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Training Manual

Comprehensive Options Assessment in Hydropower Development

Network for Sustainable Hydropower Development in the Mekong Countries (NSHD-M)

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Comprehensive Options Assessment in Hydropower Development

PREFACE

Intergovernmental co-operation between countries that share the Mekong River and its tributaries commenced in 1957 when the United Nations founded the Mekong River Committee. The Mekong was then one of the world's largest unregulated rivers, and the Committee was to capitalise on the river's economic potential. In 1995 a new Mekong Agreement established the Mekong River Commission (MRC), with a more holistic mandate: 'to promote and co-ordinate sustainable management and development of water and related resources for the countries' mutual benefit and the people's well-being by implementing strategic programmes and activities and providing scientific information and policy advice'. The 1995 Mekong Agreement also placed the MRC under the direct responsibility of its four member states: Thailand, Laos, Cambodia and Vietnam. The MRC also engages with two important upstream partners,, China and Myanmar, on its shared water courses.

The development of the Mekong's water resources have included the establishment of a number of large dams, on both the river's main stem and tributaries, in all four member countries. These dams were constructed for a variety of purposes, including flood protection, irrigation and hydropower. These dams have been controversial, due to their negative effects on natural and social environments—to the extent that some member countries, such as Thailand, have ceased building dams altogether.

In 2000, the World Commission on Dams (WCD) published *Dams and Development: A New Framework for Decision-Making*. In the report WCD proposed an approach based on the recognition of rights and the assessment of risks, particularly taking into account the core values of equity, efficiency, participatory decision-making, sustainability and accountability, when building dams. In addition, the report identified seven strategic priorities, associated principles, and twenty-six guidelines for the way forward.

On completion of its mandate, the WCD was disbanded. To maintain the WCD's momentum, the United Nations Environment Programme (UNEP), as a neutral entity to disseminate the WCD report and facilitate inclusive, multi-stakeholder dialogues at national and local levels, reviewing the WCD's recommendations, agreed to host a follow-up initiative: the Dams and Development Project (DDP). One of the outputs of the DDP process was *A Compendium of Relevant Practices for Improved Decision-Making on Dams and their Alternatives*.

Against the backdrop of previous water resource development projects, with their many negative legacies, the German Development Cooperation, through GIZ, agreed to promote the sustainable development of the Mekong's water resources, by facilitating learning among member countries, to minimize adverse effects and optimise the benefits of new projects. GIZ recognised developmental challenges, faced by emerging economies worldwide; in particular, an ever-increasing need for sustainable, renewable energy (in particular, hydropower in the Mekong region). This led to the establishment of the Network for Sustainable Hydropower Development in the Mekong Countries (NSHD-M), including academics and researchers from MRC member states and China. Key functions of the NSHD-M are human resource development and advanced training, as well as dialogue and regional networking to share information and good practices.

These objectives will be achieved through the sharing of information on six key topics:

- Dealing with Social Aspects
- Sustaining River Basin Ecosystems

- Comprehensive Options Assessment
- Hydropower and Economic Development
- Hydropower Development on Transboundary Rivers
- Hydropower and Climate Change

It is intended that these topics will be addressed in six respective training manuals, supported by country-specific case studies, developed by academics and researchers from MRC member states and China. This training manual covers ‘Comprehensive Options Assessment’.

Each of the training manuals is being developed in three phases: the development of generic manuals of sufficient scope and depth, the adaptation of these generic manuals to align with Mekong basin states' country-specific legal and institutional frameworks and socio-economic conditions, and further adaptations as may be required, including the translation of the training manuals into local languages.

GIZ promotes and supports participatory learning and adopts a ‘Participatory Adult Learning Approach’ (PALA). Participatory adult education is founded on the belief that people have a right to influence the decisions that affect their lives and that adult learners come with particular goals and ideas about education. Thus, participatory education programs involve learners in making decisions about their own learning, particularly through activities chosen or created by the learners theselves. This, in turn, validates learners’ knowledge and needs, enhances academic achievement, and shapes the extent to which participants can exercise control in the classroom, their lives, and communities. According to adult education scholars, the purposes of participatory education are to enhance learners’ autonomy, critical thinking, leadership, and active citizenship.

It is important that what is taught is applicable to real life situations. A workshop will, therefore, provide an opportunity for adult learners to apply what has been learned to real-life situations and job requirements. Learners will be encouraged to share their experiences and possible solutions, turning workshops into learning cooperatives.

Adults have different experiences throughout life which lead to the accumulation of knowledge. Some experiences are based on past learning, others on everyday community life and work. All of these are significant resources from which to draw on during the learning process and to share with others. It is important to establish what learners’ existing knowledge is and to encourage them to share what they’ve accumulated with others.

Participants learn more by listening and actively participating than by taking detailed notes. Learners must actively participate in order to satisfy their learning needs. In participatory learning, learners actively participate to determine what and how they learn. This may include the objectives, knowledge, skills and attitudes or actual teaching methods. Traditionally, a teacher delivers information; however, in participatory learning, a student learns by doing.

While a participatory approach is encouraged, at times information must still be presented . Examples include: giving instructions, giving advice or suggestions, summarizing, giving explanations or demonstrations. The challenge is to provide necessary information without learners becoming bored.

Other ways in which participatory learning can be implemented include: group work, group discussions, brainstorming, role play, field work, and questions and answers.

From this manual, the trainings are intended to be participatory in nature, optimising the benefits of the ‘Participatory Adult Learning Approach’.

Applying modern adult learning methods at the Trainer-of-Trainers Workshop in Phnom Penh, March 2013

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1. INTRODUCTION TO THE LARGE DAMS AND HYDROPOWER DEBATE

1.1 Background

1.1.1 Key Aspects

- The debate on large dams and hydropower can be traced over several decades through international initiatives and resulting normative frameworks, concerning environmental and social safeguards and human rights, including:
  - United Nations Conference on the Human Environment, 1972;
  - Brundtland Commission, 1987;
  - UN Conference on Environment and Development, 1992;
  - The Millennium Report, 2000;
  - World Summit on Sustainable Development, 2002; and
  - The Rio +20 conference, 2012.
- In 2000, the World Commission on Dams (WCD) proposed an approach, based on the recognition of rights and assessment of risks, five core values, seven strategic priorities and twenty-six guidelines.
- As a follow-up to the WCD, the UNEP Dams and Development Project (UNEP-DDP) was a neutral entity to disseminate the WCD Report and to facilitate a review of its recommendations at national and local levels, through inclusive multi-stakeholder dialogues.
- The International Hydropower Association has achieved much consensus on its 2011 Hydropower Sustainability Assessment Protocol

1.1.2 Training Aids

Purpose of session	The purpose of the session is to introduce the debate that has developed in the international community about large dams and specifically hydropower.
Learning objectives	• To understand the origin and the extent of the dams debate. • To know of the many institutions that has been involved. • To know the core issues in the debate. • To appreciate the volume of the body of knowledge.
Time required for session	60 – 90 minutes

Preparatory reading	1. World Commission on Dams. 2000. *Dams and Development a New Framework for Decision-making.* The Chairman's and Commissioner's Forewords 2. UNEP, Dams and Development Project. 2007. A Compendium of relevant practices for improved decision-making on dams and their alternatives. The Executive Summary
Discussion topics	• The WCD and DDP ended when they had achieved their mandate. Is there an argument for having a permanent institution to guide dams and development? Could the International Hydropower Association serve this purpose? • In today's world, is the following view still acceptable: "It is alright if some people suffer, as long as more people are benefiting?" • Principle 15 of the Rio Declaration states: o "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." • How could this principle be applied to hydropower dams?
Exercises	1. Draw a time line of the most important events in the "dams and development" dialogue. 2. List large water infrastructure projects in your country that are controversial or have under-performed technically, economically, environmentally or socially.
Additional Reading and core reference list	1. World Commission on Dams. 2000. Dams and Development a New Framework for Decision-making. 2. UNEP, Dams and Development Project. 2007. A Compendium of relevant practices for improved decision-making on dams and their alternatives. 3. Moore, D.; Dore, J. and Gyawali, D. 2010. *The World Commission on Dams + 10: Revisiting the large dam controversy*. Water Alternatives 3(2): 3-13. www.water-alternatives.org 4. Porter, I and Shivakumar, J. (eds) *Doing a dam better: the Lao People's Democratic Republic and the story of Nam Theun 2*. The World Bank. www.worldbank.org.
Case Studies	None

1.1.3 The Environmental Thread

Awareness of the negative impacts of unfettered technological development first occurred in the United States during the post-World War II industrial boom. In 1969, the US promulgated the National Environmental Policy Act (NEPA)—the first national legislation to mandate environmental assessment and required results be published in a detailed environmental statement. Subsequently, this prompted extensive research into the methods needed to comply with NEPA and environmental assessment.

The US approach provided the catalyst for broader international initiatives. In 1972 at the United Nations Conference on the Human Environment, the United Nations Environment Programme (UNEP) was launched. In 1987, the World Commission on Environment and Development (WCED, commonly called the Brundtland Commission, published its report, *Our Common Future*. It called for development that met the needs of the present generation without compromising the ability of future generations to meet their own needs, and prompted the use of the term "sustainable development". By the start of the 1990s, three major instruments of international environmental law existed: the International Framework Convention on Climate Change, the International Convention on Biodiversity, and the Montreal Protocol on Ozone.

In 1992, the UN Conference on Environment and Development (UNCED) was held in Rio de Janeiro. It discussed a wide range of environmental issues. The output was *Agenda 21 - the environmental agenda for the 21st century*. Chapter 18 of the Agenda deals with water resources. Paragraph 40 of Chapter 18, calls for *"...the development of national and international legal instruments that may be required to protect the quality of water resources, including for environmental impact assessment".* The Conference's Rio Declaration, Principle 17 states:

> *"Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority."*

In 2000, the Report of the Secretary General of the United Nations (The Millennium Report) stated:

> *"The ecological crises we confront have many causes. They include poverty, negligence and greed - and above all, failures of governance. These crises do not admit of easy or uniform solutions."*

Apart from proposing the Millennium Development Goals (MDG), the report called for the "*building of a new ethic of global stewardship*". It held that effective environmental policy must be based on sound scientific information and called for governments to create and enforce environmental regulations.

In 2002, the World Summit on Sustainable Development (WSSD) reaffirmed the international community's commitment to Agenda 21. Paragraph 19 of the Johannesburg Plan of Implementation called on all states to:

> *"... encourage relevant authorities at all levels to take sustainable development considerations into account in decision-making, including on national and local*

development planning, investment in infrastructure, business development and public procurement. This would include actions at all levels to:

(a) …….

(e) ***Use environmental impact assessment procedures****".*

In 2012 at the United Nations Conference on Sustainable Development (Rio +20) the international community again reaffirmed the principles that had been developed in the above mentioned conferences.

The Heads of State expressed their determination to:

> *"... re-invigorate political will and to raise the level of commitment by the international community to move the sustainable development agenda forward*" and "*to eradicate poverty and promote empowerment of the poor and people in vulnerable situations*".
>
> And
>
> "*We acknowledge that climate change is a cross-cutting and persistent crisis, and express our concern that the scale and gravity of the negative impacts of climate change affect all countries and undermine the ability of all countries, in particular, developing countries, to achieve sustainable development and the Millennium Development Goals, and threaten the viability and survival of nations*" and "*We underscore that broad public participation and access to information and judicial and administrative proceedings are essential to the promotion of sustainable development*".

The declaration also introduces the "green economy" and a set of guidelines to the debate[1].

Moreover there was agreement to launch a process to develop a set of sustainable development goals (SDGs).

1.1.4 Sustainability Concept

The sustainability concept was crystallized by the World Commission on Environment and Development in 1987. It is development that meets "... *the needs of the present generation without compromising the ability of future generations to meet their own needs*". The Rio Declaration on Environment and Development elaborated 18 principles of sustainability. It is now generally accepted that the concept integrates the economic, social and environmental dimensions of development, which require rights-based, equitable and inclusive processes that enhance sustainability at global, regional, national and local levels.

2012 was the International Year of Sustainable Energy for All. The Secretary General of the United Nations established the initiative (SE4ALL) and reported[2]:

[1] United Nations. *The future we want*. Resolution adopted by the General Assembly A/RES/66/288, 123rd plenary meeting. 27 July 2012

"5...Without access to modern energy services, it is not possible to achieve the Millennium Development Goals.

6. The availability of adequate, affordable and reliable energy services is essential for alleviating poverty, improving human welfare, raising living standards and, ultimately, achieving sustainable development. Adequate ***sustainable*** *energy services are critical inputs in providing for human health, education, transport, telecommunications and water availability and sanitation.*

7. Achieving ***sustainable*** *energy for all involves the development of systems that support the optimal use of energy resources in an equitable and socially inclusive manner while minimizing environmental impacts. Integrated national and regional infrastructures for energy supply, efficient transmission and distribution systems and demand programmes that emphasize energy efficiency are necessary for sustainable energy systems."*

1.1.5 The World Commission on Dams

For years, governments, civil society organisations, development officials, industry associations and private sector proponents have debated the costs and benefits of large dams. In recent years, the building of any dam has drawn environmental, social or political controversy. The 1990s saw an escalation of these conflicts. Proponents pointed to the social and economic development benefits that dams make possible, such as providing electric power, irrigation and water supply. Critics argued that project funding, whether public and/or private, systematically downplays the adverse environmental, social and economic impacts of dams and exaggerates the benefits. By the mid-1990s, an estimated 800,000 dams existed worldwide, with some 40-80 million people displaced and impoverished by them, and raging international controversy over the merits of further large water infrastructure projects.

In April 1997, IUCN and the World Bank sponsored a small but significant workshop in Gland, Switzerland. Representatives of diverse interests came together to discuss the highly controversial issues associated with large dams. To the surprise of participants, deep-seated differences on the development benefits of large dams did not prevent a consensus emerging that a new way forward was needed, which led to the formation of a multi-stakeholder World Commission on Dams (WCD).

The WCD was established in February 1998 and began its work under the chair of Professor Kader Asmal. Its 12 members were chosen through a global search process to reflect regional diversity, expertise and varying stakeholder perspectives. The Commission was independent, with members serving in individual capacities, and not as representatives of an institution or a country.

The Commission began by consolidating worldwide knowledge and experience with large dams. To give its analysis and conclusions a solid foundation, the WCD commissioned, organised or accepted:

- In-depth case studies of large dams on five continents, together with two country papers.

[2] United Nations. 2012. *International Year of Sustainable Energy for All, 2012: Report of the Secretary General*. Report A/67/314. 16 August 2012

- A cross-check survey targeted at 150 large dams in 56 countries.
- 17 thematic reviews, grouped into five dimensions of the debate.
- Four regional consultations.
- Inputs submitted by interested individuals, groups and institutions.

Analysis of the knowledge base confirmed that whilst some dams have been successful, many large dam projects have fallen short of their physical and economic targets, have led to irreversible damage to river ecosystems, and have had serious negative effects on affected communities.

In November 2000, the WCD report, *Dams and Development: A New Framework for Decision-Making*, was published[3]. The WCD report has a number of elements: a summary report, a main report and the knowledge base. Together they present more than 4000 pages of collective wisdom on dams.

The Commission proposed a way forward characterised by:

- An approach based on the recognition of rights and assessment of risks;
- Five core values:
  - equity,
  - efficiency,
  - participatory decision-making,
  - sustainability,
  - accountability.
- Seven strategic priorities:
  - gaining public acceptance,
  - comprehensive options assessment,
  - addressing existing dams,
  - sustaining rivers and livelihoods,
  - recognising entitlements and sharing benefits,
  - ensuring compliance,
  - sharing rivers for peace, development and security.
- Twenty-six guidelines for implementing the strategic priorities.

Following the fulfilling of its mandate, the Commission then dissolved with the words:

"*We have told our story. What happens next is up to you*."

1.1.6 The DDP and the Compendium

To maintain the momentum created by the WCD, and as a neutral entity to disseminate and facilitate a review of the WCD Report, through national and local multi-stakeholder

[3] The WCD website has closed. At the time of writing the main report was available at http://wwf.panda.org/what_we_do/footprint/water/dams_initiative/dams/wcd/

dialogues, UNEP agreed to host a follow-up initiative called the Dams and Development Project (DDP). The DDP had four key elements:

- Promoting national, regional and global multi-stakeholder dialogues.
- Detailing non-prescriptive practical tools.
- Networking and communication.
- Disseminating information.

The objectives of the DDP's second and final phase (2005-2007) were to:

- Support multi-stakeholder dialogues at country, regional and global levels for improving decision-making on dams and their alternatives, with the aim of engaging all stakeholders, particularly on governments.
- Produce non-prescriptive tools to help decision-makers, by drawing on all relevant existing criteria and guidelines for the planning and management of dams and their alternatives.

The outcome of the second objective was the publication 'A Compendium of Relevant Practices for Improved Decision-Making on Dams and their Alternatives'. The Compendium is an tool to assist policy makers, decision makers, professionals and other stakeholders in the planning and management of dams and their alternatives. It deals with a set of key environmental and social topics (Text Box 3.1), which were prioritised by the DDP process, and gives examples of relevant practices, which have actually been implemented.

Box 1.1-1: Key Issues dealt with by the Compendium

- Identification of options (Chapter 2)
- Stakeholder participation (mechanisms) (Chapter 3)
- Social impact assessment and addressing outstanding social issues (Chapter 4)
- Compensation policy and benefit-sharing mechanisms (Chapter 5)
- Environmental management plans (Chapter 6)
- Compliance (Chapter 7)
- International policy on shared rivers (Chapter 8)

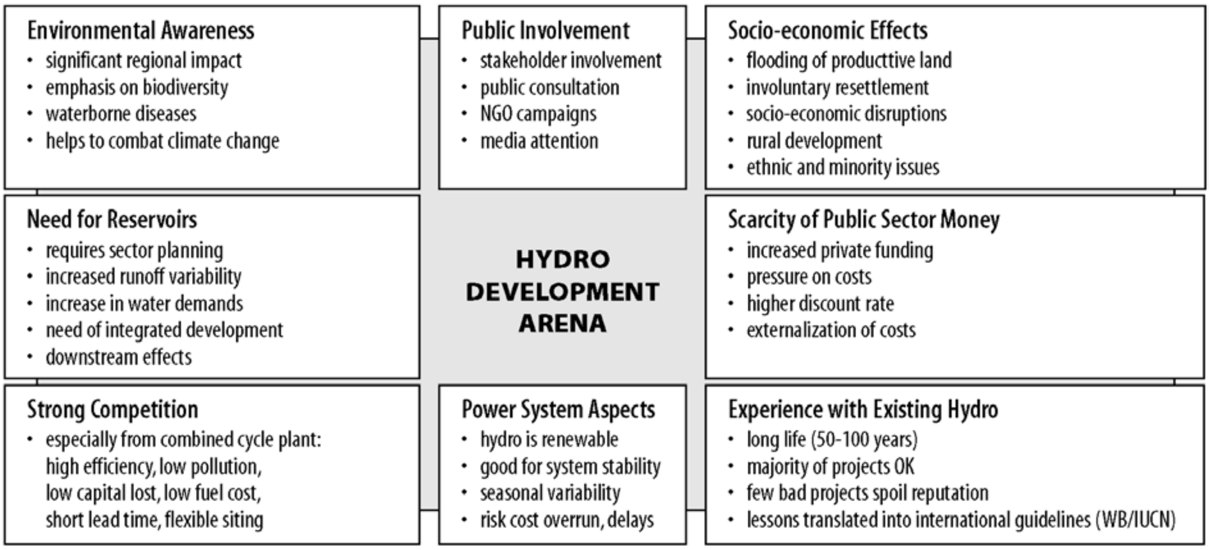
Source: UNEP-DDP (2007): *A Compendium of Relevant Practices for Improved Decision-Making on Dams and their Alternatives.*

1.1.7 The Hydropower Thread

1.1.7.1 The International Energy Agency

The International Energy Agency presents Figure 1.1-1 as a general illustration of the hydropower development arena.

Figure 1.1-1: IEA Context for Hydropower Development



Source: International Energy Agency. 2000. *Hydropower and the Environment: Present Context and Guidelines for Future Action.* Implementing Agreement for Hydropower Technologies and Programmes. Annex III. Subtask 5 Report. VOLUME II: Main Report.

The IEA also recognises the paradigm shift in the approach to planning for hydropower projects and presents Table 1.1-1 as an expression of this trend.

Table 1.1-1: Trends in the Planning of Hydropower Projects	
Old Planning Concept	**New Planning Concept**
A hydro project is a technical scheme to: • provide basic technical infrastructure to improve supply of power/water.	A hydro project is part of an integrated set of technical, environmental and social measures (e.g., Integrated Water Resource Management) to: • cover basic needs of people in a sustainable manner (water, light, power, irrigation, flood control) through multiple use projects; • accelerate rural development to improve the welfare of people in the region – • particularly those directly affected by the project; • improve environmental and flood protection; • minimize GHG emissions.
Planning is the government 's responsibility, often assisted by international development agencies.	**Planning involves many partners/ stakeholders, including:** • government; • people affected; • non-governmental organizations; • private sector developers; • financing institutions.
A least-cost planning procedure: • identifies least-cost projects to cover power/water needs; • carries out unavoidable social and environmental impact mitigation at minimum cost; • carries out detailed studies.	**Multi-criteria planning procedures must:** • be part of sectoral development plans; • include rigorous study of project alternatives, including the No-Project option; • prepare a comprehensive comparison matrix, showing pros and the cons of each alternative from technical, environmental, social, economic, financial, risk and political perspectives; • quantify secondary and external costs and benefits, as well as risk; • reach consensus among stakeholders about overall best alternative to be developed; • carry out detailed studies
Public Sector Projects are:	**Private/Public Sector Projects are:**

• developed and owned by government; • funding partly from international • development agencies.	• developed and owned by private sector, with or without government participation; • financed largely from commercial sources; • often catalysed by international development agencies, who provide funding guarantees; • often have access to semi-concessional funding if stringent international guidelines for social and environmental impact mitigation are followed.
Source: International Energy Agency. 2000. *Hydropower and the Environment: Present Context and Guidelines for Future Action.* Implementing Agreement for Hydropower Technologies and Programmes. Annex III. Subtask 5 Report. VOLUME II: Main Report. p33.	

1.1.7.2 International Hydropower Association (IHA)

As the DDP process unfolded, the International Hydropower Association (IHA) launched its own initiative. The Association's accepted the WCD Report's core values but not all of its strategic priorities or guidelines. The 2004 IHA Sustainability Guidelines and the 2006 IHA Sustainability Assessment Protocol were published. These first attempts were dismissed by several international organisations as a biased view of the hydropower industry, and the documents failed to gain much credibility.

To its credit, the IHA, in 2008, launched a new initiative on the Protocol, which, like the WCD and DDP, worked through an international forum of stakeholders, as part of its governance system. The forum comprised representatives of organisations from diverse sectors, with varying views and policies on sustainability issues related to hydropower development and operation. The 14 Forum members included representatives of governments of developed and developing countries, commercial and development banks, social and environmental Non Governmental Organisations (NGOs), and the hydropower sector. After two-and-a-half years of work, the revised Protocol was published in 2011. The principles incorporated into the Protocol are shown in Box 1.1-2.

Box 1.1-2: Hydropower Sustainability Assessment Protocol Principles

The Hydropower Sustainability Assessment Protocol is a sustainability assessment framework for hydropower development and operation. The principles incorporated into the Protocol are:

- Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- Sustainable development embodies reducing poverty, respecting human rights, changing unsustainable patterns of production and consumption, long-term economic viability, protecting and managing the natural resource base, and responsible environmental management.
- Sustainable development calls for considering synergies and trade-offs amongst

economic, social and environmental values. This balance should be achieved and ensured in a transparent and accountable manner, taking advantage of expanding knowledge, multiple perspectives, and innovation.
- Social responsibility, transparency, and accountability are core sustainability principles.
- Hydropower, developed and managed sustainably, can provide national, regional, and local benefits, and has the potential to play an important role in enabling communities to meet sustainable development objectives.

Source: International Hydropower Association. 2011. *Hydropower Sustainability Assessment Protocol:* Background Document.

Disclaimer: This material is only intended to convey the nature and purpose of the IHA Protocol and does not in any way constitute training in the actual use of the Protocol.

The Protocol is governed by the Hydropower Sustainability Assessment Council. A Charter, which sets out rules concerning the formation and decision-making of the Council, as well as Terms and Conditions for Use of the Protocol, were adopted in June 2011. These key documents are available on www.hydrosustainability.org.

The Protocol allows for the production of a sustainability profile for a project, through assessing its performance on certain criteria. To reflect the different stages of hydropower development, the Protocol includes four sections, each of which has been designed as a standalone document. Through an evaluation of basic and advanced expectations, the Early Stage tool may be used for risk assessment and initial dialogue, prior to advancing to detailed planning. The remaining three documents—Preparation, Implementation and Operation—set out a graded spectrum of practice, calibrated against statements of basic good practice and proven best practice. The graded performance within each sustainability topic also provides the opportunity to promote structured, continuous improvement.

Assessments rely on objective evidence to support a score for each topic, which is factual, reproducible, objective and verifiable. The system provides for accreditation by independent assessors. The Protocol will be most effective when embedded into business systems and processes. Assessment results may be used to inform decisions, to prioritize future work and/or to assist in external dialogue.

1.1.8 Water Alternatives: WCD + 10

In 2010, *Water Alternatives* an on-line interdisciplinary journal addressing the full range of issues that water raises in contemporary societies, published a special edition styled WCD+10. Its purpose was to provide an opportunity ten years after the WCD to take stock of the evolution in thinking about the complex and diverse issues that still surround decisions about dams and development. In a review based on the papers submitted the editors extracted the following trends[4]:

- Perspectives differ on the impact of the WCD Report and process;
- Water and energy demands continue to rise and drive dam development;
- Climate change is now a greater driver of hydropower expansion;
- New financiers are changing the loci and framework for decision-making processes;

[4] Moore, D.; Dore, J. and Gyawali, D. 2010. *The World Commission on Dams + 10: Revisiting the large dam controversy*. Water Alternatives 3(2): 3-13. www.water-alternatives.org

- Negative consequences of dams on the environment and livelihoods of dam-affected communities remain critical issues;
- The quest for new decision-making tools and approaches continues, from assessment protocols to economic analysis;
- How can participation, compliance, accountability, and performance be ensured?; and
- Multi-stakeholder platforms continue to show promise for informing and shaping negotiated agreements that result in better sharing of the resources, benefits, and costs associated with dams.

The editors conclude that the papers demonstrate the need for a renewed multi-stakeholder dialogue at multiple levels. "*This would not be a redo of the WCD, but rather a rekindling and redesigning of processes and forums where mutual understanding, information-sharing, and norm-setting can occur.*"

1.1.9 Mekong River Basin

In 2006, the Asian Development Bank, the Mekong River Commission and the World Wide Fund for Nature established a task force to drive an initiative on *Environmental Considerations for Sustainable Hydropower Development* (ECSHD). The purpose of the ECSHD was to develop tools to assist decision making for sustainable hydropower development in the Mekong River Basin. The approach was similar to that of the IHA (described above) in that it aligned with the stages of the hydropower project cycle.

In 2010, ECSHD and further partners published the Rapid Basin-wide Hydropower Sustainability Assessment Tool (RSAT). The RSAT was designed to target the most important issues that are necessary for a basin-wide approach to sustainable hydropower development.

The primary aims of the assessment tool are:

- To provide a common basis for dialogue and collaboration on sustainable hydropower between key players;
- To highlight and prioritise areas of hydropower sustainability risk and opportunity in a particular basin or sub-basin for further more detailed study; and
- To identify capacity building needs in the basin.

The key themes are identified as:

- Continuous improvement;
- Basin-wide understanding and protection of values;
- Integration between basin planning and hydropower development regulatory and management frameworks;
- Co-operation between different countries sharing a river basin;
- Balance of social and environmental criteria with economic and technical criteria in decision making processes;
- Consistency in approaches across a river basin;
- Informed participation of stakeholder in decision making and broad community support;
- Climate change – a cross-cutting issue; and
- The topics and criteria used in the assessment.

The MRC has also formed the Initiative on Sustainable Hydropower (ISH) specifically focuses on advancing regional cooperation for the sustainable management of the growing number of hydropower projects within a basin-wide perspective. Through the Initiative, the MRC assists its Member Countries in relating decisions on hydropower management and development to basin-wide integrated water resources management perspectives.

2 PLANNING, GOALS AND NEEDS ASSESSMENT

This module introduces the options assessment process.

It deals specifically with the part of the process up to needs assessment—to emphasise that needs should drive all development initiatives. Options always exist for meeting needs; unfortunately, a general tendency has been to take the shortcut and propose an infrastructure project.

The module emphasises that there are policy, strategy and management options for every development need.

It also notes that options assessment occurs on many levels, and that the stakeholders and decision-makers are generally different on each level. At the national level, priorities are often determined by political considerations and involve politicians. At the project level, stakeholders include the potentially affected communities, who will have far more immediate and tangible interests.

This manual is primarily concerned with hydropower. It should be noted, however, that the international discourse has turned to the water-energy-food nexus. In the absence of sufficient clarity and agreement of these analytical frameworks, this manual will rely on the traditional position that “water” encompasses direct human needs—as well as water needed for food production, through irrigation.

2.1 Introduction to Options Assessment

2.1.1 Key Aspects

- There are alternatives to every policy, strategy, plan or project.
- Needs assessment precedes options assessment.
- Options are assessed against criteria.
- The process must be open, transparent and participatory.
- Governance is central.
- Options are often determined by normative frameworks and resource endowment.
- The options assessment process is a requirement of most development financing institutions.

