pre)feasibility studies or lack of important information in reports that were dated several decades ago. With respect to these problems and to produce meaningful and comparable results in the Study, on several occasions, expert judgements were the only means available to provide data that could not be acquired otherwise from the beneficiaries.

Upon collection, the data were analysed and assessed. The database HPP-DB was complemented with inputs from BR3 (hydrology) BR5 (grid connection) and BR7 (environment) and fed into MCA as an input.

1.4 Links with other tasks / background reports of the Study

Because the HPP-DB is one of the key study tools and a reference document for further analysis, the level of interaction with other tasks of the Study is very high.

Task 6 is linked to Tasks 2 and 3 (Assessment of the current situation in Institutional, Organisational, Legal and Regulatory framework relevant for the hydro power development) and the outputs from these tasks have been used to update and classify the HPP development and maturity status within the HPP-DB. Information and feedback from the developers that was collected during Task 6 (HPP-DB) was also used in the preparation of BR-4 (Regulatory and institutional guidebook for hydropower development).

Task 6 is linked to Tasks 4 (Hydrology), 5 (Grid connection) and 7 (Environment), as the findings of these Tasks were iteratively integrated into the HPP-DB and have also used the data provided by HPP-DB within their respective scopes of work.

Tasks 8-9 and 12 (GIS and IDMS) as supporting activities enabled the implementation of the HPP-DB into the GIS system. The GIS facilitates the use of the information provided throughout the course of the Study, and is also intended to enable continuous usage of the results and outputs after the Study is completed.

The HPP-DB is an output of Task 6 — a database of planned greenfield HPP projects and planned significant rehabilitation projects of the existing HPPs, both of more than 10 MW of installed capacity per unit.

Task 1, as one its outputs, has a separate slightly different database of all existing HPP projects in the WB6 region as per the status of 31 December 2016. Both database structures have been aligned so that they can be easily integrated into one single database for the purposes of GIS presentation. The rehabilitation / revitalisation projects are common items in both databases and caution has been applied to avoid the duplication of these projects in the final GIS database.

The Multi-Criteria Assessment (MCA) of greenfield HPP projects that was undertaken within Task 10 extensively relies on the information provided in the HPP-DB. Projects identified in the HPP-DB and which are later analysed and classified within the MCA process, enable the verification and putting into perspective the existing WB6 hydropower development strategies, implementation plans and programmes. These HPP perspectives are also used to confirm the reasonableness of the recommendations laid out within Task 11.

2 Methodology

The methodology applied under Task 6, related to greenfield projects analysis, followed these steps:

1. Developing a preliminary draft of the database (i.e. the structure and information to be collected);
2. Collection of information from publicly-available sources: studies, national strategies, spatial planning documents, reports, government bodies & institutions, web-sites etc.;
3. Further refining and development of the information to be collected (in coordination with other tasks and particularly, in relation to the development of the MCA methodology);
4. Conducting a more detailed evaluation of the available documentation and the extraction of relevant information;
5. Definition of the precise locations of the HPP projects (based on the location of the turbine room) to be used in the GIS database;
6. Coordination and verification of available data with key local stakeholders (mainly representatives of the public utilities and line ministries in charge of energy);
7. Out of all identified HPP entries, identify HPP candidates with sufficient levels of available information (indicating also the project maturity level);
8. Working with national HPP development experts to acquire further information and comments on HPP issues, risks and other relevant aspects of HPP candidates.
9. Analysis of the collected data, per river basins, per countries and other relevant parameters.
10. Interaction with other tasks to produce additional data resulting from expert analysis.
11. Feed the resulting data on HPP candidates to MCA analysis;

Steps 1 and 2 were conducted within the Scoping stage of the project, while steps 3-7 were undertaken in the Study stage of the project. Steps 3-7 were iteratively repeated until a sufficient level of information completeness had been achieved and a sufficient level of agreement on the data had been reached between the involved parties.

Steps 9-11 were undertaken after a sufficient level of information completeness was achieved.

As previously mentioned, data were collected for greenfield HPP projects of greater than 10 MW of planned installed power generation capacity and for all significant rehabilitation projects at existing HPPs of greater than 10 MW installed capacity. This threshold of 10 MW was introduced for the following reasons:

- Projects below 10 MW of installed capacity, although very numerous, have a limited effect on the overall electricity balance in the region as no more than approx. 3-5% of electricity from these smaller HPPs is produced by such plants;
- Prospective projects below 10 MW are very numerous (approx. 1,000 in WB6), which makes collection of reliable data impossible within the scope of this Study;
- Generally, there is a quite low availability of data for planed HPPs below 10 MW, because of very uncertain prospects despite concessions being granted; in many cases, even hydrology and basic technical parameters are unknown until the final planning stage; and
- In 4 WB6 countries (except Kosovo and Serbia), 10 MW is the limit for obtaining the status of privileged producer under their respective national renewables support schemes. Recent trends towards phasing out the existing FiT schemes and introducing more market-oriented models are expected to substantially decrease the economic attractiveness of many of the planned small HPP projects.

The database of projects obtained through the above-described procedure was initially screened for projects where there was no basic information available (e.g. on installed capacity, expected annual output, investment cost, location, plant type etc.). The absence of even the most basic project information made it impossible to further analyse the project with MCA methodology. Absence of the most basic information also indicates that the identified HPP entry has not really been studied in sufficient detail, thus has very low maturity. Such projects were eliminated from further analysis in the Study.

In the next step, the database with the remaining HPP projects; HPP candidates, was used as an input for the MCA Level 1 (MCA1)-screening, based on four key criteria: (i) technical adequacy, (ii) financial viability, (iii) environmental acceptability, and (iv) realisation readiness (project maturity). Projects that scored above a set threshold were further assessed in more detail – in the MCA Level 2 process. Projects that qualified for MCA Level 2 assessment were scored against many indicators, which resulted in their final score and their ranking in several Groups as follows:

A. *HPP candidates with **good comparative performance** among the assessed HPPs, i.e. the candidates with the MCA score above a defined MCA Level 2 threshold;*

B. *the HPP candidates with **moderate/medium comparative performance** against the MCA indicators; i.e. the candidates with the MCA score below the MCA Level 2 threshold*

C. *the HPP candidates which **underperformed against the key MCA indicators**, i.e. the candidates that scored below MCA Level 1 threshold*

0. *HPP candidates which were not analysed, due to insufficient data.*

Further analysis in this report will focus on projects in Groups A, B and C, unless noted otherwise.

The MCA methodology is described in more detail in BR-8.

Data collected / obtained from HPP developers (ministries, utilities, others) – representing the data and knowledge base of HPP candidates, obtained from a vast number of reports produced in the last decades – were generally not independently cross-checked nor verified (e.g. information on investment costs or expected electricity output) because that would, in most cases, require a new feasibility study at the individual HPP level by a third party. Cross-checking was performed in cases of contradictory data or apparent error. Similarly, the proposed technical solutions for individual HPPs based on available (pre)feasibility studies obtained from the developers could not be fully validated by the Study because that would require very specialised expertise, considerable time and resources for each prospective hydropower project. Finally, we should stress that the initial number of identified HPP entries from all these sources was as high as approximately 480 HPP projects throughout the WB6 Countries.

Rehabilitation projects were also evaluated within the course of this study. However, the differing issues related to rehabilitation projects made MCA evaluation of these projects impossible. The data on planned rehabilitations were collected from plant operators, in addition to the data provided by operators, an estimation was made of the required rehabilitations currently not being planned by their operators. These data were analysed and recommendations developed.

3 Hydropower database structure

The initial HPP-DB database, developed in MS Excel, which was used for preliminary project identification was organised in a total of 8 tabs grouped by different topics/aspects of HPP development. The organisation and information collected under each tab is described below.

As aforementioned, the HPP-DB includes projects of more than 10 MW of installed capacity where the hydro power plant that can be treated as a standalone facility (i.e. having one or more turbine / power generation units). However, in some cases, HPP projects with a capacity close to (but below) 10 MW by individual HPP facility were also included in the database. HPP projects that are individually smaller than 10 MW but that form part of a well-connected cascade, which in total has a capacity over 10 MW were also included and selected for further analysis on an individual basis. Generally, if a cascade in total is significantly over 10 MW, it was still considered in further analysis, but if the cascade was only slightly over 10 MW, it was not considered further.

Each of the HPPs within a cascade has been listed in the HPP-DB as an individual entry. However, in the analysis it has been considered as a functional part of a cascade. In the same manner, it has been treated as a part of a cascade in the hydrological (Task 4) and environmental (Task 7) evaluations.

For some projects that are included in the HPP-DB, the hydropower development activities were still at the phase in which the variant of the exploitation of the hydro scheme has not yet been selected. The HPP-DB is project focused and requires considerable project/site specific information. Therefore, the data of the variant which is, by expert opinion, assessed as the most probable (or least improbable) were used in the HPP-DB[3]. Considering the typically relatively low maturity of such projects, it is to be noted that different variants might prove to be more feasible with further investigations and development activities in the future. It may also be that new variants are developed in the future; however, that could not be assessed within the scope of this report.

The database was structured to collect various information. Some of these data were used for the MCA process. Data that was used only for MCA level 1 assessment and data used for both MCA1 and MCA2 were identified separately (MCA1 and MCA2).

3.1 TAB 1 - Basic Information

In the “Basic Information” TAB, the following information and data are presented: project name, owner/promotor, country, location, plant size, installed capacity by plant, average annual electricity output, capacity factor, plant type and generation type.

Project Name

The official project name of the specific HPP is given here with additional information if a certain HPP is part of a cascade (shown in the form *Cascade name/Project name*).

Owner / Promotor

Known Owners / Promotors / Investors are given here. If there is more than one Owner / Promotor / Investor, all are shown and separated by semicolon sign (;).

Country

The Country in which project is situated is given here. Countries are shown with their corresponding abbreviations (ALB, BIH, MNE, MKD, KOS and SER) which are explained in the List of abbreviations and symbols. In case of cross-border projects, all involved countries are indicated.

Machine room - Location

The location of the machine room of the project is given here. All locations are shown in the form of the WGS 84 coordinate system (i.e. xx. xxxx (N), xx. xxxx (E)). Used for MCA1.

[3] In some cases selected variants are not optimal from the hydro-energy resource usage or other aspects, but reflect the current status of the projects.

Dam - Location

The location of the dam of the project is given here (if there is a dam). All locations are shown in the form of the WGS 84 coordinate system (i.e. xx. xxxx (N), xx. xxxx (E)). Used for MCA2.

Plant size

A plant size classification is given here. All projects are divided in 2 groups: Small (installed capacity of less than 10 MW) and Large (installed capacity larger than 10 MW). This data category is used for the easer sorting of projects.

Installed capacity by plant

The installed capacity of the plant/project is given here. The value is given in Megawatts [MW]. Used for MCA1.

Average annual electricity output

Average annual electricity output is given here. Value is given in Megawatt-hours [MWh]. Used for MCA1. Only the generation in the particular project plant is considered. Effects on generation in downstream plants is not considered.

Capacity factor

The planned Capacity Factor, which is defined as average annual electricity output divided by installed capacity multiplied with 8,760, is given here. Capacity factor is expressed as a percentage of the expected generation compared to the maximum possible generation, as determined by the installed capacity.

$$Capacity\ factor\ [\%] = \frac{Average\ annual\ electricity\ output\ [MWh]}{Installed\ capacity\ by\ plant\ [MW] \cdot 8760\ [h]} \cdot 100\%$$

Plant type

The plant type of each HPP is given here. They are divided in 3 groups: run-of-river (ROR), reservoir (RES) and reversible (REV) HPPs. Also, reservoir HPPs are separated into HPPs with machinery room near the dam (DAM) and HPPs with machinery room further away from the dam – i.e. the derivation type HPPs (DER). Used for MCA1.

Generation type

Generation type is given here; base load (BL) or peak load (PL). This designation is dependent on the expected generation profile. (Note: this information could be obtained for just a few HPP projects).

In addition, there are several other columns in TAB 1 which are added for merging and synchronizing with database on all existing HPPs that was developed within Task 2. These 4 columns are listed and described further below.

Comments

Key issues regarding the respective project are mentioned here.

Output in previous year

Output in previous year is given here. Depending on the reference year, a certain output is shown here with a value expressed in MWh. This information was used only for existing projects – data for which were collected and presented in BR-1. These columns were integrated in the HPP-DB to produce a single database including both existing and planned HPP projects.

Normalised output - last 15 years

The normalised output in the last 15 years (2001-2015), provided the HPP was in operation, is given here. Values are given in MWh. Used for existing projects only. See the explanation in “Output in previous years”.

Average annual capacity factor - last 15 years

The average capacity factor for the last 15 years is given here. The value is shown as a percentage. See formula above for the explanation of Capacity factor. Used for existing projects only. See explanation in “Output in previous years”.

Maximum annual output

The maximum annual output achieved during the period of HPP operation since its commissioning is given here in terms of generated electricity (MWh) and the year in which it occurs (in separate columns). Used for existing projects only. See explanation in “Output in previous years”.

3.2 TAB 2 - Hydrology / Water Management

In the Hydrology / Water Management TAB, the following information and data are presented: river and river basin, median flow, usable reservoir storage, total reservoir storage and cumulative effects within HPPs chain.

Drainage basin, watershed, river basin, sub-river basin, river, tributary 1 and tributary 2

A Unique Classification System of Hydrography in the WB6 region has been prepared to support Task 4. It includes all the hydrological elements relevant for the existing and planned HPPs throughout the WB6 region and is organised in several levels as follows: Drainage Basin, Watershed, River Basin, (Sub)River Basin, River, Tributary 1 and Tributary 2. HPPs in the database are located in the hydrological classification system depending on their river position. This enables searching and analysing the database by any of the classified hydrological elements, particularly by river basin. Further details are provided in BR-2 covering Task 4 activities.

Medium flow

Median annual flow of the HPP river is given here, in cubic meters per second [m^3/s].

Usable reservoir storage

Usable reservoir storage available to the HPP is given here. This is applicable only for RES (DAM/DER) type HPP projects. Entries are possible either as volume, in millions cubic meters [10^6 m^3] or energy in Megawatts [MWh], or both.

Total reservoir storage

The total reservoir storage is given here. This is applicable only for RES (DAM/DER) type HPP projects. Entries are possible either as volume, in millions cubic meters [10^6 m^3] or energy in Megawatts [MWh] or both.

Cumulative effects within HPPs chain

Cumulative effects are given here. Entries are descriptive, as more accurate and quantifiable information were not available. The entries usually specify whether the project is a part of a planned cascade and how many projects are planned within a cascade.

3.3 TAB 3 - Technical Information

In the Technical Information TAB, the following information and data are presented: design head, design flow, configuration and turbine types, grid connection level - line and point, dam type, dam height and maximum elevation height of backwater/accumulation.

Design head

The planned designed head of the HPP is given here. Values are shown in meters [m].

Design flow

The designed flow is given here. It is the total designed flow through all turbines present and is presented in cubic meters per second [m^3/s].

Configuration and turbine types

Details about configuration and turbine types are given here. It is descriptive text with the number, type and power of turbine/s.

Grid connection level, line and point

Details about the grid connection voltage level, line route and connection point are given here. Descriptive text with kV level and overhead line details (distance, points from-to).

Dam type

Details about the dam are given here. Descriptive text with construction type and material of dam.

Dam height

The height of proposed dam is given here. Values are shown in meters [m].

Maximum elevation height of backwater/accumulation

Backwater/accumulation maximum elevation height is given here. Values are shown in meters above sea level [m.a.s.l.]. Used for MCA2.

3.4 TAB 4 - Economic and Financial Information

In the Economic and Financial information TAB, the following information and data are presented: total investment cost (which is further divided into preparatory works, project construction and supervision and grid connection related costs), year when investment was evaluated, producer price in industry index change, normalized investment cost, anticipated financing model, support scheme type and description, specific investment (investment cost per MW of installed capacity and investment cost per MWh of production), external cost-benefits, nominal corporate cost of equity, nominal corporate cost of long term debt, fixed O&M, variable O&M, other OPEX, corporate financing structure – debt to equity ratio, SS price, duration of the SS contract.

Total investment cost

The total investment cost of the project is presented here. This includes all direct costs related to the project as reported by the project promoters. The value is shown in €million. Based on the year when the (pre)feasibility study of a certain project was made, these costs require to be normalised and adjusted so they are mutually comparable between projects. See "Year when investment was evaluated", "Producer price in industry index change" and "Normalised total investment cost", below. It should be noted that the accuracy of the investment cost estimation largely depends on the age of the study and level of detail of the study (prefeasibility, feasibility, main design…). Depending on the quality of the input documents, it is possible that the investment costs reported here do not fully represent all anticipated costs related to the project implementation (such as other infrastructure relocation, infrastructure modification, environmental mitigation costs or others).

Year when investment was evaluated

Indicates the year of the study during which the expected investment costs were evaluated.

Producer price in industry index change

The Producer Price in Industry (PPI) index provides information on how much the prices of durable industrial products have changed from year to year. EU28 PPI indices were used as a proxy to normalise the investment costs evaluated in different years. Using PPI indices, all investment costs were normalised to 2016. This measure partiality mitigates the problems related to investment costs input data as described above. Table 3.1: summarises the PPI changes from each year of the included period relative to the reference year of 2016 (PPI index 100).

Table 3.1: PPI change relative to reference year of 2016

REGION/YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007
European Union (28 countries)	85,26	89,1	90,1	89,6	88,8	90,2	92,5	94,9	96,1
REGION/YEAR	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
European Union (28 countries)	99,5	96,8	100	104,4	106,4	106,5	104,5	103,2	**100**

Normalised total investment cost

The total investment cost of the project normalised to the reference year of 2016 is given here. The value is shown in €million (€2016). It is calculated as product of total investment cost evaluated in the design year and the PPI index change between that year and the reference year. After this adjustment, investment costs between projects can be compared. Used for MCA1.

Anticipated financing model

The financing model and structure is given here. Short annotations are presented with important financing information. This information was obtained only for a few projects.

Preparatory works

Preparatory works costs are given here. They are part of the total investment cost and represent studies, permits, taxes, expropriation, infrastructure etc. The Value is shown in €million. This information was obtained only for a few projects.

Project construction and supervision

The project construction cost is given here. It is the part of the total investment cost which is connected to the construction of HPP and other infrastructure (excluding grid connection). The value is shown in €million. This information was obtained only for a few projects.

Grid connection

Grid connection-related costs are given here. They are the part of total investment costs which are connected to the construction of grid and similar infrastructure. The value is shown in €million. This information was obtained only for a few projects.

Support scheme type

The support scheme (SS) type is given here. If the project is eligible for a support scheme, it is marked as feed-in tariff (FIT) or other (O). If there is no support, none (N) is shown. In line with current legislation, projects with capacity larger than 10 MW applicable for a support scheme are only in Serbia and Albania. This threshold is 30 MW in Serbia and 15 MW in Albania. 10 MW is the threshold for support schemes in Bosnia and Herzegovina, Montenegro, Kosovo and the former Yugoslav Republic of Macedonia.

Support scheme description

The Support Scheme description is given here. A brief description is presented especially if Support Scheme type is anything other than FIT.

Specific investment

The specific investment related to installed capacity is calculated as the total investment cost divided by the installed capacity of the HPP. This value is shown in euros per megawatt [€/MW].

Investment per unit production

The specific investment cost per unit of production is calculated as the total investment cost divided by the average estimated annual electricity output of the HPP. This value is shown in euros per megawatt-hour [€/MWh]. Used for MCA1.

External cost & benefits

External cost & benefits are briefly annotated here (for example irrigation, flood protection, waterway creation/extension etc.). These have not been fully considered in the MCA process nor have they been quantified.

Nominal corporate cost of equity

Estimated corporate cost of equity of the project developer/Investor, provided in nominal terms, expressed as a % value. These were estimated based on publicly available data, expert judgement and own database. Used for MCA2.

Nominal corporate cost of long term debt

Estimated corporate cost of long term debt of the project developer/Investor, provided in nominal terms, expressed as a % value. These were estimated based on publicly available data, expert judgement and own database. Used for MCA2.

Fixed O&M

Fixed operation & maintenance costs of individual HPPs. These costs were mainly estimated as generally they were not available from project developers. Used for MCA2.

Variable O&M

Variable operation & maintenance costs of individual HPPs. These costs were mainly estimated as generally they were not available from project developers. Used for MCA2.

Other OPEX

Other OPEX includes costs that are neither classified as fixed costs nor as variable O&M costs. They include items like community initiatives, management fees etc. These costs were mainly estimated as generally they were not available from project developers. Used for MCA2.

Corporate financing structure – debt to equity ratio (D/E)

This data was estimated or taken from corporate balance sheets where available. Used for MCA2.

SS price

This is the monetary value of the support scheme contribution to HPP development. The data is provided in €/MWh for projects that are eligible for renewable energy support schemes. Used for MCA2.

Duration of the SS contract

The length of time for which the support scheme financial contribution will last. This data is based on the applicable national legislation on support schemes for renewable energy. Used for MCA2.

3.5 TAB 5 - Environmental and Social Information

In the Environmental and Social Information TAB, the following information and data are presented: if the project is within a protected area and if so, the type of protected area, the possibility that construction will be forbidden on environmental grounds, the availability of a SEA and EIA, project-specific environmental and social concerns, potential multi-purpose use and transboundary/riparian issues.[4]

Project within protected area

If the project is within an existing or a planned protected area it is marked as 1, while if it is outside such an area it is marked as 0. Used for MCA1.

Type of protected area

If the project is within a protected area, then the type of protected area is given here. The types of possible protected area entries are: National Park (NPA), Ramsar (RAM), Natura 2000 (NAT), Biosphere (BIO), Hucho[5] (HUC), Emerald (EME), Strict Nature Reserve (SNR), Wilderness Area (WA), Management Areas of Habitats/Species (MHS), Nature Monument (NM), Natural Park (NP), Protected Natural Landscape (PNL), Protected Cultural Landscape (PCL) or other (OTH). For projects where it is expected that their location may be in a future protected area, still to be declared, this is marked with the abbreviation for that specific protected area together with an added asterisk (for example: EME* for a project that is within an expected Emerald area). Multiple entries are allowed. Used for MCA1.

Possible construction forbiddance

[4] It is well-understood that a planned HPP outside of a protected area / Natura 2000 zone can have impacts within, and vice-versa. This protected area “flag” in the database is therefore used as a basic indicator during the MCA level 1 process, and is subsequently refined in the MCA level 2 and Final Expert Assessment stages.

[5] Even though Hucho is a species of fish and not a protected area, this classification is used here as indication important for environmental assessment of HPP`.

If construction of the project is legally forbidden due to any reason, that reason is given here. A short statement with a brief description and explanation are shown.

Availability of SEA/EIA

If a SEA (strategic environmental assessment) has been completed for a plan, programme or a strategy considering HPP development or an EIA (environmental impact assessment) has been completed for the project, it is marked and shown here. If both SEA and EIA have been completed in the past, both are shown.

Environmental and social concerns

Important environmental and social concerns are given here. A brief description with specific concerns and impacts are shown.

Multi-purpose use

The prospective multi-purpose use of the project is given here. In a similar way to external cost benefits, additional uses of the project are noted here, such as irrigation, flood protection etc.

Transboundary/riparian issues

If there are any transboundary/riparian issues, they are presented here. A brief description with possible or known issues is shown.

3.6 TAB 6 - Maturity Information

In the Maturity information TAB, the following information and data are presented: general status, grid connection status, type of intervention, status of completed preparatory works, permits obtained, energy strategy, spatial planning, land ownership, water rights, financial assistance, in operation from/planned commissioning and year of upgrade/refurbishment.

General status

The general status of the project is given here. Depending on the project's status, it is marked as planned (P), under construction (C) or in operation (O).

Grid connection status

The status of the process for the connection to the grid is given here. Depending on the status, it is marked in a general way and is not aligned with national specifics: application (APP), preliminary connection approval (PCA), design (DSN), connection approval (CA), construction (CON) and use permit (UP). Used for MCA2.

Type of intervention

The type of intervention is given here. It is shown as either a greenfield project (GF) or a rehabilitation project (RH).

Status of completed preparatory works

The status of completed preparatory works is given here. The documents prepared and processes undertaken at different phases of the project are shown: preliminary assessment (PA), prefeasibility study (PF), spatial planning (SP), feasibility study (FS), site investigations (SI), environmental permit (EP), preliminary design (PD), main design (MD), obtaining financing (OF) and tendering process (TP). Even though the licencing procedure is not the same in each of the countries, the entries made here are used as an indication of the overall maturity and development status of the project. Used for MCA1.

Location permit

Information on if a location permit has been obtained for the project is given here: 0 if not obtained, 1 if in the process of obtaining, 2 if obtained. Used for MCA2.

Construction permit

Information on if a construction permit has been obtained for the project is given here: 0 if not obtained, 1 if in the process of obtaining, 2 if obtained. Used for MCA2.

Tendering for construction works

Information on if tendering for construction works for the project has been finalised is given here. If not, it is marked as 0. If it is in the process of tendering it is marked as 1 while if tendering is complete, it is marked as 2. Used for MCA2.

Energy strategy

Information on if the project is identified within the national energy strategy is given here. If the project is in an energy strategy or other similar national energy policy document it is marked as 1 while if it is not, it is marked as 0. Used for MCA2.

Spatial planning

If the project is included in the relevant spatial planning documentation, this is denoted with an appropriate abbreviation: national/entity spatial plan (NSP), regional/cantonal spatial plan (RSP) or special purpose spatial plan (SSP). Only the highest level of spatial planning is considered (under the assumption that lower level spatial plans are, or will be, aligned with the higher level spatial plan). Used for MCA2.

Land ownership

Information about land ownership is given here. If the owner/promotor/investor has ownership or building rights over the land where the project should take place it is marked as 2 while if he doesn't, it is marked as 0. If resolution of land ownership issue is in process, then it is marked as 1. Used for MCA2.

Water concession contract

Information about the project's water concession contract is given here. If the owner/promotor/investor has agreement, document, and proof (such as water conditions, water permit etc.) to use water as a resource it is marked as 2 while if he doesn't, it is marked as 0. If the issuance of a water concession contract is in process, then it is marked as 1. Used for MCA2.

Financial assistance

If there is any financial assistance (expected or already engaged) by a third party, it is given here. Financial assistance could be provided by IFI (international financial institution) or financial assistance can be provided via an agent, bank or scheme. A brief description or short entry is shown.

In operation from/planned commissioning

The year of start of operations (for existing/rehabilitation projects) or planned commissioning date for the (planned) HPP project is given here.

Year of upgrade/refurbishment

The year of upgrade/refurbishment of (existing) HPP projects is given here. The years for both already refurbished plants and planned for refurbishment are shown.

3.7 TAB 7 - Other Aspects

In the Other Aspects TAB, sources and additional information are provided.

Sources

The sources who/which gave information and data are given here. If there is more than one source, they are divided by a semicolon sign (;).

Additional information

Any additional information from other or third-party sources are given here. These comments can include online findings, opinions and others.

3.8 TAB 8 - MCA Results

In the MCA Results TAB, the MCA ranking result and comments connected to the ranking process are provided. These are obtained based on the MCA analysis completed during Task 10.

MCA ranking result

The result of the MCA process is given here. The ranking is divided to A, B, C and 0. Category 0 denotes that either: i) insufficient information was available to conduct even an initial screening on the project, ii) the project is a variant that was assessed as not the most probable, or iii) that the project is smaller than 10 MW of installed capacity.

Comments

Possible comments connected to ranking are given here. A short descriptive text with explanation is shown.

3.9 Additional data and columns

TABs 1 to 6 contain additional help-columns which provide information on available documentation (from which data was collected depending on TAB and section) and comments (additional notes and observations depending on TAB and section).

4 HPP-DB data collected

Extensive research and investigative work conducted during this study resulted in a total of 480 identified HPP projects (HPP entries), the clear majority of these being larger than 10 MW. The initial data collection also included some smaller projects, but close to 10 MW (i.e. in the range 7 – 9.99 MW), and some projects individually smaller than 10 MW, but which are a part of a cascade which in total capacity is larger than 10 MW.

The data collected also included projects: (i) already in the construction phase, and (ii) several projects which are mutually exclusive; i.e. variants of the same overall hydro scheme on a particular river/watershed.

4.1 Rehabilitation projects

Rehabilitations of existing HPPs have been clearly, unambiguously and unanimously recognised as **priority hydropower investments** by virtually all relevant beneficiaries and stakeholders in the Study, including the EC, financing institutions, national authorities, plant operators, expert institutions and individuals and civil society.

Rehabilitation projects are primarily **essential to safeguard existing aging hydropower generation capacities and to enable the continuation of their service for a future period**. In effect, rehabilitation projects are generally not primarily aimed towards the prospect of increasing power, capacity or electricity generation but rather towards maintaining the existing capacity and generation; they focus on avoiding the loss of their capacity and energy production, as well as the loss of planned revenues in the case of discontinuation or technical degradation of the facility. Potential increase in capacity and generation output is a welcome additional benefit, when it is achievable. In addition, rehabilitation projects also provide a good opportunity to implement additional environmental improvement measures that were often not considered at the time that the plants were constructed.

In terms of the availability of financing (in effect, typically the owner's capacity to take additional debt), rehabilitation projects can be in competition with greenfield projects from the owner's, i.e. the same investor's, perspective. The decision on the rehabilitation of existing units is not whether to undertake the rehabilitation or not, but is only about the optimum timing for that investment and its scope - which depends on the owner's current priorities, actual plant operational issues and financing availability. Investment considerations on a new greenfield HPP, on the other hand, might result in a positive or a negative investment decision. In assessing the feasibility of a greenfield HPP project, the financial and economic analysis is aimed at assessing the costs and benefits of the new MWh being produced. In assessing the feasibility of rehabilitation projects, the primary issues are safeguarding the existing capacity, prolongation of the service life time, avoiding lost generation, increasing plant availability, increasing safety and similar. So, from the investor's perspective, the value of additional capacity usually comes only after securing refurbishment of the currently-owned generation assets.

Most existing large HPPs are owned and operated by state-owned power generation utilities in the WB6 countries. In the case where a state guarantee for obtaining financing is required, rehabilitation projects are in competition with other infrastructure projects if such loan-security mechanisms are expected from the lending institution. For the mostly quite-indebted power utilities prevailing in the region (many have taken loans for the rehabilitation of their thermal power plants), their potential to finance from their own sources is very limited. Therefore, the scope and timing of rehabilitation measures is mainly related to loan availability and financing terms. In conditions of typically scarce resources, there is a general tendency that rehabilitation measures tend to be postponed to the latest reasonable deadline. Such strategies can, however, be very risky as potential failures of even minor supporting parts (e.g. turbine bearings) could cause an unplanned outage of the facility for several months, which always has detrimental financial consequences and every utility wants to avoid such situations.

In terms of the availability of financing, it could be considered that rehabilitation and greenfield HPP projects are in competition from the HPP investment portfolio point of view. However, this is limited only to specific cases of financing. From the business perspective, rehabilitations and greenfield projects differ considerably in:

- The objective / rationale for intervention;
- Economic / financial indicators, as the costs of rehabilitation measures (typically relating to electrical and mechanical parts while the civil construction part will last for many additional decades) by which the service lifetime of the HPP is prolonged is definitively much lower than the costs of construction of a greenfield HPP;

- Impacts on the environment, as any new greenfield HPP is additional and may cause significant impact on the environment and the water bodies with their surrounding areas.

Many of these elements cannot be even properly monetarised. However, based on the experience of IFIs typically supporting such projects and the current plans of HPP operators, one could conclude that the rehabilitation of the existing HPP would always come prior to any greenfield HPP if a common list of prioritised HPP investments is to be established. There are some exceptions in very specific and rare cases (e.g. some very old small HPPs constructed before 1950 which have been turned into museums because the complete reconstruction and renewal of equipment is not sensible).

Environmental issues are a primary concern of the developers when assessing greenfield HPPs, as these are very often the reason a HPP development project gets cancelled. In rehabilitations of existing HPPs, plant owners do not perceive the environmental aspects as critical. However, priority in upgrading hydropower installations should also be given to improve their ecological footprint through the application of a wide range of environmental protection measures. Beside applying EAF and building fish passes at HPPs

Another significant difference between greenfield and rehabilitation projects is reflected in licensing complexity; usually being very demanding for greenfield projects and significantly simpler and easier for rehabilitation projects.

In the following sections, it will be explained further that rehabilitation projects generally are necessary for plant operators, while greenfield investments are a matter of reaching a positive or negative investment decision. In terms of optimisation of financing availability and competing for financing, the operator may have a certain flexibility in timing the investment in rehabilitation projects.

According to the results of BR-1, the demand for electricity in the region will still steadily increase until 2030/2050 but with decreasing annual growth rates over time. To ensure a sufficient electricity supply to meet that growth reasonably from a countries own resources (i.e. national security of electricity supply) and not to be too dependent on the vulnerable electricity market still under development, a WB6 country ***must both: (a) maintain existing HPP capacities through rehabilitation projects, and (b) provide additional capacity through greenfield projects[6].*** This is also emphasized in the Final Report of the Study.

Table 4.1 summarises key differences in assessing greenfield and rehabilitation projects for HPPs.

Table 4.1: Key differences between rehabilitation and greenfield projects

Aspect category	Rehabilitation projects	Greenfield projects
Primary driver	Extension of the plant lifetime Operational safety	Additional capacity and energy generation
Other drivers	Increased capacity and energy generation	Water management Flood protection, irrigation
Environmental aspects	Usually not limiting, except where environmental mitigation measures are planned / required	Limiting
Licensing and permitting aspects	Relatively simple	Complex and demanding
Project scope	Arbitrary	Defined
Implementation dynamics	Can be intermittent	Construction time defined and limited
Project owner	Operator / owner of the existing HPP	Investor (of any kind)
Financing	Generally well-established financing models	Unpredictable as each financier has its own rules

The analysis below is based on the inputs received from plant operators. Unfortunately, the level of information received from some of the operators indicates that the rehabilitations are not considered with sufficient attention

[6] In a more general perspective, the expected growth in demand will need to be met by both: a) maintaining the existing electricity generation capacities, not limited to HPPs (given that these capacities will meet the environmental standards and reasonable cost of generation); b) investing in new generation capacity (not limited to hydro generation capacity only).

nor have adequate and timely rehabilitation plans been made by some of the plant operators. This lack of adequate planning has made adequate detailed comparative analysis of rehabilitation projects impossible within the scope of this project.

The sections below elaborate on the complexity and the specifics of rehabilitation projects. As opposed to greenfield projects, the entire range of HPP rehabilitation project benefits is not always obvious to the operators, nor are its boundaries so defined.

4.1.1 Risk of losing production; the main case for rehabilitation projects

Existing HPP schemes with a proven track record and no obvious technical problems often have a difficult case to lobby for their rehabilitation investment. No imminent problem is pushing the investment decision and the risk of losing the available capacity and generation due to major equipment or structure failure is often not perceived to its full negative financial extent. Postponing the rehabilitation increases the risk of such a failure occurring. Depending on the nature of that failure, the lost production and revenues can significantly outweigh the cost of the entire rehabilitation project. Failure of capital equipment (such as a catastrophic fault in the generator, or destruction of major axial bearing etc.) would result in the following general sequence of events:

1. Unplanned stopping of the plant, the need to inspect the facility and exactly determine the scale and scope of the damage/failure.
2. Identify the potential supplier of equipment (not always easy for equipment produced 40 years ago).
3. Procure the replacement equipment (possibly using public procurement procedures which usually increases the duration of the procurement)
4. Have the replacement equipment produced (or damaged equipment repaired), possibly also wait for a production slot. Production of the equipment often includes also modifications in the design.
5. Replacing and commissioning the replacement/repaired equipment.

