International Forum on Pumped Storage Hydropower

Brief Presentation of the Initiative for the future of Pumped Storage

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IENE WEBINAR

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INTERNATIONAL FORUM ON PUMPED STORAGE HYDROPOWER

- Launched in November 2020 by the International Hydropower Association (IHA)
- Chaired by the U.S. Department of Energy

The Forum brings together governments, industry, financial institutions, academia and NGOs

- to share their experiences
- build best practice and
- shape the future of pumped storage

Steering Committee : 11 governments and 5 development banks
Founding Partners : more that 60 Organizations (Leading research, development and financial organizations)

Steering Committee Members & Observers

Partners

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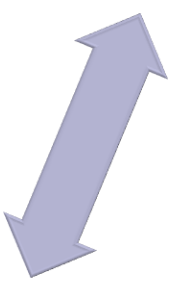
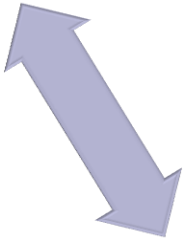
Market & Policy Frameworks

(Led by GE Renewable Energy)

This area of work seeks to explore the various markets, services and contract options to highlight the current investment barriers but also opportunities for PSH development. Furthermore, applied to PSH to incentivise and de-risk development, inclit will examine how new and innovative market mechanisms could be uding learning lessons from other sectors

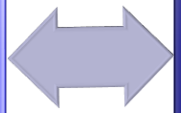




Capabilities, Cost and Innovation

(Led by Voith Hydro)

This area of work seeks 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 driving even greater PSH flexibility



Sustainability

(Led by EDF)

This area of work seeks to promote a greater understanding of PSH's sustainability profile across different locations, including ways to best utilise the tools and latest approaches available such as the Hydropower Sustainability Tools

Governance & Work Programme

Summary of Proposed Deliverables

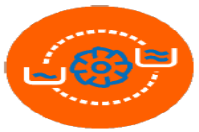
Pumped Storage Hydropower International Forum

Policy & Market Frameworks

- Position paper
- Barriers mapping
- Screening of remuneration schemes
- Overview of best practices

Sustainability

- Life Cycle Assessment (LCA)
- Sustainability tools implementation
- Value creation for local community



Capabilities, Costs & Innovation

- Comparisons with other storage technologies
- Potential Mapping
- Cost and Performance Benchmarking
- Innovative Technologies Roadmap

Dissemination

Events:

- World Hydropower Congress
- Regional webinars & topical workshops

Online communications:

- Forum website
- Social media campaign

Linkage with international initiatives:

- IRENA Collaborative Framework
- IEA Market Report
- XFLEX HYDRO
- IEA Hydro

Link to join groups:
https://tinyurl.com/y4mnrzdt

Working group roadmap

3rd Nov:
Forum Meeting
- Draft work programme presentation
- Call for partners

Dec '20:
Kick-off with Partners
- Partners to discuss and agree on the work programme
- Assign sectional leads

March '21:
Inputs from regions:
- Barriers
- Remuneration schemes
- Best practices

May '21:
Intermediate feedback to SC
- Opportunity for regional webinars to discuss progress and receive feedback

