INTERNATIONAL ENERGY AGENCY

IMPLEMENTING AGREEMENT FOR
HYDROPOWER TECHNOLOGIES
AND PROGRAMMES

ANNEX VIII

HYDROPOWER GOOD PRACTICES:

ENVIRONMENTAL MITIGATION MEASURES AND BENEFITS

May 2006

International Energy Agency

The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organization for Economic Co-operation and Development (OECD) to implement an international energy programme.
It carries out a comprehensive programme of energy co-operation among twenty-six of the OECD's thirty member countries. The basic aims of the IEA are:

- to maintain and improve systems for coping with oil supply disruptions;
- to promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organizations;
- to operate a permanent information system on the international oil market;
- to improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- to assist in the integration of environmental and energy policies.

IEA Hydropower Implementing Agreement
(Implementing Agreement for Hydropower Technologies and Programmes)

The IEA provides support for international co-operation and collaboration agreements in energy technology R&D, deployment and information dissemination, called the IEA Framework for International Technology Co-operation. The Framework sets out the legal and management support for activities of more than 40 active technology agreements in the programme, called Implementing Agreements.

The Hydropower Implementing Agreement is a collaborative programme among member countries and consists of an Executive Committee and a number of task forces which have been set up within its organization to track specific study themes, called "Annexes". Member countries are represented by various organizations including electric utilities, government department and regulatory organizations, electric research organizations, and universities. The overall objective is:

- to improve both technical and institutional aspects of the existing hydropower industry;
- to increase the future development of hydropower in an environmentally and socially responsible manner;
- to provide objective, balanced information about the advantages and disadvantages of hydropower.

There are currently seven participants, namely Canada, China, Finland, Japan, Norway, Sweden, and France.

In the first phase of activity (Phase 1: 1995-1999), surveys and studies on four tasks had been carried out, they are: 1. Hydropower Upgrading (Annex I), 2. Small Scale Hydropower (Annex II), 3. Hydropower and the Environment (Annex III), 4. Education and Training in Hydropower (Annex V).
In the second phase (Phase 2: 2000-2004), three tasks that took over the theme in Phase 1 in expanded form and one new task were set up, they are: 1. Small Scale Hydropower (Annex II), 2. Public Awareness (Annex VI), 3. Hydropower Competence Network for Education and Training (Annex VII), 4. Hydropower Good Practices (Annex VIII).

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Acknowledgements

Since the Preparatory Meeting in September 2000, 16 meetings of the Annex have been held (7 Expert Meetings, 4 Open Workshops and Symposia, and 5 Executive Committee Meetings), in an open, friendly atmosphere. Steady progress has been made in our activities, and all participants, who have joined our meetings have had the chance to intensify their mutual understanding of the purpose of Annex VIII activities.

We would like to express our gratitude to all the parties concerned who have taken part as team members, those who have taken part in Annex VIII Expert Meetings, Workshops, Symposia, etc., the authors of valuable reports, and all those who provided valuable information for the elaboration of reports.

We thank the members of the Executive Committee for Hydropower Implementing Agreement and the secretariat for their support, guidance, and cooperation. We also thank the members of International Hydropower Association (IHA), as well as hydropower and environment experts from various countries, for their valuable opinions and advice at the joint meetings of hydro organizations held in conjunction with international hydropower conferences.

We thank the affiliated bodies and companies that have kindly allowed their employees to attend these conferences on behalf of the participants and have taken care of arrangements for conference venues, namely the Central Research Institute of the Electric Power Industry (CRIEPI, Japan), Hydro-Québec (Canada), the New Energy Foundation (NEF, Japan), Bureau of Reclamation (USA), Argonne National Laboratory (USA), Natural Resource of Canada (Canada), Kemijoki Oy (Finland), UNESA (Spain), Iberdrola (Spain), Vannkraft Ost (Norway), DSI-General Directorate of State Hydraulic Works (Turkey), EIE-General Directorate of Electrical Power Resources (Turkey), ADEME (France) and UNIDO.

The names of authors who supported the purpose of Annex VIII activities and kindly submitted reports are listed separately.

Finally, we would particularly like to mention the following persons who have played a positive part in and supported our activities over the last 5 years. Dr. Yoichi Miyanaga, in particular, offered positive participation and guidance all the way through, from planning and proposing the Annex VIII activities to collecting project data and compiling the final report. Our special thanks to go to him.

Mr. Jean-Etienne Klimpt, Ms. Myriam Truchon, Ms. Karin Seelos, Dr. Shoichi Murakami, Dr. Yoichi Miyanaga, Mr. Masakazu Itakura, Mr. Hitoshi Koyabu, Mr. Masakazu Hashimoto, Mr. Kunikiyo Yanagihara, Mr. Keisuke Kumihashi, Ms. Chika Sannomiya, Ms. Yumiko Shigeta, Mr. Junichi Isono, Mr. Frans Koch, Mr. Niels Nielsen, and Ms. Lori Nielsen.

April 2006
Tokio Morimoto, Operating Agent for Annex VIII

Executive Summary

Annex VIII "Hydropower Good Practices", is one of the task forces established under the IEA Hydropower Implementing Agreement. The objectives of this Annex are to collect "Good Practices" from all over the world with respect to specific measures that bring about favorable results at each stage of planning, constructing, and operating hydropower projects. These aim to avoid negative social and environmental impacts in implementing new hydropower projects and maintaining and managing existing hydropower plants and also to optimize the positive outcomes obtained and provide balanced and objective information to all the stakeholders including people who are directly affected by the projects.

In selecting and collecting the examples of Hydropower Good Practices, the term "Good Practice" is defined as cases in which the mitigation measures taken contributed to resolution of environmental or social problems associated with hydropower projects, as well as cases in which hydropower projects produced social and environmental benefits. As the hydropower projects inherently take many forms, Good Practices are found in a wide variety of forms. Therefore, a classification system based on 15 key issues was selected which included biophysical and social-economic problems related to construction and operation of hydropower plants as well as sharing of incidental benefits. This became the criterion for selecting and collecting cases. The cases collected on this basis were edited not only by participants in Annex-VIII activities and Executive Committee members of the Hydropower Implementing Agreement, but also by persons involved in hydropower industries in each country who endorsed the purposes of this activity and provided voluntary cooperation in order to prepare a Good Practice Report for each project. The format of these reports has been standardized so that readers can easily acquire the necessary information to understand the outline of the projects and Good Practices associated with them. In addition, the effect of mitigation measures and benefits was highlighted by using specific numerical values as well as including critical comments on the projects from third parties. The number of Good Practice Reports assembled and prepared in such a way reached 60, collected from 20 countries worldwide. Despite some regional bias, favoring certain countries and continents, this is the first report in which so many cases of Good Practice have been systematically collected from all over the world.

The contents of the Hydropower Good Practices reports have been found to vary greatly. This indicates that the groups that implemented the projects faced many environmental and social problems with respect to hydropower development, and made significant efforts to realize responsible hydropower development by acceptable methods. For biophysical problems, items related to proper assessments and evaluations such as "implementation of environmental impact assessment" and "participation of experts" were given as major success factors. For socio-economic problems, items related to partnership with regional communities such as "consultation with stakeholders" and "participation of local residents in decision making process" were given as major success factors. Additionally, the appropriateness and reality of these items were verified by evaluating the collected Good Practices against recommendations for making existing and planned hydropower plants environmentally and socially acceptable, as outlined in the report of Annex III "Hydropower and the Environment", the predecessor of Annex VIII.

Social, environmental, and economic impacts resulting from hydropower projects depend largely on the natural or social environment of the affected region as well as the factors attributable to the projects themselves, such as their size and location, so these impacts can have multiple aspects. For example,

among the cases collected, one documents how cool effluent water from a deep layer water intake system impacts agriculture, while another documents how warm effluent water affected reproduction of salmon. Therefore, in selecting mitigation measures to reduce adverse impacts or enhancement measures to optimize positive outcomes, it is important to adopt “tailor-made” measures. These should be suitable for individual, specific cases considering the natural and social environment of the location where projects are implemented, and incorporate the latest technologies and knowledge.

