Future of Hydropower

Asia Clean Energy Forum Deep-Dive Workshop, Manila, Philippines | 6 June 2017

iha
international hydropower association

09:00 to 09:10		Introduction to IHA
09:10 to 09:30		Renewables integration and energy storage
09:30 to 10:00		Modernisation and digitisation
10:00 to 10:30		Public-private risk sharing and project preparation facilities Climate finance and green certification
10:30 to 11:00		Break
11:00 to 11:30		Greenhouse gas reporting Resilience to climate change and adaptation
11:30 to 12:00		Sustainability reporting
12:00 to 12:30		Summary

Agenda for Future of hydropower workshop

iha
international hydropower association

international hydropower association

Our mission

advancing sustainable hydropower

Four strategic objectives:

- Advancing policies and strategies for the sector
- Building a vibrant community
- Creating a platform for knowledge
- Delivering value for members

About the International Hydropower Association

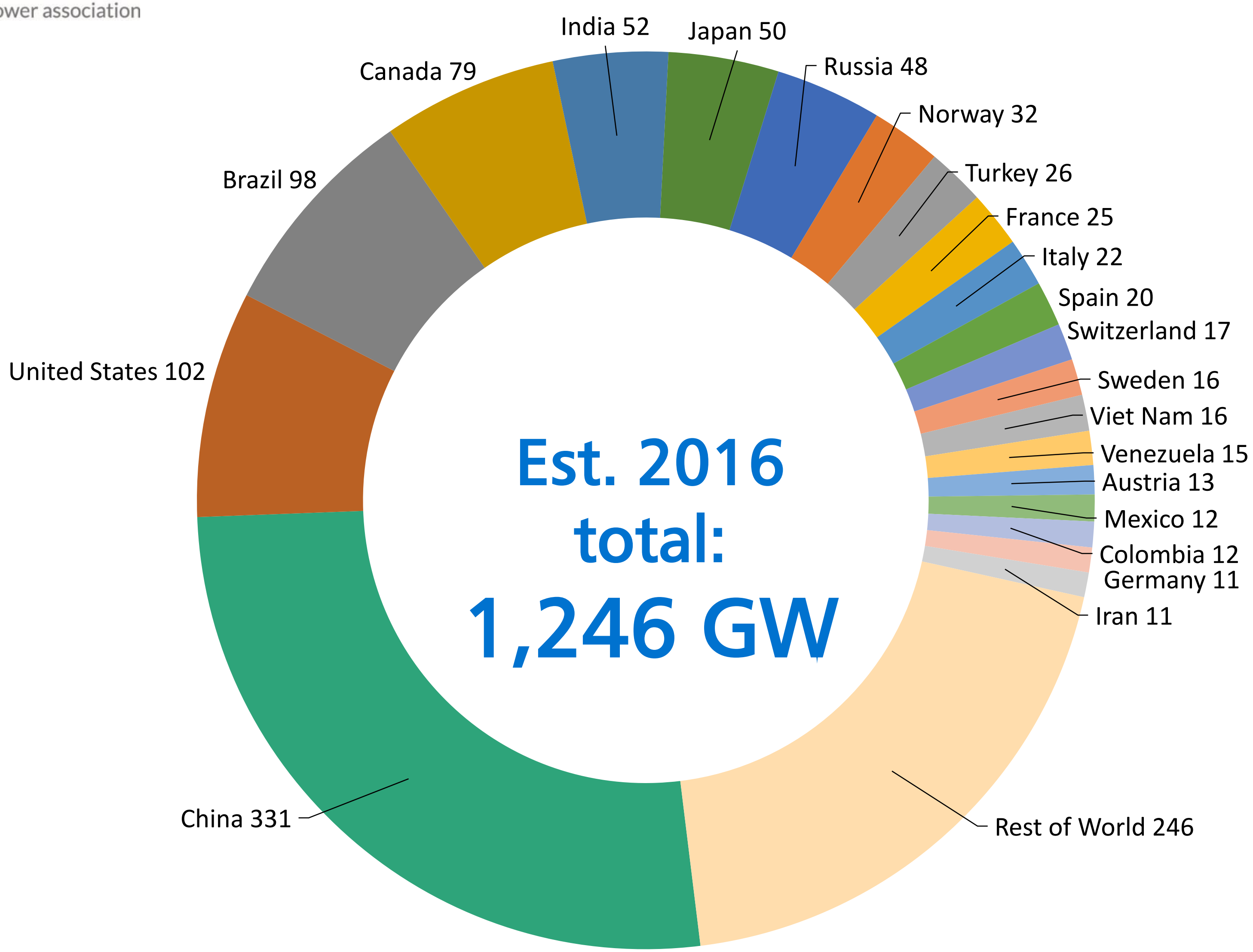
- Climate resilience and adaptation
- Clean energy systems
- O&M, safety
- Sediment management
- Regional development
- Water footprint
- Hydropower benefits
- Greenhouse gas reporting
- Project finance and investment
- Sustainability assessment

- Sector monitoring
- Online articles, case studies
- Briefings, concept notes
- Good practice guidelines
- Identification of experts
- Knowledge networks
- Webinars
- Workshops and events
- International initiatives

iha international hydropower association

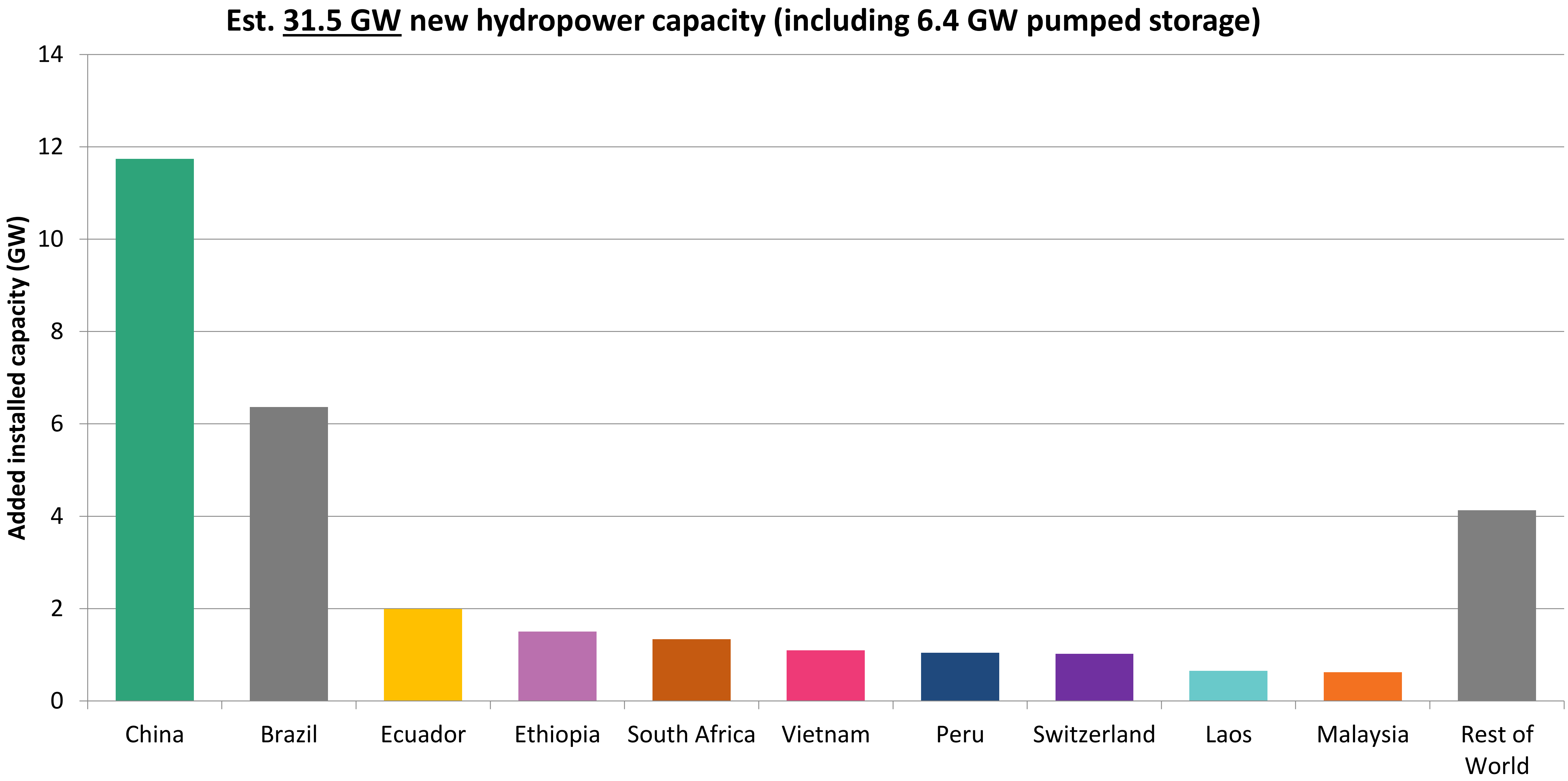
10 key topics for the future of hydropower

