IEA :Implementing Agreement for Hydropower Technologies & Programmes
Hydro Vision International, IEA Hydro's Program to Advance Hydropower Worldwide
14 to 17 July 2015, Oregon Convention Center, Portland, OR, USA

IEA Hydro's Annex-XI on

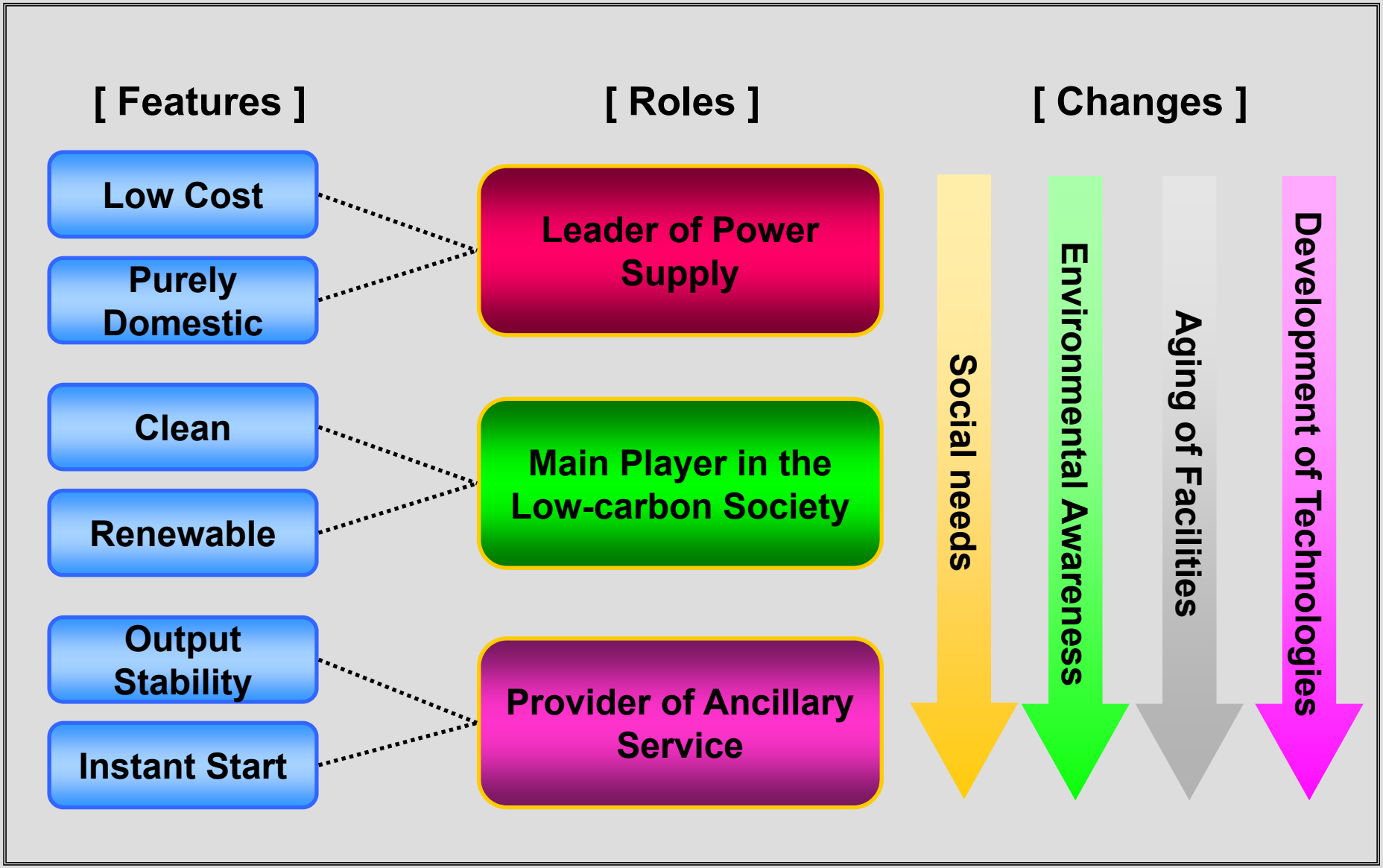
Renewal and Upgrading of Hydropower Plants

