IEA :Implementing Agreement for Hydropower Technologies & Programmes
HYDRO 2015 Session 33: Renewal and upgrading of hydropower plants,
IEA session, Bordeaux, France, 26 to 28 October 2015

Summary of IEA Annex-XI activities and launch of the Final Reports

Wednesday 28 October, 2015

Annex-XI Operating Agent

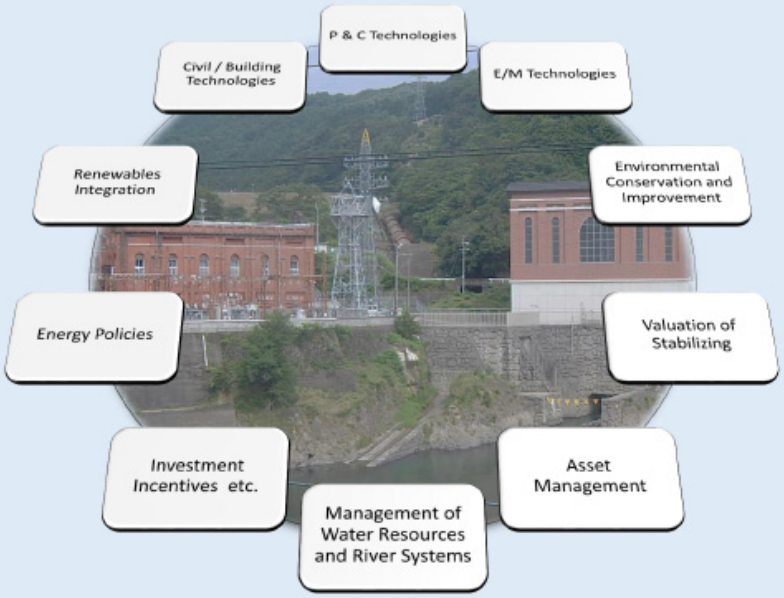
Takashi AKIYAMA

Annex-XI Flier

IEA HYDROPOWER

The International Energy Agency Implementing Agreement for Hydropower Technologies and Programmes

IEA Hydro Annex-XI : RENEWAL & UPGRADING of HYDROPOWER



Case History Collection

70 Case Histories from 10 Countries

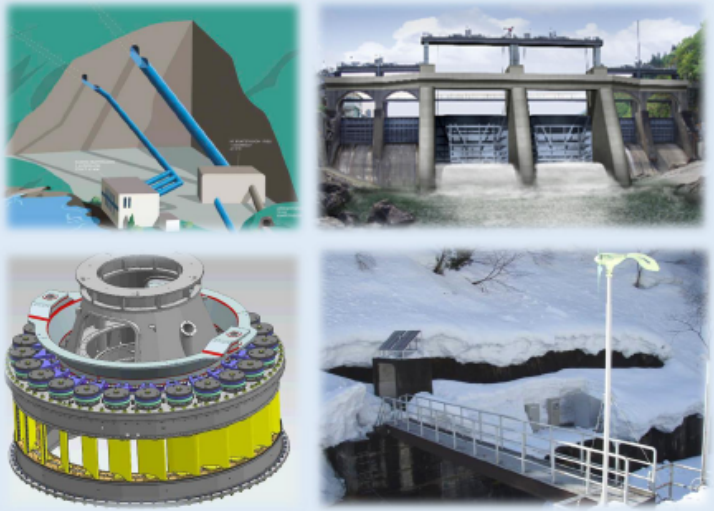
To access and download the Analysis Report and Case Histories, visit the IEA Hydro website at www.ieahydro.org.

Background and Purpose of the Annex-XI

- Many hydropower facilities worldwide are approaching the time for renewal.
- Given the situation, it is necessary to renew / upgrade such facilities in a way that accommodates change of social / natural environment, change of the electricity market and the functions / values expected of hydropower today.
- Case Histories, gathered from around the world, have been systematically analyzed to present processes leading up to renewal / upgrading, as well as economic rationale / environmental feasibility that served as judging criteria.
- The analysis report will provide significant reference material for hydropower operators, E&M manufacturers and various specialized consultants.

What were Trigger Causes of Renewal and Upgrading Projects?