The total duration of the process described above can be anywhere from several months to more than a year for capital equipment. Should such a failure occur at the start of the wet season, this could mean that practically the entire annual production and corresponding revenues would be lost, not to mention the costs of the repairs/replacement equipment themselves.

The example above is to illustrate that a rehabilitation project's feasibility should be assessed with consideration of the risk of lost production as the primary issue, not only with considerations of potential power and capacity increase.

4.1.2 Scope of rehabilitation projects

The scope of a rehabilitation project should be defined so that it prepares the HPP for the next decades of its operation, not just to replace the equipment that has passed its expected lifetime.

A typical scope of a rehabilitation project is difficult to define as it is very site specific. Activities may include:

- Structural integrity measures (scour protection, dam monitoring, spillways/flood release capacity[7])
- Changing the turbine rotor and bearings
- Changing the generator, transformer, switches and other electrical equipment
- Changes to hydro-mechanical equipment
- Limited improvements in intake and discharge structures and other hydro-technical facilities (tunnels, penstock, channels)
- Increasing a degraded reservoir volume (by dredging, for example)

In addition to these activities, further interventions may be implemented, such as:

- Conversion from analogue to digital technology in instrumentation and control
- Introducing automation and remote-control features
- Enabling online monitoring and reporting of key plant parameters

[7] Sufficient spillway/flood release capacity should be considered with particular attention as recent floods in the region suggest increased extreme values/annualities (HQ100, HQ1000).

- Enabling the plant to provide additional system services and hence increase revenue

As part of rehabilitation projects, IFI's often consider also the training of new, young personnel, both to ensure the crew for the plant into the coming decades, but also to maximize the benefits of switching from analogue to digital technology. In the eyes of some IFIs, properly trained staff that would operate the plant in the most optimal way possible can contribute more to the plant's instantaneously available capacity and energy yield than certain technical improvements that may result in some small percentage improvements only.

It should also be noted that HPP operators often implement several modifications/new equipment installations during regular (annual) plant outages. Therefore, the boundaries of rehabilitation projects vs. investment maintenance activities are not strictly defined. In that respect, rehabilitation projects often span many years as their implementation is planned against optimum usage of the water available and annual outage plans.

Therefore, planning of rehabilitation measures in existing HPPs is, and should be, typically a continuous task in all plants, to obtain high-quality inputs to management for decision-making and obtaining financing, comprehensive specification for procurement of goods and services, to be able to carry out a high-quality procurement, and most importantly, to accomplish the planned measures on time without any negative and possibly very costly unplanned outages.

4.1.3 Safety aspect

As mentioned in the section above, rehabilitations often include activities aimed at increasing or maintaining the safety of the existing HPPs, a particularly important issue in high dam HPPs. Safety is without doubt a key aspect of HPPs, and may be the sole reason for undertaking a rehabilitation project. According to the data received from the plant operators, no existing HPP larger than 10 MW has safety issues that would initiate a rehabilitation project. Generally, any activity aimed at prolonging plant lifetime through renewal of equipment at the same time increases the operational safety of the plant.

There are concerns that some of HPPs in Albania may have safety issues regarding dam safety; however no information regarding this could be collected throughout this study.

4.1.4 Increase of rated power and plant electricity generation

Increase of rated power is usually a secondary target of rehabilitation projects. The capacity of the HPP is defined by the installed flow (limited by the HPP structures: tunnels, penstock, turbine stator etc.), and the available head (defined by geography). Thus, only minor improvements and modifications can be applied to increase the capacity, unless the HPP was originally designed for subsequent expansion. From a pure mechanical aspect, the potential of capacity and generation increase is fairly limited by the already high efficiency factors of existing HPPs, and fixed structures of the scheme (for example the diameter of the tunnel and the penstock, draft tube). It is generally not feasible to change the fixed structures of the scheme as it would usually require complete reconstruction of key plant structures. The cost of such activities, additionally augmented by the cost of demolishing of old structures and considerable plant downtime and lost production, would greatly exceed any potential benefit that may be achieved.

The potential for the increase of generation is larger as it can be affected by optimisation of operational procedures; for example, improved water and reservoir management. However, these are operational issues and not necessarily dependent on the rehabilitation itself.

The hydrology patterns in recent years seem to show a tendency toward more extremes, however the overall annual rainfall currently seems to be remaining constant. With respect to the changing patterns of rainfall, the potential for electricity generation does not change so much, but it is becoming more challenging to the plant operators in terms of optimum water and reservoir management and planning.

4.1.5 Decrease of operational costs and increasing availability

Activities undertaken within rehabilitation projects can include improvements and modifications related to the implementation of advanced sensing and monitoring technologies, often paired with digital remote control and supervision of the plant. This enables the achievement of the following:

- Increased plant availability due to improved predictive maintenance;

- Reduced service and maintenance costs; predictive vs. corrective maintenance;
- Reduction of staffing requirements and associated costs due to remote control and predictive maintenance procedures.

As with many other possible improvements, the introduction of the above improvements does not necessarily need to be related to rehabilitation, but can also be, at least partially, introduced through regular plant improvements and maintenance.

4.1.6 Environmental aspects

The potential for reducing or mitigating overall HPP environmental impacts during rehabilitation projects is in most cases possible, compared with the current state (exceptions being cases of the establishment of new, or enlargement of, reservoirs aiming to increase the production capacity of an HPP). However, a review of environmental improvements implemented at existing HPP refurbishments shows these have been of very limited scope. Operators in the region generally do not exploit the full flexibility potential of existing HPPs to ensure and maintain Ecologically Acceptable Flow (EAF). See BR-3 on Environment for detailed analysis of EAF, related to existing HPPs. Sometimes a minimal flow is applied, which is not sufficient in itself to preserve the quality and quantity of river biota.

HPPs represent an obstacle in the natural flow of a river. Many of the existing HPPs that have undergone rehabilitation up to now did not have fishpasses, nor have fishpasses been implemented within the scope of the rehabilitation. The water level difference between upstream and downstream often exceeds 15 m which is something of a practical limit for the installation of fishpasses. Aquatic ecosystems have over the years developed independently, being separated by the existing dam, and the rivers have not been recognised as fish migration routes. This approach does not follow modern guidelines and European directives, since open corridors are required and are recognised as one of the top priorities in the sustainable use of the hydro potential of rivers. Opposed to that, in the small HPPs constructed in the past decade, fish migration has been recognised as a major issue and implementation of a fishpass is very often considered mandatory (see BR-3 on Environment for detailed analysis of fishpasses, related to existing HPPs).

Beside applying EAF and building fishpasses at HPPs sites where practical, further mitigation measures can be used to minimise the impacts of an existing HPP.

1. Opening of the corridors in the tributaries of the accumulation lakes, by establishing fishpasses at impassable weirs or removing obstacles in the watercourse that are no longer in function. In the tributaries, we often find spawning grounds for fish species, which means that populations can survive if fish have access to their spawning grounds.
2. Changing the operation of the HPP. By minimising the amplitude or/and frequency of the releasing discharge, the impact of the hydropeaking[8] can be reduced. In case of a cascade HPP, this negative effect can be mitigated by harmonising the operation of all the HPPs in the chain.
3. Ensuring sediment transportation by the HPP, to prevent river bed erosion and the lack of gravel, which is needed for spawning grounds for fish below the dams.

As these measures generally decrease the income of the operators and increase their costs, they are generally not eager to introduce these measures unless required by either financing requirements from IFI's or legal requirements. As the information on rehabilitation plans were received from the plant operators, no such measures were reported. Case by case analysis would need to be undertaken to determine the need and the scope of such measures in each of the rehabilitation projects. Besides technical documentation, the basis for the environmental rehabilitation plan should be up-to-date ecological studies.

4.1.7 WB6 rehabilitation potential

Exiting HPPs in the WB6 are analysed in detail in BR-1. In that report, it can be seen from the data collected on existing HPPs that most of installed capacity in the region was put online in the sixties and in the seventies of the

[8] Practice when plant is operated with large and rapid swings of flow discharge; employed in order to generate electricity during the peak-load hours.

previous century. A distribution of the years of the start of the commercial operation of HPPs throughout the WB6 are given in Figure 4.1. An industry standard is that approximately 40-50 years is considered an appropriate operational lifetime before major rehabilitation of HPPs is required. In the context of the WB6, this shows that at least 4,500 MW of HPPs are now getting into, or already are in, the age for rehabilitation (although this figure needs to be decreased for HPPs that have already undergone rehabilitation).

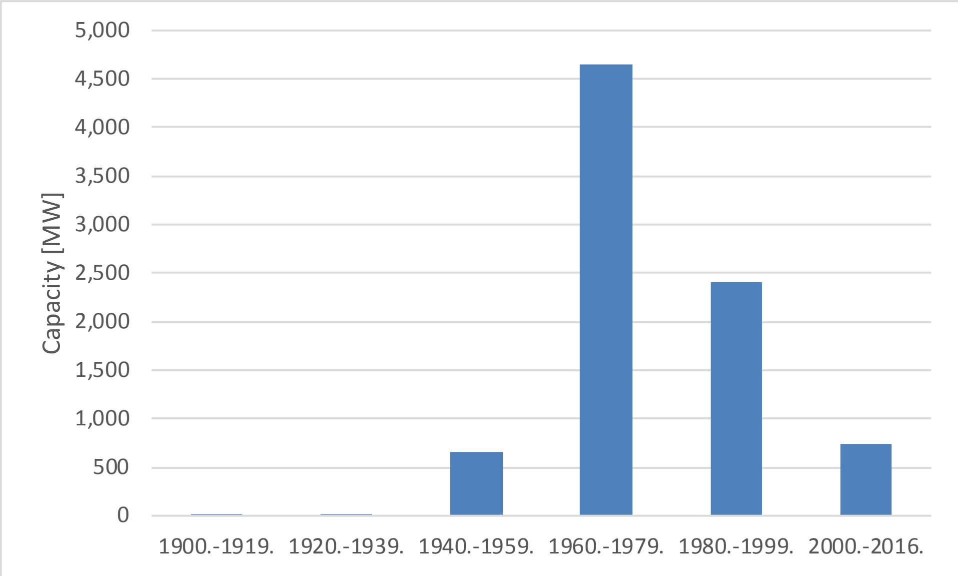


Figure 4.1: Commercial operation starting year for HPPs in WB6

A closer look at individual plants (larger than 10 MW) is presented below in Figures 4.2. and Tables 4.2-4.7.

This analysis is made under the assumption that plants should undergo significant rehabilitations 40 years after start of commercial operation, or other periods of time based on the input from plant operators where that is available. The year at which rehabilitation is due is provided until 2050 in the figures and only up to 2030 in the tables. *Italics* in the tables represent rehabilitations that have been already undertaken; normal font represents planned rehabilitations.

A closer look at the rehabilitation plans of plant operators is given in Figure 4.2. Note that plants that have both finished certain rehabilitation, and have subsequent rehabilitations planned are mentioned twice in the figure.

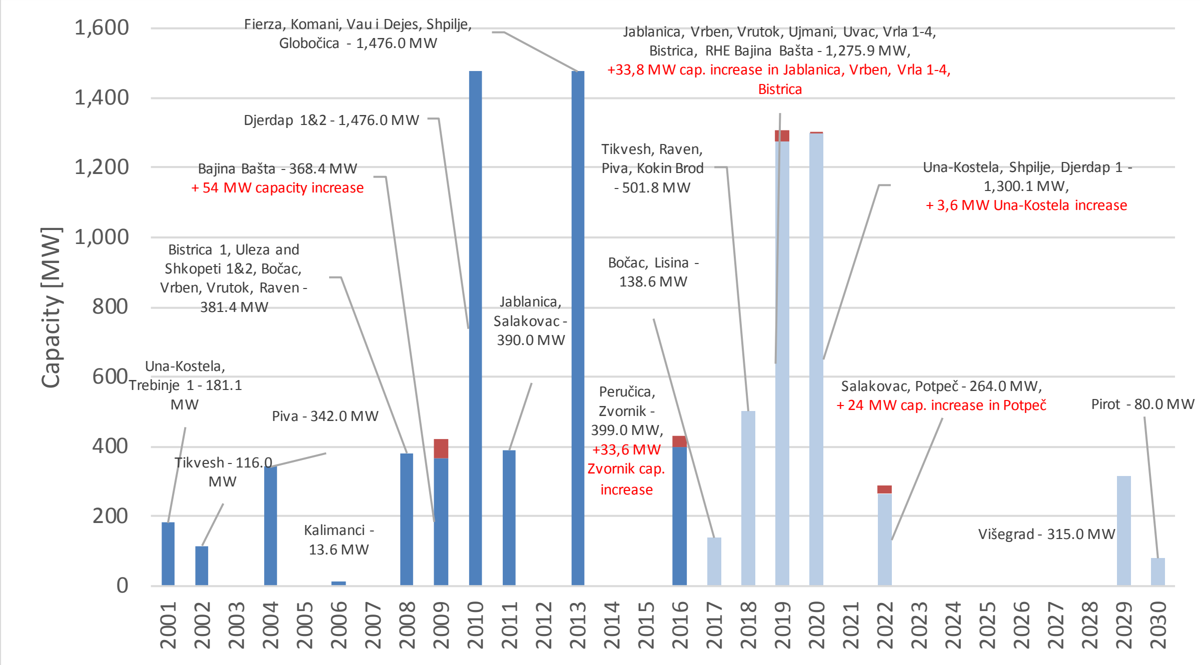


Figure 4.2: Rehabilitations completed and planned in WB6 for HPPs larger than 10 MW

Many rehabilitations are planned or are due in the coming period. In total that sums up to approximately 3,700 MW of HPP capacity to be rehabilitated in next 5 years. The scope of these projects varies considerably. This will represent a significant effort and financial burden for the operators / owners of these HPPs.

It is obvious that in all individual WB6 countries, as well as in aggregate at the regional level, there is a significant backlog of HPPs requiring rehabilitation. This will represent an enormous task and financial burden for the operators / owners of these HPPs.

On the other hand, this refurbishment backlog represents a considerable portfolio of investment projects with high probability of implementation, and as such, they represent an opportunity for strengthened cooperation with IFIs that traditionally support such measures. However, this is also an indication that the current operators are likely to be unable to act as investors in greenfield HPPs in the forthcoming decades during which time they are expected to have significant debt repayment obligations in respect of the refurbishment activities which will naturally be their topmost priority.

Table 4.2: Rehabilitation of existing HPPs (>10 MW) in Albania

HPP	Start of operation	Capacity (MW)	*Rehabilitation year*	Rehabilitation plans (past and future) *)	Increase in capacity & output	Investment cost (mln €)	Rehabilitation due
Fierza	1976	500.0	*2013 - ongoing*	*Completed: dam safeguarding* Planned/ongoing (up to 2021) Rehabilitation of the Turbine and generator 1-4 (TG 1&3 possible power uprate) Hydraulic system at intake, generator excitation system	20 MW 72 GWh	26.9 5.4	**2016**
Bistrica 1	1962	22.5	*2008*	*scope not clear*			**2002**
Komani	1985	600.0	*2013 - ongoing*	*Completed: dam safeguarding* Planned/ongoing: (up to 2021) One transformer (170 MVA), switches and transformer blocks		3.85	**2025**
Vau i Dejes	1970	250.0	*2013 - ongoing*	*Completed: dam safeguarding* Planned/ongoing: Online monitoring system for TG set Excitation system for Unit 1 & 2		5.16	**2010**
Uleza	1954	25.2	*2008*	*scope not clear*			**1994**
Shkopeti	1956	24.0	*2008*	*scope not clear*			**1996**
Ashta 1	2013	22		Based on the concession contract the electro-mechanical equipment should be rehabilitated after 26 years of operation	4.4 MW, 36 GWh		**2039**
Ashta 2	2013	34.2		Based on the concession contract the electro-mechanical equipment should be rehabilitated after 26 years of operation	5.8 MW, 28 GWh		**2039**
Vlushe	2014	14.2		Based on the concession contract the electro-mechanical equipment should be rehabilitated after 26 years of operation	2.4 MW, 7.6 GWh		
Total		**1,492**			**32.6 MW / 143.6 GWh**	**41.3**	

*Note: *) as reported by the utilities – the operators of the existing HPPs.*

Legend: *Rehabilitations due*

(white)	Rehabilitation performed in time, in progress or to be performed
(red)	(sufficient) rehabilitation still not performed and overdue.
(orange)	(sufficient) rehabilitation probably not performed and possibly overdue

Table 4.3: Rehabilitation of existing HPPs (>10 MW) in Bosnia and Herzegovina

HPP	Start of operation	Capacity(MW)	*Rehabilitation year*	Rehabilitation plans (*past* and future)	Increase in capacity & output	Investment cost (mln €)	Rehabilitation due
Višegrad	1989	315					**2029**
Bočac	1981	110	*2008-2017*	*Completed: Turbine regulator, generator excitation, UPS, 110 kV switchgear, TG set cooling system, SCADA/DCS.* Planned: 35 kV yard reconstruction, new TS 35/110 kV			**2017-**
Jablanica	1955	180	*1997-2008, 2011*	Planned: Hydraulic system. Increase of capacity for 6 X 1.7 MW, increase in output for approx. 27 GWh	6 x 1.7 MW, 27 GWh	3	**2019**
Salakovac	1982	210	*2011*	Planned: Turbine, generator, governing system, EM[9] equipment	No	30	**2022**
Una-Kostela	1954	10.1	*2001*	*Completed: Changing the EM equipment* Planned: Reconstruction & expansion, environmental improvement measures	3.6 MW	16.8	**2020**
Trebinje 1	1968	171	*2001*	*KfW Power III project, 2001-ongoing:* *Completed: 2001-2004 digital control system implementation, excitation system* *2004-2010 replacing draining, cooling, air compressor systems, transformers* Planned: (ongoing) Turbine & Generator rehabilitation		10	**2008**
Bogatići	1947	10		Planned: New machine hall, new HME equipment (including turbines, penstock)		9.2	**1987**
Total		**1,006**			**13.8 MW / 27 GWh**	**69**	

[9] EM – stands for electro-mechanical; turbine-generator set.

Table 4.4: Rehabilitation of existing HPPs (>10 MW) in the former Yugoslav Republic of Macedonia

HPP	Start of operation	Capacity(MW)	*Rehabilitation year*	Rehabilitation plans (*past* and future)	Increase in capacity & output	Investment cost (mln €)	Rehabilitation due
Kalimanci	1970	13.6	*2006*	*Completed: replacement of equipment* Planned: Replacement of PLC		0.1	2010
Vrben	1959	12.8	*1998 - 2005, 2008 -2015*	*Completed: Generators, HME*[10] Planned: Block transformers, OHTL to HPP Vrutok, accumulator batteries, main valves of aggregates, new turbines & turbine equipment	3.6 MW, 7.1 GWh	4.6	**~ 2019**
Shpilje	1969	84	*1986 -1988, 2001- 2005 2013 - 2015*	*Completed: Various* Planned: Synchronous generator 1 + Rotor; Rotor of Synchronous generator 2, 3; Block transformer 1, 2, 3; Energy transformer; Auxiliary energy transformers and equipment for own power supply; 35 kV facility; 35 kV OHTL HPP Spilje - HPP Globocica; Accumulator batteries and rectifiers; Hydro-mechanical equipment of valve chamber and feed plate valve chamber; Pre-turbine butterfly stopper of turbine 1, 2 and 3; Inflow pressure pipeline	0 MW, 3.5 GWh	3.9	**~2020**
Tikvesh	1968	116	*2002 – 2005*	*Completed: Turbine equipment* Planned: Replacement of the two energy transformers; Stationary accumulator batteries; Replacement of hydro-mechanical and electrical equipment; Replacement of pre-turbine butterfly valve of turbine A and B	0 MW, 0.2 GWh	0.84	**~2018**
Vrutok	1973	165.6	*1998 – 2005, 2008 – 2015*	*Completed: Generators, HME* Planned: Reconstruction and revitalisation of TS Vrutok 35/10/0.4kV; Replacement of OHTL HPP Vrutok - HPP Vrben 35 kV; Replacement of accumulator batteries; Replacement of turbine bearings and turbine axle; Replacement of needles' servomotors of units C and D in HEC Vrutok; Reconstruction and repair of the chamber at the joint of the inflow from the tailing tanks and concrete pads of the water-line shafts	0 MW, 7.2 GWh	4.05	**~2019**
Raven	1973	21.3	*1998 – 2005, 2008 – 2015*	*Completed: Generators, HME* Planned: Replacement of accumulator batteries; Replacement of poles and bearings of the aggregates	No	0.92	**~2018**

[10] HME – hydromechanical equipment

HPP	Start of operation	Capacity(MW)	*Rehabilitation year*	Rehabilitation plans (*past and* future)	Increase in capacity & output	Investment cost (mln €)	Rehabilitation due
Globočica	1965	42	*1977 – 1982, 1986, 1992, 2001-2005, 2013-2015*	*Various activities* Replacement of the synchronous generator and rotor on units A and B; Replacement of block transformers A and B; Replacement of energy transformer and auxiliary energy transformers and equipment for own power supply; Reconstruction of OHTL HPP Spilje - HPP Globočica 35 kV; Replacement of accumulator batteries; Replacement of hydraulic and hydro-mechanical equipment; Replacement of pre-turbine butterfly valve of turbine A and B; Conductive apparatus Francis turbine of aggregates A and B	0 MW, 4.4 GWh	5.8	**~2019**
Total		**455**			**3.6 MW / 22.4 GWh**	**20.2**	

Table 4.5: Rehabilitation of existing HPPs (>10 MW) in Montenegro

HPP	Start of operation	Capacity (MW)	*Rehabilitation year*	Rehabilitation plans (*past and* future)	Increase in capacity & output	Investment cost (mln €)	Rehabilitation due
Perućica	1960	307	*1992 – 2012, ongoing*	*Completed: Hydraulic system, HME, I&C[11], switchyard, intake system, new turbine-generator.* Planned: Increase of supply channels capacity, reconstruction & modernisation of EM equipment & control & SCADA systems (Units 5, 6, 7). Reconstruction & modernisation of hydro-mechanical equipment on intake and dam. Hydraulic measurement system. 110&220 KV switchyard reconstruction Optional addition of Unit 8 (58.5 MW). Optional addition of Zeta inflow (45 GWh)	25 MW[12], 25 GWh 45 GWh	38.8 (+21.5 optional) (+26.5 optional)	**ongoing**
Piva	1976	342	*2004 - ongoing*	*Completed: Design & partial intake system equipment, excitation system, 220kV yard, UPS* Planned: Turbine control system, own consumption, 35/10 kV TS, 10 kV, 0.4 kV, control system, dam monitoring system Optional: replacement of TG sets & transformers (56.83 mln €, 67.6 MW, 28.5 GWh) Downstream riverbed dredging (2 mln €, 19 GWh increase of production)		10.2 (+58.83 optional)	~2018

[11] I&C - instrumentation & control equipment

[12] Due to hydraulic issues in intake structures the actual increase in available capacity is expected to be "only" 25 MW.

HPP	Start of operation	Capacity (MW)	*Rehabilitation year*	Rehabilitation plans (*past* and future)	Increase in capacity & output	Investment cost (mln €)	Rehabilitation due
Total		**649**			**25 MW / 70 GWh**	**155.8**	

Table 4.6: Rehabilitation of existing HPPs (>10 MW) in Kosovo

HPP	Start of operation	Capacity (MW)	*Rehabilitation year*	Rehabilitation plans (*past* and future)	Increase in capacity & output	Investment cost (mln €)	Rehabilitation due
Ujmani	1979	35					**2019**
Total		**35**					

Table 4.7: Rehabilitation of existing HPPs (>10 MW) in Serbia

HPP	Start of operation	Capacity(MW)	*Rehabilitation year*	Rehabilitation plans (*past* and future)	Increase in capacity & output	Investment cost (mln €)	Rehabilitation due
Bajina Bašta	1966	422.4	*2009*	*Completed: Rehabilitation of all 4 units*	*54 MW, 200 GWh*	*65.5*	**Finished 2012**
Uvac	1979	36					**2019**
Potpeč	1967	54		Planned: Installation of new unit and rehabilitation of 3 existing units. Commissioning 2023	24 MW, 40 GWh	43	**2022**
Djerdap 1	1972	1,206	*2010*	*Completed: Rehabilitation of 3 units* Planned: Rehabilitation of remaining 3 units	0 MW, 150 GWh	216.5	**~2020**
Djerdap 2	1985	270	*2020*	*Completed: rehabilitation of HME equipment*			**2020**
Pirot	1990	80					**2030**
Kokin Brod	1962	22.5					**~2018**
Vrla 1-4 (HPP Vlasina)	1955	128.5	*2018*	Planned: Complete rehabilitation of HME equipment	9 MW,	60	**2018**
Lisina	1977	28.6					**2017**
Bistrica	1966	104		Planned: Complete rehabilitation of HME equipment	11 MW, 23.4 GWh	18.32	**2019**
RHE Bajina Bašta	1982	614		Planned: Turbines rehabilitation			**2019**
Zvornik	1955	125.6		Ongoing: *Complete rehabilitation; HME equipment, TS, SCADA, I&C*	33.6 MW, 62.5	70	**Ongoing - 2019**

HPP	Start of operation	Capacity(MW)	*Rehabilitation year*	Rehabilitation plans (*past and* future)	Increase in capacity & output	Investment cost (mln €)	Rehabilitation due
					GWh		
Total		**3,092**			**131.6 MW / 475.9 GWh**	**473.3**	

The data presented in Tables 4.2-4.7 above indicate that, taking into account either the stated plans of the plant operators or the required rehabilitations due to a nominal 40-year expected service lifetime, in the next 5-year period (2017-2022), a total of 3,962 MW of HPPs are due for rehabilitation works of varying scope. Summarized investment cost of rehabilitation projects with available data is over 760 mln €. Considering that cost information is not available for significant number of projects, the total cost of coming rehabilitation projects will be significantly higher. To a certain degree, in Serbia and in Albania there is significant HPP capacity where rehabilitation projects seem to be overdue or may become overdue in the coming years unless planning is undertaken immediately. However, before reaching a definite conclusion, a case by case analysis of each plant would need to be undertaken.

A brief analysis of capacity and generation increase in rehabilitation is performed on projects for which sufficient data was available. The following can be concluded

- The average expected increase in capacity is approx. 4% and in generation approx. 5-6%. These averages also include the addition of new unit at HPP Potpeč, which is technically not a rehabilitation, but the addition of a new unit. Within the next 5-year period, the planned increase in capacity in existing HPPs is 152 MW and the planned increase in generation due to rehabilitation projects is 539 GWh. Extrapolating these estimations to include HPPs to be rehabilitated after 2022 as well, the total expected increase in capacity and generation is up to approximately 200 MW and 670-770 GWh, respectively.
- Unit investment, expressed in Euro per added MWh of generation is on average 1,137 €/MWh (however varying widely from case to case, depending on the scope of the rehabilitation). In addition to that, rehabilitation projects often include undertakings not directly related to capacity and generation increase.

Rehabilitation projects are not optional. They are more or less mandatory (as opposed to greenfield projects which are optional). On rehabilitations, the owners decide on the timing, scope and dynamics of their rehabilitation projects in line with their requirements, the actual issues each plant faces and their financing capacity.

A provisional list with the status and reasoning of rehabilitation projects in WB6 HPPs larger than 10 MW is provided in Table 4.8. According to the above, there are four key drivers for rehabilitation:

Safety issues; during the course of this study, the project team did not receive any information on potential safety issues related to existing HPPs. There was some unofficial information that certain safety issues may exist related to HPPs and dams in Albania, however no confirmation was received.

Plant lifetime extension; it is considered that major rehabilitations (usually including changing of key electromechanical equipment like turbine and generator) are key factors for major rehabilitation and plant lifetime extension. Thus, rehabilitation projects including these interventions are considered as major rehabilitations, while others are considered minor.

Environmental improvements; the majority of existing HPP in WB6 region are not equipped with fishpasses, furthermore there are practically no plans for building them during the process of rehabilitation (except for HPP Una Kostela). To our knowledge, there are two HPPs in the capacity range above 10 MW, which have fishpasses: HPP Ujmani (Kosovo) and HPP Zvornik (Serbia). We did not have any reports on the performance of these two fishpasses at our disposal. Issues related to EAF and water usage by HPP in the WB6 region is in detail explained in Section 4.8 of BR-3. So far, we obtained data on determined EAF for five HPPs planned for the rehabilitation: HPP Višegrad and HPP Una – Kostela (BIH) and HPP Shiplje, HPP Tikveš and HPP Globočica in MKD. The vast majority of existing HPPs do not have EAF determined.

Recommendations for REHAB HPP:

1. Data on existing fishpasses and their functionality must be obtained and reviewed by experts (hydrologists, ichthyologists).
2. Fishpasses are the most commonly used mitigation measures, used to mitigate negative impacts of existing HPPs. There are published documents and guidelines that need to be incorporated in order to construct functional fishpasses for the present fish assemblages, with special care for the largest species (Danube salmon, sturgeons) and species with special requirements (European Eel).

3. “Guidelines and technical solutions for restoring river continuity for fish migration, prepared for Danubian countries” by ICPDR (2013a), gives some technical framework for fishpasses, that can be used by different fish communities along the river course, as well as by sturgeons, as the largest fish in the drainage basin.
4. “Guiding Principles on Sustainable Hydropower Development in the Danube River Basin” (ICPDR, 2013b) stress the importance of restoring migration routes of sturgeons in the Danube and major tributaries. Planning new hydropower plants in river sections formerly used by sturgeons must at minimum include sturgeon migration and habitat requirements in the requested EIA, and in dialogue with Priority Areas of EUSDR - PA2 (Energy) is essential. The allocation of funding to restore sturgeon migration at the Iron Gate dams (Djerdap 1 and Djerdap 2) must be pursued with highest priority.
5. Elver and eel passes must be considered for existing HPP on rivers in the Adriatic and Aegean drainage basin.
6. Adoption of legislation, which requires the building of fishpass, is necessary. Monitoring of functionality of fishpasses should be prescribed.
7. Downstream fishpasses, fish friendly turbines, adaptations of the operational mode of spill flow and modifications of hydropower plant management are methods to enable downstream migration (AG-FAH, 2011). Some measures should be applied, especially on the rivers where European eel is, or was historically present and where upstream connectivity for the species is going to be approved.
8. Since EAF methodology is not adopted in legislation in all countries, this should be a priority for them. For areas with conservation status, with high ecological values or areas inhabited with rare or endangered species, special holistic approaches should be planned. Monitoring compliance with the EAF is very important and should also be implemented in legislation.
9. The forthcoming European Commission "guidance document on Natura 2000 and hydropower" is mentioning good practice examples in mitigating impacts and applying ecological restoration measures to hydropower.

The above issues are covered in more detail in Section 3.6.1.1 of BR-3.

Capacity and generation increase; These are recorded in the table below but are not significant except in cases of HPP Potpeč, Bistrica and Zvornik, and potentially Piva and Perućica.

Projects marked green represent a provisional selection of priority rehabilitation projects based on the following methodology:

- Project rehabilitation is either overdue or will become overdue within 3 years;
- Rehabilitation is expected to include significant interventions on capital hydromechanical equipment.

In order to produce a definitive list, more detailed information is required from plant operators.

Table 4.8: Comparative list of rehabilitation needs with green highlighted provisional priority projects

HPP	Capacity [MW]	Rehabilitation due	Planned investment [mln. €]	Rehab overdue or close (and not started)	Rationale			
					Necessary safety measures	Plant lifetime extension / major rehabilitation	Environmental improvements	Increase in capacity / generation
Fierza	500	2016						20 MW / 72 GWh
Bistrica 1	22.5	2002						
Komani	600	2025						
Vau i Dejes	250	2010						
Uleza	25.2	1994						
Shkopeti	24	1996						
Višegrad	315	2029						
Bočac	110	2017						
Jablanica	180	2019	3					10,2 MW / 27

HPP	Capacity [MW]	Rehabilitation due	Planned investment [mln. €]	Rehab overdue or close (and not started)	Rationale			
					Necessary safety measures	Plant lifetime extension / major rehabilitation	Environmental improvements	Increase in capacity / generation
								GWh
Salakovac	210	2022	30					
Una-Kostela	10.1	2020	16.8					3,6 MW
Trebinje 1	171	2008	10					
Bogatići	10	1987	9.2					
Kalimanci	13.6	2010	0.1					
Vrben	12.8	2019	4.6					3,6 MW / 7,1 GWh
Shpilje	84	2020	3.9					3,5 GWh
Tikvesh	116	2018	0.84					0,2 GWh
Vrutok	165.6	2019	4.05					7,2 GWh
Raven	21.3	2018	0.92					
Globočica	42	2019	5.8					4,4 GWh
Perućica	307	Ongoing	38.8 (+36.5)					(23 MW / 64 GWh)
Piva	342	2018	10.2 (+58.3)					(67,6 MW / 47,5 GWh)
Ujmani	35	2019						
Bajina Bašta	422.4	Finished 2012						
Uvac	36	2019						
Potpeč	54	2022	43					24 MW / 40 GWh
Djerdap 1	1206	2020	216.5					150 GWh
Djerdap 2	270	2020						
Pirot	80	2030						
Kokin Brod	22.5	2018						
Vrla 1-4 (Vlasina)	128,5	2019	60					9 MW
Lisina	28.6	2017						
Bistrica	104	2019	18.32					11 MW / 23,4 GWh
RHE Bajina Bašta	614	2019						
Zvornik	125.6	Ongoing-2019	70					33,6 MW / 62,5 GWh

Legend:

overdue or within 3 years	significant	significant rehabilitation	significant measures planned / required	significant capacity / generation increase
within 8 years	minor	minor rehabilitation	minor measures planned / required	minor capacity / generation increase
no data	no data	no data	no data	no data
started or after 8 years	none	completed	none	none

These selected projects (marked with green) sum up to total 3,165 of MW of installed capacity in the priority list for rehabilitation. The total reported expected capacity increase of these projects is 105 to 206 MW or 2.8 – 5.6% (as some of the plants already had been uprated, also for some no information on possible power uprate was available), depending on the feasibility of capacity increase in Piva and Perućica. At the same time, the generation increase is 5.5 – 6.5%.

4.2 Greenfield projects

4.2.1 Preliminary screening

Out of all the projects identified in the research, HPP entries, investigation and data collection campaign, a screening has been conducted to screen the projects suitable for further analysis. The screening was based on the following criteria:

Exclusion of projects in construction

Projects in construction were excluded from further analysis. These projects generally have very little need for further intervention, financial support or similar support. Since they have obtained all the necessary licenses it is assumed that all potential issues and conflicts have been resolved.

Minimum available data criteria

A basic minimum amount of data needed to be known on the projects in order to include them in further analysis. The minimum available data indicates that at least preliminary documentation exists about the project and enables at least basic analysis of the projects.