This report covers the methodology used to collect the case histories of Hydropower Good Practice and comments on the outlines and trends identified. The 60 case histories can be found on the CDRom appended to this report.

It is recommended that this report be disseminated to a wide spectrum of stakeholders including developers who implement hydropower projects, governmental organizations, investment institutions, non-government organizations, and regional inhabitants so that the sustainability of hydropower can be evaluated in an appropriate and objective manner.

1. Introduction

Water and energy are indispensable for human sustenance. The demand for water and energy on a global scale is forecast to increase greatly in the future, in accordance with population growth and improved living standards. As such, we in the 21st century are required to secure water resources and to introduce renewable energy sources that are environmental friendly. The "Plan of Implementation" adopted at the Johannesburg Summit[1] (September 2002) recommended that renewable energy technologies (including hydropower) should be developed and global shares of renewable energy resources expanded (item19e). Meanwhile, at the 3rd World Water Forum[2] (March 2003), "Water and Energy" were established as a major theme, and the need to develop water resources and contemporary issues concerning hydropower generation were debated. At the "Renewables 2004"[3] conference held in June 2004, the cabinet ministers from more than 150 countries signed a "Political declaration" identifying hydropower generation as one of the renewable technologies "to be substantially increased with a sense of urgency". In October 2004, an UN Symposium on Sustainable Hydropower held in Beijing[4] again called for increased efforts to develop more sustainable hydropower through another declaration expressing an international consensus on the importance of appropriate water resource development.

In industrialized nations, new installations of dams, reservoirs, and hydropower plants are decreasing due to a limited growth in demand for energy and fresh water and an exhaustion of suitably economic sites for hydropower development. In developing countries, conversely, securing water resources to meet with huge increases in fresh water demand for drinking water, irrigation, etc., is an urgent task, and more dams will need to be built. Moreover, these countries lend themselves to the promotion of hydropower development since they have many highly economical yet undeveloped sites and have a tremendous increase in electric power demand. There are also expectations for the development of small-scale hydropower as an isolated power source for remote areas that are far from power grids, as a means of providing electricity for local unelectrified communities. Furthermore, with the Kyoto Protocol having become effective in February 2005, applying the Kyoto Mechanism (especially Clean Development Mechanism (CDM)) to hydropower will be assumed to facilitate hydropower development in developing countries.

Hydropower is a well established technology that uses using water without depleting it. It is the most reliable renewable energy and emits very low greenhouse gases. Yet, there is occasionally debate on the negative social and environmental impacts caused by some hydropower projects. These issues are now broadly understood by the scientific community and the general public. In awareness of these negative impacts, we are required to mitigate these impacts and to promote hydropower development that can be accepted by affected people and society. Based on our experiences and data, we need to clarify, what makes hydropower development sustainable, so that it is both technically and economically attractive as well as socially and environmentally friendly.

[1] World Summit on Sustainable Development (Johannesburg, South Africa, August 24th to September 4th, 2002)
[2] The 3rd World Water Forum (Kyoto-Shiga-Osaka, Japan, March 16th to 23rd, 2003)
[3] International Conference for Renewable Energies (Bonn, Germany, June 1st to 4th, 2004)
[4] United Nations Symposium on Hydropower and Sustainable Development (Beijing, China, October 27th to 29th, 2004)

Annex III "Hydropower and the Environment", from Phase 1 of the IEA Hydropower Agreement, presents Guidelines[5] that show the impacts of hydropower development on society and the environment, as well as measures for circumventing or mitigating these impacts. It also gives recommendations for improving environmental measures in existing and future hydropower plants. These Guidelines are not only based on outstanding cases oriented to high-level environmental management (Best Practice), but also on rigorous examination of experience acquired by persons in charge of managing environmental issues.

Annex VIII "Hydropower Good Practices" started its activities in September 2000, as a continuation from the outcome of these Annex III activities, and was officially launched in December of the same year. Its objectives are (1) to support diminishing negative environmental impacts and optimizing positive outcomes of hydropower projects, (2) to assist in the mitigation plan of environmental impact assessment, and (3) to disseminate impartial information on successful measures for environmental protection and social benefits in hydropower projects. In order to provide information on the benefits of hydropower, "Hydropower Good Practice Reports" were compiled which summarize solutions to environmental key issues as well as giving examples of the various benefits associated with hydropower development.

These Reports present specific success stories in mitigating environmental and social impacts related to hydropower projects, and specific examples of the various benefits generated by hydropower projects. These specific project examples should provide a useful source of information not only for policy-makers, decision-makers, developers, local residents, non-governmental organizations, and other stakeholders in hydropower projects, but also for the citizens of all over the world.

2. Methodology

An outline of the methodology adopted by Annex VIII to select the Good Practice Reports is described in the following chapter.

2.1. Definition of Good Practice

In various countries around the world, a very large variety of hydropower projects have been developed throughout the last century and more will be developed in future. Moreover, the social values which make hydropower development acceptable varies in different countries and regions of the world. Judgments on the value of measures to mitigate negative impacts also differ from country to country and region to region, and will depend on the geographical and socio-political conditions of the project site as well as on the project's scale. Thus, all measures that allow the management of key issues leading to responsible hydropower development in an appropriate and broadly accepted manner are considered in this initiative to be "Good Practice". We have defined "Good Practice" in the current perspectives as follows.

[5] Hydropower and the Environment: Present Context and Guidelines for Future Action (May 2000 IEA Hydropower Agreement Annex-III)

(1) Practices where environmental and social problems were resolved successfully as a result of mitigation measures
(2) Practices that provided social and/or environmental benefits through hydropower development

The term "projects" used here refers to hydropower projects, in which Good Practices were adopted, as distinct from Good Practice itself.

2.2. Classification by Key Issues

Good Practice in hydropower projects can take a manifold variety of forms. We decided to examine environmental impact mitigation measures in their relationship to six main biophysical issues and four main socio-economic issues. These biophysical and socio-economic issues were identified through a comprehensive five-year study in "Hydropower and the Environment: Present Context and Guidelines for Future Action", the outcome of Annex III activities in Phase 1. Besides these mitigation challenges, we also focused on the various benefits that hydropower projects can provide in addition to power generation, and examined these benefits as Good Practice from a social perspective. The following table shows the fifteen key issues drawn from the debate.

Categories		Key Issue	
A	Biophysical Impacts		
		1	Biological Diversity
		2	Hydrological Regimes
		3	Fish Migration and River Navigation
		4	Reservoir Sedimentation
		5	Water Quality
		6	Reservoir Impoundment
B	Socio-Economic Impacts		
		7	Resettlements
		8	Minority Groups
		9	Public Health
		10	Landscape and Cultural Heritages
C	Sharing of Development Benefits		
		11	Benefits due to Power Generation
		12	Benefits due to Dam Function
		13	Improvement of Infrastructure
		14	Development of Regional Industries
D	Non-Categorized		
		15	Others

2.3. Model Format of Good Practice Reports

Since Good Practice has multiple facets, it would not be appropriate to define or introduce it in a uniform manner. Nevertheless, from the reader's point of view, a certain uniformity of format is desirable to facilitate understanding, coherence and comparisons. Having this in mind, the working group decided to use the following Model Formats to collect information in a systematic and rigorous way.

Mitigation Type Good Practice Report	Benefit Type Good Practice Report
Key Issues	Key Issues
Keywords	Keywords
Abstract	Abstract
1. Outline of the Project	1. Outline of the Project
2. Features of the Project Area	2. Features of the Project Area
3. Major Impacts	3. Benefits
4. Mitigation Measures	4. Effects of the Benefits
5. Results of the Mitigation Measures	5. Reasons for Success
6. Reasons for Success	6. Outside Comments
7. Outside Comments	7. Further Information
8. Further Information	

2.4. Selection of Good Practice Candidates and Collecting of Good Practice Reports

Three methods of collecting Good Practice Reports from around the world were followed.

(1) Reports written and recommended by participants in Annex VIII activities, the IEA Hydropower Agreement Executive Committee Meetings, and other Annex activities.