- Degradation due to ageing and recurrence of malfunction
- Environmental deterioration
- Needs for higher performance
- Needs for safety improvement
- Needs due to third party factors
- Accidents / Disasters



Progress of the Keage Hydropower Plant

1868 Meiji Restoration — Meiji — 1912 — Taisho — 1926 — Showa — 1951 — 1989 — Heisei — 2012

- 82: First electric ramp
- Sino-Japanese War
- Russo-Japanese War
- World War I
- World War II
- Reorganization of power company
- 66 70 73 78: EXPO, Nuclear, Oil shocks
- 90-: Bubble burst
- 97: COP3
- 11.3.11: Great East Japan Earthquake, Fukushima No.1 crisis

Beginning of hydropower development | Dam construction | Large Dam | Environmentally-conscious development

1891 COD of the Keage Plant (the first commercial power plant)

Pelton turbine

1st stage:
20 Pelton turbines
(DC. and AC.)

1897 **1760kW**

1891 **160kW**

2 Pelton turbines
(DC.)

Power house at 2nd stage (existing)

1912 **4800kW**

2nd stage:
5 horizontal
Francis turbines

1936 **5700kW**

3rd stage:
2 vertical Francis
turbines

Power house at 3rd stage (in-service)

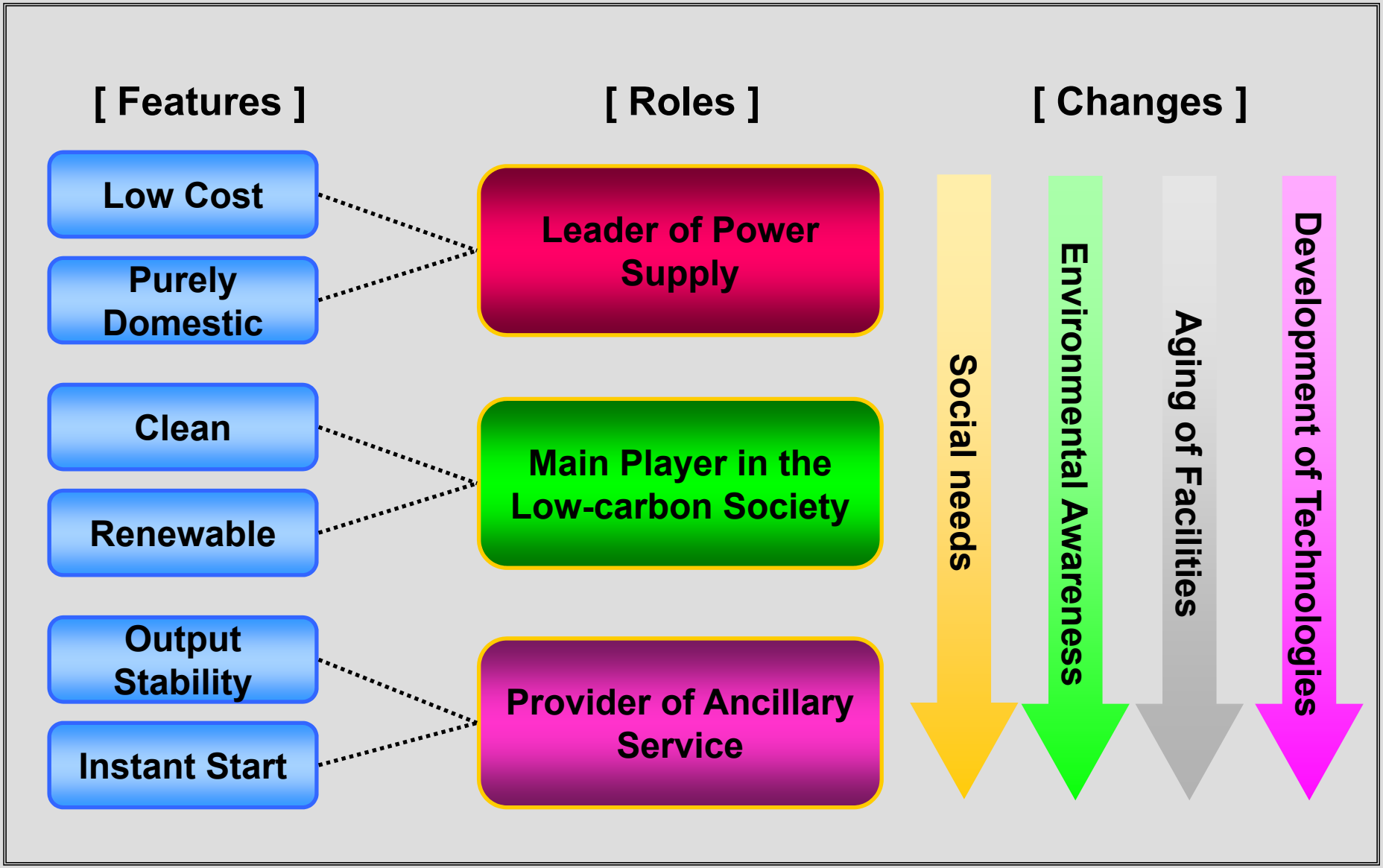
Increasing the demand for drinking water

