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Western Balkans Investment Framework WBIF

Regional Strategy for Sustainable Hydropower in the Western Balkans

Final Workshop, Skopje, 12th December 2017

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Regional Strategy for Sustainable Hydropower in the Western Balkans

Background & Introduction

Martyn Osborn - MLT SPM Energy Sector

Final Workshop, Skopje, 12th December 2017

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Project Synopsis

Client: European Commission, DG NEAR

Contractor: WBIF-IPF3 Consortium

Expert team: 30 experts (EU and WB6) and 2 subcontractors

Duration: Scoping Phase (May-June 2016) + **Study Phase** (Oct. 2016 – June/Dec. 2017)

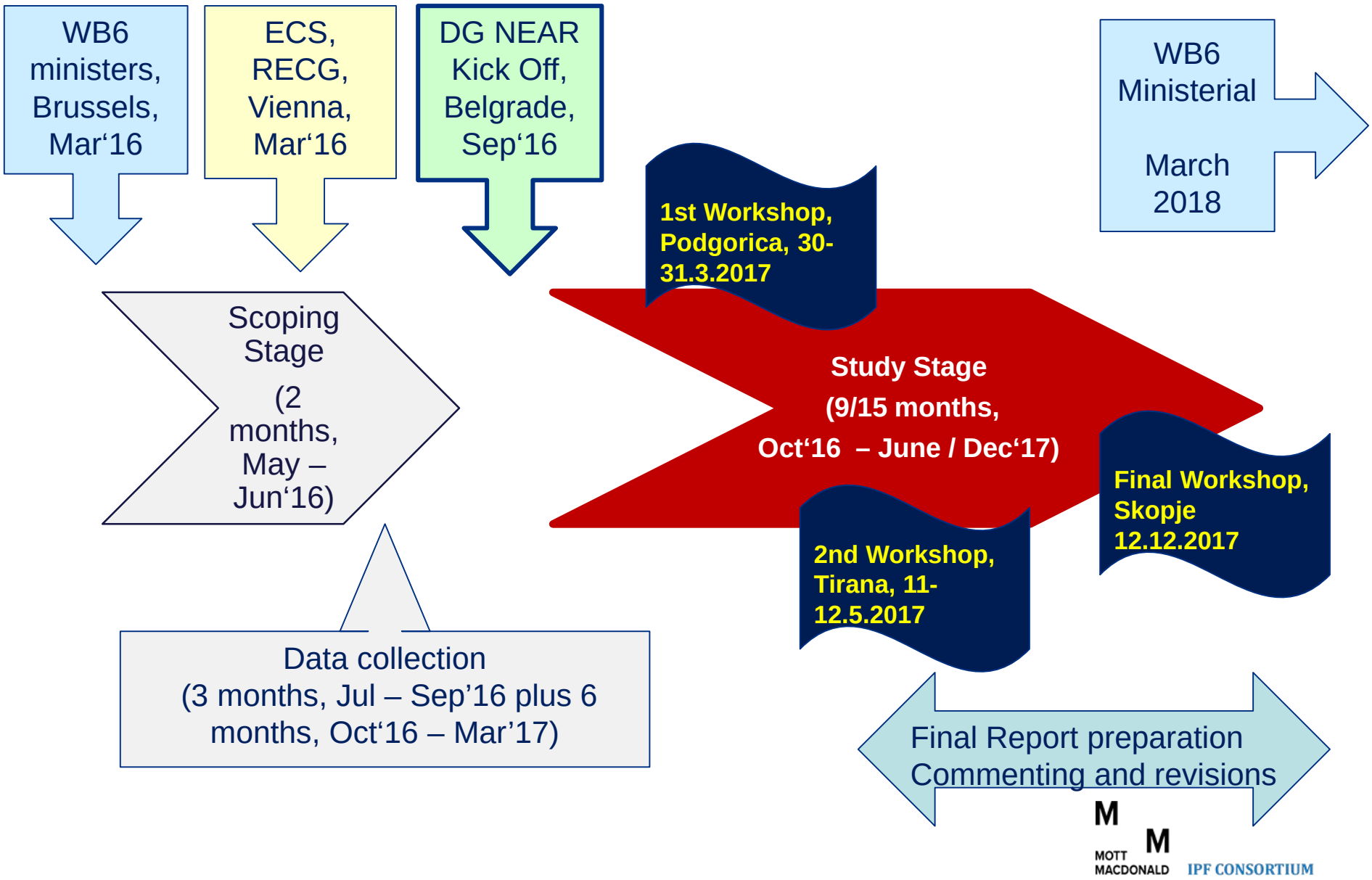
Deliverables: 8 technical Background Reports, Final Report, 1 conference, 2 technical workshops, final workshop, inputs to the MC-WB6 meeting (Trieste, March, 2018)

Objective: Contribute to fostering the harnessing of environmentally and climate change **sustainable hydropower generation in the WB6 region** in line with strategic objectives of the European Union and the ECT obligations of its Contracting Parties.

Purpose: Development of a study determining a list of hydro power project (HPP) development priorities by (i) river basin, (ii) type of planned HPP facilities (storage, run-of-river, reversible), through which the remaining hydro-power potential in the region will be evaluated. Aiming at utilising the sustainable hydropower potential, the following priorities shall apply:

1. **Repair, refurbishment, upgrade and rehabilitation of existing HPPs**
2. **Sustainable greenfield HPPs**

Timeline – Important Study Stages and Events



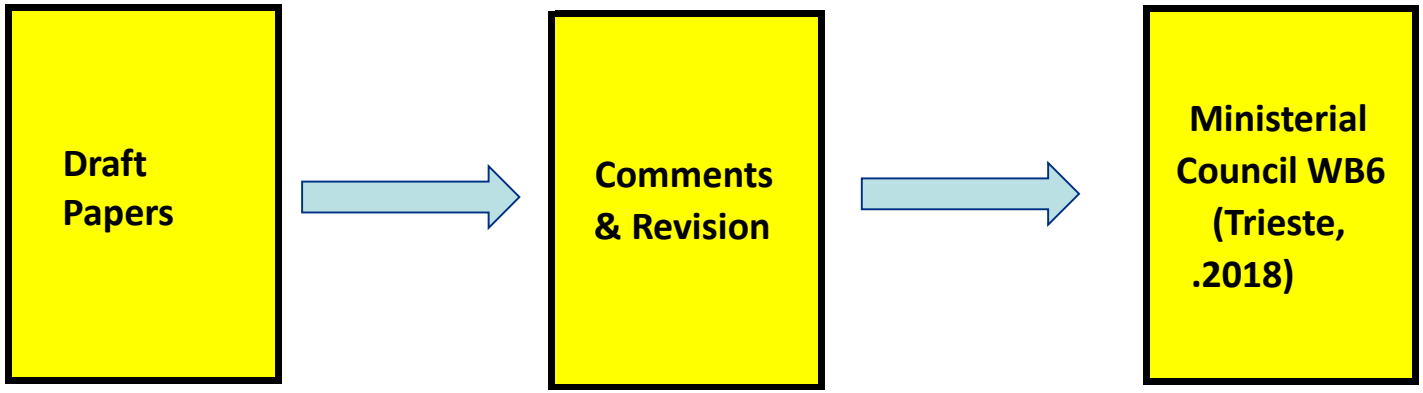
Task & Deliverables: Report Status

BR	Title	Status
1	The Role of Hydropower	Final. Revised on basis of comments received.
2	Hydrology, Integrated Water Resources Management, and Climate Change	Final. Revised on basis of comments received.
3	Environmental Considerations	Final. Revised on basis of comments received.
4	Regulatory and Institutional Guidebook	Final. Revised on basis of comments received.
5	Transboundary Considerations	Final. Revised on basis of comments received.
6	Grid Connection Considerations	Final. Revised on basis of comments received.
7	Inventory of Planned Hydropower Projects	Final. Revised on basis of comments received.
8	Potentially Sustainable Hydropower Projects	Final. Revised on basis of comments received.
9	Final Report	Draft Final. Summary of above BR's.

Note: Some changes to BR order, titles and content since Tirana

Task & Deliverables: Output Papers

SP	Title	Source
MC-SP1	Executive Summary – "Regional Strategy for Hydropower Development"	Final Report; Background Reports
MC-SP2	"Draft Principles for Sustainable Hydropower Development in the Western Balkans"	DG NEAR
MC-SP3	"Draft Indicative List of Potential Projects for a Sustainable Development of Hydropower in the Western Balkans"	DG NEAR



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Regional Strategy for Sustainable Hydropower in the Western Balkans

Role of Hydropower

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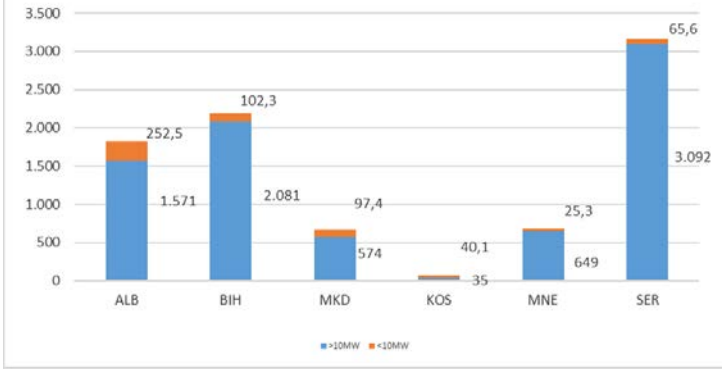
Existing HPPs of all capacity Ranges in WB6

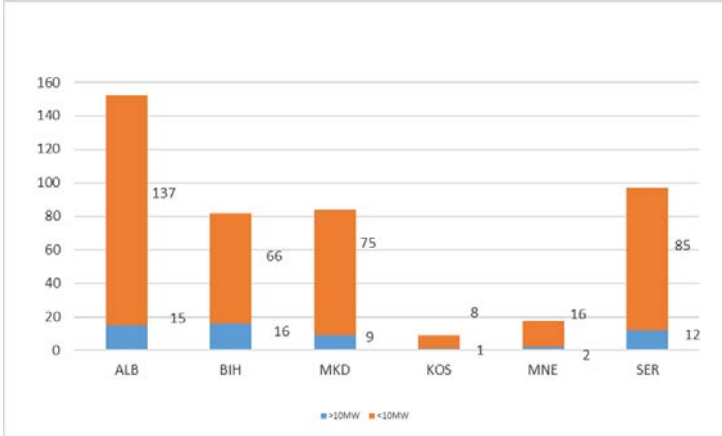
55 HPPs (12%) of all existing HPPs produce 97% of energy, 93 % capacity

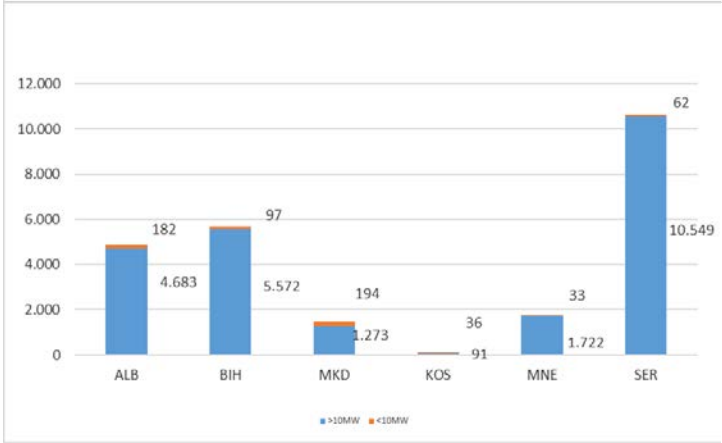
Number of hydro power plants (-, %)							
		>10MW	(%)	<10MW	(%)	Total	(%)
1	ALB	15	27,3	137	35,4	152	34,4
2	BIH	16	29,1	66	17,1	82	18,6
3	MKD	9	16,4	75	19,4	84	19,0
4	KOS	1	1,8	8	2,1	9	2,0
5	MNE	2	3,6	16	4,1	18	4,1
6	SER	12	21,8	85	22,0	97	21,9
	WB6	**55**	100,0	**387**	100,0	**442**	100,0
	Share	***12,4***	***(%)***	***87,6***	***(%)***	***100***	***(%)***