Tuesday, 14 July, 2015

Annex-XI Operating Agent

Takashi AKIYAMA

Roles of Hydropower in Japan



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

2nd stage:
5 horizontal Francis turbines
1912
4800kW

3rd stage:
2 vertical Francis turbines
1936
5700kW

Increasing the demand for drinking water

1979
4500kW

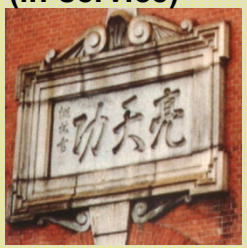
Present

Power house at 3rd stage (in-service)

1891
160kW

2 Pelton turbines
(DC.)

Power house at 2nd stage (existing)



Utilizing the hydropower reflects God' will.

Annex-XI activities

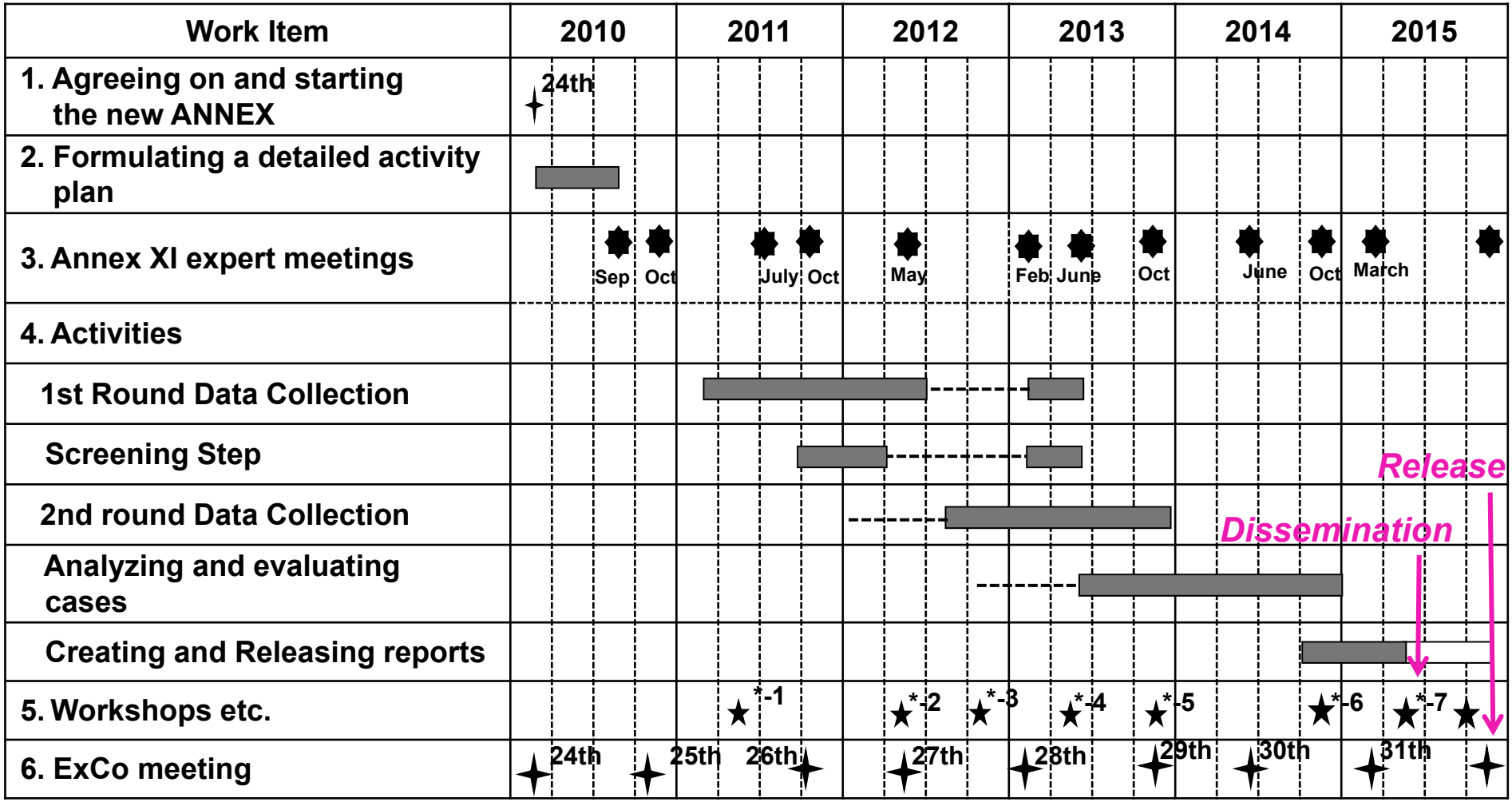
(Background)