The minimum data required for the projects was the following:

- location of the project
- installed capacity
- annual electricity generation
- plant type
- required investment
- information on existing project documentation

The criterion of minimum available data was applied to screen out the projects which are not sufficiently developed, i.e. no developer has found even a minimum interest to perform at least a preliminary analysis which could provide the minimum required data.

Projects above 10 MW

This criterion eliminated all individual projects below 10 MW. Individual projects below 10 MW that are a part of a cascade where the majority of the projects are above 10 MW were included in the analysis. Cascades where most of the projects are below 10 MW are excluded.

This size limit is imposed for two reasons: 10 MW is the size which is eligible for financial support schemes throughout the WB6, thus the type of developers and the nature of many development issues (particularly financing) is different than for HPPs which are to compete on the electricity market. In addition, already in the Scoping stage it has been established that large projects (over 10 MW) give the major overall contribution in energy yields and added installed power and thus are much more significant from the system and strategic point of view. Lastly, even with the limit of minimum 10 MW, 480 HPP projects remained identified in the region. An even larger number would make any detailed analysis within the approved resources virtually impossible.

Only one variant of each scheme

In cases where several variants of a particular hydro scheme were identified, or several variants of a project were identified, only one variant has been selected for further analysis. That variant was selected in accordance with expert assessment of the most probable variant to be further developed.

Projects that were screened out were mainly (if their location was known) included in the GIS, however their MCA ranking is noted “0”.

The application of the above criteria resulted in the overall number of projects to be further analysed decreasing to 136 MCA1 projects.

Figure 4.3 shows the number of HPP entries in each of WB6 countries that were screened for further analysis in MCA1; HPP candidates and the number of projects which were eliminated based on the above criteria.

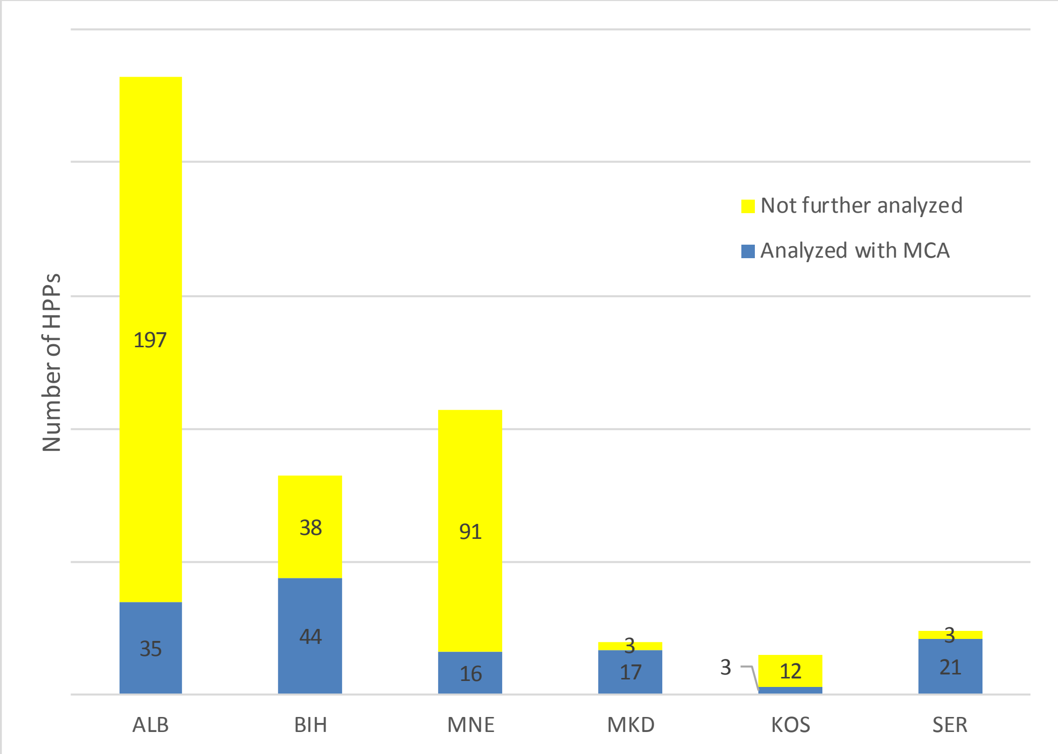


Figure 4.3: Number of HPP candidates and screened out HPP entries in WB6

It can be noted that most of the projects were identified in Albania. That is in line with several very large concession programmes issuing tenders in which a total of over 170 concessions were issued for over 500 individual HPP projects.

A number of projects that were screened out in BIH is a result of both projects smaller than 10 MW and of a lack the minimum data required for some projects.

Montenegro is a specific case where a number of projects are still in the phase of variants: it has not been decided which is the preferred option, and generally the level of project documentation is relatively low. For these reasons, several projects have been screened out in Montenegro.

The following analysis will consider only the projects which were subjected to further MCA analysis, the so called HPP candidates. Within this study, a total of 136 greenfield HPP candidates (HPP candidates) were identified. Data on other projects is also stored in the database, so they can be used in case some of these projects become interesting for development or analysis.

Figure 4.4 shows the greenfield HPP candidates that were identified and screened within this study.

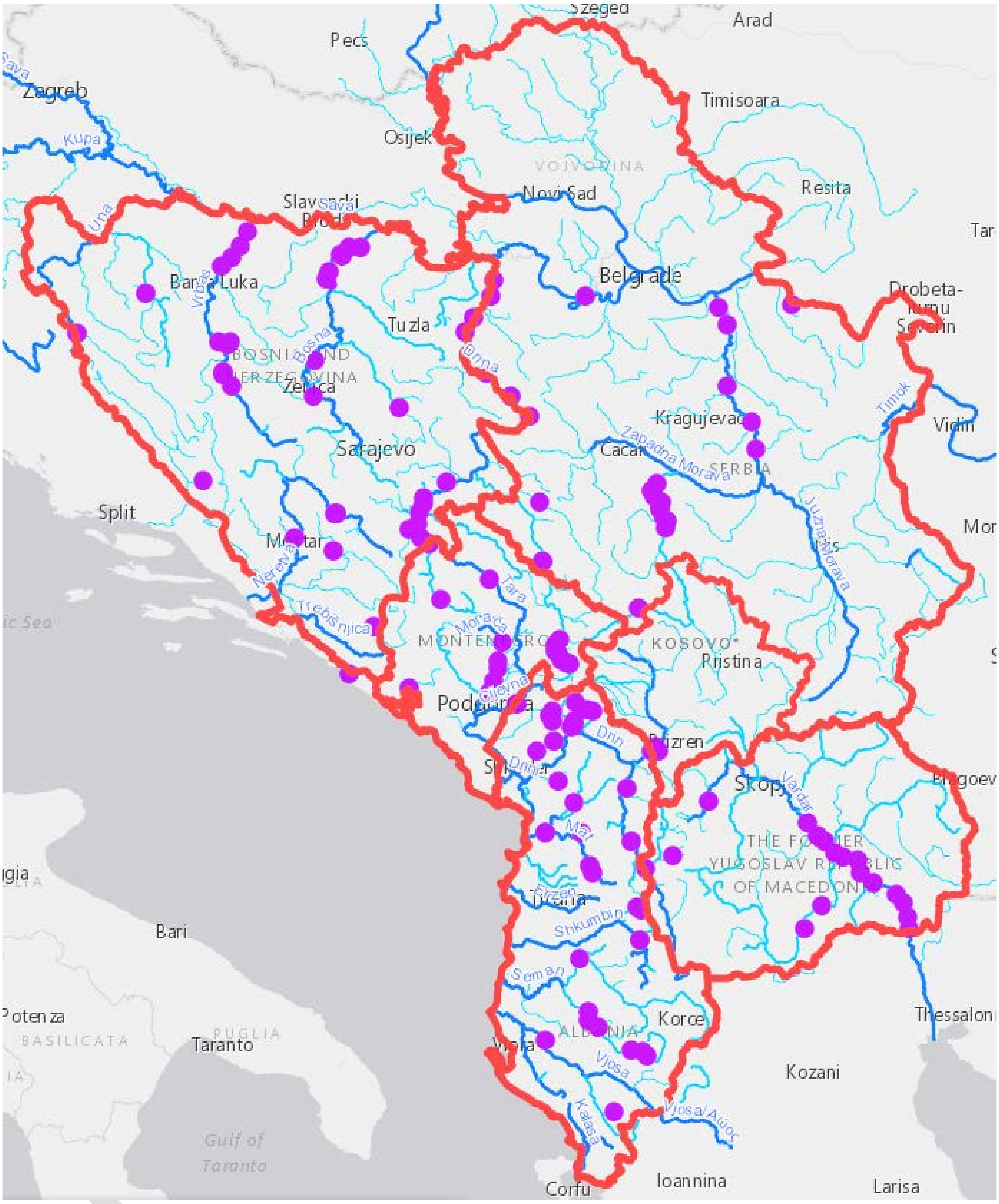


Figure 4.4: Screened greenfield HPP candidates in WB6

A detailed list of all projects is enclosed in subsequent sections.

4.2.2 Total capacity

The total capacity of 136 HPP candidate projects per country and per the size of the plant, with particular note to reversible HPPs is given in Figure 4.5.

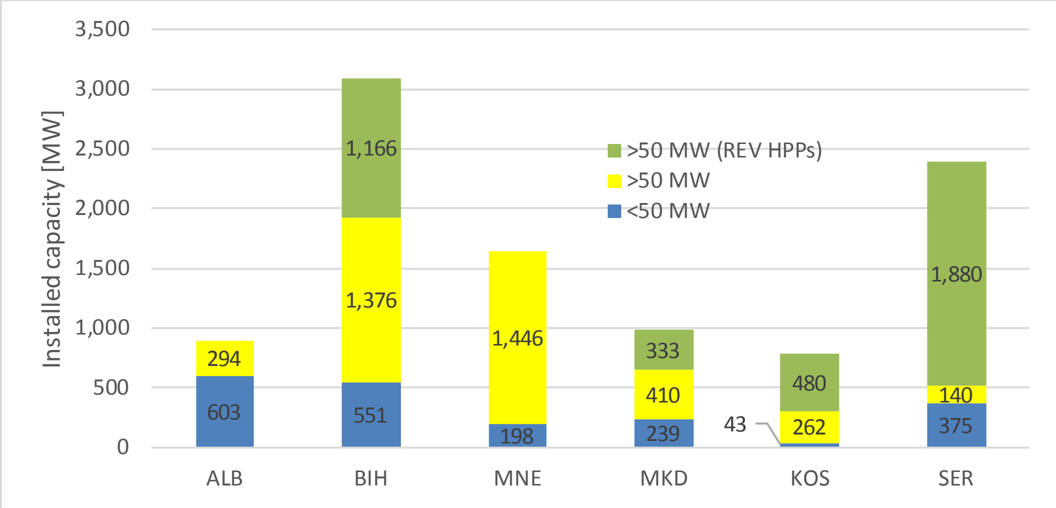


Figure 4.5: Total capacity of greenfield MCA1 HPPs

BiH contributes the most to the potential added capacity, with Serbia also representing significant contributions, both augmented with significant reversible capacity potential. Note that all per country analysis in Section 4 is performed by assigning the cross-border projects to the country that nominated the project. For example, even though it is a cross-border project between BiH and Serbia, the Srednja Drina cascade has been counted as a BiH project since it was nominated by ERS.

The total capacity of 136 HPP candidates in the WB6 is also given in Table 4.9. It can be concluded that there is significant additional potential in all WB6 countries. This can be observed both in absolute terms and when compared to current installed capacity in each of the WB6 countries.

Table 4.9: Total capacity of HPP candidates in WB6 (MW)

MW	ROR	RES	REV	Total
ALB	390	507	0	897
BIH	712	1,216	1,166	3,093
MNE	11	1,633	0	1,644
MKD	211	438	333	982
KOS	0	305	480	785
SER	468	47	1,880	2,395
Total	1,792	4,146	3,859	9,797

Note: ROR - Run-of-river, RES - Reservoir, REV - Reversible.

4.2.3 Total energy production

The total planned production of HPP candidates is given in Figure 4.6.

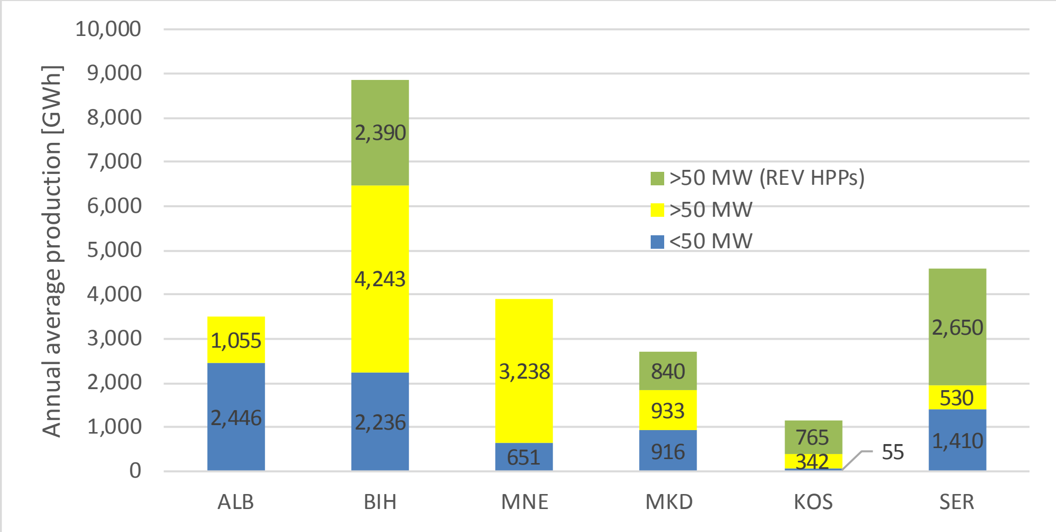


Figure 4.6: Total electricity generation of HPP candidates

The total electricity generation of 136 HPP candidates in the WB6 is also given in Table 4.10 below.

Table 4.10: Total electricity generation of HPP projects in WB6 (GWh)

GWh	ROR	RES	REV	Total
ALB	1,710	1,790	0	3,500
BIH	2,954	3,525	2,390	8,869
MNE	35	3,855	0	3,889
MKD	896	953	840	2,690
KOS	0	398	765	1,163
SER	1,864	76	2,650	4,590
Total	7,459	10,597	6,645	24,701

Similar to capacity, the potential for additional generation is significant, both in absolute terms and in terms relative to countries current electricity consumption and the future projections. Current electricity demand in WB6 is approximately 65 TW, and projections up to 2030 are approximately 80 TWh as per the results presented in BR-1. Comparing this with the total potential of greenfield HPPs of 18 TWh (not including Reversible HPP's which negatively contribute to the net energy balance) it is obvious that, at least theoretically, only greenfield HPPs can meet the projected increase in demand. The figures above can be compared to the projections on the electricity demand and the generation portfolio mix as discussed in BR-1.

The above generation estimations were based on the inputs provided by the project promotors. Although not so significant for the summaries presented above, it should be noted that it has often been proved that the generation estimations of individual projects turned out to be significantly overstated. This is largely due to the insufficient, erroneous or outdated hydrological data used to produce these generation estimations.

4.2.4 Overall development status/maturity

A simplified table/classification of the project maturity has been used as developed in BR-2 for the purposes of the preliminary assessment of projects' maturity. Maturity categories are defined as follows:

PF; prefeasibility study developed
FS; feasibility study developed
EP; environmental permit obtained
CP; construction permit obtained, or in process
UC; under construction

Figures 4.7 – 4.9 below present the maturity status of HPP candidates.

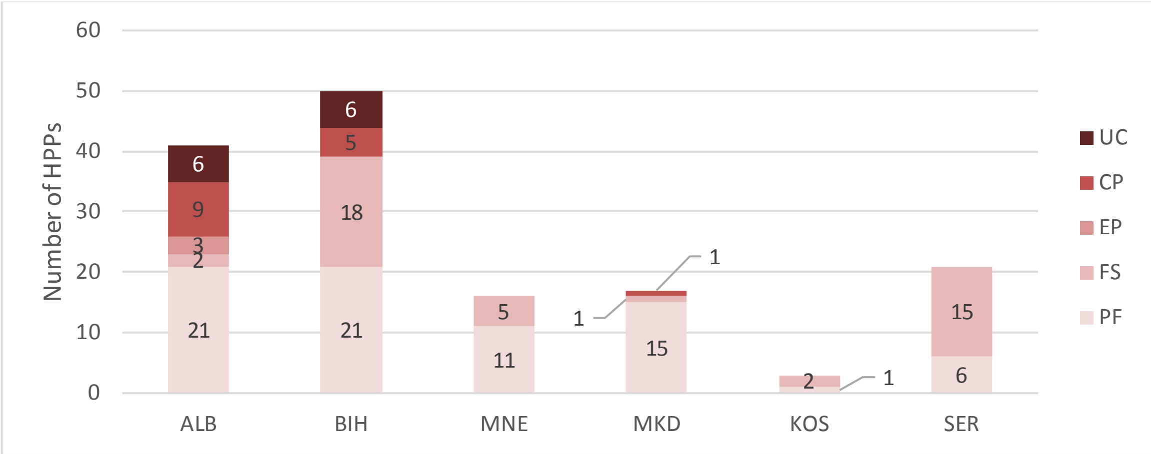


Figure 4.7: Number of HPP candidates by maturity and per country

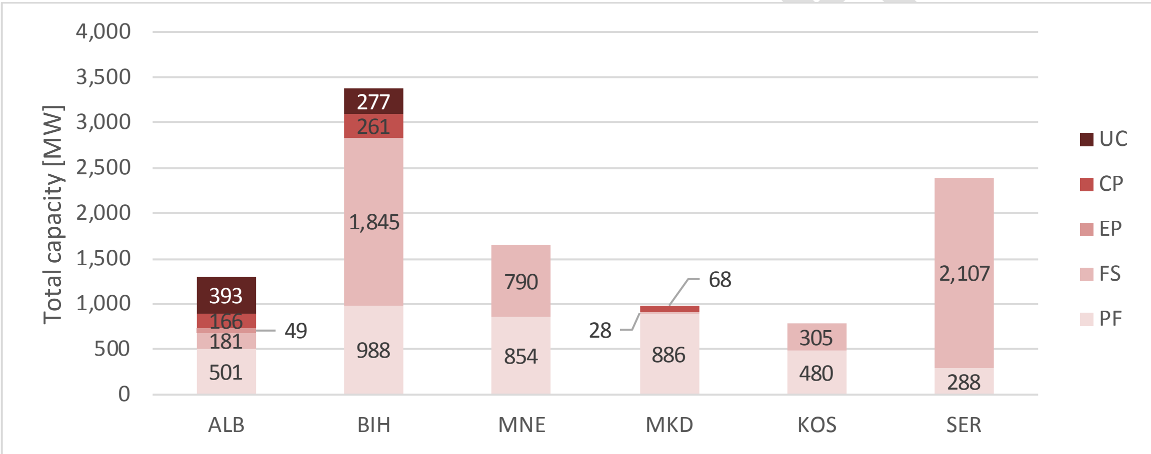


Figure 4.8: Total capacity of HPP projects by maturity and per country (MW)

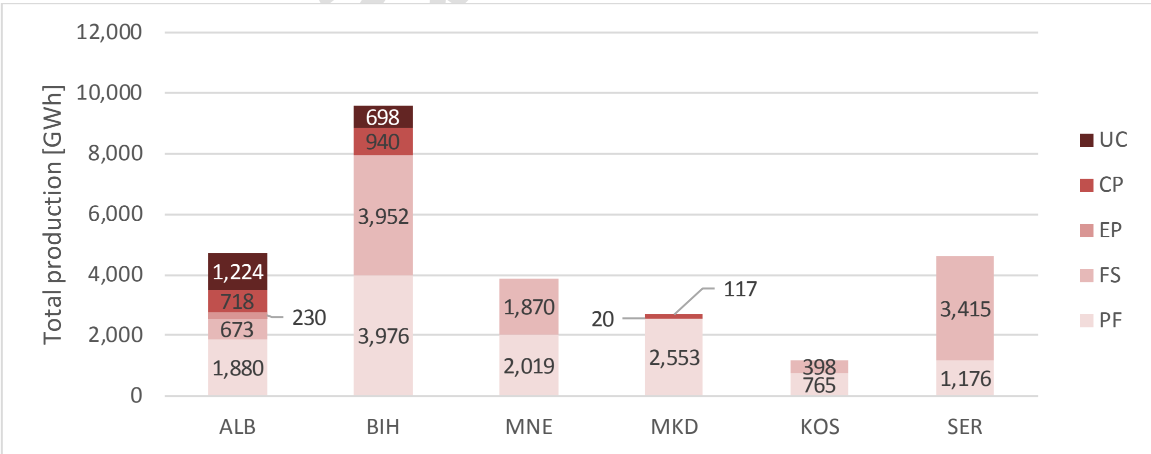


Figure 4.9: Total generation of HPP projects

Even though many HPP candidate projects have been identified in the course of this study, only a few of them are at an advanced stage of development; i.e. having construction permit obtained or in process; 9 projects in Albania, 5 in Bosnia and Herzegovina and one in the former Yugoslav Republic of Macedonia. The total capacity of these projects is 481 MW. These projects are as follows:

ALB: Pesqesh, Suha, Shkopet 2, Shkopet 3, Gomsiqe 1, Mollas, Seke, Begaj, Kiri 1

BiH: Buk Bijela, Paunci, Foča, Cijevna 3, CHE Vrilo

MKD: Boškov Most

Even considering the late stage of development of some of these projects, it is still uncertain when, or even whether their construction will start, particularly considering the difficulties some of these HPPs are facing. More details on the projects are provided in the following sections. All other projects are in pre-feasibility or feasibility phase. This points to two conclusions:

- Very little additional generation from large hydro can be implemented in the near-term period.
- Significant effort should be put into developing the documentation for the most promising projects.

In addition to the relatively low level of documentation developed, some of the projects have outdated documentation, i.e. in practical terms the documentation needs to be at least revised if not completely redone. Figure 4.10 illustrates the distribution of the age of the HPP project documentation.

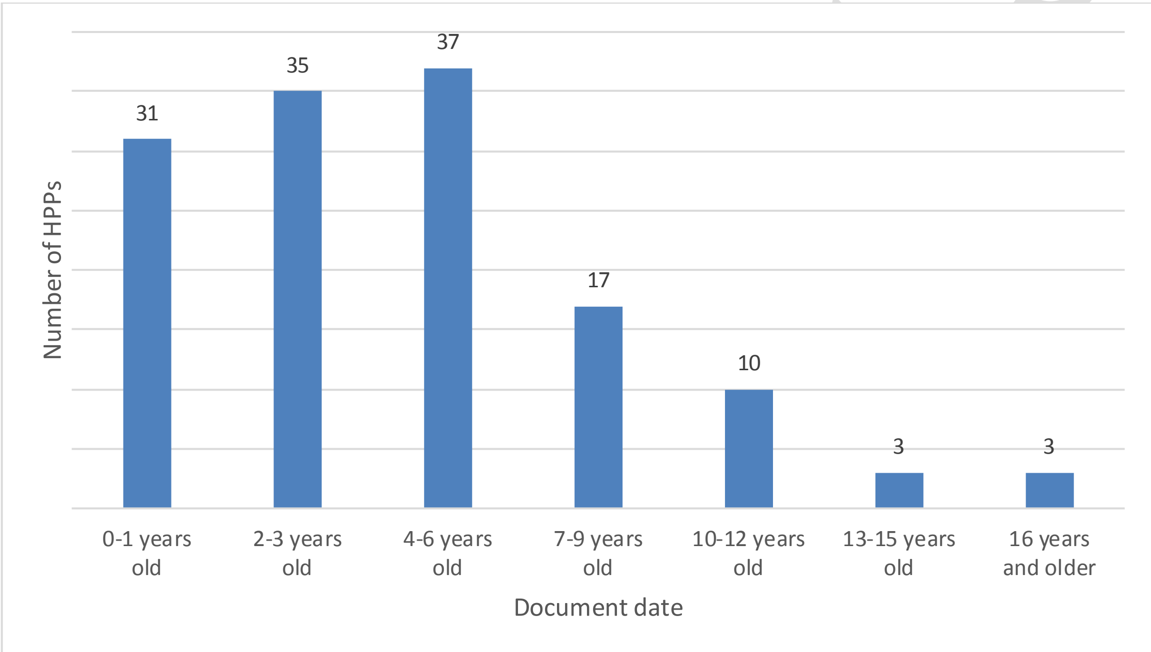


Figure 4.10: Age of the most recent documentation on HPP projects

Regarding electricity market changes, it can be considered that all projects having documentation older than 3 years need to have their feasibility assessments revised. That means that 70 out of 136 projects need to revise their feasibility assessments.

That is particularly emphasised having in mind the turbulent changes in the electricity markets in past 10 years; considering both the electricity market prices changes and creditors/investors' appetite for risk and related cost of financing. The financial environment has thus significantly changed and assumptions used in feasibility analyses from 5 or more years ago are often very much off the mark. Much of the analyses was performed approximately 8 years ago, i.e. in 2008 or even earlier; practically before the great financial crisis. Similar relevant observations can be made also for the electricity market prices; in the range of 100 €/MWh in 2008, and approximately 40 €/MWh in today's electricity markets.

Other issues were also encountered in assessing the maturity of the projects. These made the comparison of project maturity in different countries very challenging. The main issues are listed below:

- The understanding of the level of documentation development varies from country to country and from one project promoter to other. It is often found that a document is referred to as a feasibility study even though it contains only basic analysis, i.e. it is at the prefeasibility level based on the understanding of other promoters.

- Licensing and permitting procedures vary from one country to another, similar permits/licences sometimes are named differently from one country to another. Also, similarly named permits may be issued at different stages of licensing procedure from one country to another.
- Construction permits (possibly also others) may sometimes be issued only for a part of the project while other components of the project still do not hold a permit. This difference was not recognised in data collection.
- Some permits the project is reported to hold may soon expire (or even may have expired during the process of the data collection)
- Documentation developed for the project, if outdated, may sometimes be completely irrelevant if the project circumstances have changed such as: spatial planning or actual use of space, environmental requirements, market and financial conditions and similar.

Interface with IOLR

Within BR-4 (Tasks 2 and 3), a detailed analysis of IOLR regimes in all WB6 was conducted. That resulted in considerations comparing the maturity of projects in different countries. Data presentation on the maturity of projects is presented in a simplified manner in line with the paragraphs above; however, in the MCA analysis of each of the projects, country-specific considerations have been taken into account.

Projects in construction

Projects currently in construction were not evaluated in the MCA analysis, nor are included in analyses presented in this report. They are also not included in the evaluation of existing HPPs presented in BR-1. They are therefore presented in Table 4.11 (only projects above 10 MW capacity).

Table 4.11: HPPs above 10MW capacity, currently in construction

Project name	Owner / promotor	Country	Installed capacity (MW)	Average annual electricity output - (MWh)	Plant type	River basin	Usable reservoir storage - (MWh)	Total normalised investment cost (mil. €)	Additional information
Gjorica / Okshtun+Trnove+Lubalesh 1	DITEKO L.td	ALB	14.95	76,581	ROR	Drin-Bune		21	Installed capacity of entire cascade is 30.65 MW. Concession granted 2009.
Gjorica / Lubalesh 2+Gjorice	DITEKO L.td	ALB	1.,86	47.361	ROR	Drin-Bune		22	Installed capacity of entire cascade is 30.65 MW. Concession granted 2009.
Dragobia	Dragobia Energy L.td	ALB	15.44	60,988	DER	Drin-Bune		18	Some reports say 22.76 MW. Concession granted 2009.
Fani / Fangu	AS energji shpk / Ayen Energji AS	ALB	74.6	221,400	ROR	Mat	49,079	177	Concession granted 2011.
Devoll / Moglice	Devoll Hydropower Sh.A. / Statkraft AS	ALB	177	468,000	RES	Seman	114,974	591	Concession granted 2009.
Vjosa / Kalivac	Kalivac Green Energy L.td	ALB	100	350,000	ROR	Vjose	224,098	132	Activities from 1997-2007 and stopped since. Initiative to stop further development on Vjosa and its tributaries due to environmental concerns. Dispute between Italian concessionaire and Alb government. Investor started an ICSID case.

Project name	Owner / promotor	Country	Installed capacity (MW)	Average annual electricity output - (MWh)	Plant type	River basin	Usable reservoir storage - (MWh)	Total normalised investment cost (mil. €)	Additional information
									Concession granted 2007.
Bistrica casade / B-1	HE Bistrica d.o.o. Foca / ELEKTROPRIVREDA " Republike Srpske, Elektrodistribucija a.d. Pale, KALDERA COMPANY d.o.o. Laktasi, BDY Czech, a.s.	BIH	10.7	42.600	DER	Sava		0	Ministry of Industry, Energy and Mining is responsible for this project.
Bistrica casade / B-3	HE Bistrica d.o.o. Foca / ELEKTROPRIVREDA " Republike Srpske, Elektrodistribucija a.d. Pale, KALDERA COMPANY d.o.o. Laktasi, BDY Czech, a.s.	BIH	16.1	62,430	DER	Sava		0	Ministry of Industry, Energy and Mining is responsible for this project.
Mrsovo	Comsar Energy Hidro d.o.o. Banja Luka / Comsar Energy Group Ltd	BIH	36.8	140,600	RES	Sava		99	
Vranduk	Elektroprivreda BiH	BIH	19.63	96,380	ROR	Sava		64	Construction contract awarded to Končar-Strabag consortium.
Gornji Horizonti / Dabar	Hidroelektrane na Trebisnjici and Elektroprivreda Republike Srpske	BIH	159.15	270,600	DER	Trebišnjica	42,416	178	
Ulog	Energy Financing Team d.o.o. (BiH) Trebinje / EFT Investments PLC/EFT HE „Ulog" d.o.o	BIH	35	85,000	DER	Neretva		66	Construction delays due to unanticipated issues regarding geological conditions on site.
Total			670.23	1,922,300				1,367	

A total 12 HPPs larger than 10 MW are currently in construction in the WB6, with total capacity of 670 MW and planned generation of 1,922 GWh. That additional capacity and generation is expected to become available in the system in the coming years[13]. Total investment is estimated at over 1,3 bln € (data are not available for all projects). 6 of 12 are located in Albania and 6 in Bosnia and Herzegovina. Other WB6 countries currently have no HPPs in construction.

4.2.5 Overview per river basin

Promoting the integrated river basin approach to HPP development in the WB6 is one of the goals of this study. The graphs below present the analysis of HPP development projects per river applicable river and sub-river basins as classified in the BR-2 on hydrology. Figure 4.11 - Figure 4.13 show the number of projects, their planned capacity and the planned generation per each river basin and per plant type.

[13] It seems that in the construction of HPP Ulog, the investor has encountered issues regarding the geology of the site and that modifications to the design will be required.

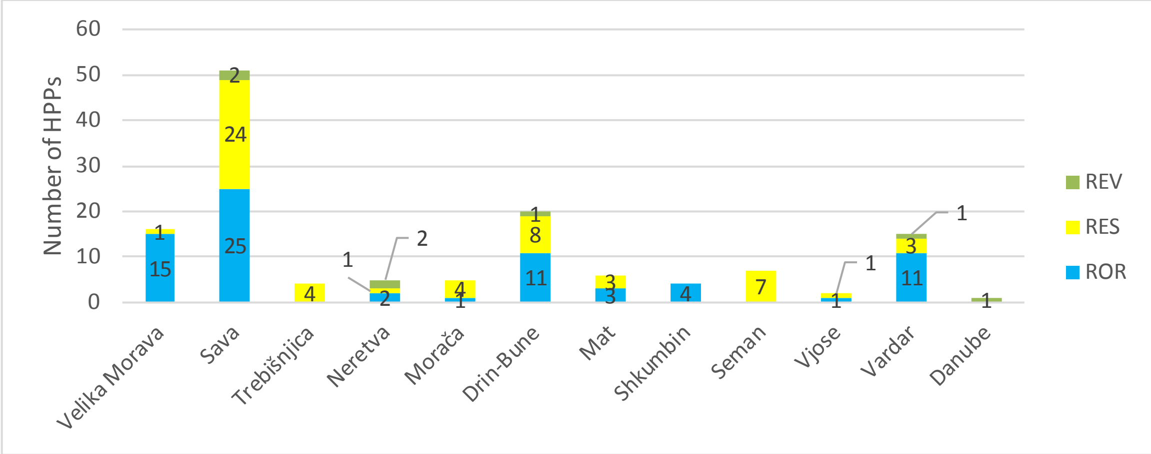


Figure 4.11: Number of HPP projects per river basin

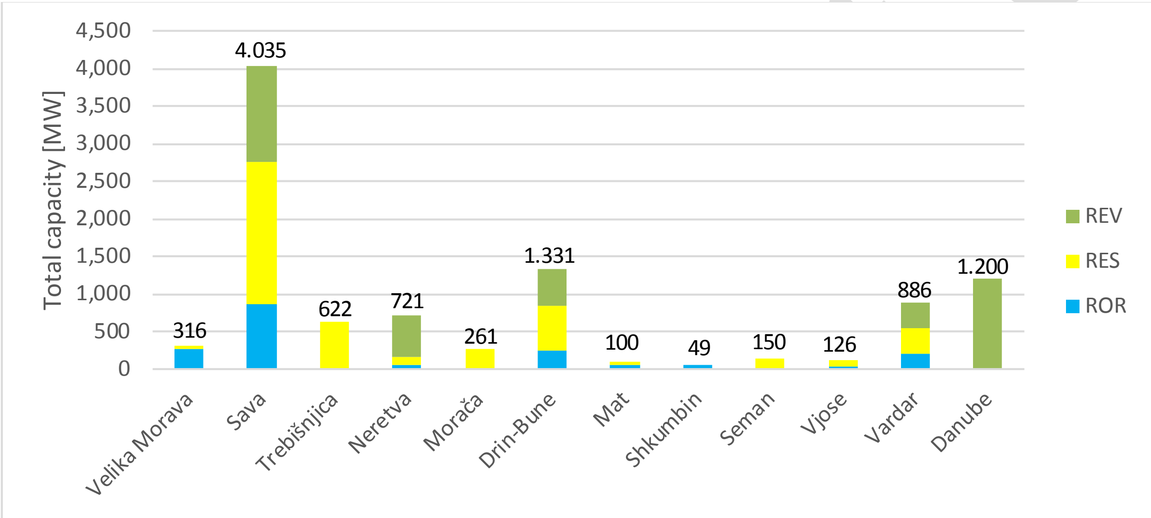


Figure 4.12: Total capacity of HPP projects per river basin (MW)

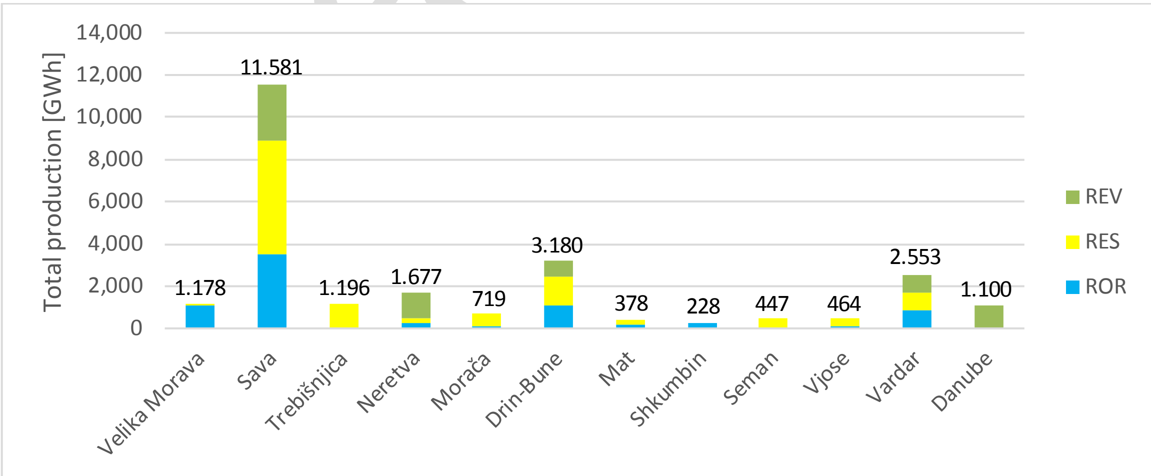


Figure 4.13: Total generation of HPP projects per river basin (GWh)

It can be seen that Sava sub-river basin has the largest remaining exploitable hydro-energy potential. The figures presented here can be compared versus the assessed remaining hydro-potential as presented in BR-1.