(2) Reference searches of academic papers, reports, hydropower-related journals, etc., followed by selection of those highly acclaimed as Good Practice internationally, domestically, or regionally, and direct requests for cooperation to the relevant authors or competent bodies.

(3) Introduction of Annex VIII activities at international conferences related to hydropower, for example, Hydro 2005 and Waterpower, through the experts' meetings before conferences, workshops, poster galleries, etc., and indirect requests for cooperation.

For Asia and Oceania, method (2) was adopted. For other regions, methods (1) and (3) were mainly followed. All the Good Practice Reports collected in this way were written and submitted on a voluntary basis.

2.5. Quality Assurance of Good Practice Reports

A number of methods were adopted to ensure a high level of quality and reliability of the submitted Good Practice reports. Peer reviews by experts in hydraulic power and interviews with the authors considered the essential items forming the content of the Good Practice Reports. Materials and comments from third party organizations were published as appropriate.

Furthermore, as a means to obtain a suitable external quality assurance review for the Good Practice Reports, three Workshops were held at international conferences related to hydropower from the second half of 2003. The Good Practice Reports that had already been compiled at the first draft stage were introduced and critical views of the workshop participants were sought. From this input, necessary additions and amendments were made that improved the quality of the reports.

3. Outlines and Trends in Good Practices

During our activities over a period of about 5 years, we were able to obtain and edit 60 Good Practice Reports from 20 countries worldwide. These reports describe various benefits or mitigation measures related to environmental and social issues, and are all highly interesting. Within this chapter, we will summarize trends that have been identified through analysis of the Good Practice cases presented in the Appendix to this report.

Table 1 gives a list of the Good Practice Reports, while Figure 1 shows the location of the projects. The projects in Table 1 are classified under Key Issues and include Project Name, Country, Good Practice Subjects, Project Types, Phases of Good Practice Implementation, Sub Key Issues, Climate, and Reasons for Success. A detailed description of the projects can be found in the appended CD-ROM.

3.1 Trends vis-à-vis Regions and Topology

The following trends emerged through the analysis of the 60 Good Practice Reports collected from 20 different countries.

- Viewing the Good Practice Reports in terms of their regional distribution, 48 cases, 80% of the total were from Asia (including Japan) and North America, but few from Europe, Africa, South America and the Middle East. There were also many reports from OECD Member countries (46 cases, 77%), but few from non-Member countries. No reports were received from Russia, Eastern Europe, or Central America.

- Based on Koeppen's climate classification**,** many Good Practice cases are located in temperate climates (40 cases, 67%), but few from tropical or continental climates.

Although there was a geographical bias with respect to the provenance of the Good Practice Reports, this is the first systematic effort to compile data on so many cases of Good Practice from various parts of the world.

3.2 Trends observed for each Key Issue

The collected Good Practice Reports were classified into one of 15 pre-determined Key Issues, depending on their principal content (Major Impacts and Mitigation Measures, or Benefits and their Effects). As far as possible, we also attempted to define Sub Key Issues for reports that had a secondary content. All in all, we successfully collected Good Practice Reports for all of the 15 pre-determined Key Issues, which fall in one of the following three categories: (a) biophysical impacts, (b) socio-economic impacts or (c) sharing of development benefits.

a) **BIOPHYSICAL IMPACTS** (Key Issues 1-6)

Biological Diversity (KI-1)

- In cases classified under "Biological Diversity", many cases were associated with recent projects which were relatively large-scale and included pumping projects.
- The following are the major measures taken to avoid loss of biodiversity.
  - Understanding the influence of the project on the surrounding environment, and selection and implementation of appropriate conservation measures based on the environmental impact assessment
  - Restricting the impacts on the ecosystem by constructing various types of structures underground
  - Regeneration of vegetation by planting
  - Conservation of a river ecosystem by maintaining flows capable of maintaining the river
  - Implementing measures to prevent invasion of foreign species throughout the duration of projects ,including the construction period
  - Follow-up studies after the measures are taken and evaluation of their effectiveness
- As a specific example, a construction period was limited to the 4-month non-nesting period in a year to protect reproductive activities of large resident raptors. (Okutadami & Otori Expansion Hydropower Project, Japan).

Hydrological Regimes (KI-2)

- In many cases classified under "Hydrological Regimes", the measures taken were as a result of recent requests from stakeholders after several decades of project operation.
- The following are the major measures taken to mitigate the influence of changes in hydrological regime.
  - Recovery of a river ecosystem by keeping flow rates required for river maintenance
  - Reservoir management considering the influence on local stakeholders
  - Raising and maintaining river levels by installing weirs around estuaries
  - Follow-up studies after the measures are taken and evaluation of effectiveness
- As a specific example, an investigation to determine the hydrological regime capable of maximizing hydropower took into account the flow rate and water temperature suitable for the life cycle of Atlantic Salmon (Oncorhynchus spp.) (Ulla Forre Hydropower Project, Norway).

Fish Migration and River Navigation (KI-3)

- For cases of fish migration, methods of upstream/downstream transportation and prevention of ingress at power intakes were documented.

- The following are the major measures taken to promote fish migration and to reduce mortality rates and damage to fish which pass through hydraulic turbines or spillways.
  - Installation of a fishway in an existing dam, and implementation of measures to attract fish with a sodium lamp
  - Installation of measures to direct fish at the intake (acoustic type, mercury lamp)
- As a specific example, mortality rates of fish caused by passing through hydraulic turbines were lowered by installing a screen for sorting out fish entering the intakes and returning them, through a bypass pipe, to the river. (Puntledge Power Plant, Canada).

Reservoir Sedimentation (KI-4)

- In terms of regional distribution, cases classified under "Reservoir Sedimentation" were mainly limited to small-scale reservoirs in Asia.
- The following are the major measures taken to reduce or eliminate sediment flowing into reservoirs.
  - Reduction of sediment by constructing flood bypass tunnels going around a reservoir
  - Construction of small-scale weirs to trap earth and sands and subsequent removal by dredging.
- As a specific example, a "sand scouring procedure in case of flood" was adopted to reduce the influence on the downstream river environment. This closely duplicated the natural state where earth and sand flowing into the reservoir were discharged from the sand scouring facility (Dashidaira Dam, Japan).

Water Quality (KI-5)

- The largest number of cases (10) were collected on the subject of water quality. Mostly they were related to the operational stages of a project, rather than the planning or design stages.
- The following are the major measures taken to improve water quality in reservoirs and downstream areas.
  - Temperature control considering the growth of fish by installing selective water intake facilities
  - Reduction in water turbidity by selecting the operation of dams and constructing bypass tunnels
  - Elimination the occurrence of abnormal odor or taste of the water in reservoirs by installing full thickness aeration and circulation facilities
  - Reduction of outbreak of red tide in reservoirs by developing fresh water red tide treatment vessels
  - Treatment of heavy metals discharged from copper mines located upstream of dam
- As a specific example, a fishkill caused by oversaturation of dissolved oxygen which occurred downstream of the spillway could be reduced by modifying the spillway structure and reviewing the operation based on the results of investigations by experts. (Yacyreta Hydroelectric Project, Argentine and Paraguay).

Reservoir Impoundment (KI-6)

- Cases classified under "Reservoir Impoundment" include an assessment of the impact of dam construction and reservoir impoundment on the environment, conducted by a survey team including experts. The results were reflected in the project plan.
- The following are measures taken to mitigate social and environmental impacts relating to impoundment of reservoirs.
  - Reductions in the scale of regulating reservoir levels and preservation of wetlands by maintaining appropriate water level

- Comparison of alternative reservoir water level reductions reflecting the results of environmental research.

