



Research programme to support multipurpose hydropower

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There is a growing expectation for hydropower as a future key player in a low-carbon society, as it represents a domestic, affordable and sustainable source of energy. In addition to providing base load, hydropower is gaining renewed recognition for its load-balancing system capabilities coupled to the increased penetration of intermittent wind energy and solar power. In particular, storage hydropower provides a wide range of energy and non-energy services, with the latter including flood protection, irrigation flows and navigation. While hydropower is an accepted and mature technology, the electricity sector is changing continuously and a programme of hydropower research is essential to ensure its place in the energy supply mix as a sustainable user of water resources.

The IEA Hydropower Implementing Agreement (IEA Hydro) works under the auspices of the International Energy Agency (IEA), with a mission to 'encourage through awareness, knowledge and support, the sustainable use of water resources for the development and management of hydropower'. This is achieved through its Strategic Programme, which entails research on items of importance to member countries, as well as broader initiatives from the IEA Hydropower Technology Roadmap, launched at HYDRO 2012 in Bilbao, Spain. IEA Hydro currently manages six Annexes, each led by an Operating Agent, with input from participating countries based on their specific interests. The work of the IEA Hydro is disseminated through reports available on the website: www.ieahydro.org.

Annex II: Small-Scale Hydropower

Advances in fully automated hydropower installations and reductions in manufacturing costs have made small-scale hydro increasingly attractive. Annex II is engaged in several tasks:

- Worldwide small hydro information and technology exchange website
- The Small Hydro International Gateway website (www.smallhydro.com) has more than 1700 registered users and includes 350 listings in the on-line directory of experienced small hydro individuals available to provide advice. With an extensive small hydro library, it

includes a database of potential sites with RETScreen evaluation files for USA non-powered dams and Ontario small dam sites.

- Government policies and experience: What works and what does not?

The original report on government policies and experiences, provided by six countries/organizations is being updated based on recent input including comments received from presentations and panel discussions at international conferences.

- Sustainable small-scale hydropower in local communities

The collection of survey material and case histories highlighting small hydro projects that are financially successful and socially accepted is drawing to a close, with analysis and reporting planned for early next year.

Annex IX: Hydropower Services

Annex IX has developed a programme to investigate the services provided by storage hydro projects and to establish the economic values of energy management, water management and other socio-economic services. The objectives of Annex IX are to enhance the understanding of:

- the type of energy and non-energy services hydropower can provide to energy security, water security and sustainable development;
- the potential consequences of providing such services for the hydropower sector in terms of required adjustments in operation, maintenance and development practices;
- appropriate economic assessment methods to quantify the value of these services;
- how the costs of providing multiple services are apportioned between stakeholders; and,
- how regulatory frameworks, market mechanisms and business models can sustain or hamper the optimal deployment or development of multipurpose hydropower services.

The work is sub-divided into two 'Tasks', one focusing on the value of grid services, such as ancillary services to stabilize the grid, and the other on analysing non-energy services, such as flood/drought protection, and irrigation and aquaculture. Case studies will be used to validate economic assessment methods, quantifying the added value created by a specific hydropower scheme in a given river basin, through its vari-

ous multipurpose enabling functions.

Annex XI: Renewal and Upgrading of Hydro Plants

Many hydropower facilities worldwide have reached or are approaching the end of their original life, with both growing needs and opportunities for their renewal and upgrading. In most cases, this is economically more attractive, per unit of energy produced, than developing new projects.

Annex XI has gathered case histories from around the world covering good practice in the renewal and upgrading of existing hydropower plants, covering two main categories:

- public policies, decision indicators, facilitation measures, asset management criteria and life cycle cost evaluation; and,
- modern technologies and good practices in terms of systems and materials.

This knowledge will be used to identify and convey effective policies, assistance measures, criteria for decision-making and innovative technologies and approaches to the broad hydropower community. The Annex will prepare a Summary Report and Appendix with Case Histories to be launched at HYDRO 2015. Dissemination will be on-line through the IEA Hydro website, supported by a brochure for distribution at appropriate venues. Further presentations on important findings and key points will be made through technical papers and conference presentations.

Annex XII: Hydropower and the Environment

The starting point of Annex XII was recognition that the present state-of-the-art of hydropower reservoir GHG emissions has numerous uncertainties and diverging positions, which preclude its consideration in energy policies, legislation and regulations.

The Annex on 'Managing the Carbon Balance in Freshwater Reservoirs' manages a comprehensive programme with the objective of:

- increasing knowledge on processes linked to reservoir GHG emissions;
- standardizing GHG flux evaluation methods; and,
- developing an acceptable methodology to measure, model and manage the carbon balance in reservoirs.