2.1.2 Training Aids

Purpose of session	The purpose of the session is to introduce the broad framework, within which options assessment takes place.
Learning objectives	At the end of the session the trainee will understand the need for options assessment and its framework.
Time required for session	60 to 90 minutes
Preparatory reading	None
Discussion topics	Discuss the extent to which the strategic planning framework in your country provides for inter-sectoral interaction.
Exercises	List the national level planning instruments in your country.
Additional Reading	UNEP-DDP 2007. UNEP-DDP (2007): *A Compendium of Relevant Practices for Improved Decision-Making on Dams and their Alternatives.* p19-20.
Case Studies	None

2.1.3 Background

Comprehensive options assessment was identified by the World Commission on Dams as one of the seven strategic priorities needed for an improved framework for decision making on dams and hydropower. According to the WCD, infrastructure planning needed to consider all of the technical, financial, economic, environmental, social and institutional characteristics of a project in making decisions on dams and hydropower. Discussion often boils down to the question: *Should a dam be built or not*? This is unfortunate as the options assessment process is iterative and should start at the highest planning and political decision making processes, where a state determines its water, food and energy needs. The UNEP Dams and Development Project took up the issue and added further practical content.

The key message articulated by the WCD on the priority is:

> *"Alternatives to dams do often exist. To explore these alternatives, needs for water, food and energy are assessed and objectives clearly defined. The appropriate development response is identified from a range of possible options. The selection is based on a comprehensive and participatory assessment of the full range of policy, institutional, and technical options. In the assessment process social and environmental aspects have the same significance as economic and financial factors. The options assessment process continues through all stages of planning, project development and operations."*[5]

The WCD further recommended the following policy principles if the strategic priority was to be effectively implemented:

- Development needs and objectives are clearly formulated through an open and participatory process before the identification and assessment of options for water and energy resource development.
- Planning approaches that take into account the full range of development objectives are used to assess all policy, institutional, management, and technical options before the decision is made to proceed with any programme or project.
- Social and environmental aspects are given the same significance as technical, economic and financial factors in assessing options.
- Increasing the effectiveness and sustainability of existing water, irrigation, and energy systems are given priority in the options assessment process.
- If a dam is selected through such a comprehensive options assessment process, social and environmental principles are applied in the review and selection of options throughout the detailed planning, design, construction, and operation phases.

Historically, project decisions were made following a comparison—often restricted to technical and financial criteria in a least-cost analysis of similar projects within a sector. This tendency often underestimated social and environmental impacts. However, a decision to build or not to build a hydropower project ideally emerges from a comprehensive and participatory assessment of the full range of policy, institutional and technical options, starting early in the planning process. Box 2.1-2 details this.

Box 2.1-1: Why Comprehensive Options Assessment?

[5] World Commission on Dams. 2000. *Dams and Development - A New Framework for Decision-Making*. Earthscan Publications Ltd. p221.

- The magnitude of the water development challenge in the 21st Century: traditional supply strategies alone cannot meet the demands of growing populations in many water-stressed countries and regions. New supply options are needed, along with options that contribute to better management of existing assets, and reductions in water demand.
- The increased number of technical options now available.
- The emphasis placed on poverty alleviation in the global development agenda.
- The shift in financing of development initiatives from governments to multiple sources, including public-private partnerships. This has imposed greater rigor on financial returns and thereby on the need to find the most efficient investment option.
- The need for governments to ensure that their decisions are sound and reflect the interests of all their citizens.

Source: Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264. p7.

Box 2.1-2: Advantages in Starting Options Assessment Early

- Better decisions are likely to emerge, because the assessment is not constrained by sector-specific orientations.
- Inappropriate options can be eliminated early. This is particularly important for infrastructure projects, because proponents may spend considerable time and resources on site investigation works, baseline data, monitoring, and studies for projects that are clearly inferior to other options. Early options assessment can also result in the need to develop basic information profiles for a wide range of options.
- Governments have more flexibility to address the legitimate interests and concerns of all constituencies. This also helps with other, related strategic decisions, such as improving the enabling environment, sector financing, and regulatory and institutional reform.
- There is better opportunity to "fast track" specific initiatives and projects where consensus is reached early.
- Upstream assessment makes subsequent decision-making more efficient by avoiding the need to re-open the options debate for each decision.
- If a dam does emerge as a preferred option, then it will be as a result of a legitimate, strategic choice among alternatives. This has great advantages in getting public support, acquiring financing for the dam, and avoiding costly delays.

Source: Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264. p46

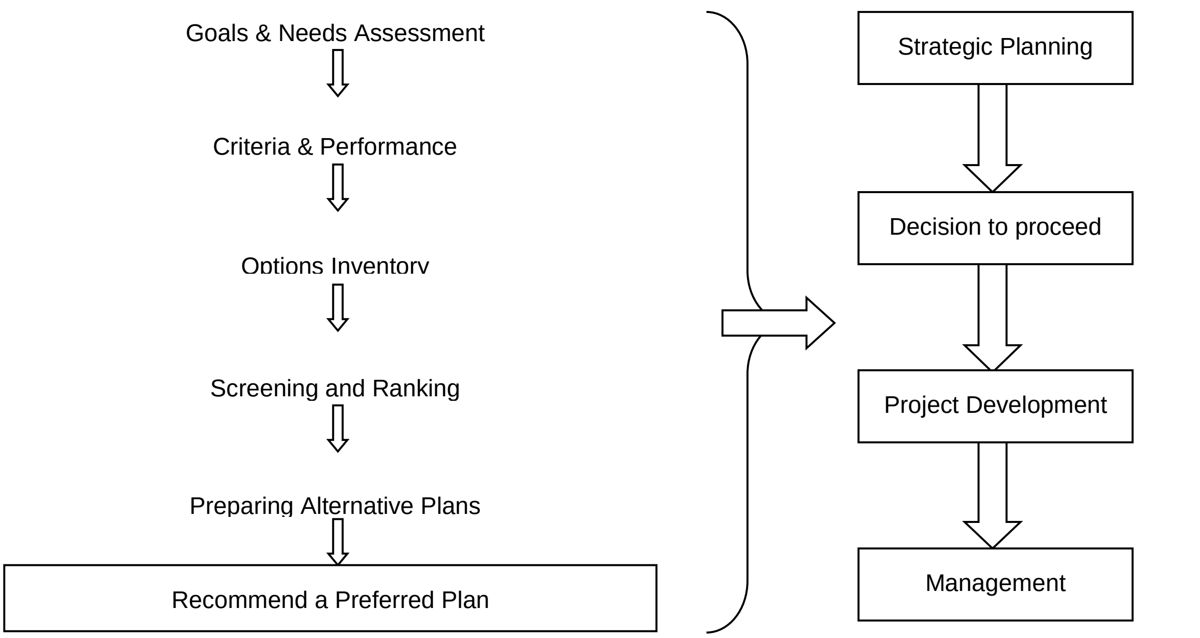
In the developing world, hydropower projects and associated electricity distribution networks are a national issue; thus, planning processes start at the national level. This emphasises that the options assessment process for a hydropower development will evolve over the planning cycle.

The options assessment process is usually envisaged as a series of steps (see Figure 2.1-1). However, it is also necessary for the options assessment process to adapt to the scope and scale of the planning level and project stages—and that pertinent feedback links be provided between levels to ensure a fluent, adaptive planning and management process, without compromising the overall objectives.

Where development paths have been settled at national level, the options at project level become more focused:[6]

> *"The analysis of alternatives included several dimensions: alternatives to supply side expansion; hydroelectricity in the optimum capacity expansion strategy; alternative hydro projects to Trung Son; and alternative dam sites at the Trung Son project level; and finally, alternative reservoir operating level for the selected site."*

Figure 2.1-1: Typical Steps in an Options Assessment Process



Source:UNEP-DDP 2007. UNEP-DDP (2007): *A Compendium of Relevant Practices for Improved Decision-Making on Dams and their Alternatives*

Comprehensive options assessment faces a number of challenges (see Box 2.1-3).

Box 2.1-3: Comprehensive options assessment challenges

[6] The World Bank. 2011. *Trung Son Hydropower Project*. Project Appraisal Document. Report No: 57910 – VN. p7.

- The context-specific character of options and detailed data required for assessment are rarely readily available;
- Stakeholder identification, participation and involvement;
- Responsibility for conducting the process;
- Limitations of existing assessment tools, of their broad acceptance, and of data availability;
- Overcoming bias towards individual options;
- Long time period;
- Funding sources; and
- Appropriate consideration of the various planning levels. It is considered that the options assessment process should adapt to the scope and scale of the planning level and project development stages, and that pertinent feedback links be provided between the levels to ensure a fluent adaptive planning and management process without compromising the overall objectives.

Source: UNEP-DDP 2003. *Comprehensive options assessment of dams and their alternatives: Background material.* Issues Based Workshop #1

Ideally, a national plan would determine the priorities and general development trajectory for the whole nation. Sectoral plans would then internalise the national plan and promote strategies to further its aims. Then, project planners would have a rational framework within which to work. All of this would happen within a participatory process; public acceptance (WCD Strategic Priority No 1) would be gained; and project costs would be borne by the beneficiaries.

In reality, the WCD found that this has seldom been achieved. Projects were often identified in a sectoral or local framework by power groups within society, while vulnerable members were left to bear many project impacts and costs—and not necessarily sharing the benefits. A large part of this problem is the impracticality of expecting all members of society to be able to participate and protect their interests in all national and sectoral planning. Moreover, at national (and partially sectoral level planning), the process can be abstract and conceptual.

It is inevitable, then, that a policy decision to base a state's electricity generation programme on hydropower, for example, rather than other renewable sources (or imported fossil fuels) is taken in the national interest without any direct participation from potentially impacted individuals or communities. Such a policy would have to be informed by an understanding of the potential negative impacts and costs and should set a broader framework, within which sector and regional strategies could be developed. The inability of potentially affected communities to negotiate in their own and broader social and environmental interests drew international NGOs into the dams—particularly the hydropower—debate, which culminated in and became entrenched by the WCD-DDP processes. This was the case in 2004--in the Nam Theun 2 project in Lao PDR:[7]

> *"To address the third pillar of the decision framework—obtaining broad support from international donors and civil society for the country's development strategy and the NT2 project itself—the World Bank, other donors, the developers, and the government engaged in an intensive process of information sharing, discussion,*

[7] Porter, I and Shivakumar, J. (eds) *Doing a dam better: the Lao People's Democratic Republic and the story of Nam Theun 2*. The World Bank

and debate. This process culminated in a series of international workshops held in Bangkok, Paris, Tokyo, Washington, and Vientiane to provide major stakeholders with information on NT2 and to solicit the views of international civil society organizations on the project. The design and location of these workshops were driven by the dynamics of the dialogue about the project. In projects with a similar context, such workshops can be highly useful.

Project assessment was marked by debate, disagreement, and tension among the various partners and stakeholders. Some of the tension reflected substantive differences of view on the standards to be met by the project. For example, on the adequacy of local consultations in relation to the World Bank's standard of "meaningful" consultations, the developers and government were satisfied with the initial set of meetings with local communities, whereas critics argued that they offered only one- way flows of information and were often misunderstood by the communities. Another key point of contention between the developers and the World Bank was the treatment of downstream impacts and the inclusion of mitigation measures in the project's base budget."

See also Box 2.1-6.

At the sectoral (or basin) level, the response to national policy is to develop strategic options to meet national goals and needs, together with the criteria and performance measures by which a strategy may be assessed. It is also, then, more practical to envisage a process where individuals and communities voice their opinions through representative, NGO, CBO or other institutions. At this level, processes such as IWRM are well-defined and should be followed to better structure needs assessment and planning responses. Such a sectoral (basin) strategic plan must be based on project pre-feasibility information, prepare an options inventory, and prioritise potential project interventions that meet the strategic need.

At the planning level, the project prioritisation of several alternatives must be validated by improving information through feasibility studies, encompassing variables such as site location, size, social and ecological impacts, and the direct participation of potentially affected individuals and communities.

The international discourse about hydropower and large dams has, since the World Commission on Dams, tended to focus on social and ecological impacts. The contention persists that there is a narrow focus on the benefits of a hydro project, while insufficient attention is paid to environmental impacts and the poor, who often have to carry many indirect costs. A comprehensive options assessment is directed at securing sustainable sources of water, food and energy whilst avoiding or mitigating negative impacts on those least able to bear them. It must consider all aspects and add, at least, economics, finance, engineering (technical) and institutional analyses and carefully weigh all direct and indirect benefits against all direct and indirect costs.

In exploring options it will be rare that a single project will meet the development need; rather the analyst should be constantly alert to the possibility of complementary interventions that may enhance the project itself or make a difference to its viability.

Box 2.1-4: Dams and development needs

Many of the controversies over dam projects have focused attention on whether a dam was the most appropriate response to a development need or objective, and whether these were correctly identified in the first place. In some cases project objectives were not clearly stated, particularly in relation to broader national and local development goals. In others, the decision to proceed with a dam was taken before considering all options or following strong backing from specific constituencies that undermined options assessment. This failure to assess strategic options rigorously at an early stage has led to a number of disputes.

Source: World Commission on Dams. 2000. *Dams and Development - A New Framework for Decision-Making*. Earthscan Publications Ltd. p221

The planning and needs assessment must be a balanced process that establishes the positive reasons for implementing a project and, at the same time, address any negative reasons why the project should not be implemented. The desirable characteristics of an options assessment are set out in Box 2.1-5. Particular care is required in the case of large hydropower projects where there many potential adverse impacts might occur—and where the process is often under intense scrutiny. The core objective is to make the best possible decision. This requires thoroughness and transparency at all times, and any deviation from these attributes will elicit a response from individuals or non-governmental organisations of the nature shown in Box 2.1-6.

Box 2.1-5: Characteristics of options assessment

- An options assessment is part of a decision-making process that works towards identifying the most appropriate options to satisfy defined needs.
- These processes are conducted at policy, strategic planning and project levels.
- These are driven by a needs assessment that reflects local, sub national and national goals and is influenced by international commitments;
- These are transparent and built on explicit assumptions, which result in documented decisions;
- These include the full range of alternatives relevant to the articulated need, such as demand- and supply- side measures, structural and non-structural alternatives, and conventional and nonconventional options;
- They are participatory, involving, among others, project-affected groups at local levels, and representatives of interest groups at the strategic planning and policy levels;
- They recognize and address limitations of the knowledge base and available resources;
- They are iterative processes, with time-bound outcomes, designed to meet both short and long-term needs;
- These integrate the consideration of environmental and social factors, together with technical, economic and financial factors.

Source: UNEP-DDP. 2007. *Dams and development: A compendium of relevant practices for improved decision making on* *dams and their alternatives*.

Box 2.1-6: Ten Reasons for NOT financing the Nam Theun 2 Project

1. Proponents have failed to demonstrate Nam Theun 2's economic viability.
2. Nam Theun 2 is viable only by monopoly.
3. Nam Theun 2 has no market demand.
4. Nam Theun 2 is part of EGAT's high-risk monopoly expansion.
5. The Nam Theun 2 deal remains secret, not subject to regulatory oversight or competitive bidding in Thailand or Lao PDR.
6. World Bank experts are on record warning against uncompetitive power purchase deals (like Nam Theun 2).
7. Nam Theun 2 would sink Electricité du Laos further into debt.
8. Rural communities in Lao PDR would be better served by investments in cheaper off-grid technologies.
9. Nam Theun 2's output is more costly and less economically valuable than gas-fired combined cycle plants and decentralized supply options in terms of reliability, operating flexibility, and security of supply.
10. Thai power consumers and citizens groups want utility reform.

Source: Ryder G. 2004. *Ten Reasons Why the World Bank Should Not Finance the Nam Theun 2 Power Company in Lao PDR*. Probe International pamphlet. Downloaded from http://probeinternational.org/ on 16 Jan 2013

2.1.4 Enabling Environment

Effective options assessment is impossible without positive steps to create an enabling environment for stakeholders. These include:

- attitudinal approaches, such as inclusivity, receptiveness, openness, transparency and patience;
- sharing of all information;
- allocation of time and financial resources;
- undertaking stakeholder analysis
- maintaining current training and financing of stakeholder groups where appropriate; and
- communication and outreach.

In order to implement the COA process thoroughly, aspects of the enabling environment include capacity building, political will, and budgetary resources, within the implementing agency.

2.1.5 Normative Frameworks

The options and needs assessment for projects with a transboundary dimension, takes place within national and international policy and legal frameworks, largely related to energy, water and the environment. The international dimension is particularly important because the majority of dams are constructed on shared rivers.

The international legal framework for water and the environment includes, apart from customary international law, the following instruments[8]:

- Convention on the Non-navigational uses of International Watercourses 1997 (yet to enter into force)[9];
- Convention on Biological Diversity. 1992;
- Convention on Wetlands of International Importance Especially as Waterfowl Habitats. 1971 ("Ramsar");
- Convention to Combat Desertification. 1994
- The Berlin Rules on Water Resources Law of the International Law Association. 2004;
- The opinion of the International Court of Justice in the Gabcikoco-Nagymaros case decision. 1997;
- Multilateral regional treaties such as the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin. 1995; and
- Bi-lateral treaties between states.

In addition most states would respect the international policy instruments, including:

- Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972;
- Rio Declaration on Environment and Development. 1992. Including Agenda 21: Chapter 18: Protection of the Quality and Supply of Freshwater Resources;
- United Nations Millennium Declaration, 2000;
- World Summit on Sustainable Development: ("Johannesburg") Plan of Implementation, 2002;
- 2005 World Summit Outcome; and
- United Nations Conference on Sustainable Development Rio + 20 Outcome document "The future we want", 2012.

Several international institutions provide guidelines directed at water resource development:

- The safeguard and other policies of multilateral development financing institutions such as the World Bank, the Asian Development Bank and the International Finance Corporation;
- The Equator Principles of the Equator Principles Association of 78 international private financial institutions; and
- The International Hydropower Sustainability Framework.

2.1.6 Budgetary Processes

The implications for funding and budgets are: that comprehensive option assessments increase up-front costs in order to reduce longer term costs, associated with delays and conflict; that small-scale, dispersed options require access to micro-credit for

[8] McIntyre o. 2007. *Environmental Protection of International Watercourses under International Law*. Ashgate.

[9] See Tanzi A and Arcari M. 2001. *The United Nations Convention on the Law of International Watercourses: A framework for sharing*. Kluwer Law International.

implementation; and that public resources will need to be devoted to options assessments at planning levels within and across each sector.

Planning is always a trade-off between the need for certainty and the cost of the data and information needed to achieve it. For example, where sector level hydropower planning is undertaken, it is mostly done so at a desktop. Here it would be inconceivable to initiate social interventions with potentially affected parties and conduct geological investigations by drilling every possible dam site if the option became a final choice.

The WCD found was that options were either not identified or eliminated too early in the process. This was attributed to lack of stakeholder participation, inadequate resources for sufficient investigation, unwillingness to take the necessary time, and other reasons.

In the developing countries, international development finance institutions often influence the planning processes and options assessment. In many instances project level planning will not be financed unless the policy and strategic level planning has been completed.

2.2 Session 2.2: Needs Assessment in Planning Processes

2.2.1 Key Aspects

- Needs are determined by regional, national and sectoral planning processes.
- National planning usually takes place in a development planning framework and is driven by social and economic aspirations, while being moderated by finance, national resource endowments and environmental protection.
- Hydropower development is informed mainly by energy needs and options and competing demands for water, most often expressed in an integrated water resources management paradigm.
- Environmental impacts are linked to strategic level needs in a strategic environmental assessment framework, at the transboundary level by transboundary diagnostic analysis, and by environmental impact assessment at project level.

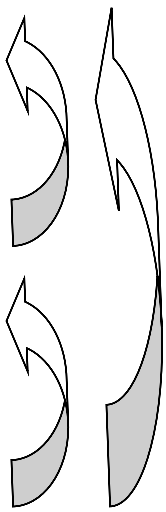
2.2.2 Training Aids

Purpose of session	The purpose of the session is to explore the planning processes that define energy and water needs.
Learning objectives	At the end of the session the trainee will have an understanding of development planning, energy planning and water planning, as well as the processes that link energy and water needs to environmental impacts.
Time required for session	90 to 120 minutes
Preparatory reading	UNEP-DDP 2007. *A Compendium of Relevant Practices for Improved Decision-Making on Dams and their Alternatives.* p20-21.
Discussion topics	Discuss the tradeoffs between water supply and hydropower.
Exercises	List the energy and water sectoral planning instruments in your country.
Additional Reading	None
Case Studies	None

2.2.3 Introduction

A project needs assessment is never its own, separate initiative but rather a collation of information from higher level legislation, policy and planning at regional, national and sectoral levels. Moreover, *"both the nature of decisions and those making the decisions change at different stages in the planning cycle of a large dam. The information required at each stage varies but, throughout, the ecological and social implications should be given as much consideration as the engineering and economic aspects"*[10]. A representation of the planning hierarchy is presented in Table 2.2-1. Note that planning is an iterative process with feedback loops.

Table 2.2-1: The infrastructure planning hierarchy

Influences	Planning Levels	Feedback	Typical Content	Participants
Legislation International conventions and treaties Policy Best practice Participation	Macro		National development plan / strategy (economics, growth, priority sectors employment, environment) Policy & legislation Budgets	Politicians
	Sector		Sector strategies, Catchment management strategies Master plans SEA	Planning bureaucracy Stakeholders
	Project		ESIA Engineering design Implementation Environmental Management Plans	Technical bureaucracy Stakeholders Affected communities

At the international level many countries have already committed to conventions such as the UN Framework Convention on Climate Change (and Kyoto Protocol) and the "Ramsar" Convention.

[10] McCartney, M. and J. King. 2011. *Use of decision support systems to improve dam planning and dam operation in Africa*. Research for development series – 02. CGIAR Challenge Program for Water and Food. Available at www.waterandfood.org

Assessing the need (demand) for energy and water services in different sectors—and the relationship of these needs to wider development goals—is the first, essential step in options assessment. See Box 2.2-1 for a list of factors to consider. The development goals of the broader society, as expressed in national development plans at the economic, financial and sectoral level, should be disaggregated to the point where they can be addressed at a project level. This is an intense, participatory process.

Box 2.2-1: Factors when Identifying and Defining Needs and Objectives

- Identify and rank the needs of different groups from the outset, including the needs of those groups upstream and downstream of proposed infrastructure, whose livelihoods depend on environmental services.
- Account explicitly for immediate needs and ensure they are not compromised by the duration of the planning exercise. (That is, the needs of some groups may be so urgent they must be met without undue delay.) It is possible to fast track priority options to meet those needs, provided this is acceptable to all stakeholders. For example, in Case 9 (Berg River, South Africa), a series of water restrictions aimed at high-volume users, as well as other demand management and wastewater recycling measures, were introduced to address water shortages and ensure poorer areas were serviced before approval to proceed with a new dam was given.
- Account for broadly defined development needs, including those associated with the Millennium Development targets. Often countries have explicitly stated their long-term objectives in their Country Development Framework, or Five-year Plan. This should include macroeconomic needs, such as reducing imports (food or fossil fuel), macroeconomic stability, and foreign exchange balances—as well as socioeconomic objectives, such as poverty reduction.
- Account for development effectiveness. For example, when meeting the need for water services for irrigation, also consider options that enhance the likelihood of delivery of other inputs such as seed, fertilizer, labour, and credit.
- Include the needs of other sectors in the assessment. This is especially true where multi-function options such as dams are considered, given their broad and systematic impacts and the scale of the investment.
- Account for changes in development needs over time. This is especially important when considering assets with long lifetimes. This would, for example, encourage the identification of options that provide flexibility.

Source: Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264. p45

2.2.4 Policy formulation

At the national level governments formulate policies in a national development context. This necessarily accounts for all sectors and addresses national issues, such as economic growth, employment, poverty alleviation, industrialisation, food security and many more. Some policies are written into legislation, which makes them unavoidable. National governments also make sectoral policies. While the policy formulation process is outside the scope of this manual, it is axiomatic that options assessment takes place within the policy framework.

2.2.5 Development Planning

“Development planning” generally refers to a broader set of planning initiatives, undertaken at a macro and hierarchical level, which may be multi-state, national, provincial, or local in nature. These initiatives set super-ordinate goals and are intended to guide the more detailed planning the implementation of projects of many sectors. In many instances they set out the policy position of an economic community, national government, state-owned enterprise or local government. Such plans are long-term, policy-rich, strategy-focussed, multi-sectoral, and set priorities in terms of sectors and resources. A few examples are shown in Table 2.2-2, which expands on some of the levels in Table 2.2-1 and presents additional information.

Table 2.2-2: Examples of planning hierarchy

Entity	Plan/ Strategy	Purpose	Sample Content
Southern African Development Community (SADC)	Regional Indicative Strategic Development Plan (RISDP)	To coordinate the collective development efforts of the 15 SADC member states	Description of socio-economic situation Priority intervention areas Financing arrangements Coordination Monitoring and evaluation
South Africa Department of Planning	National Development Plan, 2030	This is an economic and social plan for South Africa. It provides a broad strategic framework to guide key choices and actions.	Diagnostic Externalities National capabilities A firm commitment to achieving a minimum standard of living which can be progressively realised through a multi-pronged strategy Building environmental sustainability and resilience Other

South Africa Sectoral Departments	National Electricity Plan	In theory: identification of the requisite investments in the electricity sector that maximize the national interest. In practice: identification of the investments in the electricity sector, which allows the country to meet forecasted demand with the minimum cost to the country.	Policy clarification Economic impact issues Demand projections Target makeup of electricity generating technologies and sources Incentives for renewable energy
	National Water Resources Strategy	Management of national water resources	The national supply and demand picture Issue identification such as pollution Strategies Priority setting
Vaal River and Thukela River Basins	Catchment Management Strategy (A variation on an IWRM Plan)	Management of the basin's water resources	The basin supply and demand picture Planning at basin level Resources issues Strategies
Escom	Ingula Pumped Storage Project	Increase peak demand generating capacity	Conceptual design EIA scoping

At the international level, initiatives such as the Millennium Development Goals influence many national planning initiatives and set targets, which, in turn, inform national development needs. At the same time, policy shifts in one aspect of the economy can lead to increased needs in others. See Box 2.2-2 for an example of the broader consequences of a policy shift.

Box 2.2-2: Case study: Bujagali hydropower project, Uganda

During the 1990s, the Government of Uganda successfully introduced economic liberalization policies, resulting in macroeconomic growth of close to 7% annually with comparable growth in electricity demand. While overall economic growth was impressive, investments in power and other infrastructure did not keep pace. According to a private investment survey in 1998, inadequate and unreliable grid power supply was rapidly emerging as the main impediment to private investment (domestic and international) and sustained economic growth.

The government's power development strategy was formalized in the 1999 Electricity Act. The policy aimed to improve power services in the short-term and position for future power development by restructuring and commercializing power sector institutions, mobilizing private sector expertise, and encouraging foreign and domestic private investment in the electricity industry. The Bujagali Hydropower Project was identified as an option to plug the power deficit brought about by the economic growth.

Source: Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264.

2.2.6 Water Resources Planning

The concept of integrated water resource planning (IWRM) is found in Agenda 21, Chapter 18, Paragraph 16:

> *"Water resources development and management should be planned in an integrated manner, taking into account long-term planning needs as well as those with narrower horizons, that is to say, they should incorporate environmental, economic and social considerations based on the principle of sustainability; include the requirements of all users as well as those relating to the prevention and mitigation of water-related hazards; and constitute an integral part of the socio-economic development planning process."*

The idea, which crystallised into IWRM, was to foster a more balanced and inclusive approach to water decision-making ie one that considered social equity and environmental sustainability, along with economic efficiency (the three E's).

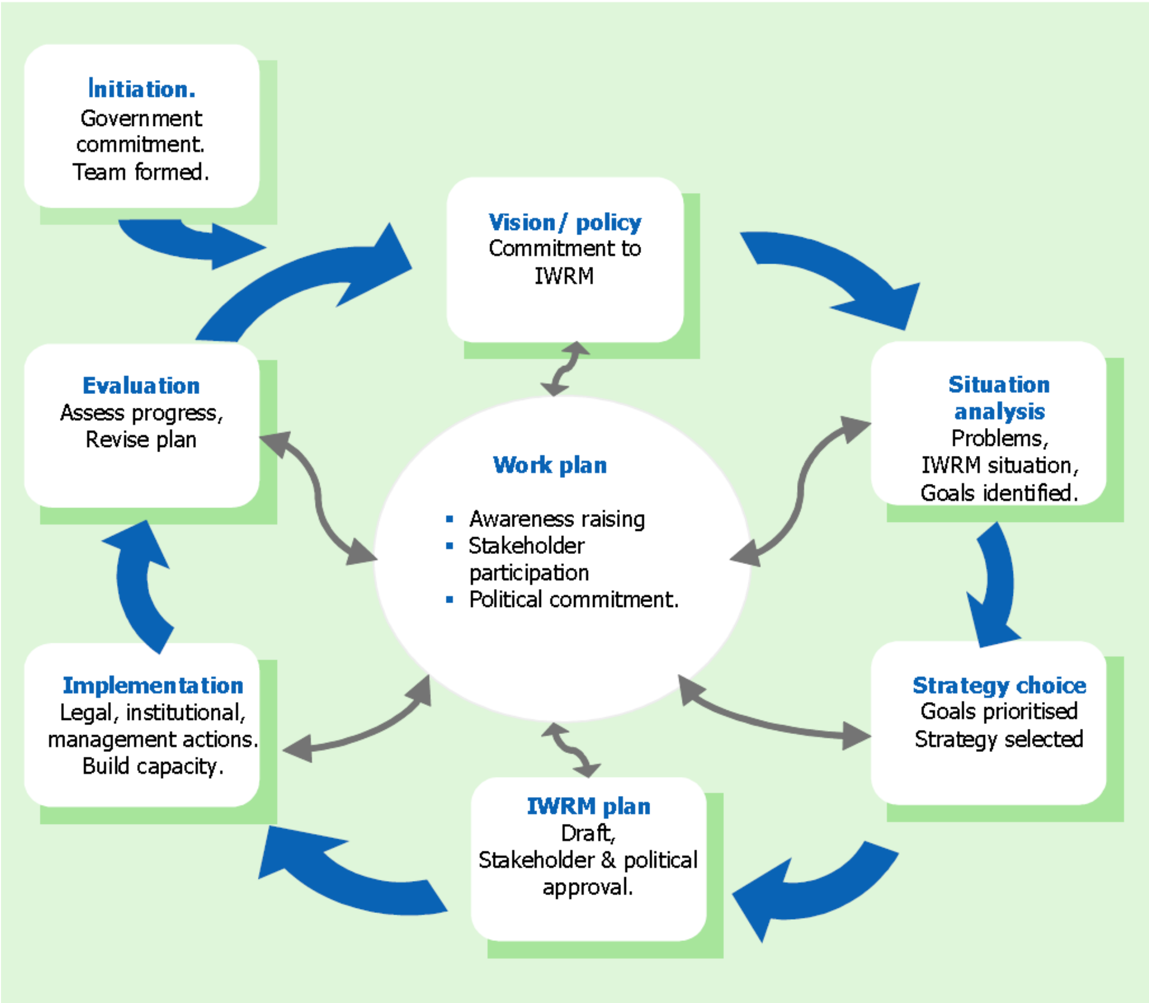
Water resource planning has an extensive literature (largely by the Global Water Partnership) built around the integrated water resource planning (IWRM) concept. IWRM is defined as[11]:

> *"IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".*

The conceptual framework is depicted in Figure 2.2-1.