Installed capacities in hydro power plants (MW, %)							
		>10MW	(%)	<10MW	(%)	Total	(%)
1	ALB	1.571	19,6	252	43,3	1.824	21,2
2	BIH	2.081	26,0	102	17,5	2.183	25,4
3	MKD	574	7,2	97	16,7	671	7,8
4	KOS	35	0,4	40	6,9	75	0,9
5	MNE	649	8,1	25	4,3	674	7,9
6	SER	3.092	38,6	66	11,3	3.157	36,8
	WB6	**8.001**	100,0	**583**	100,0	**8.584**	100,0
	Share	***93,2***	***(%)***	***6,8***	***(%)***	***100***	***(%)***

Electricity generation in hydro power plants, 2001-2015 (GWh, %)							
		>10MW	(%)	<10MW	(%)	Total	(%)
1	ALB	4.683	19,6	182	30,2	4.865	19,9
2	BIH	5.572	23,3	97	16,0	5.669	23,1
3	MKD	1.273	5,3	194	32,2	1.468	6,0
4	KOS	91	0,4	36	5,9	127	0,5
5	MNE	1.722	7,2	33	5,4	1.755	7,2
6	SER	10.549	44,2	62	10,3	10.611	43,3
	WB6	**23.891**	100,0	**603**	100,0	**24.495**	100,0
	Share	***97,5***	***(%)***	***2,5***	***(%)***	***100***	***(%)***



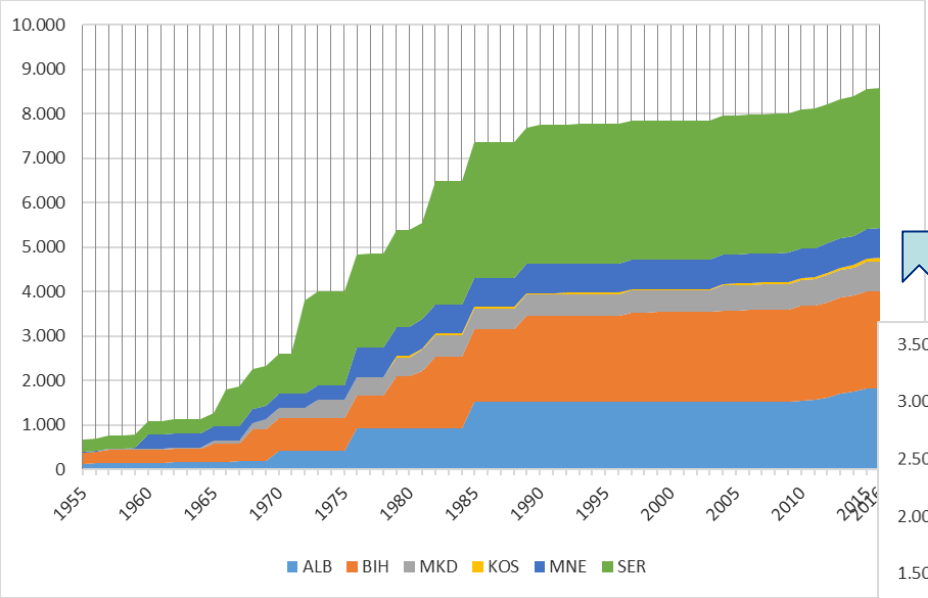




Historic Commissioning of HPPs (1955-2016)

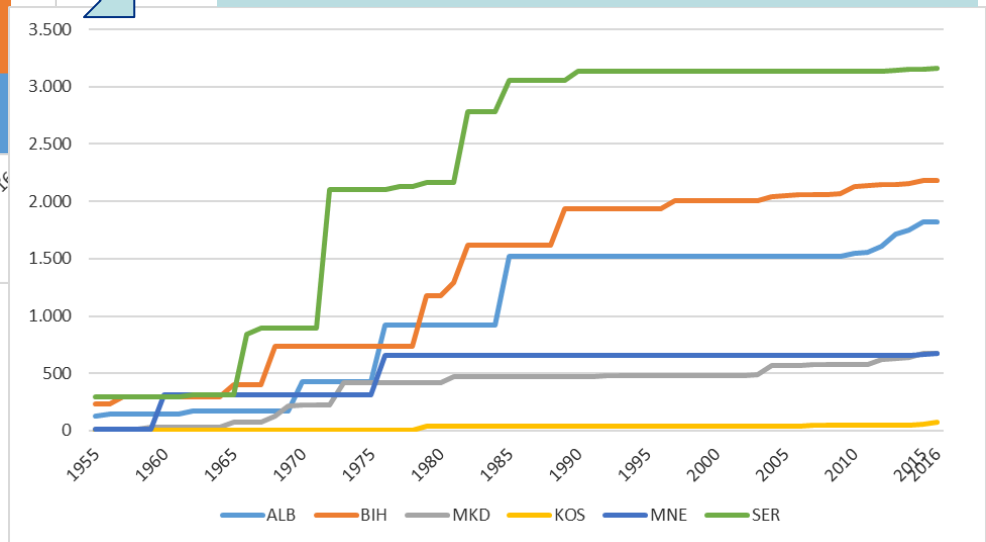
Average HPP-capacity addition achieved during 1955-1990 was 202 MW per annum while in the period 1991-2016 it dropped to mere 32 MW per annum.

Period	MW	%	MW/a
Before 1955	678	7,9	
During 1955-1990	7.081	82,5	202,3
During 1991-2016	825	9,6	31,7
Total	8.585	100,0	



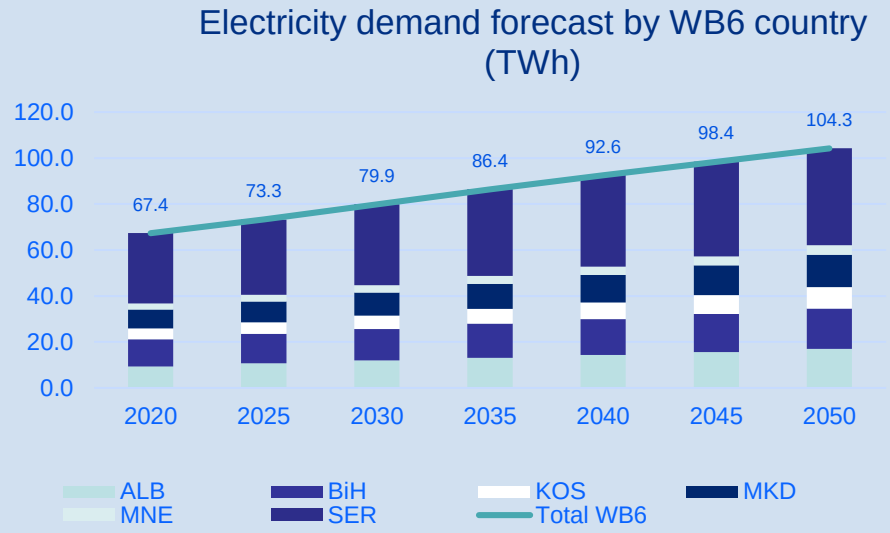
Reasons can be attributed to:

- "Best" HPPs already implemented,
- Disintegration of former SFRJ followed by wars in the '90s,
- End of central planning and coordinated water management, lack of cooperation between newly established states,
- Lack of financial capacity of power utilities / states for investment intensive projects,
- Growing investment risks in emerging market conditions, and
- Continued unresolved transboundary issues

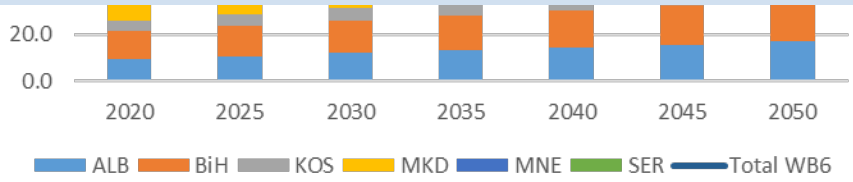


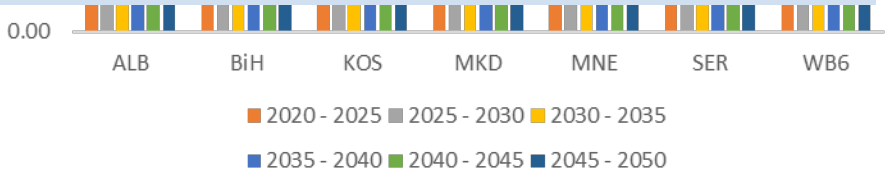
Electricity Demand Forecast to 2050

In all WB6 countries, electricity consumption will grow (including the effect of EE measures) during 2020-2050, in total for WB6, from 67 TWh in 2020 to 104 TWh in 2050. Average annual growth from 2020-2025 (1.69%) will however gradually decrease to 1.17% (2045-2050).



- WB6 expected to miss 2020 NREAP targets
- Without significant new RES, cannot expect to meet enhanced 2030 targets (27%)
- PV, Wind need Hydropower to balance their operation





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SWOT analysis on hydropower development in WB6 (1)

STRENGTHS	WEAKNESSES
• **High share** of hydropower in power generation mix in WB6 (in the past as well as likely to remain in future). • Hydropower's **flexibility** • Hydropower is the **cleanest** and most flexible RES-E generation • Remarkable, proven and **long tradition in HPP technology** in the Region • Hydropower is the **most reliable** renewable power generation source that ensures **predictable** and guaranteed **low electricity prices** in the long-run • **Long-term predictable** production costs and selling prices	• Legal and **regulatory gaps** and imperfections • Very **complicated** and **lengthy** concessioning, permitting and licensing procedures in most WB6 countries • Poor **political continuity** and long-term commitment of frequently changing governments • Lack of interest of international shareholders being in **ownership structures** of regional power utilities to invest in large HPPs • Multiple users of water resources (multipurpose utilisation of water) with **conflicting objectives** • **Incapability** of states and **power utilities** (in state-ownership) to take a considerable **stake in capital-intensive greenfield HPP projects**

SWOT analysis on hydropower development in WB6 (2)

OPPORTUNITIES	THREATS
• **High share of still unutilised hydropower potential** in all WB6 countries • Hydropower production **efficiently substitutes** for polluting thermal power generation • GHG **emissions reduction** benefits • Improved **Security** of electricity supply • Technological development offers multiple improvements • Intraday markets **opportunities for hydropower** • New **scheduling and operation** principles • Economic recovery and social stability, **multiple macro-economic benefits**	• **Environmental and social risks if HPPs are improperly planned** • Improper understanding of a need for **consideration of EU Water Framework Directive and other applicable EU legislation** • **Limited readiness for transboundary cooperation** and mutual planning at River (Sub) Basin level • Financial **risk for investors** in conditions of presently **low electricity market prices** • Transboundary issues. **Unsolved and possibly continued transboundary issues**, in most cases inherited from the former SFRJ represent a real challenge for the new political set-up in the Region

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Regional Strategy for Sustainable Hydropower in the Western Balkans

Hydrology, Integrated Water Resources Management, and Climate Change

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Climate Change

One of the world's most ambitious climate protection targets set for **2020** has been set up by the EU:
20% GHG emissions decrease goal over the pre-industrial (1990) levels.

- WB6 **not on track** to meet 2020 targets

For **2030**, the EU's policy framework is based on broader energy sector targets adopted in October 2014, notably:

- At least 40% cuts in GHG emissions (from 1990 levels);
- At least **27% share for renewable energy** in gross final energy consumption;
- At least 30% improvement in energy efficiency.