- As a specific example, a new biotope has been created through impoundment in reservoirs, with the result that biodiversity is preserved. This case is from the La Grande Complex (Laforge-1, Canada), which is included under the classification “KI-8: Minority Group”.

b) **SOCIO-ECONOMIC IMPACTS** (Key Issues 7-10)

Resettlement (KI-7)

- Recent cases classified under “Resettlement” were related to enforced evacuation of inhabitants following implementation of relatively large-scale project in developing countries, including India and Brazil.
- In all the cases, the aim was reconstruction of regional communities and improvement in the standard of living for the displaced residents, with the resettlement programs paying attention to the following points:
  - Securement of employment opportunities so that resettled people may have a sustainable livelihood
  - Maintenance of social infrastructure (roads, water services, communication establishments, schools, hospitals, etc.)
  - Provision of sufficient information to communities and participation by the affected population in the resettlement process

Minority Groups (KI-8)

- Two cases were collected under “Minority Groups” related to hydropower development in Quebec, Canada, based on the partnership between hydropower companies and the native inhabitants.
- In one case the native inhabitants (Montagnais) planned and implemented hydropower development through a partnership established in collaboration with the hydropower utility to ensure long-term social and economic development of the community (Minashtuk Generating Station).
- In another case, mitigation measures for the native inhabitants, who lost the basis of a traditional life-style due to hydropower development (Cree) were implemented by a non-profit organization in which the native inhabitants participated (La Grande Complex (Laforge-1)).

Public Health (KI-9)

- Two cases classified under “Public Health” were collected covering improvements in public health of community residents in the resettlement program, and ensuring that any danger to community health resulting from the project was properly managed.
- In one case deaths resulting from infectious diseases were substantially reduced by improving various facilities including hospitals and community healthcare centers after resettlement (Chamera Hydroelectric Project Stage-1, India)
- In another case information campaigns for community inhabitants continuous monitoring of water quality and health risk assessment were conducted when a temporary increase in mercury concentration of fish was caused by impoundment of the reservoir (La Grande Complex, Canada)

Landscape and Cultural Heritages (KI-10)

- Cases classified under "Landscape and Cultural Heritages" include considerations in the planning and design stages of projects for the protection of surrounding landscape and cultural heritage, prior to new hydropower development, re-development of hydropower plants and repair of facilities.
- The following are the major measures taken to preserve natural beauty over the project area and protect cultural properties with high historic value:
  - Design of power station buildings to conform with the surrounding landscape, on a project specific basis
  - Design of soil dumps by a landscape designer considering the characteristics of surrounding areas
  - Planting of soil dump sites and stone quarries based on the vegetation of the region
  - Keeping the landscape of rivers in a natural environment as much as possible by constructing weirs using natural rocks to adjust the water level, and constructing small islands in impounded areas
  - Restoration of the landscape surrounding an existing waterfall, during dam restoration work
- Other cases relate to protection of cultural heritage in which relics of an ancient civilization were to be submerged by a reservoir. These were preserved following research and excavation by an international research team consisting of experts including archeologists (Border Euphrates Project, Turkey).

c) **SHARING OF DEVELOPMENT BENEFITS** (Key Issues 11-14)

Benefits due to Power Generation (KI-11)

- Cases are included in which electric power supply made huge contributions to communities and national economies.
- Specific examples include continuous development for over fifty years by modifying the basins of four rivers and thoroughly utilizing the water resources (Integrated Hidaka River System Hydropower Development, Japan).
- While the majority of cases classified under this category are related to such large-scale developments, a case of rural electrification using a micro hydropower plant, one of the current topics related to hydropower generation, was included (Mahagnao Micro-hydro Demonstration Project, Philippines).

Benefits due to Dam Function (KI-12)

- Cases were collected of multi-purpose projects including irrigation, flood control, and water supply, which benefited communities and improved the inhabitants standard of living.
- Other cases relate to multi-purpose dams including one where automated groundwater management systems were installed to keep the level of groundwater and the flow rate in a natural condition during construction of a dam. This system was designed to mitigate changes in groundwater level in surrounding areas (Freudenau Hydropower Plant, Austria).

Improvement of Infrastructure (KI-13)

- A case was collected in which the standard of living of indigenous inhabitants was improved by constructing new roads, interconnecting coastlines with inland areas, and a road network and camps to make hunting easier. Other works included upgrading recreation and sanitation facilities such as water supply and sewerage systems, water service networks and landfills (Saint-Marguerite 3, Canada).

Development of Regional Industries (KI-14)

- Cases classified under this category include the role of a hydropower plant as a useful resource for communities to provide tourist routes and places of recreation and relaxation. Work included the upgrading of the surrounding environment centering on dams (preservation of the natural environment, construction of recreation facilities, etc.). The local government was responsible for attracting public attention and promoting autonomous and sustainable activities in the reservoir areas.
- Other cases related to tourism businesses include the introduction of a fisheries industry in a reservoir. In this case, the income of inhabitants of the community doubled (Cirata Hydroelectric Power Project, Indonesia).

d) **Non-categorized** (Key Issue 15)

Others (KI-15)

- Cases classified under this category include three that are not applicable to the previous 14 key issues, and cover the effective use of trees cut down during dam construction and driftwood staying in reservoirs.

3.3 Trends in Project Type and Good Practice Implementation Phase

There have been various arguments as to whether run-off or the hydropower plants with a reservoir place a higher burden on the environment. Generally, the reservoir type has been said to be more detrimental to the environment. However, in the Good Practice cases recorded in this report, many outstanding examples of good practice among hydropower developments with reservoirs (19 cases, 32%) were documented. Multipurpose hydropower development also accounts for a significant proportion of cases (15 cases, 25%).

With regard to the timing of appropriate management measures for biophysical impacts, many of the Good Practice examples have been implemented once the hydropower project entered the operational stage. This is probably because additional environmental improvements were made to relatively older hydropower plants which started operation several decades ago, and when a comprehensive environmental impact assessment system had not yet been established. Nowadays, in new hydropower projects, mitigation and enhancement measures are expected to be devised in the planning stage of development. Specifically for social impact mitigation measures such as “resettlement of local residents” and “protection of minorities”, detailed measures are worked out during the project planning phase.

3.4 Trends in Reasons for Success

The most recurrent reasons cited for success are: “implementation of environmental impact assessment”, “consultation with experts”, “detailed preliminary surveys”, and “appropriate planning and design”.

To mitigate socio-economic impacts, “coordination with stakeholders” is frequently cited, while “partnership with local communities and collaboration with NGOs” are among those given particular importance. Some attention is also given to factors such as “participation of local residents in the decision-making process”. Now, even in developing countries, the days of unilateral development are over, and projects need to be promoted with positive inclusion of the views of local people.

In cases concerning Sharing of Development Benefits (KI-11-14), our analysis shows that it is very important to ensure economic spin-offs for the project implementation area.

3.5 Comparison with IEA Guidelines

The Guidelines drawn up in Annex III of the IEA Hydropower Agreement (Phase 1) identify the principal matters that should be taken into account in order to develop environmentally and socially acceptable hydropower projects in the future. By comparing the collected case studies with these Guidelines, their appropriateness and practicality was examined.

- Good Practice Reports related to Biophysical Impacts (KI-1 to 6) include many cases that corresponded to the following items:
  - Consult Recognized Experts (Recommendation 2-9)
  - Public Participation in EIA (Recommendation 2-14)
  - Ecological Flow (Recommendation 3-9)
  - Follow-Up Programs (Recommendation 4-3)
  - Integrate Local Ecological Knowledge (Recommendation 5-9)

- Good Practice Reports related to Socio-Economic Impacts (KI-7 to 10) include many cases that corresponded to the following items:
  - Public Meetings or Hearing (Recommendation 2-15)
  - Threats to Vulnerable Social Groups (Recommendation 3-3)
  - Inform & Consult Local Communities (Recommendation 5-1)
  - Involvement of affected Peoples (Recommendation 5-5)
  - Resettlement & Rehabilitation Program (Recommendation 5-7)

- Good Practice Reports related to Sharing of Development Benefits (KI-11 to 14) include many cases that correspond to each guideline of Recommendation 5 "Sharing Benefits with Local Communities", especially to the following:
  - Inform & Consult Local Communities (Recommendation 5-1)
  - Economic Spin-offs (Recommendation 5-4)

4. Summary and Conclusion

To meet the growing demand for fresh water and energy around the world, and particularly in developing countries, we need to make more sophisticated and thorough use of water resources (drinking water, domestic water, irrigation water, industrial water, water for power generation, etc.). Rather than letting river water (which provides the majority of water resources) simply discharge into the sea, increased efforts should be made to allow mankind to benefit from this vital resource. In this context, the need for multipurpose hydropower development can be expected to rise in the coming decades, making the accurate assessment of negative and positive impacts a more complex challenge. Therefore, to ensure sustainable development, various mitigation and enhancement measures have to be integrated at the early stages of project planning. Furthermore, appropriate mitigation measures not only for hydropower development that is newly planned and implemented in future, but also for the refurbishment and upgrading of hydropower plants which are currently in operation, need to be devised.