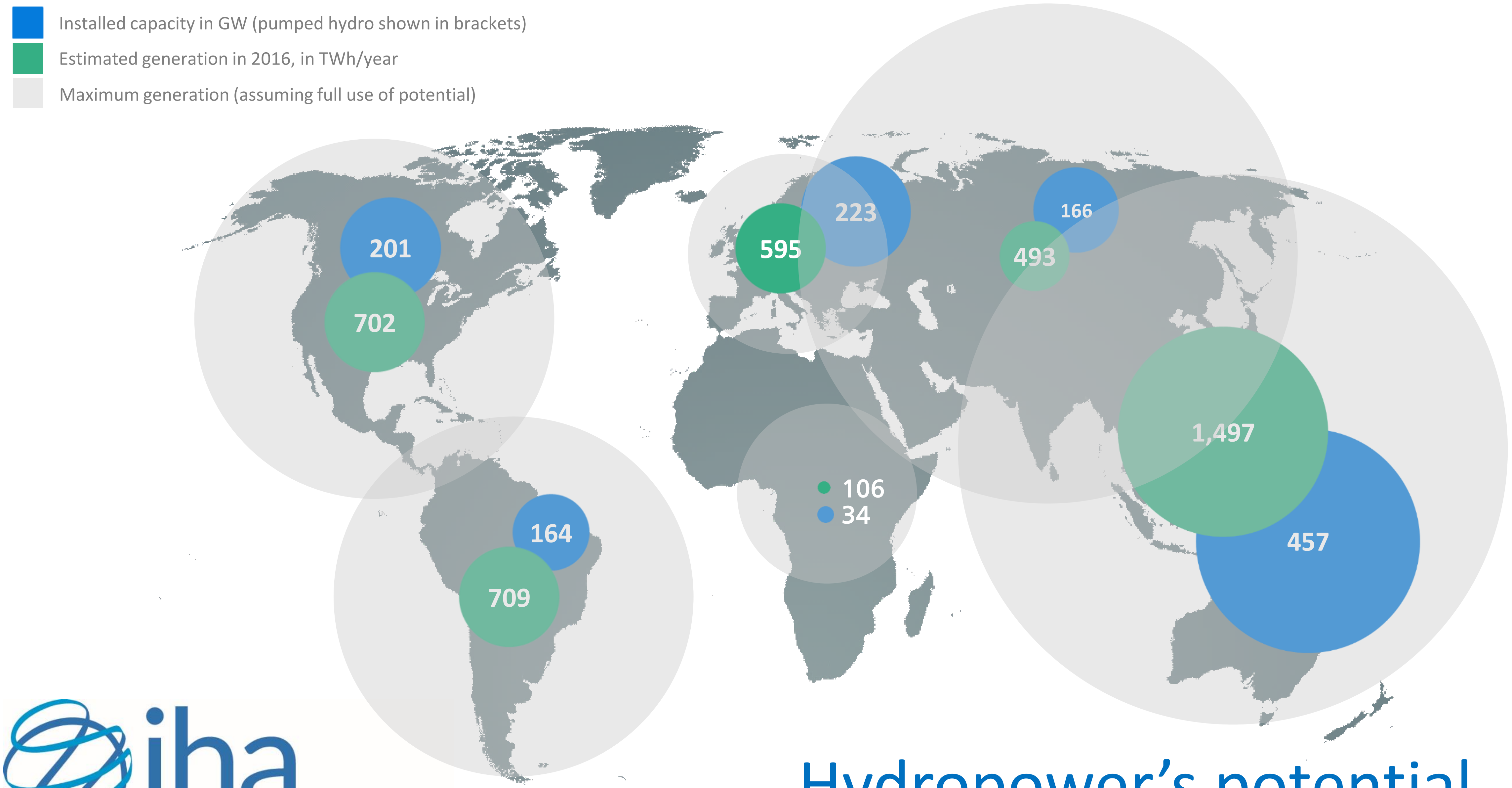
Total hydropower capacity for 2016



Total hydropower generation in 2016: 4,100 TWh

New capacity added in 2016





iha
international hydropower association

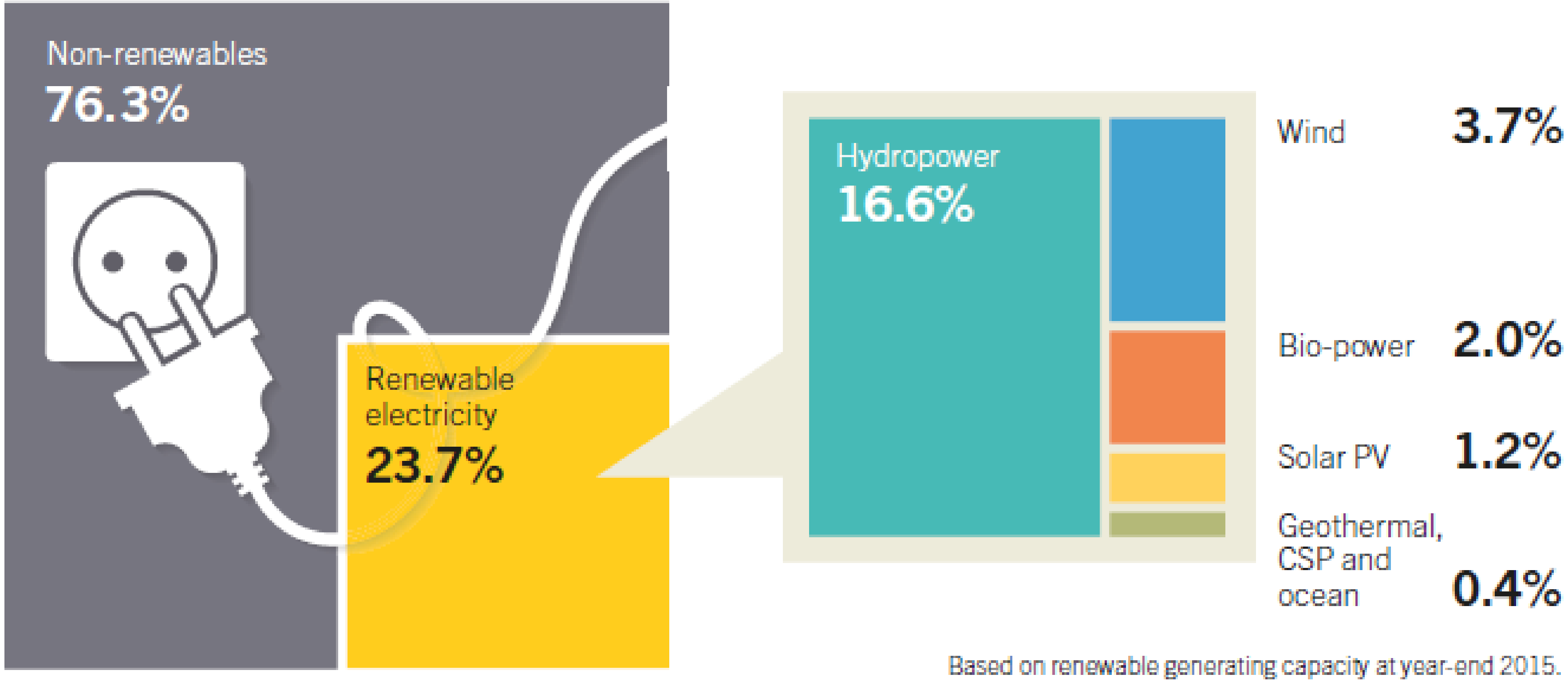
Hydropower’s potential

Countries with the greatest undeveloped hydropower potential

Country Name	Total Potential (GWh/y)	Current Utilisation (%)	Undeveloped (GWh/y)
Russia Federation	1,670,000	10	1,502,300
China	2,140,000	41	1,259,325
Canada	1,180,737	32	798,630
India	660,000	21	523,245
Brazil	817,600	48	424,600
Indonesia	401,646	3	388,809
Peru	395,118	6	373,339
DR Congo	314,381	2	306,610
Tajikistan	317,000	5	301,197
USA	528,923	52	256,303
Nepal	209,338	2	206,014
Venezuela	260,720	31	180,121
Pakistan	204,000	14	174,658
Norway	300,000	45	165,296
Turkey	216,000	27	157,757
Colombia	200,000	22	155,518
Angola	150,000	3	146,184
Chile	162,000	12	142,784
Myanmar	140,000	4	134,924
Bolivia	126,000	2	123,704

iha
international hydropower association

Figure 3. Estimated Renewable Energy Share of Global Electricity Production, End–2015



Based on renewable generating capacity at year-end 2015.
Percentages do not add up internally due to rounding.

iha
international hydropower association

Large range of low-carbon capacity available

- From kW to GW in a single project
- Option to export electricity in regional grids