May/June '21:
Draft recommendations

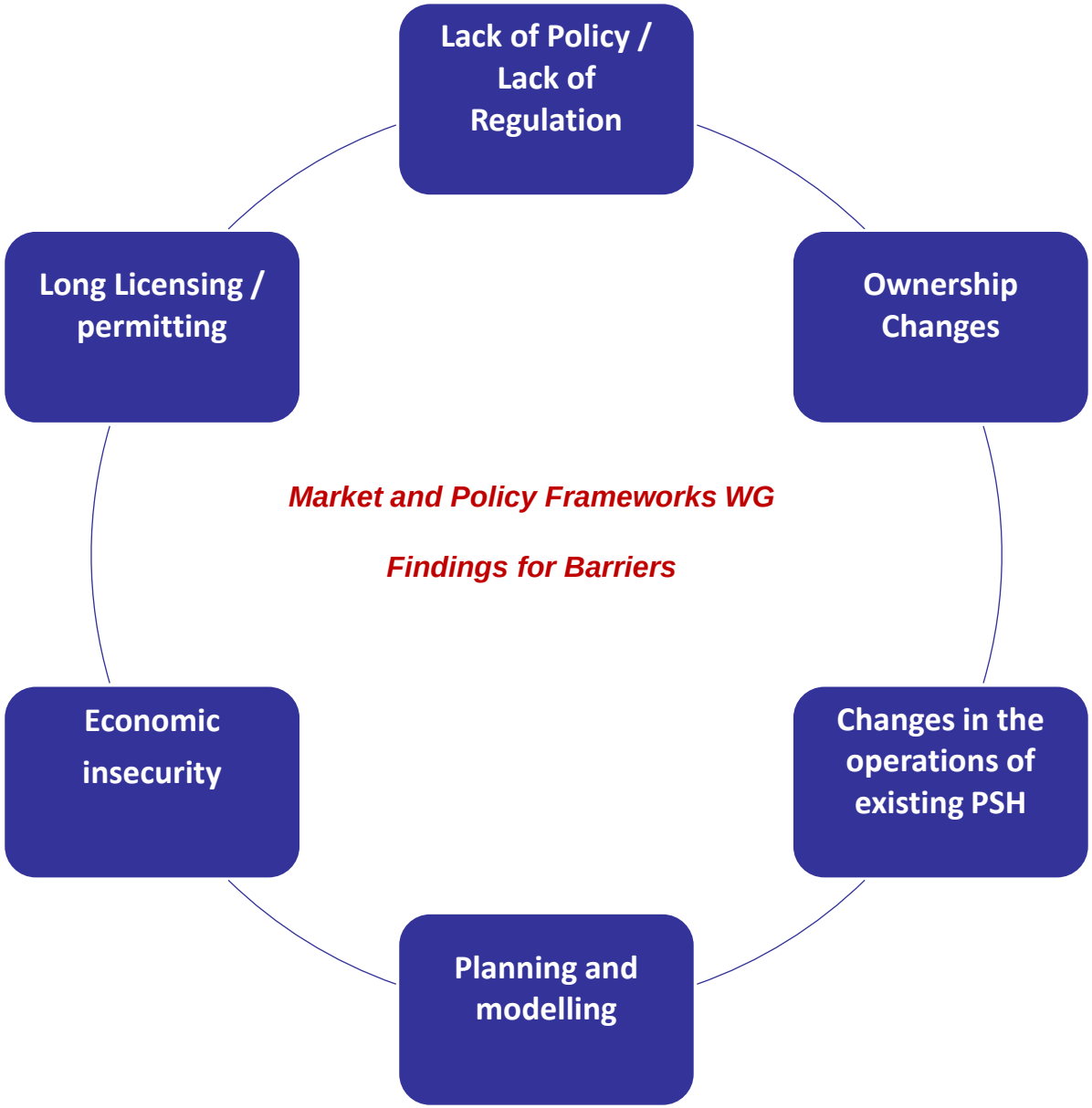
July/August '21:
Position paper finalised