When considering appropriate measures to manage environmental and social issues in future hydropower development, it is important to learn from past experience. Until now, however, there has been a lack of broad-ranging and systematically compiled information on such past cases. This collection of case studies presents specific examples of successful experiences in mitigating negative environmental impact related to hydropower development around the world, as well as specific examples showing a variety of benefits created by hydropower development. Having analyzed 60 Good Practice cases from 20 countries worldwide, it is concluded that effective mitigation measures have been developed and implemented to manage the environmental and social key issues related to these hydropower projects.

The contents of the 60 specific Good Practice cases reveal a wide diversity. Since the environmental, social and economic impacts of hydropower projects differ from country to country and from region to region, depending on the project size and the topographical, environmental and social circumstances of the project site, measures to mitigate negative impacts and to optimize positive outcomes must be project specific. Therefore, it is difficult to elaborate specific standards on a global scale. Rather than simply copying the various impact mitigation measures that have been implemented in the past, it is important to learn from past experience, as well as to add the latest technology and knowledge in devising "tailor-made" impact mitigation and enhancement measures to suit specific circumstances.

5. Recommendations

Based on the results of the Annex VIII activities, proposals to mitigate negative environmental, social and economic impacts, and increase positive outcomes related to hydropower development will be proposed. These can help enhance the sustainability of new projects as well as projects already in operation or scheduled for refurbishment.

a) Sharing of information on specific Good Practices

Information on Good Practices in properly addressing adverse environmental, social, and economic impacts associated with hydropower development and optimizing the benefits obtained, should be shared by the hydropower communities around the world and utilized to promote hydropower development in future.

b) Appropriate and objective assessment for evaluating the sustainability of hydropower development

Information on Good Practices related to mitigating adverse environmental, social, and economic impacts associated with hydropower development, and optimizing the benefits should be utilized to evaluate the sustainability of new and existing hydropower projects in objective terms. This information can then be used to help increase the global share of renewable energy. In other words, this information should be provided to a wide spectrum of stakeholders including government bodies, NGOs, and local residents, and should be put to use in objectively evaluating the value of hydropower and forming constructive debate between its proponents and opponents. In particular, measures to mitigate adverse impacts of hydropower development and the benefits associated with hydropower development, which have often not been highlighted in the past, should be duly appreciated.

c) **Planning "Tailor-made" measures to mitigate adverse impacts and optimize the benefit**

Environmental, social, and economic impacts resulting from hydropower development differ from country to country and region to region, depending on the size of the project and the topographical and environmental conditions and the social situation. Hence, mitigation and enhancement measure need to be project specific.

d) **Promotion of cross-sectoral cooperation**

Recently, reference documents such as guidelines have been published by various organizations. These include national hydropower associations in various countries, international hydropower associations (International Commission on Large Dams (ICOLD), the International Commission on Irrigation and Drainage (ICID), the International Hydropower Association (IHA), etc.), as well as the IEA. In future, it is recommended that cross-sectoral collaboration be strengthened and international standards for objective assessment of hydropower projects be developed. This initiative aims at contributing to the global effort of making hydropower development more sustainable, through the documentation of Good Practices and the highlighting of successful experiences.

e) **Future Challenges**

It is desirable that new examples of Good Practices are added and accumulated continually and systematically. This will allow the final report of Annex VIII activities to cover a wider regional area and collect more cases covering the full range of issues. This will overcome the present deficiencies in some areas and enhance the value of this report to users. For example, although sand sedimentation into reservoirs is one of the most urgent issues that require prompt measures all over the world, the collection of cases includes only one example which is related to a small-scale reservoir in Asia. In addition, it is possible to collect cases on subjects and issues not already included in this report. This could include "change in river topography associated with flooding or sand sedimentation" and "outbreak of water-borne infectious diseases", which have already been recognized widely, and cases dealing with contributions towards the reduction of global warming (for example, CDM using hydropower) as a contemporary case related to benefits brought about by hydropower development.

Table 1: List of Good Practice Reports (1/2)

	Key Issue & Project Name (*1)	Country	Main Subject (GP) (*2)	Project Type (*3)	GP Phase (*4)	Sub Key Issues	Climate (*5)	Major Reasons for Success
KI-1: Biological Diversity								
1	Okinawa Seawater PSPP	Japan	Ecosystem Conservation Measures	PS	CO		Cf	Consult Experts
2	Okutadami & Ohtori Expansion Hydropower Project	Japan	Ecosystem Conservation Measures	R	PC	11	Cf	EMS, Proper Design, Adadptive Mnagement
3	Shin-Hannou Substation	Japan	Afforestation and Revegetation of Construction Site in Harmony with Surrounding Environments	SS	PCO	10	Cf	Consult Experts
4	Tomura PP	Japan	Post-Project Investigation of River Ecosystem Recovery	R	O		Df	Consult Experts & Stakeholders, Proper Monitering
5	Palmiet PSPP	South Africa	Ecosystem Conservation by Environmental Management Plan	PS	PCO	14	Cs	EIA & Proper Planning, Consult Experts & Stakeholders
KI-2: Hydrological Regimes								
1	Futagawa Dam	Japan	Ecological Flow and Monitoring of River Ecosystem Recovery	MPD	O		Cf	Proper Design
2	Tsuga Dam	Japan	Ecological Flow and Monitoring of River Ecosystem Recovery	R	O	1	Cf	Consult Experts & Stakeholders
3	Aishihik Hydro Generating Facility	Canada	High Water Management in Reservoir in conjunction with Water License Renewal	R	O	1,6,8,10	Df	Consult Stakeholders
4	Churchill River Diversion Project	Canada	A Weir to Raise River Water Level, Protection of Fish and Ecosystem	-	O	3,10,13	Df	Consult Stakeholders & Proper EIA
5	Ulla-Forre Hydropower Project	Norway	Hydrological Regime Best for Hydropower and Riverine Ecology	CPX	O	3	Cf	Consult Experts & Stakeholders
KI-3: Fish Migration and River Navigation								
1	Daini Numazawa PP	Japan	Acoustic Fish Entrainment Prevention Device	PS	O		Cf	Consult Experts, Extensive Investigation
2	Funagira PP	Japan	Fish Ladder and Monitoring of Fish Migration	MPD	O	1	Cf	Consult Experts
3	Maan Dam	Taiwan	Large-scale Fish Ladder and Monitoring of Fish Migration	R	O		Cf	Consult Experts, Extensive Investigation
4	Chambly Dam	Canada	Fishway	-	O		Cf	Extensive Investigation, Proper Design
5	Puntledge PP	Canada	Fish Bypass Screen at Power Intake	R	O		Cf	Extensive Investigation, Proper Design
KI-4: Reservoir Sedimentation								
1	Dashidaira Dam	Japan	Large-scale Sediment Flushing Operation	R	O		Cf	Consult Experts & Stakeholders, Extensive Investigation, Proper Operation
2	Miwa Dam	Japan	Sediment Control for Dam by Bypass Tunnel	MPD	O	12	Cf	Consult Experts, Extensive Investigation
3	Cameron Highlands Hydroelectric Scheme	Malaysia	Sediment Management by Silting Weir & Dredging	CPX	O		Af	Proper Design
KI-5: Water Quality								
1	Asahi Dam	Japan	Diversion of Sediment and Turbid Water during Flood	PS	O	4	Cf	Consult Experts, Extensive Investigation
2	Hydropower Dams in Hida River System	Japan	Selective Intake & Dam Group Operation	CPX	O	14	Cf	Consult Experts & Stakeholders, Extensive Investigation, Proper Operation
3	Kamafusa Dam	Japan	Water Quality Control by Aeration in Reservoir	MPD	O		Cf	Extensive Investigation, Proper Design
4	Kobo Dam	Japan	Measures against Turbid & Cold Water and Ecological Flow	R	O	2	Cf	Consult Stakeholders, Extensive Investigation
5	Tsukabaru Dam	Japan	Reduction of Water Bloom by Ultraviolet Irradiation	R	O		Cf	Proper Design
6	Mingtan PP	Taiwan	Water Quality and Ecology in Reservoir	PS	O	1	Cf	Consult Experts, Proper Design
7	Arrow Lakes Generating Station	Canada	Reduction of Dissolved Gas Supersaturation (DGS)	R	O	1,2,14	Cf	Consult Stakeholders, Public Participation, Proper EIA
8	Shasta Dam	USA	Water Temperature Modification & Salmon Habitat Restoration	R	O	1	Cs	Proper Design
9	Yacyreta Hydroelectric Project	Argentina & Paraguay	Reduction of Dissolved Gas Supersaturation (DGS)	R	O	1	A	Extensive Investigation, Proper Design
10	King River Power Development	Australia	Voluntary EIA, Water Quality associated with Copper Mine	R	C		Cf	Proper EIA & Planning, Inform & Consult Local Comunities
KI-6: Reservoir Impoundment								
1	Numappara PSPP	Japan	Marshland Conservation	PS	PCO	1	Cf	Consult Experts & Stakeholders
2	Sugarloaf Reservoir Project	Australia	Management of Environmental and Social Impact	-	PCO	1,2,5	Cf	Proper Planning and Design, Consult Stakeholders, Monitoring
KI-7: Resettlement								
1	Chiew Larn Multipurpose Project	Thailand	Rebuilding of Resettled Communities	MPD	PC	12,13	Af	Proper Planning
2	Song Hinh Multipurpose Project	Vietnam	Rebuilding of Resettled Communities	MPD	PC	13	Am	Proper Planning, Public Participation, Consult Stakeholders
3	Uri Hydroelectric Project	India	Rebuilding of Resettled Communities	ROR	PC	13	C	Proper Planning, Public Participation, Consult Stakeholders
4	Salto Caxias Hydropower Development Project	Brazil	Rebuilding of Resettled Communities	R	PC	13	Cf	Consult Stakeholders