1) WB6 will be **considerably impacted** by climate change
2) Less precipitation in the **longer-term overall**
3) Increased **changes to seasonal** precipitation
4) **Floods** in the autumn/winter and **droughts** in the spring/summer would mostly affect run-of-river HPPs and HPPs with small reservoirs. In these types of HPPs, an **overall power generation decrease** is expected.
5) Future **temperature increase** => **increasing evaporation** => **decrease of hydropower production on reservoir** type HPPs that have high storage area/volume ratio and small reservoirs.

A regional strategy for the management of water resources is key to successful climate change adaptation in the Western Balkans. The water resources in the region have a high exposure and sensitivity to climate change, and the **fates of flood protection, agricultural and hydropower sectors are all closely tied to the water sector**.

Adaptation to Climate Change

Impacts are **principally associated** with **direct effects** on power generating potential, but **also indirectly through increased general demand** for energy for heating and cooling due to higher or lower temperatures.

The adaptation of hydropower facilities to climate change, characterised by **occurrence of extreme low and high discharges**, should be in **reservoir development**. Reservoir volumes should be sized to **compensate for the increased seasonal water imbalance** in future.

Water demand and **water use** in the river basins in which a HPP could be constructed, must be taken into account.

Individual assessments of what the effect of **climate change** may be on **hydrological yield** and consequently **energy yield** for the expected 40/80 years of a given HPP asset life should be undertaken as **part of feasibility study** investigations.

The development of **sustainable flood protection** in a particular river basin with a reservoir type HPP **should be possible without compromising** the environmental objectives of the WFD.

Hydrology – Hydropower planning considerations

1) **Water Framework Directive** (Directive 200/60/EC), => the development of river basin management plans.

2) **Integrated Water Resources Management** (IWRM) systems:
- **coordinated development** and management of water, land and related resources
- **equitable allocation** of economic and social welfare
- maintain **sustainability of vital ecosystems**
- consideration of **upstream / downstream**, independent of borders.
- **essential stakeholder engagement** and participation

3) Use of applicable guidelines (e.g. ICPDR).

4) The application of sustainability principles require that **water management and utilisation** be considered in the context of a **whole catchment area** and not on a river-by-river or project-by-project basis. When **one or more interventions** in a river system are planned, e.g. reservoirs, then the **cumulative impacts will be significant**, and should be assessed in accordance with EU acquis and international best practices.

Best Practices - Hydrology

Proposed reservoirs use:

A hydropower reservoir could, when **developed in conjunction with flood protection**, provide significant benefits. The use of a reservoir for flood control can help flood prevention in downstream countries and regularise flow regimes.

Diversion of a **water quantity from one river basin to another** should be approached on an individual basis. The transfer of water is **not specifically excluded**.

Geographical position of reservoir:

If a reservoir (or cascade) in an upstream state A, has positive or negative externalities in downstream state B, then **negative impacts and externalities** should be **mitigated within the economic feasibility** of the planned HPP. Together with any beneficial effects and externalities, a **Cost-Benefit Analysis will be developed and used for negotiations**. **Cumulative Impact Analysis** will be used as a reference for the evaluation of reservoir impacts on a downstream state B. If the flow downstream is modified in a beneficial way it can be the **subject of compensation** from state B to state A or the opportunity to rightfully **participate in an investment model**.

Hydrology - Guidance

- Legally required **environmental impact assessments** as requested by **EIA, Espoo Convention, Habitats Directive and WFD**, together with project planning and **strategic environmental assessment (SEA) for plans and programmes**, to foresee environmental impacts and address if the project should proceed. Then during construction and operation, mechanisms to **monitor and mitigate cumulative environmental impacts**.

- Measures to monitor and mitigate **water balance, sediment transport** and **connectivity of biodiversity**. Development of a **river monitoring service** at gauging stations located at state borders.

- Mechanisms to **assess the socio-economic effects** of hydropower/flood protection reservoirs: in this respect the existing agreement, especially if relatively old, should be rewritten and negotiated again.

- **Economic effects of multipurpose reservoirs, but predominately energy and flood protection, should be maximised**, to promote faster realisation under the condition that **environmental impacts are mitigated realistically**. The **Water Framework Directive (and Floods Directive when applicable)** should be taken fully into account.

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Environmental Considerations

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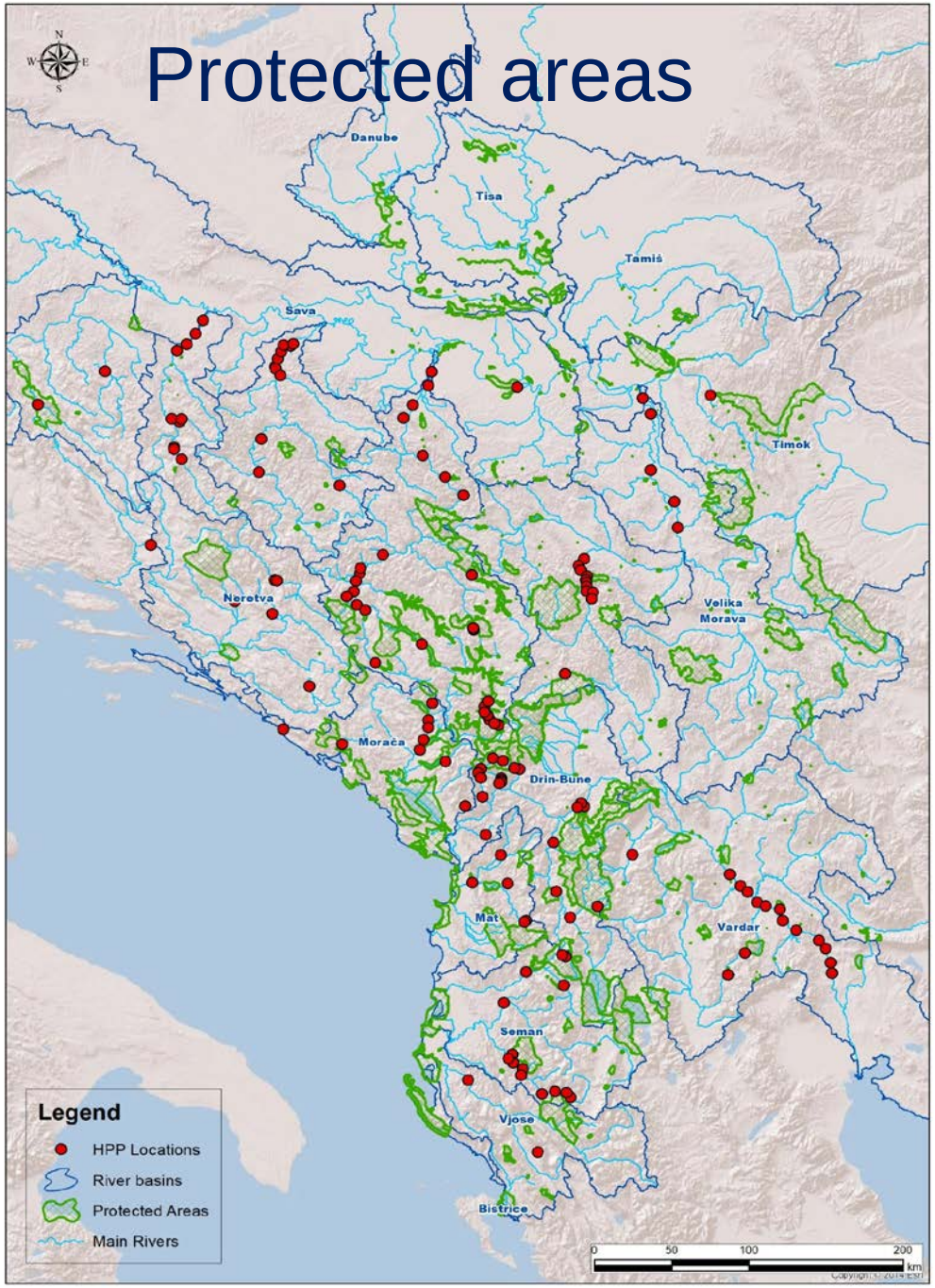
Environmental data and Environmental Assessment

The Purpose and Activities envisaged by the ToR:

- Assess Environmental and Social **Main Impacts of Hydropower** development
  - analysis at (i) river basin level and (ii) country-level of identified greenfield hydropower schemes
- Provide **data to the Multi-Criteria Assessment** (MCA) of prospective HPP projects
  - the main goal being to develop a sound environmental basis including social aspects (resettlement, land use, cultural heritage, fish fauna, transmission lines)

Environmental Assessment Basis

- The MCA scoring system defined the **criteria and sub-criteria** to be used from the **environmental perspective**, their **relative weights** and the **scoring system** to be applied. Also "**deal-breaking**" criteria were identified and defined.
- The **quality of** associated **environmental documentation varies** throughout the region, notwithstanding the fact that most of the governing national environmental legislation **is already harmonised** to a great extent with EU legislation.
- However, **gaps do seem to exist** in the regulations and procedures for obtaining environmental consent.
- The requirements of **EU environmental legislation** and **applicable international conventions** shall remain the reference for hydropower projects in WB6 countries.
- The most important to fully consider in the HPP development process is **the Water Framework Directive**, the **Floods Directive** and the **Birds** and **Habitats Directives** in addition to the **EIA and SEA Directives.**



Protected Areas

If a HPP is **planned inside a protected area** (or an area **proposed** for protection), additional assurances are needed that construction will not negatively affect habitat and species in the area. According to EU environmental legislation, **construction in a protected area is possible only under a very limited set of circumstances** (e.g. Birds and Habitats Directives – Analysis of the impacts through development of Appropriate assessment, According to Article 4(7) of WFD).

To avoid irreversible damage to nature, we recommend that **all WB6 countries define areas in the specific river basin for further HPP development and areas in which HPP development should be limited or completely avoided ("no–go" zones), and Natura 2000 designations.**

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Areas of Special Importance for fish fauna in WB6

Overview of **threatened fishes** of WB6 region reveals that there are some areas with **outstanding diversity**, high portions of **endemic species** and with **pristine and preserved rivers** that present remarkable a habitat for many native species.

- Self-sustainable populations of Danube salmon in BiH, SER and MNE.
- The Neretva drainage with its endemic fish fauna in BiH.
- The Morača river drainage with Lake Skadar and its unique fish fauna in MNE and ALB.
- The Drin river drainage with Lake Ohrid and Lake Prespa and its unique fish fauna in MKD and ALB.
- The Vjose river as one of the last preserved rivers of Europe in ALB.

Mitigation Measures

HPPs planning will require **SEA at the river basin level**, and **EIA at the project level**. In practice, mitigation measues have only limited positive effects, so planning HPP must be done carefully to **minimise and mitigate** impacts.

Most commonly used mitigation measures are: **fishpasses** and applying **Ecological Accaptable Flow (EAF)**.

Further mitigation measures can be used to minimise the impacts of the existing HPP:

- **Opening of the corridors in the tributaries** of the accumulation lakes (providing fishpasses or removal of the obstacles)
- **Changing the operation of the HPP**. By minimising the amplitude or/and frequency of the releasing discharge **the impact of the hydropeaking can be reduced**. In case of **cascade HPP**, negative effect can be mitigated by **harmonizing the operation** of HPP in the chain.
- **Ensuring sediment transportation** by the HPP, to **prevent river bed erosion** and the lack of gravel needed for **spawning grounds** for fish below the dams.