The Neretva river basin includes also the contribution from CHE Vrilo on the river Šuica. The River Šuica is a swallet; however for simplicity it has been included with Neretva river basin. The Danube (with Đerdap 3 HPP) on the other hand is shown separately although not a river basin according to the classification laid out in BR-2.

4.2.6 Total estimated investment

Following the analysis of the maturity status of HPP candidates, the total investment in HPP candidates is presented with considerations of maturity below in Figure 4.14.

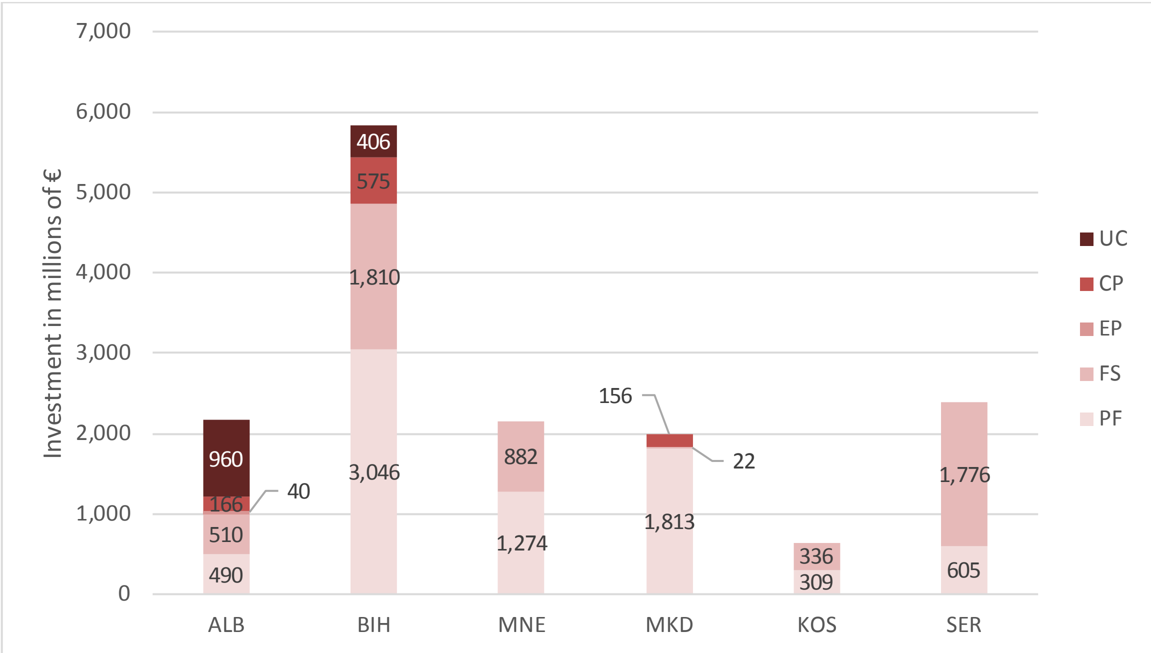


Figure 4.14: Total investment in HPP projects in WB6 (mln €)

The total investment of all HPP candidates is estimated at 15 bln €. Considering the status of development of projects, these financing requirements are not immediate, but will be distributed over the coming years.

4.2.7 Specific investment

Prior to the MCA1 analysis and results, several preliminary comparisons were conducted to provide initial information on HPP candidates.

Comparison of specific investment costs was especially interesting. Specific investment costs provide a very good indicator of the financial feasibility of the plant.

Due to the varying capacity factors of the projects, specific investment cost per annually generated MWh (in €/MWh) is a more relevant measure then specific cost per MW of installed capacity. It is shown in Figure 4.15.

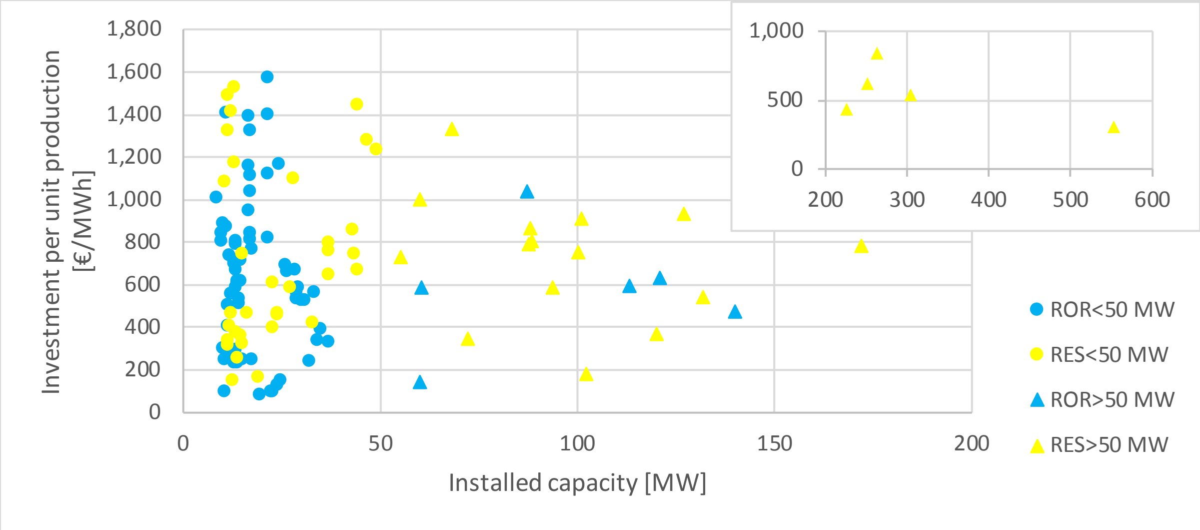


Figure 4.15: Specific investment cost per annually generated MWh of HPP candidates

Very large plants are shown in a small frame in the upper right corner of the figure. Data on the specific investment costs are scattered, ranging from below 200 €/MWh to 1,600 €/MWh. The trend of specific costs per MWh decreasing with the increase of the size of the plant is not so obvious.

It should be kept in mind that cost (investment) information is coming from documentation of various levels of detail and accuracy (from preliminary analysis to bankable feasibility studies). Also, certain documentation is relatively old, so might not reflect the current prices[14], legal and other requirements.

Similarly, Figure 4.16 shows the specific cost of HPP candidates per installed capacity (€/MW).

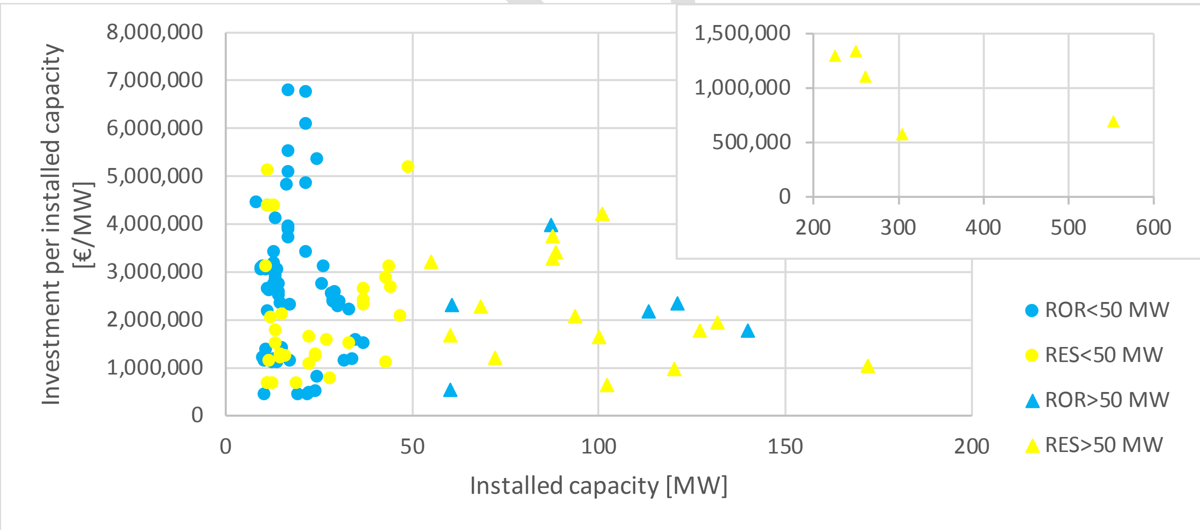


Figure 4.16: Specific investment cost per installed capacity of HPP candidates

The effect of economies of scale; specific cost per MW and per MWh decreasing with the size of the plant can be observed as shown in Table 4.12. Reported investment costs for several HPP projects seem to be unrealistically low, as they result in specific investment costs of well below 1 mln €/MW. Such cases are mostly observed in Albania, for smaller, privately developed projects. This suggests that the quality of documentation is inadequate.

[14] As a partial measure to alleviate this issue, all prices from the documentation were adjusted for inflation and levelized to 2016.

Table 4.12: Average specific investments per plant size and per country. In €/MW and €/MWh

€/MW	<50 MW	>50 MW	Total
ALB	1,414,911	1,201,727	1,345,047
BIH	2,978,368	2,241,597	2,452,190
MNE	3,166,771	1,057,793	1,311,393
MKD	3,683,027	1,779,229	2,480,690
KOS	1,101,194	1,101,194	1,101,194
SER	2,513,637	1,785,714	2,315,759
Total average	2,484,502	1,587,422	**1,890,930**

€/MWh	<50 MW	>50 MW	Total
ALB	349	335	345
BIH	734	727	730
MNE	961	473	554
MKD	961	782	871
KOS	855	843	845
SER	668	472	615
Total average	647	603	**622**

The specific investment cost per MWh of generated electricity can be easily compared against the prices of electricity on the market. That gives a rough and quick indication of the scale of duration of the simple payback period (not taking into account the time value of money, nor construction time). Comparing the figures presented in Table 4.12: vs the current market prices of electricity of approximately 41 €/MWh[15] reduced for the average estimated OPEX of 10 €/MWh provides at least part of the explanation why it is so difficult to reach an investment decision on greenfield HPP projects today; the market prices are very low and unfavourable for the development of capital intensive projects such as hydropower. The specific investment per annual generation (€/MWh) was divided by the current market price of electricity (reduced for estimated OPEX) to obtain a rough estimation of the number of years required for simple payback. The results of this simple exercise are presented in Figure 4.17.

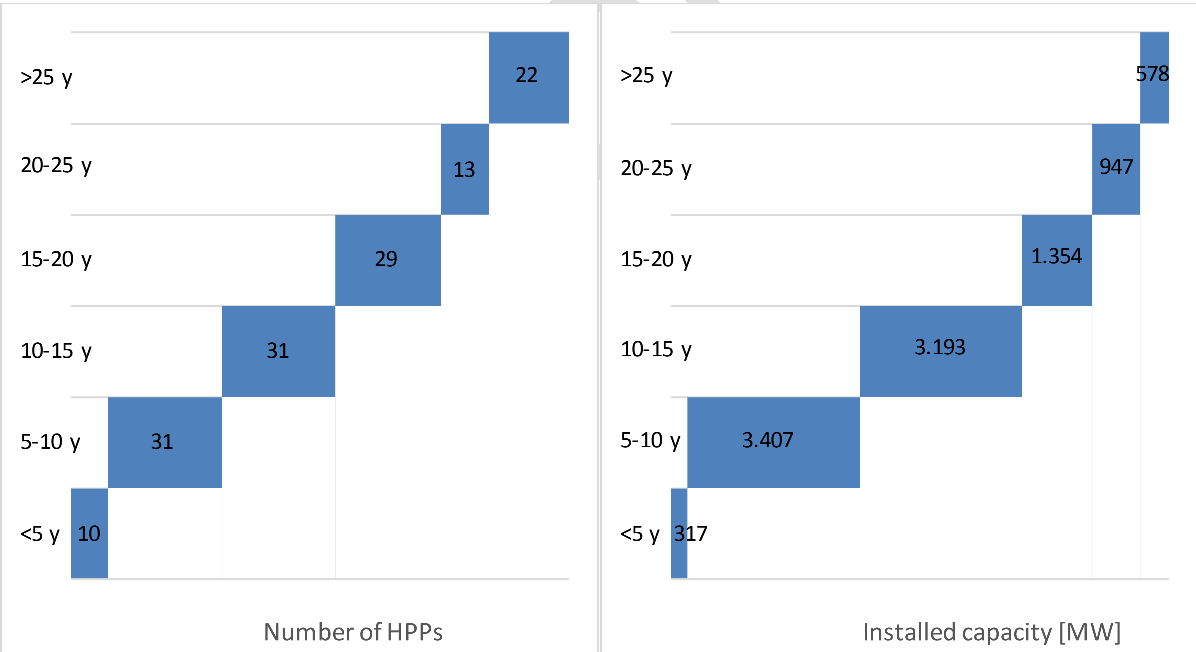


Figure 4.17: Rough estimation of the simple payback period for HPP candidates, with estimated OPEX

OPEX costs were obtained only for a fraction of the HPP candidates. The analyses of these projects expressed in OPEX per MWh of annual generation are given in Figure 4.18. For the purposes of this analyses, average OPEX costs can be assumed to be approximately 10 €/MWh.

[15] Mean of HUPX peak and base futures for 2018; in April 2017. www.hupx.hu

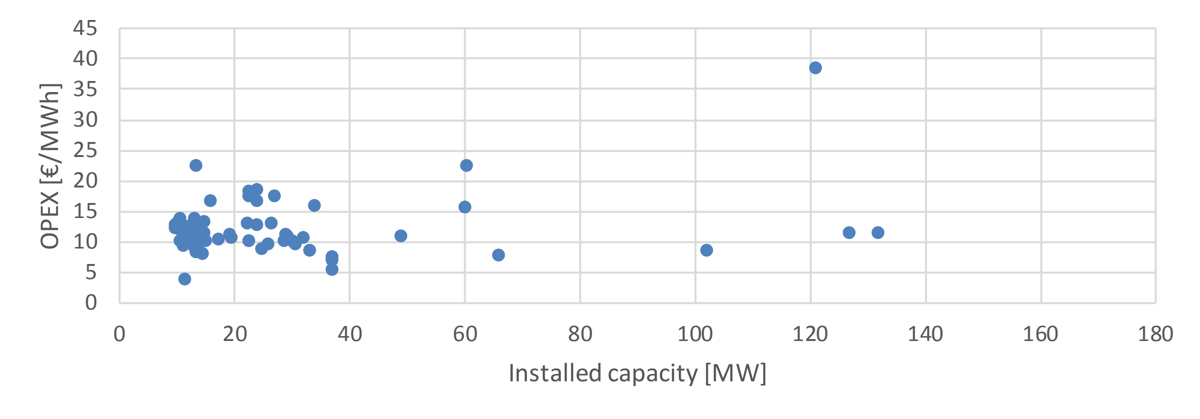


Figure 4.18: Unit OPEX costs of HPP candidates

It can be observed that the simple payback period of the largest number of projects is over 25 years, which makes these projects very challenging for financing. The insight gained through the preliminary analysis presented above can be used as a rough indicator of the investment considerations and financing terms required by these projects.

Market liberalisation and the absence of PPAs for large hydro power projects, exacerbated by other market insecurities (boiling down to price and volume risks) are in direct contrast to the long-term nature of hydro power project investments.

Hydro-power projects often have significant multidimensional effects (flood protection, irrigation, etc.). These are usually a challenge to identify if they are positive or negative, to quantify and an even larger challenge is to establish the direct beneficiary of these effects. That, together with historical reasons, are the key to why usually vertically integrated power utilities are the promotors and sole investors in HPP projects in WB6. However, today's utilities are participants in the open energy markets and are reluctant to accept non-energy related costs of HPPs, including environmental mitigation measures to enhance sustainability.

Efforts in the future that would facilitate the implementation of these multidimensional, beneficial projects should be designed in such a way that all the beneficiaries of the projects are identified and the investment cost is allocated accordingly. The non-energy generation parts of the HPP investments should be eligible for support, potentially via pre-accession (and later structural) EU funds.

The long-term horizon of HPP projects and multidimensional benefits makes close cooperation between the state (and even states-neighbours) almost an imperative for the development of such projects. State commitment should be in terms of i) reducing the risks that can be managed by the state, ii) helping to identify beneficiaries of multidimensional effects of HPPs and mediating between them to properly address the benefits and divide the investment and other costs, iii) mandating and facilitating integrated resource planning.

Concerning the liberalised market, investments in new generation capacities would greatly benefit from the existence of effective regional electricity, balancing and ancillary services markets. This includes both the full implementation of third energy package and also the establishment of effective and sufficiently liquid national or regional markets.

Reversible HPPs specific investment

Because of their specific purpose and construction elements, reversible HPP candidates are not included in the above analysis in Section 4.2.7.

Reversible HPPs are a specific case, as their net energy generation is very small or negative and their gross energy generation is not a function of the water inflow. Another key parameter when considering reversible HPPs is their usable reservoir storage. Data are given in Figure 4.19. Specific investment of 5 out of 7 reversible projects is in the range 0.5 – 0.7 mil €/MW. The usable energy storage of analysed reversible projects in total sum up to 464 GWh.

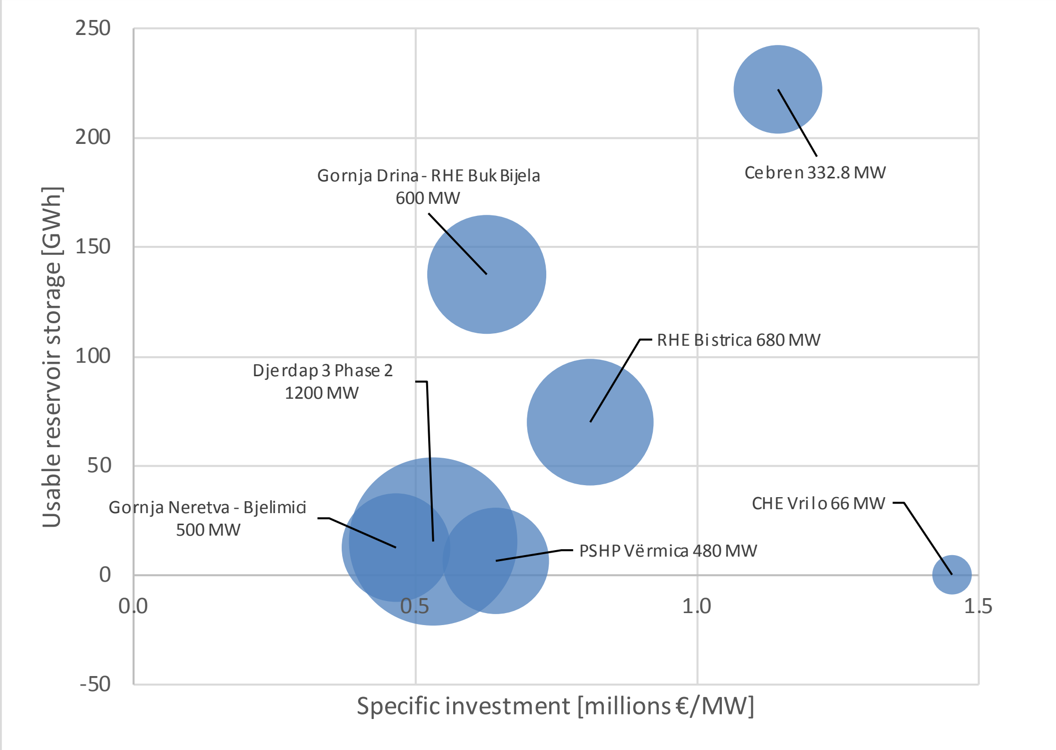


Figure 4.19: Reversible HPPs specific investment vs. installed capacity and usable reservoir storage

4.2.8 Capacity factor

The capacity factor of the project indicates the quality of the hydrological conditions on one side and the relative sizing of the turbines to the available water flow. Figure 4.20 depicts the analysed capacity factors. Plants larger than 200 MW are shown in the small frame in the upper right corner.

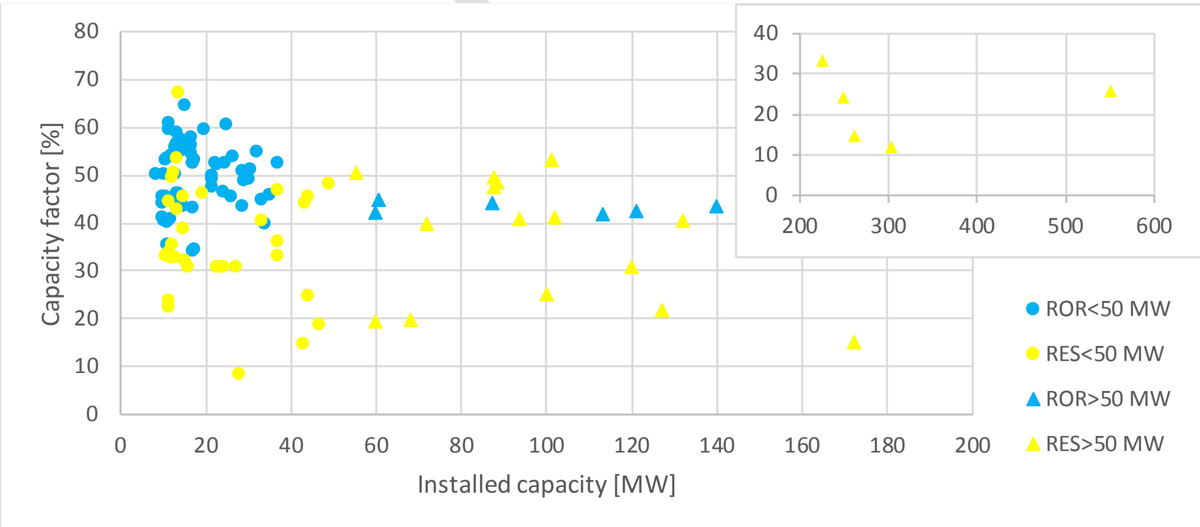


Figure 4.20: Capacity factors of HPP candidates

On average, run-of-river projects have slightly higher capacity factor of 49.2%, while reservoir projects have an average capacity factor of 34.5%.

4.2.9 Reservoir plants analysis

Reservoir plants can add significant value to the operator - as they can provide daily, monthly, seasonal or even yearly energy storage and can provide significant operational flexibility to their operator. A comparison of planned additions in terms of added energy storage per country is presented in Figure 4.21.

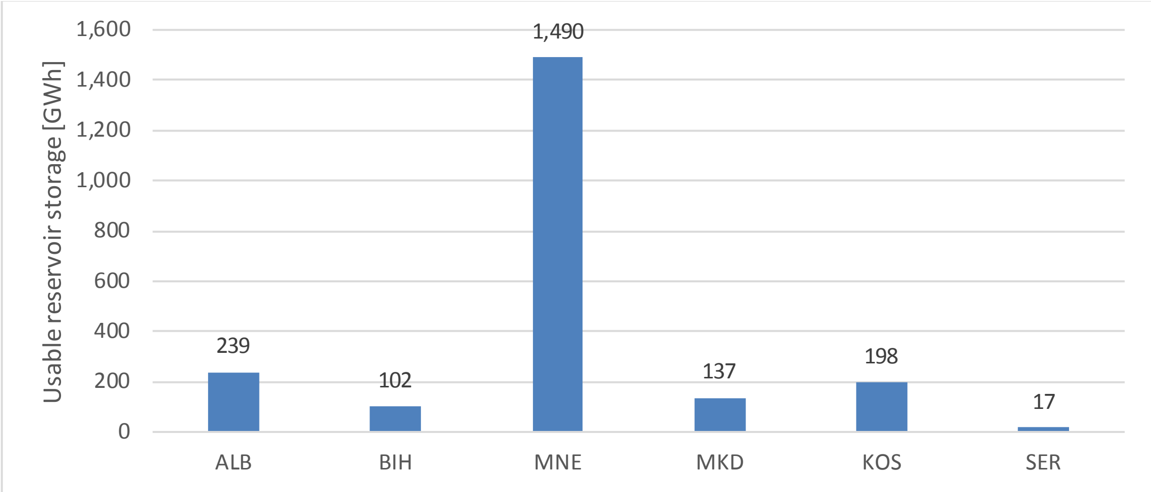


Figure 4.21: Planned additional usable reservoir storage per country (in GWh)

In total, HPP candidate projects could add additional almost 2,182 GWh of energy storage (not including 464 GWh of storage in reversible projects)

4.2.10 Environmental aspects of greenfield HPP development

The construction and management of hydropower plants affects many aspects of the environment, provoking many consequences, both positive and negative, upon the environment, ecosystems and society.

In order to avoid irreversible damage to the environment and natural values and resources, the full scope of environmental impact assessment must be conducted prior to HPP construction. The first step should be the development of HPP planning document(s); strategies, plans or programmes, if missing. Parallel with planning document, a strategic environmental assessment (SEA) must be conducted at earliest stage to analyse variants, recognise possible negative effects and give general guidelines for the next phases of HPP development. The next step is to conduct an environmental and social assessment, focused on proposed HPP location(s).

The environmental and social assessment (EIA, ESIA) should be focused on developing a set of measures to mitigate expected impacts to acceptable levels wherever possible. Alternative mitigation measures should be developed and the effectiveness of the proposed measures must be estimated after implementation, so an adequate monitoring programme must be proposed. If monitoring results are negative, one or more measures should be adopted or added to already existing set of mitigation measures.

The cumulative effects should be assessed against a maximum development scenario of HPPs to determine the theoretical overall cumulative effect, already in the SEA phase on strategies, plans and programmes (including energy ones) and then in more detail at project level, depending on the proposed HPP location. The main focus of cumulative effects must be on sediment transport, water balance and migratory fish obstacles.

For a detailed quantitative assessment of cumulative impacts assessments (relating to, for example, water flows, sedimentation transport, fish paths) by river basin, one needs to have; (i) an integrated water management plan, (ii) a plan of construction of HPPs (small and large) on the main water streams and tributaries including the dynamics of their commissioning, (iii) Natura 2000 designated areas with target species list, and the conducting of an Appropriate Assessment (AA) according to Article 6 of the Habitats Directive etc. In practice, these preconditions are not fulfilled in the WB6 region at present but priority should be given to fulfil them as soon as possible.

The full scope of environmental and social impacts of hydropower projects depends on many intertwined factors, but mainly on project size, type or technology used and the site's local conditions regarding environmental conditions and social features of local population. The impacts of each HPP project are quite unique, however, it is possible to distinguish the impacts on environment and local population between two traditional types of power plants: large HPPs and small HPPs. Large HPP projects with large dams and large surface accumulation reservoirs have so far attracted most of the negative connotations in discussions between investors on one side and NGOs and population on the other. Some of the most frequent environmental and social impacts of HPPs are summarized in Table 4.13.

Table 4.13 Most common impacts of large HPPs

Impact	Environmental (E) and/or Social (S)
Direct	
Flooding of Natural Habitats	E
Downstream Hydrological Changes (Including disruption of sediment transportation and deposition and subsequent changes in downstream riverbeds and coastal erosion).	E
Loss of Cultural Property	S
Resettlement	S
Loss of Aquatic and Terrestrial Species and Habitats	E
Changes of the ecological flow regime	E
Water changes and temperature changes	E
Displacement and disturbance of species	E
Impact on Fish and Other Aquatic Life	E
Indirect	
Deterioration of Water Quality	E
Water-related Diseases	S
Impact on Fish and Other Aquatic Life	E
Rapid Growth of Floating Aquatic Vegetation	E
Reservoir Sedimentation	E
Emission of Greenhouse Gases from Reservoirs	E
Potential Dam Breach	E & S
Change of Landscape Visual Value	S
Impacts of Associated Civil Works	
Access Roads	E & S
Power Transmission Lines	E
Quarries and Borrow Pits	E
Impacts of Induced Development	
Follow-on Development Projects	S

The WB6 Countries are not part yet of the European Union and the Birds and Habitats Directives and Environmental Assessment Directives (EIA Directive and SEA Directive) are transposed and implemented into national legislation at different levels within the WB6. Nevertheless, they committed to transpose and implement them, and full and detailed assessment based on relevant and valid data must be conducted as well as protected areas and Natura 2000 sites should be designated. If only historical data can be found, research must start a couple of years prior to planned construction and EIA development.

The WB6 countries are signatories to the Energy Community Treaty, which is supporting the EU environmental Acquis implementation (relevant legislation here are the SEA Directive, EIA Directive and Article 4(2) of the Birds Directive).

As mentioned before and in other reports, the EIA Directive (amended in 2014), the SEA Directive, the Habitats Directive, the Birds Directive, the Water Framework Directive and the Floods Directive as well as applicable international conventions have to be fully considered in HPP development process, independently of where the countries are in their transposition and implementation status

When developing HPP projects, the following documents should be taken into account:

- CIS Policy Paper on WFD and Hydro-morphological pressures
- Water management, Water Framework Directive & Hydropower, Common Implementation Strategy Workshop, Brussels, 13 - 14 September 2011, Issue Paper (final version), November 2011
- Water Framework Directive & Hydropower, Common Implementation Strategy Workshop Berlin, 4-5 June 2007, Key Conclusions
- Common Implementation Strategy for the Water Framework Directive; WFD and Hydro-morphological pressures; POLICY PAPER; Focus on hydropower, navigation and flood defence activities; Recommendations for better policy integration, 2006
- WFD and Hydro morphological pressures, Technical Report; Good practice in managing the ecological impacts of hydropower schemes; flood protection works and works designed to facilitate navigation under the Water Framework Directive, 2006
- Sustainable Hydropower Development in the Danube Basin, Guiding Principles, 2013
- Hydropower Case Studies and Good Practice Examples; ANNEX to "Guiding Principles on Sustainable Hydropower Development in the Danube Basin", 2013
- Measures for ensuring fish migration at transversal structures, Technical paper, 2013 and others.

More detailed elaboration of the environmental aspects of WB6 hydropower development and analysis per projects is presented in BR-3.

4.2.11 Multipurpose projects

A number of projects analysed in this study have a multipurpose dimension. In some cases, the hydrotechnical (water engineering and management) dimension is even more pronounced then the sole energy generation aspect of the project. The methodology used to perform multi criteria analysis (MCA) in this study and the low level of documentation that these projects have available, did not allow these "non-energy" aspects to be considered.

In addition to that, several upstream projects will influence the overall performance and energy generation of existing downstream projects. This has also not been considered within the scope of this study.

4.3 Greenfield HPP candidate projects in Albania

Looking at the HPP candidates, Albania has the largest remaining hydro potential in WB6.

As per September 2016 data of the Ministry of Energy and Industry, in the period 2005-2015 the Albanian government signed a total of 184 concession contracts for the construction of 505 HPPs with a total generation capacity of about 2,200 MW and with a forecast investment of around 3 bln €.

Data collection on HPP projects that were planned under the above-mentioned concession contracts proved to be a very demanding task, partially due to the large number of concession contracts involved, and partially due to the lack of a sufficiently organised and filled database of HPP concession contracts issued in Albania.

The Ministry of Energy and Industry is the government side party to these contracts and AKBN (National Agency for Natural resources) is the institution entrusted to monitor the execution of concession contracts.

The concession contracts are usually signed for the exploitation of particular rivers or watersheds. As the developers/investors progress and develop project documentation with the HPP projects, they are expected to report on their progress to the AKBN. A specific challenge to the project team was to collect all the required data for such a large number of HPP projects.

Concessions issued up to now were based on a tendering process that favoured bids with larger installed power. Among other parameters, that resulted in several over-capacity projects, which hinders their feasibility. In addition to that, the basic hydrological data is often insufficient and/or measurements inadequate, which also resulted in the overestimation of feasible installed power at several sites.

Other problems identified through the development, construction and operation of HPPs are:

- Problems with sediment transport and sediment removal structures; which negatively influences the turbines performance and life expectancy;
- Lack of fishpasses and control of EAF in many of the newly built HPPs;
- Overall lack of environmental protection measures during the construction of HPPs;
- Difficulties in securing equity by the project owners;
- Difficulties in sourcing debt financing, due to the poor financial efficiency of the projects;
- Not sufficiently clear and transparent licensing and permitting process; overlapping of the competences between institutions, duplication of work, various interpretations of law, lack of respect for deadlines on behalf of institutions, delays in the communication from institutions to investors.

The above figures of a total of 505 individual HPP projects include some projects which are already implemented or in construction (114 plants with 280 MW capacity already in operation, and 38 plants with capacity of 511 MW – including HPP Devoli HPP with 255 MW currently under construction), thus these are not a matter of analysis of this study. A significant number of these projects are below 10 MW size limit. Also, for a number of these projects even the basic (MCA1 level) amount of information was not available.

Another specific issue in the case of Albania is the fact that most HPPs in development are not developed by the national electricity utility but by a number of private investors. This implies an increased need for coordination and cooperation between the Albanian government and relevant institutions and private developers to ensure that the Albanian strategic goals and interests are protected and met.

Concerning the numerous issues identified in the development of Albanian HPPs and the vast number of concessions issued opposed to relatively modest number of implemented projects, there have been several initiatives to revise issued concession contracts. The underlying idea has been to cancel the contract where non-performance is caused by significant delays and concession contract breaches by the concessionaire, and to streamline the projects where non-performance is caused by the government or some if its institutions. Even though AKBN is appointed as a concession contract monitoring body on behalf of the government, it seems AKBN alone does not have sufficient influence nor clear directions on how to resolve these issues.

Considering all the issues identified in Albania and its significant available hydro potential, further work to enable adequate harnessing of the hydro power potential in a sustainable way would need to be carried out:

- A more detailed HPP database needs to be established within AKBN, to enable communication and data sharing with other relevant institutions (energy planning, transmission & distribution system planning, environmental protection, spatial planning, other infrastructure planning, water management etc.), both for the purposes of integrated planning and reporting, and also for improved concession contract monitoring.
- Development and implementation of integrated water planning and management measures and procedures.
- Adequate consideration of environmental issues with the proper implementation of SEA and EIA Directives as well as international best practices, including cumulative and transboundary assessments, and the designation of protected areas/Natura 2000 sites/no-go zones.