The programme was initiated with a broad field measurement campaign across eleven hydropower sites in Brazil, with a complete hydrological year of monitoring for each. Eight of the projects were in operation and three under construction, with their reservoirs not yet impounded.

An international team of experts worked on developing guidelines to provide a reference framework for carrying out quantitative analyses. Volume 1, with a focus on measurement programmes and data analysis, was launched at HYDRO 2012, Bilbao, Spain. This guideline was notable for the introduction of the net GHG emission concept, being the difference between post-impoundment balances of GHG emissions and removals, excluding GHG emissions from unrelated anthropogenic sources, and pre-impoundment balances of GHG emissions and removals.

Volume 2, with a focus on modelling, will be launched at HYDRO 2015, Bordeaux, France. The remaining activities to complete the work of the Annex include:

- documenting the results of the Brazilian field campaigns;
- completing the second phase of the Brazilian field measurement campaign and the development of mechanistic modelling tools;
- preparing Guideline Volume 3 with a focus on best practices on reservoir carbon balance management; and,
- preparing documents on fair allocation of reservoir GHG emissions and unrelated anthropogenic sources, to each of its services including hydropower generation.

This last activity will be based on an acceptable methodology and best practices in managing the reservoir carbon balance.

Annex XIII: Hydropower and Fish

The Annex on Hydropower and Fish aims to foster collaborative research

to increase knowledge and provide a better understanding of the effects of hydropower on fish. This will make it possible to identify best practices for management and mitigation, and to provide sound advice on ways for industry, investors and governments to make good decisions for sustainable hydropower. The scope of investigations and research will cover impacts for new hydropower developments, operation of existing hydropower and the modernization of hydro plants and their equipment.

The main scope of this work will be the development of a roadmap guideline for sustainable fish populations and management in rivers with hydropower production. Chapters will include case histories focused on best practice and cover the following topics:

1. Introduction to hydropower and fish.
2. Estimation of impacted populations.
3. Regulatory requirements.
4. Design of upstream passages.
5. Design of downstream passages.
6. Monitoring techniques.
7. Environmental flow requirements.
8. Pest fish management.
9. Reservoir management.
10. Management models.

Annex XIV: Management Models for Hydropower Cascade Reservoirs

Designing a single hydro plant and reservoir or operating and managing existing hydro plants are complex tasks. The challenges are compounded in a cascade system with different stakeholders and different requirements. Each hydropower reservoir has impacts and/or dependencies on other upstream and/or downstream projects, yet has to be optimized for power generation and water services, and has to meet all requisite environmental, safety, and social compliances.

The purpose of this Annex is to examine key issues that need to be addressed in the design of new hydropower cascade reservoir projects, and the operation and management of existing plans. Examples will be presented of both successful management models and lessons learned. The Annex will conclude with documentation and dissemination of the findings, including case histories from the participating member countries.

Key issues to be covered include:

- safety compliance, specifically the routing of large floods;
- consistent management of environmental and social risk issues;
- meteorological and hydrological monitoring, modelling and forecasting, flow routing, specifically the interdependencies along the cascade;
- flow dispatch approaches for power generation optimization including coordination with other sources of generating such as thermal and nuclear.
- dispatch rules for providing other energy and water services; and,
- operational constraints and their cumulative impacts.

Enabling issues that will also be addressed include:

- communication models between cascade reservoir operators and managers; and,
- governance models, specifically for multiple owners and cross-boundary issues.

Participation in the IEA Hydro Research Programme

IEA Hydro welcomes participation from government agencies, utilities and research organizations with an interest in undertaking collaborative research on hydropower research topics to support the sustainable use of water resources. Please contact us through: www.ieahydro.org.



IEA Hydro Sessions during HYDRO 2015

As usual, IEA Hydro will make a substantial contribution to the technical sessions at HYDRO 2015 – Advancing Policy and Practice, which will take place from 26 to 28 October in Bordeaux, France.

- A session on Hydropower and Fish, chaired by Niels Nielsen, of IEA Hydro, will include presentations and discussions by IEA Hydro country representatives on the development of a roadmap/guideline for sustainable fish populations and management in rivers with hydropower production.
- A session on Hydro Plant Rehabilitation and Refurbishment, chaired by Boualem Hadjerioua of Oak Ridge National Laboratory, USA, will include presentations and discussions by IEA Hydro country representatives on the work of Annex XI on hydropower upgrading. The session will conclude with the launching of the Final Report.
- A session on GHG Emissions from Reservoirs, chaired by Albert de Melo of CEPEL, Brazil, will include presentations and a panel discussion on the measurement, modelling and management of GHG emissions as part of Annex XII. The session will conclude with the launching of the Guideline, Volume 2, on Modelling.