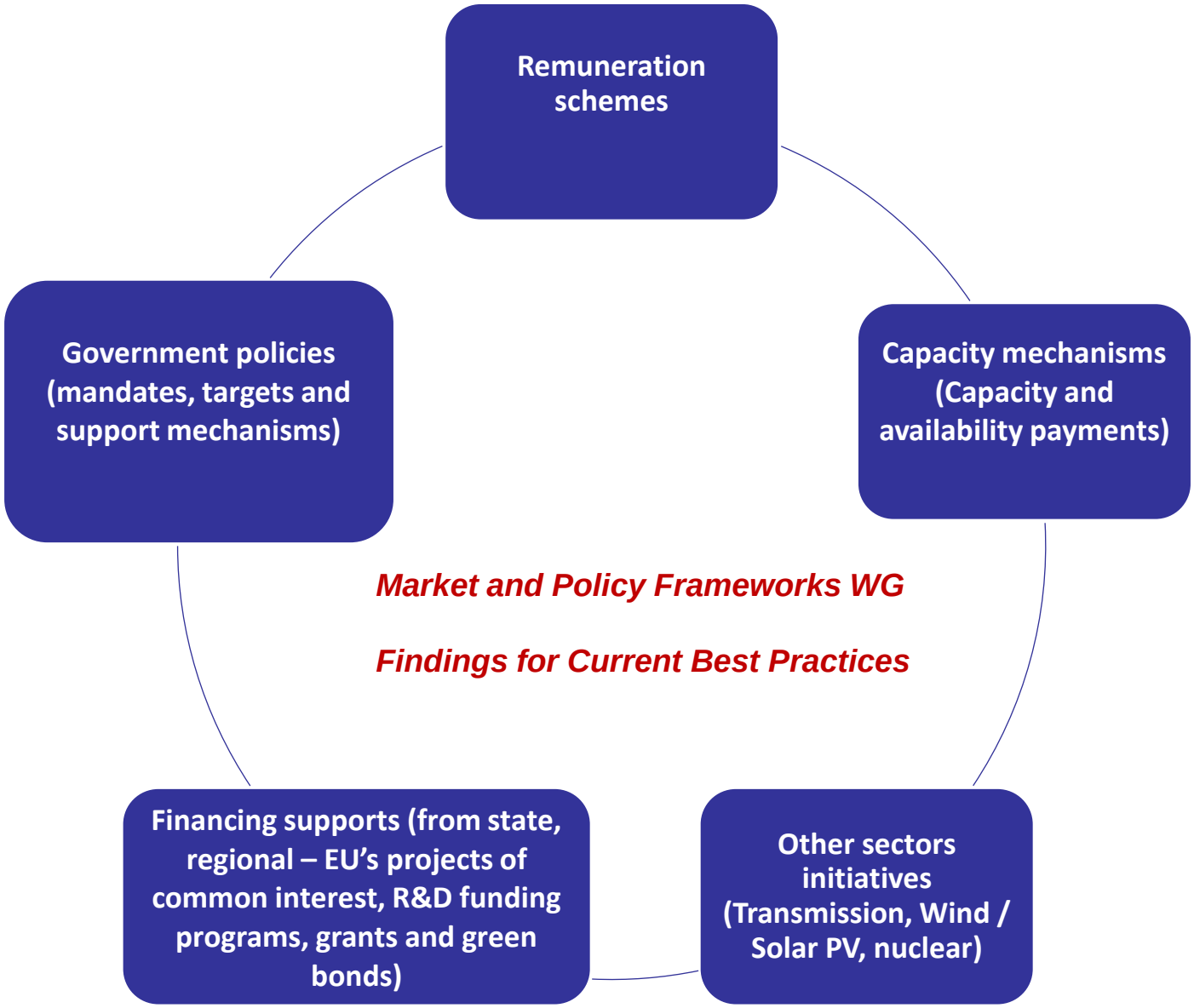
23-24 Sept '21:
Paper released at World Hydropower Congress

Sept/Oct '21:
communications
- ✓Regional Webinars
- ✓Online and Social media campaign

11 months to set the scene and make recommendations

INTERNATIONAL FORUM ON PUMPED STORAGE HYDROPOWER - BARRIERS




Remuneration schemes
Capacity mechanisms (Capacity and availability payments)
Other sectors initiatives (Transmission, Wind / Solar PV, nuclear)
Financing supports (from state, regional – EU's projects of common interest, R&D funding programs, grants and green bonds)
Government policies (mandates, targets and support mechanisms)
Market and Policy Frameworks WG
Findings for Current Best Practices

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Barriers and Challenges to PSH development

- **Policy / regulation**

  Very few countries have set targets for energy storage, and some of them only focus on battery energy storage or hydrogen deployment. Therefore Governments through policy decisions are picking technology winners and losers rather than selecting based on technical merits, costs, or other appropriate factors

- **Ownership**

  In many markets, PSH were developed under regulated market conditions and were therefore owned by vertically integrated utilities which managed the overall value chain of electricity from generation and Transmission and Distribution. Such models allowed integrated energy storage into long-term, system-wide resource planning, achieving economies of scales and benefiting the overall power system.

  However, new market designs have emerged and unbundling of power entities require clear ownership rules for energy storage assets to enable investments. The categorization of energy storage as Transmission or Generation assets helps to determine its potential revenues, i.e. whether it can provide flexibility and balancing services in competitive markets or contribute to transmission and distribution deferral. Most of recent legal frameworks classify storage assets as a generation asset, preventing system operators for transmission and/or distribution to own storage devices. It helps developing a level playing field for all energy asset owners but this is a significant barrier to transmission and distribution deferral, one of the highest-value applications for storage.