Selected Regional recommendations (1):

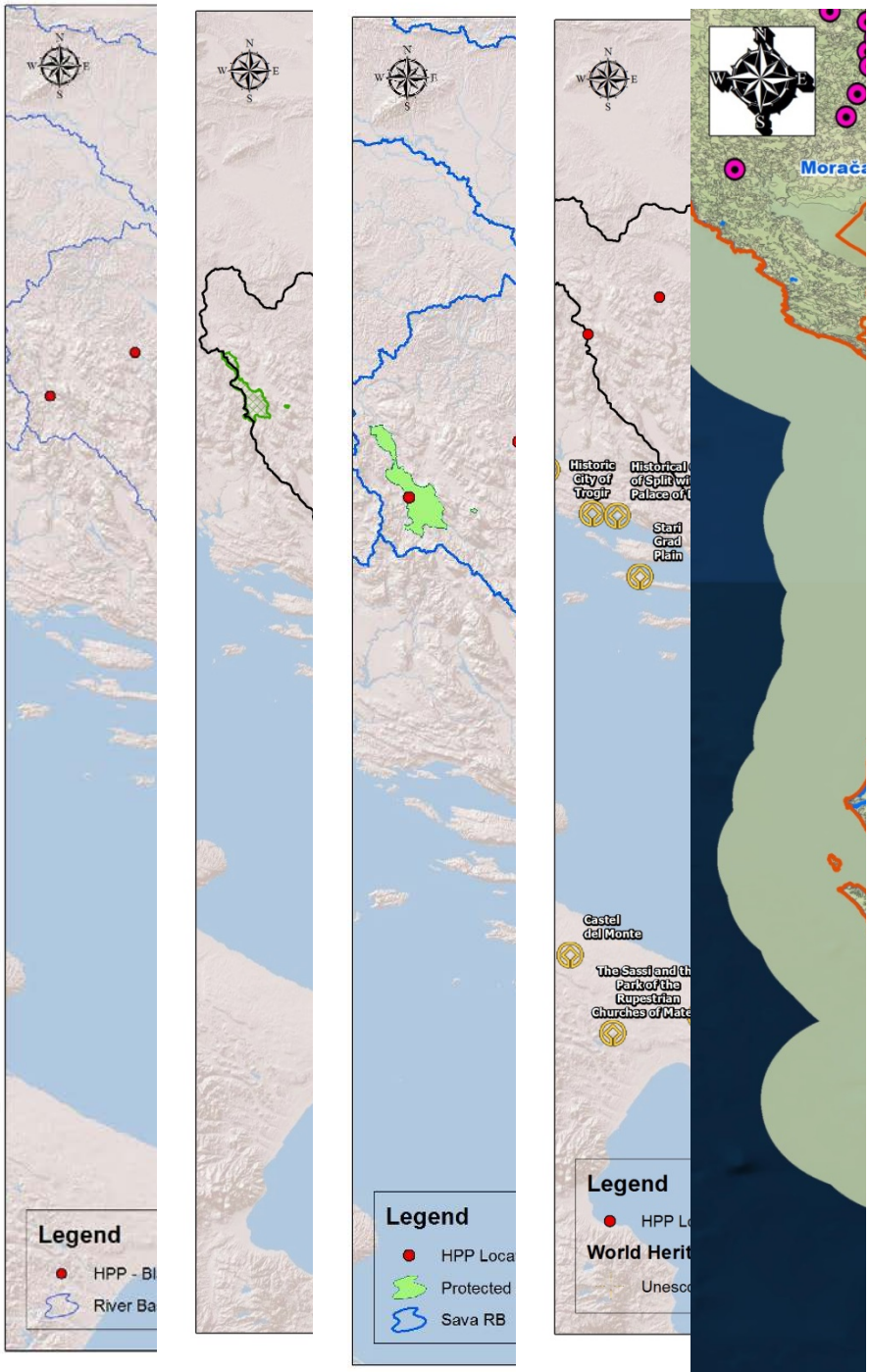
- Establishment of **Ecologically Acceptable Flow** (EAF), and the processes for monitoring that the EAF is maintained.
- **Transboundary issues and cumulative effects** must be addressed properly at the river basin area level.
- WB6 countries should start as soon as possible, for all **planned HPP's with potential transboundary impact**, development of **transboundary river basin environmental impact assessments** (transboundary EIA), or **cross-border SEA, including CIA**, as an activity to be carried out at the earliest stage of project identification.
- A full **assessment of cumulative effects** should be undertaken for **every hydropower project** during the HPP project's development.
- **Open and transparent disclosure**, implemented from the start of a hydropower project can help to prevent, mitigate and monitor adverse effects, and on social systems, where the dialogue will ensure that any emerging adverse effects are shared in a fair and equitable manner between the countries.

Selected Regional recommendations (2):

- Sustainable development of hydropower in the WB6 region relating to possible environmental and social impacts would be greatly improved if **regional level planning** and pre-planning mechanisms and procedures were in place, **especially regarding the establishment of "no-go" areas for new hydropower plants.**
- Development of **monitoring systems** for the effectiveness of **prescribed mitigation measures** is essential for the assessment of their successful application.
- It is recommended for the countries of WB6 region to develop a **harmonised methodology for EAF calculation**, and to harmonise respective regulations across the region.
- All WB6 countries need to develop a **public inventory of all planned protected areas**.

Selected Regional recommendations (3):

- It is essential to **map all the riparian habitats** and **harmonise habitat data** across the region. Including a regional inventory of benthic fauna and invasive species.
- Prior to planning any new HPP, an ichthyological survey should be done in order to obtain **additional data on fish fauna**, which is often inadequate.
- WB6 countries should adopt **legislation, which requires the building of fishpasses**. Monitoring of functionality of fishpasses should be prescribed.
- All countries in the region should make a strong effort to ensure **that all pollutants are moved outside of the flood plains** (e.g. landfill) or are appropriately managed (e.g. wastewaters).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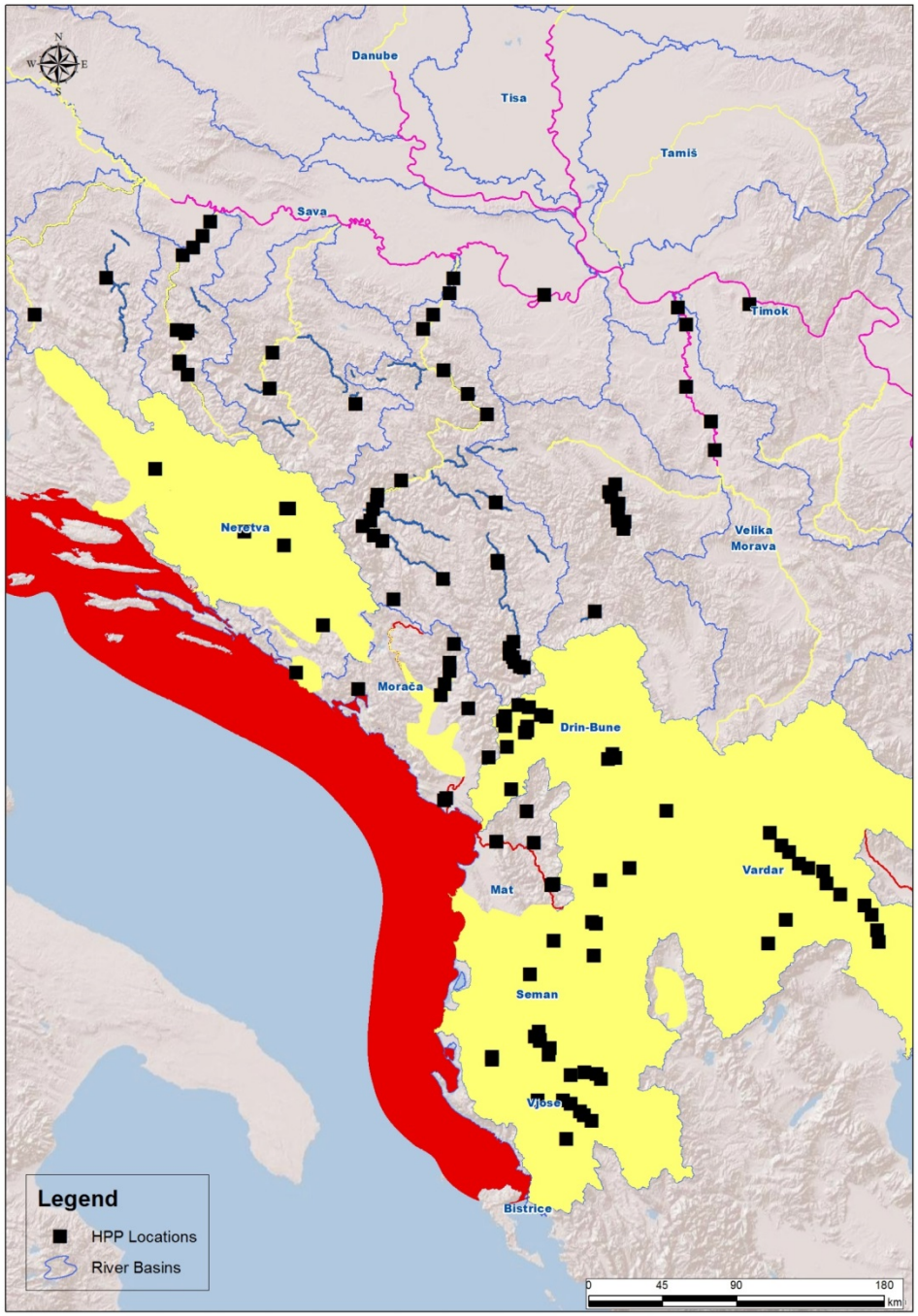
Historic City of Trogir
Stari Grad Plain
Castel del Monte
Morača


Danube
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Legend
HPP Locations
River Basins
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Regulatory and Institutional Guidebook