Figure 4.22 and Table 4.14 show the identified and analysed HPP projects in Albania. Green areas on the maps represent various protected areas.

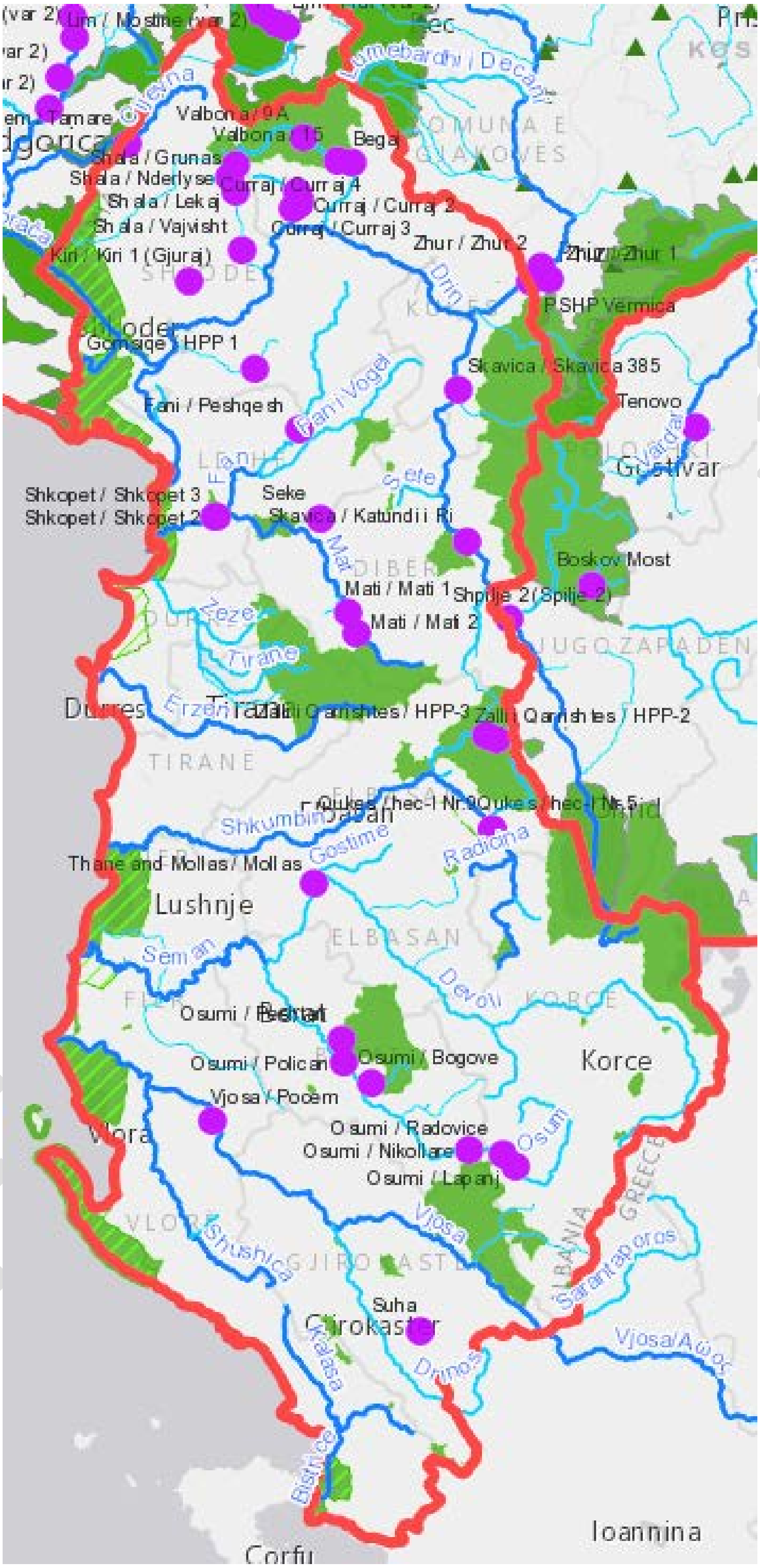


Figure 4.22: HPP candidate projects in Albania

Table 4.14: List of HPP candidate projects in Albania

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
WB6.HMP.937	Cem / Tamare	22.6	103,000	ROR	Morač a		220	12.6	10.5	PF SP FS SI EP PD	
WB6.HMP.926	Valbona / 9A	12.8	60,290	ROR	Drin-Bune		132	12	14.3	PF SP FS SI EP PD	Concession granted 2013.
WB6.HMP.933	Valbona / 15	13.8	66,525	ROR	Drin-Bune		118.21	14	15.4	PF SP FS SI EP PD	Concession granted 2013.
WB6.HMP.165	Begaj	24.8	131,000	ROR	Drin-Bune		247.85	12	19.9	PF SP FS SI EP PD	Concession granted 2014.
WB6.HMP.019	Curraj / Curraj 1	10.5	48,930	ROR	Drin-Bune		157.40	8	12.1	PF SP	No activities. Concession granted 2011.
WB6.HMP.020	Curraj / Curraj 2	13	57,000	ROR	Drin-Bune		164.11	9.5	15.0	PF SP	No activities. Concession granted 2011.
WB6.HMP.021	Curraj / Curraj 3	17.4	81,084	ROR	Drin-Bune		204.58	10.2	20.1	PF SP	No activities. Concession granted 2011.
WB6.HMP.022	Curraj / Curraj 4	32	153,600	ROR	Drin-Bune		509	12	37.0	PF SP	No activities. Concession granted 2011.
WB6.HMP.943	Shala / Grunas	10.4	45,700	ROR	Drin-Bune		94	13.4	4.7	PF SP	
WB6.HMP.944	Shala / Nderlyse	19.5	101,400	ROR	Drin-Bune		128	20.5	8.4	PF SP	
WB6.HMP.945	Shala / Lekaj	22.2	101,800	ROR	Drin-Bune		128	22	9.8	PF SP	
WB6.HMP.947	Shala / Vajvisht	60	220,800	ROR	Drin-Bune		124	62	32.1	PF SP	
WB6.HMP.913	Kiri / Kiri 1 (Gjuraj)	19.187	77,420	DER	Drin-Bune		6.5	14.46	12.8	PF SP FS SI EP PD	Concession granted 2013.
WB6.HMP.064	Gomsiqe / HPP 1	13.3	62,030	DER	Drin-Bune		200.7	8.11	23.5	PF SP FS SI EP PD OF MD	Concession granted 2009. 2 HPPs in cascade, Gomsiqe 2 - 8,25 MW.
WB6.HMP.112	Drini / Skavica 385	132	467,000	DAM	Drin-Bune	60.168,3 0	111	142.6	255.0	PF SP FS SI PD	Tender has been cancelled. Seems that the project will be developed by KESH with foreign partner (to be selected).
WB6.HMP.111	Drini / Katundi i Ri	49	206,000	DAM	Drin-Bune	1.065,87	46	127.7	255.0	PF SP FS SI PD	Turkish company won concession tender. However, the tender was cancelled. Concession still not issued.
WB6.HMP.917	Mati / Mati 1	14.7	50,000	DER	Mat		81	22	18.0	PF SP	
WB6.HMP.918	Mati / Mati 2	14.8	58,600	DER	Mat		78	26.6	18.9	PF SP	
WB6.HMP.124	Seke	12.66	55,700	DER	Mat		189.78	8	8.5	PF SP FS SI EP PD MD	Concession granted 2013.
WB6.HMP.031	Fani / Peshqesh	34	118,400	ROR	Mat		91	44.29	40.4	PF SP FS SI EP PD MD	Concession granted 2011.
WB6.HMP.061	Shkopet / Shkopet 2	13.356	53,256	ROR	Mat		23.5	30	15.9	PF SP FS SI EP	Concession granted 2013. Court investigation on concession tender.
WB6.HMP.062	Shkopet / Shkopet 3	10.612	42,069	ROR	Mat		24	33	12.6	PF SP FS SI EP	Data for Shkopet 3&4. Concession granted 2013. Court

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m^3/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
											investigation on concession tender.
WB6.HMP.115	Qukes / hec-I Nr.5	10.8	50,388	ROR	Shkum bin		76.19	17	14.7	PF SP	Concession granted 2011.
WB6.HMP.119	Qukes / hec-I Nr.9	15	84,532	ROR	Shkum bin		99.94	18	20.9	PF SP	Concession granted 2011.
WB6.HMP.036	Zalli i Qarrishtes / HPP-2	10	39,800	ROR	Shkum bin		323.86	3.74	12.0	PF SP	Concession granted 2013.
WB6.HMP.037	Zalli i Qarrishtes / HPP-3	13.1	52,800	ROR	Shkum bin		256.54	6.12	15.6	PF SP	Concession granted 2013.
WB6.HMP.014	Osumi / Lapanj	24	64,730	DER	Seman		84.08	32.69	29.7	PF SP	No official information on these projects. Many inputs assumed or off the record information. Seems that the projects are at much earlier stage of development then indicated. Concession granted 2013.
WB6.HMP.016	Osumi / Radovice	22.5	60,680	DER	Seman		76.58	33.65	37.2	PF SP	No official information on these projects. Many inputs assumed or off the record information. Seems that the projects are at much earlier stage of development then indicated. Concession granted 2013.
WB6.HMP.015	Osumi / Nikollare	27	72,820	DER	Seman		93.22	33.17	42.8	PF SP	No official information on these projects. Many inputs assumed or off the record information. Seems that the projects are at much earlier stage of development then indicated. Concession granted 2013.
WB6.HMP.012	Osumi / Bogove	24	64,720	DER	Seman		85.34	32.21	30.4	PF SP	No official information on these projects. Many inputs assumed or off the record information. Seems that the projects are at much earlier stage of development then indicated. Concession granted 2013.
WB6.HMP.011	Osumi / Polican	22.5	60,680	DER	Seman		83.75	30.77	24.4	PF SP	No official information on these projects. Many inputs assumed or off the record information. Seems that the projects are at much earlier stage of development then indicated. Concession granted 2013.
WB6.HMP.010	Osumi / Peshtan	16	43,150	DER	Seman		61.48	29.81	20.1	PF SP	No official information on these projects. Many inputs assumed or off the record information. Seems that the projects are

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
											at much earlier stage of development then indicated. Concession granted 2013.
WB6.HMP.071	Thane and Mollas / Mollas	13.6	80,000	DER	Seman	497,08	43	38	20.4	PF SP FS SI EP PD MD	Seems the developer is looking for further financing. Concession granted 2009.
WB6.HMP.060	Suha	24	97,680	ROR	Vjose		284	10	12.3	PF SP FS SI EP	No activities. Concession granted 2011.
WB6.HMP.408	Vjosa / Pocem	102	366,800	DER	Vjose	177.083, 33	374.8	16	66.3	PF SP	In 2016 Turkish company won the tender, however it has been cancelled. Initiative to stop further development on Vjosa and its tributaries due to environmental concerns. Potential issue regarding the transparency and public participation in EIA procedure.

4.4 Greenfield HPP candidate projects in Bosnia and Herzegovina

Bosnia and Herzegovina is rich in hydro resources and despite its significant existing hydro generation, there is significant potential that is still unexploited. By far the largest potential lies in the river Drina, which is largely shared with Serbia. Exploitation of that potential needs to be conditioned by an interstate agreement or another arrangement that would enable the projects to be developed and implemented.

HPP candidates in BiH are given in Figure 4.23 and in Table 4.15. Green areas and green triangles mark protected areas and protected sites.

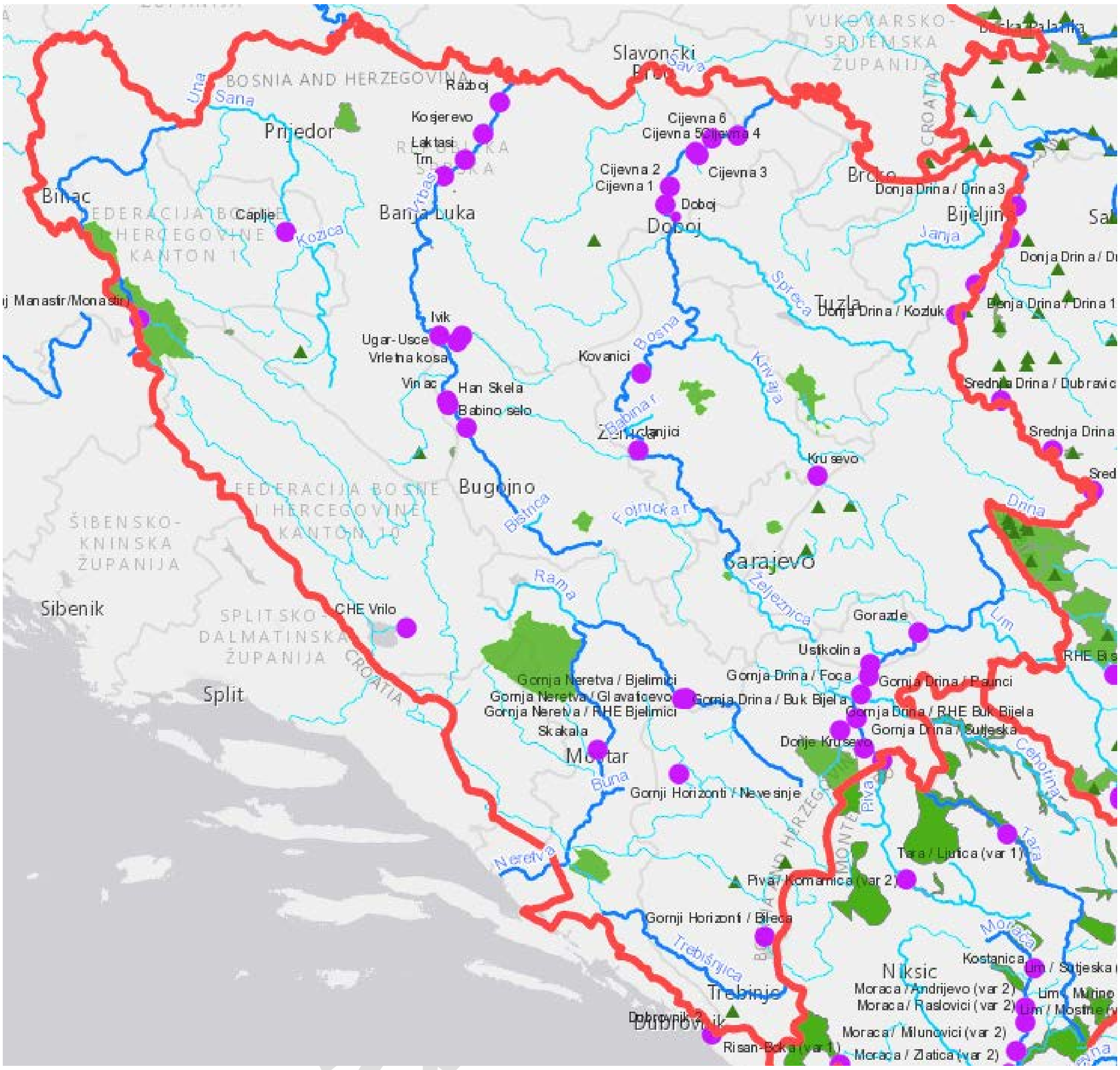


Figure 4.23: HPP candidates in BiH

Table 4.15: List of HPP candidates in BiH

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
WB6.HMP.229	Unac (Rmanj Manastir/Monastir)	72	250,000	DAM	Sava	0.00	120	80	87.0	PA SP	Area in I zone of protection according to IUNC; NP Una.
WB6.HMP.235	Caplje	12	56,800	ROR	Sava		11,2	120	31.7	PA SP	Candidate for construction within long term development plan of EP BiH. Development stalled due to lack of support from municipality.
WB6.HMP.183	Babino selo	11.5	59,900	DER	Sava		23.4	32	30.3	PF FS SI SP	Candidate for construction within long term development plan of EP BiH. Planned unification of design for Babino Selo and Vinac HPPs.
WB6.HMP.227	Han Skela	12	52,000	DAM	Sava	888.89	36.5	30	24.4	PF SP	

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
WB6.HMP.184	Vinac	11,5	61,300	ROR	Sava		40	32	25.1	SP PF	Candidate for construction within long term development plan of EP BiH. Planned unification of design for Babino Selo and Vinac HPPs. Opposition to construction from Municipal government (Jajce).
WB6.HMP.236	Ivik	11.2	21,880	DAM	Sava	902.22	50	20	7.4	PF SP	Border between "jurisdictions" of EP HZHB and ERS
WB6.HMP.213	Vrletna kosa	11.2	23,257	DAM	Sava	591.11	55	20	7.4	PF SP	Border between "jurisdictions" of EP HZHB and ERS
WB6.HMP.214	Ugar-Usce	11.6	33,188	DAM	Sava	2,497.22	66.5	20	13.4	PF SP	Border between "jurisdictions" of EP HZHB and ERS
WB6.HMP.217	Trn	21.42	89,090	ROR	Sava		12	160	73.0	PF SI SP	Project development stopped in 2010. No activities since. Water management. flood protection & irrigation role.
WB6.HMP.218	Laktasi	21.42	92,990	ROR	Sava		12	160	104.3	PF SI SP	Project development stopped in 2010. No activities since. Water management. flood protection & irrigation role.
WB6.HMP.219	Kosjerevo	21.42	93,050	ROR	Sava		12	160	130.4	PF SI SP	Project development stopped in 2010. No activities since. Water management, flood protection & irrigation role.
WB6.HMP.220	Razboj	21.42	92,020	ROR	Sava		12	160	144.9	PF SI SP	Project development stopped in 2010. No activities since. Water management, flood protection & irrigation role.
WB6.HMP.215	Krusevo	10.69	30,767	DER	Sava	399.23		18	33.3	PF SP	Candidate for construction within long term development plan of EP BiH.
WB6.HMP.180	Janjici	13.3	68,250	ROR	Sava		15.4	75.75	55.0	PF FS SI SP OF	Candidate for construction within long term development plan of EP BiH.
WB6.HMP.181	Kovanici	13.3	65,700	ROR	Sava		8.66	84.4	38.8	PF FS SI SP	Candidate for construction within long term development plan of EP BiH.
WB6.HMP.231	Cijevna 1	14.1	67,700	ROR	Sava		6.44	250	36.5	PD SP FS	Multipurpose role (flood protection). Potential spatial planning conflicts with other infrastructure. Project status not clear.
WB6.HMP.232	Cijevna 2	14.2	69,600	ROR	Sava		6.3	250	35.7	PD SP FS	Multipurpose role (flood protection). Potential spatial planning conflicts with other infrastructure. Project status not clear.
WB6.HMP.233	Cijevna 3	13.9	69,000	ROR	Sava		6.31	250	42.4	SP FS EP MD	Multipurpose role (flood protection). Potential spatial planning conflicts with other infrastructure. Project status not clear.
WB6.HMP.234	Cijevna 4	13.9	69,900	ROR	Sava		6.35	250	42.4	PD SP FS	Multipurpose role (flood protection). Potential spatial planning conflicts with other infrastructure. Project status not clear.
WB6.HMP.410	Cijevna 5	13.2	62,400	ROR	Sava		6.2	250	42.0	PD SP FS	Multipurpose role (flood protection). Potential spatial planning conflicts with other infrastructure. Project status not clear.
WB6.HMP.411	Cijevna 6	12.9	63,100	ROR	Sava		6.2	250	44.0	PD SP FS	Multipurpose role (flood protection). Potential spatial

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
											planning conflicts with other infrastructure. Project status not clear.
WB6.HMP.423	Doboj	8.39	36,800	ROR	Sava		4.75	210	37.2	PD SP FS	Multipurpose role (flood protection). Potential spatial planning conflicts with other infrastructure. Project status not clear.
WB6.HMP.200	Gornja Drina / Sutjeska	44.08	95,620	DER	Sava	9,960.38	91	52	138.1	FS PD	Positive effects on downstream HPPs.
WB6.HMP.409	Gornja Drina / RHE Buk Bijela	600	1,164,850	REV	Sava	137,500.00	586.9	120	376.1	FS SP	Positive effect for downstream HPPs.
WB6.HMP.198	Gornja Drina / Buk Bijela	93.52	332,300	DAM	Sava	816.44	29	350	194.4	SP FS EP PD	"Small" Buk Bijela with lower dam height to avoid transboundary issues with MNE. Positive effects on downstream HPPs.
WB6.HMP.208	Gornja Drina / Foca	44.15	175,900	DAM	Sava	161.18	13.7	350	117.8	SP FS EP PD	
WB6.HMP.199	Gornja Drina / Paunci	43.21	166,900	DAM	Sava	67.48	10.98	450	124.4	SP FS PD	Positive effects on downstream HPPs.
WB6.HMP.201	Ustikolina	60.48	236,800	ROR	Sava		14.5	450	139.9	FS SP	Candidate for construction within long term development plan of EP BiH. Development stalled as Urban conditions were denied in 2015. due to missing spatial planning.
WB6.HMP.237	Gorazde	37	169,900	ROR	Sava		9.2	450	56.3	PA SP	Candidate for construction within long term development plan of EP BiH. Strong opposition from local public.
WB6.HMP.196	Srednja Drina / Rogacica	113.28	413,420	ROR	Sava		17.24	800	245.6	PF SP	Transboundary issues. Positive effect for downstream HPPs & water management.
WB6.HMP.190	Srednja Drina / Tegare	120.94	448,050	ROR	Sava		18.68	800	284.6	PF SP	Transboundary issues. Positive effect for downstream HPPs & water management.
WB6.HMP.191	Srednja Drina / Dubravica	87.23	335,480	ROR	Sava		13.71	800	348.2	PF SP	Transboundary issues. Positive effect for downstream HPPs & water management.
WB6.HMP.192	Donja Drina / Kozluk	88.5	376,000	DAM	Sava	706.77	12.94	800	303.2	PF SP	Transboundary issues. Positive water management & flood protection effects.
WB6.HMP.193	Donja Drina / Drina 1	87.7	363,700	DAM	Sava	822.19	12.83	800	287.1	PF SP	Transboundary issues. Positive effect for water management and flood protection.
WB6.HMP.194	Donja Drina / Drina 2	87.8	379,800	DAM	Sava	1,006.04	12.71	800	329.0	PF SP	Transboundary issues. Positive effect for water management and flood protection.
WB6.HMP.195	Donja Drina / Drina 3	101	469,100	DAM	Sava	1,543.06	14.97	800	427.2	PF SP	Transboundary issues. Positive effect for water management and flood protection.
WB6.HMP.245	Gornja Neretva / RHE Bjelimici	500	1,029,000	REV	Neretva	12,626.26	617	110	232.9	SP FS	Candidate for construction within long term development plan of EP BiH.
WB6.HMP.175	Gornja Neretva / Bjelimici	100	219,400	DAM	Neretva	20,467.17	103.35	110	165.7	FS SP	Candidate for construction within long term development plan of EP BiH. Even though

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
											project has been in development by Intrade energija, in 2016 EP BiH submitted an unsolicited request for concession for Glavaticevo, Bjelimici and PHE Bjelimici.
WB6.HMP.202	Gornja Neretva / Glavaticevo	28.5	108,250	ROR	Neretva		44.98	72	72.9	SP FS	Candidate for construction within long term development plan of EP BiH. Even though project has been in development by Intrade energija, in 2016 EP BiH submitted an unsolicited request for concession for Glavaticevo, Bjelimici and PHE Bjelimici.
WB6.HMP.176	Skakala	26.4	124,300	ROR	Neretva		11		82.3	PF PD	Border area between "jurisdictions" of EPHZHB and EP BiH
WB6.HMP.225	CHE Vrilo	66	196,130	REV	Neretva	220.00	154	50	95.9	PD SP SI	
WB6.HMP.206	Gornji Horizonti / Nevesinje	60	100,600	DER	Trebišnjica	54,545.45	127.1	55	100.5	FS PD SP	Positive effects on downstream HPPs.
WB6.HMP.207	Gornji Horizonti / Bileca	33	116,400	DER	Trebišnjica	6.11	63.1	60	49.3	FS PD SP	Tunnel Fatnicko field - Bileca is completed.
WB6.HMP.189	Dubrovnik 2	304	318,000	DER	Trebišnjica	6,544.44	295	120	173.1	FS SP	Development of second phase is burdened by transboundary issues involving Croatia, BiH (both RS and FBiH) and Montenegro.

BiH has a specific political and territorial organisation; with state level government, two entity government levels, a cantonal level in one of them (FBiH), and further municipal level authorities. This organisation makes the development of HPP projects very demanding, with jurisdictions between different government levels often intertwined and boundaries unclear. The additional level of cantonal governments makes that even more challenging for developers in FBiH.

Due to the specific situation in BiH and significant entity autonomy in the energy sector, short listed HPP candidates and overall HPP development situation will be commented separately for FBiH and for RS.

4.4.1 HPP projects in FBiH

Within the Federation of Bosnia and Herzegovina, two major players in terms of new HPP development are the two public electricity utility companies: JPEP BiH from Sarajevo ("Javno preduzeće elektroprivreda Bosne i Hercegovine") and EPHZHB from Mostar ("Elektroprivreda Hrvatske zajednice Herceg Bosne").

The complexity and entanglement of the jurisdictions between the government levels in FBiH pose a significant obstacle to the development of greenfield HPPs.

In addition, the lack of an adopted spatial plan and energy strategy poses further challenges to HPP project developers.

4.4.2 HPP projects in RS

ERS is the main developer concerning projects larger than 10 MW. Projects on the river Drina are largely subject to the resolution of transboundary issues between the concerned countries. The so-called small Buk Bijela and reversible Buk Bijela are the only Drina river projects which are exclusively within the jurisdiction of RS and could be developed by ERS alone. However, it might be the case that RS is reluctant to proceed with the development of “small”[16] Buk Bijela as it hopes for the resolution of transboundary issues with Montenegro and agreement to construct “large” Buk Bijela. Foča and Paunci projects are also fully in the territory of RS and can be developed by ERS alone.

Projects on upper (“Gornji horizonti”) Trebišnjica river are in the development phase, while the extension of the existing Dubrovnik HPP is subject to agreement with HEP and Montenegrin and FBiH authorities. More details are provided in BR-5 on Transboundary considerations.

Projects on Vrbas river were developed by Norwegian Statkraft; however the activities have been dormant in recent years indicating that the developer may have lost interest in further development.

4.5 Greenfield HPP candidate projects in the former Yugoslav Republic of Macedonia

The main developer regarding large HPP projects is the national power utility ELEM. Government support for the development of HPP projects is strong. However, in the recent period, several disagreements have emerged with the EU bodies and IFIs considering financing the development and implementation of proposed HPP projects. The disagreements are mainly related to environmental concerns regarding the proposed projects. Considering that, EBRD has recently announced its cancellation of the financing of HPP Boškov Most. It remains to be seen whether the Government and ELEM will resolve the financing issue with other potential investors or they will adjust their investment plans to IFIs’ requirements to obtain their funding.

The communication with stakeholders in the former Yugoslav Republic of Macedonia within this study has been channelled through the Prime Minister office as a single point of contact. According to the position received from the Prime Minister office, the main challenges for future development of hydropower in former Yugoslav Republic of Macedonia is a) a too large consideration given to environmental issues to the detriment of the economic development benefits of hydropower, and b) investment risks inherent to the liberalised electricity markets. More detailed information on the future plans and outlook of HPP development was not shared with the consultants within the course of this project.

On the other hand, the development of small HPPs (less than 10 MW) was increased, with several rounds of concessions issued and a number of projects already successfully implemented or under implementation.

Analysed HPP candidates are given in Figure 4.24 and Table 4.16.

[16] “small” and “large” are used to annotate the height of the dam. “small” project variant has a lower dam and the resulting accumulation does not cross into Montenegro. “large” Buk Bijela accumulation crosses into Montenegro with its higher dam.

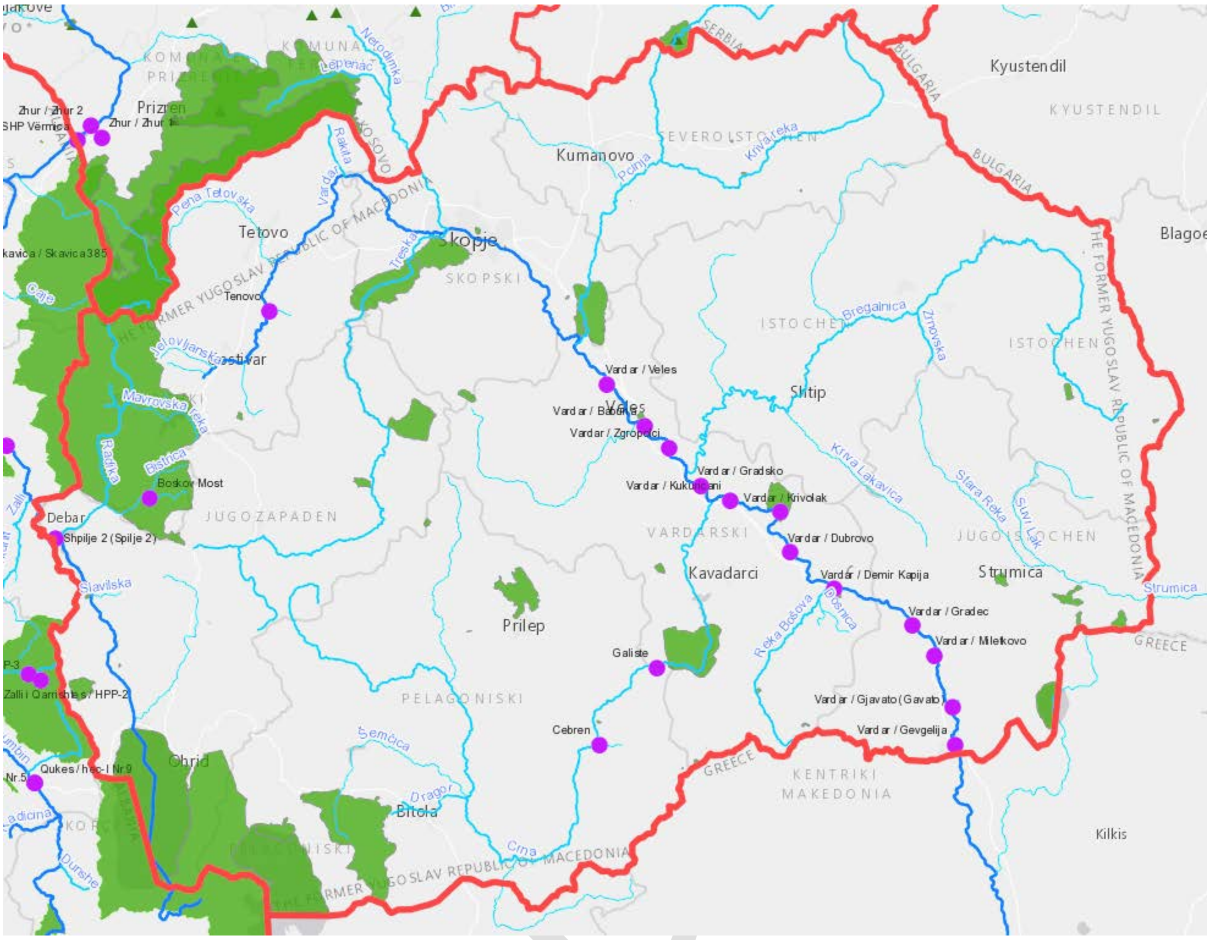


Figure 4.24: HPP candidate projects in the former Yugoslav Republic of Macedonia

Table 4.16: List of HPP candidate projects in the former Yugoslav Republic of Macedonia

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
WB6.HMP.347	Boskov Most	68.2	117.000	DER	Drin-Bune	470.17	357	22	156.2	PD TP SP	Within NP Mavrovo. In 2017 EBRD cancelled the loan for the project.
WB6.HMP.368	Shpilje 2 (Spilje 2)	28	20.000	DAM	Drin-Bune	48,179.01	85.2	36	22.0	FS	Currently the development is halted as FS showed negative results due to electricity market conditions.
WB6.HMP.367	Tenovo	35	140.000	ROR	Vardar				55.0	PF TP	Ongoing tender for Prefeasibility Study. Additional generation on the existing HPPs on Treska river cca 140 GWh and possible installation of new HPP with annual generation of 74-92 GWh.
WB6.HMP.350	Cebren	332.8	840.300	REV	Vardar	222,106.78	174	231	380.6	PF TP SP	Ongoing tender for concession: 11 bids received. Each bid with different conceptual solution. Tender for PS to determine optimum solution. Project dependent on realisation of HPP Galiste.
WB6.HMP.352	Galiste	193.5	262.500	DAM	Vardar	77,041.67	130	180	235.7	PF TP SP	Ongoing tender for concession: 11 bids received. Each bid with different conceptual solution. Tender for PS to determine optimum solution.
WB6.HMP.351	Vardar / Veles	93.1	310.380	DAM	Vardar	8,487.75	53.5	195	159.5	PF TP SP	Ongoing tender for Prefeasibility Study. Storage submerges existing railway. Necessary relocation.

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
WB6.HMP.356	Vardar / Babuna	17.3	51,957	ROR	Vardar		8.5		40.1	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution
WB6.HMP.357	Vardar / Zgropolci	16.9	50,347	ROR	Vardar		8.3		66.8	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution
WB6.HMP.358	Vardar / Gradsko	16.9	63,722	ROR	Vardar		8.3		66.2	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution
WB6.HMP.359	Vardar / Kukuricani	16.9	77,541	ROR	Vardar		8.3		63.0	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution
WB6.HMP.360	Vardar / Krivolak	16.9	77,603	ROR	Vardar		8.3		65.4	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution
WB6.HMP.361	Vardar / Dubrovo	16.9	77,478	ROR	Vardar		8.3		86.1	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution
WB6.HMP.362	Vardar / Demir Kapija	24.4	112,107	ROR	Vardar		12		130.5	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution
WB6.HMP.349	Vardar / Gradec	55.2	243,370	DAM	Vardar	2,747.22	27.15	240	178.1	PF TP SP	Ongoing tender for Prefeasibility Study.
WB6.HMP.363	Vardar / Miletkovo	16.7	79,685	ROR	Vardar		8.2		92.2	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution
WB6.HMP.364	Vardar / Gjavato (Gavato)	16.7	81,841	ROR	Vardar		8.2		113.7	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution
WB6.HMP.365	Vardar / Gevgelija	16.6	84,148	ROR	Vardar		8.3		79.9	PF TP SP	Ongoing tender for Prefeasibility Study. Expected revising of the technical solution

4.6 Greenfield HPP candidate projects in Montenegro

Montenegro is very rich in hydro-energy potential. Its hydro-energy potential could be considered as one of the largest national natural resources. Adequate exploitation of this potential could significantly contribute to the national economy. On the contrary, though, the level of development of HPP projects in Montenegro is generally quite low. Most projects are only at pre-feasibility level and even these analyses are generally more than 10 years old. Many of the potential sites are only generally analysed and the exact projects have not been defined yet. Some of the proposed technical solutions are no longer adequate or are not possible due to a different usage of the land in practice (e.g. Lim river). This indicates the dormant HPP development activities in the past decade and more. In the past, EPCG, a national electricity utility (formerly republic utility) was the driver of HPP development. In 2009, 49% of shares, including the majority management rights of EPCG were sold to the Italian A2A.