Table 1: List of Good Practice Reports (2/2)

Key Issue & Project Name (*1)		Country	Main Subject (GP) (*2)	Project Type (*3)	GP Phase (*4)	Sub Key Issues	Climate (*5)	Major Reasons for Success
KI-8: Minority Groups								
1	La Grande Complex (Laforge-1)	Canada	Joint Implementation of Remedial Measures with Indigeneous People	R	PCO	1,13	Df	Public Participation
2	Minashtuk Generating Station	Canada	Partnership with Indigeneous Community	ROR	PCO	11	Df	Support Local Community
KI-9: Public Health								
1	Chamera Hydroelectric Project Stage-1	India	Infrastructure Improvement	ROR	PCO	7,13	C	Proper Planning, Public Participation, Cooperation with Local Governments
2	La Grande Complex	Canada	Management of Health Issues due to a Temporary Mercury Increase	CPX	O	5	Df	Inform & Consult Local Communities, Public Health Program
KI-10: Landscape & Cultural Heritage								
1	Chinda PP	Japan	Conservation of Historical Waterfall	ROR	O		Cf	Extensive Investigation, Proper Design
2	Six PPs in Kurobe River	Japan	Powerhouse Landscape Design	ROR	PCO	11	Cf	Proper Design, Consult Stakeholders
3	Border Euphrates Project	Turkey	Transfer and Preservation of Inundated Cultural Heritage	R	PC	7	Bs	Extensive Investigation, Consult Experts
4	Aurland Hydropower Development Project	Norway	Conservation of Natural & Cultural Landscape	CPX	PCO		Cf	EIA, Proper Design, Revegetation
5	Kokkosniva Hydropower Plant	Finland	Preservation of Old Village & Riverine Habitat	ROR	PCO	1,6	Df	Consult Experts & Stakeholders, Proper Design
KI-11: Benefits due to Power Generation								
1	Integrated Hidaka River System Hydropower Development	Japan	Power Supply & Regional Development	CPX	O		Df	Proper Planning & Design, Consult Stakeholders
2	Large Scale PSPPs in TEPCO	Japan	Improvement of Power System Performance	PS	O		Cf	Proper Planning & Design, Improving Economic Efficiency
3	Mahagnao Micro-hydro Demonstration Project	Philippines	Rural Electrification & Regional Industrial Development	ROR	O	14	Am	Proper Planning & Design
4	Keban Dam & Hydroelectric PP	Turkey	Power Supply & Industrial Development	MPD	O	14	Bs	Proper Planning & Design
KI-12: Benefits due to Dam Function								
1	Bhumibol Dam	Thailand	Irrigation & HPP	MPD	PCO		As	Consult Stakeholders, Proper Planning & EIA
2	Nam Ngum I Hydropower Plant	Laos	Multipurpose Benefits for Local Communities	MPD	PCO	14	Am	Contribution to Regional Industries, Support from Outside Parties
3	Ataturk Dam & Hydroelectric PP	Turkey	Regional Development by MPD	MPD	PCO		Df	Consult Stakeholders
4	Freudenau Hydropower Plant	Austria	Ground Water Management	MPD	PCO	5,6	Cf	Extensive Investigation, Consult Stakeholders, Parmanent Monitoring
KI-13: Improvement of Infrastructure								
1	Sainte Marguerite 3	Canada	Regional Benefits & HPP	R	PCO	8,14	Df	Inform & Consult Local Communities
KI-14: Development of Regional Industries								
1	Gosyo Dam	Japan	Environmental Improvement & Tourism Development at Dam Site	MPD	PCO	1,11	Cf	Consult Stakeholders
2	Kurobegawa No.4 PP	Japan	Tourism Development with Dam	R	PCO		Cf	Good Location, Proper Planning & Design, Cooperation with Local Community
3	Miyagase Dam	Japan	Tourism Development with Dam	MPD	PCO	1,7	Cf	Good Location, Proper Planning & Design, Cooperation with Local Governments
4	Yasaka Dam	Japan	Environmental Improvement & Sightseeing Development at Dam Site	MPD	PCO		Cf	Involvement of Local Government & Communities
5	Cirata Hydroelectric Power Project	Indonesia	Reservoir Fishery in Resettlement Program	MPD	PCO	7	Af	Proper Design, Vocational Training
KI-15: Others								
1	Shin-Shimodaira & Shin-Koara PPs	Japan	Use of Wood Wastes from Dam Site	ROR	C		Cf	Consult Stakeholders
2	Taki Dam	Japan	Use of Driftwood in Reservoir	R	O		Cf	Proper Design
3	Tomisato Dam	Japan	Recycling of Felled Trees in Dam Site	MPD	C		Cf	Improve Economic Efficiency

Total Nos. of GPRs: 60

Project Name (*1): PP = Power Plant, PSPP = Pumped Storage Power Plant

Main Subject (GP) (*2): HPP = Hydropower Power Plant, MPD = Multi-purpose Development

Project Type (*3): ROR = Run-of-River, R = Reservoir, PS = Pumped Storage, MPD = Multi-purpose Development, CPX = Complex, SS = Sub Station

GP Phase (*4): P = Planning Phase, C = Construction Phase, O = Operation Phase

Climate (*5): A = Toropical, B = Dry, C = Temperate, D = Cold, E = Polar

Figure 1. Regional Distribution of Projects (60 cases from 20 countries)