Operational flexibility and efficiency

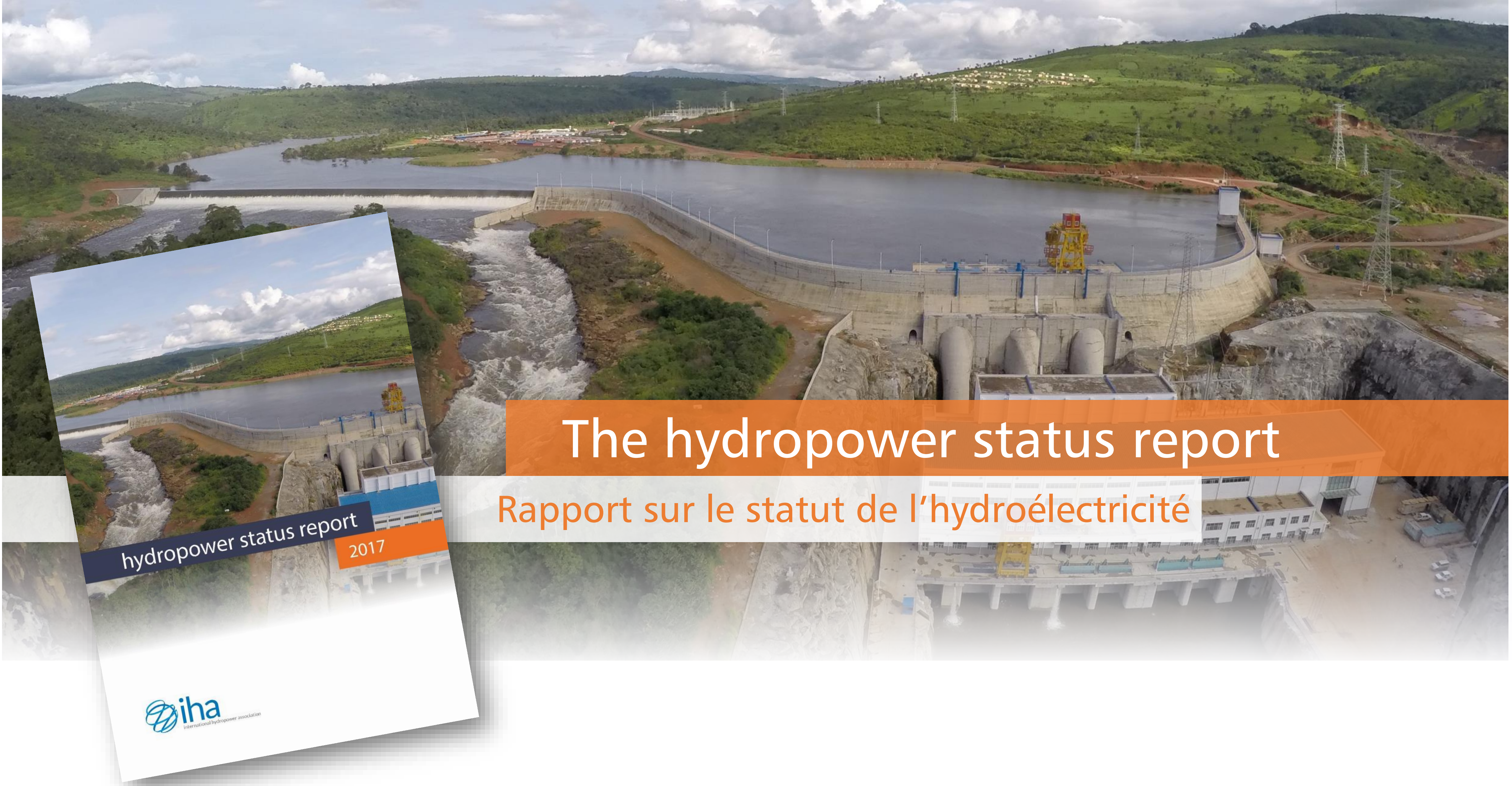
- Fast start-up and shut-down
- Highly efficient and adjustable output

Storage and back-up

- Rapid availability, can be used as a back-up
- Option to absorb surplus (pumped storage)

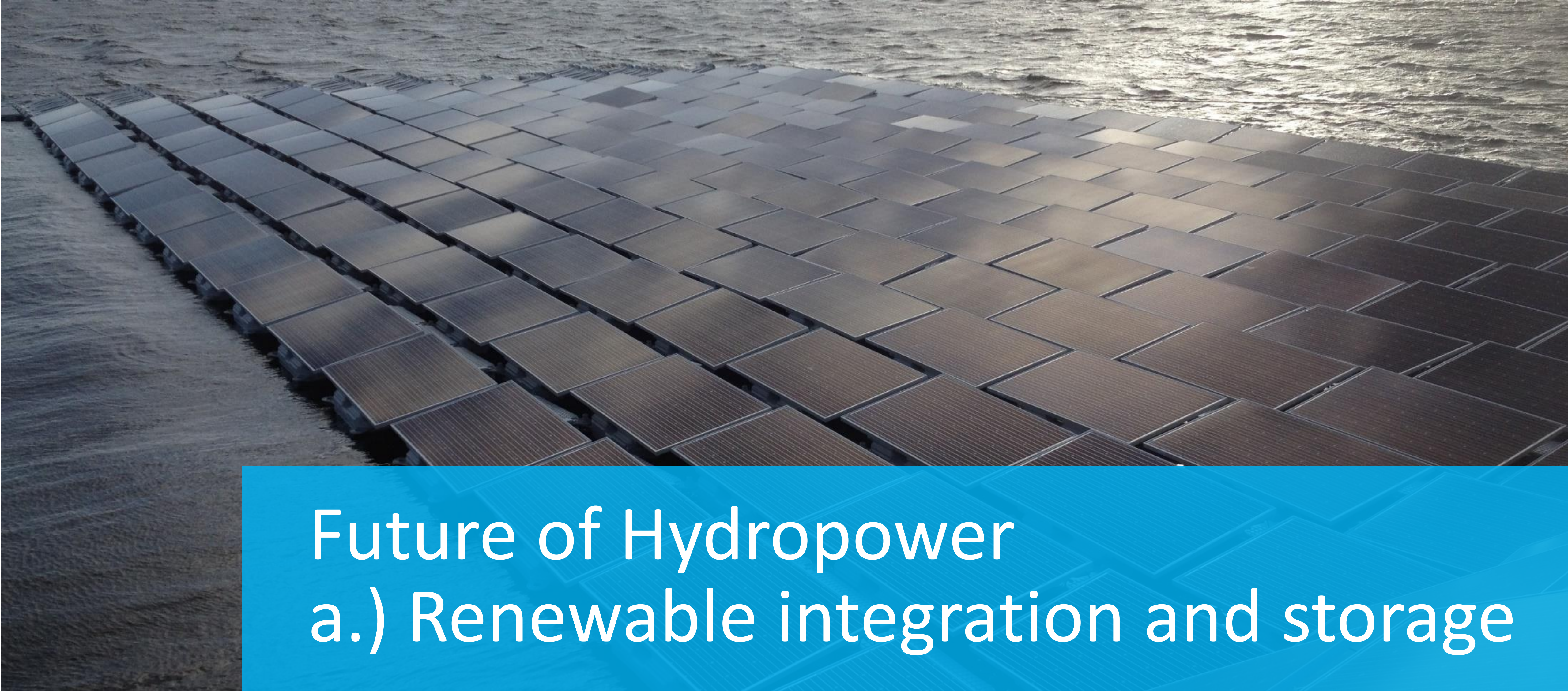
Multiple freshwater services

- Water supply, irrigation, navigation, tourism
- Climate-change adaptation (flood and drought mitigation)