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



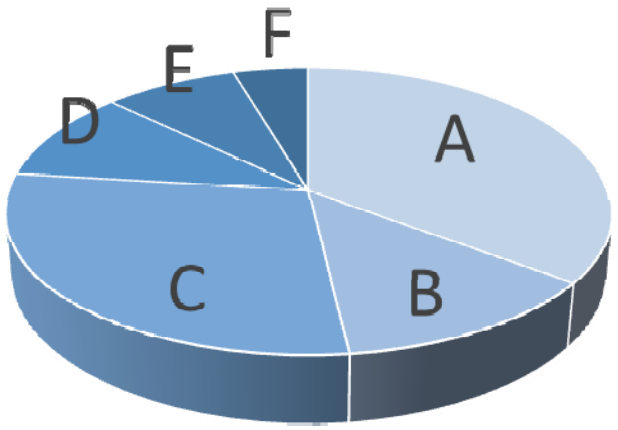
*-1 : Sacramento, USA *-2 : Washington, D.C., USA *-3 : Bilbao, Spain *-4 : Oslo, Norway
*-5 : Innsbruck, Austria *-6 : Lake Como, Italy *-7 : Portland, OR, USA

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

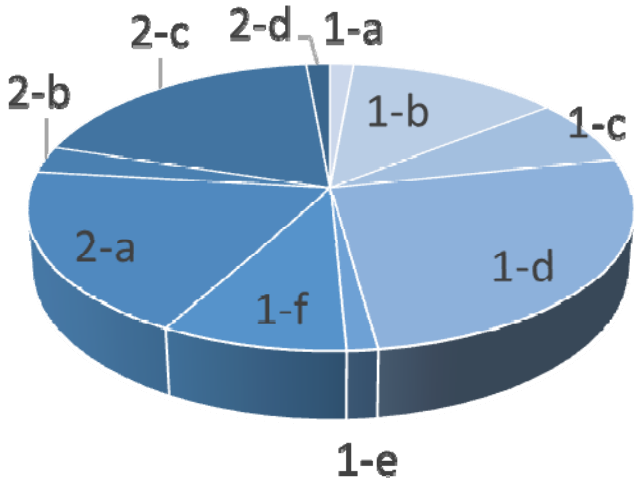
b) System and Reliability Improvement in Protection & Control (P&C)

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

Hidaka River system:

4 water systems, 13 HPPs, Total Output 646MW

Kurobe River Systrem:

1 water systems, 11 HPPs, Total Output 894MW

Kiso River system :

1 water systems, 33 HPPs, Total Output 1,074MW

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

Kurobe River System:

Flushing operation（Dashidaira Dam, Unazuki Dam）

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

Shin-Maruyama (Shin- Maruyama Dam): Dam Raising Project

Cat.1-(d) Asset management

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

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

Shin-Kuronagi No. 2 HPP, Nagatono HPP, Ishioka #1 HPP

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

Ontake HPP

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

Pirttikoski HPP, Poatina HPP, Tungatinah HPP, Hunsfos East HPP, Kongsvinger HPP, Rendalen 2 HPP, Waitaki HPP

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

Accelerate improvement and expansion of existing U.S. hydropower facilities to increase of annual generation and value

Flaming Gorge HPP, Us.7 Rhodhiss HPP

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

Cat.1(e)-1 Power System Stabilization

Okutataragi Pumped storage HPP :

Refurbishment of Generator-Motor rotating speed from Fixed to Variable type

→Securement of Frequency Control Ability

Estreito HPP : Added the Condenser Operation Function on existing conventional power station