[11] Global Water Partnership. *Integrated Water Resources Management*. TAC Background Paper No 4. 2000. p22. www.gwpforum.org.

Figure 2.2-1: IWRM Conceptual framework



Source: CapNet and Global Water Partnership. 2005. *Integrated Water Resources Management*. Training Manual. www.gwpforum.org.

The catchment, or river basin, is the preferred scale for water resources management. This is irrespective whether the basin is transboundary such as the Mekong. Article 26 from the WSSD Plan of Implementation called for the development and implementation of:

> "…..*national/regional strategies, plans and programs with regard to integrated river basin, watershed and groundwater management*….."

The IWRM approach seeks to balance environment, economics and social equity.

It has become fairly common that various "basin studies", "basin plans", "catchment management plans/ strategies" and others have been developed in the IWRM framework. See Box 2.2-3. Unfortunately, in many instances, the "silo" paradigm that exists at the national department level of many states works against a full commitment to multi-sectoralism.

Box 2.2-3: Example: 2010-15 Mekong River Basin Development Strategy

The preparation and adoption in 2011 of the Basin Development Strategy by the Lower Mekong Basin Countries is an important milestone in the history of cooperation under the framework of the Mekong River Commission (MRC). Developments in the Lancang-Upper Mekong Basin in China and in the Lower Basin are changing the Mekong's flow regime. The private sector is now actively seeking investment opportunities to meet growing demand for goods and services, which the river can provide if effective regulatory systems are in place.

The Strategy defines a dynamic basin development planning process, which will be reviewed and updated every five years. It defines the following strategic priorities for basin development:

- opportunities and risks of current developments addressed;
- irrigated agriculture expanded and intensified;
- environmental and social sustainability of hydropower development greatly enhanced;
- essential knowledge acquired;
- options for sharing benefits and risks identified;
- climate change adaptation strategy implemented; and
- basin planning integrated into national systems.

The Strategy also includes:

- basin objectives and management strategies defined for water-related sectors;
- national-level basic water resources management processes strengthened;
- basin-level water resources and related management processes strengthened;
- rigorous basin-wide environmental and social objectives and baseline indicators defined; and
- capacity building programme implemented, linked to MRC's overall initiatives and complementary to national capacity building activities.

Source: INBO and GWP. 2012. *The Handbook for Integrated Water Resources Management in Transboundary Basins of Rivers, Lakes and Aquifers*

2.2.7 Electricity Planning

A thematic paper prepared for the WCD found that "... *in general, at both the global and regional level there is no shortage of primary energy resources to meet foreseeable demands for electricity generation over the next 50–100 years*". [12]

Hydropower is part of electricity generation, which, in turn, is part of the broader energy sector. See Box 2.2-4 for notes on hydropower's potential role. In the context of options, energy forms other than electricity present a range of options. For example, at the household level, solar water heating and gas cooking are viable options, which can significantly reduce the demand for grid

[12] Eberhard, A., et al. 2000. *Electricity Supply and Demand Side Management Options*, Thematic Review IV.1 prepared as an input to the World Commission on Dams.

electricity. An example of strategic planning at the energy (rather than the electricity) level is found in Angola[13]. The resources available for electricity generation also present options such as coal, oil, natural gas, nuclear, biomass, wind, solar, geothermal and ocean energy. Clearly, selection is limited to the resources of the region or country.

In rural settings, initiatives to improve the sustainability of traditional energy resources and development of appropriate technology and alternative energy sources may constitute options to both electricity use (in the short- to medium-term), and to the extension of the central electricity grid into the area. Traditional energy forms (biomass, agriculture and animal wastes) are dominant sources of energy, and the resource base is increasingly over-exploited or under stress in many countries.

Box 2.2-4: Hydropower's potential role in expanding electricity services

Hydropower could play a major role in expanding electricity services, especially in the developing world. The magnitude and timing of this role will depend on several factors:

- national policies, strategic choices and national resource endowments;
- the ability to find common ground on a series of controversial social equity and ecological issues, surrounding dam site selection, planning, construction and operation;
- the outlook for competing demand side management (DSM) and electricity supply options, including the emergent renewable sources;
- the evolving context of power sector market reform and regulation, and the sources, availability, structure and cost of project financing;
- the extent of stakeholder participation in planning and decision making; and
- emerging goals for sustainable development and its implementation, especially with relation to widening access to modern energy services in poorer countries and reducing the risks of environmental degradation at local, regional and global levels.

Source: Eberhard, A., et al. 2000. *Electricity Supply and Demand Side Management Options*, Thematic Review IV.1 prepared as an input to the World Commission on Dams, Cape Town

The nature and form of electricity planning (a sub-set of energy planning) has received less attention in the international literature than water resources. Typically an electricity plan would deal with:

- Diagnostics of current situation;
- Integration with nation development planning;
- Growth in demand derived from economic, social and demographic research;
- Descriptions of policy and other normative frameworks;
- Long-term budgetary forecasts;
- A target apportionment to the different types of generation (gas, nuclear, solar, coal);
- Provisional project priorities.

The case study of Thailand's Power Development Plan is provided in Box 2.2-5, as well as that of the Nile Equatorial States in Box 2.2-6..

[13] International Energy Agency. 2006. *Angola Towards an Energy Strategy.*

Box 2.2-5: Thailand Power Development Plan Case study

Thailand has a Ministry of Energy, a National Energy Policy Council (NEPC) and the Energy Generating Authority of Thailand (EGAT). EGAT's current plan is the third in the series. It was finalised following a number of public hearings and prepared within the following framework:

- Extend the planning horizon from 15 years to 20 years (2010-2030).
- Revise Thailand's Load Forecast, based on the National Economic and Social Development Board's long term economic growth.
- Analyze and integrate the effects of demand side management projects in both the load forecast and the generation expansion planning.
- Combine into the plan the re-estimated amount of power purchases from renewable energy sources, noting the Alternative Energy Development Plan 2008–2022.
- Review the amount of power purchase from small power producers in 2009-2015, further noting the National Energy Policy Council's Resolution on 24 August 2009 to promote power production by cogeneration systems.
- Reconsider power imports from neighbouring countries, and identify only promising projects.
- Lower greenhouse gas emissions.

The PDP provides a detailed list of planned projects and addresses the above framework in chapters on:

- Assumptions in the formulation of PDP 2010
- Power demand forecast
- Thailand Power Development Plan (actually the detail of demands and supply)
- Demand side management
- Renewable energy
- Cogeneration system
- Nuclear power plant projects
- Greenhouse gas emission reduction in power sector
- Transmission System Development Plan

Source: Electricity Generating Authority of Thailand. 2010. *Summary of Thailand Power Development Plan 2010-2030*. Report no. 912000-5305

Box 2.2-6: NELSAP Social and environmental assessment for hydropower options

Following dialogue between the Nile equatorial lakes countries and the World Bank, the need for a comprehensive strategic regional assessment of different power options was formulated for the region, building on a ranked study of hydropower options, identified by the Nile Equatorial Lakes Subsidiary Action Programme (NELSAP). The approach to undertake a broad-based power options analysis, including issues to be covered in a strategic/sectoral, social and environmental assessment, was agreed on by power experts from the Nile equatorial lakes region in May 2002. The objective of this assessment was twofold:

- To prepare the World Bank and other investors for possible requests to support the NELSAP power development programme;
- To assist riparian countries of the Nile equatorial lakes region in their selection of power

supply options (including interconnections) by contributing to informed and transparent decision-making before major funds to investigate individual options are committed.

The assessments covered the current situation in the region a review of energy policies and legal and administrative frameworks as they apply to the promotion of power development options; an assessment of the power needs; the identification and screening of power development options; a comparative analysis and ranking of power development options that were retained after screening; the development of portfolios of power options; an overview of cumulative impacts on the region of the development of such portfolios; and the definition of mitigation measures that can be applied to reduce the social and environmental impacts of these portfolios.

As the assessment was a regional study, it was implicit that the process would be based on energy demands and supply options for the interconnected systems. However, information has also been provided on some off-grid options, such as solar photovoltaic power, mini/micro hydropower, wind energy conversion systems and diesel. Indicative costs and potential applications for these options provide useful contexts for assessing costs and performance of on-grid options that are the target of the assessment. The potential for demand-side management to reduce new generation requirements was also noted.

Through a review of previous studies and extensive stakeholder consultation, the assessment was able to compile a strong set of recommendations with 330 megawatts capacity (one 30-megawatt gas facility and three hydro schemes for the balance) at four different locations. Recommendations were made for further studies on other generation options (Nile Basin Initiative 2005).

Source: DDP Compendium p28

A procedure for preparing a hydropower inventory at the basin level has been proposed[14].

2.2.8 Strategic Environmental Assessment (SEA)

SEA generally represents the highest level of environmental planning. SEA can relate to policy and strategy; however, in relation to hydropower development SEA is related to rivers. SEA is distinct from environmental impact assessment (EIA). See Table 2.2-3.

Table 2.2-3: Strategic Environmental Assessment (SEA)	
Definition	"[A] process of anticipating and addressing the potential environmental consequences of proposed initiatives at higher levels of decision-making. [SEA] aims at integrating environmental considerations into the earliest phase of policy, plan or programme development, on a par with economic and social

[14] Brasil Secretaria de Planejamento e Desenvolvimento Energético. 2007. *Manual for Hydropower Inventory Studies of River Basins*. Ministry of Mines and Energy. Secretariat of Planning and Energy Development; CEPEL. – Rio de Janeiro : E-papers, 2010.

	considerations" (Sadler, 1995).	
Comparison	**EIA**	**SEA**
	Is reactive to a development proposal	Is *pro-active* and informs development proposals
	Assesses the effect of a proposed development on the environment	Assesses the effect of the environment on development needs and opportunities
	Addresses a specific project	Addresses areas, regions or sectors of development
	Has a well defined beginning and end	Is a continual process aimed at providing timely information
	Assesses direct impacts and benefits	Assesses cumulative impacts and identifies implications and issues for sustainable development
	Focused on the mitigation of impacts	Focused on maintaining a chosen level of environmental quality
	Narrow perspective and a high level of detail	Wide perspective and a low level of detail to provide a vision and overall framework
	Focus on project-specific impacts	Creates a framework against which impacts and benefits can be measured
Conceptual Hierarchy	SEA	Higher level such as regions or sectors
	Project EIA	Development proposals & projects
	Environmental Management Systems	Construction & operation of projects

	Monitoring & Data Collection	Feedback to higher levels
Source: CSIR (South Africa) 1996. *Strategic Environmental Assessment – A Primer*. ENV/S-RR 96001		

2.2.9 Transboundary Diagnostic Analysis/ Strategic Action Plan (TDA/SAP)

2.2.9.1 Introduction

TDA is the methodological approach adopted by the Global Environment Facility (GEF). Its focus is environmental issues. The production of a TDA (analytical component), followed by a Strategic Programme of Action (SAP) (strategic component), is a requirement for most International Waters (IW) projects, proposed for GEF financing[15].

With a few exceptions, the development of a hydropower project has transboundary environmental implications; thus, a TDA/SAP analysis is generally focussed on existing problems and is invaluable during options assessment.

The key principles underlying the TDA/SAP process are presented in Box 2.2-7. Many of these should be applied in all strategic planning.

Box 2.2-7: Key principles underlying the TDA/SAP process

Adaptive management

Adaptive management can be defined as a systematic, rigorous approach for deliberately learning from management actions with the intent to improve subsequent management policy or practice. Simply put: the TDA/SAP adaptive management cycle involves assessing the problem (through the TDA), formulating a strategic plan with robust indicators (through the SAP), implementing the actions identified in the SAP, and monitoring the outcomes—both short-term and long-term—and adapting the plan accordingly.

The Ecosystem Approach

The Ecosystem Approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way, and which recognizes that people with their cultural and varied social needs, are an integral part of ecosystems.

Sustainable Development

Sustainable Development underpins all GEF IW Projects. The goal of the International Waters focal area is the promotion of collective management for transboundary water systems and subsequent implementation of the full range of policy, legal, and institutional reforms and investments contributing to sustainable use and maintenance of ecosystem services.

Poverty Reduction

Fundamentally, poverty is a denial of choices and opportunities, and a violation of human dignity. It is an aim

[15] Bloxham, M.J., Richards, J.P., Glegg, G.A., Cooper, P, Caballero, P, Mee, L.D. 2005. *Training course on the TDA/SAP approach in the GEF International Waters Programme*. University of Plymouth. 1st edition, training materials in 6 modules (Train-Sea-Coast Programme).

of the TDA/SAP Approach to actively encourage poverty reduction or alleviation practices to be incorporated into the SAP development process to reduce the level of poverty in communities, regions and countries.

Gender Mainstreaming

Gender Mainstreaming was defined by the United Nations Economic and Social Council in 1997 as 'a strategy for making women's as well as men's concerns and experiences an integral dimension of...the policies and programmes in all political, economic and societal spheres so that women and men benefit equally and inequality is not perpetuated.' It is the intention of the TDA/SAP Approach to actively encourage gender mainstreaming practices to be incorporated into the SAP development process to ensure that all individuals, male and female, have the opportunity to participate and benefit equally.

Climate Variability and Change

Climate variability and change is now an inescapable reality. Human activity is leading to ever increasing levels of greenhouse gas (GHG) emissions and steadily compromising the natural resources needed to maintain the health of the planet. Climate change has been recognised as a significant driver (or root cause) of a number of transboundary problems in international waters. Consequently, the effects of climate change (in terms of cause and impact) must be well understood during the TDA/SAP process to ensure that future interventions in GEF international waters projects are both resilient and adaptive.

Collaboration With Other Approaches

In order to reduce the replication of effort, encourage more efficient use of resources (financial, time and knowledge), and ensure there is no conflict between approaches; the TDA/SAP process should encourage collaboration and integration with other approaches, including national, regional and international processes, initiatives or plans that have been, or are currently being, developed for the water system.

Stakeholder Consultation and Participation

Stakeholders are any party who may - directly or indirectly, positively or negatively – affect or be affected by the outcomes of projects or programs. Consequently, a wide range of stakeholders are involved in the TDA/SAP process. These can include the Government, regulatory agencies, businesses, communities, civil society and NGOs.

Stakeholder consultation and participation can be defined as the process through which people with an interest (stakeholders) influence and share control over development initiatives and the decisions and resources that affect them.

Stepwise consensus building

To ensure an effective TDA/SAP Process, it is important to encourage stepwise consensus building. By including clear stakeholder representation at all stages, consensus-building is more likely, increasing the probability that the outcome will be “owned” by the stakeholders and sustainable in the long-term.

Transparency

The TDA/SAP process will be in the public domain. Stakeholders should agree to freely share the necessary information and information products, taking care that full recognition is given to information sources.

Accountability

Parties committing themselves to implementing the SAP must be fully accountable for their actions. Stakeholder groups, sectors and government agencies responsible for implementing the actions proposed within the SAP must be clearly and unambiguously identified.

Inter-sectoral policy building

Responsibilities for water resources development and management are often fragmented over many sectors. Solutions should be cross-cutting throughout the decision-making process by sector and level. In order to develop a pragmatic SAP, direct participation of all key sectors involved in the transboundary problems should be encouraged, to ensure inter-sectoral policies are developed when necessary. This involvement will normally consist of all key government ministries in participating countries, as well as other relevant stakeholder representatives.

Donor partnerships

The TDA/SAP process is designed to build partnerships between development partners (donors) in order to address the identified problems and, where necessary, to assist governments to cover the costs of baseline actions. An effective donor partnership will act as an incentive for commitment to the SAP and avoid duplication of efforts by the donor community.

Government commitment

Endorsement of the SAP as a binding agreement between governments should be an important management objective of the process. If the process has been conducted in a stepwise manner, this final step is achievable. A SAP that does not involve a high level of formal commitment is unlikely to be taken seriously as a roadmap for policy development and implementation.

Source: International Water Learning Exchange and Resource Network. Viewed on http://manuals.iwlearn.net/tda-sap-methodology/introduction on 28 February 2013.

2.2.9.2 The TDA[16]

The TDA is an objective, non-negotiated assessment. which uses the best available verified scientific information to examine the state of the environment and the root causes of its degradation. The analysis is carried out in a cross sectoral manner, focusing on transboundary issues without ignoring national concerns and priorities. It provides the factual basis for the formulation of a SAP, which embodies specific actions (policy, legal, institutional reforms or investments) that can be adopted nationally—usually within a harmonized multinational context—to address major transboundary concern(s). The long term goal is to restore or protect a specific body of water or transboundary ecosystem.

The TDA consists of 5 steps:

[16] Most of this section and the next is taken from the International Water Learning Exchange and Resource Network. Viewed on http://manuals.iwlearn.net/tda-sap-methodology/introduction on 28 February 2013.

1. Identification and initial prioritisation of transboundary problems (often termed “Scaling – Scoping – Screening”)
2. Gathering and interpreting information on the environmental impacts and socio-economic consequences of each problem
3. Final prioritisation of transboundary problems
4. Causal chain analysis (including root causes)
5. Completion of an analysis of institutions, laws, policies and projected investments (institutional/governance analysis)

The features of a TDA are shown in Box 2.2-8.

Box 2.2-8: Features of the Transboundary Diagnostic Analysis (TDA)

- “The process of jointly developing a TDA is important for countries so that they learn to exchange information and work together. Inter-ministry committees are often established in each country sharing a water body to provide that country-specific input on the shared basin or marine ecosystem. This helps to determine the transboundary nature, magnitude, and significance of the various problems pertaining to water quality, quantity, biology, habitat degradation, or conflict.
- After the threat is identified, the countries can determine which problem(s) are priorities for action—relative to less significant problems and/or those of solely national concern. In addition, the root causes of the conflicts or degradation, and relevant social problems, are also included in the analysis so that actions to address them may be determined later. The scienctific community from each country is often involved as the TDA is intended as a technical document, and key stakeholders are expected to participate. If a stakeholder identification or social analysis was not done in preparation, it should be included in the TDA process.
- This TDA process provides an opportunity for the countries to understand linkages among problems and the root causes of environmental problems in economic sectors. As a result, more holistic, comprehensive solutions may be identified to enable responding to many different conventions in a cost-effective manner. The TDA process allows complex transboundary situations to be broken up into smaller, more manageable components for action as specific sub-areas of degradation or priority “hotspots ”are geographically identified within the larger, complex system. Some of these may be deemed high priority; others may not.”

Source: Bloxham, M.J., Richards, J.P., Glegg, G.A., Cooper, P, Caballero, P, Mee, L.D. 2005. *Training course on the TDA/SAP approach in the GEF International Waters Programme*. University of Plymouth. 1st edition, training materials in 6 modules (Train-Sea-Coast Programme).

A key process in the TDA is causal chain analysis (CCA). CCA is predicated on the belief that problems are best solved by attempting to address, correct or eliminate root causes, as opposed to merely addressing immediately obvious symptoms. The GEF version of CCA includes three levels of causes[17]:

[17] International Water Learning Exchange and Resource Network. Viewed on http://manuals.iwlearn.net/tda-sap-methodology/introduction on 28 February 2013.

- "**Immediate**" or technical causes (sometimes known as primary causes) are usually the direct causes of the problem. They are predominantly tangible (e.g. enhanced nutrient inputs), and with distinct areas of impact, with the exception of causes such as atmospheric deposition or climate change. Immediate causes, usually technical in nature, are the most straightforward to quantify, prioritise and geographically locate using maps. Examples include damming for abstraction and changes in land use.
- "**Underlying**" causes are those that contribute to the immediate causes of a transboundary problem. They can broadly be defined as underlying resource uses and practices, and their related social and economic causes. Examples of the former are unsustainable practices; and of the latter, a lack of investment and governance failures (legislation, regulation, enforcement)
- "**Root**" causes are often related to fundamental aspects of macro-economy, demography, consumption patterns, environmental values, and access to information and democratic processes. Most of these are beyond the scope of GEF intervention; however, it is useful to document them, because some proposed solutions may be unworkable if the root causes of the problem are overwhelming. Actions taken nearer to root causes are more likely to have a lasting impact. Root causes can be classified into the following groups:
    - education and formulation of values;
    - national regional and international governance issues;
    - poverty, wealth and inequality;
    - population pressure and demographic change;
    - climate change;
    - development models and national macro-economic policies; and
    - social change and development bias

To ensure sufficient reliable information on which to base the TDA and subsequent SAP, it is usual practice, in addition to the causal chain analysis, to develop thematic reports on key aspects where information is poor or absent. Topics vary depending on the circumstance. A few are briefly described below[18].

- **Stakeholder analysis** (I.e. Developing and understanding all stakeholders potentially involved in matters such as whom they represent, organisational structures, policy positions, etc.;
- **Governance analysis** of the exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes and institutions, through which citizens and groups articulate their interests, exercise legal rights, meet their obligations, and mediate differences.
- **Gender Analysis**
- **Climate Change Analysis**
- **Any other** topics, such as biodiversity, pollution, flooding, fisheries.

2.2.9.3 The SAP

A SAP:

- Is a **negotiated** policy document;

[18] International Water Learning Exchange and Resource Network. Viewed on http://manuals.iwlearn.net/tda-sap-methodology/introduction on 28 February 2013.

- establishes **clear priorities for action** to resolve the priority transboundary waters problems;
- identifies **policy, legal and institutional reforms and investments** needed to address the priority transboundary waters problems; and
- its preparation is a **cooperative process** among key stakeholders in the countries of the region.

The preparation of a SAP should be highly cooperative and collaborative among the countries of the region. SAP preparation can be divided into two key phases[19]:

1. Strategic Thinking:
   a. Defining the vision
   b. Setting goals or status statements
   c. Brainstorming new ideas/opportunities for innovation
   d. Identifying options or alternatives
2. Strategic Planning:
   a. National and regional consultation processes
   b. Setting strategies for implementation
   c. Action planning - Setting actions, timescales, priorities and indicators
   d. Drafting the SAP
   e. Steps towards SAP implementation

2.2.10 Other forms of assessment

2.2.10.1 Cumulative Environmental Assessment (CEA)

Cumulative environmental assessment pertains to when a series of projects, of the same nature, is planned. Each project contributes to the cumulative (overall) impact on the river basin or region. CEA links to both SEA and EIA.

2.2.10.2 Social Impact Analysis/ Assessment (SIA)

Social impact analysis refers to the non-ecosystem (i.e. human) dimension. SIA is sometimes linked to economics as economic and social assessment (ESIA). A companion manual on the topic of social aspects is concurrently under development.

2.2.10.3 Health Impact Assessment (HIA)

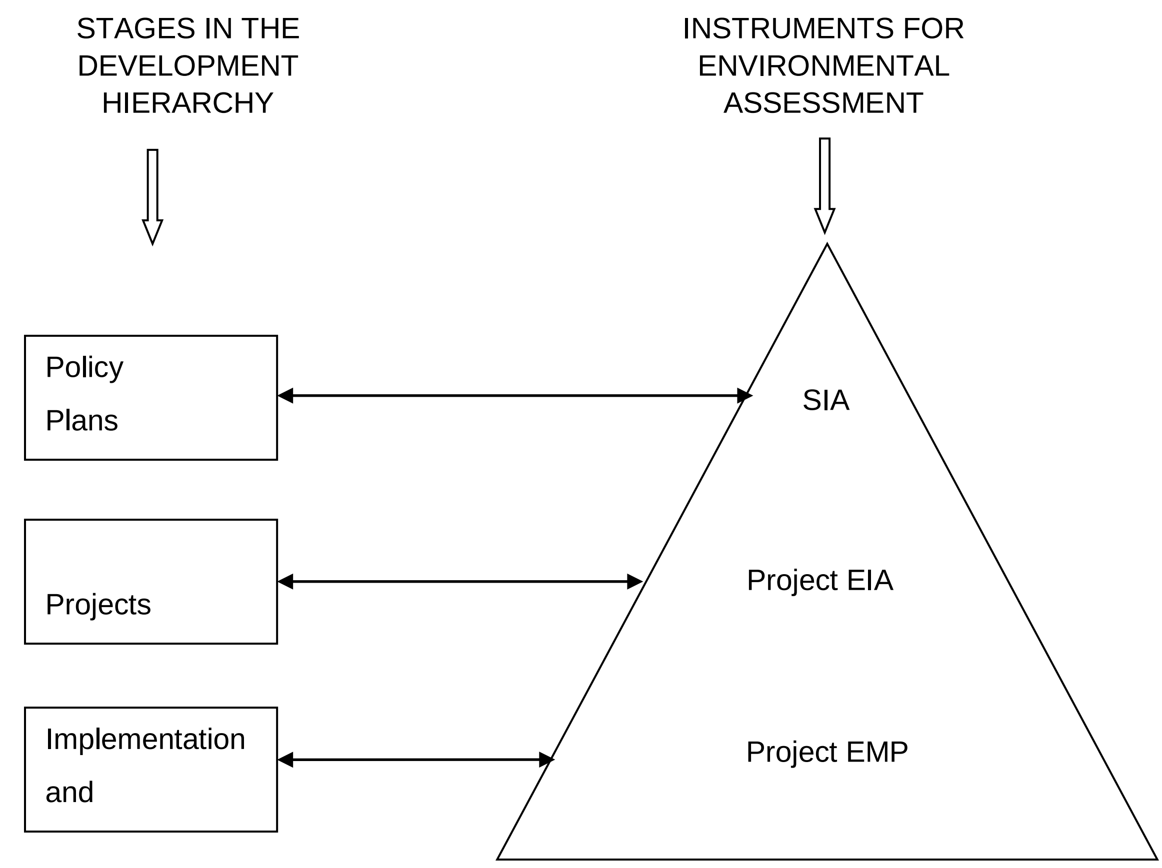
In hydropower projects involving a dam or major river channel reconfiguration, health impacts, such as from water-borne disease vectors and the arrival of construction workers, often justify a specialist health impact assessment.

[19] International Water Learning Exchange and Resource Network. Viewed on http://manuals.iwlearn.net/tda-sap-methodology/introduction on 28 February 2013.

2.2.10.4 Strategic Impact Assessment (SIA)

"*SIA can be defined as a systematic process for evaluating the environmental consequences of proposed policy, plan or program initiative in order to ensure they are fully included and appropriately addressed at the earliest stage of decision-making on a par with social and economic considerations*"[20]. It is more appropriate for policies, programmes and plans. See Figure 2.2-2 for the relationship in the development hierarchy.

Figure 2.2-2: SIA, EIA, EMP and their relation to the Development Hierarchy



Source: African Development Bank. 2003. *Strategic Impact Assessment Guidelines*

[20] African Development Bank. 2003. *Strategic Impact Assessment Guidelines*

3 IDENTIFICATION OF OPTIONS

This module describes the process of identifying options and their analyses.

At the national or provincial level analytical frameworks, such as strategic environmental assessment, integrated water resources management, energy planning, social accounting matrixes, transboundary diagnostic analysis, and others, are well established. Similarly, at the project level analytical frameworks, such as social and environmental impact assessment and cost benefit analysis, are well established.

These analyses usually identify options and provide essential data for sound decision-making.

The generalised challenge of options assessment is to make the best possible decisions at:

- The national scale between policy options;
- The intermediate scale between strategic options;
- The local or sectoral scale between projects.

However, each of the above-mentioned analytical frameworks generates proposals from a restricted analytical space. Options assessment is the process that seeks to bring all factors to bear on a decision. The most common technique, and that proposed by the WCD, is multi-criteria analysis.

3.1 Setting Criteria and Performance Measures

3.1.1 Key Aspects

- The setting of criteria and performance measures requires the participation of stakeholders to be effective.
- Stakeholders can be involved at several stages of options assessment process.
- Criterion can be defined as the "principle or standard that a thing is judged by" and an indicator is a "variable from which the status of a criterion can be inferred".

3.1.2 Training Aids

Purpose of session	To describe how criteria for evaluating options are selected
Learning objectives	To be able to set up a list of option assessment criteria
Time required for session	60 to 90 mins
Preparatory reading	None
Discussion topics	1. Add social and environmental criteria to Table 3.1-1. 2. Differentiate stakeholders at different levels (e.g. on empowerment, knowledge levels, training, communication, responsiveness).
Exercises	None
Additional Reading	Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264. pp92-96
Case Studies	None

3.1.3 Introduction

Module 2 described the planning processes that defined and quantified needs—and usually pointed towards solutions. A further preparatory step is coming to consensus on criteria and performance measures, by which a proposal could be consistently evaluated and compared with other proposals.

3.1.4 Stakeholders

The setting of criteria and performance measures requires the participation of stakeholders to be effective (as with all steps in the options assessment process). See Box 3.1-1. The scope of this manual does not include participation issues. Separate manuals on social and environmental issues are being concurrently prepared in this series. Those manuals deal extensively with participation issues. See Box 3.1-2. The reader should also refer to a source book on *Stakeholder Involvement in Options Assessment* [21]

Box 3.1-1: Benefits of Stakeholder Involvement
The evidence presented here strongly suggests that investing time and resources up-front in a planning exercise for water and energy development is the best way to manage the social risks associated with major interventions in the water resources sector. Stakeholder involvement in options assessment forms a risk management approach for major water resources interventions in a number of ways: • Moving the assessment into strategic planning helps develop a stronger, more diverse portfolio of interventions for project planning, including the identification and early clearance of fast-track projects, which address immediate needs ,and the early elimination of poor projects. • Involving stakeholders in the strategic planning exercise helps improve public acceptance of proposed development projects . • Involving stakeholders in the identification and assessment of alternatives in project planning improves project quality, reduces risks for all involved, and enhances compliance with agreements reached during project preparation.
Source: Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264.