The hydropower status report

Rapport sur le statut de l'hydroélectricité



Future of Hydropower
a.) Renewable integration and storage

iha
international hydropower association

RENEWABLES WORKING TOGETHER

Energising the future
COP21
RENEWABLE ENERGY TRACK

LABEL
PARIS2015
COP21·CMP11

7 December
11:30-13:00
UNFCCC Blue Zone
COP21

International Renewable Energy Alliance

ISES International Solar Energy Society

WWEA World Wind Energy Association

IGA International Geothermal Association

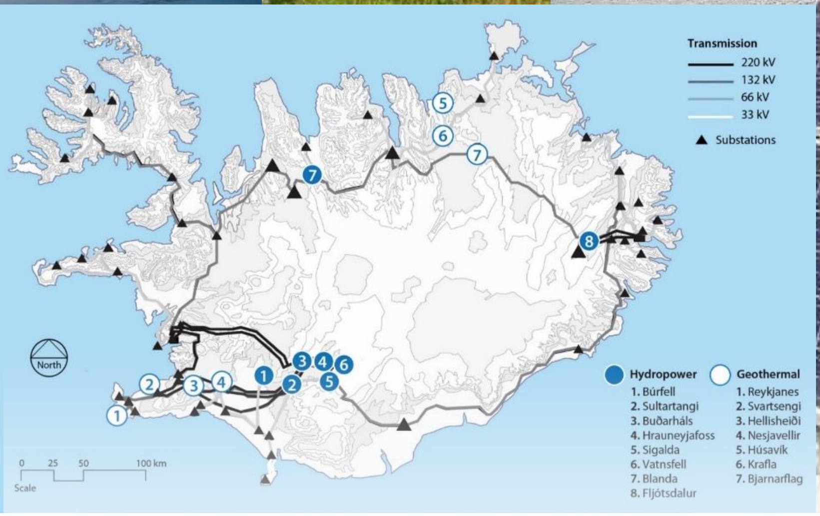
World Bioenergy Association

iha international hydropower association

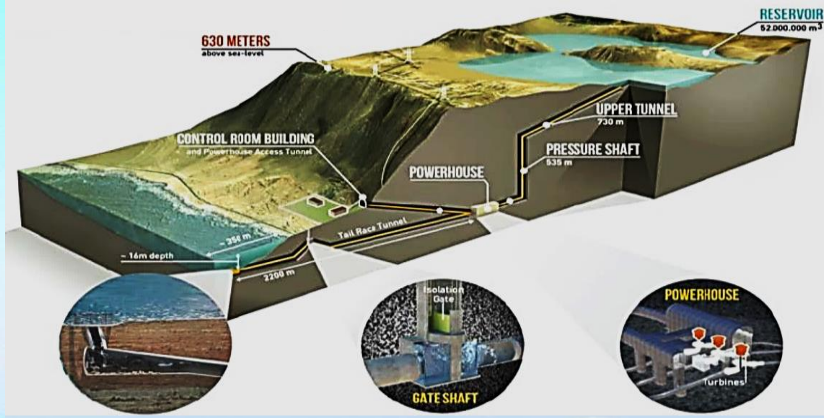
In collaboration with

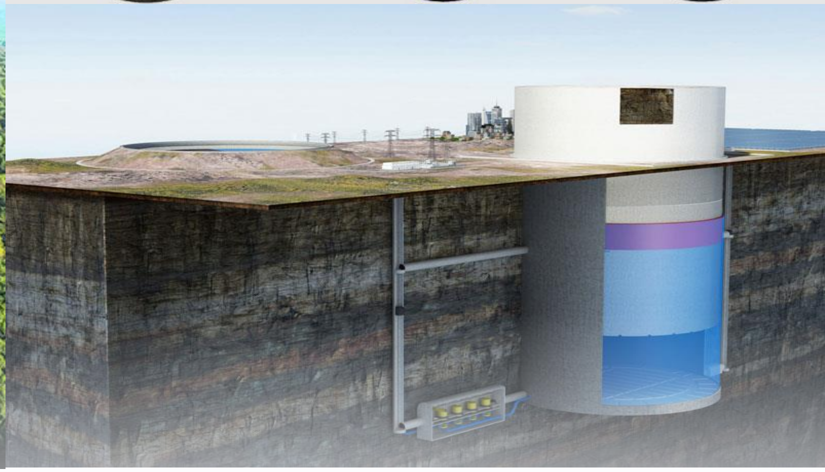
REN21 Renewable Energy Policy Network for the 21st Century





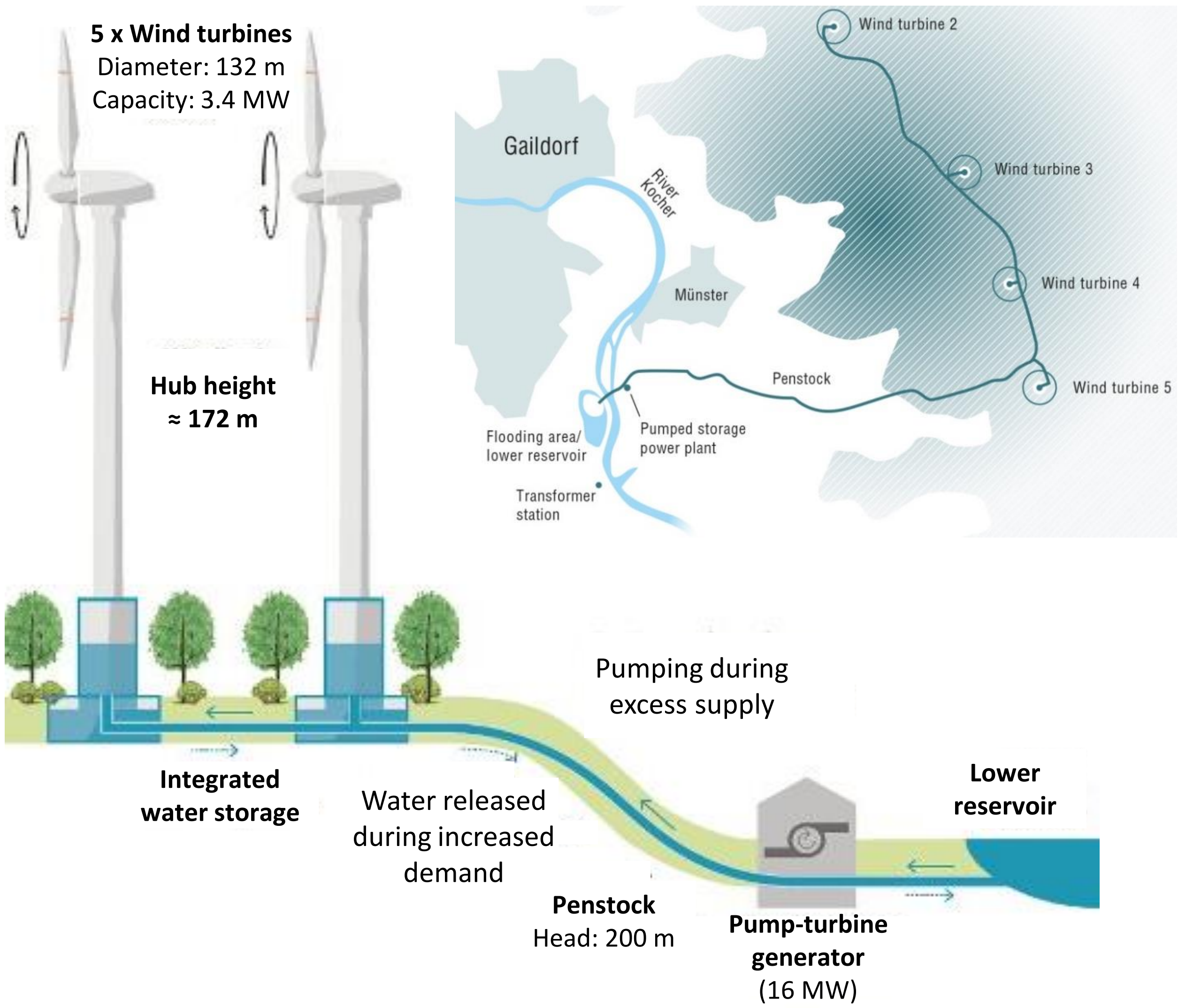




Renewables working together for grid stability

Innovative pumped hydro for system storage

iha
international hydropower association



Naturstromspeicher: Wind-Pumped Storage

iha
international hydropower association

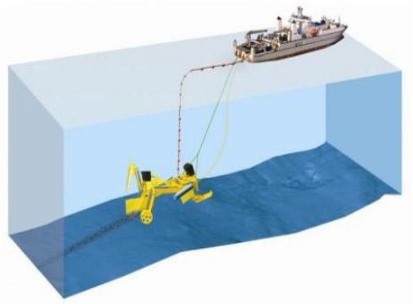
Benefits of “floatovoltaics” installed in hydropower reservoirs

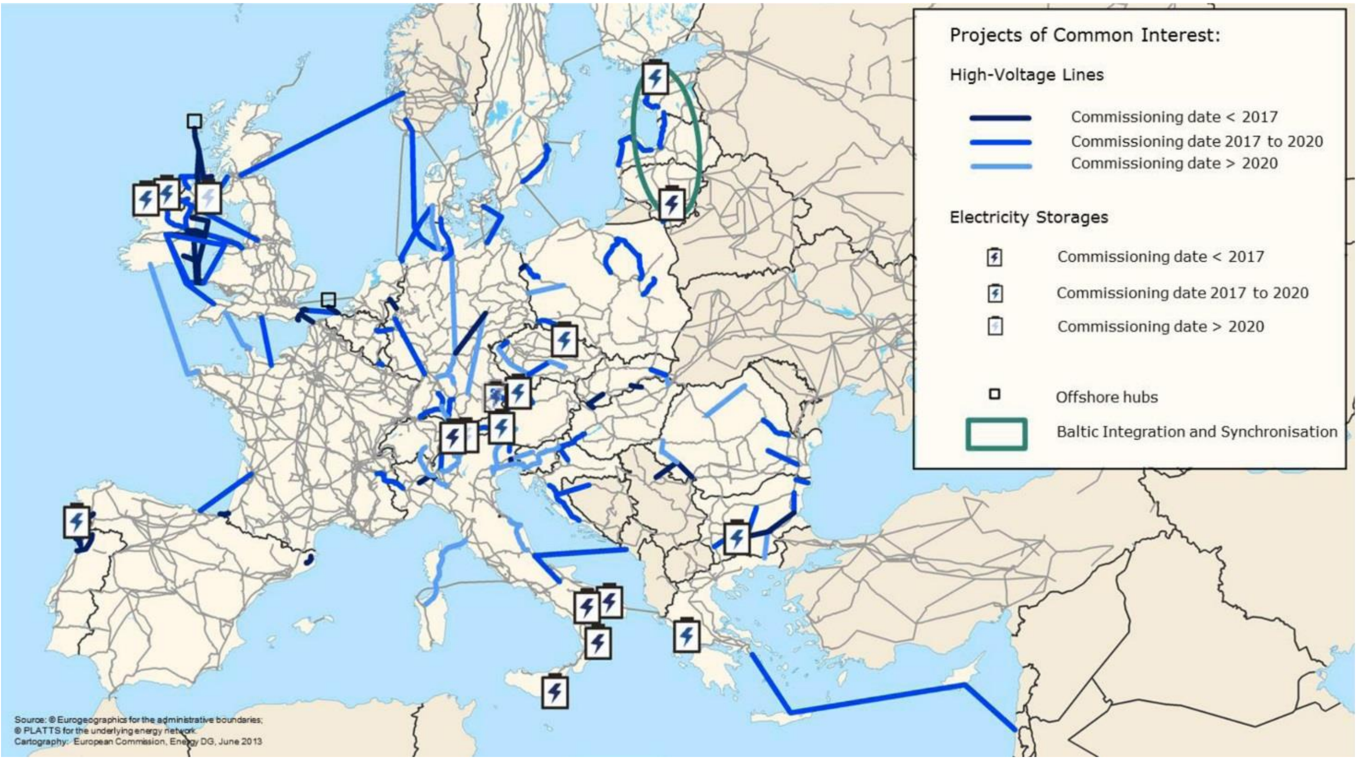
- Utilises existing transmission infrastructure
- Water helps cooling and increases PV efficiency (10%)
- Potential to reduce evaporation and conserve water