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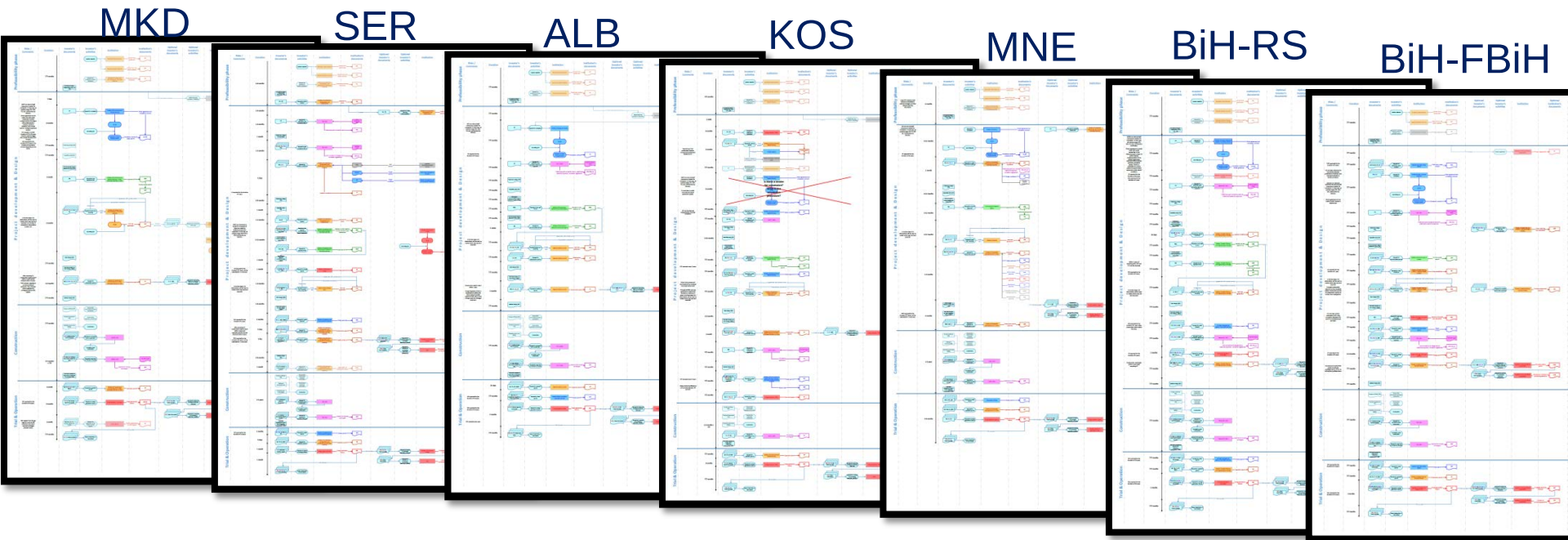
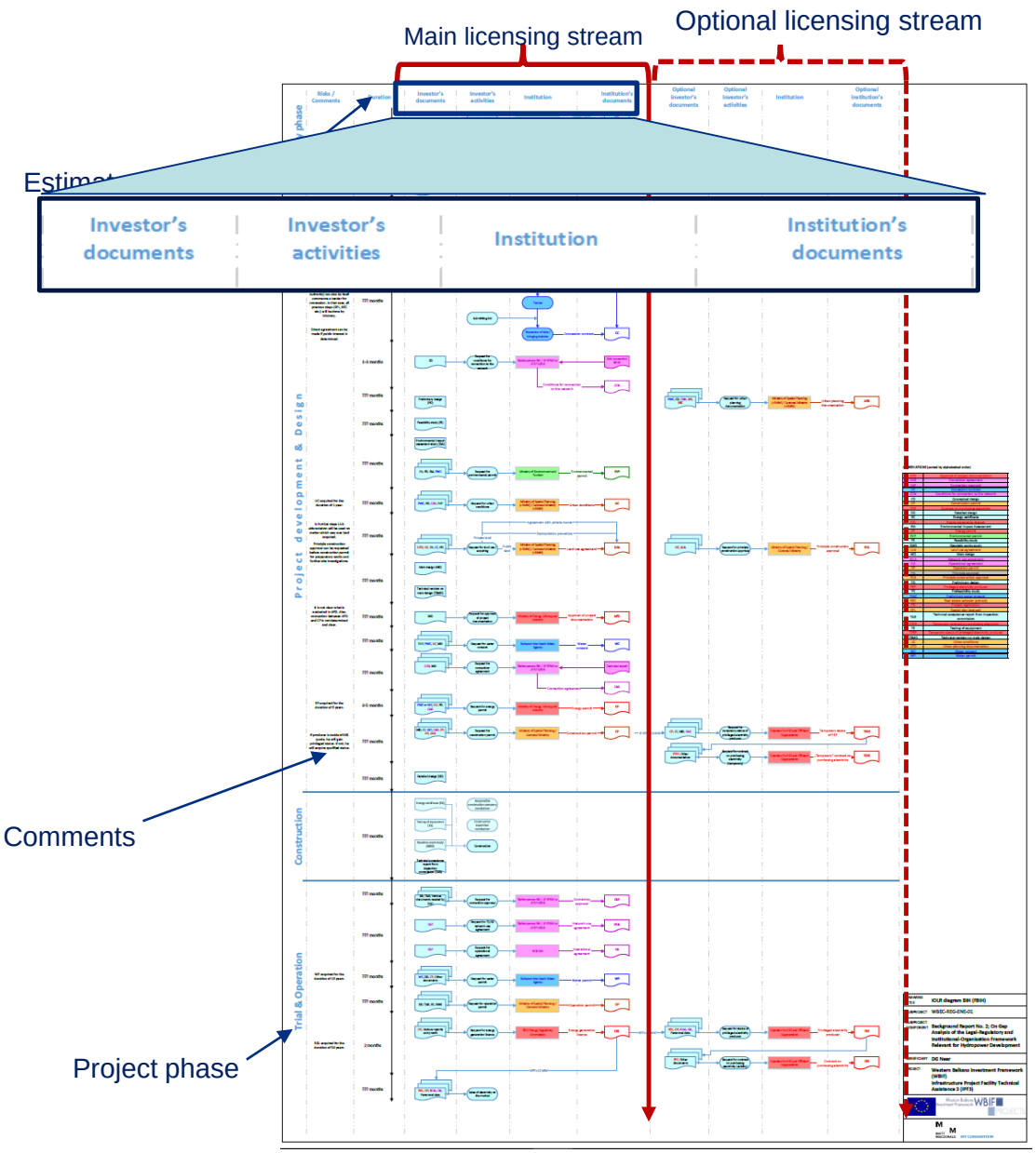
I.O.L.R. Background Report and flow diagrams

- I.O.L.R. framework relevant for HPP development was investigated in all WB6 countries and comparative analysis was conducted
- Number of rules and procedures is applicable to other power generation development projects
- Findings, Conclusions & Recommendations are presented in the Report
- Maturity of the projects could be assessed only after understanding of the entire (often rather complex) project development procedure

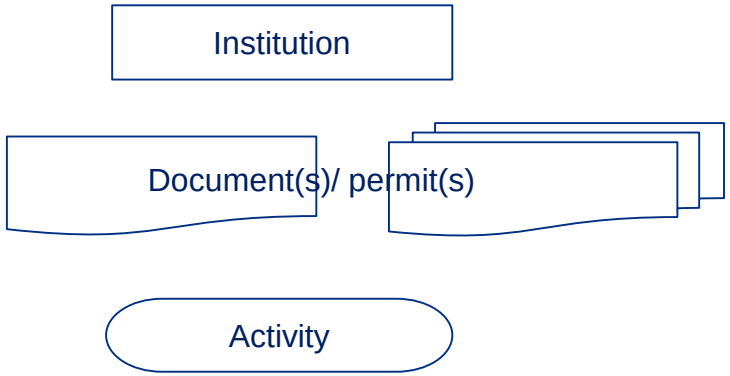


IOLR diagram design



Color & shape coding for easier understanding

Construction	Yellow background, red letters
Grid	Purple background, dark purple letters
Energy	Red background, dark red letters
Environment	Green background, dark green letters
Concessioning & Resources	Blue background, dark blue letters
General	Grey background, grey letters
HPP Developer	Light blue background, black letters



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Institutional-Organisational-Legal-Regulatory (I.O.L.R.) framework

- I.O.L.R. framework for development of hydropower generation in WB6 **was significantly improved** in the recent years, targeting **full compliance** with the 3rd EU Energy Package
- Beneficiary countries are candidates or potential candidates and are **hence committed** to transposing and implementing the EU legislation:
  - Beneficiary countries should therefore transpose and abide by WFD provisions and associated guidance - **Water Framework Directive** (Directive 200/60/EC), Esp 4.7 “heavily modified water bodies”
  - Planning and implementation **of Integrated Water Resources Management** (IWRM) systems.
  - Hydropower schemes should undergo a process of thorough IWRM planning where both **Strategic Environmental Assessment** (SEA) and **Environmental Impact Assessment** (EIA), including **transboundary** assessments
  - The same applies to **EU acquis and/or international agreements**

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Transboundary Considerations

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Transboundary - Legal Framework

From the aspect of their impact on hydropower development in the region, the following **Conventions** should be applied together with the implementation of the **EU Acquis** containing transboundary aspects (i.e. of the EIA, SEA and WFD):

- Convention on Environmental Impact Assessment in a Transboundary Context (**Espoo 1991**);
- Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (**Aarhus 1998**);
- Danube River Protection Convention (1998).

Transboundary issues and the transboundary authorisation process are covered by EU legal instruments. Specifically, the transboundary process is **regulated by three pieces of key EU legislation**:

- The **SEA Directive** with its obligation to **consult another country** in the case of potential transboundary impacts of a program or strategy.
- The **WFD Directive** with its requirement to **adopt** (and revise on regular basis) **a RBMP** in close coordination with **other states** in the case of a Transboundary River Basin.
- The **EIA Directive** with its obligation to notify and **consult another country** in the case where a project is likely to have a negative impact on another country.

Transboundary – Current Situation

WB6 transboundary status:

1)90% of the territory of the South-East Europe **is now within transboundary** river basins since break up of Yugoslavia

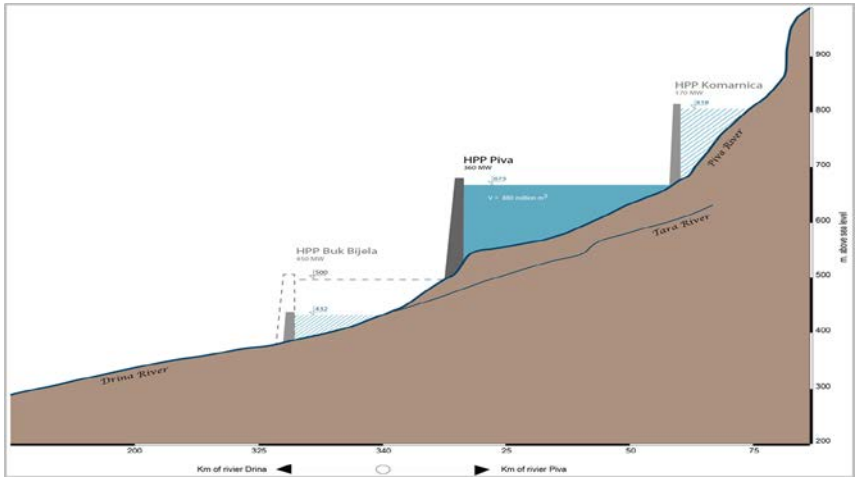
2)Very few historical bilateral agreements are **still valid**

3)Multi-country **coordination and cooperation** at basin and regional level offers the best opportunity for **optimisation**

4)Improving basin-wide hydrology **monitoring,** and **knowledge sharing** are often solutions

5)Coordination across the (international) **river basin** is a **requirement** under the EU **Water Framework Directive** (WFD), through agreeing **IRBMP**

6)Practical application/achievement of **equitable water sharing** necessitates the establishment of **a proper International River Commission (IRC)** such as the International Commission for the Protection of the Danube River (ICPDR)



Changed focus in transboundary issues in WB6:

•Until present, transboundary issues predominately dealt with **water quality aspects and to some extent biodiversity;**

•The **greatest omission noted is in sharing hydropower potential**, so transboundary cases remained as they were or at best went to worse by sizing down of **best reservoir locations** that could enable regulation of floods.