- **Licensing / permitting**

  long processes that include many steps from site selection, pre-feasibility / feasibility studies as well as environmental and social assessments, to permitting/licensing from one or various entities. Unlike other technologies that can go from proposal to realization in under six years, a pumped storage plant might take more than 10 years until it is operational

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- **Economic**

  There are several reasons for this, but at the core, it results from two related considerations. First, private development is difficult because of the large capital outlay that is required to build a pumped storage plant. Second, plant revenues are uncertain due to uncertainty surrounding market and regulatory rules and future market conditions.

  In addition to the large capital outlay, revenue uncertainty associated with the operation of pumped storage plants limits development. This uncertainty manifests in two primary ways: the difficulty of predicting revenue streams over long timeframes due to market conditions and emerging technologies, and the existing regulatory and market paradigms where storage assets are only remunerated for a fraction of the benefits they do and could provide to the system

- **Changes in the operations of existing PSH**

  PSH plants were largely used to complement non-flexible generation, particularly nuclear power plants. Accordingly, their operations were predictable and followed a fairly straightforward approach of being charged using excess power at night and dispatched during times of peak demand by vertically integrated utilities that maximized PSH operations for system efficiency. The continued deployment of renewables has seen more volatile price spreads. PSH plants should be able to take advantage of this increasing volatility and charge or dispatch as market prices move. However, PSH plants in Europe with less robust ancillary service markets have not been as fortunate. In both situations, potential and unpredictable revenues from energy arbitrage are insufficient to support the construction of new PSH projects.

- **Planning and modelling**

  In many instances, decision makers, such as transmission operators or system planners, utilize models that are not robust enough to fairly evaluate the differing storage technologies. For example, many use data based on the existing technologies within their systems, which in the case of PSH, would be old technology (30 years as in the case of the US).

  Another issue is that these decision makers attempt to use batteries as the baseline when comparing technologies, which can skew the results. For example, using a 5-year life to compare batteries vs PSH costs, will skew the results to batteries vs using 40-80-year life. Many of the models also do not take into consideration unique, climate change events such as those recently experienced in the state of Texas, US.

  The above is compounded by the decision makers lack of knowledge and education about Pump Storage in general. Thus, this technology many times is not considered in long-term generation planning/integrated resource planning.

Recent government led developments and Best Practices

- **Government policies (mandates, targets and support mechanisms)**

  PSH development support in India

  - *India declared that large hydropower (greater than 25 MW) was officially a renewable energy resource. This move will enable new, large projects to benefit from the non-solar Renewable Purchase Obligation which mandates that regional utilities must purchase a portion of their electricity from hydropower.*
  - *More recently, India also moved to a real-time market in electricity which will encourage and reward more flexible generation sources.*
  - *To further support this aim, the Indian government has requested the World Bank to carry out a study to determine the flexibility of hydropower and investigate appropriate market and regulatory framework for hydropower flexibility, particularly for pumped storage.*
  - *In addition, the country recently amended its National Wind-Solar Hybrid Policy to clarify that pumped storage could be used in hybrid wind solar projects, to promote large grid-connected hybrid wind-solar PV development and efficient grid utilisation.*

  Capacity markets supporting the modernisation of pumped storage plants in the UK

  - *in Europe, capacity markets such as those in the United Kingdom (UK), France and Italy have failed to offer sufficient to support for greenfield PSH development due to low clearing prices and the short-term nature of the contracts offered. In the UK though, capacity market payments have benefited existing PSH stations, to the extent that such payments have helped finance modernisation and refurbishment work.*

- **Financing supports (from state, regional – EU's projects of common interest, R&D funding programs, grants and green bonds)**

  Direct financial support to promote the wider economic benefits of PSH

  - *A factor that has supported the development of renewable energy has been its potential to help achieve economic development objectives, especially in rural and regional areas. This includes the promotion of technology development and manufacturing companies as well as project developers. It also includes jobs created from construction, maintenance and operations, industry and supply chains, and indirect increases in local commerce (e.g. hotels, restaurants, and stores) associated with energy project development (example of 250 MW/2000 MWh Kidston pumped storage project in Far North Queensland, Australia which benefitted from grant funding and is set to receive a 30-year concessional loan, worth AU$ 610 million, from the federal government's Northern Australia Infrastructure Facility (NAIF) to support its development.*