Floating PV Installations

iha
international hydropower association

Regional level   Projects of Common Interest, Europe (2014-2020)





- Increasing pumped storage capacity (Bulgaria, Estonia, Austria, …)
- New HVDC interconnection (for ex. Norway-Germany, Norway-UK…)

iha international hydropower association

Interconnecting renewables for greater security

Chuxiong advanced control system in Yunnan, China

- **5 wind farms, 2 solar PV and hydropower totalling 879 MW**
- **Centralised dispatch control centre will optimise the three resources to ensure firm and steady power output.**



iha
international hydropower association

Wind – Solar – Hydro
Integrated Control System

Questions

Future of Hydropower
b.) Modernisation and digitisation

Modernisation et digitalisation

Three topics covered at the WHC workshop in Addis:

1. Modernisation of existing hydropower assets

2. Different models for O&M

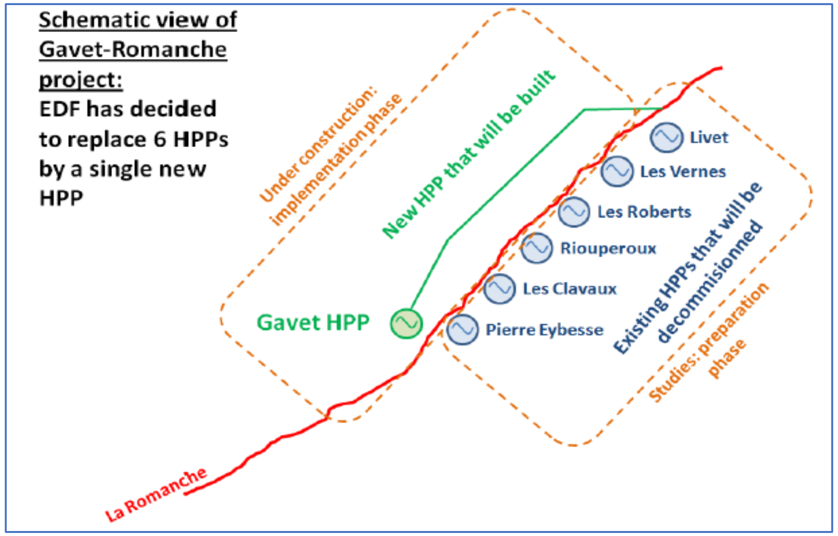
3. Digitisation of operations


Mount Coffee-Liberia before and after modernisation

international hydropower association

Operations & maintenance:
Modernisation of existing assets

Case studies on refurbishment



Replacement of old small plants with one larger plant using new technology:

France. EDF Romanche-Gavet 94 MW project, generating 560 GWh/yr, replacing six facilities with total capacity of 82 MW / 405 GWh/yr

http://www.hydrosustainability.org/Protocol-Assessments.aspx

Refurbishment of larger plants can provide more power than building many new small plants:

Sweden. Hydro provides 45% generation, and large hydro (>10 MW) 95% of that. Renovation of 39 projects (36 of which > 10 MW, 22 of which > 100 MW) over 1990-2010 replaced by 24 times the reduction in generation from review of 90 concessions

Potential increase of 3000 GWh/year in future from refurbishment of existing large-scale, allowing river restoration elsewhere without losing production or balancing capacity

http://www.sei-international.org/publications?pid=2297

Three main models for O&M

Model 1 - Operation and Maintenance in the hands of the Owner of the scheme (standard model worldwide).

Model 2 - O&M responsibility totally or partially transferred to a Private or semi-private Independent Operator under an O&M (or management) contract with the Owner.

Model 3 - O&M responsibility entrusted to the EPC Contractor as part of the EPC contract.

Model 1 - Operation and Maintenance in the hands of the Owner of the scheme (standard model worldwide).

Pros:

- Responsibility for O&M lies with the entity which has the highest interest in ensuring a sustainable flow of revenues and the long-term safety and performance of the works.

- Cheapest for the Owner (no risks to be borne by any other party).

Cons:

- The Owner –often a public entity- may not be in a position ensure a proper level of O&M performance with its sole human and financial resources.

EEP Genale Dawa (GD3) Hydropower Project

- Capacity – 254 MW
- Dam type – CFRD with height of 110 m
- 12 Km Headrace tunnel (TBM)

- Reservoir Capacity - 3.7 Bm^3
- Three (3) units

Status

- Over all **87%** complete

Model 2 - O&M responsibility totally or partially transferred to a Private or semi-private Independent Operator under an O&M (or management) contract with the Owner.

Pros:

- A solution to compensate for the weaknesses of the public Owners
- A way to share and disseminate best O&M practices

Cons:

- Difficult to set up a fair contract which balances the diverging objectives of the Owner and the Operator (risks and rewards)
- Not a long term solution

Mount Coffee-Liberia O&M under contract

iha
international hydropower association

Operations & maintenance:
Modernisation of existing assets

Model 3 - O&M responsibility entrusted to the EPC Contractor as part of the EPC contract.

Case study in Algeria where GE Renewable will implement O&M contract.

Pros:

- As an interim solution (4 or 5 years), it can compensate for the absence of other viable alternative at the time of commissioning
- Incentive for the EPC Contractor to build the project with good quality standards, in addition to its contractual performance liabilities and guarantees.

Cons:

- Same as Model 2
- Some EPC Contractors will subcontract this task to a 3rd party (a professional Operator).

WORLD BANK GROUP

- Unavailability of spare parts
- Shortage of adequately trained operator and maintenance staff
- Lack of special measuring and testing instruments
- Unavailability of condition monitoring devices
- Design issues to perform the required output
- Operation in forbidden zones of units for reactive load management
- Not conducting protection tests at the right time

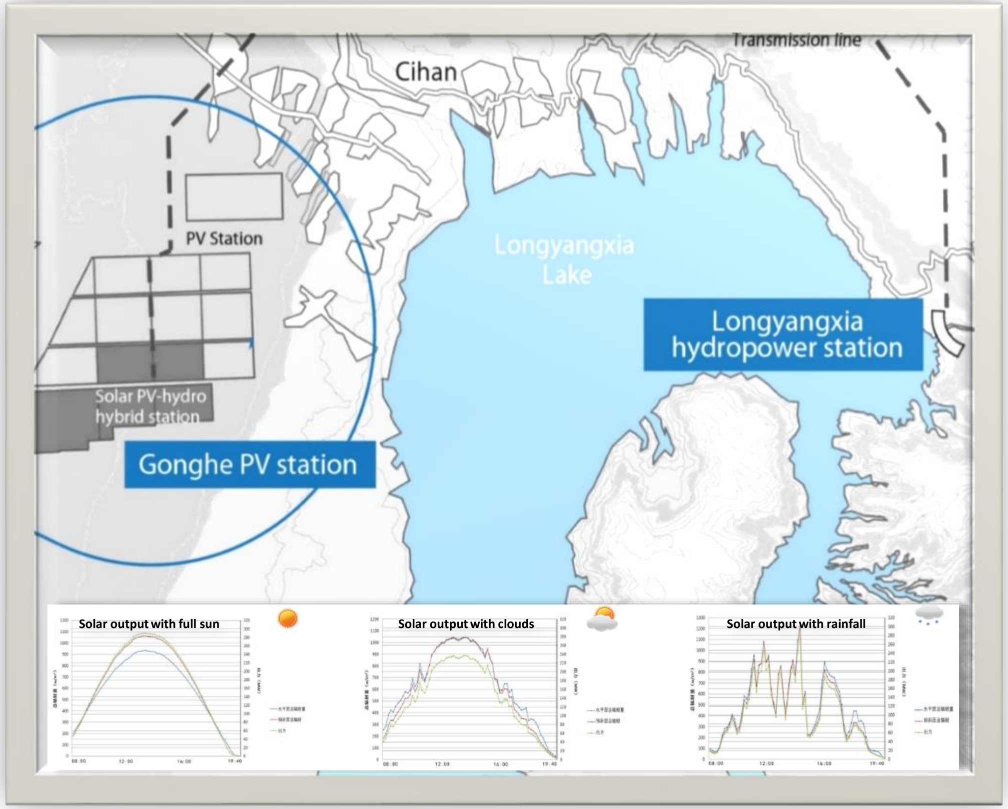
Operations & maintenance:
Challenges with O&M