Benefiting from Transboundary Cooperation

- The **range of benefits** that can be realised in a transboundary situation is **motivating countries to abandon the unilateral decision** making usually practised**, in favour of joint action**. However, joint action is only possible if the benefits from cooperation are higher than those from unilateral action and countries have a full understanding of that.
- The key message is that **without properly addressing Transboundary Issues** the best use of the hydropower potential, and water resources in general, **will be lost**. It has been demonstrated that co-operation between parties is possible and good practices of sharing hydropower potential have been established in the past. Nevertheless, **resolving transboundary concerns** is in the **best interest of countries**, for mutual benefit.
- Planning hydropower development at the **level of river basins**, with the development of integrated River Basin Management Plans as required by the **EU Water Framework Directive**, will ensure that **all countries' interests are considered.**
- Hydropower projects based on transboundary cooperation may present not only opportunities for **sharing electricity production** and **participating in regional EU electricity market**, but potentially also **co- financing opportunities.**

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Grid Connection Considerations

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Grid Connections – Rules and Procedures

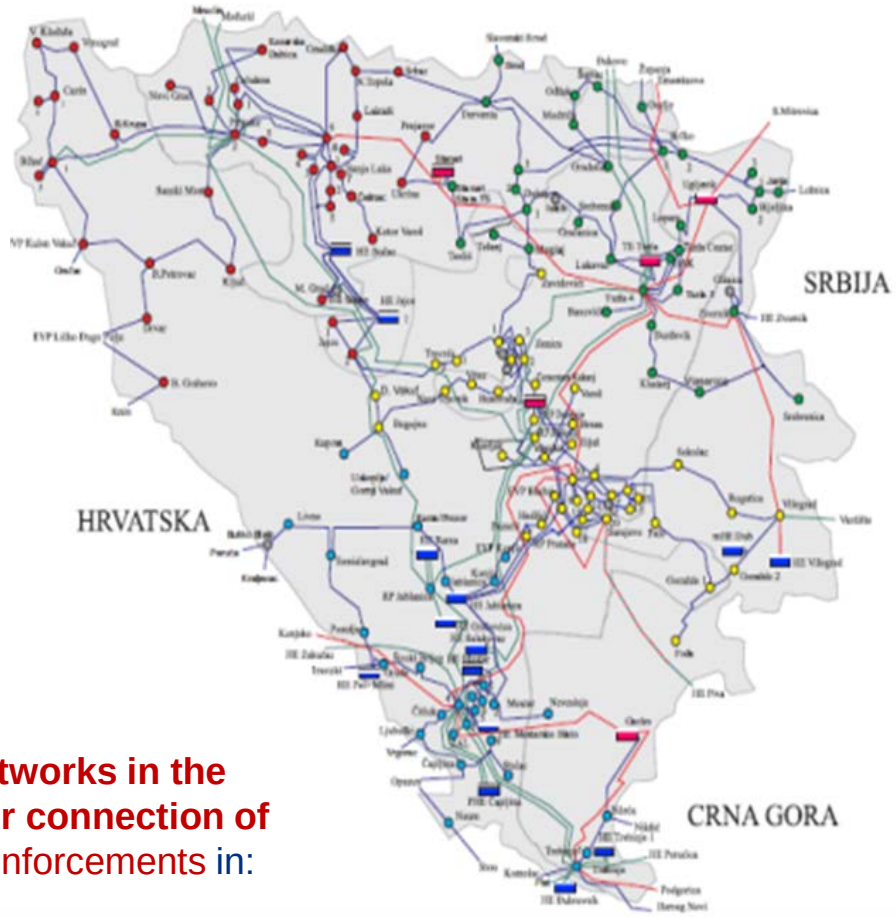
- Primary and secondary legislation for transmission networks in WB6 countries (except in BiH) is **fully harmonised** with the EU 3rd Energy Package
- Secondary legislation and all by-laws in distribution networks **are still lagging** in spite of significant progress in recent years
- Grid connection procedures are **reasonably well-defined**, although additional determinations and transparency is needed in some countries
- Connection charging methodologies are approved by the national Regulators, but additional transparency and consistency is required
- Ownership of connection points assets from investors to network operators is **not equitably regulated** in majority of WB6 countries.

Grid Connections – Grid Absorption Capability

Transmission network: Transmission network capacities and facilities will never be a constraint for HPP projects.

All new HPP projects connected to the transmission network:

- **increase overall stability** of the regional power system operations,
- **improve power system control** capacities, and
- **increase opportunities for integration of other RES** generation facilities, such as wind and solar PV generation.



Distribution network: Capacity of the distribution networks in the region is insufficient to facilitate growing demand for connection of small HPPs. Distribution networks require significant reinforcements in:

- Network facilities
- Control facilities,
- Human resources

Distribution Codes are getting improved, but still underdeveloped

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Inventory of Planned Hydropower Projects

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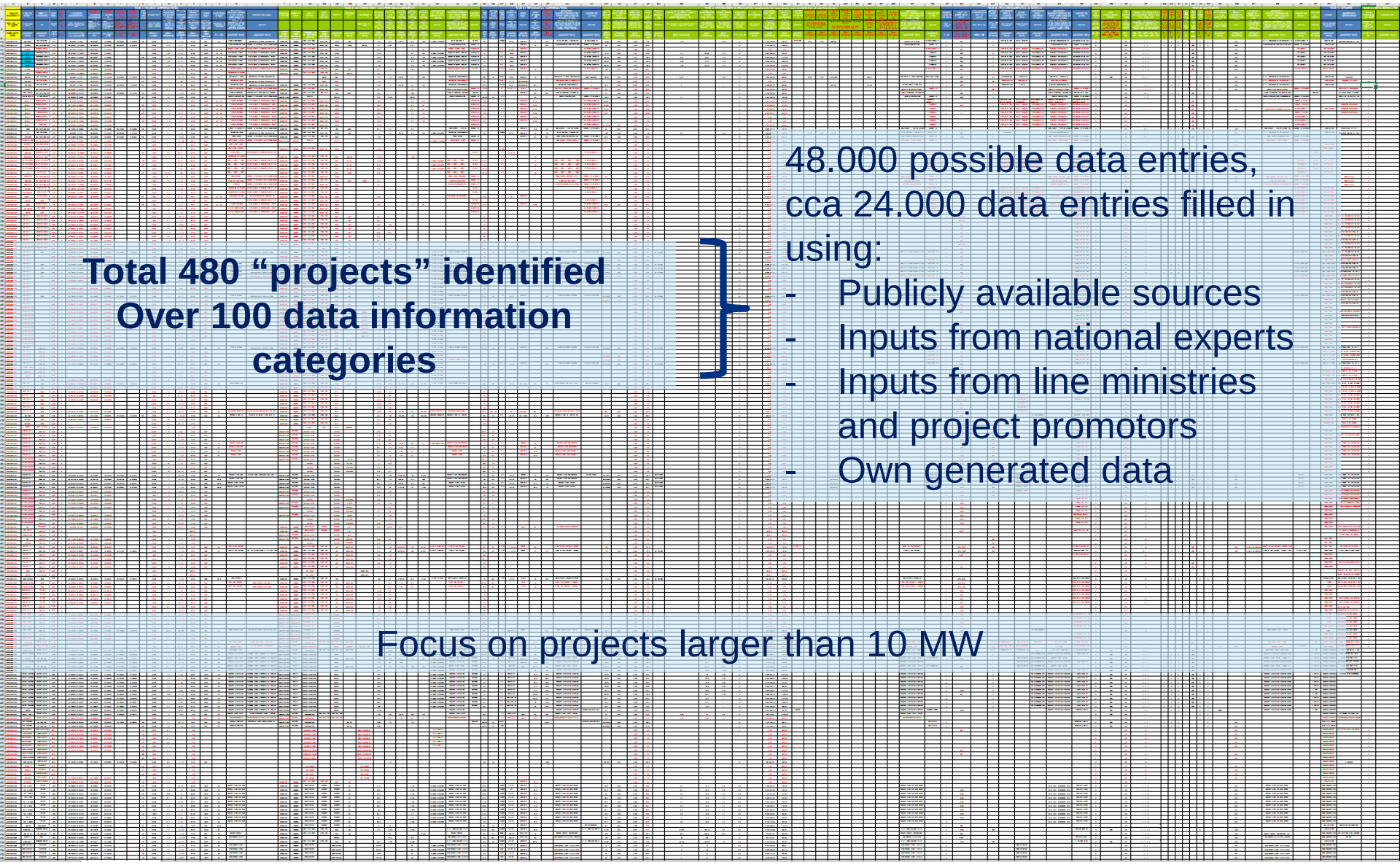
Background

- **Bottom-up** approach in assessing the remaining hydro-power potential:
  - HPP **rehabilitation** potential
  - **Greenfield** HPP's
- **"Real-life" approach** resulted in smaller figures on the remaining "implementable" potential as a **number of practical limitations** have been taken into account
- Based on **decades of actual project development** and numerous studies and work already undertaken

Methodology HPP-DB



Total 480 “projects” identified
Over 100 data information categories

48.000 possible data entries, cca 24.000 data entries filled in using:

- Publicly available sources
- Inputs from national experts
- Inputs from line ministries and project promotors
- Own generated data

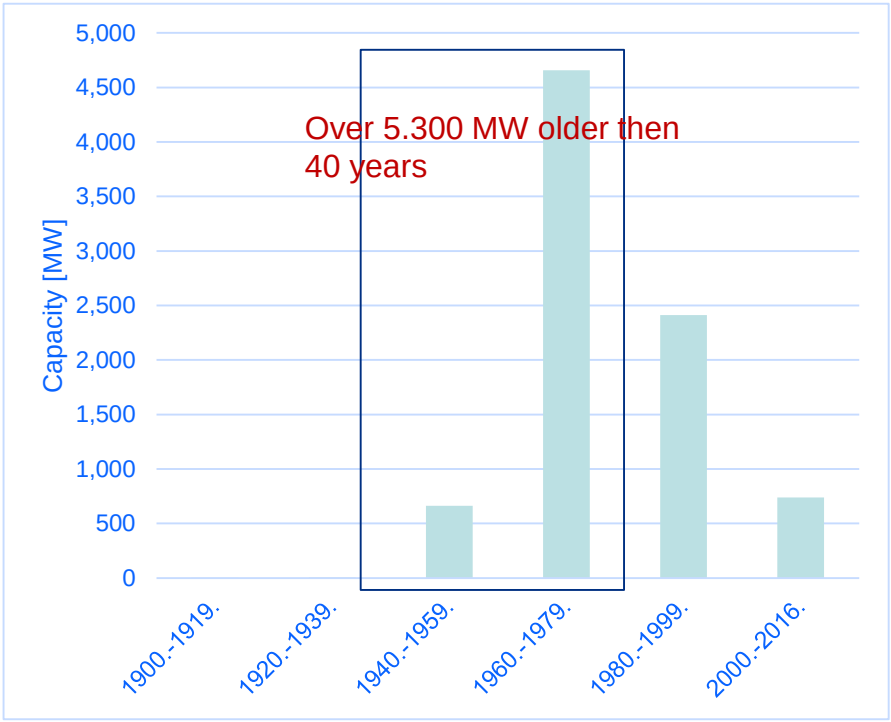
Focus on projects larger than 10 MW

Rehabilitation potential in WB6 – Introductory notes

- **Fleet of HPPs in the region is aging HPP capacity, over 2/3 older then 40 years**

Priority drivers of rehabilitation projects:
- safeguarding and maintaining the existing HPP capacity
- Resolving possible safety issues

Secondary objectives (possible)
- Increasing capacity and generation (MW and GWh)
- Improving/implementing environmental protection measures
- Operational optimisation & cost reductions



Rehabilitations of all HPPs in WB6 **are a must** for safeguarding the existing HPP capacity and the current level of power generation from hydropower sources in the region

Difficult to prioritise rehab projects without detailed cooperation with owners

- Assessing rehabilitation projects by 4 criteria:
  - **Rehabilitation due** (40 years)
  - **Safety related** actions required
  - **Environmental protection** actions required/planned
  - **Increase in MW/GWh** planned
- Not all data available