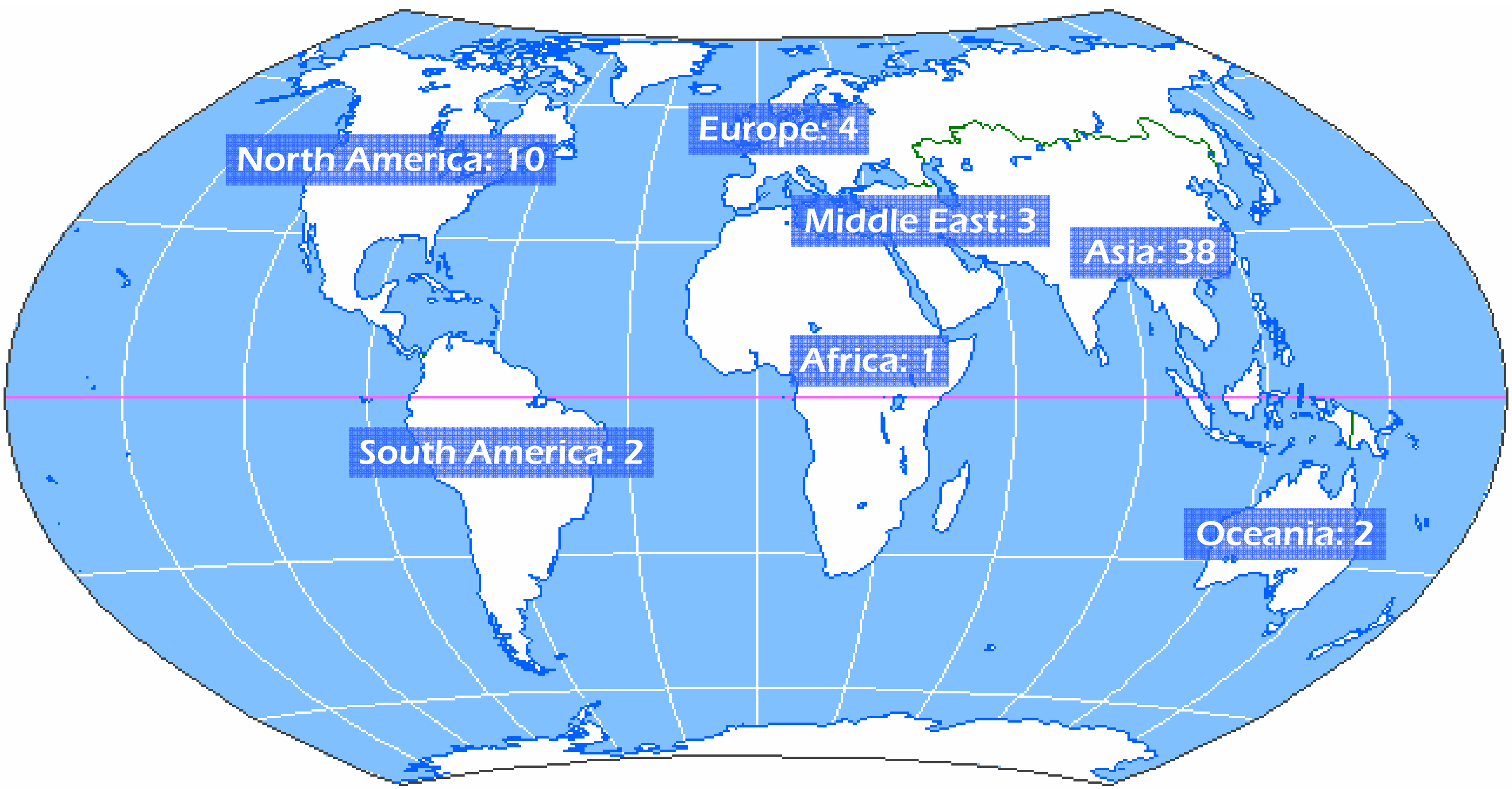

Figure 2. Number of Good Practice Reports by Region

Region / Country	No. of GPR	%
Japan	27	45.0
Asia	11	18.3
North America	10	16.7
Europe	4	6.7
Middle East	3	5.0
Oceania	2	3.3
South America	2	3.3
Africa	1	1.7
Total	60	

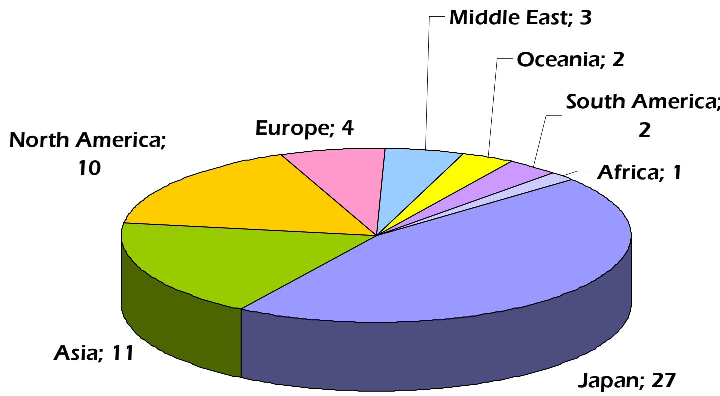

Figure 3. Number of Good Practice Reports by Economic Region

Economic Region	No. of GPR	%
OECD	46	76.7
Asia	11	18.3
Latin America	2	3.3
Africa	1	1.7
Total	60	

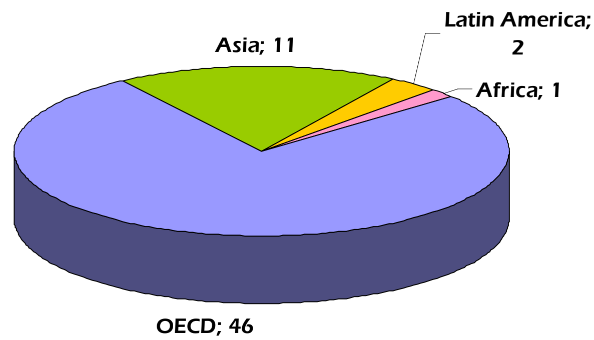

Figure 4. Number of Good Practice Reports by Climate Region

Climate Region	No. of GPR	%
C: Temperate	40	66.7
D: Cold	10	16.7
A: Tropical	8	13.3
B: Dry	2	3.3
Total	60	

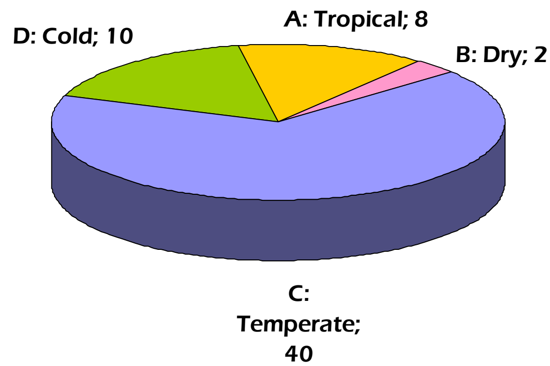

Figure 5. Number of Good Practice Reports classified by Region and Key Issue

* No, of Good Practice Reports in each KI includes the projects which are applicable to Sub Key Issues.

	Key Issue	Japan	Asia	North America	Europe	Middle East	Oceania	South America	Africa	Total	%
1	Biological Diversity	9	1	4	1		1	1	1	18	15.8
2	Hydrological Regimes	3		3	1		1			8	7.0
3	Fish Migration & River Navigation	2	1	3	1					7	6.1
4	Reservoir Sedimentation	3	1							4	3.5
5	Water Quality	5	1	3	1		1	1		12	10.5
6	Reservoir Impoundment	1		1	2		1			5	4.4
7	Resettlement	1	5			1		1		8	7.0
8	Minority Groups			4						4	3.5
9	Public Health		1	1						2	1.8
10	Landscape & Cultural Heritage	3		2	2	1				8	7.0
11	Benefits due to Power Generation	5	1	1		1				8	7.0
12	Benefits due to Dam Function	1	3		1	1				6	5.3
13	Improvement of Infrastructure		4	3				1		8	7.0
14	Development of Regional Industries	5	3	2		1			1	12	10.5
15	Others	3					1			4	3.5
Total		41	21	27	9	5	5	4	2	114	