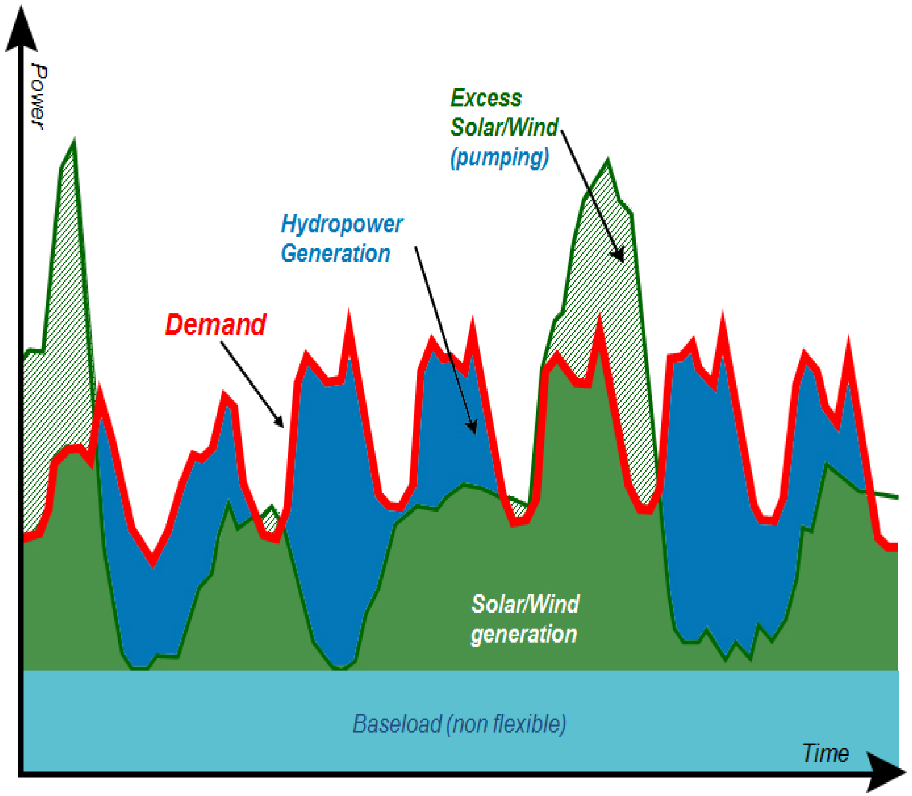
iha
international hydropower association

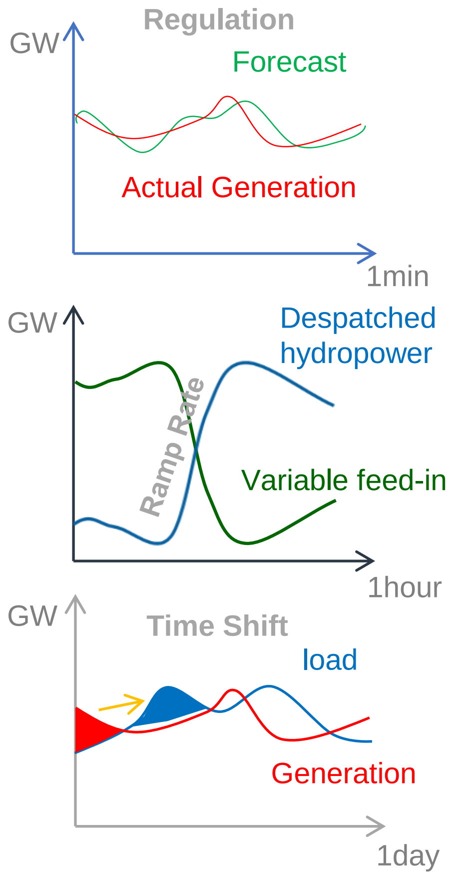
Star Hydro Patrind Hydropower Plant in Pakistan

iha
international hydropower association

Operations & maintenance:
Sediment management issues







Smart modernisation and digitisation

international hydropower association

Hydropower Digitization

“Digital solutions will help energy suppliers to run their hydropower plants even more efficiently or reduce operational costs. In addition, analyzed and interpreted data will allow a much deeper understanding of the machines. Modern technologies will identify anomalies and allow utilizing hydropower assets more effectively and efficiently.”

Uwe Wehnhardt, CEO Voith Hydro

Questions

Nick Troja:

- Public-private risk sharing and project preparation facilities
- Climate finance and green certification

break

international hydropower association

Future of Hydropower

Climate change mitigation and resilience

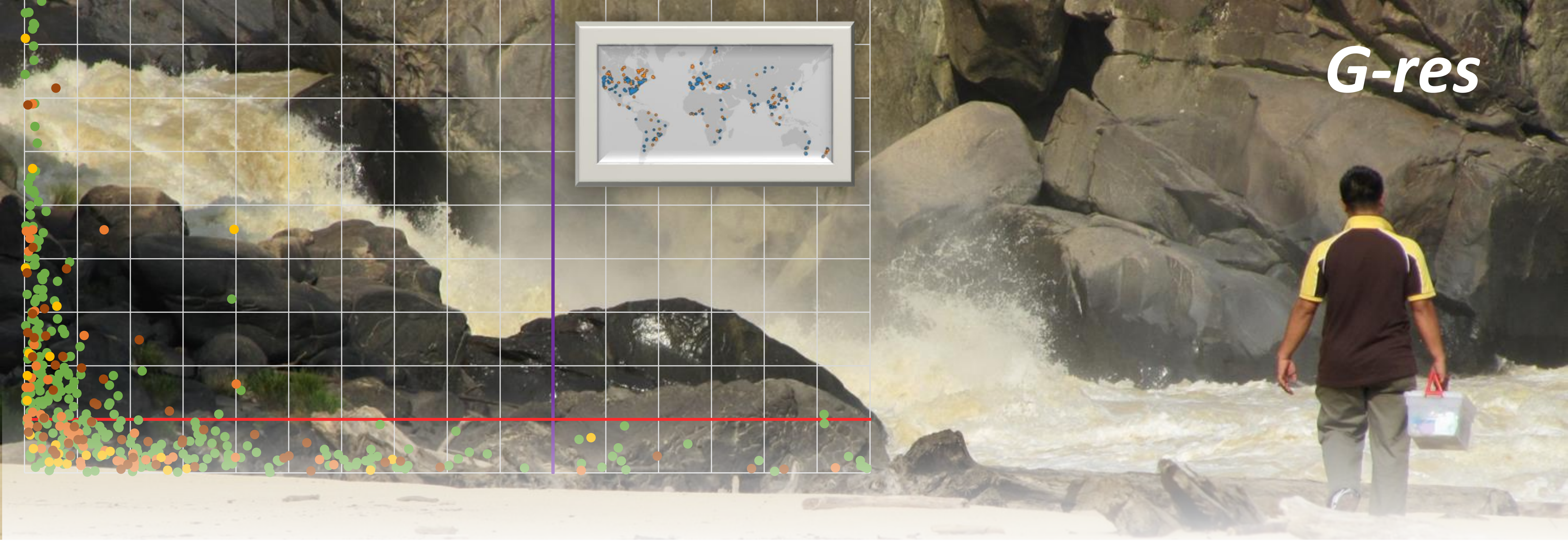
Asia Clean Energy Forum Deep-Dive Workshop 6 June 2017

iha
international hydropower association

IHA’s work on climate change mitigation,adaptation and resilience

- **Emissions**: The hydropower sector has a tool to measure the impact of a reservoir on the carbon cycle in a river basin; the G-res tool, has been developed under a joint initiative between IHA and UNESCO.
- **Mitigation**: Hydropower is a renewable energy in its own right; in addition, storage projects enable other, variable renewables (solar and wind) – and larger storage means it has greater potential to enable more low carbon energy.
- **Resilience**: Any project evaluation needs to consider the climate-change risk to the services it is intended to provide. Guidelines for decision-making under uncertainty for new and modernization projects are under development.
- **Adaptation**: Ability to store and regulate water flow may provide adaptation services, to protect against increased flood/drought frequency and intensity.

iha international hydropower association



Reporting on hydro's carbon footprint

iha
international hydropower association

the G-res tool

In association with:

Sponsors:

the *G-res* tool

The G-res tool provides a way to estimate GHG emissions without involving large-scale field campaigns and multi-year studies

- New guidelines for eligibility criteria for green and sustainable hydropower (Climate Bonds Initiative).
- Revision of the IPCC 2006 Guidelines for National GHG inventories to be released in 2019.
- Recent academic papers have asserted that GHG emissions from reservoir formation are much higher than previously thought.
- Risk that hydropower is excluded from some financing and investment mechanisms.