1979 **4500kW**

Present

Utilizing the hydropower reflects God' will.

Roles of Hydropower in Japan



Annex-XI activities

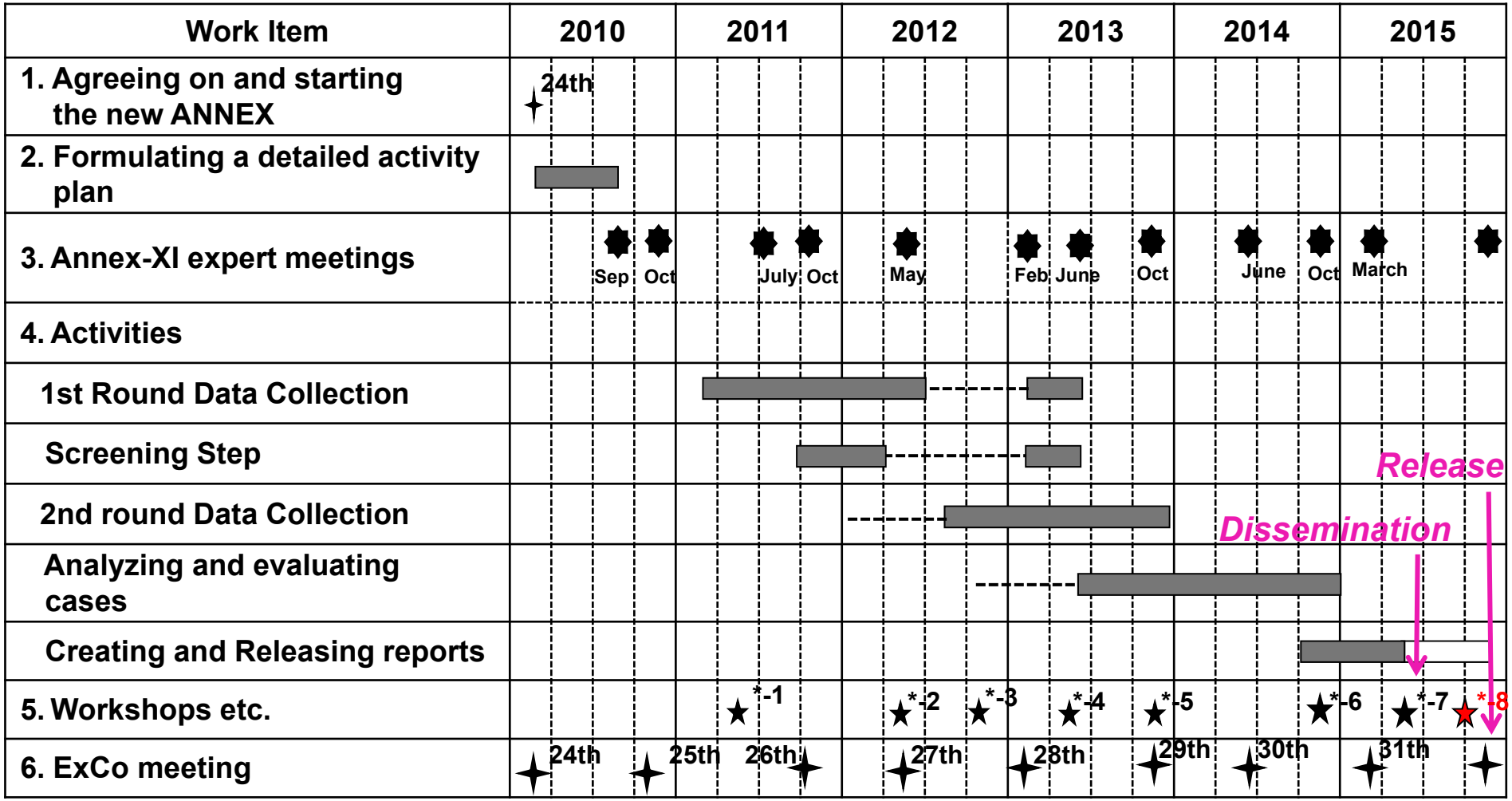
(Background)

