THE INTERNATIONAL ENERGY AGENCY TECHNOLOGY COLLABORATION PROGRAMME ON HYDROPOWER

IEA Hydropower

STATEMENT OF OBJECTIVES (DRAFT)
ANNEX XVII

1. ANNEX INFORMATION

Annex Title: Measures to enhance the Climate Resilience of Hydropower
Operating Agent: OKUMURA Hirofumi (J-Power, Japan)
Participating Countries (expected) : Japan, Switzerland, EU, Malaysia, China, Canada, and other countries

2. BACKGROUND AND ANNEX DESCRIPTION

In recent years, risks caused by climate change are common concerns across the world. This is true for hydropower plants and some are forced to have long-time operation stoppage with recovery works for flood damage with climate change as post-maintenance. In order to protect power facilities, hydropower producers need to analyze potential risks and implement precautionary measures to reduce the risk as far as possible, and to have flood damage mitigation measures such as pre-remodeling works against new hazards triggered by climate change.
There is also a concern of the increase of sediment inflow to reservoirs that might be caused by glacier retreat and intensive rainfall with climate change. So, hydropower producers are requested to maintain power generation function with further optimized reservoir sediment management to secure reservoir capacity.
The theme of this Annex is "Measures to enhance the Climate Resilience of Hydropower", and a survey will investigate specific measures that hydropower producers should take to enhance the climate resilience of hydropower.
The core survey items are as follows:

① Forecast of potential natural hazards triggered by climate change and evaluation of countermeasures and design criteria for safety check of power facilities
② Countermeasures to mitigate damage to hydropower plant facilities caused by extreme floods
③ Reservoir sediment management

Regarding the survey target, scope of the target shall be set according to the framework of river administration in each country.

3. ANNEX OBJECTIVES

The main objectives of ANNEX XVII are as follows:
This Annex identifies risks caused by climate change and investigates the countermeasures that hydropower producers should take against flood risks and other risks caused by climate change. Surveys will be conducted among research institutions and hydropower owners/operators. The surveys will make an inventory of probable hazards due to climate

change which may endanger power facilities and evaluate the risk mitigation effect of the countermeasures that hydropower producers can take. The surveys will include case histories of flood damaged hydropower plant facilities in each country and they will be reviewed and systematized based on the analysis and evaluation of the risk mitigation effect of the countermeasures. The outputs of the survey will be fed back to hydropower producers and contribute to the mitigation of flood risks in the expanding climate change around the world.

The Annex will not address changes in electricity generation caused by hydrological alterations resulting in less or more water or seasonal shifts of the generation.

ANNEX task
The work plan is divided into the following three tasks.

Task 1 : Forecast of potential natural hazards triggered by climate change and evaluation of pre-emptive countermeasures and design criteria for safety check of power facilities
Task 2 : Countermeasures to mitigate damage to hydropower plant facilities caused by extreme floods
Task 3 : Reservoir sediment management

At the completion of each task, a survey report will be compiled under the items of "Survey results", "Analysis / Evaluation" and "Systematization / Recommendation".

3.1 TASK 1 – Forecast of potential natural hazards triggered by climate change and evaluation of pre-emptive countermeasures and design criteria for safety check of power facilities

Task Objective

The Task 1 Objectives are as follows:

- Amid concerns about an increase of flood damage risks and other risks triggered by climate change, it is necessary for hydropower producers to take measures in order to play the role of ensuring the safety of power generation facilities and the stable supply of electric power. So, power facilities should be designed to withstand events triggered by climate change impacts such as extreme floods based on the proper design criteria and other pre-emptive measures
- Design bases are regularly reviewed and updated according to new hydrological analysis taking into account the effect of climate change. In order to evaluate the current design criteria, it is planned to make an inventory of probable hazards due to climate change which may endanger flood safety and other safety and operational aspects of power facilities. Potential new hazards affecting flood safety may be linked to new potential landslides, glacier lake outbursts with mud flows in addition to the expansion of flood discharge scale and it is necessary to forecast the potential natural hazards for the safety check of power facilities.

  This survey will summarize the forecast of potential natural hazards triggered by climate change and an evaluation of the design criteria and other mitigation measured for the safety check of power facilities.