Importance of *G-res*

the *G-res* tool

- Calculates the Net GHG (CO_2 and CH_4) balance of the reservoir landscape before it was flooded.
- Calculates the Net GHG balance after flooding, how it evolves through time and calculates total emissions over its lifetime (100 years).
- Estimates how much of this Net GHG impact is influenced by other activities in the reservoir and its catchment.
- Estimates the GHG emissions incurred due to construction of dam infrastructure.
- If the reservoir has multiple uses, it will apportion the GHG emissions fairly among these purposes.

Features of *G-res*

iha
international hydropower association

the *G-res* tool

1) Conceptual scientific paper:

"GHG fluxes from freshwater reservoirs: what does the atmosphere see?"

Paper will challenge existing conceptual thinking on how GHG emissions are assessed from reservoirs.

2) Results paper:

"Global GHG footprint of freshwater reservoirs"

3) Model details:

"Model development for the estimation of GHG emissions from reservoir formation"

Deliverables

iha
international hydropower association

Better understanding of climate resilience

international hydropower association

2015 IHA workshop and survey on climate resilience

Posted articles on IHA website:

- Preparing for climate change in hydropower development.
- What does climate resilience mean for the hydropower sector?
- How can we build climate resilience into a project?


CLIMATE CHANGE

iha
International hydropower association

SURVEY RESULTS

HYDROPOWER AND CLIMATE RESILIENCE

As the impacts and risks associated with climate change become more evident, stakeholders are seeking information on how hydropower assets will withstand changing conditions and how owners, operators and developers are addressing risks within their corporate processes and decision-making.

In light of this, the International Hydropower Association (IHA) undertook a survey of more than 50 companies active in the hydropower sector to determine how they view climate risks and what actions they are or are not taking to address those risks.

Climate resilience, while not clearly defined for the hydropower sector, is a concept that allows us to consider the vulnerability of a company, asset or set of assets to climate change. It also helps us to examine how the associated risks to these assets and to corporate performance can be managed.

Furthermore, hydropower systems are characterised by their longevity, and are traditionally designed on the basis of historical hydrological data. However, under climate change, the past is no longer a reliable indication of the future. Decision-makers must consider how to prepare for potential impacts of climate change through the development of systems – both physical and corporate – that are capable of absorbing change.

In particular, decision-makers must act today with data and information that may or may not prove reliable over the longer term.

Although all risks are characterised by a level of uncertainty, climate change brings an unfamiliar set of risks and limited experience in how to address them.

Through the IHA survey on climate resilience, we sought to gain a better understanding of how hydropower companies view climate threats and opportunities, as well as the actions companies are taking to address those risks.

Survey methodology

IHA, with the support of Mott McDonald, prepared a range of questions with multiple choice and free form answer options.

The survey questions were reviewed by experts from the World Bank, the University of Massachusetts, the University of Manchester and Industrial Economics.

The survey was sent to 100 companies working in the hydropower sector around the world. It remained open for a period of two weeks, after which 56 responses were received. Five survey responses were deemed to be duplicate or incomplete and were discarded, leaving 51 completed surveys to analyse.

continued >

International Hydropower Association

Chancery House, St Nicholas Way,
Sutton, London
SM1 1JB, United Kingdom

T: +44 20 8652 5290
F: +44 20 8643 5600
E: iha@hydropower.org

hydropower.org

international hydropower association

Climate resilience case studies

EBRD Qairokkum Hydro Power Rehabilitation Project

- **Project**: US$ 208 million for the rehabilitation of a 170MW HPP in Sughd province.

Challenges

- Shifting glacial, snow-melt and precipitation patterns
- Increasing hydrological variability, unreliable supply

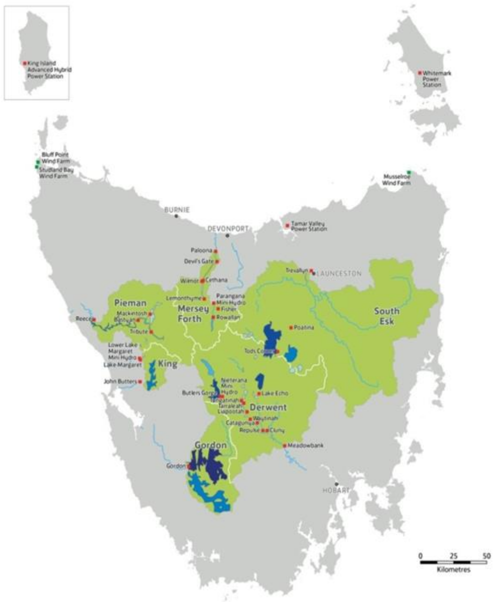
Response

- Feasibility work based on hydrological/climate modelling
- 9 scenarios capturing uncertainty
- Economic/financial analysis of several design options (e.g. turbine selection; spillway design)
- Capacity building in predicting and managing hydrological variability

international hydropower association

Hydro Tasmania Building resilience

- Generation planning over a range of time-scales based on state-of-the-art hydrographic data and hydrological forecasting.
- Upgrades and maintenance of their power stations, dams and other infrastructure to ensure sustainability of their generation system into the future.
  - according to a 10-Year Asset Management Plan as well as projections of major capital works up to 30 years into the future
  - spillway upgrades and dam safety improvements are particularly important for climate resilience.
- Drought management procedures to manage low lake levels and accompanying risks to social and environmental values.



iha
international hydropower association

Building Resilience (cont)

- Emergency management planning and practice exercises to address risks relating to floods, bushfire and extreme weather events.
  - Preventative actions include regular maintenance regimes for vegetation, roads and buildings to minimise risks.
- Identification of low-lying assets and considering risks relating to sea level rise (e.g. Reece, Trevallyn)
- Support for research to improve understanding of various aspects of climate change
  - hydropower lake ecosystem resilience indicators
  - research on and development of hybrid off-grid renewable energy systems

IHA and World Bank Group working to produce Climate Resilience Guidelines

- pre-Congress workshop on WBG Climate Resilience Guidelines

- Focus session; Climate Resilience; co-convenor World Bank Group

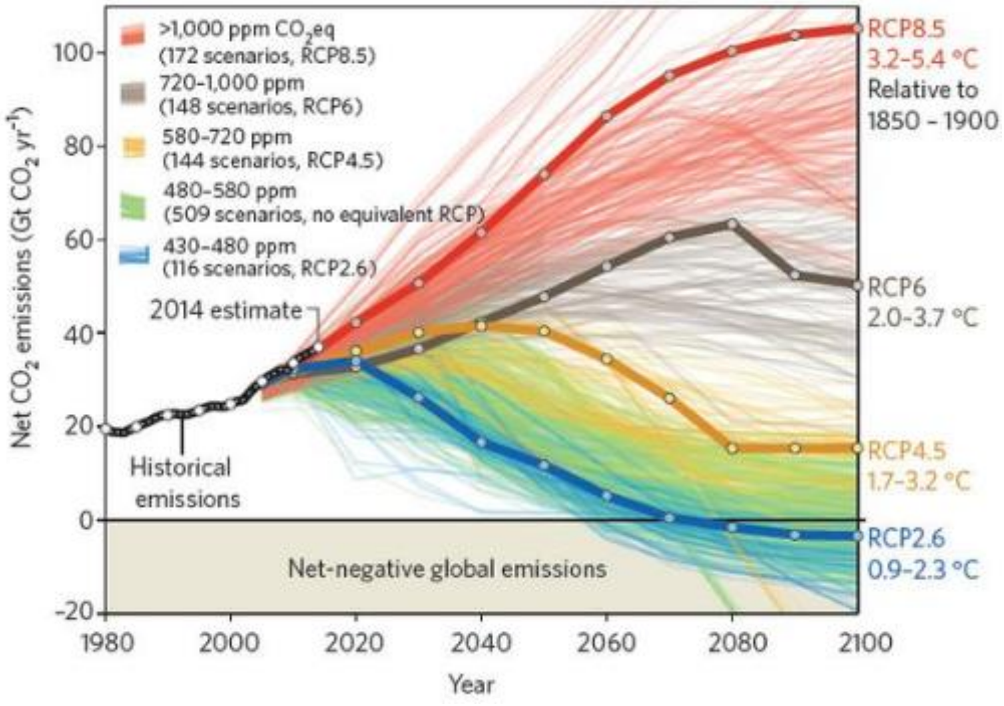
iha international hydropower association

Multi-Stakeholder Process

- IHA
- ICOLD
- Developers and asset owners/operators (including Joule Africa, Hydro Tasmania, Landsvikjun, Manitoba Hydro and EDF)
- EBRD, EIB, DFID, Asian Development Bank and African Development Bank and Inter American Development Bank
- Climate Bond Initiative
- United Nations Economic Commission for Africa
- King and Spalding
- Academics and independent experts