1. There are growing concerns not only in Japan but also in other industrialized nations about the aging of hydropower facilities.
2. There is a growing expectation for hydropower as a future key player in low-carbon society, as it represents a domestic, affordable and CO2-free source of energy.
3. In the western world, small- or medium-sized pumped-storage hydropower is gaining renewed recognition as a load-balancing system to complement the intermittent wind and solar power.

(Purpose)

- The taskforce is trying to gather as many good case histories as possible from around the world on the renewal and upgrading of existing hydropower plants.
- The information will be used to identify and convey effective policies, assistance measures and innovative technologies to the rest of the world.

Overall Schedule



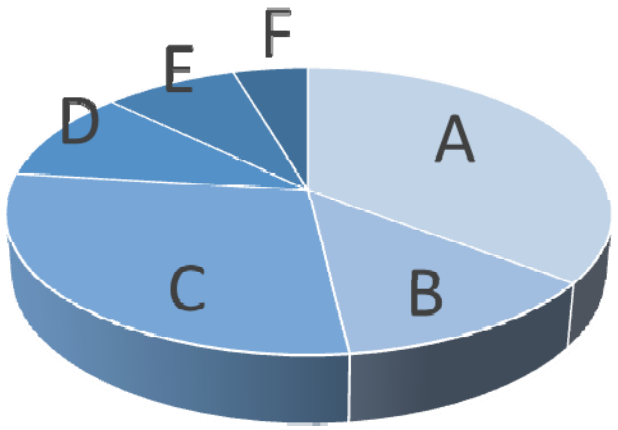
*-1 : Sacramento, USA *-2 : Washington, D.C., USA *-3 : Bilbao, Spain *-4 : Oslo, Norway
*-5 : Innsbruck, Austria *-6 : Lake Como, Italy *-7 : Portland, OR, USA *-8 : Bordeaux, France

Trigger Causes of Renewal and Upgrading

Trigger Causes	Expected Performance
(A) Ageing and recurrence of malfunction	(a) Improvement of efficiency
	(b) Improvement of durability and safety
	(c) Cost reduction
	(d) Easy maintenance with less labor
(B) Environmental deterioration	(a) Sedimentation reduction
	(b) Improvement of river environment
(C) Needs for higher performance	(a) Addition of units, Expansion of power & energy
	(b) Role change of hydropower generation Addition of new functions
(D) Needs for safety improvement	(a) Improvement of safety
(E) Needs due to third party factors	(a) Sustainable operation （sometimes accompanied by power reduction）
(F) Accidents / Disasters	(a) Recovery

Trend of Trigger Causes

Trigger Cause	No. of Case	%
A : Ageing, Malfunction	38	35.2
B : Environmental Deterioration	14	13.0
C : Higher Performance	31	28.7
D : Safety Improvement	11	10.2
E : Third Party Factor	9	8.3
F : Accidents / Disasters	5	4.6
Total	108	



Key Points to be focused and analyzed

Summary Report

Category-1. Public Policies, Facilitation Measures, etc.

Key Points

a) Energy policies of Countries & States

b) Investment incentives;
Feed-in-Tariff (FIT), Renewable Portfolio Standard (RPS)

c) Integrated management of water resources and river systems

d) Asset management, strategic asset management and Life cycle cost analysis

e) Projects justified by the Non-monetary valuation of stabilizing unstable power system in the up-coming low-carbon society

f) Environmental conservation and improvement

Key Points to be focused and analyzed

Summary Report

Category-2. Modern Technologies, Systems, Materials, etc.

