Pumped Storage Hydropower International Forum

International Forum on Pumped Storage Hydropower

Draft Summary of Emerging Findings (May 2021)

To promote and enhance the role of pumped storage in the clean energy transition, the Forum's Steering Committee, comprised of governments, intergovernmental organisations and multilateral development banks, established three Working Groups: 'Policy and Market Frameworks', 'Sustainability', and 'Capabilities, Costs and Innovation'. Led by Lead Partners, these Working Groups bring together expertise from governments, the hydropower industry, financial institutions, academia and NGOs to help address common challenges facing pumped storage hydropower (PSH) development.

This is a draft summary of emerging findings for feedback. The Steering Committee encourages Forum Partners to actively contribute to the areas of work where you are best able to leverage your skills, expertise and resources. Please get in touch with Samuel Law (Samuel.Law@hydropower.org) and Olivia McCue (Olivia.McCue@hydropower.org) should you wish to participate in any of the Working Groups.

Please do not cite any part of this paper. Final deliverables will be launched in September 2021 at the World Hydropower Congress.

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Policy & Market Frameworks Working Group

Lead Partner: GE Renewable Energy

Chair: Pierre Marx, Managing Director, North America, GE Hydro Solutions

While PSH will be critical in maintaining power system stability under high levels of variable renewable energy, many of its services are not fully recognized nor adequately remunerated. In addition, most policy and market frameworks do not adequately incentivise investment in greenfield PSH development. Given the long lead times involved, investment decisions are needed now to ensure solutions are available in advance of market needs.

This Working Group will explore the various services and markets to highlight the current investment barriers in addition to emerging opportunities for PSH development. A key focus of the group will be developing country and regional specific policy recommendations for government decision makers and regulators that de-risk development. Furthermore, it will examine how new and innovative market mechanisms and lessons learned from other sectors could be applied to PSH.

With thanks to over 20 supporting organisations, regional papers are also emerging to provide more specific recommendations to regions and countries.

Draft key financial barriers

Revenues:

- Lack of long-term revenue certainty to underpin investment decisions.
- Missing markets for increasingly scarce and valuable system services – i.e. inertia/system strength, capacity/storage etc. Additional flexibility provided by PSH not recognized.
- Energy imbalances across regions caused by not having enough storage resources to integrate renewable generation as well as a lack of compensation for storage services.

Policies and mandates:

- Lack of overall energy policy integrating storage needs (linked to variable renewable energy penetration) and price on externalities, to support the viability of the investments – incentives to be guaranteed for investors.

Market design:

- Lack of energy planning mechanisms and competitive markets that send appropriate signals to ensure enough resources built to integrate variable generation, particularly long duration capacity.

Draft key non-financial barriers

Technology recognition:

- Lack of knowledge among decision makers and policy makers of all the benefits that hydropower and PSH can bring, especially its ancillary benefits.

- Technology-agnostic policies: mandates/incentives that pick winners and losers without regards to technical merits/true costs. Integrate capabilities in respect of both MW and MWh for a fair comparison of all the storage technologies.
- Acknowledge the immediate wider societal benefits that the construction investment in PSH brings.

Identification of storage needs:

- Need for reform and changes to rules and operations to achieve a low carbon future.
- Models used by energy planners and decision makers that are not robust enough to accurately evaluate various storage technologies.

Permitting and licensing:

- Extremely lengthy permitting procedure for PSH as compared to other storage technologies.

Draft main recommendations on Policy and Market Frameworks

Planning & modelling

- Policy makers need to assess the long-term storage needs of their future grids now to avoid unnecessary costs later as more and more variable renewables come onto the system. This is a low cost, no regrets option.
- These assessments should follow a consistent, technology neutral approach to evaluating storage and other flexibility options that takes into account the full spectrum of grid needs including deep storage, grid services, and environmental impacts including land use and decommissioning.
- Opportunities for sharing assets such as PSH across regional borders should be given full consideration.
- Perspective PSH sites should be mapped to understand the full potential.
- Existing hydropower assets should be assessed for their potential to convert to PSH.
- Existing PSH assets should be assessed for their potential to upgrade to the latest technology to enhance the benefits they bring to the system.

Licensing and permitting

- Licensing and permitting arrangements must be timely, proportionate and must take advantage of the range of internationally recognised tools for assessing the environmental and social impact of hydropower (including PSH). These can be deployed by policy makers with confidence.

Green recovery

- PSH should be included in post COVID green recovery programmes.

Electricity market design

- In designing market products, policy makers must ensure that those products provide enough long-term revenue visibility to stimulate investment in the most efficient low carbon technologies. There are several options to do so, including ensuring appropriate contract lengths, allowing for 'bundled' grid services products and introducing income floor mechanisms.
- Providers of ancillary services such as frequency control and inertial services should be remunerated for those services.
- Where PSH can participate in ancillary services markets, those market rules should be stressed test to ensure they are not inadvertently excluding the most efficient technologies and low carbon solutions should be prioritized.

- Transmission system operators should be allowed and encouraged to procure PSH where that would be the most efficient way of managing grids.
- Market rules should be reformed to allow participation of technologies such as PSH in transmission and generation markets, if necessary, through the creation of a new storage asset category.

Finance

- PSH should actively participate in finance mechanisms like green bonds.
- Governments should give consideration to recoverable grants that allow the sharing of project risks between Government and developers to support private investment and development.

Sustainability Working Group

Lead Partner: EDF Hydro

Chair: Antoine Malafosse, International Project Manager, EDF Hydro

While PSH is a key enabler of a more reliable and cleaner grid, its development and operations can have environmental and social impacts. It is therefore critically important that these are well understood, and measures are taken to avoid and mitigate such impacts. To do so, international industry good practice in sustainability should be adopted at every stage of a project's life cycle. The overall objective of the Sustainability Working Group is to develop guidance and recommendations on how PSH can best support future power systems in the clean energy transition in the most sustainable way.