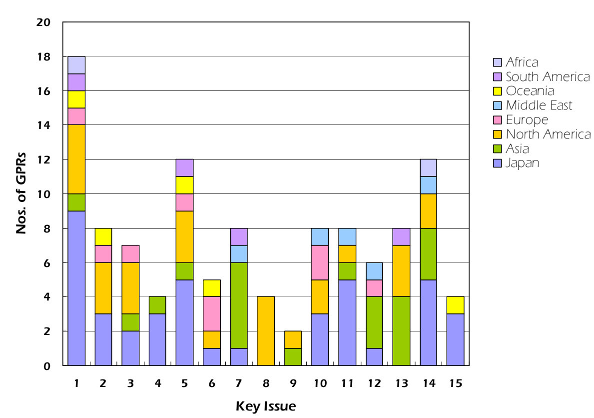

Figure 6. Number of Good Practice Reports by Project Type

Region / Country	No. of GPR	%
Run of River	8	13.3
Reservoir	19	31.7
Pumped Storage	7	11.7
Multipurpose	16	26.7
Complex	6	10.0
Others	4	6.7
Total	60	

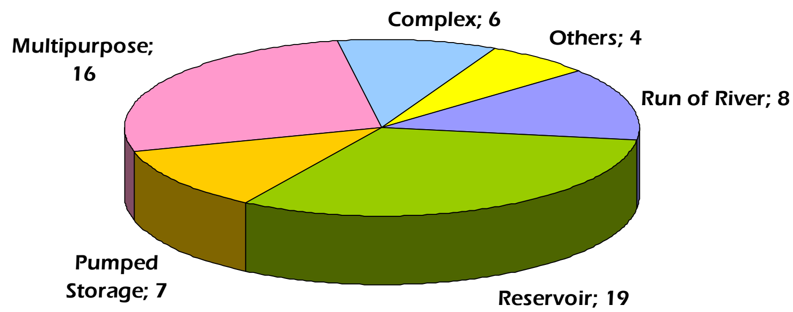

Figure 7. Number of Good Practice Reports by Region and Project Type

Region / Country	Run of River	Reservoir	Pumped Storage	Multi-purpose	Complex	Others	Total	%
Japan	3	8	5	8	2	1	27	45.0
Asia	3	1	1	5	1		11	18.3
North America	1	6			1	2	10	16.7
Europe	1			1	2		4	6.7
Middle East		1		2			3	5.0
Oceania		1				1	2	3.3
South America		2					2	3.3
Africa			1				1	1.7
Total	8	19	7	16	6	4	60	

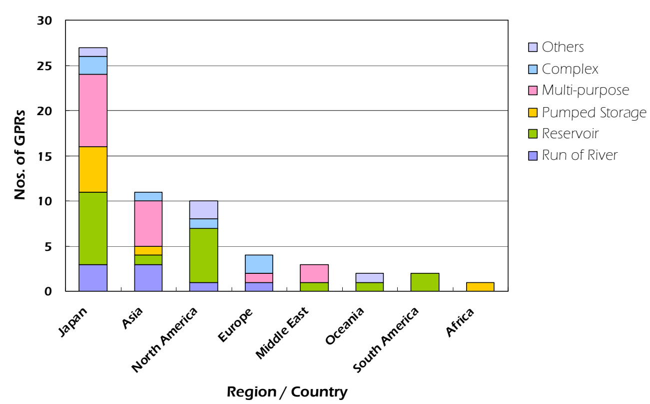

Figure 8. Number of Good Practice Reports by Key Issue and Project Type

* No, of Good Practice Reports in each KI includes the projects which are applicable to Sub Key Issues.

	Key Issue	Run of River	Reservoir	Pumped Storage	Multi-purpose	Complex	Others	Total	%
1	Biological Diversity	1	8	4	3		2	18	15.8
2	Hydrological Regimes		4		1	1	2	8	7.0
3	Fish Migration & River Navigation		2	1	1	1	2	7	6.1
4	Reservoir Sedimentation		1	1	1	1		4	3.5
5	Water Quality	1	5	2	1	2	1	12	10.5
6	Reservoir Impoundment	2	1	1			1	5	4.4
7	Resettlement	2	2		4			8	7.0
8	Minority Groups	1	3					4	3.5
9	Public Health	1				1		2	1.8
10	Landscape & Cultural Heritage	3	2			1	2	8	7.0
11	Benefits due to Power Generation	3	1	1	2	1		8	7.0
12	Benefits due to Dam Function	1			5			6	5.3
13	Improvement of Infrastructure	2	3		2		1	8	7.0
14	Development of Regional Industries	1	3	1	6	1		12	10.5
15	Others	1	2		1			4	3.5
Total		19	37	11	27	9	11	114	

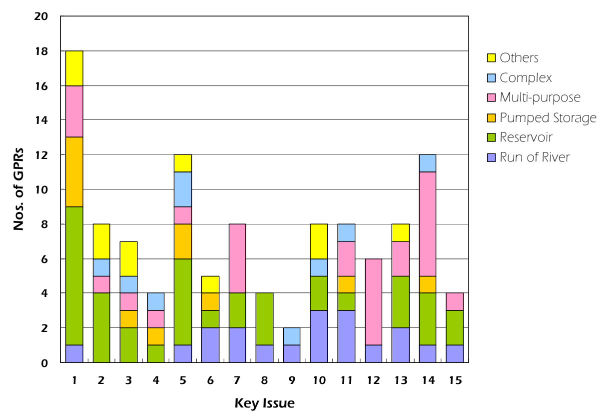

Figure 9. Number of Good Practice Reports by Key Issue and Project Phase

	Key Issue	No. of Project	Planning	Construction	Operation	Total	%
1	Biological Diversity	5	3	4	4	11	10.3
2	Hydrological Regimes	5			5	5	4.7
3	Fish Migration & River Navigation	5			5	5	4.7
4	Reservoir Sedimentation	3			3	3	2.8
5	Water Quality	10			9	9	8.4
6	Reservoir Impoundment	2	2	2	2	6	5.6
7	Resettlement	4	4	4		8	7.5
8	Minority Groups	2	2	2	2	6	5.6
9	Public Health	2	1	1	2	4	3.7
10	Landscape & Cultural Heritage	5	4	4	4	12	11.2
11	Benefits due to Power Generation	4			4	4	3.7
12	Benefits due to Dam Function	4	4	4	4	12	11.2
13	Improvement of Infrastructure	1	1	1	1	3	2.8
14	Development of Regional Industries	5	5	5	5	15	14.0
15	Others	3		3	1	4	3.7
Total		60	26	30	51	107	

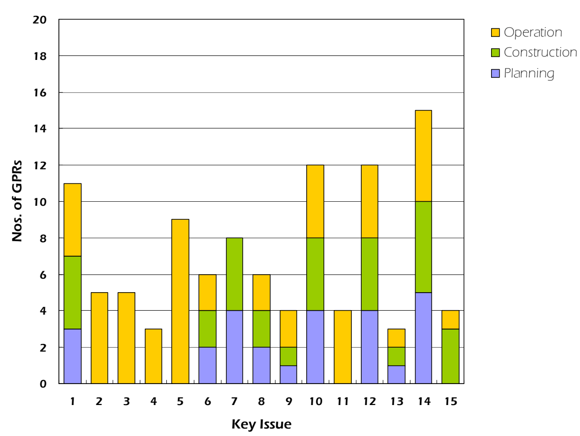

Figure 10. Number of Good Practice Reports by Key Issue and Major Reasons for Success

	Key Issue	Consulting with Recognized Experts	Comprehensive Investigation in Advance	Appropriate Planning and Design	Coordination among Stakeholders	Public participation in Decision-Making Process	Improvement of economic effectiveness	Others
1	Biological Diversity	3	1	2	2			1
2	Hydrological Regimes	2	1	1	3	1		
3	Fish Migration & River Navigation	3	4	2				
4	Reservoir Sedimentation	2	2	1	1			
5	Water Quality	3	7	4	2	1		1
6	Reservoir Impoundment	2		1	2			
7	Resettlement	1	1	1	1	3		1
8	Minority Groups				1	1		
9	Public Health	1	1	1		2		2
10	Landscape & Cultural Heritage	1	3	3	2			
11	Benefits due to Power Generation			4	1		1	
12	Benefits due to Dam Function		1	3	2	1		1
13	Improvement of Infrastructure				1			
14	Development of Regional Industries			3	1	3		3
15	Others			2	2	0	1	
Total		**18**	**21**	**28**	**21**	**12**	**2**	**9**