Box 3.1-2: Working with Stakeholders
"... the process of soliciting the views of people affected by the project through local consultations. Early efforts were one- way monologues that transmitted technical information but did little to elicit surfacing of uncomfortable questions or opinions. These shortcomings were addressed after 2003, when a new methodology elicited fuller and more unscripted feedback. To ensure that the consultation process was robust and meaningful, the international financial institutions engaged a well- respected international social anthropologist, with expertise on Lao PDR, to monitor the efforts. The consultation efforts successfully brought forward a broad array of opinions, which were incorporated into the project design and approach; however, the array of livelihood options (which were

[21] Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264. Executive Summary.

overwhelming to some resettlers) could have been simplified, and the findings of the consultations could have been more fully harvested by better cataloguing, using, and archiving the information collected."

Porter, I and Shivakumar, J. (eds) *Doing a dam better: the Lao People's Democratic Republic and the story of Nam Theun 2*. The World Bank. p22.

Stakeholders can be involved at several stages of options assessment process. These include:

- Identification of alternative proposals;
- Selection and weighting of criteria and performance measures; and
- Scoring or ranking proposals in multi-criteria analyses.

The principles that should be followed for stakeholder involvement are as follows[22]:

- Create an enabling environment for stakeholder involvement and options assessment;
- Involve all relevant stakeholders;
- Assess all options strategically and comprehensively; and
- Reach a decision.

3.1.5 Multi-purpose options

It is common that, in the sectoral planning processes described in the previous module, inter-sectoral benefits have not been fully taken into account. An example would be a hydropower project optimised for power supply but, which missed an opportunity to provide water supplies. The WCD found that the economic and financial viability of a project could be enhanced if the benefits to all sectors of the economy were considered and provided the option was structured so as to realise the benefits from all sectors.

3.1.6 Criteria and performance measures

A criterion can be defined as the "*principle or standard that a thing is judged by,*" while an indicator is a "*variable from which the status of a criterion can be inferred*".

For typical hydropower projects, criteria are very similar. One way to derive a set of criteria is to start with those developed in the IHA Sustainability Protocol. Development finance institutions also provide analytical frameworks that include criteria. It is, however, preferable to consider every project as unique and to work through criteria accordingly.

Criteria selected should:[23]

[22] Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264.

[23] Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264. p92

- Be linked to the needs and objectives of the interest groups identified in the preceding step;
- Include social and environmental criteria, as well as technical and economic criteria;
- Include criteria that reflect national and regional development objectives and policies;
- Include criteria that look at impacts of options over their life cycle;
- Be exclusive (i.e. not effectively the same as any other criteria);
- For each option, the social and environmental costs should include both mitigation costs and any residual, unmitigated costs; and
- Be explicit and, to the extent possible, quantitative.

Box 3.1-3 illustrates how environmental costs were internalized in the National Power Plan in Pakistan.

Box 3.1-3 Internalization of Environmental Costs in the Pakistan Power Sector

When coal, gas, and oil-fired thermal generation options were considered in the Pakistan National Power Plan (1992-1994), each option needed to conform to Pakistan's national regulations on air emissions (CO2, SO 2, NO, etc) for both single-point emissions and incremental additions to the airshed. The assessment was made using emission models, which predicted the concentrations of emissions for different technologies and levels of mitigation, taking into account topography and climate conditions. Similarly, the cooling systems for thermal plant (once-through cooling) were designed, so that large volumes of water, abstracted from rivers and link canals from irrigation districts, were within temperature limits when discharged back into the source. Both atmospheric and riverine emissions were monetarized and expressed as costs for each of these thermal options, through increased operating costs and capital costs (including larger cooling systems, more expensive low-sulphur oil and coal inputs, and scrubbers) required to meet national standards.

Alternative plans identified the cumulative air shed impact of the thermal options. Hydro options also estimated the cumulative basin impacts, including impacts on ecological processes and services, combined flood storage and mitigations, impacts on sediment and nutrient cycles, biodiversity impacts, and resettlement.

Source: WAPDA. 1994. *Pakistan National Power Plan* Cited by Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264.

Criteria can:

- Exclude projects; for example, projects that significantly change river flows in protected areas should be considered excludable, as well as options that cannot deliver services in a certain time frame;
- Relate to performance criteria—that is, provide a certain amount of drought security or electrical supply at peak demand; and
- Relate to development objectives—that is, provide an opportunity for regional development, including certain minimum benefits or local security to poor people.

A structure for criteria, based on a typical development finance institutions appraisal framework, is shown in Table 3.1-1. Note that this table does not include social and environmental criteria.

Table 3.1-1: A typical structure for assessment criteria

Policy criteria	1) The project must fit with identified priorities on a national and local level; 2) The project must meet a need expressed by the community
Technical criteria	1) The proposed solution must be technically feasible and flexible enough to meet current and future needs; 2) The least-cost solution should have been identified, along with reasons in the case it is not utilised; 3) The project should use technology appropriate to project needs, including (as far as possible) the use of generally known and accepted codes of practice.
Financial criteria	1) The project should be financially viable (measured either by a positive net present value or an internal rate of return above a cut-off value); 3) The sources of funds should be clearly identified; 4) Government subsidies (fiscal subsidies, not cross-subsidies), if included, should be aimed at specific target groups, have a defined time horizon, and be directed at capital cost components (not operating costs); 5) The project cash flow (including any subsidies) must be sufficient to cover both investment and operation requirements, including servicing and repayment of loans used to finance the project; 6) The financial risks should be identified and found to be acceptably low.
Economic criteria	1) The project should be economically viable, (i.e. its net present value should be positive or the benefit-to-cost ratio should be greater than one); 2) The project should be clearly preferable to any alternative or competing project, (i.e. when alternative solutions exist, the project should represent the

	least-cost of all of these); 3) The project should be socially desirable (or the overall social impact of the project should be positive).
Source: Davis M and Horvei T. 1995. Handbook for the economic analysis of energy projects. Development Bank of Southern Africa	

3.1.7 Multi-level Criteria

For the Nam Theun 2 Hydropower Project in Laos, the nomenclature of “disciplines” and “issues” were used. The “disciplines” used were:[24]

- Financial aspects;
- Social aspects;
- Ecological aspects;
- Technical aspects;
- State of Preparedness
- Economic aspects; and
- Development in Project Affected Area.

Each discipline was assigned an importance weight, and each of these disciplines was subdivided into issues. Each issue was assigned a weight within the discipline. For example, the Economic Aspects discipline had an importance factor of seven percent and consisted of the issues:

- Ability to compete with thermal plants in Thailand
- Magnitude of external costs vis-à-vis GOL income
- Magnitude of external benefits vis-à-vis GOL income
- General infrastructure benefits - roads and bridges
- General infrastructure benefits - national 500 kV grid
- General infrastructure benefits - electrification
- Employment effect, development of vocational skills
- Project risks (delays, cost overrun, reduced generation)
- Potential economic effect of dam break (or fire Hong Sa)

In all, 55 issues were identified and subsequently scored in a multi-criteria analysis (see Annex 1 on SCREENING AND RANKING OF OPTIONS). For this analysis scores were recorded, first by stakeholders, and second by a team of technical experts, who were appointed for the purpose. Multi-criteria analysis is further elaborated in Module 5.

[24] Oud E. 2003.*The Nam Theun 2 Hydro Project in Laos*. In: *Case Studies in Comprehensive Options Assessment of Dams and their Alternatives*. UNEP DDP Issue Based Workshop #1.

3.2 Session 3.2: Seeking Options

3.2.1 Key Aspects

- The golden rule is that for every objective or need there will be several ways (options) in which it can be achieved.
- Involving stakeholders in identifying the options helps ensure that a diverse range of options is identified.
- At the national level, governments make options choices when formulating policy instruments, such as national development plans.
- What are important are the feedback loops of the reality from strategic, sectoral and project planning and implementation.
- Unless such an analysis integrates with other sectors, it is impossible to achieve sustainability.
- It is suggested that at the policy level four options (alternative energy forms, purchasing electricity externally, and conventional electricity generation, as well as conservation and demand management). The WCD provides a proforma list of available options.

3.2.2 Training Aids

Purpose of session	The purpose of the session is to outline how to go about identifying options.
Learning objectives	At the end of the session the trainee will be able to structure a process than conducts an exhaustive search for options for satisfying the identified need.
Time required for session	60 to 120 mins
Preparatory reading	UNEP, Dams and Development Project. 2007. *A Compendium of relevant practices for improved decision-making on dams and their alternatives*. pp 21-22
Discussion topics	Who are the stakeholders? How should they be identified?
Exercises	Add additional options to Figure 3.2-2.
Additional Reading	None
Case Studies	Review the Yacambu-Quibor case study in Box 3.2-1. What is the likelihood of similar circumstances in your country?

The identification of options is based on the needs assessment. Note that some of the approaches described above in Session 2.2 yield a project list directly or as a logical further step.

3.2.3 Clarifying objectives

Objective (or goal) setting is closely aligned with needs and options assessment. The golden rule is that for every objective there will be several ways (options) in which it can be achieved. Objectives are hierarchical in nature. At the macro level, infrastructure such as hydropower may not even be an immediate option. (For example, if a macro objective is to achieve food security, options might be to increase irrigation, turn to bio-engineering, or increase food storage). If increasing irrigation is the chosen option here, at the next level it becomes the objective. To achieve this objective, all the factors of production (capital, skills, markets, land, water, energy) would need to be improved. To achieve the objective of improving energy services, the options might be electrification, liquid fuel distribution channels, etc. For achieving the objective of increased electrification, generating capacity and distribution infrastructure is needed. For achieving the objective of increasing generating capacity, there are options of hydropower (concentrated or dispersed), alternate fuels, etc.

In all of this complexity, it can be easy to gloss over options, accept conventional wisdom, or poorly define the core objectives; however, poorly defined objectives lead to poor options identification, assessment, and choice.

3.2.4 Principles for identifying options

Some general principles for identifying options for particular needs are:

- **Involving stakeholders in identifying the options.** This helps ensure that a diverse range of options is identified, which represent development objectives and needs assessments. The involvement of the stakeholders also makes the deletion of unfeasible options and the fast tracking of options that meet immediate needs less controversial.
- **Include options at all scales of intervention**. Depending on the type of exercise, options may include initiatives at the household scale, community scale, and/or the scale of larger infrastructure developments. It may mean using options identified in earlier river basin and community level planning work.
- **Include options from different time frames and properly recognize lead times**. To meet both immediate and future needs, the options inventory should include options that have different time frames. It also requires realistic assessments of the timeframe for implementation of supply projects and for the effects of demand side measures to occur.
- **Include supply-side efficiency options**. Improved management of existing assets can significantly reduce the need for new infrastructure while improving the quality and access to services at less cost than new infrastructure.
- **Include demand-side management options.** Reductions in demand for services through pricing reforms; improvements in source-, transmission- and end- user efficiency; and educational programs can significantly reduce requirements for new supply infrastructure, or take pressure off supply development programs. Where a country has low levels of access to basic services, as in many parts of East and Southern Africa, the benefits from demand management will be limited although they can still play a role alongside new supply development.

- **Include policy interventions and institutional arrangements.** Better focused policy and more efficient institutional arrangements can help facilitate development of new supply options, increase supply efficiencies, or better manage demand. These policy and institutional options can include cost recovery programmes, new tariff structures, private sector initiatives, decentralisation and management transfer.
- **Address remaining social concerns from past projects**. Social and environmental problems from past projects can influence public attitudes toward new infrastructure. In many cases, promises of compensation and sharing of benefits from large scale projects have not been kept. This is a complex subject that does not lend itself to global statements. However, addressing legacy issues may be a sensible option where it will enhance the acceptance by stakeholders of new developments.

3.2.5 Stakeholders

The Yacambui-Quibor project in Venezuela (Box 3.2-1) is a case study of what can be achieved when local stakeholders are actively engaged in identifying options to meet their needs—as well as what may transpire if they are not.

Box 3.2-1: Case Study on Stakeholder Involvement

When the Government of Venezuela withdrew the budget allocation for the heavily opposed US$500 million Yacambu-Quibor water transfer project in 1986, it expected the decision to be widely welcomed. What followed illustrates that affected communities can, if given a lead role in decision-making about dams, turn failures into successes.

The project involved transferring water from the Yacambu River in the Orinoco watershed to the state of Lara to irrigate 15,000 hectares in the semi-arid Quibor Valley and double the water supply to Barquisimeto, a rapidly expanding metropolitan area experiencing water shortages. Physical infrastructure included a large dam and a 26-kilometer tunnel across the Los Andes Mountains. Soon after construction started in 1975, the project had become embroiled in legal disputes with civil contractors, and work stopped.

It was apparent that the communities in the Yacambu River watershed totally rejected the project. They had received no information on how the transfer of water from their area would affect them, and they felt they risked losing land and entitlements, while receiving no benefits. Farmers in the Quibor Valley, the intended irrigation beneficiaries, claimed they were kept in the dark as to how they would individually and collectively participate in the project, or even benefit. The absence of information on how water would be allocated made the farming communities fear that a poorly implemented project might add to the conflicts that already existed among small, medium, and large landholders in the valley at a critical time of agrarian and land reform. This was despite the fact that the groundwater aquifers feeding their existing irrigation schemes were failing, and competition for water was growing.

In spite of their misgivings about the project, the Lara community mounted an effective, cross party campaign in response to the government's announcement that funding was to be withdrawn from the project. As a result, the national government established a public company with the mandate to develop the Yacambu-Quibor project, to identify mechanisms for water allocation and use, and subsequently implement the project. To do so, the public company engaged intensively with the communities and stakeholders in the development of the project. The company's Board was formed *from the stakeholders in the project. It immediately took the step of constituting a Consulting Council comprising important community organizations, including representatives from local municipal governments, civil society, farming associations, and NGOs. Members came from the Quibor Valley, the Yacambu river watershed, and the Barquisimeto metropolitan area, i.e. the three affected regions.*

Staff started by drawing up a stakeholder communication strategy. Based on the feedback they received, they began engaging the communities in dialogue about community concerns. In the Yacambu watershed, this led to open discussion of the impacts of the water diversion and community involvement in the evaluation and selection of mitigation options. When a Watershed Conservation Plan was eventually developed, objections to the project from this region were withdrawn. Similarly, through formal and informal agreements, consensus was reached among the irrigation interests in the Quibor Valley on water allocation and sharing. With consensus emerging on how to proceed, the central government re-instated the project budget, and today community members widely believe the project will provide an important contribution to Lara's economic development.

Source: Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264.

3.2.6 Policy, strategic, project options

At the national level, governments make options choices when formulating policy instruments, such as national development plans (see section 2.2.5). The main determinants at this level are factors such as national resources endowment, the state of development, and competitive advantages in trade, among others.

> *"The policy framework and sector strategy of a country have increasingly become the focus of the debate over large projects with the need for a comprehensive policy and regulatory framework that creates 'a level playing field' as the means to enable the full breadth of options to be fairly considered and assessed without being constrained by policy distortions or subsidies. However, due to other national and geopolitical and social considerations such as environmental sustainability, deliberate policy measures may be introduced to influence (promote or discourage) the adoption certain options in meeting basic needs. These could be in the form of environmental taxes, green electricity quotas.*
>
> *To this end, policy-makers have to choose the instruments or policy options that enable a country to meet its broad strategic and development objectives. Such policy instruments and options contribute significantly in shaping the landscape in which options will be identified, adopted and implemented. As an example policy makers may require that they internalize the externalities in the electricity production. For this they have to find a solution that gives the best outcome in terms of efficiency, cost minimization, impact on the job market, security of supply, equity of the instrument, technological innovation, certainty of the level of the internalization, and feasibility. The choice of the instrument will require some trade-offs among these criteria"*[25].

[25] Nhete T & Chiramba T. 2011. *Comprehensive Options Assessment for sustainable development of infrastructure: Training Manual*. United Nations Environment Programme.

What are important are the feedback loops of the reality, considered next to strategic, sectoral and project planning and implementation. First, it is axiomatic that a government cannot, for example, pursue a policy of irrigation expansion to improve rural livelihoods unless adequate water resources are available. Second, a government cannot, for example, pursue a policy of industrialisation, unless there are resources, such as transportation infrastructure, skilled human resources and power, available. Third, a government cannot, for example, in relation to the topic of this manual, pursue a policy of electricity expansion, unless it also makes policies concerning the impact of the power stations on people and the environment.

The reality is that, although extensive technical analysis often exists to support the choice of options, the decisions at this level are largely political in nature. But this is not to say that the strategic, sectoral or project planner should not carefully analyse trade-offs that must be made. This analysis should be compared to the underlying assumptions of the higher level policy or strategy, and if major discrepancies exist, they should be highlighted and placed in the feedback loop, which will, in due course, contribute to the adjustment of the higher level policy or strategy.

It is only in this way that the high level approach advocated by the WCD can be achieved[26]:

> *"The approach developed by the Commission of* ***recognising rights and assessing risks*** *(particularly rights at risk) in the planning and project cycles offers a means to apply these core values*... (i.e. equity, efficiency, participatory decision-making, sustainability, and accountability) ... *to decision-making about water and energy resource management."*

3.2.7 Sectoral Analysis

Sectoral analysis is one of the standard tasks of government departments in all states. This analyses largely reviews resources and develops scenarios. Sectoral analysis must integrate with other sectors to achieve sustainability.

A sectoral analysis of "energy" resources for the Loa PDR is shown in Table 3.2-1. The analysis is actually directed at options for electricity generation, a sub-set of energy options, as the most convenient energy carrier.

Table 3.2-1: Energy resources in the Lao PDR	
The Asian Development Bank undertook an energy sector assistance programme evaluation for the Lao PDR in 2010. A brief summary of the analysis of energy resources is shown below.	
Hydropower.	The Lao PDR has 'vast hydro potential' with a technical potential of

[26] World Commission on Dams. 2000. *Dams and Development a New Framework for Decision-making. Earthscan pxxxiii*

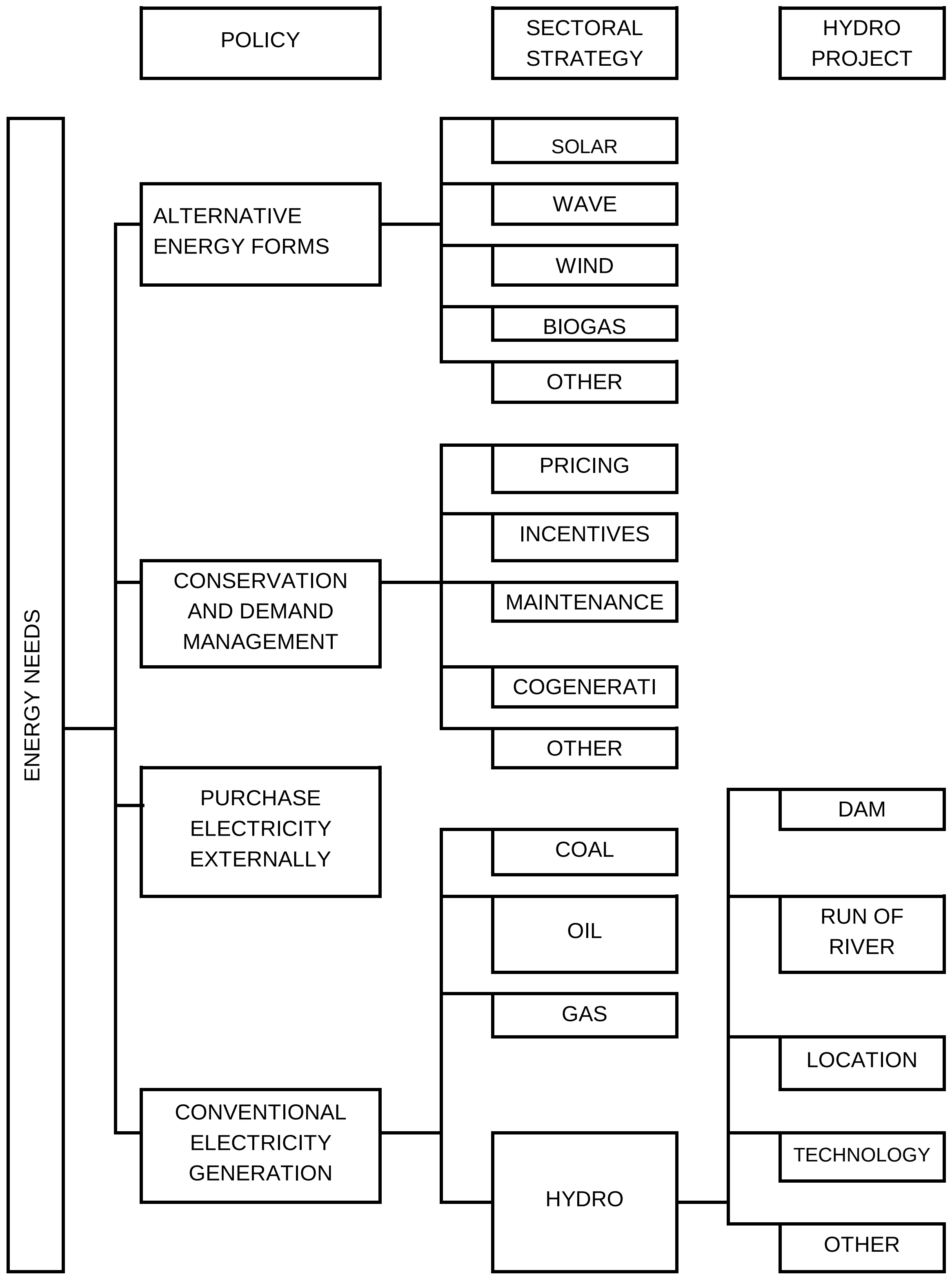
	18 000MW (albeit based on outdated information).
Coal and lignite	Coal reserves are meagre.
Oil and gas	There are no proven oil and gas reserves.
New and renewable energy options	The key influencers are: (i) the stated government goal to provide electricity access to 90% of households by 2020, coupled with the fact that extension of power transmission lines to remote areas to feed small communities would be a suboptimal and high-cost approach; (ii) the need to reduce dependence on imported oil; and (iii) the need to reduce fuel wood consumption, in recognition of the need to limit deforestation. There is a programme to pilot and deploy: (i) biomass; (ii) complement transport fuels; (iii) use micro and pico hydropower and wind power technologies to generate electricity in off-grid or localized grid or a grid-connected mode; (iv) use solar home lighting systems for off-grid power supply; and (v) wind
Source: Asian Development Bank, Independent Evaluation Department. 2010. *Evaluation Study: Energy Sector in the Lao People's Democratic Republic*. Reference Number: SAP: LAO 2010-42.	

3.2.8 Inter and intra sectoral options

This manual is directed principally at hydropower; however, a state's development path may, for example, be to pursue food security through encouraging the expansion of irrigation. Thus, the state's decision may be to devote its water resources to that goal. Furthermore (and bearing in mind that if large dams are to be viable in political, financial, economic and social terms, they generally have to be multi-purpose), there is an equivalent options space for other sectors, including irrigation, water supply, flood control etc. Each sector must be evaluated in detail. The available intra-sector options are identified from the sectoral analysis. It should be noted that, internationally, the planning discourse is turning towards the energy-food-water nexus.

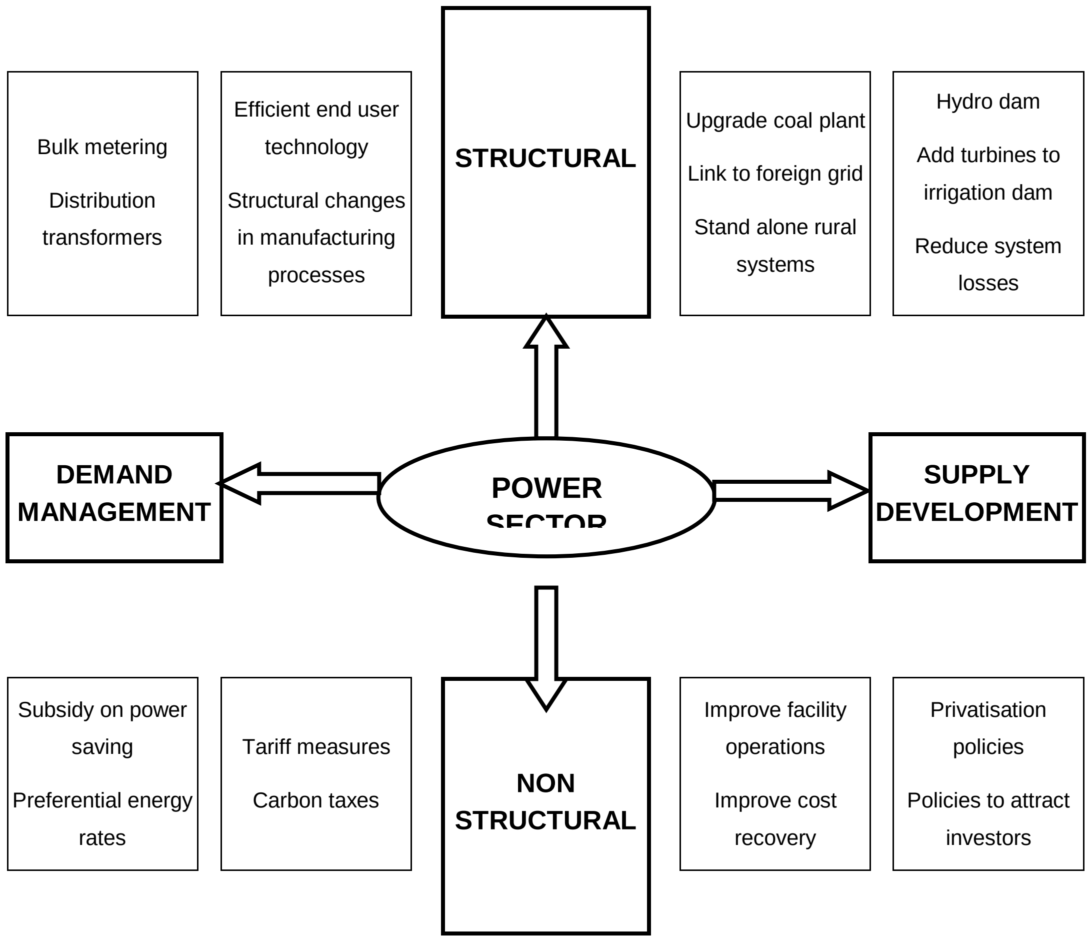
Figure 3.2.1 depicts possible options before hydropower might be chosen. It suggests that at the policy level there are four options viz alternative energy forms, purchase electricity externally and conventional electricity generation (these three based on using more energy) and conservation and demand management (based on using less energy and more efficiently). At the sectoral level each of these has various options and for conventional electricity generation one of these might be hydropower. At the hydropower project level there are further options. It must be stressed that the options are generally non-exclusive ie more than one could be pursued simultaneously. The diagram is meant to encourage planners to move systematically from needs to the optimal project.

Figure 3.2-1: Hierarchy of Energy Options leading to Hydropower



In a complementary approach, the UNDP and the World Bank[27] suggest that effective identification of sectoral options should take place along the two principle dimensions shown in Figure 3.2-2 (Structural/Non Structural and Demand/Supply). In the first dimension, a structural solution is one where infrastructure is increased (or modified). A non-structural solution is one achieved, for example, by changing tariffs. In the second dimension a demand management solution is one directed at limiting demand by discouraging use or encouraging greater efficiency. A supply development solution is one where available supply is increased. In Figure 3.2-2, the boxes with the smaller non-bold print present options in that quadrant. For example, "Subsidy on power saving" is a non-structural, demand management solution while a "Hydro dam" is a structural, supply development option. The figure is a prompt to remind planners to seek options in the whole of the option space.

Figure 3.2-2: Example of Power Sector Options



Source: Practical Action Consulting 2006. *Issue of Identification of Options in the context of Dam Planning and Management.* Final Report to UNEP/DDP. (Adapted from the World Bank, 2003)

[27] Joint UNDP/World Bank Energy Sector Management Assistance Programme. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. ESM264. p224

3.2.9 Location options

In hydropower planning the site determines the output that can be realised from the hydrology, topography and geology. There is always the temptation to select or eliminate site options solely by matching potential to assessed need for a particular phase. This, however, neglects all of the other parameters that go into determining the optimal choice. For example, a site with smaller potential output may have lower environmental and social impacts. It is better to go into the feedback loop and redefine the power objective for the phase.

3.2.10 Management and operation options

It has been noted that the final decision on large hydropower projects is mainly political in nature. At this level the appeal of new projects is undeniable. It is also usually undeniable that the initial optimal option is improvement in efficiencies of the existing system. These include demand management, loss reduction, plant upgrades and operating rules.

3.2.11 The WCD list of available options

The WCD provided the proforma list of available options in Box 3.2-2.

Box 3.2-2: WCD options for water and energy services

Today, a wide range of options for delivering water and electricity services exists, although in particular situations the cost and feasibility of these options will vary in the face of constraints, such as natural resource endowments and site location.The Commission found that:

- Many of the non-dam options available today – including demand-side management, supply efficiency and new supply options – can improve or expand water and energy services and meet evolving development needs in all segments of society.
- There is considerable scope for improving performance of both dam projects and other options.
- Demand management, reducing consumption, recycling and supply and end use efficiency measures all have significant potential to reduce pressure on water resources in all countries and regions of the world.
- A number of supply-side options at all scales (ranging from small, distributed generation sources or localised water collection and water-recovery systems to regional-interconnection of power grids) have emerged that – on their own or collectively – can improve or expand the delivery of water and energy services in a timely, cost-effective and publicly acceptable manner.
- Decentralised, small-scale options (micro hydro, home-scale solar electric systems, wind and biomass systems), based on local renewable sources, offer an important near-term, and possibly long-term, potential particularly in rural areas far away from centralised supply networks.
- Obstacles to the adoption of these options range from market barriers to institutional, intellectual and financial barriers. A range of incentives – some hidden – that favour conventional options limit the adoption rate of alternatives

Source: World Commission on Dams. 2000. *Dams and Development a New Framework for Decision-making. pxxxi*

3.3 Characterising Options

3.3.1 Key Aspects

- Life Cycle Assessment holds that projects should be compared, based on their performance throughout their useful lives.
- The Precautionary Principle (Approach) should be applied to all options.
- Each option should have a risk analysis.
- There are voluntary "risk-givers" and "involuntary risk-takers."
- The IHA Sustainability Protocol is designed as a tool for assessing hydropower projects through four project life-cycle stages.