Key Points

a) Technological innovation & deployment expansion of Electro-Mechanical (E/M) equipment

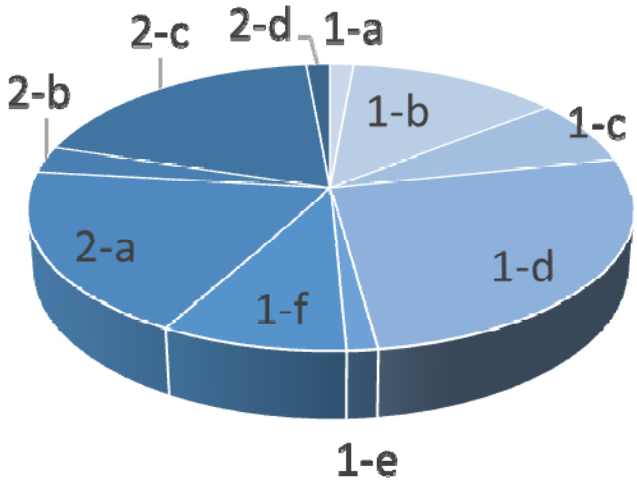
b) System and Reliability Improvement in Protection & Control (P&C)

c) Technological innovation, deployment expansion and new materials used for Civil Engineering (C/E) works

d) Integration of other renewable energies into hydropower systems

Trend of Key Points

Key Point (Main)	No. of Case	%
1-a : Energy Policies	1	1.4
1-b : Investment Incentives, etc.	9	13.0
1-c : Water Resources / River Systems	5	7.2
1-d : Asset Management	18	26.1
1-e : Stabilizing	1	1.4
1-f : Environmental	6	8.7
2-a : E / M Technologies	13	18.8
2-b : P /C Technologies	2	2.9
2-c : Civil / Building Tecnologies	13	18.8
2-d : Integration	1	1.4
Total	70	



Cat.1-(a) (b) Energy Policies and Investment Incentives

Cat.1-(a) Energy Policies of Countries & States

■Energy policy and action plan to renewable energy in each country

Every country, according to its own conditions, has defined specific energy policies with the aim of establishing sustainable development and a recycling society. Energy policies are heavily reflected in the individual measures and policies including supportive measures from the government, and have a big impact on business activities. This report is described with a focus on the information about renewable energy of each country's energy policy.

Cat.1-(b) Investment Incentives (FIT, RPS, Subsidies, Financial Assistance, Tax deductions)

■Investment Incentives to achieve the target about renewable energy in each country

- **Measures, Status of the progress, Effect**
- **How investment incentives ought to be**

Cat.1-(c) Integrated management of river systems

Cat.1-(c) Integrated management of water resources and river systems

Cat.1-(c)-1 River system integrated development

The integrated development of a single river system by a single developer enables a more systematic and efficient development utilizing the water resource from the point of total optimization throughout the year.

Cat.1-(c)-2 Integrated Sediment Management in River Basin

From the perspective of run-off management, there are projects that see an entire river as a single run-off system and use the collaborative sand discharging approach to efficiently manage run-off across the entire river system.

Cat.1-(c)-3 Comprehensive development plan

There are also pioneering projects based on general development planning with balanced multi-purpose applications including water treatment, irrigation, flood prevention and industrial water, in addition to power generation.

Cat.1-(d) Asset management

Cat.1-(d) Asset management, strategic asset management and life-cycle cost analysis

Making a decision in accordance with asset management is an effective and economical way to refurbish the facilities.

Cat.1-(d)-1 Asset management using existing facilities

Cat.1-(d)-2 Asset management for improvement of safety

Cat.1-(d)-3 Asset management, Strategic asset management

Cat.1-(d)-4 HAP (Hydropower Advanced Project)

Cat.1-(e) Stabilizing unstable power systems

Cat.1-(e) Projects justified by the non-monetary valuation of stabilizing unstable power systems in the up-coming low-carbon society

Amidst the increase of complexity and diversity in the configuration of power sources, there is a growing importance in stabilizing power systems through voltage and frequency adjustments.

Cat.1(e)-1 Power System Stabilization

- At an existing pumped storage hydro-plant, a constant speed generator was replaced with a variable-speed generator to actively contribute to the stabilization of power systems.

- The use of added condenser function is expected to stabilize the system voltage.

Cat.1-(f) Environmental Conservation and Improvement

Since hydro-plants have a very long service period, it is necessary to implement various measures to accommodate environmental changes and social needs.