In recent years, EPCG has not shown significant interest in the development of new HPP projects, and the main driver of the development is the Ministry of Economy. This is also defined in the Law on Energy (2016) which establishes the Ministry of Economy as responsible for strategic development in the field of energy. The Ministry requires additional resources and capacity building to be able to fully take on its designated role.

Exceptions to the situation described above are the projects on Morača and Komarnica. Development of documentation and site investigations for HPP Komarnica are currently in process and are being conducted jointly by EPCG and EPS (51%:49%), based on the agreement between the two companies. A tendering process for concession for HPPs on Morača river was started in 1998 and again in 2010, unfortunately, both times unsuccessfully. Currently, negotiations are ongoing with possible foreign partners outside the official tendering procedure; however it is still unclear which model of partnership this would be, i.e. who would be concession holder/owner/user of the future HPPs.

Other activities currently ongoing are regarding the Lim watershed; EPCG, in cooperation with Ministry of Economy, is launching a tender for procurement of consultancy services aimed at revising and bringing innovation to the existing studies of hydropotential on the Lim river.

It should be noted that the current Spatial plan envisages only plants on Morača and Komarnica. No other projects of HPPs larger than 10 MW have been listed. In addition, in 2004 the Montenegrin parliament passed the Declaration on the protection of the Tara river (OG 78/2004). Even though UNESCO protects the Tara canyon as a world heritage site, the Declaration extended that protection to the entire Tara river. Emerald zones as they are drafted currently might further hinder any further development of some HPP projects in Montenegro. HPP Ljutica and HPP Koštanica, two projects on the Tara river, may encounter significant problems not only due to the foreseen protected areas, but also due to issues regarding the planned highway towards Serbia. In addition, there are transboundary issues with Serbia regarding water usage.

Boka project is planned by Montenegro; however it is planning to use the same water currently used in Trebišnjica and Dubrovnik HPPs.

Environmental protection concerns that seem to have been the motivation for the limitations set out above should be duly considered and properly evaluated when developing the required hydro resources planning document of Montenegro. That document should provide a balance between environmental and economic development concerns.

The lack of adequate documentation and information for a number of projects was the reason why many of the identified projects could not be sufficiently analysed and consequently were not considered as HPP candidate projects. The development of HPP planning documentation with accompanying prefeasibility assessments for the identified projects is therefore important to assess the actual technical HPP potential in Montenegro in today's context.

Montenegro shares most of its hydropotential with neighbouring countries, therefore reaching interstate and intercompany agreements is essential for the future development of majority of HPP candidate projects.

Figure 4.25 and Table 4.17 present a list of analysed HPP candidate projects. Green coloured areas indicate various protected areas.

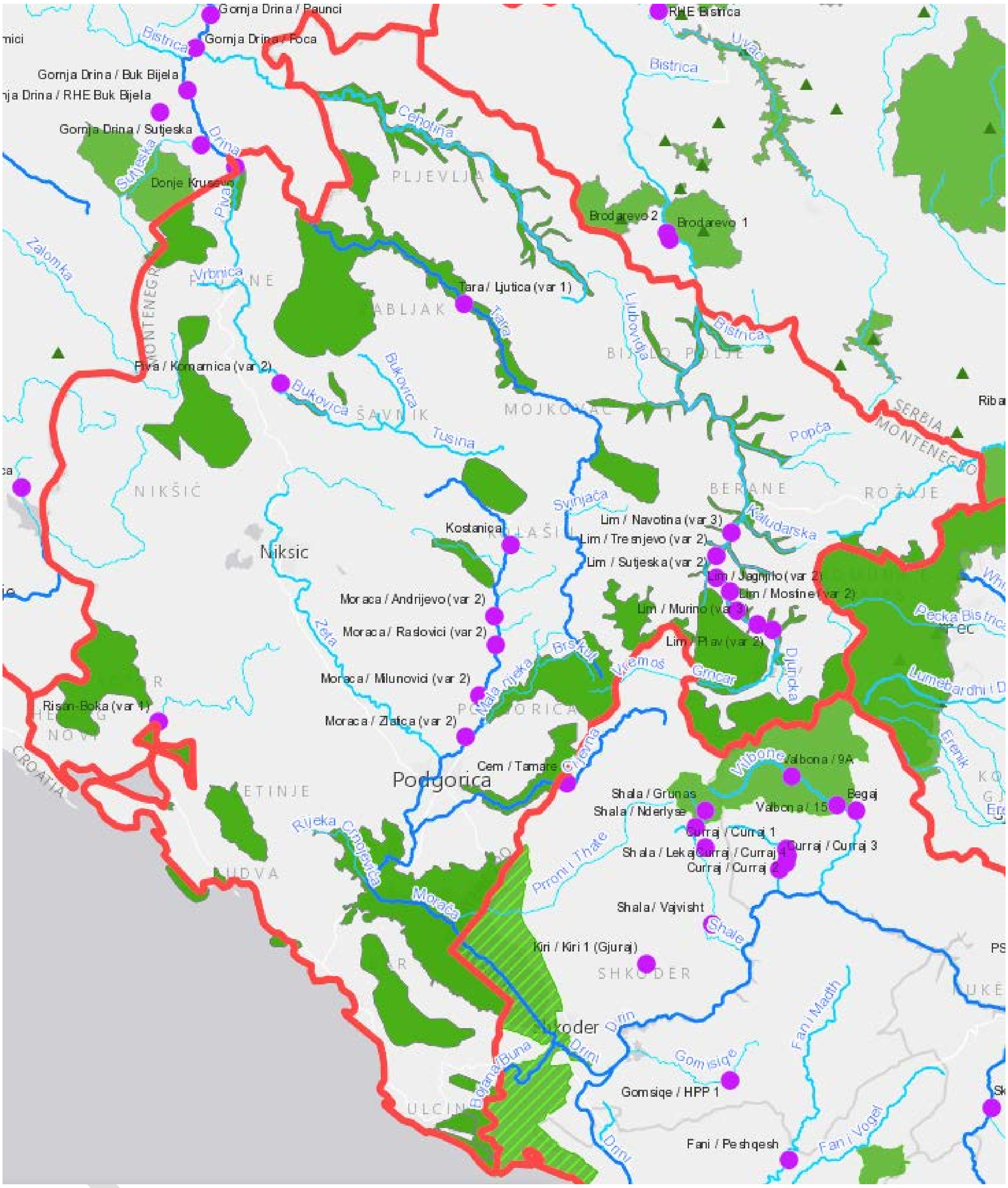


Figure 4.25: HPP candidate projects in Montenegro

Table 4.17: List of HPP candidate projects in Montenegro

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
WB6.HMP.444	Risan-Boka (var 1)	225.4	661,040	DER	Trebišnjica	967,788.89	400	70	290.2	PA	Transboundary issues. Project would use "MNE part" of Bilećko lake. Likely negative effects on the existing plants Trebinje 1&2, Dubrovnik
WB6.HMP.260	Kostanica	552	1,254,000	DER	Morača	330,000.00	690	92	383.2	FS PD	Transfer of waters from Tara to Moraca. Effects on possible Moraca HPPs and Drina HPPs. Transboundary issues. Variant with reversible HPP also considered. Possible land use conflicts with planned highway. Tara protection declaration.
WB6.HMP.261	Moraca / Andrijevo (var 2)	127	240,900	DAM	Morača	29,398.15	85	120	225.8	SI PD FS SP TD	Negotiations ongoing with potential strategic partners. Possible redesign. Existing project documentation (PFS) is developed for Andrijevo Var1 (level 285). This variant (Andrijevo 2) is level 250.
WB6.HMP.262	Moraca / Raslovici (var 2)	37	106,900	DAM	Morača	668.06	36	120	85.2	SI PD FS SP TD	Negotiations ongoing with potential strategic partners. Possible redesign.
WB6.HMP.263	Moraca / Milunovici (var 2)	37	117,200	DAM	Morača	582.41	38	120	89.3	SI PD FS SP TD	Negotiations ongoing with potential strategic partners. Possible redesign.
WB6.HMP.264	Moraca / Zlatica (var 2)	37	151,000	DAM	Morača	1,113.43	38.5	120	98.1	SI PD FS SP TD	Negotiations ongoing with potential strategic partners. Possible redesign.
WB6.HMP.278	Piva / Komarnica (var 2)	172	227,000	DAM	Sava	47,777.78	135	130	178.3	PA SI SP	Field investigations and FS ongoing in cooperation of EPCG & EPS.
WB6.HMP.252	Tara / Ljutica (var 1)	250	533,000	DAM	Sava	109,826.39	145	200	333.3	PA	Project development difficult due to protected area & Tara protection declaration of MNE. Potential land use conflicts with planned highway to Serbia.
WB6.HMP.267	Donje Krusevo	120	321,900	DAM	Sava	2,500.00	56	240	119.1	PA	Option in case of "small" Buk Bijela
WB6.HMP.272	Lim / Plav (var 2)	13.1	48,800	DER	Sava	0.00	39	40	57.2	PA	Ongoing renewal of studies to determine possible technical solution; due to land use conflicts related to previous solutions.
WB6.HMP.428	Lim / Murino (var 3)	11.2	43,400	DER	Sava	0.00	32.85	40	57.5	PA	Ongoing renewal of studies to determine possible technical solution; due to land use conflicts related to previous solutions.
WB6.HMP.275	Lim / Mostine (var 2)	12.9	36,900	DER	Sava	0.00	25.28	60	56.4	PA	Ongoing renewal of studies to determine possible technical solution; due to land use conflicts related to previous solutions.
WB6.HMP.276	Lim / Jagnjilo (var 2)	11.4	33,500	DER	Sava	0.00	22.36	60	49.8	PA	Ongoing renewal of studies to determine possible technical solution; due to land use conflicts related to previous solutions.
WB6.HMP.426	Lim / Sutjeska (var 2)	12	37,000	DER	Sava	0.00	23.6	60	52.4	PA	Ongoing renewal of studies to determine possible technical solution; due to land use conflicts related to previous solutions.
WB6.HMP.320	Lim / Tresnjevo (var 2)	11.1	34,500	ROR	Sava		21.77	60	48.5	PA	Ongoing renewal of studies to determine possible technical solution; due to land use conflicts related to previous solutions.
WB6.HMP.432	Lim / Navotina (var 3)	15	42,200	DER	Sava	0.00	22	80	31.6	PA	Ongoing renewal of studies to determine possible technical solution; due to land use conflicts related to previous solutions.

4.7 Greenfield HPP candidate projects in Kosovo

Kosovo's hydro-energy potential is not large. This is reflected through "only" 3 HPP candidate projects being identified and analysed: Zhur I, Zhur II and Vermica. The current priority of Kosovo's government in terms of energy is the development of new lignite power plant(s), utilising existing large reserves of lignite.

Zhur HPP has reasonable technical documentation which was developed in 2009 (although only with a preliminary EIA assessment). However, the validity of this documentation is now questionable due to significant unresolved transboundary issues with Albania. The waters that were to be collected and directed towards the planned HPP Zhur are already being used in several small HPP projects that have recently been licenced and constructed in Albania (HPPs on Luma river catchment: Orgjost (5 MW), Bele 1 (5.1 MW), Bele 2 (11.7 MW), Porberg (9 MW). HPPs on Lapaj river catchment: Lapaj (12.6 MW), other small HPPs (4.5 MW)). Thus, the development of HPP Zhur would adversely impact the water inflow to these plants.

Vermica is a reversible HPP project. The project is at a very early stage of development (project idea). Thus, its environmental suitability and feasibility is yet to be analysed. The Vermica project idea envisages a reversible HPP practically without additional natural inflows into the upper reservoir. That makes HPP Vermica feasibility challenging bearing in mind the lack of a power balancing market in Kosovo and in the region.

Figure 4.26 and Table 4.18 provide details on HPP candidate projects in Kosovo.

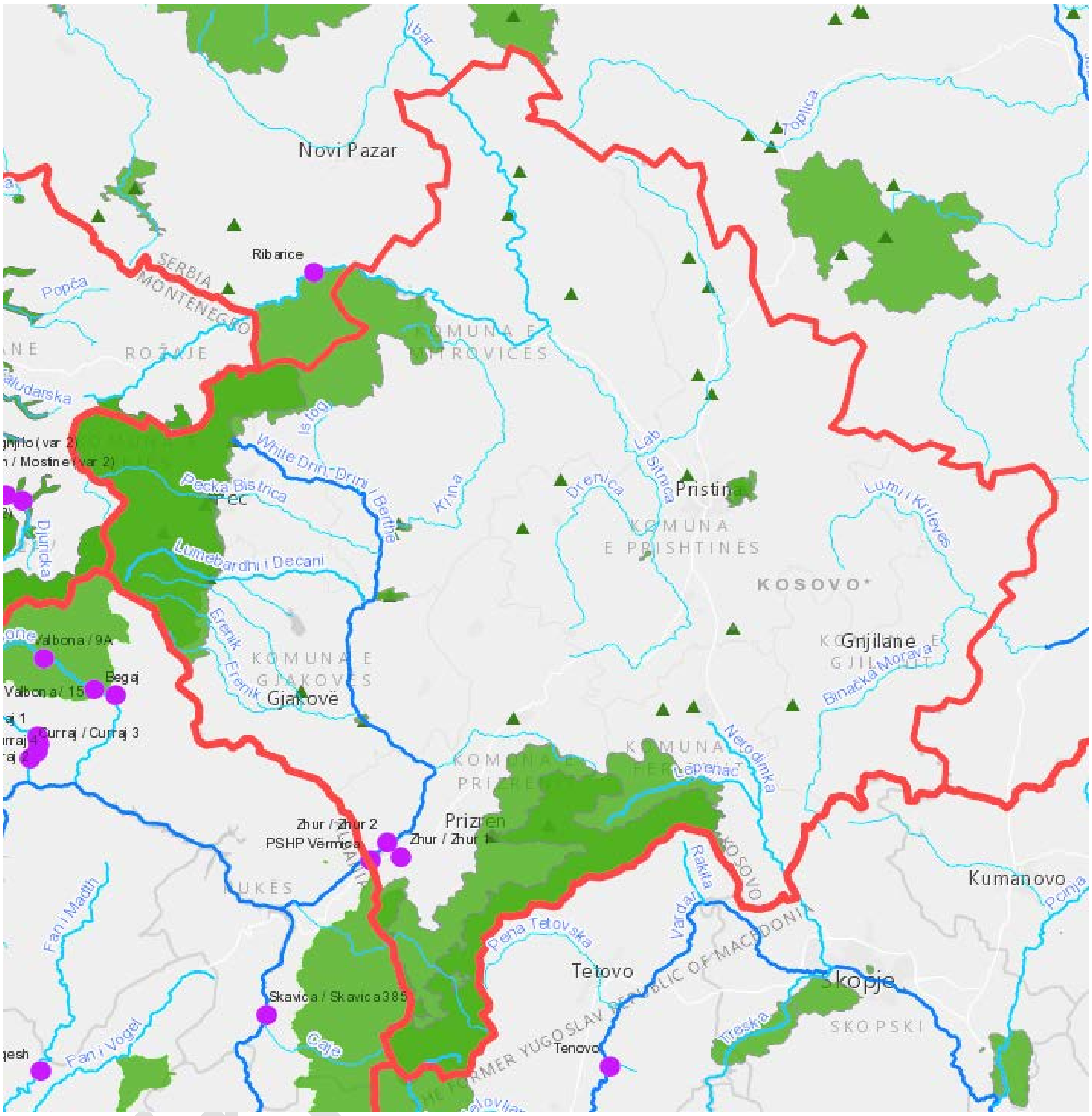


Figure 4.26: HPP candidate projects in Kosovo

Table 4.18: List of HPP candidate projects in Kosovo

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
WB6.HMP.373	Zhur / Zhur 1	262	342,200	DER	Drin-Bune	170,154.44	533.38	50	288.5	FS SI	Transboundary issues. Water use conflicts with several SHPPs in ALB.
WB6.HMP.374	Zhur / Zhur 2	43	55,390	DER	Drin-Bune	27,926.11	85.41	50	47.4	FS SI	Transboundary issues. Water use conflicts with several SHPPs in ALB.
WB6.HMP.383	PSHP Vërmica	480	765,000	REV	Drin-Bune	6,564.10	750	65	308.6	PA	

4.8 Greenfield HPP candidate projects in Serbia

EPS is the main developer of greenfield HPP projects in Serbia. Projects on the rivers Ibar and Velika Morava have been developed in partnership with the German RWE and the Italian SECI. It is unclear currently whether these partnerships will be continued or EPS will finish the development of these projects alone. In any case, the projects' design will in all likelihood need to be changed and the financial feasibility reassessed. The Bistrica project, although with well-developed documentation, does not seem to be among the top priorities of EPS. EPS is also involved in the development of transboundary projects on the Drina river, and in the development of the Komarnica project in Montenegro. Further Drina river project development is subject to the resolution of transboundary issues and determining and aligning the interests of all relevant parties. The Đerdap 3 project, with its design size of 1,200 MW represents a very significant investment for EPS and might need to be reassessed, both in terms of electricity market needs and the capacity of EPS to implement a project of such size.

At the moment, it seems that EPS, as the largest HPP developer and investor in Serbia, has a priority focus and its funds are oriented towards renewing and expanding its coal thermal generation capacity.

Brodarevo projects are being developed by a private developer. However, it seems they have been stalled due to a combination of several factors, both from the side of the developer and from the side of the state and its institutions.

Figure 4.27 and Table 4.19 give the information on the HPP candidate projects identified in Serbia.

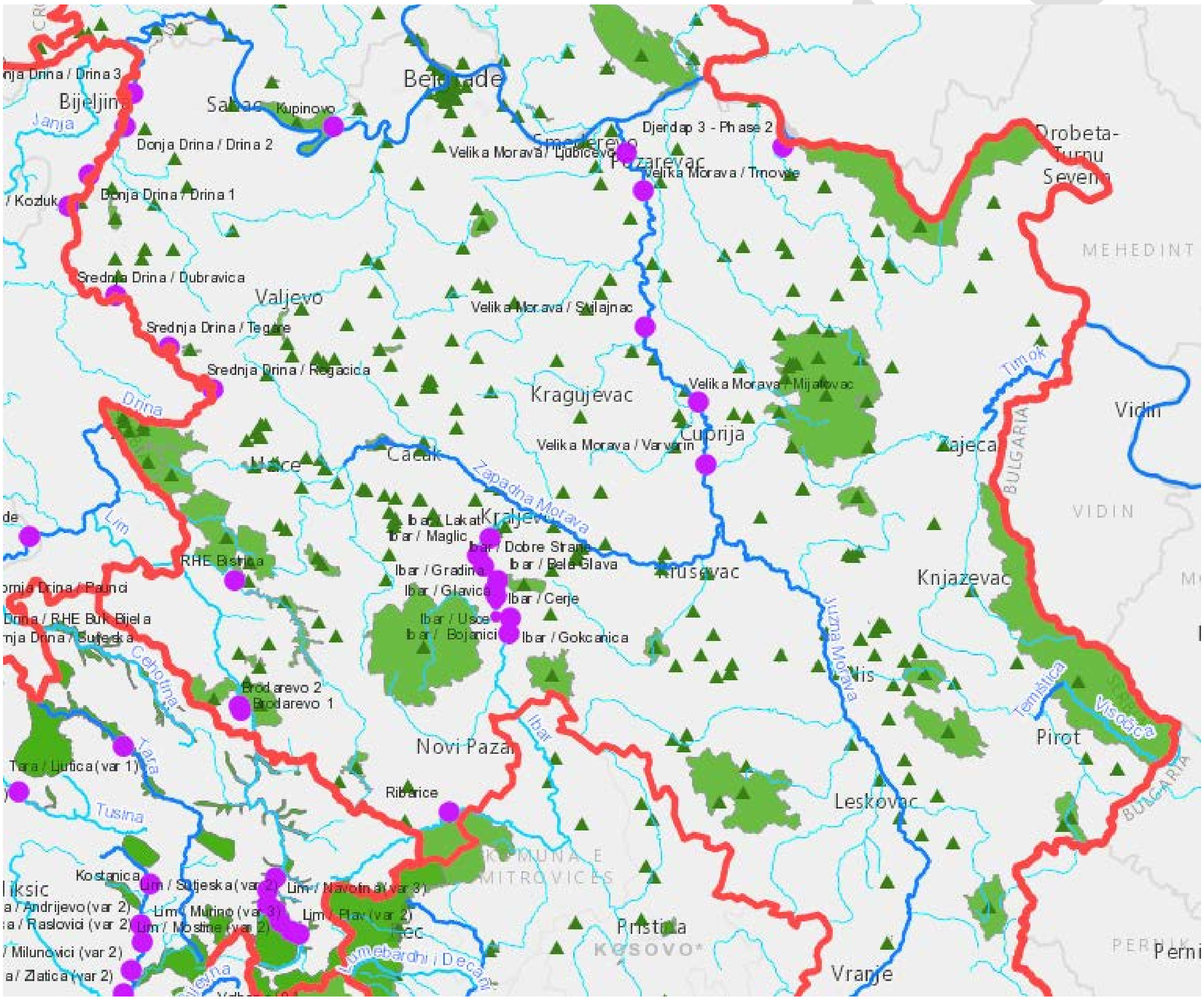


Figure 4.27: HPP candidate projects in Serbia

Table 4.19: List of HPP candidate projects in Serbia

Project ID/number	Project name	Installed capacity (MW)	Average annual electricity output (MWh)	Plant type	River basin	Usable reservoir storage (MWh)	Design head (m)	Design flow (m³/s)	Total normalised investment cost (mil. €)	Status of completed preparatory works	Additional information
WB6.HMP.397	Brodarevo 1	26	103,000	ROR	Sava		19.73	150	71.1	FS SI SP	Environmental permit cancelled.
WB6.HMP.401	Brodarevo 2	33.1	129,100	ROR	Sava		24.7	150	73.4	FS SI SP	Environmental permit cancelled.
WB6.HMP.447	RHE Bistrica	680	1,550,000	REV	Sava	69,958.85	397	216	551.1	FS SI PD	
WB6.HMP.404	Kupinovo	140	530,000	ROR	Sava				250.0	PA	
WB6.HMP.396	Ribarice	46.7	76,100	DER	Velika Morava	16,738.35	88	62	97.3	FS SI PD MD	
WB6.HMP.385	Ibar / Lakat	13.5	54,399	ROR	Velika Morava		14.83	110	38.3	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.386	Ibar / Maglic	13.4	52,191	ROR	Velika Morava		14.44	110	41.2	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.387	Ibar / Dobre Strane	14.49	55,895	ROR	Velika Morava		15.63	110	39.9	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.388	Ibar / Bela Glava	14.56	55,476	ROR	Velika Morava		15.71	110	34.2	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.389	Ibar / Gradina	11.7	41,841	ROR	Velika Morava		11.85	110	30.8	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.390	Ibar / Cerje	13.19	50,143	ROR	Velika Morava		14.35	110	36.1	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.391	Ibar / Glavica	9.68	37,189	ROR	Velika Morava		10.6	110	30.0	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.392	Ibar / Usce	9.81	35,235	ROR	Velika Morava		11.75	110	29.8	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.393	Ibar / Gokcanica	10.95	38,245	ROR	Velika Morava		12.83	110	33.3	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.394	Ibar / Bojanici	10.23	36,008	ROR	Velika Morava		12.3	110	32.0	FS SI PD	JV of EPS & SECI. Unclear continuation of cooperation. Likely redesign of the cascade.
WB6.HMP.453	Velika Morava / Varvarin	28.9	122,900	ROR	Velika Morava		9.2	375	69.7	PF SI	JV between EPS and RWE. Unclear continuation of cooperation.
WB6.HMP.452	Velika Morava / Mijatovac	30.1	129,400	ROR	Velika Morava		10	375	68.7	PF SI	JV between EPS and RWE. Unclear continuation of cooperation.
WB6.HMP.451	Velika Morava / Svilajnac	28.8	128,000	ROR	Velika Morava		9.5	375	68.7	PF SI	JV between EPS and RWE. Unclear continuation of cooperation.
WB6.HMP.450	Velika Morava / Trnovce	29.3	128,100	ROR	Velika Morava		9.6	375	75.7	PF SI	JV between EPS and RWE. Unclear continuation of cooperation.
WB6.HMP.449	Velika Morava / Ljubicevo	30.6	137,100	ROR	Velika Morava		10.1	375	72.7	PF SI	JV between EPS and RWE. Unclear continuation of cooperation.
WB6.HMP.448	Djerdap 3 - Phase 2	1,200	1,100,000	REV	Danube	15,416.67	374	400	638.1	FS SI PD	

5 Proposals for concrete follow-up actions

5.1 Regional level

Table 5.1: Proposed actions at the regional WB6 level

SN	Brief description of proposed Action	Assumed implementing agent	Anticipated timeframe
1	Large number of projects are transboundary. Support regional (and intra-country cooperation). Respect obligations for trans-boundary consultations in line with EU legislation and Espoo Convention.	DG NEAR, ECS, Governments	Permanent action item
2	Support plant operators to enable the adequate planning of rehabilitation projects, together with potential environmental improvement measures. Support implementation of rehabilitation projects.	DG NEAR, ECS, IFIs	ASAP/Permanent action item
3	Undertake hydro-development and planning study focused on Albania in order to clarify the situation	ALB Line Ministry, DR NEAR, IFIs	ASAP
4	Promote the development of a functioning electricity market, which would provide additional momentum for private investors in HPPs.	Line ministries, ECS, Regulator	Permanent action item

5.2 Country level

Table 5.2: Proposed actions at the country level

SN	Brief description of proposed Action	Assumed implementing agent	Anticipated timeframe
	(1) **Albania**		
1.1	Assure implementation of the relevant environmental acquis (i.e. EIA, SEA, WFD, Floods Directive, nature protection) and international agreements (i.e. Espoo Convention)	Government, Line ministries	ASAP
1.2	Strengthen HPP development planning process and procedures, including the integrated hydrological resources planning and management approach, spatial planning, grid connection planning.	Line ministries, IFIs	ASAP
1.3	Strengthen resources (probably in AKBN) for adequately managing a huge number of issued HPP concession contracts.	Government, Line ministry	ASAP
1.4	Improve the level of monitoring of HPP development concessions in order to facilitate the development and implementation of perspective HPP projects and to expedite the resolution of issues in problematic HPP projects or projects where the concession contract has been seriously breached.	Line ministry, AKBN	ASAP
1.5.	Support KESH in timely planning and execution of rehabilitation projects of their HPP portfolio.	ECS, IFIs	ASAP
1.6.	Investigate the potential and the interest of private HPP developers for cooperation with IFI's, EU, EC in the development and implementation of their HPP projects. As several projects apparently lack financing, cooperation with IFIs and EU institutions could ensure that good quality projects are developed in a transparent and sustainable manner. At the same time, the developers will benefit from bridging the financing gap.	ECS, DG NEAR, IFIs, Line ministries	ASAP
	(2) **Bosnia and Herzegovina**		
2.1	Assure implementation of the relevant environmental acquis (i.e. EIA, SEA, WFD, Floods Directive, nature protection) and international agreements (i.e. Espoo Convention)	Governments, Line ministries	ASAP
2.2	Reaching Interstate agreements is crucial for the development of a significant	Governments,	Mid term

SN	Brief description of proposed Action	Assumed implementing agent	Anticipated timeframe
	portion of identified projects (Drina, Trebišnjica)	Line ministries	
2.3	Promote cooperation between entities and cantons in order to optimise the usage of hydro resources and enable the timely development of perspective projects.	All levels of governments in BiH	ASAP
	(3) **The former Yugoslav Republic of Macedonia**		
3.1	Assure implementation of the relevant environmental acquis (i.e. EIA, SEA, WFD, Floods Directive, nature protection) and international agreements (i.e. Espoo Convention)	Governments, Line ministries	ASAP
3.2	Development plans need to be aligned with the targeted financing institution/partner preferences.	Project developers, Line ministries	Permanent action item
	(4) **Montenegro**		
4.1	Strengthen administrative capacities in the ministries (i.e. Ministry of Tourism and Sustainable Development and Ministry of Economy) to assure implementation of the relevant environmental acquis (i.e. EIA, SEA, WFD, Nature Directives, Floods Directive) and international agreements (i.e. Espoo Convention) and to enable strategic planning of hydro development.	Government	ASAP
4.2	Develop/revise hydro resources planning documentation per selected water sheds and rivers and on the national level. The document should take into account both the environmental and economic development concerns.	Line ministries	ASAP
4.3	Reaching Interstate and intercompany agreements is crucial for the development of a significant portion of identified projects (Trebišnjica, Drina tributaries projects)	Governments, Line ministries	Mid term
	(5) **Kosovo**		
5.1	Assure implementation of the relevant environmental acquis (i.e. EIA, SEA, WFD, Floods Directive, nature protection) and international agreements (i.e. Espoo Convention)	Governments, Line ministries	ASAP
5.2	Resolve hydro resources sharing and other transboundary issues with Albania regarding HPP Zhur.	Governments, Line ministries	
	(6) **Serbia**		
6.1	Assure implementation of the relevant environmental acquis (i.e. EIA, SEA, WFD, Floods Directive, nature protection) and international agreements (i.e. Espoo Convention)	Governments, Line ministries	ASAP
6.2	Reaching Interstate and intercompany agreements is crucial for the development of a significant portion of Drina and tributaries projects	Governments, Line ministries	Mid term
6.3	Support Serbian government and EPS in execution of overdue HPP rehabilitation projects.	DG NEAR, ECS, IFIs	ASAP

6 Conclusions, recommendations and final remarks

6.1 Conclusions and the proposed list for rehabilitation projects

- Rehabilitations **are a must** for safeguarding the existing HPP capacity and the current level of power generation from hydropower sources in the WB6 region;
- Rehabilitation projects potential for additional capacity and generation is relatively modest (in the range of approx. 4% of the capacities and up to 6% of generation of remaining, non-rehabilitated HPPs larger than 10 MW). Within the next 5-year period, the planned increase in capacity in existing HPPs is 152 MW and the planned increase in generation due to rehabilitation projects is 539 GWh. Extrapolating these estimations to include HPPs to be rehabilitated after 2022 as well, the total expected increase in capacity and generation is up to approximately 200 MW and 670-770 GWh, respectively.
- Considering the information available on the current practices in the WB6, environmental issues have not been recognised as a significant driver for future rehabilitations. The main driver of rehabilitation is the extension of plant operational lifetime and increasing its reliability, with an additional potential to reduce operational costs. In future rehabilitation projects, due consideration should be given to improve their ecological footprint, through the application of a wide range of environmental protection measures.

A provisional list of priority rehabilitation projects is provided in Table 6.1. The list does not include rehabilitation projects that have already started (eg. Fierza, Komani, Piva, Peručica). That does not presume these projects are not in need of technical or financial assistance. The comprehensive list of all rehabilitation candidates with respective data is provided in Table 4.2 to Table 4.7.

Table 6.1: Provisional list of priority rehabilitation projects ("REH list")

HPP	Country	Capacity [MW]	Rehabilitation due *)	Planned investment [mln. €]
Vau i Dejes	ALB	250	2010	n.a.
Uleza	ALB	25.2	1994	n.a
Shkopeti	ALB	24	1996	n.a.
Jablanica	BIH	180	2019	n.a.
Una-Kostela	BIH	10.1	2020	16.8
Bogatići	BIH	10	1987	9.2
Vrben	MKD	12.8	2019	4.6
Shpilje	MKD	84	2020	3.9
Tikvesh	MKD	116	2018	0.84
Vrutok	MKD	165.6	2019	4.05
Raven	MKD	21.3	2018	0.92
Globočica	MKD	42	2019	5.8
Ujmani	KOS	35	2019	
Uvac	SER	36	2019	n.a.
Potpeč	SER	54	2022	43
Djerdap 1	SER	1,206	2020	216.5
Djerdap 2	SER	270	2020	
Pirot	SER	80	2030	
Kokin Brod	SER	22.5	2018	
Vrla 1-4 (Vlasina)	SER	128.5	2019	60
Lisina	SER	28.6	2017	
RHE Bajina Bašta	SER	614	2019	

*Note: *) In the absence of information from the operator, rehabilitations are regarded due after 40 years of service after its commissioning.*

6.2 Conclusions on the greenfield projects

In terms of greenfield HPP projects, the following can be concluded:

- Out of 480 identified HPP entries to our database (HPP-DB), 136 candidate HPP projects were eventually screened and selected for further detailed consideration in MCA1. Out of that, 90 projects scored sufficiently well to be evaluated in MCA2 and later in the Final Expert Assessment.
- Considering the generally low level of development of projects concepts, a number of issues and risks remain to be resolved; in particular, related to the environmental, transboundary and financial feasibility factors. Consequently, the developers should be encouraged to undertake high and updated quality documents including new feasibility studies, EIA, including on transboundary issues, cost-benefit analyses and proper public consultations;
- A number of planned HPP development projects have significant external benefits; an appropriate model should be found to value these benefits and to assign them to the relevant stakeholders and to adequately split the costs between them, thus making the construction of an HPP itself financially more attractive for private and utility investors;
- Currently, there are 670 MW of capacities with a planned generation of 1,922 GWh of HPP projects in construction that are expected to come online in the next couple of years;

Annex 1: Detailed HPP-DB

An Excel file containing the HPP-DB can be provided on request.

Annex 2: GIS

A. Objectives of GIS application for HDS

Hydropower development is strongly related to geographic context. Majority of data relevant to the Study have spatial component – existing hydro power plants, river streams, catchments, digital terrain model, land cover, protected areas etc.

Managing location-based data requires specific tools and techniques, since they are large in volume and need to be visualized in a map. Central GIS database for data storing and web GIS application for presentation of data have been developed with the purpose to provide access to spatial data for project team experts during development of the Study and to present data and results of the Study to other users and public in a proper way,

The ability to store spatial data centrally, thus providing access for multiple users at the same time, to visualize spatial data in a digital map while observing spatial relationships and exploring spatial patterns in data, could help users make proper decisions and access data with ease.

The purpose of GIS application is to support the Study in the assessment and presentation of all spatially enabled data, while providing centralized data access for multiple users at the same time. GIS data and application have been used by project team experts during the Study preparation as well as all other users/institutions interested in results of the Study.

Special attention has been paid to usage of the created GIS application after completion of the Study and setup of user levels and access authorisations for each level. This shall be summarized in the following sub-sections.

B. Technical features of HDS-GIS

This sub-section gives an overview of the basic technical features of HDS-GIS. More technical data, together with overview of options and instructions for using the application is given in the User Manual that was prepared by our GIS team.

GIS application consists of web-based GIS viewer GDi LOCALIS Visios with advanced functionality, running on top of Esri ArcGIS platform. Geographic content related to the Study is embedded into existing web GIS application already developed for the purpose of the REG-CON project of the WBIF-IPF3 Consortium. For the purpose of the Study, existing application is configured and scaled to provide required functionality. Any user (client) who wants to access the application only needs to have one of the recent Internet browsers (Google Chrome, Mozilla Firefox, Internet Explorer, Apple Safari…) and Internet connection. There is no need for plug-ins or any additional software or licenses on the client side.