3.3.2 Training Aids

Purpose of session	To introduce common approaches in the identification and characterisation of options
Learning objectives	To understand some of the considerations in setting up an options analysis
Time required for session	90 to 120mins
Preparatory reading	WCD Report p286 to 287
Discussion topics	Discuss the application of the Precautionary Principle to a project in your country.
Exercises	List the factors that should be considered in the life-cycle analysis of a hydropower project.
Additional Reading	International Risk Governance Council (IRGC). 2008. *An introduction to the IRGC Risk Governance Framework.* Executive Summary. *www.irgc.org.*
Case Studies	None

3.3.3 Life Cycle Assessment (LCA)

Life Cycle Assessment holds that projects should be compared, based on their performance throughout their useful lives. Originally from the manufacturing sector, LCA has been adapted and applied in the power sector. LCAs can ensure a broad outlook on environmental concerns by:

- Compiling an inventory of relevant energy and material inputs and environmental releases;
- Evaluating the potential impacts associated with identified inputs and releases; and
- Interpreting the results to help make a more informed decision.

In the energy sector it is apposite for considering the greenhouse gas emissions (GHG) of options.

3.3.4 Precautionary principle

The precautionary principle was first recognised in the World Charter for Nature, adopted by the UN General Assembly in 1982. It gained widespread prominence at the 1992 Rio Conference on the Environment and Development. Principle 15 of the Rio Declaration, states that:

> *“... in order to protect the environment, the precautionary approach shall be widely applied by States according to their capability. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation”*.

The precautionary principle is also referred to in the United Nations' Framework Convention on Climate Change and the Convention of Biological Diversity. This repetition throughout international conventions suggest the principle has become part of international environment law. In the European Union it is entrenched in statute law.

Alternate descriptions are:

> *"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."*[28]

> *"The precautionary principle applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen by the EU"*.[29]

With regards to options assessment for hydro projects, the application of the precautionary principle can be included as part of risk management. In this case, it applies to both ecological and social matters.

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[28] Science and Environmental Health Network. 1998. *Statement of the Wingspread Conference on the Precautionary Principle*

[29] Commission of the European Communities. 2000. *Communication from the Commission on the Precautionary Principle*

An important consequence of the principle is that when potential harm exists due to presence of scientific uncertainty, the onus shifts onto the proponent to prove that the proposals and the mitigation measures will be sufficient to achieve the environmental objectives:

> *"Decision-makers need to be aware of the degree of uncertainty attached to the results of the evaluation of the available scientific information. Judging what is an "acceptable" level of risk for society is an eminently political responsibility. Decision-makers faced with an unacceptable risk, scientific uncertainty and public concerns have a duty to find answers."*[30]

Measures based on the precautionary principle should be, inter alia:

- proportional to the chosen level of protection;
- non-discriminatory in their application;
- consistent with similar measures already taken;
- based on an examination of the potential benefits and costs of action or lack of action (including, where appropriate and feasible, an economic cost/benefit analysis);
- subject to review, in the light of new scientific data; and
- capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment.

3.3.5 Risk analysis

Every option comes with a set of risks. Risks influence preference for an option and must be brought into the options assessment process.

A risk is defined by ISO 31000 as "*the effect of uncertainty on objectives".* Risk management is the science of identification, assessment, prioritization, and resource allocation directed minimizing potential losses and maximizing opportunities. Risk management is a rapidly evolving field and has become ubiquitous in the infrastructure financing field.

Some risks have been historically part of dams and hydropower—as the natural risk of hydrology and the management risk of construction completion—while others are evolving. Issues increasingly analysed in a risk framework include environment and project affected livelihoods. A recent development of risk into the social field is evidenced by the World Bank's Social Risk Management Framework[31]. The framework is based on two assessments:

> *"(i), the poor are typically most exposed to diverse risks ranging from natural (such as earthquake and flooding) to manmade (such as war and inflation), from health (such as illness) to political risks (such as discrimination), and*
>
> *(ii) the poor have the fewest instruments to deal with these risks."*

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[30] Commission of the European Communities. 2000. *Communication from the Commission on the Precautionary Principle*. p4

[31] The World Bank. 2003. *The World Bank's Approach to Social Protection in a Globalizing World*

The WCD addressed risk as part of the “rights and risks” approach, distinguishing between “voluntary risk takers” and “involuntary risk bearers”. See Box 3.3-1. The latter “*must have the legal right to engage with risk takers in a transparent process to ensure that risks and benefits are negotiated on a more equitable basis.*” It also concludes that the comprehensive engagement of stakeholders in options assessment, as well as other aspects of the project planning and preparation process, will considerably reduce the risk of delays, cost escalation, and reduced benefits.

Box 3.3-1 Voluntary risk takers and involuntary risk bearers

Traditionally the developers of large hydropower projects, whether private sector or government proponents, are “**voluntary risk takers**”. The private sector has been able to manage the risk of projects through specific, established procedures, including requiring high financial rates of return and using contractual agreements and sophisticated third party recourse and arbitration mechanisms. Governments have weighed the risks inherent in undertaking dam projects against the risks of not undertaking them.

There are those, however, on whom risk has been imposed. The ‘**involuntary risk bearers,**’ include people to be displaced by the project. These people may face years of uncertainty and direct risks to their livelihoods—even before the project is approved and before resettlement or land purchase. They may be unable to obtain finance for investments in farm infrastructure or equipment, and local government may not maintain or develop services for communities on the verge of displacement. Risks to displaced communities are compounded in cases where they have no say in the decisions but are obliged to bear the consequences. Downstream communities that depend on existing river flows to maintain their resource base are often not given any say in deciding the nature of projects. Yet these populations face the risk of losing access to resources, potentially undermining their ability to maintain sustainable livelihoods. Lower priority generally accorded to these types of risks is compounded by the absence of tangible safeguards, and/or the failure to implement and enforce those that do exist.

In such cases, as with other involuntary risk bearers, adopting a precautionary approach is particularly relevant in order to avoid impacts. It is also essential to identify appropriate inputs by interested parties to the options assessment process and to the planning and project cycles.

The precautionary approach, articulated in the Rio principles, forms part of a structured approach to the analysis of risk, and is also relevant to risk management. Decision-makers faced with scientific uncertainty and public concerns have a duty to provide answers where risks and irreversibility are considered unacceptable by society.

Source: World Commission on Dams. 2000. *Dams and Development a New Framework for Decision-making*. Earthscan. p207.

ISO 31000 by nature provides a very general framework for risk management and must be adapted to the sector and project. The general principles are helpful in any context. See Box 3.3-2**.**

Box 3.3-2: Principles of risk management

ISO 31000 holds that risk management should:

- Create value. (Resources expended to mitigate risk should be less than the consequence of inaction, or, as in value engineering, “the gain should exceed the pain.”)
- Be an integral part of organizational processes.
- Be part of decision making process.
- Explicitly address uncertainty and assumptions.
- Be systematic and structured.
- Be based on the best available information.
- Be tailorable.
- Take human factors into account.
- Be transparent and inclusive.
- Be dynamic, iterative and responsive to change.
- Be capable of continual improvement and enhancement.
- Be continually or periodically re-assessed.

Source: http://en.wikipedia.org/wiki/Risk_Management, citing ISO 31000

Risk may be included as one of the criteria or may be a separate assessment. A sample of standard techniques is presented in Box 3.3-3

Box 3.3-3: A Selection of Risk Analysis Techniques

- Qualitative techniques:
  - A logical framework in which the categories of risk and assumptions about managing these risks are elaborated;
  - Risk matrices that show the probability of risk occurrence (as high, medium, low) against the seriousness of the impact, and those impacted;
  - Poverty and vulnerability risk analysis that indicates the risk that a particular option poses to poor and vulnerable groups.
- Quantitative techniques:
  - Probabilistic analysis that indicates the likelihood of certain goals, such as a specific internal rate of return being achieved;
  - Spreadsheet-based applications of various kinds.

Source: Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264.p 104

The risk management process must integrate with the project management cycle in a manner analogous to the environmental management process. In the early stages of project options assessment the risk assessment is limited by the availability of data. As project data increases and becomes more certain, so should risk analysis should intensify and become more comprehensive.

In large hydro projects the risk analysis is generally not a separate function or report, but the parts are rather integrated with aspects of the preparation, such as financing, environmental impact assessment, and construction planning. One can expect, however, that risk in hydropower projects will generally follow the trend in development financing institutions and corporate management in establishing a chief risk officer function and assuming a far more independent position.

The International Risk Governance Council (IRGC) is an independent organisation whose purpose is to improve the understanding and management of emerging systemic risks that may have significant impacts on human health and safety, the environment, the economy and society. It has been proposed that risk governance is an important aspect of any large project undertaken by society. The Council's concept of risk governance is presented in Box 3.3-4

Box 3.3-4: IRGC concept of risk governance

Risk governance *deals with the identification, assessment, management and communication of risks in a broad context. It includes the totality of actors, rules, conventions, processes and mechanisms and is concerned with how relevant risk information is collected, analysed and communicated, and how management decisions are taken. It applies the principles of good governance that include transparency, effectiveness and efficiency, accountability, strategic focus, sustainability, equity and fairness, respect for the rule of law and the need for the chosen solution to be politically and legally feasible as well as ethically and publicly acceptable.*

Risk accompanies change. It is a permanent and important part of life and the willingness and capacity to take and accept risk is crucial for achieving economic development and introducing new technologies. Many risks, and in particular those arising from emerging technologies, are accompanied by potential benefits and opportunities.

The challenge of better risk governance lies here: to enable societies to benefit from change while minimising the negative consequences of the associated risks.

Source: International Risk Governance Council (IRGC). 2008. *An introduction to the IRGC Risk Governance Framework*

The basis for identifying and analysing risk is analogous to the environmental management process.

IRGC's risk governance framework is a comprehensive approach that comprises five linked phases and provides an example of how to structure dealing with risks (this section is paraphrased from the reference):[32]

[32] International Risk Governance Council (IRGC). 2008. *An introduction to the IRGC Risk Governance Framework*

1. **Pre-assessment** clarifies the various perspectives on a risk, defines the issue to be looked at and forms the baseline for how a risk is assessed and managed. Crucially, it captures and brings to the open both:
   - the variety of issues stakeholders and society may associate with a certain risk (as well as related opportunities); and
   - existing indicators, routines and conventions that may help narrow down what is to be addressed as the risk, as well as the manner in which it should be addressed.

2. **Risk appraisal** develops and synthesises the knowledge base for the decision on whether or not a risk should be taken and, if so, how the risk can possibly be reduced or contained. Risk appraisal comprises:
   - a scientific risk assessment, comprising a conventional assessment of the risk's factual, physical and measurable characteristics, including the probability of it happening; and
   - a concern assessment, comprising a systematic analysis of the associations and perceived consequences (benefits and risks) that stakeholders, individuals, groups or different cultures may associate with a hazard or cause of hazard.

3. **Characterisation and evaluation** is intended to ensure that the evidence based on scientific facts is combined with a thorough understanding of societal values when making the sometimes controversial judgement of whether or not a risk is "acceptable" (risk reduction is considered unnecessary), "tolerable" (to be pursued because of its benefits and if subject to appropriate risk reduction measures) or, in extreme cases, "intolerable"—and if so, avoided.

4. **Risk management** involves the design and implementation of the actions and remedies required to avoid, reduce, transfer or retain the risks. Based on the development of a range of options and a consideration of those most appropriate, risk management decision are put into practice. Risk management includes the generation, assessment, evaluation and selection of appropriate risk reduction options, as well as implementing the selected measures, monitoring their effectiveness, and reviewing the decision if necessary.

5. **Communication** is of the utmost importance. It enables stakeholders and civil society to understand the risk itself. It also allows them to recognise their role in the risk governance process and, through being deliberately two-way, gives them a voice in this. Once the risk management decision is made, communication should explain the rationale for the decision and allow people to make informed choices about the risk and its management, including their own responsibilities. Effective communication is the key to creating trust in risk management.

Since the early 1990s development finance institutions and private sector financiers have become increasingly aware of the reputational risk of being associated with large infrastructure projects. In fact, as has been usual, if they obtain a government guarantee, the potential reputational risk will exceed financial risks. In relation to options assessment, the analysis of the options in a reputational risk framework will favour those projects where potential environmental and social risks are lower.

Finally the risk analysis should incorporate an assessment of the potential for corruption of any of the assessment processes and in particular the final choice of the option to be implemented. This includes decision-making without essential technical investigations, non-transparent inducements and the undue influencing of decisions by power groups within the society. Adherence should be enforced to the OECD Convention on Combating Bribery of Foreign Public Officials in International Business Transactions, 1997.

3.3.6 The IHA Sustainability Protocol[33],[34]

The International Hydropower Association's Sustainability Protocol is designed as a tool for assessing hydropower projects through four project life-cycle stages: early stage, preparation, implementation, and operation. In the context of options assessment the early stage is pertinent.

The International Hydropower Association has developed the Protocol through an extensive consultative process. It embodies the following principles:

- Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- Sustainable development embodies reducing poverty, respecting human rights, changing unsustainable patterns of production and consumption, long-term economic viability, protecting and managing the natural resource base, and responsible environmental management.
- Sustainable development calls for considering synergies and trade-offs amongst economic, social and environmental values. This balance should be achieved and ensured in a transparent and accountable manner, taking advantage of expanding knowledge, multiple perspectives, and innovation.
- Social responsibility, transparency, and accountability are core sustainability principles.
- Hydropower, developed and managed sustainably, can provide national, regional, and local benefits, and has the potential to play an important role in enabling communities to meet sustainable development objectives.

Table 3.3-1: IHA: Sustainability Protocol: Early stage

Assessment Topic	Content	Examples of Evidence

[33] International Hydropower Association. 2011. *Hydropower Sustainability Assessment Protocol.* Downloaded from http://www.hydrosustainability.org on 05 December 2012.

[34] Disclaimer: This material is only intended to convey the nature and purpose of the IHA Protocol and does not in any way constitute training in the actual use of the Protocol.

ES-1 Demonstrated Need	This topic addresses the needs that justify management and infrastructure investments in water and energy services, as identified through broadly agreed local, national, and regional development objectives and in national and regional policies and plans.	Energy Master Plan; Water Development Plan; Country or regional development report; Analysis of project fit with demonstrated needs, regional land use and infrastructure development plans
ES-2 Options Assessment	This topic addresses the fit of a hydropower project under consideration amongst the options available to a region to meet energy and water needs, as well as the early stage process undertaken for considering project siting and design alternatives.	Options assessments, analysis of existing options assessments
ES-3 Policies & Plans	This topic addresses the context set by national and/or regional policies and plans for hydropower project planning, implementation and operations.	National and regional policies and plans; Evaluation of project fit with policies and plans; Evaluation of status of river basin plans and river basin sustainability issues.
ES-4 Political Risks	This topic addresses political risks of a region that may have implications for hydropower project development and operations.	Analysis of political risk; Analysis of transboundary issues, agreements and institutions; Authoritative assessment of political risk / sovereign stability; National Governance Audits; Options to address political risks; Records of meetings with representatives from governments, transboundary institutions and other key stakeholder groups.

ES-5 Institutional Capacity	This topic addresses the capacities of the institutions that have a role in the development and operation of hydropower projects.	Analysis of institutional capacities; Options to address institutional capacity shortfalls; Records of meetings with representatives from government, key institutions, independent analysts and other key stakeholder groups.
ES-6 Technical Issues & Risks	This topic addresses early identification and analysis of technical issues and risks that may influence decisions to invest in preparation of a hydropower project under consideration.	Desk-top analyses of technical issues and risks, area-specific analyses, expert opinions; Records of meetings with relevant technical experts.
ES-7 Social Issues & Risks	This topic addresses early identification and analysis of social issues and risks that may influence decisions to invest in preparation of a hydropower project under consideration.	Desk-top analyses of social issues and risks and social benefit opportunities; Area-specific analyses; Expert opinions; Records of meetings with representatives from government, NGOs, potential project affected communities, indigenous communities and other key stakeholder groups.
ES-8 Environmental Issues & Risks	This topic addresses early identification and analysis of environmental issues and risks that may influence decisions to invest in preparation of a hydropower project under consideration.	Desk-top analyses of environmental issues and risks and environmental enhancement opportunities; Strategic environmental assessments; Area-specific analyses; Expert opinions; Records of meetings with representatives from government, NGOs, local and other key stakeholder groups.

ES-9 Economic & Financial Issues & Risks	This topic addresses early identification and analysis of economic and financial issues and risks that may influence decisions to invest in preparation of a hydropower project or system of projects.	Evaluation of financial issues and risks; early stage cost-benefit analysis; Identification of sources of finance; Economic and finance issues and risk assessment; Records of meetings with representatives from government, financial institutions, development banks and key stakeholder groups.

Source: International Hydropower Association. 2011. *Hydropower Sustainability Assessment Protocol.* Downloaded from http://www.hydrosustainability.org on 05 December 2012. Pp33-42.

4 VALUING OPTIONS

INTRODUCTION TO MODULE 4

A key element in selecting an option is to understand what value the option will deliver. The common basis for comparing options is to express the value in monetary terms.

Hydropower projects are developed world wide to meet developmental, social and economic needs of countries. However, the WCD has found that they can result in hidden or unintended social and environmental consequences. These can either be negative (costs) or positive (benefits). While it is relatively easier to evaluate and assess direct costs and benefits of hydropower projects, it is not easy to assess the indirect costs and benefits—also referred to as hidden or unintended. For sustainable development and informed policy decisions, it is critically important that such costs and benefits are carefully identified, quantified and valued. Their accurate valuation greatly enhances the quality of evaluation or appraisal studies used to make implementation decisions for such projects.

Because of inter-linkages among economic sectors, hydropower projects have economy-wide impacts and welfare distributional effects. To fully understand the implications of hydropower projects, it is important that all the economic, social and environmental effects of such projects are quantified and valued through economic analyses.

Session 4.1 starts by distinguishing between financial and economic analysis before dealing with some of the valuation techniques and methods for benefits and costs. It introduces the concept of direct and indirect benefits and costs. The valuation techniques are introduced; however, it is beyond the scope of this manual to cover them in detail.

Session 4.2 introduces the analytical frameworks that use the valuation techniques to construct an overall assessment of the project. It introduces cost benefit analysis, distributional analysis and other methodologies used to evaluate the project in terms of its objectives. These analyses are also conducted over the full life-cycle of the project so the choice of a discount rate that reflects the time value of goods becomes important.

Cost benefit analysis is the most mature of the analytical frameworks; and its underlying procedure has changed little in recent years. What is more controversial (and still part of the developing science) is the valuation of costs and benefits.

At the end of the training, participants are expected to have an appreciation of the techniques that can be used to value direct and indirect costs and benefits of hydropower projects and of the techniques used to appraise them and measure their social and economic impacts. Applying the techniques are, however, in the domain of the specialist economist and beyond the scope of this manual.

Many of the topics relate to social and environmental issues and the trainer is referred to the manuals concurrently being developed on these topics.

4.1 Financial and Economic Analysis

4.1.1 Key Aspects

- Financial analysis uses market prices and direct costs and revenue streams to determine the financial viability of a project. Financial analysis uses market interest rates for discounting.
- Economic analysis seeks to take into account both direct and indirect costs and benefits, to remove the distortions in market prices, caused by market failures, by adjustments and by adding values for costs and benefits that have no market price. Economic analysis uses interest rates that more fully reflect social time preferences.
- Economic values can be directly observed from consumers' behaviour in the market place—or indirectly elicited from consumers or other market activities related to the resource or service being valued; and
- The concepts of willingness to pay and consumer and producer surplus are important in determining economic value.
- The WCD recommends that the State and developers have fundamental commitments and responsibilities for ensuring that mitigation, resettlement and development measures succeed in improving livelihoods for all affected people.
- The ability of economic methods to value externalities, such as the erosion of cultural identity, community fragmentation and food insecurity, are not robust.
- Multi-lateral development banks, such as the World Bank, have put forward 'safeguard policies' to complement economic analysis.

4.1.2 Training Aids

Purpose of session	The purpose of this session is to raise awareness on the identification of costs and benefits of large infrastructure projects, such as hydropower dams, and how such costs and benefits can be valued to capture their broader macro-economic policy objective.

Learning objectives	By the end of this session, the trainees will: • understand the concept of economic value in relation to the benefits and costs of hydropower projects; and • have gained basic insight to some of the general valuation concepts.
Time required for session	90 – 150 minutes
Preparatory reading	None
Discussion topics	1. Discuss the concept of value and its relevance in assessing costs and benefits of hydropower projects. 2. Discuss the nature and components of direct and indirect costs and benefits and how they can be valued to achieve macro-economic objectives. 3. What are the differences between direct costs in financial analysis and in economic analysis? 4. Discuss the reasons why project *benefits*, such as power and urban water supply, and *costs*, such as capital costs of construction and operating and maintenance costs, are amenable to market valuation methods while project *benefits*, such as non-commercial recreational uses, and *costs*, such as non-commercial agriculture, ecosystem/biodiversity losses, and increase in water borne diseases, are often evaluated using non-market methods.
Exercises	Briefly define the following valuation techniques: • Travel cost • Hedonic property values • Referendum voting • Contingent referendum • Mitigation/prevention values • Averted/replacement cost • Productivity/cost measures
Additional Reading	Alward B. *et al.* 2001. *Financial, Economic and Distributional Analysis*, Executive Summary. Thematic Review III.1 prepared as an input to the World Commission on Dams.
Case Studies	None

4.1.3 Distinguishing financial and economic analysis

Financial Analysis evaluates a project using prices as they appear in the market. Only the direct costs and benefits relevant to project investors are considered. A cash flow profile of a hydropower project is constructed that identifies all the receipts and expenditures expected to accrue during the project's lifetime to the authority implementing the project. For example, a financial analysis might account for a dam's receipts from power production, irrigation and/ or water supply fees, and government subsidies. Project costs might include construction, operation, maintenance, future decommissioning, and the cost of implementing measures to mitigate environmental and social impacts. Investors analyse these financial flows to determine the net financial value of the dam project. Financial analysis uses market interest rates to calculate the time value of benefits and costs. It does not take into account the hidden benefits or costs such as employment or damage to ecological systems.

Economic analysis is used to determine the economic value that a project will have in the broader economy. In order to do this it seeks to identify and value all of the patent and hidden benefits and costs. The basic premise is that market prices often do not reflect the true value to society. Economic analysis is used by the government where it is the owner and/or financier. Economic analysis seeks to take into account both direct and indirect costs and benefits, to remove the distortions in market prices caused by market failures by adjustments and by adding values for costs and benefits that have no market price. See for example the economic value of wetlands in Box 4.1-1. Economic analysis uses interest rates that reflect more fully national social time preferences.

Box 4.1-1: Economic Value of Wetlands

*"The **economic use values** of wetlands comprise the direct use of a wetland's goods, such as the consumption of fish for food, trees for fuel wood or as a building material, and water for drinking, cooking and washing. Use values also include the indirect use of a wetland's services, such as water retention capacity (including man-made for irrigation or energy production) and nutrient recycling. Lastly, option value can be distinguished as a use value - this is defined as the value of a wetland to humans to preserve an environment as a potential benefit for themselves in the future. For example, some people would be willing to pay for the conservation of a tropical rainforest as a potential source of medicine against diseases like cancer and AIDS.*

*The **economic non-use value** of a wetland refers to the non-instrumental value, not associated with use. This includes existence value - recognition of the value of the very existence of wetlands. For example, some people may have sympathy with or concern for the welfare of certain animals - a desire that certain species should exist. These people would then be willing to pay for the conservation of this species."*

Source: World Wildlife Fund Undated *The Economic Values of the World's Wetlands* p10

The distinction between financial and economic analysis is further illustrated in Table 4.1-1: Distinguishing Economic Analysis from Financial Analysis. Box 4.1-2 explains the difference between economic and financial values.

Table 4.1-1: Distinguishing Economic Analysis from Financial Analysis

ATTRIBUTE	ECONOMIC ANALYSIS	FINANCIAL ANALYSIS
Perspective	The broader society	Investors
Goal	The most effective use of scarce resources	Surplus or profit
Discount rate	Social discount or policy rate	Market cost of capital
Unit of Valuation	Opportunity cost	Market prices
Scope	All aspects necessary for a rational socio-economic decision	Limited to aspects that affect profits/surplus
Benefits	Additional goods, services, income and/or cost saving	Profit and financial return on capital employed
Costs	Opportunity costs in respect of goods and services	Financial payments according to generally accepted accounting practice

Adapted from: Mullins D, et al (2002) *A manual for cost benefit analysis in South Africa with specific reference to water resource development*. Report No TT 107/02 Water Research Commission, Pretoria.

Box 4.1-2: Differences between economic and financial values

"In sum, the main differences between the economic and financial values of project costs and benefits are made up of government taxes and subsidies, excess operating surpluses from monopolised markets, foreign exchange premiums, producer and consumer surplus and positive and negative externalities. Economic values exceed financial values as a result of output taxes, input subsidies, foreign exchange premiums, consumer surplus and positive externalities. Financial values exceed economic values as a result of output subsidies, input taxes, foreign exchange discounts, producer surplus and negative externalities".

Source: Asian Development Bank. 1997. Guidelines for the economic analysis of projects.

4.1.4 Valuing Direct Costs

Direct costs of hydropower stations traditionally referred to the financial or accounting costs of hydropower station construction or capital. This definition underestimates direct costs as it leaves out external, but important, social and environmental costs. Direct costs should include construction costs, resettlement costs, environmental mitigation costs, operations and maintenance costs and decommissioning costs. Extensive identification, gathering and evaluation of all data and information are essential. Baseline studies to enable future impact studies should be a particular focus.

Direct benefits are benefits that flow directly from the use of the water in the dam, such as potable water supply, irrigation, hydropower etc.

The valuation of direct costs and benefits in economic terms (expressed in monetary terms) is relatively simple as items included in the costs are traded and hence have market prices. In this case, value is directly observed from the prices, and total value is derived as the product of total quantity of the items and their unit price.

4.1.4.1 Construction costs

Construction costs are the costs of building infrastructure. Performance data suggests that hydropower station projects often incur substantial cost overruns in construction. While data sets from the World Bank, Inter-American Development Bank, and the Asian Development Bank reveal average cost overruns in the range of between 20 and 45% in nominal terms, there is considerable variability among samples.

4.1.4.2 Resettlement costs

Resettlement costs refer to both the process of physical relocation, (the conventional focus of resettlement programmes) and adversely affected people's economic risks, due to losses of livelihood and income sources, such as land, water, forests and fisheries. Resettlement programmes have tended to disregard the latter, resulting in increased impoverishment of resettled people. The costs of resettlement have, therefore, invariably been underestimated and under-financed.

Resettlement costs are highly variable, depending on the site-specific characteristics of the infrastructure and the environs within which it is situated. Although resettlement costs have often been overlooked, considerable effort now goes into estimating these costs for project analysis and budget purposes. The "internalised" socio-economic costs of resettlement, as budgeted by projects, are not necessarily reflective of the full economic welfare effects of social or economic impacts on adversely affected people. Rather, they represent the financial costs associated with policies and regulations in effect. Incorporating such financial costs into an economic analysis must be regarded as a second best approach, where the resulting cost-benefit analysis is intended to represent the net welfare effects on society as a whole.

4.1.4.3 Environmental costs

Adverse environmental impacts of hydropower are increasingly recognized, and efforts to internalize these in the form of mitigation projects are growing. Mitigation costs include study costs, capital expenditure on mitigation infrastructure, routine operation and maintenance expenditure, and/or the opportunity costs of lost production. The application of these measures will be site-specific and data on the costs of these measures is still unreliable, particularly as the effectiveness of the measures themselves is often questionable.

4.1.4.4 Operations and maintenance costs

Operational and maintenance (O & M) costs of dams are relatively low, constituting 1% to 3% of capital cost per annum. However, O & M costs are likely to rise over time as facilities age and efforts to mitigate the negative consequences of sedimentation are undertaken. The O&M costs of hydropower equipment are highly project specific and require specific analyses. Refurbishment costs are periodic and part of the life-cycle approach.

4.1.4.5 Decommissioning costs

Hydropower station decommissioning takes place at the end of a project's lifetime. Decommissioning is defined broadly to include a range of actions, from ceasing to produce electricity to removing the dam and taking measures to restore the river to its previous state. Decommissioning may be necessitated by safety concerns or views by dam owners that the dam is no longer profitable to operate (e.g. because of reduced storage capacity or sedimentation).

4.1.5 Valuation of direct benefits

Although the valuation of social and environmental impacts of large hydro is a commonly discussed topic, the economic valuation of the direct project benefits provided by large dams is not as straightforward as it seems[35]. For example, benefits of irrigation and multi-purpose dams entail "layer over layer of assumptions regarding irrigated areas, crops, crop yields, crop prices, land and property values…" By contrast, benefits for hydropower or urban water supply dams are simpler to estimate but prone to numerous errors, due to the fact that they are often assessed as the "savings of not going for the next more expensive alternative", such as a thermal power plant. Despite this, direct benefits of large water infrastructures can be classified into two categories:

- Permanent benefits
- Transitory or transitional benefits.