Scope of Work

The scope of work includes the following:

- An overview of potential climate change impacts for hydropower plants will be prepared based on survey results. The focus will be on safety and on operational aspects.
- Possible predictive tools, pre-emptive countermeasures and innovative design criteria to predict possible impacts and to strengthen the resilience against climate change impacts will be studied. Aspects such as the estimation of probable flood discharge triggered by climate change or potential risks such as flood waves caused by landslides or GLOF (glacier lake outburst flood) will be included.
- Innovative design criteria for power facilities will be properly sampled and evaluated considering the impact of potential natural hazards to ensure the safety of power facilities. In the review and upgrade works of design criteria, important power facilities such as dam and spillway could be covered.

Task Activities

Main activities of the task include the followings:

- Collect and document the technical information about potential natural hazards by climate change from literature published from university / laboratory or river administrator / power utility and review them. The increase of probable flood discharge triggered by climate change will be evaluated and, where available, the increase of flood discharge in the context of climate change scenarios will be documented.
- Collect and document the review and upgrade works of design criteria for power facilities as well as other mitigation measures by river administrator / power utility and investigate how they are going to revise design criteria to secure the safety of power facilities and to change reservoir operation way to mitigate flood impact as well. The survey will clarify the necessity and challenge in mitigation measures to protect power facilities.

Coordination

Task 1 will be coordinated by Switzerland.

3.2 TASK 2 – Countermeasures to mitigate damage to hydropower plant facilities caused by extreme floods

Task Objective

The Task 2 Objectives are as follows:

- Amid concerns about an increase of flood damage risks, it is necessary for hydropower producers to take measures in order to play the role of ensuring the safety of power generation facilities and the stable supply of electric power. In flood damage recovery work, it is required to formulate a recovery plan for power generation facilities and to repair the facilities at an early stage in consideration of the prevention works for similar disasters. In the recovery works against the flood damage, the survey will coordinate the recovery plan based on the damage factor analysis and the challenges in design and construction taking into account economy and construction technology.
- Flood damage recovery is the post-maintenance work against facility damage caused by external factors such as torrential rainfall, but it is also required to take preventive maintenance to mitigate damage in the future. In renewing the power generation facility as preventive maintenance to reduce flood damage, structural examinations for

functional enhancement and safety improvement in preparation for the expansion of future damage scale will be coordinated. And the case histories on efficient and labor-saving efforts on operation and maintenance will be reviewed as well.

Scope of Work

The scope of work includes the following:

- The facilities for renovation in flood disaster recovery works are for power facilities (dam, spillway, intake, waterway, headtank, penstock, power house and outdoor switchyard) that belong to hydropower producer and they will be the targets for case histories covering their damages caused by flood and/or landslide.
- In the renewal works at power facilities, not only the tangible measures (facility upgrade and/or remodel) to keep the soundness of facilities but also the intangible measures (remote and automatic control, upgrade of monitoring and patrol inspection) are to set to the targets of survey.

Task Activities

Main activities of the task include the following:

- Collect and document flood damage recovery case histories of hydropower plants and review them. Analyze and evaluate the recovery works against the flood damage taking into account economy and construction technology based on the damage factor analysis from case histories of recovery works, and coordinate the challenges of investigation, planning, design and construction on flood damage recovery.
- Collect and document renewal case histories of power facilities for flood damage mitigation and review the renewal details. Investigate how much of flood discharge did power producers estimate in the design of power facilities and how they are going to forecast the future scale of flood damage in facility renewal plan against climate change, and coordinate the issues in tangible measures (facility upgrade and/or remodel) for the soundness of facilities and intangible measures (upgrade of the facility operation and maintenance) from the renewal work case histories at power facilities.

Coordination

Task 2 will be coordinated by Japan.

3.3 TASK 3 – Reservoir sediment management

Task Objective

The Task 3 Objectives are as follows:

- Reservoir sediment management has been important from the perspective of securing effective reservoir capacity for power generation and efficient reservoir operation. So, it is required to remove sediment from the reservoir in addition to the decrease of sediment inflow from upstream.