Minimum Esri ArcGIS platform configuration for such a system includes Esri ArcGIS for Desktop and Esri ArcGIS for Server software.

Modelling, processing, creation and editing of geographic content, and preparing of all data for presentation to public and further use in web GIS application is performed using Esri ArcGIS for Desktop software. ArcGIS for Desktop Standard license or higher was required to perform all necessary tasks.

The database used as a repository for storing vector, raster and alphanumeric data is ArcSDE geodatabase on top of MS SQL Server Express. Esri ArcSDE, which provides multiuser geodatabase functionality, is a component of Esri ArcGIS for Server software. Multiuser geodatabase supports concurrent connections and more than one person accessing and editing geographic content in time. It also supports specific geodatabase features, such as cross-database replication, updates using checkout and check-in, and historical archiving, while using at the same time standard RDBMS functionality - backup, recovery, replication, SQL support, security, and so on. The database is deployed at a central server and could be accessed through the network or by using various services served from Esri ArcGIS for Server.

ArcGIS for Server license is also required in order to publish and present geographic data to audience. ArcGIS for Server provides possibility of publishing data as web services. Depending on user needs, web services can support data visualization, searching, querying, as well as data editing over the web. For this system, the minimum required license level of ArcGIS for Server is Workgroup Standard.

Data stored in database are visualized using MXD documents, which are basically documents used for organizing display of database content – vector, raster and tabular data and rules of feature behaviour in database. Vector and raster data are organized as independent layers of MXD document, where each layer is displayed independently using independent point, line, polygon and raster symbology, as well as independent display of labels, visibility scales and visible data. Layer structure provides execution of various queries and analyses which use input layer or combination of multiple input layers. For example, having HPP locations in one layer and protected areas in another could easily answer the question which HPP's are located in protected areas (overlapping analysis).

Data display in MXD documents is organized in one or more data frames, which basically represents a map with layers, whereby the layers which reference the same data could be duplicated and could show the same data using different symbols. WGS84 geographic coordinate system (EPSG:4326) is used for the purpose of this project, since the area of interest covers several countries.

Arranged MXD document are published through Esri ArcGIS for Server, and served as services to the unlimited number of different users through GDI LOCALIS Visios Web GIS application.

GDi LOCALIS Visios web GIS viewer is used for consuming of web services i.e. data sent using web services. End users can search, identify and visualize geographic data, make graphic reports and/or edit geometry and attribute data using this application. Web-oriented system, as shown in Figure A2.1 below enables access to data for infinite number of users, regardless of number of licenses, as well as access from any device (desktop computer, laptop, mobile device) and location using only internet browser and internet connection.

Figure A2.1: GIS platform – web centric

The application for user administration is an integral part of the system. Only authorized users can access data related to the Study using GDi LOCALIS Visios. There are two roles which can be assigned to each user – *viewer* and *editor*. Users in *viewer* role can see all data in the application, while users in *editor* role can update existing or insert new data, if necessary. There should be one or more persons (user administrator) who will administer users and have access to the application for user administration. User administrator(s) should be delegated from IPF Consortium and/or project team. They will have the possibility to create new users and assign them roles.

GDi LOCALIS Visios is built using JavaScript and HTML5 languages which provides using of application without need for any additional browser components (plug-in, such as Flash, Java and Silverlight). GDI LOCALIS Visios is ready for use in all recent Internet browsers, such as Mozilla Firefox, Internet Explorer, Google Chrome and Apple Safari, and also in browsers for mobile devices because of its responsive design.

C. Users of HDS-GIS

The application is currently available on GDI web server for the use by the study team. It will be made available to a set of other users in line with wider agreement on the project level, and coordinated by the Client. Any such agreement will need to be technically implemented by the developer.

User manual for the application is given in Annex 5 of this report and would be made available for future users.

Authorization to view and edit data will be redefined once the agreement on further use and administration is resolved. We assumed that the following user levels will be established:

- “view” and “view and edit” users in the development stage (this stage);
- full contents “view” and “view and edit“ users in the final stage and during the contents update stages (to be agreed with the Client);
- limited contents “view“ users – several limitation levels (to be agreed with the Client);

Currently, the log-in page looks as follows (Figure A2.2). It is a common platform for log-in, but once accessed with the “wbifhpp” login, the visibility is adjusted to this study.

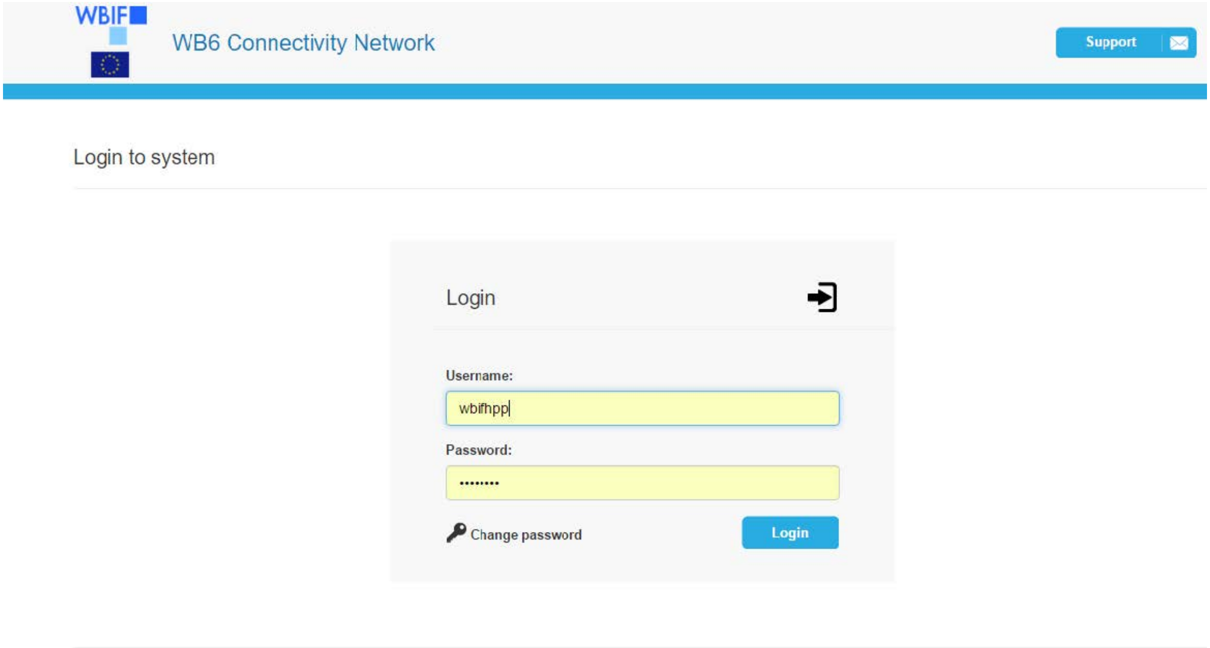


Figure A2.2: Login page

D. Approach in developing HDS-GIS

Contents of the HDS-GIS

The HDS-GIS was established and implemented throughout the scoping and study stage. In the Scoping report, a general summary of steps in the process of HDS-GIS data collection and loading was presented. This process comprises the following steps, in this general case:

A. Data collection and conversion;

B. Creation of data model;

C. Data integration and migration into the data model in central geodatabase;

D. Creation of specific documents (MXDs) and services;

In the study stage, the study team developed a more complex procedure for data collection, pre-processing and integration into the GIS application, but still based on these principles. Specific step-by-step approach was applied for different sets of data:

- Background data, including:
  - data integrated from other projects or publicly available databases,
  - data officially received from institutions contacted throughout the study and
  - data produced by the IPF team experts.
- Hydro Power Plans projects, including:
  - planned HPPs,
  - HPPs under construction and
  - existing HPPs, with or without plans for refurbishment

Background data are data which support the process of projects assessment and contribute to the presentation of the hydro power plants, in all stages of development. These data may be in form of vectors or “dummy” backgrounds, such as maps.

In the scoping stage a set of background data were collected from open resources:

- Precipitation data for the period 1981-2010, based on ECA&D station measurements (source: European Climate Assessment & Dataset project);
- River streams (source: HydroSHEDS);
- Basins (source: HydroSHEDS);
- Drainage basins - watershed boundaries (source: HydroSHEDS);
- Catchments, with precipitation data for each polygon (source: CCM River and Catchment Database);
- River basins (source: CCM River and Catchment Database);
- Main rivers (source: CCM River and Catchment Database);
- Land cover (source: CORINE Land Cover Database);
- Digital Elevation Model (source: CGIAR-CSI SRTM);
- Ramsar sites (source: Ramsar database)
- Nationally designated areas (source: EEA)
- Protected areas (source: World Database on Protected Areas WDPA)
- Esri Topography basemap with major cities, administrative boundaries, relief, roads, railways, rivers etc.
- OpenStreetMap basemap, including major power distribution and transmission lines, roads and railways

These data were **checked in detail during the study stage by the PTEs** in sense of quality and relevance of the contained information, as well as in sense of usability of the data for the subject study. The data that were evaluated as irrelevant or inaccurate were placed in a separate layer and may be neglected during the course of this study and eventually deleted.

Some information that were considered to be incomplete were **either revised or extended by the experts** to be used in the study, such as ECRINS data on watersheds and (sub) river basins. The contents were adjusted to the hydrology classification as set up by our expert.

In spite of availability of the open source information, some of the relevant information were still missing, so our team had to either **provide them from the national institutions (protected areas) or produce them (assumed flooding areas and ichtiology data).** The latter were produced from the available literature and digitalised or calculated using available information.

The structure and final contents of the layers will be described in the following sub-sections.

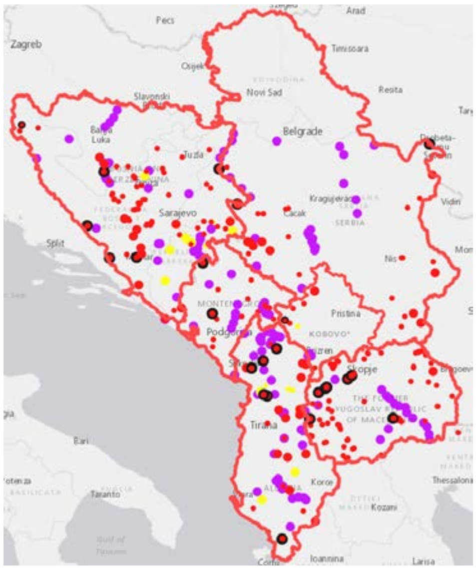


Figure A2.3: Examples of layers

Data collection referring to the **hydro power plants** and scope of this information were described in Section 3 of this report. In addition to the rehabilitation and "greenfield" projects, information about existing power plants were collected as well. The scope of information that was migrated to the HDS-GIS is smaller compared to the overall amount of information, for the following reasons:

- Size; the range of types and amount of all information collected for both planned and existing power plants is great and putting everything would cause overloaded database;
- Tidiness; related to the previous, it was essential to highlight the most important information, present it in the application and enable easy search and orientation in the database;
- Internal comments and auxiliary data; some of the information are for internal use only or are not relevant for disclosure to wider public;

The set of information contained in the database is shown in the next sub-section.

As a summary, all considered HPPs have been stored are grouped under certain criteria:

- Size of HPP - small (<10MW) and large (>10MW)
- HPP implementation status:
    - Planned HPPs
    - HPPs under construction
    - Existing HPPs, with or without plans for refurbishment

The structure of the database was implemented on this basis.

HDS-GIS development

In the scoping stage, the basic structure of the HDS-GIS was formed, representing a starting point for refinement of the structure and adding of full scale study data. The tasks that were set out in this stage and refined in the early study stage were:

- Improvement and adjustment of visibility aspects and HDS-GIS structure;
- Collection of full scale data related to HPPs (both existing and planned);
- Verification of HPP data by the IPF team and relevant national and international institutions;
- Collection and processing of other background data (river systems, electrical network, flood zones, ichtiology, protected areas, etc.);
- Data model adaptation, data migration and import;
- Configuration and customization of the application – search, identification, spatial selection etc.;
- Development of new tools for export and reporting – timeline, editing, reporting.

In this sub-section, major notes related to visibility aspects, data collection, verification and reporting are given.

Visibility aspects

The figure below represents the WB6 region, with applied borders and labels, based on the current instructions issued by the European Commission and used on all IPF projects. It is important to note that the built-in maps in the background are services used by the HDS-GIS, that cannot be altered, so in these cases we covered the labels and borders with the required additions.

The main inscription in the upper left corner, beside EU and WBIF logo is "WB6 Hydropower Development", which is applied for user account specifically prepared for this Study.

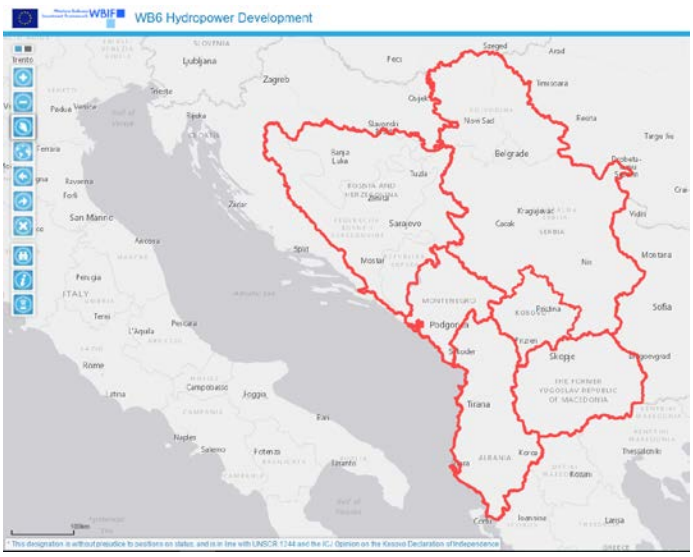


Figure A2.4: WB6 region

Major rivers

The presented data are based on CCM2 database (CCM River and Catchment Database, version 2.1), improved and extended by additional rivers/tributaries and river labels by our team. The need to extend the database was based on the fact that some rivers / tributaries where there are relevant HPP projects, were missing from the CCM2 database. On the other hand, HYDROSheds source contains much more information (even streams), but with that layer turned on, the presentation becomes overloaded and the labels cannot be added. Therefore, we decided to go for the explained approach.

Classification of hydrographic elements

The classification of the hydrographic elements (drainage basin, watershed, river basin, (sub) river basin, river, tributaries), was proposed and optimised by our Hydrologist / Water Management Expert to be used on this Study. The details on this classification are given in BR-2.

The challenge was to determine the appropriate mapping source to fit the classification. Therefore, an ECRINS (European catchments and Rivers network system) shp-file was taken as a basis, which was adjusted to the Study classification.

Figure A2.5: River and Catchment map

<u>Protected areas</u>

Initially, in the scoping stage, we used the following sources in the HDS-GIS:

- Ramsar sites (source: Ramsar database)
- Nationally designated areas (source: EEA)
- Protected areas (source: World Database on Protected Areas WDPA)

As we noticed that some of the known data were missing from these sources, we addressed the national institutions to provide us with up-to-date information. The information that we received were inserted in the HDS-GIS in separate layouts, as given in Figure A2.6.

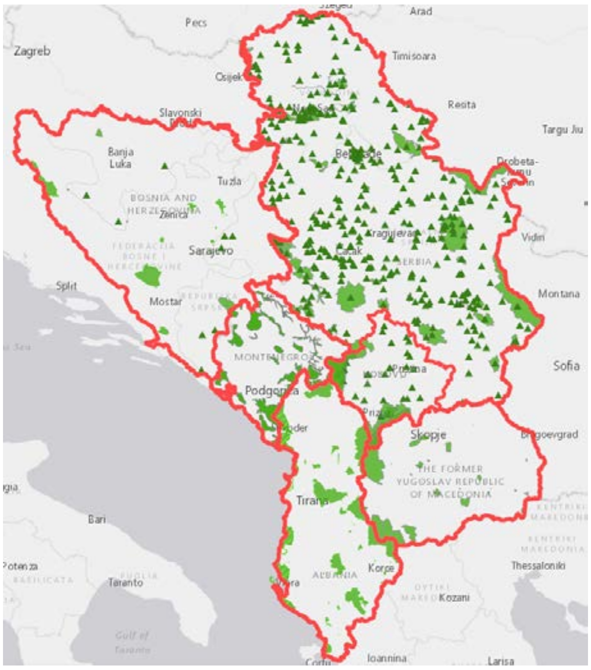


Figure A2.6: Protected Areas

Ichtiology

The relevant ichtiology data were provided by our Ichtiology expert, from relevant literature. These data comprise the following:

- hucho hucho – self-sustainable population;
- migratory species:
  - historical distribution,
  - present distribution;
- other threatened species;

Electrical network data

The electrical network data that we loaded into the HDS-GIS refer to transmission system only. The one possibility was to use ENTSO-E source which covers the complete ENTSO-E (European Network of Transmission System Operators for Electricity) network. Nevertheless, this source covers 400kV and 220kV network only, with 110kV lines covered in interconnection cases only. This is not relevant for this Study as major part of the assessed planned HPPs should connect to the 110kV transmission and distribution network.

Having this in mind, we used publicly available sources and contacted national network operators in the WB6 region to provide up-to-date HV network data and include it in the HDS-DB. These maps were georeferenced and included as “dummy” maps in the HDS-GIS, without possibility to identify any of the transmission assets as objects.

On the other hand, collection of data referring to the distribution networks, even just 35kV network, would not be a justified attempt. Therefore, the distribution network was not inserted in the HDS-GIS. It is our intention to analyse grid connection issues case-by-case, for particular HPPs and present the connection facilities for these cases.

Digital elevation model

The digital elevation model of +/- 25m accuracy is used as a tool in the HDS-GIS, when it was necessary to assess elevation data for particular locations and regions, such as estimation of potential flooded zones for accumulation lakes (Figure A2.7).

Figure A2.7: Digital Elevation

Flood zones

This is one of the "background data" that were produced by the IPF Team and assumes estimations of potential flooded zones for accumulation lakes (Figure A2.8). These data were obtained, using the available digital elevation model (DEM) and the following data for planned HPPs:

- designed coordinate of HPP dam centre and
- designed accumulation lake level

Figure A2.8: Estimation of potential flooded zone (example) – background data

We performed an initial testing procedure using the data for existing plants and compared the results with actual data, i.e. lakes' edges. The procedures proved to be efficient with exception of cases with very narrow riverbed and steep canyon slopes. In these case, DEM could not capture the elevation change, so we used other services to capture lakes' outlines (such as Google Earth).

Disclaimer: It is important to highlight that the lakes were generated exactly in a way described here above, i.e. using only the basic design parameters and DEM. In many cases, the design will assume, or has already assumed embankments to regulate the water distribution and protect the areas of interest, such as houses or other surfaces aimed for other use. This has not been considered in the generation process as it would interfere in the design process, with lots of uncertainties and would also be time and resources consuming.

Hydro power plants

The data collection referring to hydro power plants was described in Section 3 and Section 4 of this report.

Data processing mainly focused on preparation of data to be imported into the HDS-GIS. The structure of the database is presented in the next sub-section.

E. Structure and usage of HDS-GIS

The elements of the HDS-GIS and procedure for development are described in the previous sub-section. In this sub-section, the structure and available navigation, filtering, search and export tools are explained.

The GIS application interface

Detailed instructions for use of the application are given in appropriate User Manual, which is provided in Annex 2 of this report. The structure as described here refers to the structure of data collected for the purpose of this Study.

The application contains the core body (1), where map services are loaded using Esri ArcGIS for Server, main toolbar (2) and navigation toolbar (3), as shown in Figure A2.9 below.

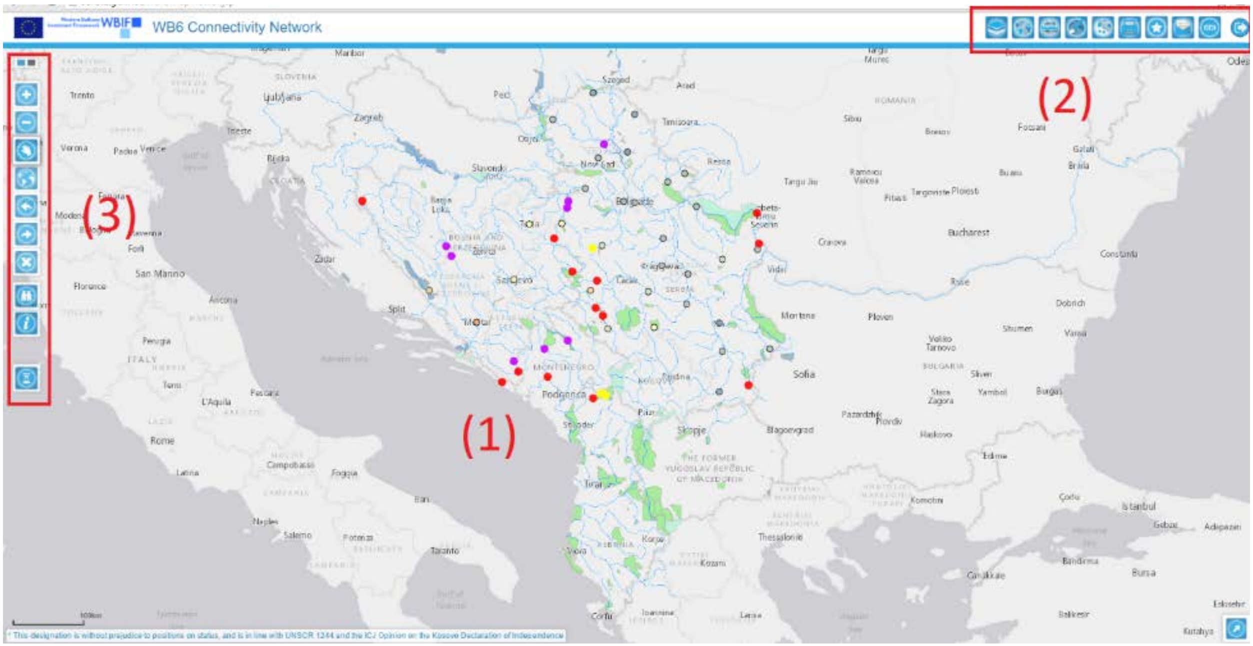


Figure A2.9: GDi LOCALIS Visios interface

The main toolbar contains tools for browsing map content, features and attributes, feature identification, measurement of length, areas and coordinates, layer management (toggle layer display, change layer symbology, filtering etc.), tools for printing and map export. The navigation toolbar contains tools for map navigation: zoom in, zoom out, full extent, previous and next extent, clear map graphics, as well as tools for data search and identification. Search and identification tools help users to solve two main GIS problems – to find where something is and to see what exists at specific location. The figure below shows “identify” window with basic information about HPPs. This window pops up when user clicks on the HPP location (symbol) (Figure A2.10).

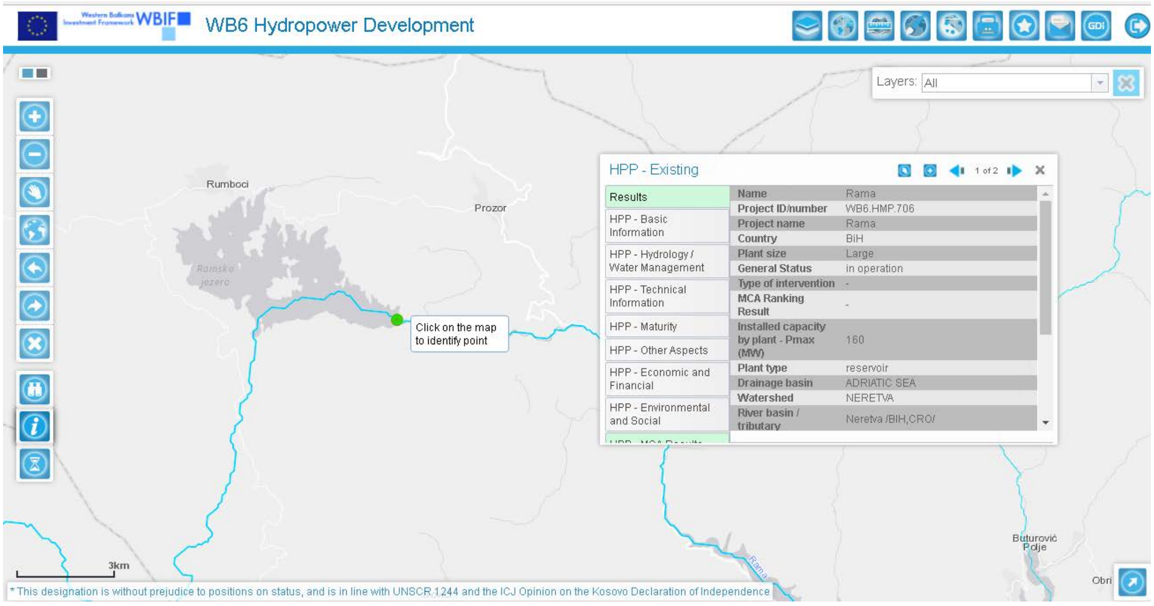


Figure A2.10: Identity window – HPP information

The application shows all relevant data – vector, raster and alphanumeric data. The application uses Web services from other servers (such as Esri ArcGIS Online services) as a background layers (basemaps) – imagery basemap, topographic basemap, OpenStreetMap basemap. These basemaps are included for free with Esri platform, hence there is no need to collect satellite or ortophoto imagery, topographic maps, street maps, major towns, administrative borders etc.

Structure of HDS-GIS

The collected data for this Study are organised in the following way (as in the application):

- Hydrology
  - HPP – Existing
  - HPP – Under construction
  - HPP – Planned
  - HPP – Other (not relevant for this report)
- Planned flooding areas
- Background data
  - CCM2 Main Rivers
  - Protected Areas
  - Ichthyology
  - ECRINS River Basins
  - ECRINS Watersheds
  - Electrical Network
- Background data – other (not relevant for this report)

These elements, presented by screenshots of the application “Table of content”, are given in the following Figure A2.11.

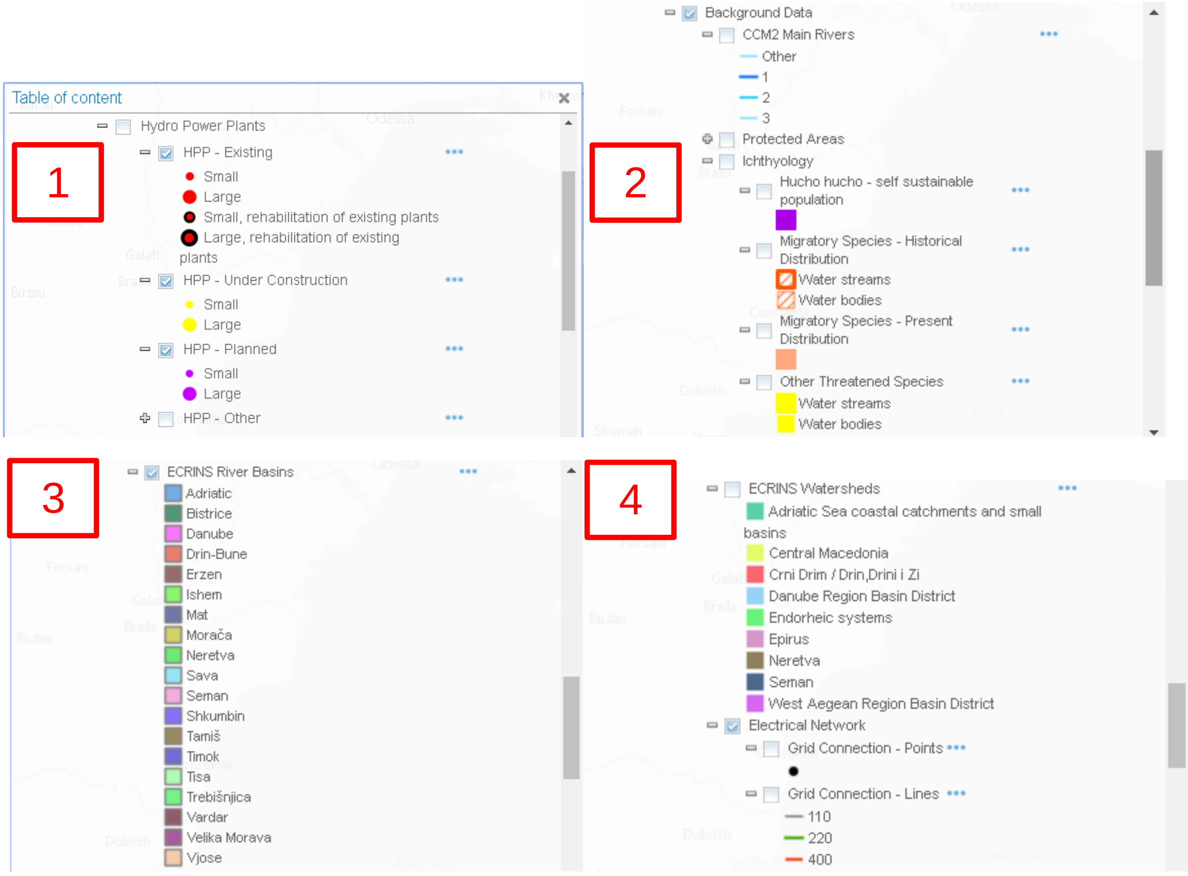


Figure A2.11: Table of Content

The layers can be turned on and off and a number of operations can be undertaken for each layer/sub-layer:

- Change of symbology,
- Create labels or
- Filter

Data filtering is essential function, especially for HPPs. It is possible to filter out projects that are for particular interest for a viewer or for presentation purpose. Currently, data can be filtered based on the following pre-defined criteria:

- Name,
- Project ID,
- Project name,
- Country,
- Plant size,
- General status (in operation, under construction, planned),
- Type of intervention,
- MCA ranking result,
- Installed capacity P_{max} (MW),
- Plant type,
- Drainage basin / Watershed / River basin / Sub-river basin / River / Tributary 1 and 2,
- Medium flow (m^3/s),
- Within protected area

Besides filtering, major function to be used is “Search” per layers (see figure below).

Data export and reporting

The collected information may be exported in several forms, for the selected set of data (achieved by Filter or Search tools):

- Export of maps with selected filtered data;
- Project fiches for selected projects, exported in rtf-format;
- Export of filtered results in form of xls-tables with selected set of data;

On random Project Fiche, generated by the application, is shown in the following figure. The project fiches will be attached to the Final Report for highest ranked projects (MCA Analysis).

MOTT MACDONALD IPF CONSORTIUM

Western Balkans Investment Framework (WBIF)

Regional Hydropower Development in the Western Balkans
(WBEC-REG-ENE-01)
Project Fiche

Gornja Neretva / Bjelimici

TAB 1 BASIC INFORMATION	Attribute values
Project ID	WB6.HMP.175
Project name:	Gornja Neretva / Bjelimici
Owner / Promotor	Intrade Energija d.o.o., Sarajevo / Intrade d.o.o., Sarajevo (25%) and Petrol dd.(51%)
Country	BIH
Location (coordinate)	43.496705, 18.138819
Plant size	Large
Installed capacity - Pmax (MW)	100.00
Average annual electricity output - Wmax (MWh)	219,400.00
Capacity factor - Wmax/Pmax*8760 (%)	25.05
Plant type	near dam
Generation type	
Available documentation	STUDIJA EKONOMSKE OPRAVDANOSTI IZGRADNJE SISTEMA HIDROELEKTRANA NA GORNJEM TOKU RIJEKE NERETVE,HE Glavatičevo, HE Bjelimići i PHE Bjelimići, Elektroprivreda BiH, 2016. (YES) / Prijedlog za dodjelu koncesije
Comment	Candidate for construction within long term development plan of EP BiH. Eventhough project has been in development by Intrade energija, in 2016 EP BiH submitted an unsolicited request for concession for Glavaticevo, Bjelimici and PHE Bjelimici.

TAB 2 HYDROLOGY / WATER MANAGEMENT	Attribute values
Drainage basin	ADRIATIC SEA
Watershed	NERETVA
River basin	Neretva /BIH,CRO/
Sub-river basin	
River	Neretva
Tributary 1	
Tributary 2	
Medium flow (m³/s)	27.80
Usable reservoir storage - Volume (m³x10x6)	81.05
Usable reservoir storage - Energy (MWh)	20,467.17
Cummulative effects within HPPs chain	
Available documentation	STUDIJA EKONOMSKE OPRAVDANOSTI IZGRADNJE SISTEMA HIDROELEKTRANA NA GORNJEM TOKU RIJEKE NERETVE,HE Glavatičevo, HE Bjelimići i PHE Bjelimići, Elektroprivreda BiH, 2016. (YES) / Prijedlog za dodjelu koncesije
Comment	Kandidat za izgradnju u okviru Dugoročnog plana razvoja Elektroprivrede BiH

TAB 3 TECHNICAL INFORMATION	Attribute values
Designed head (m)	103.35
Designed flow (m3/s)	110.00
Configuration & turbine types	2 x vertical Francis
Grid connection level, line and point (SS)	
Dam type	
Dam height (m)	110.00
Maximum elevation height of backwater / accumulation	0.00
Available documentation	STUDIJA EKONOMSKE OPRAVDANOSTI IZGRADNJE SISTEMA HIDROELEKTRANA NA GORNJEM TOKU RIJEKE NERETVE,HE Glavatičevo, HE Bjelimići i PHE Bjelimići, Elektroprivreda BiH, 2016. (YES) / Prijedlog za dodjelu koncesije
Comment	There is no HV network in the area. New connections need to ne constructed for connection of thess HPPs. They are not defined in the BiH 10-Year Network Development Plan. New 110kV SS needs to be constructed for the connection of these HPPs, together with connection to two different existing 110kV SS, SS Nevesinje i SS Foca, which makes connection costs rather significant.