Cat.1-(f)-1 Preservation for rare birds

Cat.1-(f)-2 Countermeasures for sedimentation and muddy water

Cat.1-(f)-3 Preservation for fishes

Cat.1-(f)-4 Conservation of landscape and cultural assets

Cat.1-(f)-5 3R methods (Reuse, Recycle, Reduce) for industrial waste

Cat.1-(f)-6 Measures for social environment

Cat.2-(a) Innovation and expansion of E/M equipment

Cat.2-(a) Technological innovation & deployment expansion of electro-mechanical (E/M) equipment

Cat.2-(a)-1 Upgrade of output and power generation under restricted condition in discharge, head and location

Cat.2-(a)-2 Facilities renewal to improve maintainability

Cat.2-(a)-3 Higher Performance of Hydropower by using Environmental Flow from a Dam

Cat.2-(a)-4 Upgrade of facilities by reusing existing embedded steel structures in concrete

Cat.2-(a)-5 Upgrade of the turbines which increase the design discharge within range of the vested water right

Cat.2-(b) Improvements in Protection & Control

Cat.2-(b) System and Reliability Improvements in Protection & Control

With the recent establishment of new IT technologies, digital control systems are becoming widely used in newly installed hydropower plants such as the supervisory control and data acquisition, SCADA system.

Cat.2-(b)-1 Renewal of the conventional HPP control system

Cat.2-(b)-2 Upgrade of the pumped storage power plant control system

Cat.2-(b)-3 Constant flow system applied on a standardized package type water turbine

Cat.2-(c) Innovation and expansion of civil works

Cat.2-(c) Technological innovation, deployment expansion and new materials used for civil and building works

Cat.2-(c)-1 Upgrading of Dam function under Operation

Cat.2-(c)-2 Earthquake resistance technologies

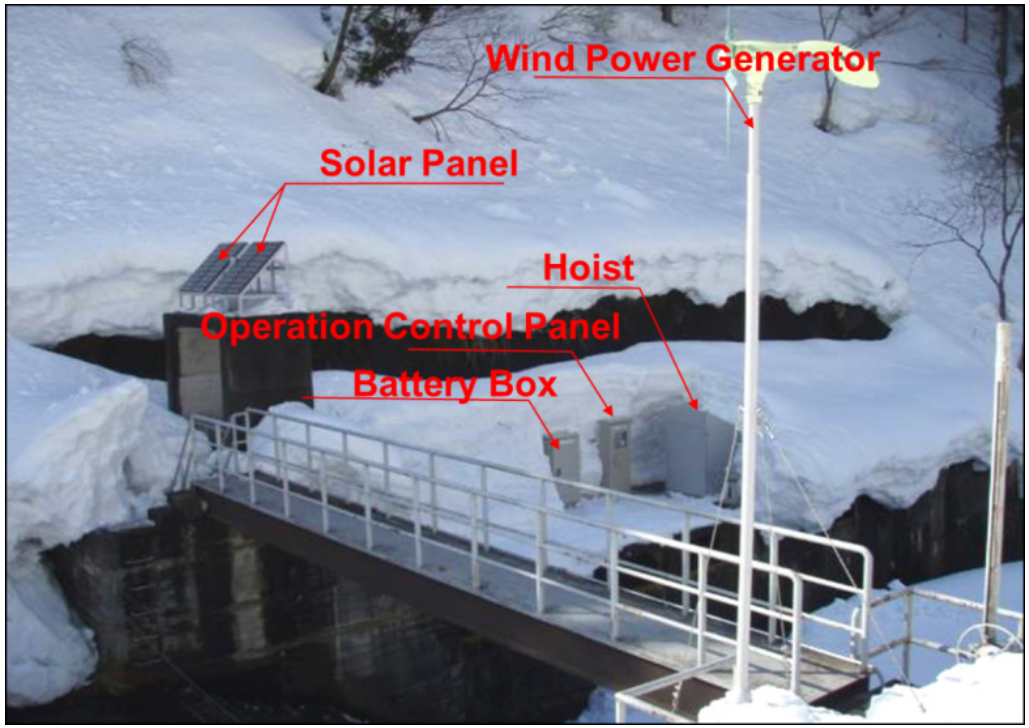
Cat.2-(c)-3 Remodeling of Existing Intake Weir and Facilities

Cat.2-(c)-4 Application of New Materials for Penstock

Cat.2-(c)-5 Re-use of Existing Facilities and/or Equipment

Cat.2-(d) Integration of other renewable energies into hydropower systems

This key-point includes cases that take advantage of both solar and wind power and utilize their advantages in hydropower generation or make up for each other's shortfalls.



Thank you for your attention !

For more information,
visit the IEA hydro website at www.ieahydro.org