Cat.1-(f) Environmental Conservation and Improvement

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

Okutadami, Ootori

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

Okuyoshino HPP, Mimikawa River System, Nishi-Yosino No.1, No.2 HPP

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

Shin-Takatsuo HPP, North Fork Skokomish HPP, Embretsufoss HPP

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

Shin-Takatsuo HPP, Rånåsfos Ⅲ HPP

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

Toyomi HPP

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

Benmore HPP

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

Toyomi HPP, Doi HPP, Minakata HPP, Kamishiiba HPP, Tagokura HPP, Sisteron HPP

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

Himekawa No.2 HPP, Estreito HPP, Kamishiiba HPP, Shin-Nogawa No.1 HPP, Hemsil 2 HPP, Cheoah HPP

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

Houri No. 2 HPP, Okudatami-Ootori HPP

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

Tagokura HPP, Hol 1 HPP

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

Rånåsfos Ⅲ HPP

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

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

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

Poatina HPP

Tungatinah HPP

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

Shiroyama HPP

Ookawachi HPP

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

Kagehira HPP

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

Mimikawa River System

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

Kawaguchi HPP, Okizumi HPP

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

Suikawa HPP, Kawabegawa No. 1 HPP

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

Yusuhara HPP, Hanakawa HPP

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

Shin-Kuronagi No.2 HPP, Shin-Onagatani No.1 HPP, Taishakugawa Dam, Hanakawa HPP

Cat.2-(d) *Integration of other renewable energies*

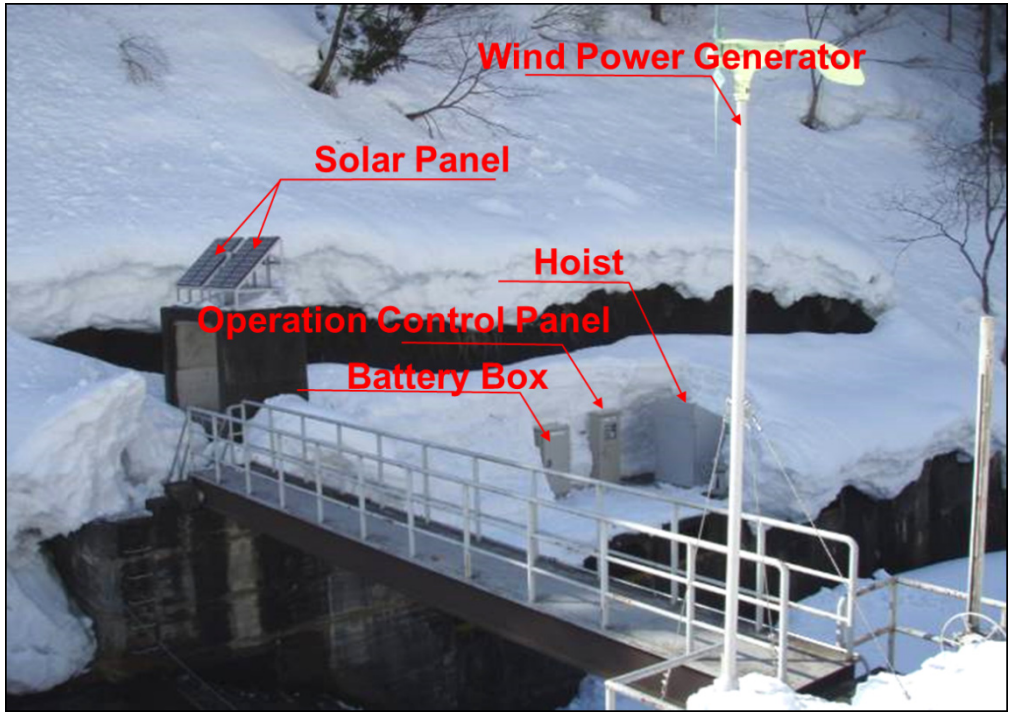
Cat.2-(d) Integration of other renewable energies into hydropower systems

Togagawa No.2 HPP :

Solar power (84W × 4)

Wind power (1,000W × 1)

Battery(12V × 108Ah × 8)



Thank you for your attention !