- Amid the forecast of the increase of flood discharge, it is required to have further optimization of reservoir sediment management on removing sediment concerning the increase of sediment inflow to reservoir.
- Regarding the way of sand removal, in addition to the conventional ways such as reservoir dredging, in-lake transport, sand-flushing through flushing gate embedded in the dam body, sediment bypass tunnel systems are starting to be newly applied. But, there are some problems in the flushing efficiency and downstream environmental impact to be considered. To solve those problems, integrated sand removal by dams located on the cascade in the same basin is proposed as the effective way and a survey will investigate challenges and solutions how each dam is having an initiative in the complex operation based on the integrated management and monitoring.

This survey will coordinate challenges of reservoir sediment management that hydropower producers would tackle.

Scope of Work

The scope of work includes the following:

- Survey on reservoir sediment management will cover the range from upstream area of sediment supply source to downstream area that environmental impact to be checked.
- Several reservoir sand removal ways (reservoir dredging, in-lake transport, flushing gate, bypass tunnel and others) will be analyzed and evaluated taking into account environmental impacts, cost effectiveness and technology.
- Integrated sand removal by dams located on cascades in the same basin is proposed as an effective way and survey will investigate challenges and solutions in the complex operation based on the integrated management and monitoring.

Task Activities

Main activities of the task include the following:

- Collect and document case histories of reservoir sediment management and review them. Analyse and evaluate reservoir sediment management from the aspects of upstream sediment supply affected by climate change, measures to decrease sediment inflow and reservoir sediment flushing measures in consideration of economy, technology and downstream environmental impact. And the issues on reservoir sediment management would be extracted and summarized through systematization.

Coordination

Task 3 will be coordinated by Japan.

4. SCHEDULE OBJECTIVES

Annex XVII Schedule

An expert meeting proposed by Japan was held on 4th October, 2021 and after exchanging opinions on survey items and study way of Annex, the final Statement of Objectives was

requested to correct and it is under discussion among expected participating countries. The target milestone schedule for the event after the Executive Committee is as follows.

Description	**Date**
Annex XVII Expert Meeting	4th October, 2021 25th February, 2022 October, 2022 March, 2023 October 2023
39th IEA Hydro Executive Committee	5th October, 2021
40th IEA Hydro Executive Committee	March, 2022
Case history collection and Questionnaire	September, 2021 to December, 2022
Survey Review, Analysis / Evaluation and Systematization	December, 2021 to December, 2022
Preparation of Draft Final Report	By the end of 2023
Report Review and Completion	March, 2024
Dissemination	2024 year later

5. COST OBJECTIVES

Activities of the Annex is a joint work by the relevant organizations, usually, activity costs will be allocated to those that are closely related with them.

The activity costs of this Annex are as follows:

- The operating agent of this Annex will cover the operating costs.
- Participants of Annex are to provide information about the case history at his own expense. Final costs to each participant will include their own direct costs to undertake the work and expenses to attend meetings.
- Costs for publicity dissemination of final reports such as printing and distribution of reports and pamphlets will be covered by the committee's fund with the approval of the executive committee.
- There may be situations where countries are willing to provide information from some of their projects as reports or case histories, but finding staff with available time to do the work might be a problem. In such circumstances, it was suggested that the ExCo Secretary might be able to help with the collection of information and preparation of documentation

6. DELIVERABLE AND DISSEMINATION OBJECTIVES

The deliverables of this Annex shall be printed materials including the contents of activities and the outline of discussions, and/or reports in electronic files.

The publicity dissemination of this Annex includes the following items:
a) Distribution of report(s) to our Annex participants
b) Distribution of report(s) to related organizations

c) Posting a downloadable report on the IEA Hydro website
d) Presentations through workshops and papers at international hydropower conferences

7. ACCEPTANCE BY EXECUTIVE COMMITTEE

Annex XVII's proposal is expected to be announced and approved at the 40th Executive Committee (March, 2022).

Signature	Signature	Signature
OKUMURA Hirofumi Operating Agent	Alex BECKITT Chair IEA Hydropower TCP	Klaus JORDE Secretary IEA Hydropower TCP
Date March, 2022	Date March, 2022	Date March, 2022