Tentative proposed priority rehabilitation projects

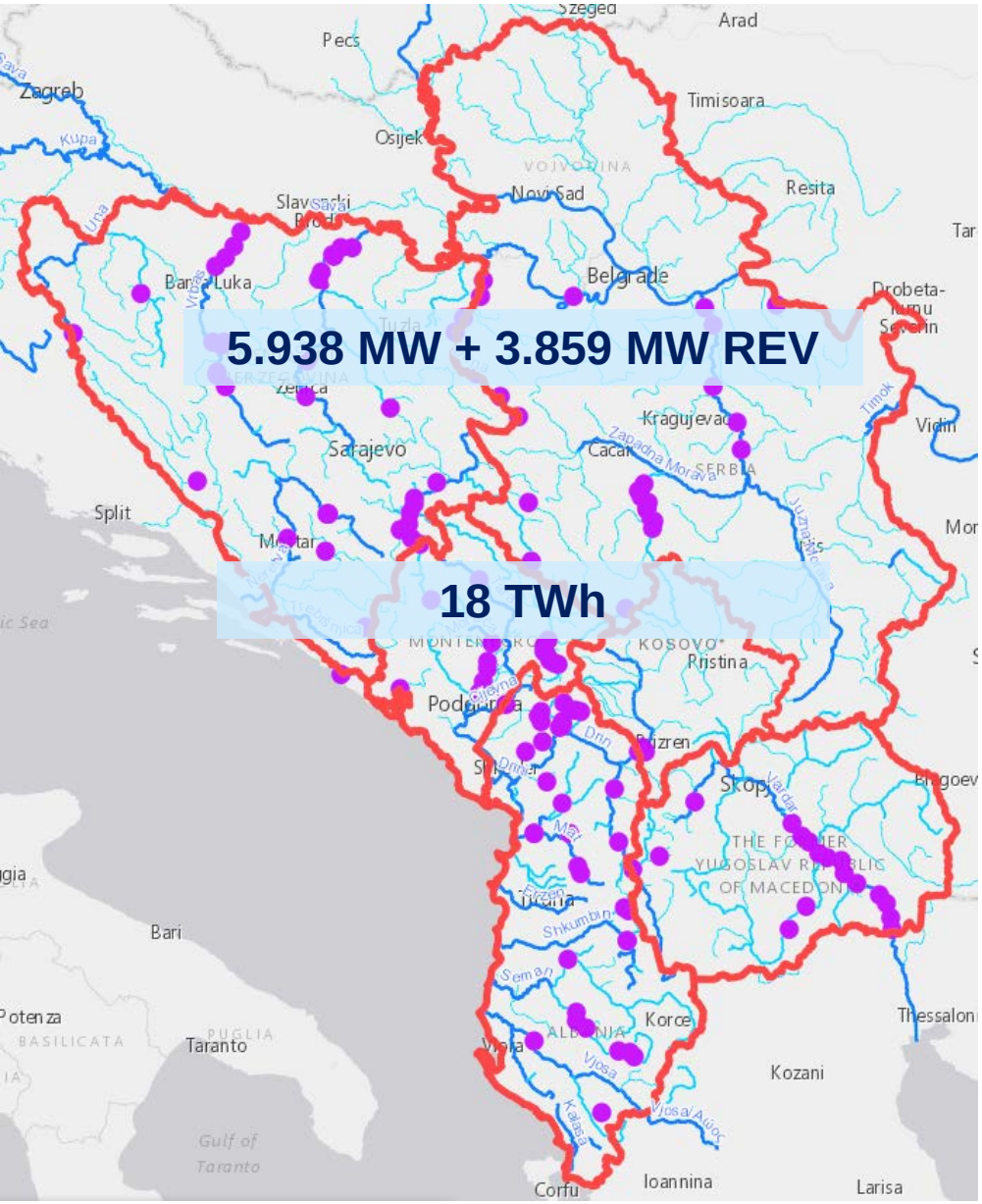
HPP	Capacity [MW]	Rehabilitation due	Planned investment [mln. €]	Rehab overdue or close (and not started)	Rationale			
					Necessary safety measures	Plant lifetime extension / major rehabilitation	Environmental improvements planned	Increase in capacity / generation
Fierza	500	2016						20 MW / 72 GWh
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 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
Peručica	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

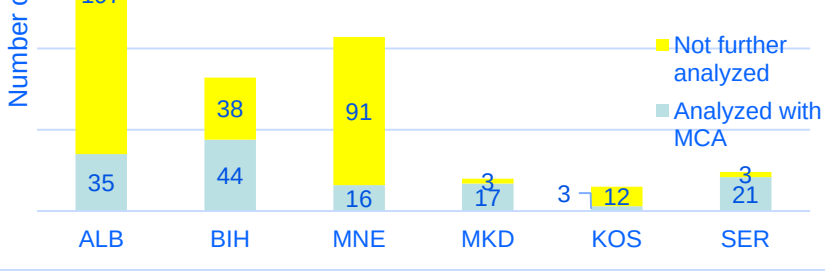
- **Capacity increase potential cca 4% (200 MW)**
- **Generation increase potential cca 6% (770 GWh)**

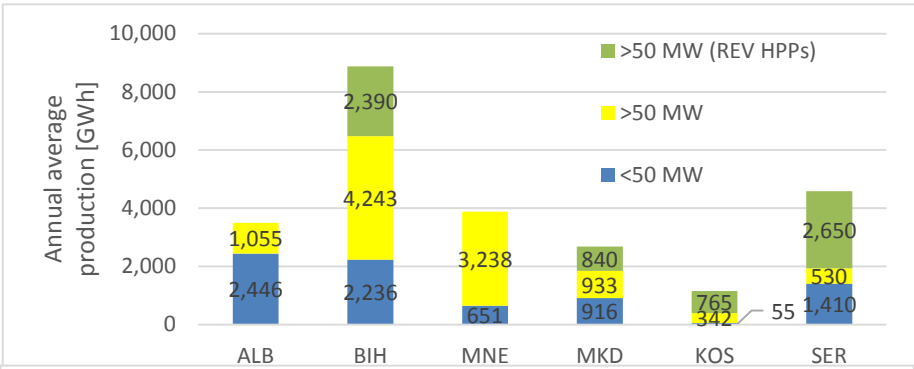
Greenfield project candidates screening

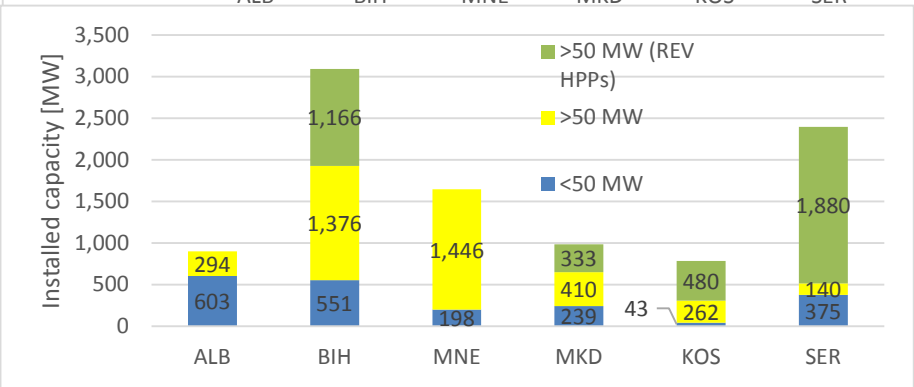


136 out of 480 identified projects eligible for MCA analysis "HPP candidates":

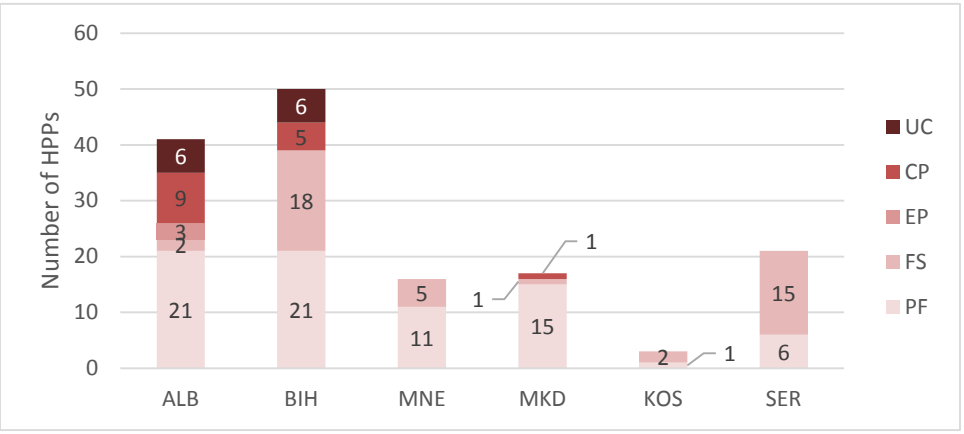
- Sufficient information available
- No projects below 10 MW
- No mutually exclusive projects (variants)

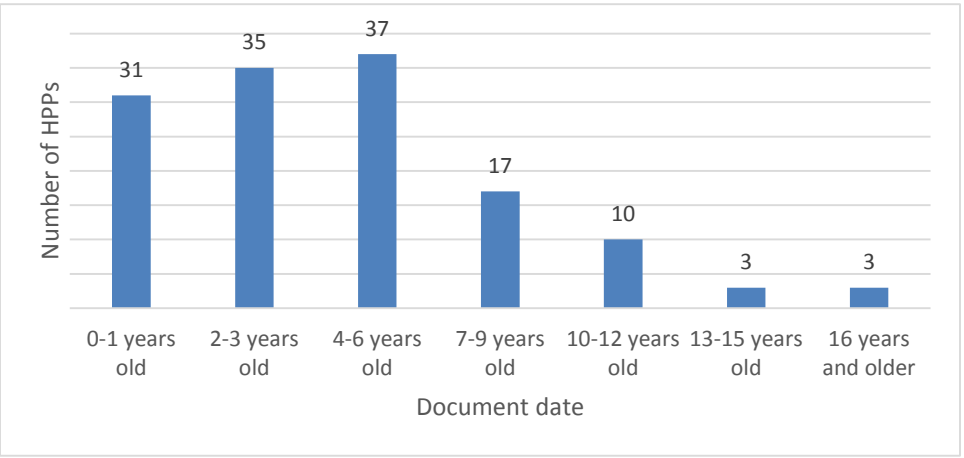






Development status of HPP candidates





Majority of projects are **far from realisation**

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

Documentation **largely needs revision & updating**

ALB	MW	BiH	MW
Fani, Fangu	74,6	Ulog	35
Moglice (Devoli)	177	Dabar	159
Kalivac	100	Mrsovo	36,8
Gjorica (5 HPPs)	25	Vranduk	19,6
Dragobia	15	Bistrica 1, 3	26,8
Vjosa	100		