TAB 4 ECONOMIC & FINANCIAL	Attribute values
Total investment cost (mil.EUR)	165.70
Year when Investment was evaluated	2,016
Normalised total investment cost for referent year	165.70
Support scheme (SS) type	none
Specific investment (EUR/MW)	1,657,000.00
Investment per unit production (EUR/MWh)	755.24
External cost benefits	
Available documentation	STUDIJA EKONOMSKE OPRAVDANOSTI IZGRADNJE SISTEMA HIDROELEKTRANA NA GORNJEM TOKU RIJEKE NERETVE,HE Glavatičevo, HE Bjelimići i PHE Bjelimići, Elektroprivreda BiH, 2016. (YES) / Prijedlog za dodjelu koncesije
Comment	Kandidat za izgradnju u okviru Dugoročnog plana razvoja Elektroprivrede BiH

TAB 5 ENVIRONMENTAL & SOCIAL	Attribute values
Within protected area	No
Type of protected area	EME
Construction forbidden due to local legislation	No
Availability of SEA / EIA	
Environmental & Social concerns	
Multi-purpose use	
Transboundary / Riparian issues	
Ecologically Acceptable Flow (m3/s)	0.00
Is the HPP equiped with functional fishpass?	
Available documentation	STUDIJA EKONOMSKE OPRAVDANOSTI IZGRADNJE SISTEMA HIDROELEKTRANA NA GORNJEM TOKU RIJEKE NERETVE,HE Glavatičevo, HE Bjelimići i PHE Bjelimići, Elektroprivreda BiH, 2016. (YES) / Prijedlog za dodjelu koncesije
Comment	Kandidat za izgradnju u okviru Dugoročnog plana razvoja Elektroprivrede BiH

TAB 6 MATURITY	Attribute values
General status	planned
Grid Connection status	
Type of intervention	greenfield
Status of completed	FS SP
Energy strategy	
Spatial planning status	
Land ownership	
Financial assistance (FA) provided by	
In operation from / planned commissioning	0
Year of upgrade / refurbishment	0
Available documentation	STUDIJA EKONOMSKE OPRAVDANOSTI IZGRADNJE SISTEMA HIDROELEKTRANA NA GORNJEM TOKU RIJEKE NERETVE,HE Glavatičevo, HE Bjelimići i PHE Bjelimići, Elektroprivreda BiH, 2016. (YES) / Prijedlog za dodjelu koncesije
Comment	Kandidat za izgradnju u okviru Dugoročnog plana razvoja Elektroprivrede BiH
Possible risks	

TAB 7 MCA RESULTS	Attribute values
MCA Ranking Result	A
Comments	

F. Conclusions and recommendations for further improvements

The HDS-GIS is a tool which is used for

- storing of data (central GIS database),
- understanding of spatial relationships between different data and
- presentation and export for further assessment and use of data and results of the Study.

The previous sub-sections demonstrate the structure and capabilities of the developed system and describes the process to develop it. Both these elements are essential for future use of the application and related data, so this may be the main conclusion of this sub-section.

The process described in the previous sub-sections required a close and intensive communication between GIS sub-team and all PTEs in order to provide or produce a reliable, relevant data and information, check, improve and / or adjust them for use on the Study, store the covering information and finally migrate the end results into the HDS-GIS. Any further updates need to incorporate such an approach.

The tasks for the period after this Study is finalised would be:

- Definition of users and data sets to be made available;
- Ensured hosting of the GIS application;
- Regular relevant updates of the both HPP and background data (such as protected areas);
- Improvement of existing and development of new tools, such as exporting tools, timelines, reports, etc.

Annex 3: IDMS User Manual

Contents

1 Aim of IDMS

1.1 Functionality

The aim of the Information and Document Management System of the project “Regional Hydro Master-Plan (Hydropower Development Study in the Western Balkans)”, in this document referred as “IDMS”, is to provide information technology (IT) support for systematic storage and retrieval of the project documents. The key functions of the system are to provide:

- secure central storage of relevant documents,
- mechanism for users for quick search of the documents,
- retrieval of the documents, potentially through external applications (GIS etc.).

IDMS is designed as a file server, enhanced with the following custom functions:

- systematic description of each document with metadata relevant to the project (country, river basin, event, hydropower plant (HPP) etc.),
- automatic document content analysis to extract potential metadata,
- full-text search of all documents, including scanned image documents,
- mechanism for approval of documents by task leaders.

1.2 Security

IDMS is not designed as a system for storage and transfer of sensitive information. All documents in the IDMS are accessible to all users of the system, i.e. all members of the project team. To allow rapid download of the documents by the end users, the documents might be stored temporarily (cached) on intermediate web services. Anyone with an appropriate link to the document can read it from the server.

Nevertheless, IDMS assures secure document storage and transfer when the users act responsibly. The security mechanisms are as follows:

- the data transfer is strictly over secure HTTPS protocol, i.e. no intermediate party can intercept and decode the documents (at least not easily and quickly),
- the only users that can register are the members of the project team; they are bound by their non-disclosure agreements to prevent any unauthorized transfer of information, including any document in the IDMS,
- key actions with the documents are logged: who and when has uploaded, authorized, removed or downloaded the document.

Users have to keep in mind that the documents in the IDMS are stored on a WEB server with public access so anyone can download the data as long as they know the address of a link with a “hard-to-guess” ID and document name. The links are available to the registered users and if they share any of the links, the document becomes publicly available.

1.3 Limitations

IDMS is a custom IT solution, developed during the project and with intended use during the project. It can and will be used for data access and storage after the project is finished, but the emphasis is on the usability during the project.

IDMS is focused on search and filtering capabilities of the stored documents, but it lacks flexible document hierarchy structure. The document hierarchy structure is fixed and follows the organization of this project. The documents are always organized by predefined project tasks and types of activities, optionally grouped in single depth folders under each activity.

2 New user registration

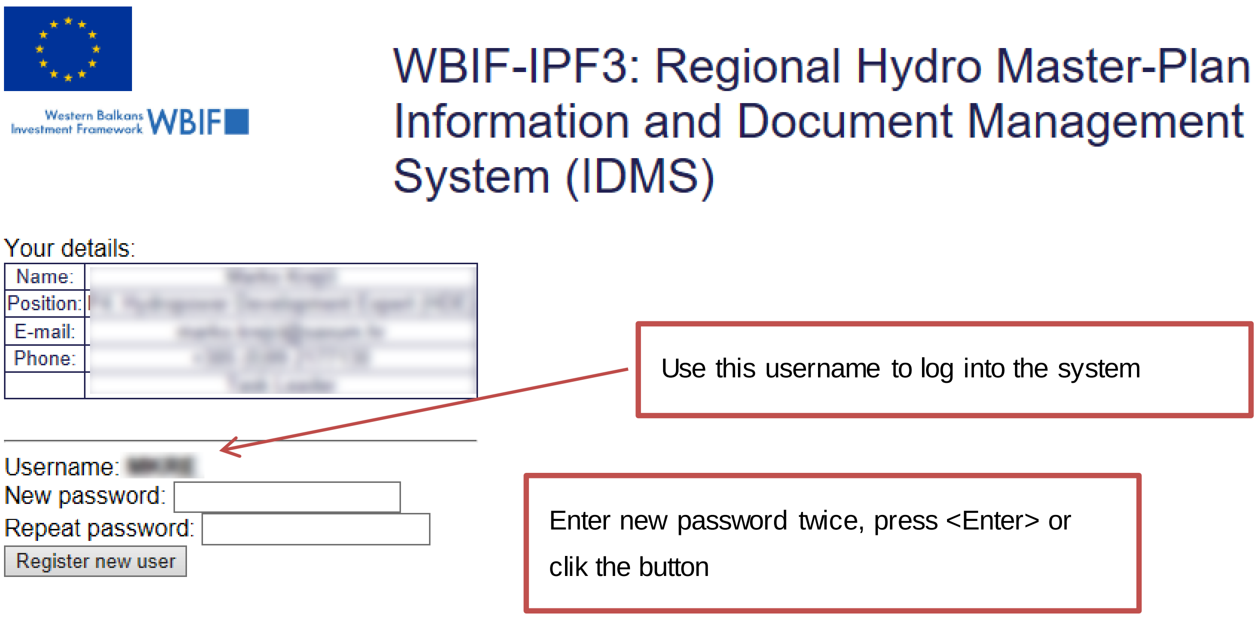
2.1 Registration procedure

Only the team members are allowed to register as the IDMS users. The list of the team members is maintained by the Team Leader (Mr. Marko Košir) who has the sole authority to include or exclude individual users.

All potential users are sent a link with which they can register. The link is in a format:

https://www.hidro-l.com/IDMS/index.php?register=xxxxxxxx and is individual for every new user. If the user is already registered, the link opens the front page where the user can enter the password and log into the system.

All data about each user are already in the database, so the new user only provides the password. It has to be entered twice, when the button “Register New User” is clicked the user is registered.



If your details are incorrect, please notify the Team Leader. Wrong data are not crucial for IDMS use, but e.g. wrong e-mail address can prevent e-mail notifications to be sent.

The only method for registering a new user is through a link with

- the only users that can register are the members of the project team; they are bound by their non-disclosure agreements to prevent any unauthorized transfer of information, including any document in the IDMS.

2.2 User privileges

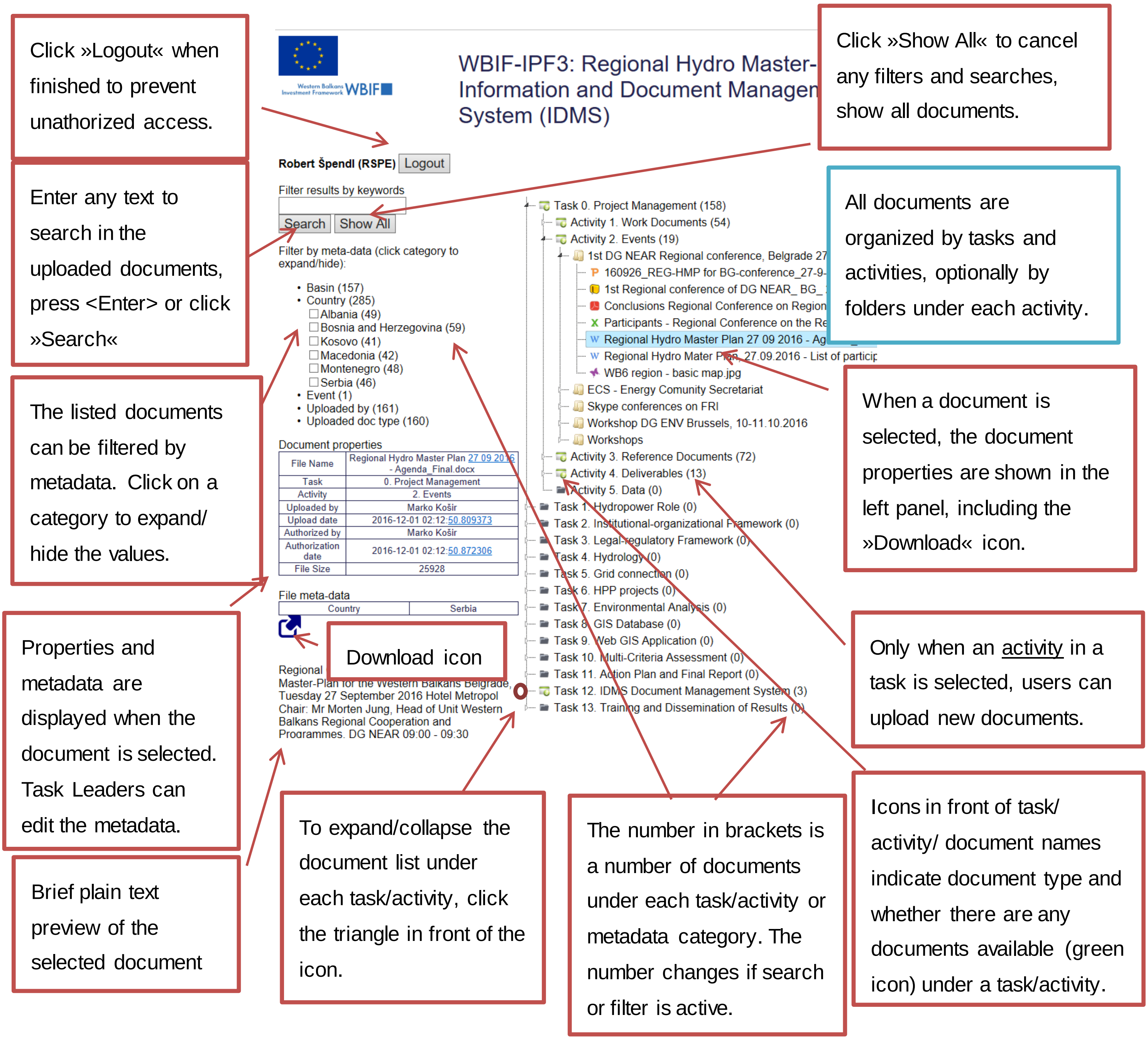
There are two types of users of the system:

- Task Leaders and
- other users

Both types of users can upload the documents and browse and search the documents. The difference is that only the Task Leaders can authorize the documents to be stored in the system. Therefore, each document has two attributes: the name of the user that has uploaded the document and the name and date of authorization of the document by the Task Leader. Task Leaders can authorize their own documents.

3 Overview of user interface

Once the user is registered and logged in the system, the user interface is opened that allows searching, browsing, uploading and downloading the documents.



4 Uploading Documents

4.1 Procedure for uploading the documents

Documents can only be loaded under one of the defined tasks and activities. There are 13+1 tasks in this project and all documents are results of one of the following activities:

1. Work Documents: active documents, written during the project, might be replaced with new versions (minutes, data to be shared with other team members etc.)
2. Events: documents for events (workshops, meetings, conferences etc.) or produced at events (presentations, lists of participants, results etc.)

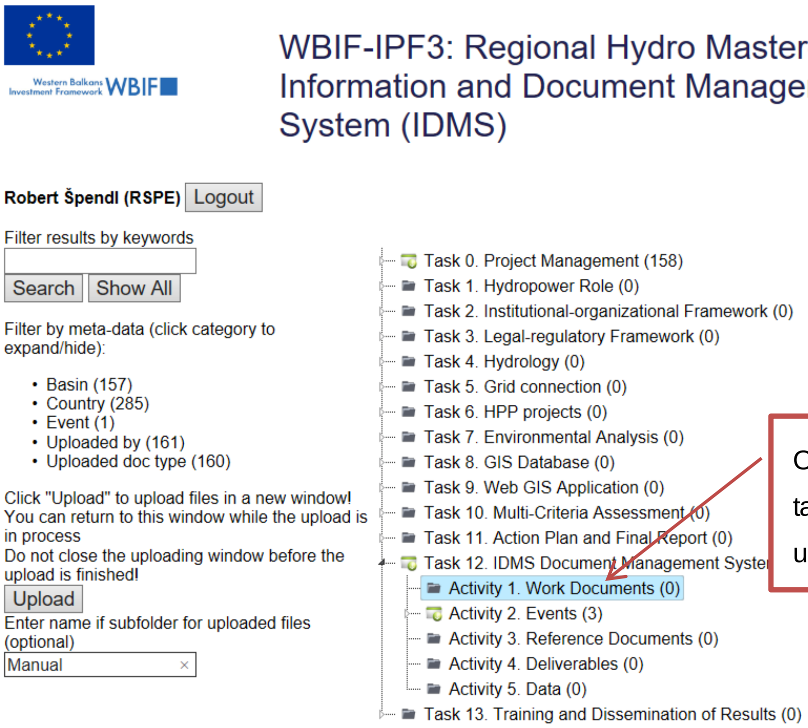
3. Reference documents: any reference documents, obtained for the project (downloaded, obtained from authorities etc.)
4. Deliverables: reports / studies / results from the project work; documents in a draft or final version, typically at the level to be submitted for internal or public dissemination
5. Data: hard data for the project work (e.g. database tables, GIS data etc.)

Anyone can upload the documents under any task and activity, but the uploads will only be visible when the Task Leader of the task, the document is uploaded to, approves the document.

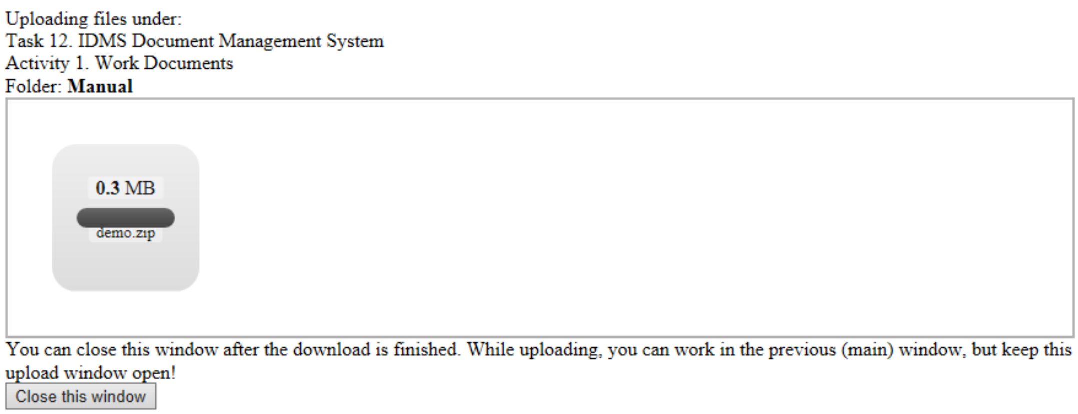
The procedure for uploading and authorizing the document is as follow:

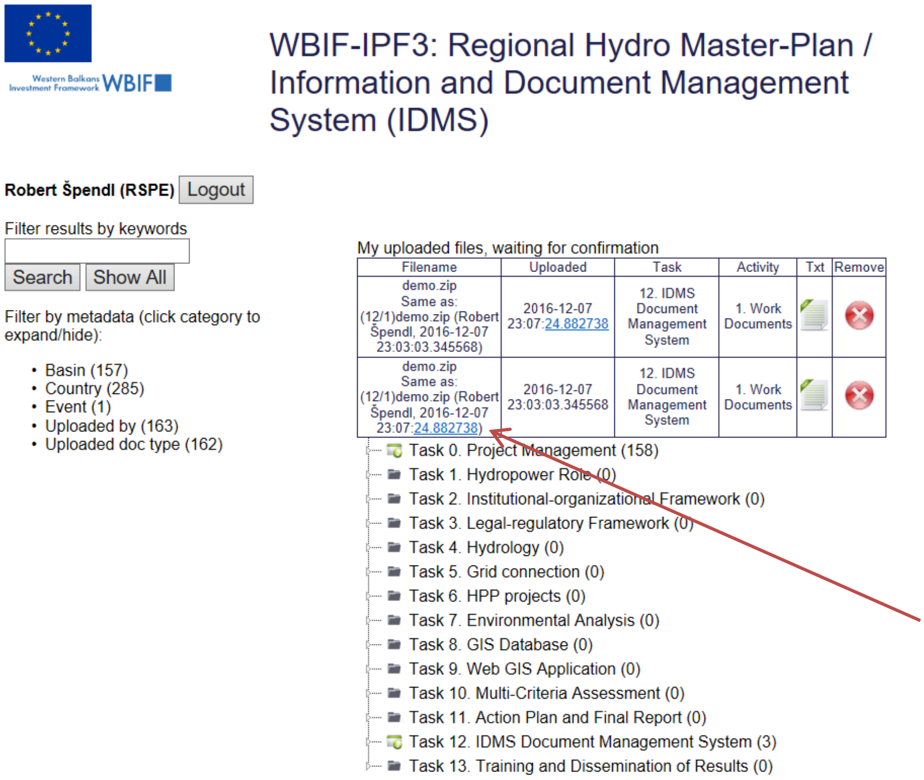
1. Select the activity and task where the document (possibly multiple documents) will be uploaded. In the left panel an “Upload” button is displayed and optionally a name of folder for the documents can be entered. If the folder already exists under the selected activity, the uploaded documents will be uploaded in the existing folder. Click on “Upload” and a new window (or tab) will open with the upload window.
2. Click to select the documents on a computer or drag-and-drop the documents into the upload window. The upload starts and all the documents that are uploaded are shown in the window with progress bars. While the documents are uploading, user can return to the main window and browse the documents, but has to keep the upload window open, otherwise the upload is cancelled. When all documents are uploaded, user can close the upload window either by closing the tab or clicking the “Close this window” button.
3. The list of uploaded documents that await authorization is shown in a table above the normal tree of tasks and documents. The user can view the plain text extract of each document or remove uploaded documents before it is authorized. In case the same document is already in the IDMS (under any task/activity or even with different name), there is a notification in the “Document Name” column.
4. The Task Leader sees a table with all uploaded documents awaiting his/her authorization. The Task Leader can download documents, authorize or remove the documents. If the task leader is uploading documents, they are show first in the table of uploaded documents (as for ordinary users) and then in the table of documents, awaiting approval (if the documents are uploaded to the task, managed by the task leader).
5. If the document is authorized, it is removed from the table and shown in the general document tree view with the other available documents.

Click »Upload« to open the upload window where the documents can be selected. Here the name of subfolder for the documents can be specified.



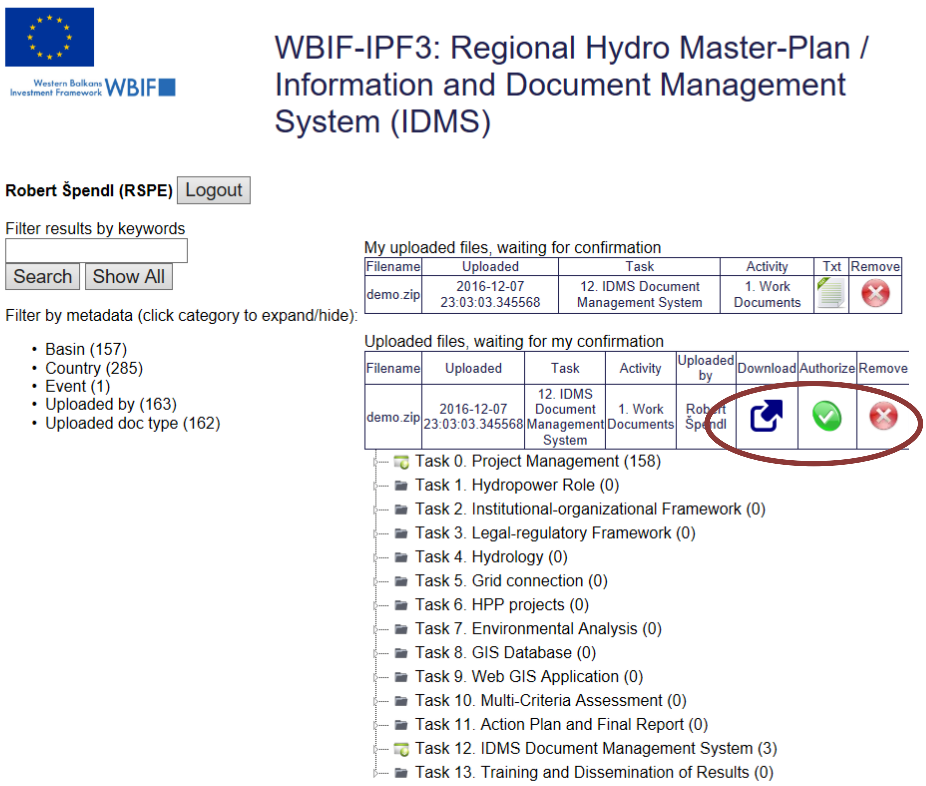
Only when an activity in a task is selected, users can upload new documents.





All uploaded documents are listed until they are authorized. User can remove any uploaded document only until it is authorized.

Any duplicate documents are detected, users are advised to remove duplicates, though it is not mandatory (identical documents can reside in the IDMS).



The Task Leader of the task, the document is uploaded to, has to authorize the document before it is available to other users in the IDMS.

The Task Leader can download the document, authorize or remove the uploaded documents.

4.2 Version control

- (not yet implemented in the 7 December 2016 version of IDMS)

Any uploaded document can be replaced with a new version. When the document is selected, an icon for uploading new version of the document is displayed next to the download icon under the list of document properties and metadata. When multiple versions of the document are available, a list is displayed under the Download & Versions icons.

5 Browsing the Documents

The documents that are authorized for IDMS are available to all users. The documents can be retrieved by browsing through the document tree, i.e. by opening appropriate task and activity level and select the file to be downloaded.

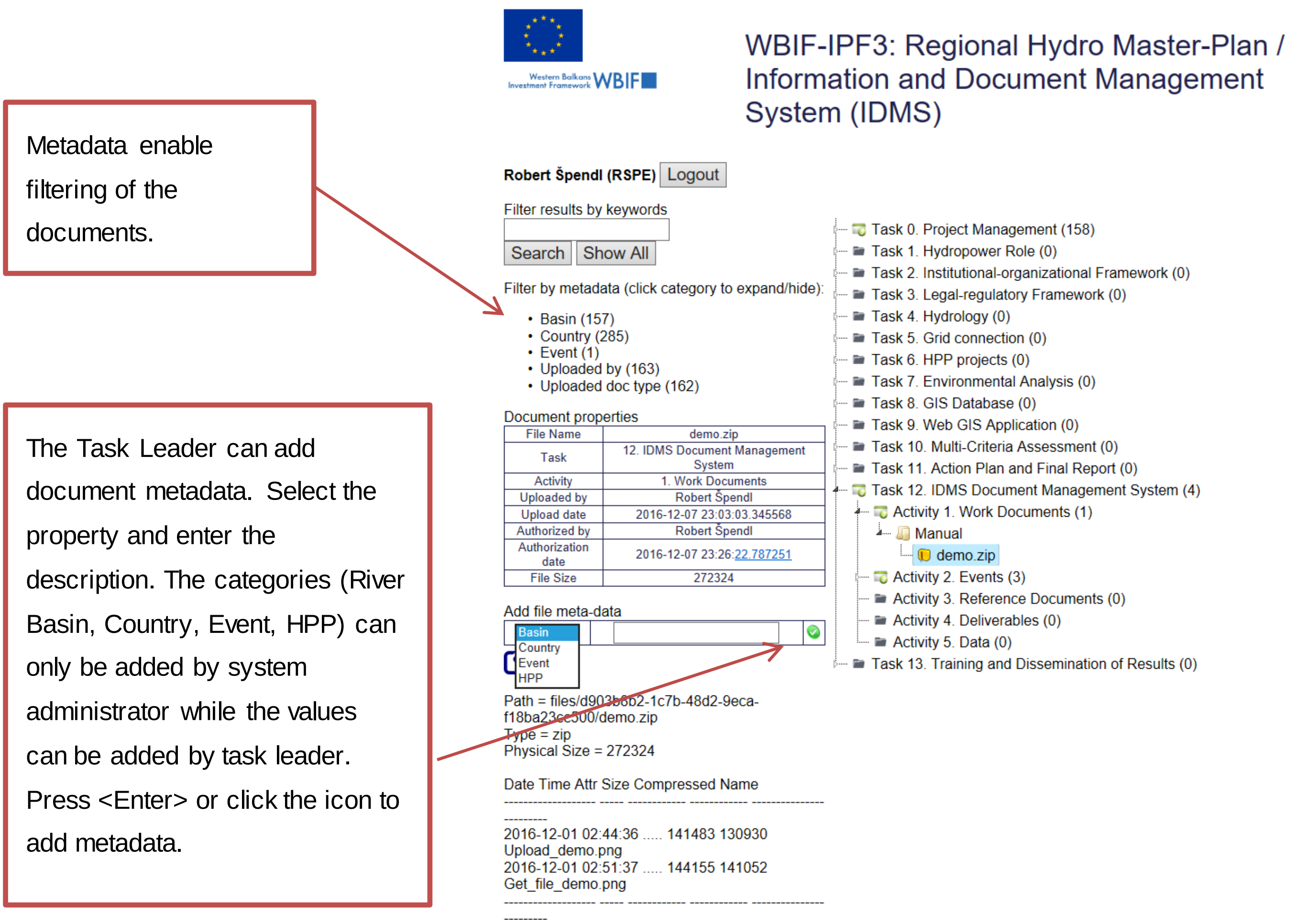
The IDMS helps finding the documents through full-text search and metadata filtering. User can enter search criteria in the "Search" field in the left panel of the main window and/or select individual metadata to be filtered. Each metadata value has an indication of number of documents that match the criterion and it changes when multiple metadata filters are selected.

6 Metadata

One of the key functions of the IDMS is ability to attach metadata to the documents stored in the system. The metadata enable efficient filtering and rapid search for relevant data.

When the document is uploaded, a plain text of the contents is extracted and analysed for potential keywords. IDMS can extract text from Microsoft Office documents (Word, Excel, PowerPoint), Open Document Format, PDF and perform optical character recognition (OCR) of the scanned PDF documents. The text is searched for predefined keywords to add initial metadata to the document. IDMS tries to find keywords to identify country and river basin name from the context of the document.

After initial automatic assignment of metadata, task leaders can add additional metadata and delete existing metadata. This is performed by selecting a document and editing the metadata. When documents in other tasks are selected, the user can only view the metadata and can't edit them.

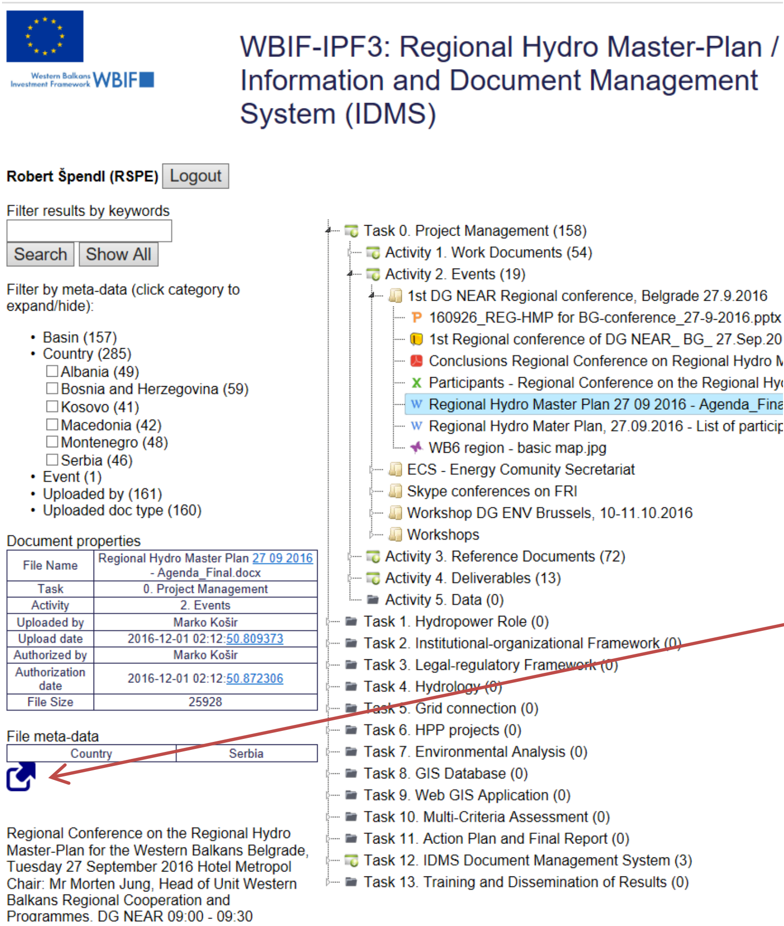


7 Downloading or Sharing the Documents

The ultimate activity of a user that was searching for the documents is downloading the document. It is performed simply by clicking the “Download” icon for the selected file. The download will start immediately in a new window.

The access to all the documents is through URL links that can be shared with other users of the IDMS or public. Note that once the link is shared, the document becomes publicly accessible, so no sensitive information shall be shared in this manner. IDMS is not designed to be a private document server with strict access control but as a quick an efficient way to share project data with team members. Some files can become publicly available (e.g. invitations for workshops, various reports and statements).

The link to the document can be shared by Right-clicking the Download Icon.



Download icon. Right-click the icon and select »Copy Link« to share the link to the document.

If the link to the document is shared, the document becomes publicly accessible. Do not upload sensitive information to IDMS.

8 Annex

8.1 Abbreviations

GIS	Geographic Information System
HPP	Hydropower Plant
IDMS	Information and Document Management System
IT	information technology
OCR	optical character recognition

Annex 4: List of used literature sources

A) INTERNATIONAL AND REGIONAL SOURCES

1. Eurostat (2016): Producer prices in industry, non-domestic market - annual data: http://ec.europa.eu/eurostat/web/products-datasets/-/sts_inppnd_a
2. Energy Community (2016): https://www.energy-community.org/
3. Balkan rivers - Save the Blue Heart of Europe (2016): http://www.balkanrivers.net/
4. Ramsar (2016): https://rsis.ramsar.org/
5. Freyhof, J., Weiss, S., Adrović, A., Ćaleta, M., Duplić, A., Hrašovec, B., Kalamujić, B., Marčić, Z., Milošević, D., Mrakovčić, M., Mrdak, D., Piria, M., Schwarz, U., Simonović, P., Šljuka, S., Tomljanović, T., Zabric, D. (2015), The Huchen Hucho hucho in the Balkan region: Distribution and future impacts by hydropower development. RiverWatch & EuroNatur, 30 pp.
6. Sikorova, K., Gallop, P., CEE Bankwatch Network (December 2015), Financing for hydropower in protected areas in Southeast Europe, EuroNatur & RiverWatch, 46 pp.
7. Schwarz, U. (September 2015), Hydropower Projects on the Balkan Rivers - Update. EuroNatur & RiverWatch, 33 pp.
8. Schwartz, U. (May 2015), Hydropower Projects in Protected Areas on the Balkans. EuroNatur & RiverWatch, 34 pp.
9. Schwartz, U. (2012), Balkan Rivers - the Blue Heart of Europe. Hydromorphological Status and Dam Projects. WCA Watch Austria & Euronature Germany &MAVA Switzerland, 150 pp. and 101 pp. Separate Annex (»River Catalogue«).
10. WWF&SEE Change Net, EIA/SEA of Hydropower Projects in South East Europe, Meeting the EU standards, 100 pp.
11. CEE Bankwatch Network (February 2015), Report on the long-term economic viability of constructing new electricity capacities for electricity exports in the Western Balkan countries, 154 pp.
12. KPMG (2010), Central and Eastern European Hydro Power Outlook, 136 pp.
13. DNV KEMA, REKK, EIHP, Energy Community (November 2013), Development and Application of a Methodology to Identify Projects of Energy Community Interest, 92 pp.

Relevant websites:

14. https://energypedia.info/wiki/Portal:Hydro
15. http://www.hydropower.org/publications
16. http://balkanrivers.net/sites/default/files/Hydros_Western_Balkans_dbase_14-12-2015.xlsx

B) COUNTRY-SPECIFIC SOURCES

Albania

1. National Action Plan for Renewable Energy Resources in Albania 2015-2020, September 2015, 67 pp.
2. Prospective Investment in Albanian Power Sector, Ministry of Economy, Trade and Energy, 2018, 19 pp.
3. Consultants' Services for Assessment of Power Generation Potential of selected Albanian Rivers, Appendix 1 – Report for Vjosa River System, May 2009, 325 pp.
4. Consultants' Services for Assessment of Power Generation Potential of selected Albanian Rivers, Appendix 1 – Report for Drin Zi River, May 2009, 259 pp.
5. Consultants' Services for Assessment of Power Generation Potential of selected Albanian Rivers, Appendix 1 – Report for Seman River System, May 2009, 270 pp.
6. Consultants' Services for Assessment of Power Generation Potential of selected Albanian Rivers, Final

Report, May 2009, 139 pp.

7. Hydroenergy in Albania, AKBN, October 2009, 18 pp.
8. Annual report - Situation of Energy Sector and activity of ERE, 2008, 121 pp.
9. Vjosa River - The Pocem Hydropower Project, 2016, 5 pp.
10. Deloitte, Extractive Industries Transparency Initiative in Albania - Report for the year 2015, December 2016, 168 pp.

National HPP development expert referencing to:

11. AKBN - Agjencia Kombëtare e Burimeve Natyrore (National Agency of Natural Resources)
12. OST - Operatori i Sistemit te Transmetimit (Albanian Transmission System Operator)

Bosnia and Herzegovina

1. *Elektroprivreda hrvatske zajednice Herceg Bosne d.d. Mostar (EP HZHB)*
2. *Javno preduzeće Elektroprivreda Bosne i Hercegovine d.d. Sarajevo (JP EP BIH)*
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