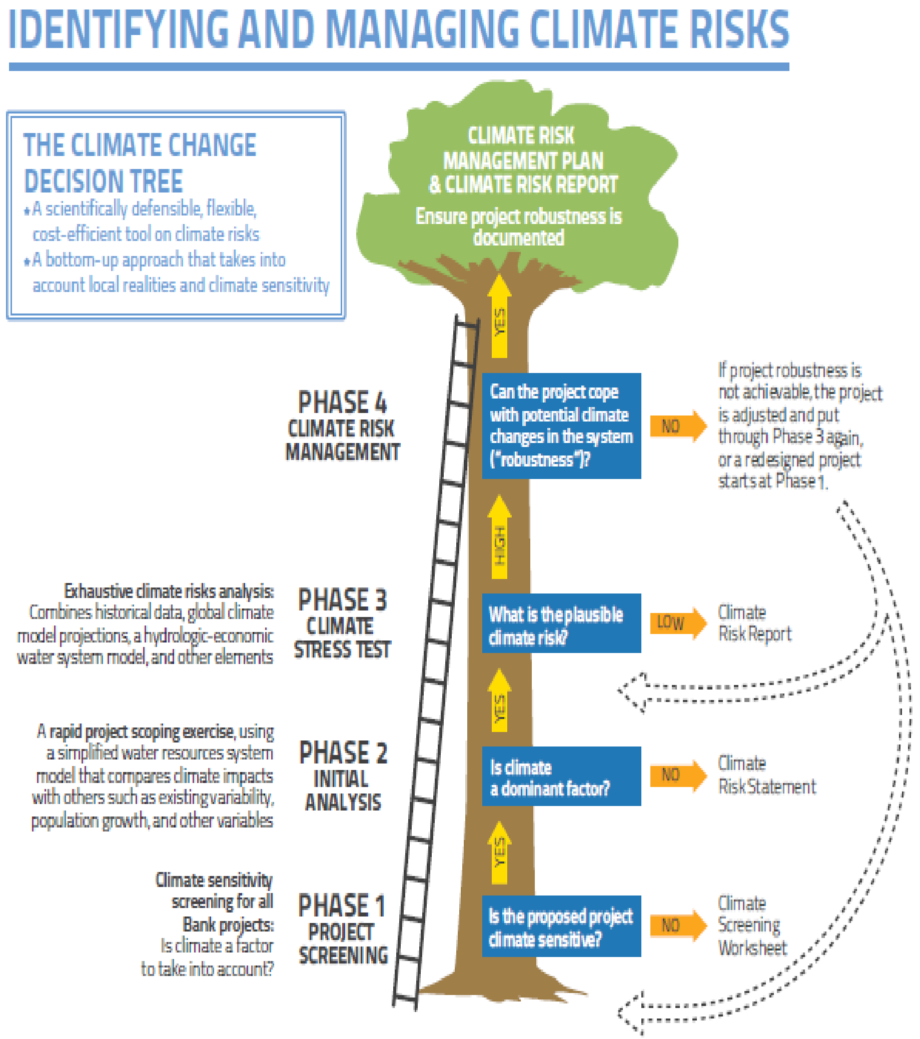
Purpose of Guidelines

- Need to connect upstream climate science with downstream engineering practices.
- Practical guidelines needed to achieve climate resilience in the planning, design, construction and operation of new projects, as well as during reviews and assessments of operational performance, rehabilitation and upgrade of existing projects.
- Need to Identify and evaluate robust approaches for planning, evaluating, and designing hydro-specific infrastructure investments.
- Guidance document is for those responsible for the planning, funding, development, construction and operation of hydropower projects in all regions of the world.
- Important to assess both functional adaptation as well as structural adaptation.



Approach to the Guidelines

- The World Bank Group requires Climate Change Resilience to be used as part of its project filtering process and is one of The World Bank Group's five strategic shifts for its climate work.
- Guidelines process therefore adapted from World Bank Decision Tree Framework with two Phases added.
- Adapted to be specific to hydropower.
- Typical engineering (pre-feasibility, feasibility, design, etc.) and ESIA stages of project analyses are shown in parallel to the six phases.
- Guidelines enhance existing hydropower design and implementation standards, manuals, protocols, bulletins, guidelines, etc.



Climate resilience guidelines for the hydropower sector – summary

Activity and phases		Key Climate Change Question	Engineering & ESIA Activities
Getting Started		What are the key climate change issues affecting this scheme?	Project conception
Phase 1	Project Screening	Is the proposed project climate sensitive?	Pre-Feasibility Study & Environmental and Social screening
Phase 2	Initial Analysis	Is climate a dominant factor?	Feasibility Study & ESIA – establishing general project characteristics with simplified climate data
Phase 3	Climate Stress Test	What is the plausible climate risk?	Feasibility Study & ESIA – refining general project characteristics with additional climate data
Phase 4	Climate and Disaster Risk Management	Can the project cope with the potential changes in the system?	Detailed stages of feasibility-level design (specific components), preparation of design drawings and tender documents, Environment & Social Management Plans
Monitoring, Reporting and Evaluation		How can resilience be tracked, monitored, evaluated, and updated?	Construction, operation & maintenance

Next steps in climate resilience and adaption work in IHA

- Final documentation of the guidelines.
- Develop concise climate resilience eligibility criteria for the Climate Bonds Initiative, utilising the IHA/WBG Climate Resilience Guidelines.
- Climate resilience measures in the Hydropower Sustainability Assessment Protocol

Questions

international hydropower association

Richard Taylor - Sustainability

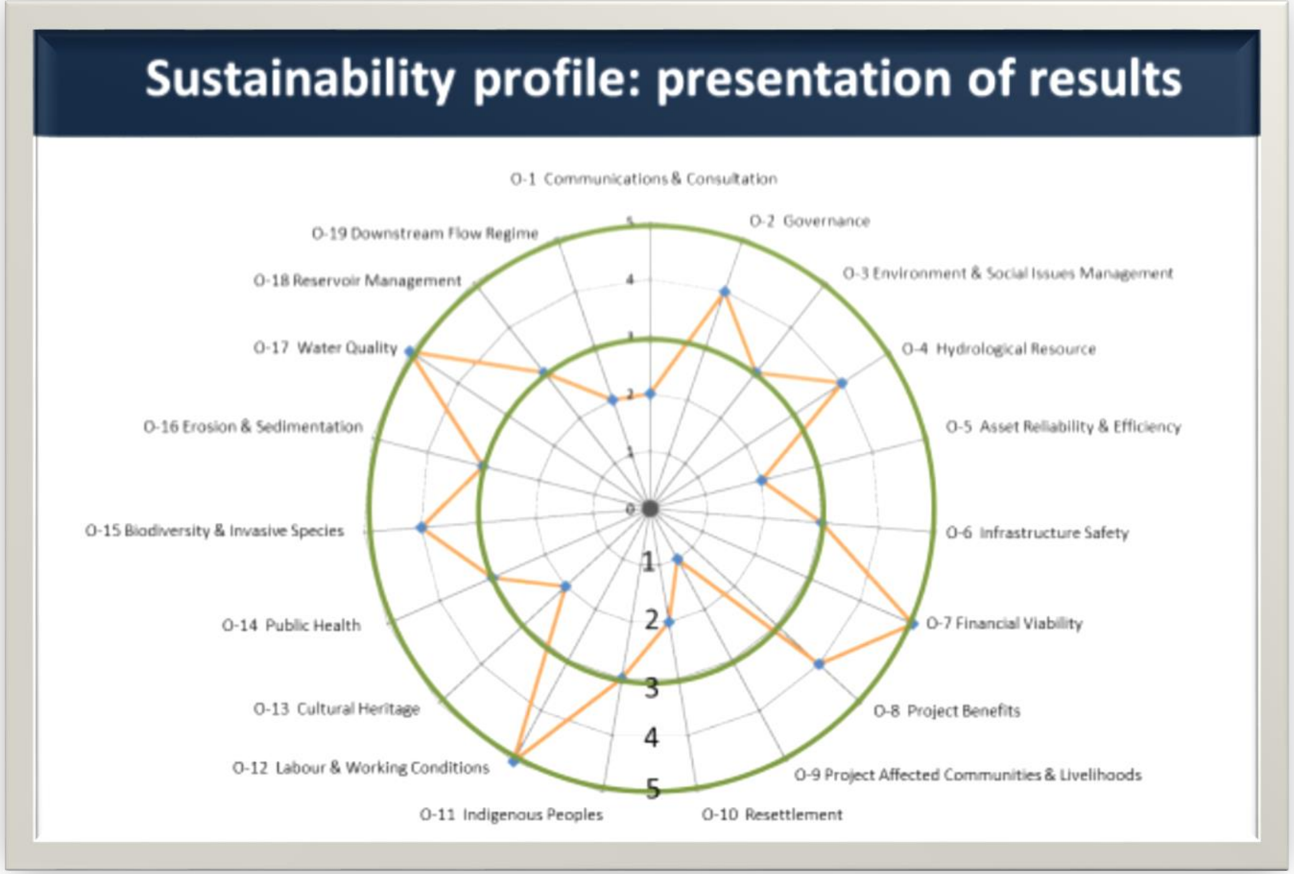
Sustainability reporting & Better Hydro

international hydropower association

Hydropower Sustainability Assessment Protocol

New initiatives:

- International Industry **Good Practice Guidelines**
- Hydropower Sustainability **Environmental & Social Check Tool**
- Accelerated process for increased number of **Accredited Assessors**, worldwide
- Continued refinement of the **Hydropower Sustainability Assessment Protocol**



New tools for sustainability assessment

iha
international hydropower association

Conclusion

hydropower.org

Find out more about hydropower worldwide