Permanent benefits are defined as benefits accruing as a result of large water infrastructures. These include benefits from using water for hydropower generation, irrigation, navigation, flood control, industrial, domestic and tourism purposes or even water royalties where the infrastructure is developed to collect water for sale. They also include permanent infrastructure (e.g. roads and houses) and benefits arising from compensation and mitigation programmes for environmental and social losses associated with such infrastructures.

Transitory benefits relate to benefits which dissipate with the completion of construction activities, (e.g., employment creation, government tax revenues, and contribution) to gross domestic product (GDP) ,related to construction activities during the construction phase of such infrastructures.

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[35] Alward B. *et al.* 2001. *Financial, Economic and Distributional Analysis*, Executive Summary. Thematic Review III.1 prepared as an input to the World Commission on Dams.

Valuation of transitory benefits is straight forward, since all of them are market based, and, therefore, market prices can be used as the basis for valuation. The value of employment creation is found as total labour earnings. Contribution to tax revenue is all taxation collected from activities related to infrastructure construction. For permanent benefits traded in markets like hydropower, urban water, industrial water and, in some cases, irrigation water, estimating values is easy as market prices are used to approximate value. In cases where market prices do not exist (e.g. navigation water, recreation water, spiritual/cultural water), indirect revealed preference approaches, as well as direct and indirect stated preference approaches, can be used. Willingness-to-pay has been used to approximate the value of water in these uses.

However, it should be noted that even where market prices exist, prices for permanent benefits of water (e.g. irrigation and navigation) may be distorted and thus not reflect the true value, because of the 'public good' nature of water. This emanates from the fact that regulation of river flows in most countries is guided by the principle that water is the property of the state, and government stewards it on behalf of the public. From an economics perspective, this classifies water, its quantity and quality, as a public good. The nature of water as a public good is also embraced in the Dublin Principles and the integrated water resources management (IWRM) approach, adopted by governments globally. The public nature of water vests governments with the overarching responsibility for water resources management, use, development, and protection in the interests of the public or society. This results in the large-scale provision of water and energy services being national or regional monopolies and resultant distortions in prices.

In spite of the above, progress has been made towards determining efficient prices for water and related services. These, together with remaining challenges, are discussed below:

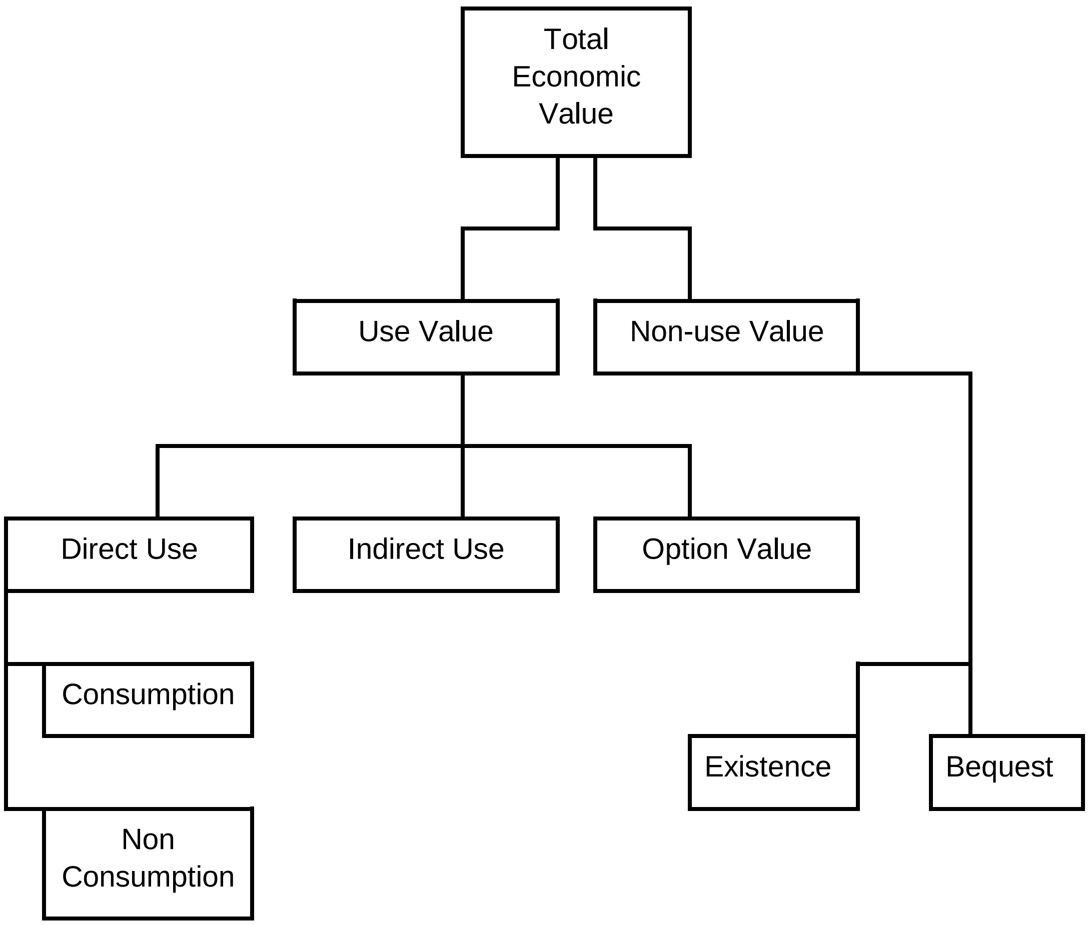
- Tariffs (i.e. financial prices) for power, municipal, and industrial water are used in many countries and can be used for approximating the value of water in these uses. However, the prices are still distorted and do not reflect efficient prices as they are still provided by monopolies in most cases.
- Increasing private sector participation in power markets will gradually ease the task of economic evaluation of power benefits as prices emerging from power pools will represent competitive/efficient market prices.
- Similar developments in water supply markets could also gradually eliminate the need to depend on willingness-to-pay surveys in the economic valuation of water.
- Economic valuation of irrigation water will probably remain a complicated affair, requiring substantial survey data and/or complex computational techniques.
- Flood control benefit will continue to rely on non-market techniques, due to its nature as a public good.
- Economic valuation of navigation services provided by dams may be based on market prices where tolls are charged, although adjustments may be necessary where substitutes are absent (i.e. road, rail or air transport) or policy distortions exist in transport markets.

Other direct benefits of dams and hydropower projects, such as commercial, subsistence and recreational fisheries and general recreation can be valued using market or non-market methods, but will need to account for the loss of such opportunities where the dam would not have been built.

4.1.6 Total economic value (TEV) concept

For some goods and services not traded in markets (e.g. ecosystems services of water) market prices do not exist. In these cases there are economic techniques that are used to estimate the value. In estimating non-marketed environmental values, the utilitarian approach uses the concept of the TEV framework. The framework typically initially disaggregates TEV into two categories: use and non-use values (Figure 4.1-1).

Figure 4.1-1: Schematic for Total Economic Value (TEV)



Use values are values derived from using the good or service either **directly** or **indirectly**, or just having the **option** to use it. The direct use can be **consumptive** (reducing the quantity of the resource) or **non-consumptive** (not affecting the quantity of the resource). Non-use value is value derived from not necessarily using the resource or service. This may be value derived from just knowing that the resource exists (**existence value**) and knowing that it can be left to posterity or as bequest for future generations (**bequest value**).

4.1.7 Introduction to valuing non-market social and ecological goods

Social and environmental 'externalities' refer to the indirect, unaccounted and conventionally uncompensated social and environmental impacts that affect aspects of people's livelihoods, ecosystem services, consumer utility and project cost outside the market mechanism. These can be negative (costs) or positive (benefits). Proper identification, quantification and valuation of these externalities are important as it improves evaluation or appraising and assessment of impacts of hydropower projects.

Key externalities of hydropower projects include impacts on water quality, wildlife, fisheries and ecosystems; avoided pollution benefits, and adverse effects on health resulting from increases in the incidence of water borne diseases.

National policies need to incorporate policy mechanisms to ensure that social and environmental externalities associated with major infrastructure development are valued appropriately and handled with due diligence.

The rationale for appropriate valuations of externalities, particularly social externalities, is underscored by WCD recommendations that:

- The State and developers have fundamental commitments and responsibilities for ensuring that mitigation, resettlement and development measures succeed in improving livelihoods for all affected people;
- Accountability for these responsibilities should be ensured through legal means, such as contracts; and
- Legal recourse at national and international levels should be available in the event of reneging on contracts.

Attainment of these measures strongly rests on the ability of economic methods to value externalities of hydropower projects. For some social and environmental costs and benefits, market prices do not exist, and thus valuation through market approaches is difficult. In this case non-market based approaches can be used to estimate the value of social and environmental externalities. However, economics is still limited in offering specialised techniques for measuring some of the less tangible outlays, like aspects of resettlement costs such as erosion of cultural identity, community fragmentation and food insecurity. Usually more than one technique is used to build confidence in the outcomes.

In addition to the recommendations of the World Commission on Dams (WCD) on these matters, multi-lateral finance institutions, such as the World Bank and the International Finance Corporation, have put forward 'safeguard policies'. Safeguard policies have also been incorporated, to some extent, in national policy frameworks in developing countries like South Africa, Brazil, Colombia, China and India. These policies are aimed at more broadly addressing macro-economic aspects of large infrastructure.

Because of the failure of markets to determine values for non-marketed ecological services, there are two major classes of techniques for measuring the value of non-market goods:

- Revealed preference approaches (roughly, what behaviour shows), and
- Stated preference approaches (roughly, what is said).

Table 4.1-2 below gives different techniques for each approach. The technique best suited to the circumstances should be used, and the outcome should be re-enforced by referencing other techniques. The reader is also referred to a summary in Nherera and Emerton[36].

Table 4.1-2: Methods for Estimating Environmental Values

	REVEALED PREFERENCE (Observed behaviour)	**STATED PREFERENCE (What the person says)**
DIRECT	Direct observed Competitive market price Simulated markets	Direct hypothetical Bidding games Willingness-to-pay
INDIRECT	Indirect observed Travel cost Hedonic property values Referendum voting Contingent referendum Mitigation/prevention/averted costs/values Productivity/cost measures	Indirect hypothetical Contingent ranking Contingent activity

Source: Adapted from Freeman, A. M. 1993. *The Measurement of Environmental and Resource Values: Theory and Methods.* Washington, D.C. Resources for the Future.

Revealed preference approaches consider decisions people make regarding activities that utilize or are affected by a resource/good/service, to reveal value. In this case, the value of the resource is imputed from behaviour of individuals observed in markets. For tradable goods and services this behaviour is depicted by the willingness-to-pay or the demand-function. Values are derived from preferences revealed by consumers' behaviour. Since the choices are based on prices, the data reveals values directly in monetary units. For traded environmental goods and services (for example, bottled water), consumers have the opportunity to reveal their preferences compared with substitutes or complementary commodities through their actual market choices.

However, many environmental systems' services, like water related ecosystems, are not privately owned nor traded; hence, their demand curves cannot be directly observed and measured. In some cases environmental resources and services, though not privately owned, are traded in the informal markets (e.g. water vending in informal markets). In such cases values are derived from 'surrogate' informal markets. In cases where the resource is not traded at all (e.g. water abstracted directly from natural systems for use by riparian

[36] Nherera B and Emerton L. Undated. *Economic Valuation methods/techniques*. Pamphlet. IUCN

residents, either for home use or small economic activities), the cost of access to water, measured by the time taken and distance travelled to the water source, can be used to estimate the value of water (travel cost method). These approaches typically focus on measuring direct use values and are not particularly useful in measuring indirect use values.

Limitations of revealed preference approached are linked to the quality of the underlying behavioural data. The reliance of such data on individual perceptions of changes, such as increases in water-borne disease risks, renders the data highly subjective. It is possible, though, to value changes in environmental quality where the changes have an obvious effect; for example, on the health of a significant proportion of a population. However, while the prevalence of water borne diseases may be an indicator of an increase in the risk factor, the use of models of disease diffusion may not be appropriate for measuring changes in environmental quality.

Limitations of revealed preference approaches are also related to the fact that the approaches rely on indirect market information that may not necessarily reflect the willingness-to-pay (or to avoid impacts) of individuals. Measures of the ‘cost-of-illness’ do not account for pain and suffering, lost leisure time, and other illness impacts. Cost-of-illness estimates therefore reflect individual decision; such estimates will vary according to individual choices, such as whether to consult a doctor or to stay home from work. Layered upon this subjectivity is the fact that these choices may be affected by the adequacy of existing health services, insurance, sick leave and socio-economic status.

Stated preference methods elicit values directly from individuals, through survey methods. The values are derived from hypothetical markets where individuals state their preferences for water and related services (e.g. ecosystems services) through surveys. To determine the value of water bodies in natural systems, for example, riparians can be directly asked what value they place on such water bodies or changing such water bodies (e.g. water abstracted from natural systems for storage in large reservoirs). In the latter case riparians could be asked how much compensation they would be willing to accept to tolerate the abstractions and their possible environmental/ecological impacts. Bidding games or willingness to accept/pay questions are used in this case. With this information the demand curve or willingness to pay function for the stream flow can be derived, and its total value estimated from the derived consumer and producer surplus.

When water and its services enter production functions of marketed goods as productive inputs, value can be observed indirectly through examination of changes in product and factor prices and in the producer’s quasi-rents. In this case the production and cost function approaches are used to estimate value.

See also the work by Dole[37] on the contingency method.

4.1.8 Synthesis

A synthesis of benefits and costs, together with potential valuation methods of a typical hydropower project, are presented below.

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[37] Dole D. 2002. *Contingency Calculations for Environmental Impacts with Unknown Monetary Values*. ERD Technical Note No. 1. ADB. www.adb.org.

Table 4.1-3: Typical Benefits and Costs and Potential Valuation Methods

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Table 4.1-3: Typical Benefits and Costs and Potential Valuation Methods

Benefit Category	Benefit Sub-Category	Potential Valuation Method
Project Power and/or Services	Power	Market price of power
	Flood control	Averted cost
	Water supply (e.g. irrigation; drinking water)	Productivity approach for irrigation water, tariffs for drinking water
	River navigation	Averted cost, productivity measure
Avoided pollution from likely Alternative Power Source	Avoided pollution	Averted cost
Other Commercial, Recreational, Social and Environmental Benefits	Commercial reservoir fisheries	Market price of fish
	Non-commercial benefits of a reservoir (e.g. recreation)	Transport cost to recreation site, entrance fee to recreation centre (if existing)
Cost Category	**Cost Sub-Category**	**Potential Valuation Method**
Physical Project Costs	Capital costs of construction	Market prices
	Operating and maintenance costs	Market prices
	Future decommissioning costs	Market prices
Environmental Impacts	Water quality impacts	Treatment costs
	Commercial agriculture, timber, wildlife and fishery	Productivity loss
	Non-commercial agriculture, wildlife and fishery impacts (e.g. subsistence; recreational)	Productivity and welfare loss, Mitigation costs
	Ecosystem and biodiversity losses, species extinction	Productivity and welfare loss, mitigation cost, willingness-to-accept loss, willingness-to-pay to prevent loss

Social Impacts	Increase in water-borne disease risks	Treatment cost
	Market-based resettlement costs (e.g. loss of property)	Replacement cost, Market price/value of lost property
	Non-market resettlement costs (e.g. loss of cultural/historic sites, erosion of cultural identity, community fragmentation)	Willingness-to-accept the loss

Source: Adapted from McKenney, B. Manion, M. & Unsworth, R. 1999. *Financial, Economic and Distributional Analysis – Review Paper*. Prepared for Thematic Review III.1 for the World Commission on Dams.

4.1.9 A note of caution on economic analysis

The ability of economic analysis to accurately reflect values is not without criticism. See Box 4.1-3.

Box 4.1-3: The Controversy Around Economic Analysis

"Controversy also surrounds the limits and the ability of methods for economic assessment to fully capture and reflect the various social and environmental impacts and values. Governments and financial institutions continue to use traditional economic and financial analysis – rate of return, discount rates, sensitivity tests and the exclusion or inclusion of indirect costs – as primary decision criteria. The debate is how adequately these are applied in practice and how they are balanced against other development objectives or criteria. Related issues include the cost recovery levels for all types of dam projects, the implications for subsidised use of water and the equity dimensions of these subsidies".

4.1.9.1.1 Source: WCD Report p22

4.2 Introduction to Economic Analysis

4.2.1 Key Aspects: Economic Analysis

- Economic analysis (specifically cost benefit analysis, or CBA) remains the dominant decision making tool when considerin a hydropower project.
- CBA is primarily concerned with economic efficiency (i.e. Is this the best project, and will the net benefits exceed the net costs by a policy-determined margin?).
- CBA usually includes immediate costs and benefits for the entire lifecycle of projects.
- Because of social time preference, discounting is crucial in CBA.
- To get a holistic picture of the impacts of large water infrastructure, it is important to use economy-wide techniques, especially computable general equilibrium models.
- A major issue in the debate over dams and development is that project-related decisions sometimes result in impact distributions that are inherently unequal, unfair and/or unjust. In such instances distributional analysis is important.

4.2.2 Training Aids

Purpose of session	The purpose of this session is to explain how economic analysis (specifically cost benefit analysis, or CBA) can be used to evaluate large water infrastructure projects, such as hydropower, and its relevance in capturing the broader macro-economic and social policy objectives.
Learning objectives	By the end of this session, trainees will understand the scope of economic analysis; specifically, cost benefit analysis and its limitations.
Time required for session	90 – 180 minutes
Preparatory reading	
Discussion topics	Discuss the limitations of cost benefit analysis. Distributional Analysis combines the use of quantitative and qualitative techniques to assess the distribution of dam project impacts. Discuss the value that this approach adds to decision making about dam projects.

Exercises	Read the following excerpt and, in groups, debate the question: • How useful are CBAs in estimating the 'externalised' costs and benefits of major infrastructure development projects, such as hydropower? "Environmentalists have it that if all the environmental damages of large water development projects were factored in, costs would surpass benefits. Same with social costs falling upon the local population threatened with resettlement or loss of livelihood, cultural values, etc. On the other hand there could also be unaccounted environmental and social benefits, from reduction in greenhouse gases emissions to new tourism and economics activities…So what would happen to CBA if these social and environmental costs and benefits were to be duly assessed? The truth is that nobody knows for sure, because it has not been done systematically. And besides, the available estimations are highly contested, with many stakeholders insisting that environmental and social goals are priceless (a statement that can be strictly true, in the case of non-replicable resources or loss of biodiversity)." Excerpt from Gutman, 2000:5
Additional Reading	Alward B. *et al.* 2001. *Financial, Economic and Distributional Analysis*, Executive Summary. Thematic Review III.1 prepared as an input to the World Commission on Dams. Mullins, D. *Contributing Paper. Macro-economic Analysis*. Prepared for the World Commission on Dams (WCD) Thematic Review III.1: Economic, Financial and Distributional Analysis.
Case Studies	Sobradinho Dam, Brazil (see appendix to this module)

4.2.3 Introduction

In Session 4.1 economic analysis was distinguished from financial analysis and techniques for **valuing** benefits and costs were introduced. The purpose of economic analysis is expressed in Box 4.2-1.

Box 4.2-1: The purpose of economic analysis

"The main purpose of project economic analysis is to help design and select projects that contribute to the welfare of a country. Economic analysis is most useful when used early in the project cycle, to catch bad projects and bad project components. If used at the end of the project cycle, economic analysis can only help in the decision of whether or not to proceed with a project. When used solely to calculate a single summary measure, such as the project's net present value (NPV) or economic rate of return (ERR), economic analysis serves only a very limited purpose.

The tools of economic analysis can help us answer various questions about the project's impact on the entity undertaking the project, on society, on the fiscus, and on various stakeholders, and about the project's risks and sustainability. In particular, they can help us:
(a) decide whether the private or the public sector should undertake the project;
(b) estimate the project's fiscal impact;
(c) determine whether the arrangements for cost recovery are efficient and equitable; and
(d) assess the project's potential environmental impact and contribution to poverty reduction.

(Project economic analysis) *.... is an iterative process that begins early in the project cycle and is used throughout it. This procedure works best when it uses all of the information available about the project, including the financial evaluation and the sources of divergence between financial and economic prices."*

Source: Belli, P. et al. 1998. *Handbook on Economic Analysis of Investment Operations*. Operational Core Services Network, The World Bank

In this session several methods of economic **analysis** are described. This description is, at a simplified level, aimed at engendering understanding the process. The actual execution of the methods requires specialized economists. Although the methods are generally used in tandem, each method has a specific purpose; thus, te approaches differ accordingly:

- In most hydropower economic analyses, the analyst will first build a picture of the national and local economies. This provides understanding of economic dynamics, while, at the same time, deriving a base-line for assessing changes that a project (or programme) may cause. Typical topics are: gross domestic product, gross geographic product, employment, incomes, and key industries, among many others.
- Cost Benefit Analysis (CBA) is the commonly used and core approach for appraising projects. CBA relates to increases in the gross domestic product and tests for economic efficiency in the broader society. CBA includes appraisal techniques for costs and benefits, discounting and risk analysis and generally relies on national data for some sub-processes, such as shadow pricing. It is often the only analysis used; however, considering the scale of hydropower projects, this should not be the case.
- Economic Impact Analysis separates the economic impact of a project into aspects of the economy, such as employment, trade competiveness, government financial flows etc.
- Distributional Analysis is used to determine which sectors and groups in the economy will benefit from or suffer costs if a particular project is implemented.

- Input-Output Analysis builds a model of the economy that helps predict the economic effects of a project in one sector on all other sectors.
- Social Accounting Matrix Analysis expands on input-output analysis by introducing socio-economic variables.
- Computable general equilibrium (CGE) models add a level of complexity to SAM models but find most application at policy level and have only been piloted in the water and hydropower sectors and are consequently not addressed in this manual.

4.2.4 Cost Benefit Analysis (CBA)

Economic Cost Benefit Analysis calculates, for the life-cycle of the project, the **net economic** benefits of developing infrastructure compared to,either alternative projects or the "do-nothing" choice. All of the benefits and costs are identified, valued (as described in Session 4.1), adjusted to economic values and "discounted" to present day values as outlined in this session.

The main criticism of CBAs of hydropower projects is that analyses often fail to incorporate the non-market (or externalised) values into net benefit calculations. Rather than attempt quantification, analysts typically describe these values qualitatively. See Box 4.2-2. As a result, project decisions based on these analyses have often been biased in favour of the project due to over-estimations of net benefits.

Box 4.2-2: Vishnugad Pipalkoti Hydroelectric Project, Economic Analysis

"The economic evaluation of VPHEP is based on cost-benefit methodology and includes a sensitivity analysis on various parameters that could affect the economic internal rate of return (EIRR) and net present value (NPV). In this economic analysis, only the direct benefits with immediate welfare implications for beneficiaries are computed. However, a hydropower project of the magnitude of VPHEP will have a number of non-quantifiable benefits particularly with respect to local and regional development. The project will positively impact the economic development of the state with respect to better infrastructure facilities to boost tourism35 and industrial development, and also a more localized impact in terms of schools, health centres, roads, and commercial establishments being set up near the project to cater to workers, project-affected families and others living in the area. (A region-wide impact study, which is beyond the scope of this analysis, would be required to adequately quantify the welfare gains on different stakeholders.)"

[VPHEP is a run-of-river type hydropower project, with a small pondage capacity, situated on the Alaknanda river in the state of Uttarakhand in northern India.]

Source: The World Bank. 2011. *Vishnugad Pipalkoti Hydro Electric Project.* Project Appraisal Document. Report No: 50298-IN

4.2.4.1 Expressing the worth of the project

The four commonly used methods for expressing the outcomes of the calculations are:

- **Net Present Value** (NPV). The NPV is the difference between discounted benefits and costs;
- **Internal Rate of Return** (IRR). The IRR is the discount rate that will make the net present value of the incremental net benefit stream or incremental cash flow equal to zero, which implies the maximum interest rate that a project can pay for the resources used if the project is to recover its investment and operating expenses and still just break even.
- **Cost Benefit ratio** (C/B). The C/B ratio is the present value of the benefits stream divided by the present value of the costs stream; and
- **Net Benefit-Investment ratio** (N/K). The N/K ratio is the present value of the net benefits divided by the present value of the investment.

4.2.4.2 The concept of 'discounting'

"*The literature on discounting is rich in alternative perspectives and suggestions.*"[38]

Discounting is a procedure used to account for the fact that resources have a "time value". In other words, money paid today is worth more than money paid a year into the future since, received earlier, the money can be invested and thereby earn a return. Discounting converts each future unit of money associated with a hydropower project into the equivalent current amount or "present value". This amount forms the basis on which costs and benefits occurring at different points in the life of a hydropower project may be compared to each other. Another way of expressing it is that it is the rate at which society trades off current and future consumption. Note that the discount rate has no impact on project costs or performance, only on its value when compared to competing projects.

The higher the discount rate, the lower the present value of both future benefits and costs. Because hydropower projects generally have long life cycles, the calculation is sensitive to the chosen discount rate. Note also that if the project has relatively high initial costs and delayed benefits (e.g. from building in initial surplus capacity), the project will reflect less favourably than a project with lower initial costs and immediate benefits.

In financial analysis, a basic rule of project appraisal aimed at addressing future net benefits is to use a discount rate that best reflects the 'opportunity cost' associated with the project. The opportunity cost of a given project is equal to the value of resources and/or benefits foregone as a result of a decision to invest in that project. Therefore, when conducting financial analysis, proposed projects are discounted at a rate that closely reflects the possible return on alternative investments. In private sector projects the selected discount rate is often the interest rate on borrowings or the opportunity cost of capital.

In economic analysis where the discount rate is chosen to reflect the economic or social time preference of the broad economy or society, the selection of a discounting rate becomes more challenging. The ways in which a discount rate is set for projects on an economic basis are:

[38] Alward B. *et al.* 2001. *Financial, Economic and Distributional Analysis*, Executive Summary. Thematic Review III.1 prepared as an input to the World Commission on Dams.

- Policy considerations, which usually includes the prescription that projects in all sectors (in a jurisdiction) use the same discount rate;
- A direct relationship to the national central bank rate or an international interest rate; and
- International development finance institutions often prescribe a discount rate.

Within the broad dams debate, there is controversy over the link between discounting and sustainability. Critics say that current discount practice favours the implementation of large hydro and other projects that are inherently unsustainable. The practice leaves future generations worse off.

4.2.4.3 Shadow Prices

A financial analysis uses market prices. However in economic terms the analysis is concerned with opportunity costs, which are often not well reflected in the market price. For example, where projects use unskilled labour in an area of high unemployment, the opportunity cost of using that labour approaches zero. In economic analysis the market price of the labour is adjusted, and economists speak of "shadow prices". For hydropower projects the tariff that provides the benefit may be distorted by government policies or subsidies and not reflect the true value. In this case, a shadow price is needed as well. However, "*It would be absurd to expect the project analyst of any single investment to prepare, from a blank sheet a set of appropriate shadow prices. These should be national parameters and available from the ministry of finance*"[39].

4.2.4.4 Transfer Payments

Certain payments represent only transfer of money between one actor and another and not the values of real outputs and inputs from the perspective of the national economy's GDP. An example of a transfer payment is the price distortion caused by value added tax. The contractor pays suppliers VAT, and the VAT ultimately finds its way back to the fiscus. The government pays for the project but gets the VAT back. The real project cost is lower. Therefore such materials should be priced in economic terms without the VAT.

4.2.4.5 Excluding sunk costs

A sunk cost is defined as a cost that has already occurred and cannot be changed by future decisions. Sunk costs should not be included in the CBA of a hydropower project. Expenditures and future financial obligations should not be used to justify continuing a project being reconsidered. Rather, the decision should be evaluated on the basis of the costs and benefits of continuing with the project. The more pertinent question is whether future costs incurred if the project is undertaken, continued or re-licensed are expected to be lower than future benefits.

4.2.4.6 Risk and sensitivity analysis

No project should be financed without a comprehensive risk analysis (Box 4.2-3). Hydropower projects have many risks in both benefits and costs. An output of risk analysis is

[39] Merrett, S. 1997. *Introduction to the economics of water resource – An international perspective*. UCL Press

the extent to which inputs to the CBA might change. The analytical response is sensitivity analysis. Sensitivity analysis provides a systematic method for altering the value of uncertain input parameters to test their impact on the net benefit estimate. The method is used to identify which parameters are most critical to the net benefit estimate and to provide additional information to decision makers on the likelihood of different project outcomes.

Box 4.2-3: Quantitative risk analysis

Quantitative risk analysis considerates a range of possible values for key variables (either singly, or in combination). This then results in a probability distribution of a project's expected economic net present value (ENPV) or EIRR (as opposed to a single point value). The key point for analysts and planners is the likelihood of a project's ENPV falling below zero or its EIRR falling below the economic opportunity cost of capital (EOCC). This information should be incorporated into the decision to accept or reject the project.

Source: Asian Development Bank 2002. *Handbook for Integrating Risk Analysis in the Economic Analysis of Projects*

The ability of sensitivity analysis to account for risk and uncertainty depends on how well the analyst has identified key variables. In general, rather than extending the breadth of an analysis to cover a larger set of variables, it is more useful to focus available resources on adding more depth to the assumptions and estimates of the few most sensitive and uncertain variables of the hydropower project. This exercise involves carefully defining probability distributions for each key variable and defining the relationships among those variables.

Once all assumptions, probability distributions and variable correlations have been established, probabilistic methods can be used to develop a range of simulations. The reliability of these results mainly depends on available data, the plausibility of an analyst's assumptions, probability distributions and variable correlations. See Box 4.2-4.

Box 4.2-4: Trung Son Hydropower Project (Vietnam), Sensitivity Analysis

"59. Sensitivity analysis was conducted to review the impacts of changes in key parameters with the results summarized in Table 2. The switching value is the amount by which the factor must increase or decrease to reduce the ERR to the hurdle rate of ten percent. The switching values are all highly unlikely, indicating robustness of economic returns to the main assumptions.

