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

Wednesday 28 October, 2015

Annex-XI Operating Agent
Takashi AKIYAMA
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 changes 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/upgrade, 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

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.
Progress of the Keage Hydropower Plant

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

1868
- Meiji Restoration

1891
- First electric ramp

1891
- COD of the Keage Plant

1897
- 2 Pelton turbines (DC.)

1897
- 20 Pelton turbines (DC. and AC.)

1891
- 1st stage: 20 Pelton turbines

1912
- 2nd stage: 5 horizontal Francis turbines

1912
- 4800kW

1912
- Taisho

1926
- World War I

1926
- Russo-Japanese War

1951
- Showa

1951
- World War II

1951
- Reorganization of power company

1979
- 3rd stage: 2 vertical Francis turbines

1979
- 4500kW

1989
- Large Dam

2012
- Environmentally-conscious development

11.3.11
- 11.3.11

1912
- Meiji

1926
- Taisho

1951
- Showa

1989
- Heisei

1997
- Bubble burst

2012
- COP3

82
- Sino-Japanese War

97
- Great East Japan Earthquake

11.3.11
- Fukushima No.1 crisis

1873
- Meiji Restoration

1914
- World War I

1920
- Russo-Japanese War

1951
- REorganization of power company

1974
- Nuclear Oil shocks

1995
- Bubble burst

2004
- EXPO

2009
- Bubble burst

2012
- COP3

Pelton turbine

82
- First electric ramp

1912
- 5 horizontal Francis turbines

1979
- 2 vertical Francis turbines

Utilizing the hydropower reflects God's will.
Roles of Hydropower in Japan

[ Features ]
- Low Cost
- Purely Domestic
- Clean
- Renewable
- Output Stability
- Instant Start

[ Roles ]
- Leader of Power Supply
- Main Player in the Low-carbon Society
- Provider of Ancillary Service

[ Changes ]
- Development of Technologies
- Social needs
- Environmental Awareness
- Aging of Facilities
(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

<table>
<thead>
<tr>
<th>Work Item</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agreeing on and starting the new ANNEX</td>
<td>24th</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Formulating a detailed activity plan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Annex-XI expert meetings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Round Data Collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening Step</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd round Data Collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyzing and evaluating cases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creating and Releasing reports</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Workshops etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. ExCo meeting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*-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

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

<table>
<thead>
<tr>
<th>Trigger Cause</th>
<th>No. of Case</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A : Ageing, Malfunction</td>
<td>38</td>
<td>35.2</td>
</tr>
<tr>
<td>B : Environmental Deterioration</td>
<td>14</td>
<td>13.0</td>
</tr>
<tr>
<td>C : Higher Performance</td>
<td>31</td>
<td>28.7</td>
</tr>
<tr>
<td>D : Safety Improvement</td>
<td>11</td>
<td>10.2</td>
</tr>
<tr>
<td>E : Third Party Factor</td>
<td>9</td>
<td>8.3</td>
</tr>
<tr>
<td>F : Accidents / Disasters</td>
<td>5</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>108</strong></td>
<td></td>
</tr>
</tbody>
</table>
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
Summary Report


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