In construction:
- 16 projects,
- Total 670 MW,1,9 TWh
- In **ALB** and **BiH**

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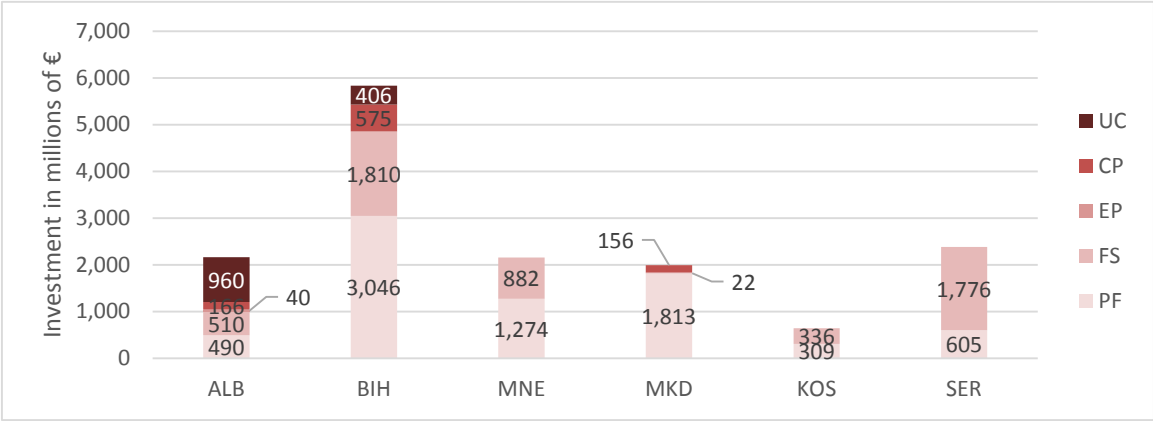
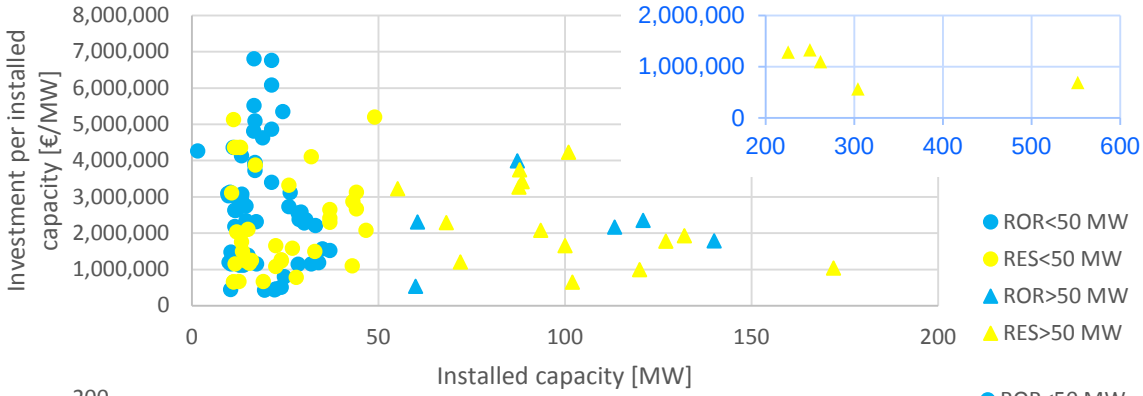
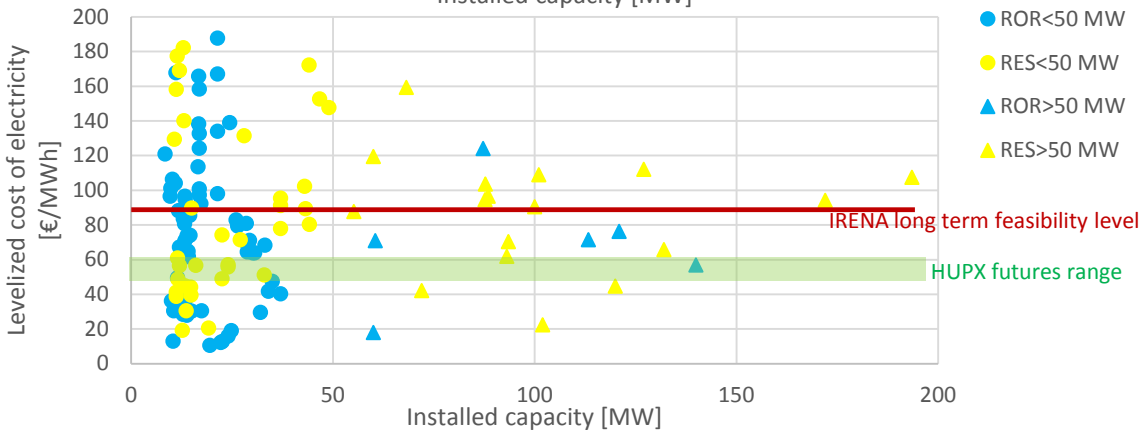
HPP candidates Investment Requirements



Total investment ~ €15 bln. Immediate requirements mostly for TA.



Unrealistically low investment estimates for some projects (mainly in ALB)



For many projects **difficult to achieve financial feasibility**

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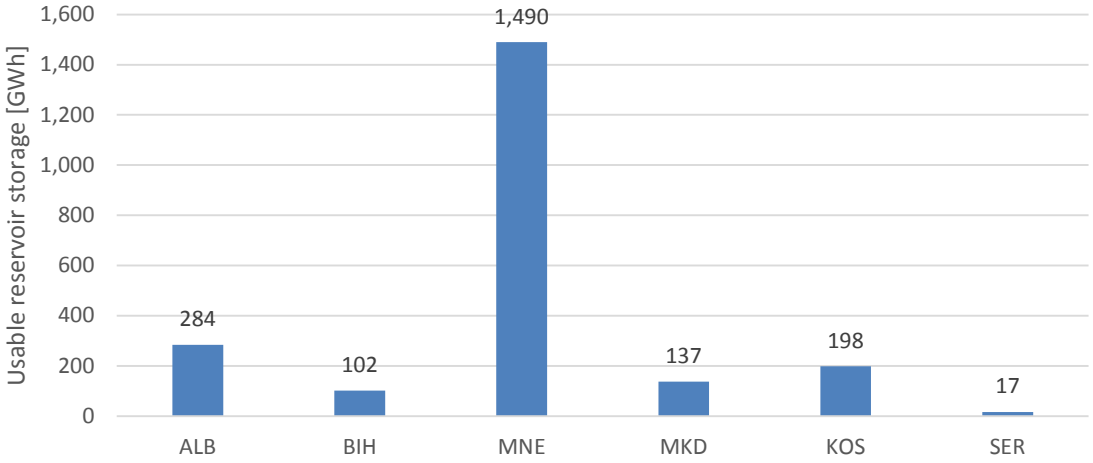
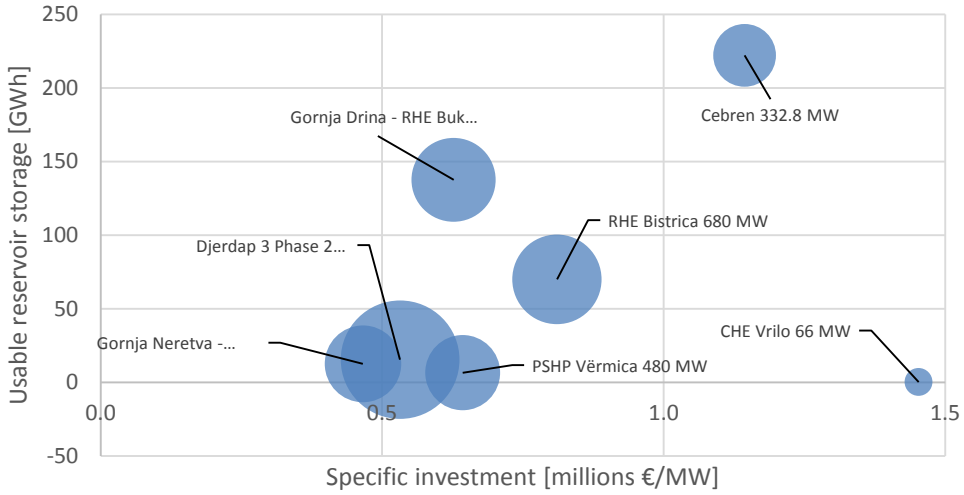
Reservoir and reversible HPP candidates



Total 2,230 GWh of usable storage from reservoir HPP candidates



7 reversible HPP candidates identified
Total 3,859 MW
464 GWh of usable energy storage

Potential for additional 2,694 GWh of energy storage

- **Important for integration of RES**

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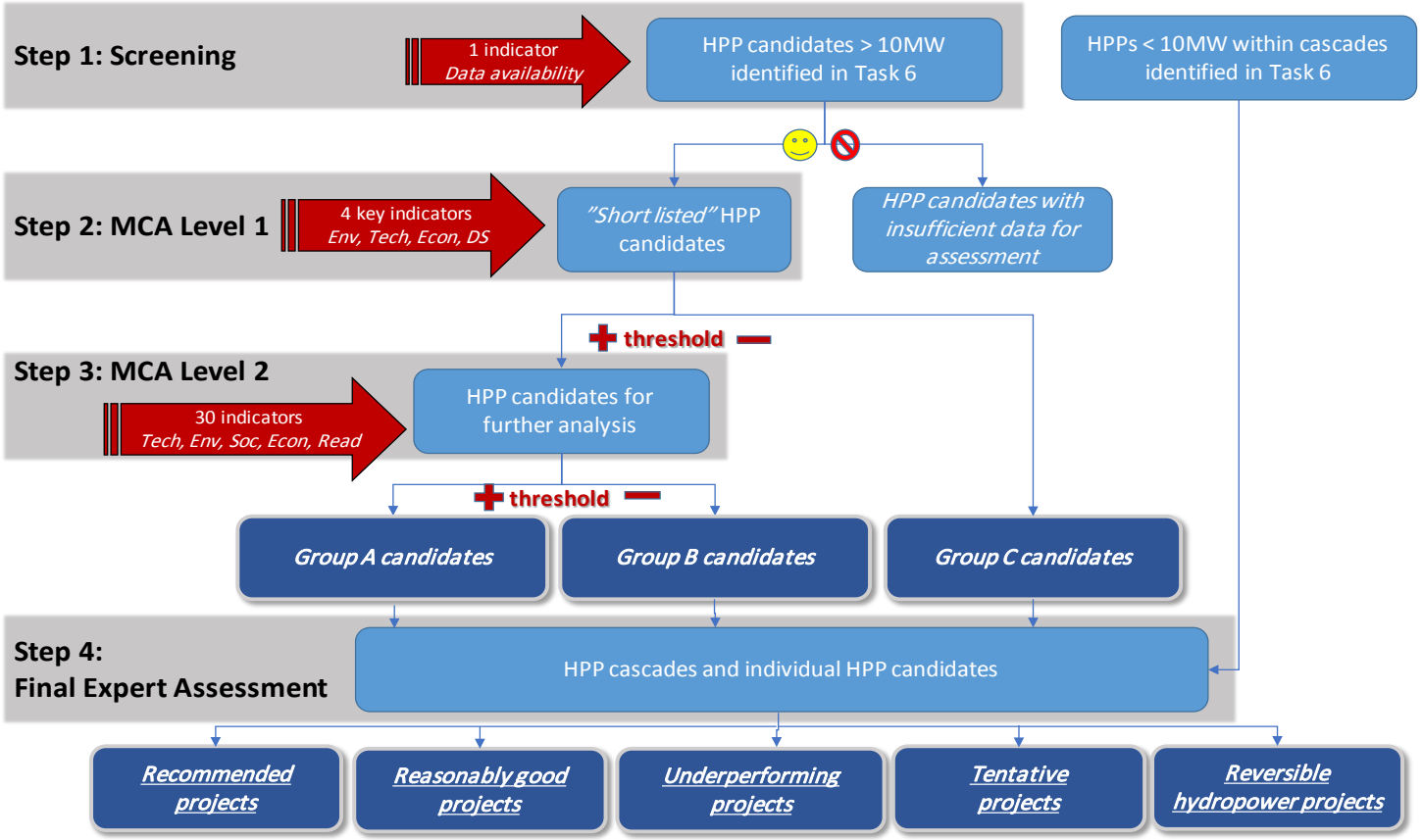
From pool of over 480 identified projects to recommended project list

Selection of comparatively the best assessed potential projects for successful development and implementation achieved through 4 consecutive steps



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Recommended projects - Comparatively the best assessed potential projects for successful development and implementation

SN	Project name	Country	River basin	Capacity (MW)	Electricity output (GWh)	Normalised investment cost (mil. EUR)	Comments
1	Gornja Neretva HPS	BIH	Neretva	128.5	327.7	238.6	Candidate for construction within long-term development plan of EP BiH. Project has been in development by Intrade energija, in 2016 EP BiH submitted an unsolicited request for concession for Glavaticevo, Bjelimici and PHE Bjelimici.
2	Mati cascade	ALB	Mat	29.5	108.6	37.3	
3	Gornja Drina	BIH	Sava	225.0	770.7	574.6	Variant with "small" buk Bijela with no cross border issues.
4	Tenovo	MKD	Vardar	35.0	140.0	55.0	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.
5	Morača cascade	MNE	Morača	238.0	616.0	498.4	MoUs signed with potential strategic partners. Negotiations ongoing. Possible redesign. Flood protection, irrigation.
6	Komarnica (var 2)	MNE	Sava	172.0	227.0	178.3	Field investigations ongoing in cooperation between EPCG and EPS.
7	Drini cascade	ALB	Drin-Bune	181.0	673.0	509.9	Tender on concession cancelled. Intention is for KESH to develop the project with strategic partner. Potential cooperation with Kosovo.
	Total			1,009	2,863	2,092	

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