Economic switching values

Factor	Switching Value

Construction costs increase	By 235 percent
Construction delays	Five years and a 62 percent cost overrun
Generation decreases	To 365 GWh
World oil prices decrease	To $42/bbl
Higher sedimentation rates reduce active storage	>10 times greater
Firm capacity less than expected	Even if zero firm capacity, above hurdle rate
Climate change reduces inflows	MoNRE “rapid decline” scenario leaves ERR above hurdle rate

60. A Monte Carlo risk assessment of the economic returns has been carried out with variations in key parameters for oil price, capital cost, firm capacity, generation, operations and maintenance costs and climate change. The probability of the ERR not reaching the hurdle rate of 10 percent is estimated at 1.9 percent.”

Source: The World Bank . 2011. *Trung Son Hydropower Project.* Project Appraisal Document. Report No: 57910 – VN. P17. www.worldbank.org.

4.2.4.7 Accounting for irreversible impacts

Certain impacts, such as the destruction of the ecosystem and prime agricultural land, are irreversible. In selecting between hydropower projects and alternative options, it is important to consider how the irreversible impacts should be weighed against those options, which would not result in irreversible impacts.

A major challenge is that traditional CBAs generally do not differentiate between reversible and irreversible impacts, and no practical economic methods currently exist to quantify ‘option’ values. It is also worth noting that no amount of time is likely to significantly reduce uncertainty about future values of ecosystems and species.

4.2.5 Economic Impact Analysis

Because of multiple inter-linkages between economic sectors, the impact of implementing a large hydropower project is felt by many[40]. The types of impacts addressed in an economic

[40] In economics, the **multiplier** effect, or **spending multiplier,** is the idea that an initial amount of spending (usually by the government) leads to increased consumption spending. This thus results in an increase in national income greater than the initial amount of spending. In other words, an initial change in aggregate demand causes a change in aggregate output for the economy, which is a multiple of the initial change. (Source: Wikipedia)

impact analysis coincide, to a large extent, with those considered in any macro-economic analysis. The analysis involves economic modelling. Unlike in the CBA, these impacts represent the indirect, rather than direct, costs and benefits of a project. Such impacts may have significant implications on how particular groups are affected by a project.

Box 4.2-5: Macroeconomic Returns of Investment in Water

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Major categories of economic impacts include the following:

- **Changes in economic growth and productivity:** Negative impacts on national and regional productivity and economic growth can ensue if an investment creates significant opportunity costs, such as the "crowding out" of investments. Alternatively, new outputs may improve the overall productivity of capital.
- **Price impacts:** Large projects may create a significant supply of outputs that may in turn offset shifts in supply and demand for related goods and services. For example, during the operational life of a project, irrigation water supplied by a dam may affect the market prices for substitutes (e.g. conservation equipment) and high value irrigated crops.
- **Production and employment impacts:** When the construction of infrastructure requires significant capital, land, labour and construction materials, this may create shortages in related markets for labour and other factors of production (e.g. capital and land).
- **Changes in government revenues and exchanges:** A project that is financed through public funds may require large capital outlays by the government. This may have ripple effects on money supply, inflation and government indebtedness. By contrast, a project located in an economically depressed area may boost regional economies (via household and business incomes) while also generating tax revenues for the government.
- **International trade and competitiveness:** If a project is large enough to increase productivity and lower the cost of production at a national level, a country's exchange rate, export position, balance of payments and international competitiveness may improve.

Box 4.2-5: Macroeconomic Returns of Investment in Water

"Evidence of the macroeconomic returns to investment in water is growing. The cost of a series of major typhoons and resulting flood damage in post-war Japan has been estimated at 5%-10% of GNP. Investment in soil conservation and flood control following legislation in the early 1960s reduced the impact of flood damage to less than 1% of GNP. A rise in investment in domestic water use was accompanied by a sharp drop in reported illnesses and death from infectious water-borne diseases and a virtual end to related infant deaths.

There are even more examples of the economic cost of lack of investment in water. In Kenya the combined impact of the winter floods of 1997/98 and drought between 1998 and 2008 has been estimated at $4.8 billion – effectively a 16% reduction in GDP. Evidence suggests that floods and drought in Kenya translate into a direct annual loss of 22% of GDP over a 2.5 year period. The Mozambique floods of 2000 caused a 23% reduction in GDP and a 44% rise in inflation. Inability to tackle hydrologic variability in Ethiopia has been estimated to cause a 38% decline in GDP and a projected 25% increase in poverty for 2003-15. Worldwide, more than 7,000 major disasters have been recorded since 1970, causing at least $2 trillion in damage and killing at least 2.5 million people."

Source: World Water Assessment Programme. 2009. *The United Nations World Water Development Report 3: Water in a Changing World*. Paris: UNESCO, and London: Earthscan. P82

The construction and operation of such models is a highly specialised field of economics and beyond the purpose of this manual.

4.2.6 Input-output (I-O) models

Input-output analysis models economy-wide, inter-sectoral (or industry) transactions. It does this in a tabular format. Although not conceptually necessary, it uses the sectors defined in the standardised systems of national accounts. Each sector (or industry) is represented in both a row and a column. The table is in equilibrium, akin to the system of double entry accounting. Each intersection then contains the model formula that relates the change (output) from the sector, due to a change (input) from another sector. This value is expressed in monetary terms. Inputs are conventionally in rows, and outputs in columns. Special balancing columns reflect the difference between inputs and the outputs—hence, the surplus or deficit that a change will have. This format, therefore, shows how dependent each industry is on all others in the economy—both as customer of their outputs and as supplier of their inputs.

The setting up of the input-output table requires a huge amount of data, as well as complex regression analysis to derive the formula. Most input-output tables are established at the national level; however, this is not necessary. Conceptually, this could be at the regional or project area level, but the data and computational demands are prohibitive.

Having an established national input-output table, the analyst is able to feed in project data and obtain a result. This result is in the form of a project's impact of the project on other economic sectors, together with the surplus or deficit the project will cause. The table remains in balance as the sum of the rows is equal to the sum of the columns.

I-O analysis works by measuring the total effect on final demand of different industries, triggered by an initial investment demand for a project. In this case, only direct impacts are assessed. To assess environmental implications, the I-O table is augmented with the environment sector. Changes in final demand are assessed from changes in the environmental variable (e.g. water quality and quantity). An example of the use of the input-output method is presented in Box 4.2-6[41].

Box 4.2-6: Use of the input output method

In this case study, the I-O model was used to conduct an economic valuation of a water transfer project in the Shanxi province of China. The I-O model was thus augmented with the water sector. The resulting model was referred to as the "input-occupancy-output model". The Wanjiazhai Yellow River-Shanxi Diversion Project (WYSDP) transfers water from the Yellow River to the water-deficient Shanxi province. The project provides 1.2 billion m^3 of water for the Taiyuan, Datong and Pingshu generating complex. The model had two distinct characteristics: first, it divided the water sector into three sub-sectors (freshwater, recycled water, and waste water treatment); second, "occupancy" was added to the input section. This was a controversial change. The "occupancy" section included fixed assets, circulating assets, labour and natural resources. The study focused on agriculture, industry and domestic uses of water.

Source: Xikang, C. 2000. *Shanxi water resource Input-Occupancy-Output table and its application in Shanxi province of China*. Paper presented at the thirteenth international conference on Input-Output techniques. Macerata, Italy

4.2.7 Social accounting matrix (SAM) models

A social accounting matrix (SAM) is similar to an input-output table; however, instead of economic sectors, it places analytical emphasis on socio-economic variables, such as incomes and health. It is a comprehensive, economy-wide data framework, typically representing a national economy. Being strictly a square matrix, the underlying principle of SAM accounting is double entry bookkeeping, by which revenues of any account are depicted along its row—whereas expenditures of the same account are shown along its column. This shows how income is generated and distributed in an economy. For a consistent SAM table, revenues and expenditures of each account must balance.

Compared to the I-O model, the SAM is more powerful in analysing socio-economic issues as it integrates demand sectors into endogenous accounts' structure; thus, SAM-based models include feedback linkages from income generation, distribution and spending. The models also allow disaggregation of households into different income groups, depending on the study objectives. This is advantageous when analyzing income effects of an exogenous change on different characteristics of households.

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The SAM is a comprehensive, disaggregated and consistent framework that captures the interdependence that exists within a socioeconomic system. For example, for every income, a corresponding outlay or expenditure should exist, and both the receiver and sender of every transaction must be identified. Accordingly, total expenditures by each account must exactly equal the total income of that account; hence, the respective row and column sums for a SAM must equate, and the SAM matrix will be square.

SAMs can be used as data framework or accounting systems, representing a comprehensive, disaggregated snapshot of the socio-economic system in a given year. Alternatively, SAMs can be used as a conceptual framework—as basis for modelling to explore the impact of exogenous changes in variables suchas exports, categories of government expenditures, and investment throughout the whole interdependent socioeconomic system (e.g. the resulting structure of production, factors, and household income distribution). SAM becomes the basis for simple multiplier analysis and the building and calibration of a variety of general equilibrium models.

With the SAM, it is therefore possible to analyse the impact of hydropower projects on the macro-economy and different socio-economic groups of households. For an example of the use of the SAM model in conjunction with financial and economic cost benefit analysis, see Box 4.2-7.

Box 4.2-7: Use of Social Accounting Matrix

The Mgeni Catchment that supplies water to the Ethekwini metropolitan area in South Africa required augmentation. There were two possible transfer schemes—namely from the moderately developed Mooi River catchment, and a much larger scheme from the underdeveloped and more distant Nkomasi River catchment. It was suggested by local interests that the Mooi River catchment itself could use the water more beneficially than the Mgeni catchment—and that it did not need to be part of augmentation proposals at all.

In a conjunctive use of CBA and SAM techniques, the economic analyst was able to come to the following conclusions:

- The Mooi-Mgeni Transfer Scheme should be part of the augmentation, highlighted by the fact that the benefit cost ratios and internal rate of return for both financial and economic CBAs were nearly double those for the Nkomasi alternative;
- Sensitivity analysis showed that there were greater economic risks associated with the larger alternate scheme because of the uncertainties in forecasting population growth;
- The water transfer would bring much more development to the Mgeni (receiving catchment), should it be undertaken, than could be realised in the Mooi (donor catchment), should it not be undertaken;
- Employment creation in the Mgeni (receiving catchment) would be ten times larger than in the Mooi (donor catchment); and
- The Mooi (donor catchment) would also receive some positive economic benefits, including greater assurance of existing supplies created by the proposed dam and employment during its construction.

Source: Conningarth Consultants (2007) *The economic viability of the MMTS-2 as a first option to augment the water supplies of the Mgeni System.* MMTS-2 Bridging Study No 8. Unpublished report P WMA07/V20/00/1707. Department of Water Affairs. Pretoria.

4.2.8 Computable general equilibrium (CGE) models

GCE models are similar to SAM-based models but use more flexible supply and demand structures. They are particularly aimed at quantifying the impact of specific policies on the equilibrium allocation of resources and relative prices of goods and factors. Despite the fact that the application of CGEs to environmental problems started three decades ago, their application to water issues has been rare, and available literature only focuses on agricultural water management policies. The skewed focus perhaps resulted from growing water scarcity and increased population pressures, which have prompted many countries to adopt water-pricing mechanisms as their primary means to regulate irrigation water consumption.

4.2.9 Distributional Analysis

4.2.9.1 Introduction

The impacts of hydropower projects tend to be distributed over a wide geographical area, through time, across socio-economic classes, and traversing political boundaries. A major issue in the debate over hydropower and development is that project-related decisions sometimes result in impact distributions that are inherently unequal, unfair and/or unjust[42]. Critics also assert that, despite some hydropower projects meeting development goals and creating net benefits, project costs and benefits are rarely evenly distributed among affected entities. The WCD finds[43]:

> *“Distributional analysis .....is an essential tool in promoting more equitable distribution of benefits and costs.”*

4.2.9.2 Income distribution

The WCD concluded that groups who suffer adverse impacts of large hydropower projects are disproportionately among the most vulnerable in socio-economic terms. Such groups often consist of people being displaced involuntarily, and at a risk of losing their means of livelihood. Without special compensation programmes that restore housing and income opportunities, hydropower projects can make these groups substantially worse off than before.

4.2.9.3 Intergenerational equity

The long lifespan of hydropower projects means that they can exert impacts for many generations. Some of the impacts begin long before dams are decommissioned, while others, particularly the irreversible impacts, perpetuate long after decommissioning.

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[42] Gutman, P. 2000. *Contributing paper: Distributional Analysis*. Prepared for Thematic Review III.1: Economic, Financial and Distributional Analysis. World Commission on Dams

[43] WCD Report p288.

4.2.9.4 Geographic areas

Criticism of hydropower projects also relates to their uneven impacts across geographic regions and national boundaries. Project costs are sometimes borne by the generating region or country, while benefits are ‘exported’—thereby accruing to ‘importing’ regions far removed from the dam’s vicinity. Conversely, benefits may accrue to the region, country or a group of investors where a hydropower project is located, while the costs are ‘exported’ downstream to another region or country.

4.2.9.5 Tools for distributional analysis

Most frameworks acknowledge two main concepts related to equity:

- There is equity in participation. This is the notion that those affected by a decision have some say in the making of that decision; and
- Equity is in outcomes. This relates to how costs and benefits resulting from decisions are distributed.

Social cost benefit analysis, using weights, and the social accounting matrix methodology provide a means for quantifying distributional effects. They have been little used, however, and qualitative and part-quantified approaches are more common. Usually the flow of costs and benefits are exhibited in a distribution matrix form. See the example in the case study attached to this module.

The primary questions in distributional analysis include the following:

- Which individuals, groups and entities will be most and least affected by the project?
- What is the original endowment of groups affected by the hydropower project (or, how well does each affected group start off)?
- How well positioned are affected groups to take advantage of gains from the hydropower project (or, conversely, to mitigate project costs)?
- What is the larger context in which groups are operating that also influences how well they fare (i.e. what is the baseline)?

Finally, the judgement as to whether the equity threshold in the distribution of costs and benefits has been reached is a policy decision.

4.3 Appendix to Module 4: Case Study: Distributional Analysis

SOBRADINHO DAM, BRAZIL

Source: Gutman, P. 2000. *Contributing paper: Distributional Analysis*. Prepared for Thematic Review III.1: Economic, Financial and Distributional Analysis. World Commission on Dams

The Sobradinho Dam, in Brazil, is an extreme case of urban benefits, coupled with enormous rural losses. The project, located on the San Francisco River, and also known as Paulo Alfonso IV, added 3,500 MW capacity to the north-eastern states of Brazil. It created a reservoir of 4,214 km^2 stretching over 325 km. and requiring the displacement of 70,000 persons. It was completed in 1982. Downstream changes in the river also resulted in the permanent flooding of 32,000 ha of rice and the displacement of 50,000 persons. The resettlement of the affected population seems to have been poorly planned and carried out. Although resettlement costs escalated five-fold (resulting on overall cost overruns of 39%), they failed to address the needs of the displaced population. Many of the new settlements failed to attract the target population, benefits were disproportionately captured by the better off, and both land concentration and poverty grew. The distributional matrix shows that the losses of the displaced population at the reservoir and downstream where large and violated equity criteria. The distributional matrix also points out that the urban gains were large enough to have compensated the rural losses, and then more. The bottom line here is that (a) some dams may deliver overall economic benefits but leave part of the population as net losers and breach equity criteria; and (b) opportunity then exists to take from the winners and compensate the losers.

Distributional Matrix of Sobradinho Dam, Brazil (completed 1982)

Social Groups	Power Benefits	Total Direct Costs	Resettlement Indirect Costs	Downstream Indirect Costs	Net Benefits
Urban all	+ 416.3	- 123.4			+ 292.9
Rural all		- 5.4			- 5.4
Resettled			- 103.5		- 103.5
Downstream				- 73.9	- 73.9
Total	+ 416.3	- 128.8	- 103.5 (EU)	- 73.9 (EU)	+ 110.1

Notes: EU = unacceptable on equity grounds

5 SCREENING AND RANKING OF OPTIONS

5.1 Screening and Ranking

5.1.1 Key Aspects

- It is for the proponent to mobilise the available decision support systems.
- Screening eliminates the lowest preference options, freeing resources for in-depth analysis of remaining options.
- Multi-criteria analysis is a sub-discipline of operations research that explicitly considers multiple criteria in decision-making environments.
- The World Commission on Dams refers to MCA in a less formal sense as a mechanism for options assessment to ensure that all information is factored into the decision process.
- The IHA Sustainability Protocol is a highly structured variation on the MCA methodology.

5.1.2 Training Aids

Purpose of session	To set out the process by which options can be ranked in a multi-criteria environment
Learning objectives	To be able to prepare and execute the extraction of a ranked list of options where there are many criteria to consider
Time required for session	90 to 120 mins
Preparatory reading	None
Discussion topics	Discuss the merits of the scoring systems outlined in section 5.1.5.2.
Exercises	Complete a multi-criteria score sheet.
Additional Reading	Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264. Executive Summary.
Case Studies	Government of Lao PDR. 2004. Power System Development Plan

5.1.3 Introduction

Screening and ranking systems ensure that the decision-makers consider all options and criteria in a structured way. It is carried out at more than one stage of the preparation process as information about the options increases and becomes more secure, while the number of potentially preferable projects is reduced.

Screening refers to a process where many options, including initial information about each option, is sparse or unreliable. Screening is a relatively coarse process, where obviously low preference options are eliminated, and the number of options is made more manageable. This allows investigation resources to be focussed on detailed investigations of the more likely option candidates.

Screening may also be made on a "go-no-go" basis; for example, where legislation prohibits construction in protected areas such as national parks.

5.1.4 Decision support systems

The screening and ranking of options depends heavily on available decision support systems. The notion of a decision support system is very wide and includes data, information, and mathematical models. It includes all information collected in the planning and analytical processes described in the previous modules.

At the sectoral level, for both power and water, sophisticated mathematical models designed for system optimisation are available[44]:

> *"In **power sector planning exercises**, system optimization and simulation models are typically used to prepare least-cost generation expansion plans for different scenarios. For example, a generation optimization model would show how the 10 highest ranked generation options fit together (that is, which power generation options are selected, in what order, and in what timeframe) under different load forecast scenarios. The system models take into account the unique characteristic of each generation option, such as their suitability for base load, mid-range, and peak power generation, and ancillary benefits such as reactive power generation. In more complex planning exercises, a family of different expansion sequences can be produced for each scenario."*

See **Box 5.1.1** for mathematical models that could from part of the decision support system in the **water resources sector**. These models will be important when the hydropower potential of a site is being determined. Unfortunately these models do not extend across sectors.

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[44] Source: Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program. 2003. *Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook*. Report ESM264.p105.

Box 5.1-1: What Are Decision Support Systems (DSSs)?

Over the last 30-40 years, major advances have been made in the development and use of a wide range of tools to assist in the planning and management of complex water resource systems. DSSs are intended to provide all managers and political decision makers with assistance in making rational decisions based, as far as possible, on an objective assessment of issues. There is no common definition of a DSS. Many definitions refer specifically to computer software, models and systems, many of which have been developed. Examples include:

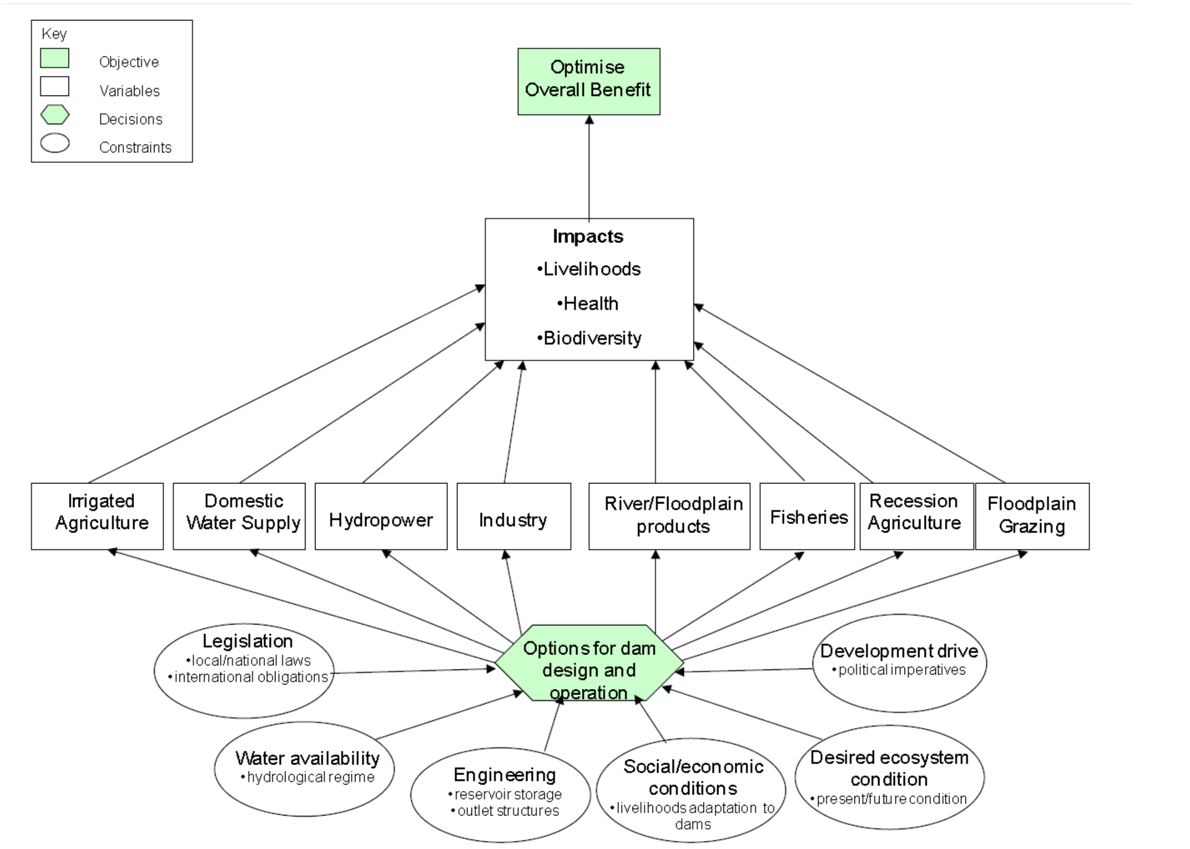
- HEC-ResSim developed to simulate reservoir systems.
- WEAP (Water Evaluation and Planning) model, developed to simulate water demand and supply.
- RIBASIM (River Basin Simulation Model), developed to simulate infrastructure operation and demand management.
- WRPM (Water Resources Planning Model), developed to simulate water allocation in catchments.

However, DSSs need not be computer-based. In fact a DSS can be anything that assists the decision making process. For example, guidelines and protocols that provide information on best practice as well as tools that facilitate dialogue between decision makers and water users are often considered to be forms of DSSs. Under this definition, in addition to computer models, commonly used forms of DSSs include life-cycle analysis, comprehensive options assessment, environmental impact assessment and strategic environmental assessment as well as approaches to estimate environmental flows and tools that mobilize stakeholders to participate in master planning of river basins.

Source: McCartney, M. and J. King. 2011. *Use of decision support systems to improve dam planning and dam operation in Africa*. CGIAR Challenge Program on Water and Food. Available at www.waterandfood.org

In this context a schematic has been proposed to represent the interlinked issues and trade-offs in planning of dams. See **Figure 5.1-1.**

Figure 5.1-1: Interlinked issues and trade-offs in planning of dams.



Source: McCartney, M. and J. King. 2011. *Use of decision support systems to improve dam planning and dam operation in Africa*. CGIAR Challenge Program on Water and Food. Available at www.waterandfood.org

The decision support system also relies on processes of knowledge management, capacity building and institutional memory. In every stage of the planning process, it is for the proponent to mobilise the available decision support systems.

5.1.5 Multi-criteria analysis (MCA)

5.1.5.1 General

Multi-criteria analysis is a sub-discipline of operations research that explicitly considers multiple criteria in decision-making environments. The concept is that no single optimal solution exists, and tradeoffs between criteria are necessary. Therefore, the approach depends on using the participant's criteria-based preferences to differentiate between solutions. It can be mathematically based, where a solution space is arrived at through relatively complex manipulation of the data. Most of the work done on MCA is at the project decision level and it has been suggested that this is determined by a ceiling of complexity. In principle, however, it can be used to assess and compare policies, programmes and projects.

For an example at a policy level about genetically modified organisms, see Nelson and Banker[45].

MCA depends on a system of scoring using many scorers, and thus presents a summated (or collective) view. The selection of scorers should not introduce biases to the process before it starts. Stakeholders other than project proponents should be well represented. Scorers should be informed so that successful use of MCA usually depends on a workshop setting, in which scorers are provided with information about the options before they score. For practical reasons this limits the group size; an upper limit of 50 scorers has been proposed. Conceptually, however, it could be extended to many more by survey methods.

MCA results have also been subdivided into groups determined by the interest the scorer has in the options. So for example the ranking determined by stakeholders has been compared to that of experts in the field.

In more advanced approaches mathematical models can be used to test sensitivity, consistency and reliability.

5.1.5.2 Scoring and Ranking

MCA usually follows one of a few systems for scoring or ranking:

1. All criteria are assigned equal weight, and the preference rank of the option is determined by the highest score.
2. Each criterion is assigned a weight, reflecting its importance, relative to the other criteria. Every criterion is then scored and adjusted by its weight before all criteria for the option are added to reflect its preference score.
3. In the WCD approach described above, all the criteria are classified into two groups, which are presented in a two-dimensional space, plotting the composite environment and social score against the composite technical and economic score.
4. The criteria are developed in groups. The criteria in a group are weighted within the group, and the group is weighted within the overall decision space. The composite score is a single value determining its overall rank (see example in the Annex to this module).

5.1.5.3 The WCD Approach

The World Commission on Dams refers to MCA in a less formal sense as a mechanism for options assessment to ensure that all information is factored into the decision process. It suggests that MCA processes should be stakeholder-driven flexible and open. This is a more intuitive approach as there is an implicit recognition that decisions on large hydropower projects are exceptionally complex involving many variables.

[45] Nelson KC and Banker MJ 2003. *Problem Formulation and Options Assessment Handbook*. International Project on GMO Environmental Risk assessment Methodologies. www.gmoera.umn.edu.

The basis of MCA is built on formal definitions as follows:

- *Principle:* A fundamental truth or law as the basis of reasoning or action;
- *Criterion:* A principle or standard that a thing is judged by;
- *Indicator:* An indicator is any variable or component of the system or management system used to infer the status of a particular criterion. The indicators promote understanding of the criteria; and
- *Verifier:* Data or information that enhance the specificity or the ease of assessment of an indicator.

The analysis proceeds in the structure of these definitions by, for example, first asking what are the fundamental principles (i.e. those stating hydropower projects must be sustainable, required by a policy position). Secondly, a criteria might be that there should be no loss of bio-diversity. Thirdly, an indicator to establish these criteria might be the anticipated extent of the loss of habitat of any endangered species. Finally a verifier might be scientific surveys. This process up to the selection of indicators pertains to options assessment because obviously there can be no verification of indicators while the project is still in the planning stages.

The WCD suggests the seven step process in Box 5.1-2.

Box 5.1-2: Seven steps in the multi-criteria decision-making process

Step 1:

The sponsoring agency prepares terms of reference and a stakeholder analysis for the overall process, and establishes an information centre. Representative stakeholder groups are contacted, and the general public is informed, through print and electronic media.

Step 2:

A stakeholder forum is formed, and representatives of stakeholder groups identify subjects to public review and comment. A multi-disciplinary planning team is formed to support the process and assembles an initial inventory of options.

Step 3:

Public comment is invited on the options inventory, including proposals for additional options. The stakeholder forum confirms the comprehensiveness and adequacy of the options inventory. Where necessary, additional steps are taken to expand the inventory.

Step 4:

The stakeholder forum decides on the criteria for screening the options, and criteria for coarse and fine ranking of options are established, with input from the planning team.

Step 5:

Options are screened by the planning team, according to the agreed criteria. Results are presented to representatives of the stakeholder group for approval and subsequently announced for wider public review or comment.

Step 6:

Sequential steps of coarse and fine ranking of options (where the number of options is large) are prepared by the planning team and submitted to the representatives of the stakeholder forum at each stage. The list of options at each stage is made public, and an adequate period for comment is provided between each stage. Public hearings may be held at each stage if appropriate.

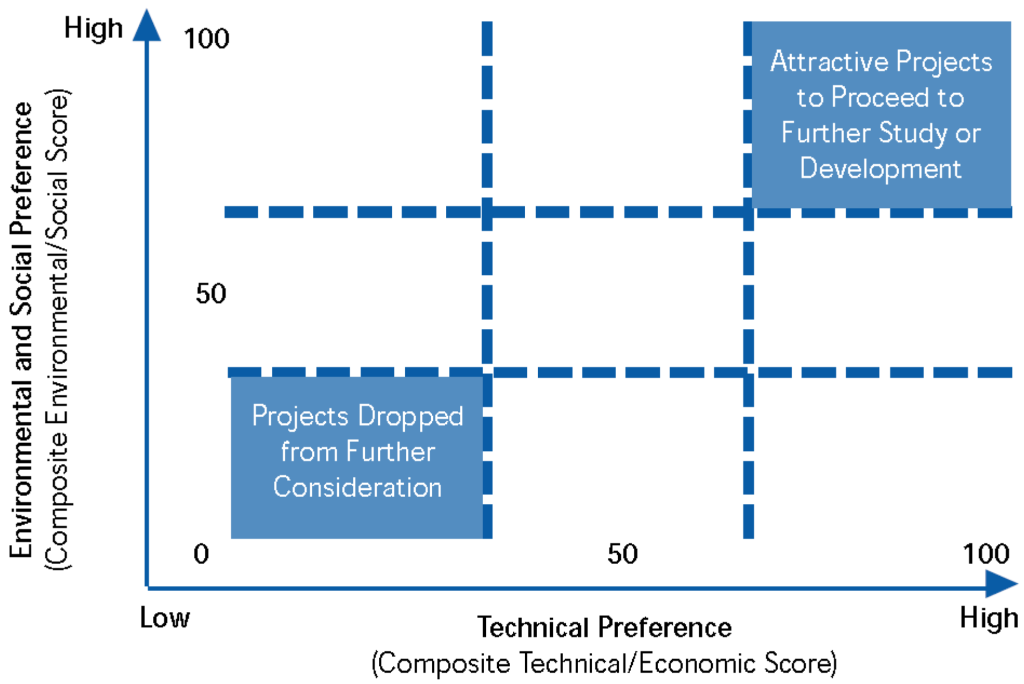
Step 7:

The final selection of options that would form the basis for detailed planning is presented to agencies, communities, or groups responsible for the detailed planning. These steps lead to preparation of a limited set of diverse development plans comprising a range of options emerging from the screening process. The multi-criteria exercise may be repeated to evaluate these alternative plans and select a preferred development plan.