Outside of market policy mechanisms

- *Outside of market policy mechanisms are targeted, technology or even project-specific interventions carried out by governments to meet an agreed upon energy need.*
- *One notable example is in the UK, where the government, recognizing that its existing nuclear fleet is coming to the end of its life, which would result in a loss of baseload low carbon capacity, entered into a financial agreement with Électricité de France and the China General Nuclear Power Group in 2016. The agreement guarantees that the 3,200 MW Hinkley Point C station (currently under construction) will receive an inflation-linked set rate for the first 35 years of operation.*
- *In Portugal, the government established the National Plan on Dams with High HydroElectric Power Potential (PNBEPH) in 2007-08. This was a program focused solely on increasing hydropower capacity, including PSH to support VRE to reaching their climate targets. It involved the government choosing the sites before auctioning them with power purchase guarantees.*

Pumped storage and the green bond market

- *The Climate Bonds Initiative (CBI), a not-for-profit organisation which develops certification standards for green bond issuances has recently published its hydropower criteria (including PSH) [39]. The hydropower sector has received the green light for climate bond finance, meaning that investors can now benefit from this mechanism to finance or refinance hydropower projects. Certified climate bonds are a very good lever to direct investment to infrastructure that supports the Paris Agreement while reducing negative impacts on local environments and communities.*

To-date, worldwide green bond issuances have reached over US$1 trillion

➢ **Other sectors initiatives (Transmission, Wind / Solar PV, nuclear...)**

Transmission

- *The case can be made that PSH resources are very much like transmission infrastructure: not only can PSH provide several transmission services, (e.g. network congestion relief, system reliability, or voltage and reactive power support) but is a capital-intensive resource with a long asset life that has system-wide benefits.*

- *Cap and floor: Insights from UK's interconnector process*
- *In the UK, to be responsive to the need for merchant transmission development to enable large scale imports and exports of energy to the European mainland, the market regulator, Ofgem, developed the Cap and Floor mechanism.*
- *In simple terms, the mechanism supports the development of merchant transmission where otherwise private developers were not able to secure financing due to uncertainty of long-term revenues.*
- *The Cap and Floor mechanism establishes a rate recovery floor, that is a minimum return, that transmission projects are guaranteed to receive from customers through regulated transmission rates.*
- *The scheme also establishes a cap, or a maximum return projects can receive, permitting market participation while protecting ratepayers and preventing windfall profits for the developer. Any revenues generated above this cap are transferred to the system operator which are used to reduce transmissions charges across the system.*

PSH as a system resource

- *In the United States in particular, there has been an ongoing debate whether energy storage is a generation asset, a transmission asset, a distribution asset or in its own category as a unique asset. Depending on the stakeholder, opinions vary widely, and historically, energy storage has been classified by the type of service it provides. Utilities in the United States are hesitant to take on a PSH resource as a transmission asset. Part of this is due to the separation between transmission and generation in formal electricity markets.*

➢ **Remuneration schemes**

Arbitrage / wholesale market (spot market, day ahead, intraday and real-time power settlement)

Ancillary or flexibility support services (frequency control, voltage regulation, black-start and inertia) (Payments for uncompensated ancillary services

➢ **Capacity mechanisms (Capacity and availability payments)**

In Israel, as a part of IEC's determination that the system required a significant deployment of long duration storage, they also developed a payment mechanism with a renumeration structure intended to ensure private financing and development

The payment structure pays on plant availability over an 18 to 20-year timeframe, depending on the project. This approach mimics, in some form, an asset in a vertically integrated market with a guaranteed level of payment to ensure development, but at the same time includes delivery and performance requirements to promote efficiency and a high level of resource performance.

The three-part payment scheme consists of the following revenue streams:

1. *Primary source of revenue: An availability payment which forms the bulk of revenue and requires the plant to be available for a minimum time during a year. In addition, there is an availability requirement that has been passed on to the equipment manufacturer who is supplying plant availability guarantees through a long-term operations and maintenance contract. This payment also includes bonus payments for dynamic benefits including ramp rates, pumping to generation switching timeframes, startup and shutdown speeds, etc.*

2. *Second source of revenue: Payment for energy.*

3. *A third and smaller source of revenue: start up and shut down payments.*

Next Steps : Recommendations to governments and stakeholders