The Sustainability Working Group has made significant progress in producing a Working Paper, which is currently in the draft stage.

Structure of the Working Paper on Sustainability

1. Sustainability Framework & assessment approach

The general approach for developing sustainable PSH projects can be structured through three major levels:

- System-level needs;
- Options assessment; and
- Project optimization.

2. Guidelines, Tools and Methods

The main guidelines of interest are the Hydro Sustainability Protocol and related tools (HSAP / HST / HESG), Climate Bonds Initiative (CBI), the EU taxonomy on Sustainable Finance and the IEA Technology Cooperation Programme (TCP) on Hydropower.

This report also presents methods and tools and their applicability to PSH technology and projects, including Hydro Sustainability Tools (HST), Multi-Criteria Analysis (MCA) and Life Cycle Analysis (LCA).

3. How tools can be used over lifecycle stages of PSH projects

Sustainability tools may be used across the lifecycle stages of PSH projects :

1. Early Stage
2. Preparation
3. Implementation
4. Operation
5. Decommissioning

4. Case studies of sustainability tools applications

- MCA for PSHs in Tanzanie (Australia)
- HSAP for Kaunertal Expansion project/Versetz PSH (Austria) & for Coire Glass PSH project (Scotland)
- HASAP/HESG for Grand'Maison PSH adaptation XFLEX project (France)

- LCA synthesis studies for PSHs
- CEDREN studies on existing reservoirs retrofit to PSH (Norway)
- Local benefits of PSH Projects

Draft main recommendations on Sustainability

a) Massive storage solutions will be needed to implement the strategic trajectory towards a net zero carbon future of power systems, and PSH projects should be considered as key enablers of this transition, as well as other storage technologies.

b) The assessment of PSH projects sustainability should rely on a multi-level approach:
   - System-level strategic assessment: To determine what are the storage, flexibility and ancillary services that a given power system needs, and will need in a long-term planning perspective – analysis at this level would result in a demonstrated need of storage & flexibility.

   - Options assessment: To identify global options that would meet energy storage, flexibility and ancillary services, based on the characteristics of services that can be provided by available and mature energy storage technologies – analysis at this level would result in a PSH demonstrated need.

   - Project optimization: To select project configuration and technical options that would result in the "best" sustainable strategic fit of PSH project to avoid, minimize and mitigate social and environmental impacts.

c) PSH projects are very site-specific, and sustainability cannot be reduced into a simplistic classification. Some key factors to consider for options assessment and project optimisation are listed in this report, to lead to an overall integration of the project into a given site configuration with associated environmental functions and sensitivity, safety issues, and social aspects, with an intent to avoid, minimize, and mitigate impacts.

d) Existing Sustainability Tools for Hydropower are adequate for PSH technology and projects assessment, and are recommended sometimes with few adaptations which can be inspired from case studies given in chapter 5 – for example: consideration could be given to the need to improve ESG risk screening tools for Early Stage phase.

e) LCA applications to PSH technology and projects are still quite recent and have been mainly conducted in the research domain. They provide interesting outcomes but also raise some fundamental questions which requires cautious attention to avoid misleading conclusions. Issue of GHG emissions from PSH reservoirs does not seem to be significant, based on long-term experience and database for the Hydropower sector.

f) PSH projects, as many Hydropower projects, can generate one-time or permanent local benefits of various nature, which must be considered in their sustainability profile assessment.

The Working Paper also makes one general recommendation that the recommendations and outcomes from the Sustainability WG must be integrated and coordinated with those from other WG's, especially:

Policy & Markets Frameworks:

- Economic viability aspects of PSH projects are also a key factor of sustainability.

Capabilities, Costs and Innovation:

- Specify and compare PSH storage and flexibility services with other technologies.
- Identify innovative solutions which may help reduce the environmental footprint of PSH technology and projects: e.g., choice of some materials.

Capabilities, Costs and Innovation Working Group

Lead Partner: Voith Hydro

Chair: Klaus Krüger, Senior Expert Plant Safety & Energy Storage Solutions, Voith Hydro

PSH is often absent in discussions concerning the need and deployment of energy storage technologies due to a lack of understanding about its capabilities, costs and potential. This area of work will seek to raise awareness of the role of PSH in addressing the needs of future power systems in a cost-effective manner. It could also provide comparisons of different storage technologies and highlight the latest technological developments.

The Capabilities, Costs and Innovation Working Group will produce three deliverables:

Deliverable 1 - Costs and capabilities comparison

This deliverable will provide an overview on flexibility options, a summary on costs and capabilities comparison and address common PSH misconceptions. The paper will provide examples and references in a supplementary document for open peer review.

Structure:

1. Executive Summary
2. Comparison on storage technologies
3. Comparison with other sources of system flexibility
4. Examples of flexibility options per country/region
5. Common PSH misconceptions

This report is currently in the draft stage.

Deliverable 2 - PSH potential mapping resources

This deliverable is to provide a comprehensive online directory of mapping resources based on existing literature. *This report is currently in the draft stage.*

Deliverable 3 - Innovative Pumped Storage Configurations & Uses

The draft Innovative Pumped Storage Configurations & Uses paper is designed to improve understanding of innovation PSH technologies and explore opportunities based on physics and evidence. The paper is led by Dr. Maha Haji, Cornell University and Prof. Alexander Slocum, MIT. Over 20 draft innovation profiles were submitted by a wide range of organisations. The innovation profiles are categorised into three overarching themes:

1. Further PSH potentials
2. Retrofitting and upgrading
3. Hybrid systems

The review of innovations and development of the draft paper is ongoing.