Source World Commission on Dams. 2000. *Dams and Development - A New Framework for Decision-Making*. Earthscan Publications Ltd. p286.

The WCD finally recommends that the results be presented in a two dimensional space, where the trade-off is between environment and social preferences and technical preferences – see Figure 5.1-2.

Figure 5.1-2: WCD Preference matrix for ranking options



Source: World Commission on Dams. 2000. *Dams and Development - A New Framework for Decision-Making*. Earthscan Publications Ltd. p285.

5.1.5.4 The IHA Sustainability Protocol Approach

The IHA Sustainability Protocol is a highly structured variation on the MCA methodology. It is more fully described in paragraph 3.3.6. While the stated objective is to test sustainability throughout the project cycle, with minor adaptations it can be used for options assessment. An important advantage would be the associated online Hydropower Sustainability Assessment Forum Knowledge Base[46].

5.1.6 The Decision-maker

This manual has described the process to arrive at a recommendation of the best option (or options in a multi-stage process). It has involved stakeholders, consultants, government officials, development finance institutions, NGOs, perhaps private investors and representative associations. Ultimately, however, the decision on any large hydro project inevitably rests with the political power. This is why it is so important that the process closely follows established government policiesm, and why the integrity of the process is never compromised.

The decision should be based on a report that describes the options assessment process and its outcomes and recommends a course of action.

5.1.7 Further Options

The process of options assessment does not end with the decision to proceed with a particular project. For example, there may be different options for:

- Optimising project capacity;
- Financing sources;
- Realising inter-sectoral benefits;
- Configuring the diversion works;
- Complying with the environmental management plan;
- Resettlement locations;
- Etc.

In each instance, the principles set out in this manual should be applied with the procedure adapted as needed.

[46] http://www.hydropower.org/sustainable_hydropower/HSAF.html.

5.2 Appendix To Module 5: Case Study: Project Ranking

Source: Government of Lao PDR. 2004. Power System Development Plan, Final Report – Vol A: Main Report (Exec Summ). Downloaded from http://www.poweringprogress.org//download//Section%201.pdf on 31 January 2013.

1.3 Project Evaluation

1.3.1 Evaluation Methodology

The TOR named 28 hydropower and two thermal projects for evaluation. The number of projects swelled to 33 after several new hydropower sites were added and one was dropped after it was found to be non-viable.

Projects were evaluated on a standalone basis and also, as appropriate, in a basin context or in conjunctive operation with other projects. Desktop techniques were employed. No fieldwork was involved; evaluations used existing data. As appropriate, evaluations were based on a common set of assumptions to facilitate project comparisons on a consistent basis.

The projects were evaluated in a two-stage process:

(i) **Screening**: Projects were evaluated initially on a technical and economic level using the Lahmeyer hydro project dimensioning and evaluation software, "EVALS". Projects were compared on the basis of their weighted average generation costs (calculated assuming a value for secondary energy at only half the rate for primary). Those with values over a prescribed threshold were discarded unless by virtue of their system fit they were likely to perform a useful function in the domestic system. Nineteen hydropower sites were shortlisted.

(ii) **Evaluation and Ranking**: Shortlisted projects were studied in more detail. Economic evaluations were preformed using EVALS. The project cash flows were adjusted to incorporate the monetary values of their positive and negative social and environmental effects. The value of weighted average generation cost, adjusted for social and environmental impacts, was used to rank projects.

1.3.2 Environmental Evaluation of Shortlisted Projects

For shortlisted projects, social and environmental effects were internalized into the evaluation and ranking process by reducing all impacts to monetary valuations. This was done using a new spreadsheet model, SESAMEE, to process the many parameters involved in valuing project impacts. The model's algorithms use market values and other input data to calculate positive and negative cash flows associated with each impact event.

Two sets of cash flows were calculated using alternative market valuations as follows:

- international ("global") values; and
- Lao ("local") values.

ANNEXURE 1 (cont.): CASE STUDY ON PROJECT RANKING

Each of the SESAMEE cash flows were separately combined with the project's economic cash flows to give aggregate cash flows corresponding to global and local market valuations. The project rankings in Table 1.3 are based on cash flows derived from global market values.

The SESAMEE approach introduces into the project evaluations large positive and negative cash flows hitherto neglected or externalized in traditional project evaluation methodologies. The influence of the SESAMEE cash flows on the ranking of projects, though, is minor except in one or two cases where projects are associated with significant environmental issues.

The SESAMEE model is new and only limited verification has been possible within the PSDP timeframe. Calibration tests against existing impact studies were reassuring.

1.3.3 Ranking of Projects

Shortlisted projects are ranked according to their relative economic performance as measured by their weighted generation costs calculated using EVALS and SESAMEE. Project rankings are presented in Table 1.3.

Projects were also analyzed on a financial basis to determine the financial tariff needed to satisfy investors and lenders. Hurdle rates were assumed as follows:

- nominal, after-tax return on equity of 17%
- minimum debt service coverage ratio of about 1.3.

A standard set of assumptions was made regarding loan conditions and concession terms to ensure comparability. The results are formatted into a supply curve (Figure 1.1).

If a project is to be promoted for IPP export development, the supply curve indicates whether it is bankable at the avoided cost prevailing at the time in the target market. If a project is to be promoted for IPP domestic supply, the supply curve indicates the wholesale tariff EdL would need to pay for bankability.

The economic ranking in Table 1.3 and the financial supply curve in Figure 1.1 are indicative and should not color judgments about specific projects. The PSDP evaluations are based on standard assumptions reflecting present conditions and do not factor in changes that may occur over the planning period. They also take no account of the potential for developers to boost the attractiveness of a project by the way they package it.

ANNEXURE 1 (cont.): CASE STUDY ON PROJECT RANKING

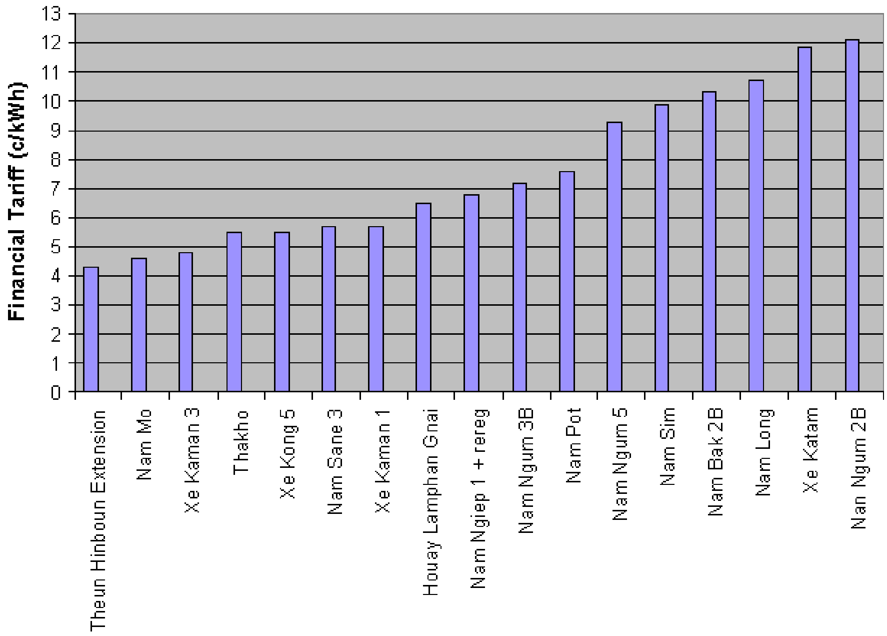
Table 1.3: Economic Ranking of Shortlisted Projects

Rank	Project	Project Type	Installed Capacity (MW)	Annual Energy Output (GWh p.a.)	Adjusted Weighted Gen'tn Cost [1/] (¢/kWh)
1	Nam Theun 2	Storage / transfer	1074	5922	1.6
2	Theun Hinboun Expansion	Storage / transfer	105	686+	2.4
3	Thakho	R-of-R / Mekong	30	214	2.6
4	Nam Mo	Storage	125	603	2.7
5	Xe Kaman 3	Storage	250	1369	2.8
6	Xe Kaman 1 (u/s reg.)	Storage	470	2086	3.1
7	Nam Ngum 2 (u/s reg.) [2/]	Storage	460	1901	3.2
7a	Nam Ngum 2B [2/]	Storage	140	196	8.7
8	Xe Kong 5	Storage	400	1795	3.2
9	Nam Sane 3	Storage	60	283	3.3
10	Nam Ngiep 1 (+ reg dam)	Storage	330	1537	3.8
11	Xe Kong 4 (u/s reg.)	Storage	490	2257	3.8
12	Nam Ngum 3B [2/]	Storage	530	2167	4.1
12a	Nam Ngum 3 [2/]	Storage	690	2859	3.9
13	Houay Lamphan Gnai	Storage	60	250	4.0
14	Nam Pot	Storage	25	99	4.6
15	Nam Ngum 5	Storage	75	317	5.4
16	Nam Bak 2B (u/s reg.)	Storage / transfer	85	389	5.6
17	Nam Long	Storage	12	63	6.2
18	Nam Sim	Storage	10	47	7.1
19	Xe Katam	Run-of-river	13	60	8.1

1/ The ranking parameter "Weighted Generation Cost" is explained in Section 6.3.3. "Adjusted" Weighted Generation Cost refers to the adjustment for environmental and social effects (positive and negative) calculated using SESAMEE.

2/ Alternative developments on the Nam Ngum 2 and Nam Ngum 3 sites are considered.

Figure 1.1: Financial Supply Curve of Projects (nominal ROE of 17%)



6 GLOSSARY

(This Glossary is taken from the WCD Report and supplemented from U.S. Department of Homeland Security. 2003 Federal Guidelines for Dam Safety: Glossary of Terms and The Economist website http://www.economist.com/economics-a-to-z. See also http://www.usbr.gov/library/glossary/)

Active (or live) storage. Volume or cubic capacity of a lake or reservoir between the maximum and minimum operating levels.

Adversely affected people. Populations who suffer negative effects during water and energy development interventions. In the case of dam projects, this includes people whose economic, social and cultural lives are negatively affected by construction works, impoundment, alteration of river flows and any ecological consequences. The term includes displaced people, host communities, and downstream and upstream populations. It may also include groups affected by the construction of transmission lines or the development of irrigation schemes, water transfer canals, sanctuaries, and so on.

Allocative efficiency refers to the use of inputs in a way that maximises total net revenues for firms or consumer surpluses for consumers.

Aquifer. An underground water-bearing layer of permeable rock, sand or gravel that is capable of yielding exploitable quantities of water.

Barrage (gate-structure dam). A structure built across a river consisting of a series of gates that when fully open allow the flood to pass without appreciably increasing the water level upstream of the barrage, and that when closed raise water levels upstream to facilitate diversion of water to a canal for irrigation or to a powerhouse for the generation of electricity.

Baseline assessment. The collection and analysis of data that describe prevailing social and environmental conditions and are used in the design of project activities and as a benchmark for future monitoring studies.

Benefit sharing. Transfer of a share of the benefits generated by a project, such as a dam, to local communities or authorities. Mechanisms for benefit sharing include preferential rates (for example, of electricity generated), revenue sharing or royalties, and equity sharing (through which local populations or authorities own all or part of the project).

Capital costs: The cost of large items of investment in infrastructure, resource development, major repairs and modernisation.

Catchment. The area that drains into a river system; in relation to a dam, the area upstream from the dam from which the reservoir receives water. (The term 'watershed' has been used in this document to convey the same meaning.)

Civil society. Non-governmental organisations, community based organisations, professional associations from all disciplines and other sectors of society that are neither government bodies nor the private sector.

Compensation measures. Alternative resources (land, property or money) provided to displaced people or others adversely affected by a project as mitigation for losses suffered.

Conjunctive water use. The co-ordinated use of surface water and groundwater resources.

Consumers: Agents who are interested in buying and consuming goods and services in a market. Their consumption preferences will reflect how much they want or value some good or bundle of goods.

Consumer surplus. The difference between what a consumer would be willing to pay for a good or service and what that consumer actually has to pay. Added to producer surplus, it provides a measure of the total economic benefit of a sale.

Contingent valuation method (CVM) asks people what they are willing to pay for a benefit, and/or what they are willing to receive by way of compensation to tolerate a cost.

Cost-benefit analysis. A method of reaching economic decisions by comparing the costs of doing something with its benefits. It sounds simple and common-sensical, but, in practice, it can easily become complicated and is much abused.

Cropping intensity. The extent of land use in a year, which reflects the degree of multiple cropping. It is the ratio of the total area cropped per year to the irrigation command area.

Cultural heritage. The cultural practices and resources of current populations (religions; languages; ideas; social; political and economic organisations) and their material expressions in the forms of sacred elements of natural sites or artefacts and buildings; landscapes resulting from cultural practices over historical and prehistoric times; and archaeological resources; including artefacts, plant and animal remains associated with human activities, burial sites and architectural elements.

Dam failure. Catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water or the likelihood of such an uncontrolled release It is recognized that there are lesser degrees of failure and that any malfunction or abnormality outside the design assumptions and parameters that adversely affect a dam's primary function of impounding water is properly considered a failure. These lesser degrees of failure can progressively lead to or heighten the risk of a catastrophic failure. They are, however, normally amenable to corrective action.

Dam safety. Dam safety is the art and science of ensuring the integrity and viability of dams such that they do not present unacceptable risks to the public, property, and the environment. It requires the collective application of engineering principles and experience, and a philosophy of risk management that recognizes that a dam is a structure whose safe function is not explicitly determined by its original design and construction. It also includes all actions taken to identify or predict deficiencies and consequences related to failure, and to document, publicize, and reduce, eliminate, or remediate to the extent reasonably possible, any unacceptable risks.

Dead storage. Storage below the lowest outlet that cannot be released under normal conditions.

Decommissioning. Removing a dam from service and, where appropriate, physically dismantling it.

Demand: Aggregation of consumers' demands, which is sensitive to preferences, prices and price of substitutes, among other variables

Demand-side management. Reducing use of water or electricity by improving the efficiency of use by the transmission system or the consumer, whether in the residential, industrial, commercial, agricultural or government sector.

Developer. The organisation (private or public sector) responsible for promoting and implementing a project, as distinct from the contractor who constructs the project.

Discounting. The process of applying a rate of interest to cost and benefit flows that is used to find the equivalent value today of sums receivable or payable in the future.

Displaced people. Communities required (often involuntarily) to abandon their settlements (homes, agricultural land, commons, forests and so on) or suffering loss of livelihood due to construction of a dam, submergence of the reservoir area, downstream impacts, building of dam-related infrastructure such as roads, and so on.

Drainage area. The area that drains to a particular point on a river or stream.

Drawdown. The difference between a water level and a lower water level in a reservoir within a particular time. Used as a verb, it is the lowering of the water surface.

Economic efficiency: Technical and allocative efficiency together are known as economic efficiency. Another definition is: the organisation of producers and consumers is such that all unambiguous possibilities for increasing economic wellbeing have been exhausted.

Ecosystem. An interacting system formed by living organisms and their abiotic environment regulating itself to a certain degree and explicitly includes the human social system.

Emergency action plan (EAP). A plan of action to be taken to reduce the potential for property damage and loss of life in an area affected by a dam failure or large flood.

Environmental flow. The specific release of water from a dam to ensure the maintenance of downstream aquatic ecosystems and key species. The flows may include seasonal or annual flows and/or regular or irregular pulses to meet ecosystem needs. They may also be linked to livelihood needs of downstream affected people.

Environmental management system. The processes by which an organisation identifies and assesses environmental problems, sets goals to address the problems, and measures and verifies progress in solving the problems.

Equity: Ensuring that vulnerable groups in society are not excluded from access to basic goods and services, in this case water.

Ethnic minorities. Social groups with a social and cultural identity distinct from the dominant society. They have been historically disadvantaged; come from non-dominant sectors of society; have low social, economic and political status; and are determined to preserve, develop and transmit to future generations their ethnic identity as the basis of their continued existence as people.

Export credit agency. A government agency that helps finance the overseas sales of a nation's goods and services, generally by providing guarantees of working capital loans for exporters, guaranteeing the repayment of loans, or making loans to foreign purchasers of the nation's goods and services. The agency may also provide credit insurance that protects exporters against the risks of non-payment by foreign buyers for political or commercial reasons.

Externalities or External Impacts. Costs and benefits that are external to the financial aspect of decision-making, and thus do not accrue to project developers and operators.

Flood. A temporary rise in water surface elevation resulting in inundation of areas not normally covered by water. Hypothetical floods may be expressed in terms of average probability of exceedance per year such as one-percent-chance-flood, or expressed as a fraction of the probable maximum flood or other reference flood.

Flood control. In relation to dams, the intention to reduce flood peaks in the river and to minimise the impact of flood events on human activities, including loss of life, social disruption, health impacts, and property and economic losses.

Flood hydrograph. A graph showing, for a given point on a stream, the discharge, height, or other characteristic of a flood with respect to time.

Flood management. A broad concept that focuses on reducing flood hazards through a combination of policy, institutional, regulatory and project measures (such as replanting catchment areas), while recognising that they can never be fully controlled. This takes into account the beneficial uses of natural floods, which are more difficult to quantify in human and economic terms but which sustain natural systems that also have economic, social, cultural and ecosystem values and functions.

Flood plain. An area adjoining a body of water or natural stream that may be covered by floodwater. Also, the downstream area that would be inundated or otherwise affected by the failure of a dam or by large flood flows. The area of the flood plain is generally delineated by a frequency (or size) of flood.

Flood routing. A process of determining progressively over time the amplitude of a flood wave as it moves past a dam or downstream to successive points along a river or stream.

Flood storage. The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood wave through a natural stream channel.

Greenhouse gases. Gases that accumulate in Earth's atmosphere and trap heat. Some are naturally occurring gases, like carbon dioxide and methane; others are made by humans, such as halocarbons.

Groundwater. Water that flows or seeps downward and saturates oil or rock, is stored underground and supplies springs and wells. The upper level of the saturated zone is called the water table. Generally, all subsurface water, as distinct from surface water.

Hazard. A situation that creates the potential for adverse consequences such as loss of life, property damage, or other adverse impacts.

Hazard potential. The possible adverse incremental consequences that result from the release of water or stored contents due to failure of the dam or poor-operation of the dam or appurtenances. Impacts may be for a defined area downstream of a dam from flood waters released through spillways and outlet works of the dam or waters released by partial or complete failure of the dam. There may also be impacts for an area upstream of the dam from effects of backwater flooding or landslides around the reservoir perimeter.

Hedonic price approach looks for a market in which goods or factors of production (such as land and labour services) are bought and sold, and observes that environmental factors are frequently attributes of those goods or factors. Given that different locations or jobs have varied environmental attributes, such variations will result in differences in property values or wages. Focussing on property values the hedonic approach attempts through the use of appropriate statistical techniques to (a) identify how much of a property differential is due to a particular environmental difference between properties and (b) infer how much people are willing to pay for an improvement in the environmental quality that they face and what the social value of the improvement is.

Hydrology. One of the earth sciences that encompasses the natural occurrence, distribution, movement, and properties of the waters of the earth and their environmental relationships.

Impoundment. Body of water formed by collecting water, as by dam.

Indigenous and tribal peoples. At its broadest, the adjective ‘indigenous’ is applied to any person, community or being that has inhabited a particular region or place prior to colonisation. However, the term ‘indigenous peoples’ has gained currency internationally to refer more specifically to long-resident peoples, with strong customary ties to their lands, who are dominated by other elements of the national society.

Integrity pacts. Voluntary undertakings related to the procurement of goods and services that are used to reduce corruption, and that are of particular use in situations where regulatory systems and institutional capacity are weak, although they have universal application. The concept was first developed by Transparency International.

Inundation map. A map showing areas that would be affected by flooding from releases from a dam’s reservoir. The flooding may be from either controlled or uncontrolled releases or as a result of a dam failure. A series of maps for a dam could show the incremental areas flooded by larger flood releases.

Large dam. A dam with a height of 15m or more from the foundation. If dams are between 5-15m high and have a reservoir volume of more than 3 million m3, they are also classified as large by the International Commission on Large Dams. In this report, everything else is considered a small dam.

Life-cycle assessment. An options assessment procedure at the front end of the planning cycle used in the energy sector to compare ‘cradle-to-grave’ performance, environmental impacts, and market barriers and incentives for different demand and supply options.

Main-stem. The main course of a river, characterised by its middle and lower reaches.

Major dams. The World Atlas & Industry Guide of the International Journal on Hydropower & Dams defines a ‘major dam’ as a project meeting one of the following criteria: dam height over 150 meters; dam volume over 15 million cubic meters; reservoir volume over 25 billion cubic meters; installed capacity over 1 000 megawatts.

Mitigation measures. The reduction of potentially significant adverse impacts.

Multi-criteria analysis. An analytical process that uses a mix of qualitative and quantitative criteria to assess and compare options, which may be policies, programmes or projects.

Multipliers. The amount by which equilibrium output of the economy changes when aggregate demand - as caused for example by the expenditure by a development project - increases by one unit. As those receiving the initial round of income generated are likely to consume a portion of the additional income, this subsequent expenditure will lead to additional ripple effects of rounds of income and consumption through the economy. The net effect of these increases in output is the multiplier effect of the initial expenditure, measured as a proportion of the initial expenditure.

Multi-purpose dam. A dam that meets two or more objectives (such as irrigation, flood control, water supply, power generation, recreation, navigation or fish and wildlife enhancement).

Opportunity cost. The opportunity cost of using a resource is the value it would command if it were used for the best available alternative.

Performance bonds. Bonds supported by financial guarantees to provide a secure way of ensuring compliance with commitments and obligations. The bond is called upon in part, or in full, to meet unfulfilled obligations and commitments or is repaid when commitments are met, either in whole or in part, depending upon the circumstances.

Precautionary approach. According to the Rio Declaration on Environment and Development, signed in 1992, where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Private goods: These are the opposite of public goods, show high exclusion and high rivalry, and are mostly goods that are consumed like food, clothes, manufactures, etc.

Producer surplus. The difference between what a supplier is paid for a good or service and what it cost to supply. Added to consumer surplus, it provides a measure of the total economic benefit of a sale.

Political Economy. Political economy is the analysis and explanation of the ways in which governments affect the allocation of scarce resources in society through their laws and policies as well as the ways in which the nature of the economic system and the behaviour of people acting on their economic interests affects the form of government and the kinds of laws and policies that get made.

Public goods: These are goods for which exclusion (excluding users) is not feasible or is too costly, and which also show non-rivalry, i.e. the consumption of one unit of the good does not affect the possibility of other user's consumption of the same good. Typical public goods are public light, fresh air, sun, beaches, defence and landscapes.

Recession agriculture. A system of agriculture that depends on the moisture of the soil as the flood recedes. Recession agriculture takes place in the floodplain, which is the area subject to seasonal flooding by the river.

Rehabilitation. The physical or social restoration of an ecosystem or a community after a dam construction project has been completed, or the process of renovating a facility or system that has deteriorated and whose performance is failing to meet the original criteria and needs of the project.

Reservoir. Any natural or artificial holding area used to store, regulate or control water.

Reservoir drawdown. The extent to which the water level in the reservoir changes on a daily or seasonal basis due to release of water from the reservoir for operations (such as irrigation or daily peaking for power generation). Emergency drawdown may be for safety reasons, or in anticipation of a major flood event.

Resettlement. Physical relocation of people whose homes, land or common property resources are affected by a development, such as dam building.

Retention. Temporary storage provided by a dam. Even when a reservoir is full, the outflow may be smaller than the inflow as a result of the retention effect.

Riparian. Lying on or adjacent to a river or lake. Used to denote people, plants or wildlife living along the water's edge.

Riparian State. Any State through which a transboundary river flows or forms part of its boundary, or that includes part of the catchment basin of a transboundary river.

Risk. A measure of the likelihood and severity of adverse consequences (National Research Council 1983). Risk is estimated by the mathematical expectation of the consequences of an adverse event occurring, i.e., the product of the probability of occurrence and the consequence, or alternatively, by the triplet of scenario, probability of occurrence, and the consequence.

Risk analysis. A procedure to identify and quantify risks by establishing potential failure modes, providing numerical estimates of the likelihood of an event in a specified time period, and estimating the magnitude of the consequences. The risk analysis should include all potential events that would cause unintentional release of stored water from the reservoir.

Risk assessment. The process of deciding whether existing risks are tolerable and present risk control measures are adequate and, if not, whether alternative risk control measures are justified. Risk assessment incorporates the risk analysis and risk evaluation phases.

River. Large stream that serves as the natural drainage channel for a drainage basin. In terms of transboundary rivers, the term relates equally to all types of waters that are or might be affected by dams.

River basin. The area from which the river system under consideration naturally receives its drainage water; may encompass a series of tributary rivers and their sub-basins.

Riverine. Features or habitats relating to, formed by, or lying within a river; living along the banks of a river.

Run-of-river dams. Dams that create an hydraulic head in the river to divert some portion of the river flows. They have no storage reservoir or limited daily pondage.

Included in this category are weirs and barrages.

Shadow Price. An estimate of the price of an input in an economically efficient market ie a market free from distortions such as taxes and price determinations.

Social Accounting Matrix. The SAM represents flows of all economic transactions that take place within an economy (regional or national). It is at the core, a matrix representation of the National Accounts for a given country, but can be extended to include non-national accounting flows, and created for whole regions or area. SAMs refer to a single year providing a static picture of the economy.

Storage. The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood wave through a natural stream channel.

Supply: Aggregation of producers' supplies, which is sensitive to production technology, prices, input costs and other factors.

Surface water. Water that flows or lies on the ground surface.

Tailwater. The water in the natural stream immediately downstream from a dam. Applied irrigation water that runs off the lower end of a field.

Travel cost method: A method to estimate the benefits of using sites (like parks) from visitors who could not demand more services according to entrance fees. The variation in the costs of travel for visitors is used to estimate the demand function for the corresponding service.

Tributary. A stream that flows into a larger stream or body of water

Water table. The level of groundwater; the boundary between ground that is saturated with water (the zone of saturation) and ground that is unsaturated or filled with water and air (the zone of aeration).

WCD Forum. A body with some 68 members affiliated to the broad range of stakeholders and interest groups involved in the dam's debate. The Forum is partly composed of members of the Reference Group from the 1997 meeting in Gland that recommended the establishment of WCD. It also has new members subsequently invited to participate by WCD. The Forum is a consultative body.

WCD Global Review. An assessment of the performance and impacts of large dams and of alternatives for water resources and energy development, based on the WCD Knowledge Base.

WCD Knowledge Base. Materials commissioned, organised or accepted by the WCD to inform its work: in-depth Case Studies of eight large dams on four continents, together with two country review studies; a Cross-Check Survey of large dams located in 52 countries across the globe; 17 Thematic Reviews grouped along five dimensions of the debate; four regional consultations; and 947 submissions from interested individuals, groups and institutions. Unfortunately the WCD web site has since closed. At the time of writing the main report was available at http://wwf.panda.org/what_we_do/footprint/water/dams_initiative/dams/wcd/

Watershed. The area drained by a river or river system or portion thereof. The watershed for a dam is the drainage area upstream of the dam.

Weir. A structure built across an open

channel to raise the upstream water level or to measure the flow of water. Weirs tend to be smaller than barrages and are not generally gated.

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8 MRC-GIZ COOPERATION PROGRAMME BACKGROUND

GIZ is supporting the Mekong River Commission (MRC) in its work in poverty alleviation and environmentally friendly hydropower development, as well as in protecting the population from the negative impacts of climate change in the Lower Mekong Basin. GIZ is directly supporting experts and managers from the MRC Secretariat, the National Mekong Committees and the Ministries for water, energy and environment in the member countries. The GIZ programme aims to achieve long-term, sustainable improvement to the livelihoods of more than 60 million people in the Lower Mekong Basin.

The GIZ programme comprises the following components (http://www.giz.de/themen/en/30306.htm):

- Supporting the Mekong River Commission in organisational reform
- Supporting the MRC in pro-poor sustainable hydropower development
- Supporting the MRC in Adaptation to Climate Change in the Mekong region
- Adaptation to climate change through climate-sensitive flood management

Supporting the MRC in pro-poor sustainable hydropower development

GIZ is advising the Mekong River Commission (MRC) on developing and implementing instruments for testing and improving the sustainability of hydropower projects. For example, this includes instruments for analysing the impacts of hydropower development in catchment areas as well as approaches for establishing benefit-sharing mechanisms within water catchment areas and beyond borders. In addition, GIZ is promoting the exchange of experiences between various river basin commissions involved in sustainable hydropower development. The project is also developing basic and advanced training measures on sustainable hydropower.

Network on Sustainable Hydropower Development in the Mekong Countries (NSHD-M)

The NSHD-M is integrated in the project 'supporting the MRC in pro-poor sustainable hydropower development' of the Mekong River Commission (MRC) - GIZ Co-operation programme. The Network was established in October 2012 by universities and research institutions in the Mekong countries Cambodia, China, Laos, Thailand and Vietnam. The network aims to

- enhance knowledge and skills on sustainable hydropower development (SHD) at academic and research institutions,
- share knowledge and experiences on SHD in the Mekong countries,
- increase awareness on SHD at all levels of decision making,
- strengthen the capacity of stakeholders, including planners and decision makers, to cope with the challenges of SHD.

The network and its activities in the Mekong River Basin are supported by GIZ on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ).

Further information on NSHD-M goals, activities and partners: www.cdri.org.kh/index.php/nshdmekong.

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