Application of the International Hydropower Association's Sustainability Assessment Protocol: Case Studies of Blanda Hydropower Plant (Iceland) and Upper Seti Hydropower Project (Nepal)

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Declaration of originality

This dissertation is substantially my own work and conforms to the Department of Engineering's guidelines on plagiarism. Where reference has been made to other research, this is acknowledged in the text and bibliography. The total length of this document, including all citations, is less than 15,000 words.

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Acknowledgements

I dedicate this work to my parents, who have always remained a constant source of inspiration in my quest for knowledge.

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Abstract

Hydropower offers a promising alternative for supplying clean and sustainable energy to meet the world's increasing demands. Hydropower already produces one sixth of the world's energy. Undeveloped potential remains in countries where the need for water and energy is the greatest. The challenge for the hydropower industry is to learn from its past experience and develop hydropower in a sustainable way. The International Hydropower Association (IHA), working for the past eight years with international specialists and through a global consultative process, has produced the Sustainability Assessment Protocol (Protocol). There were two main objectives for this study. The first was to test the Protocol in projects in different geographical, political and economical contexts, and in two different scenarios: an existing operating hydropower station and a new hydropower project in the planning stage. The operating Blanda Hydropower Plant in Iceland and the planned Upper Seti Hydropower Project in Nepal were chosen. Secondly, the Protocol was evaluated using assessment frameworks developed by Fenner et al., and Hacking. Based on audits conducted in Iceland and Nepal, and the evaluation using the two sustainability frameworks, the research has helped to demonstrate that the Protocol is a valuable and practical tool in assessing the sustainability of hydropower projects. The research also points out some of the gaps in the Protocol that need to be addressed. Lastly, the Protocol was consulted to help identify gaps in the sustainability performance of the projects in Iceland and Nepal and provide some suggestions for the owners on how to enhance the performance of these projects.

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List of Abbreviations

CEEQUAL	Civil Engineering Environmental Quality Assessment and Award Scheme
DDP	Dam Development Project
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
GHG	Greenhouse gases
HSAF	Hydropower Sustainability Assessment Forum
IEA	International Energy Agency
IHA	International Hydropower Association
IPCC	Intergovernmental Panel on Climate Change
IREA	International Renewable Energy Alliance
ISO	International Organization for Standardization
LCA	Life Cycle Analysis
LV	Landsvirkjun
MCA	Multi Criteria Analysis
MDG	Millennium Development Goals
NEA	Nepal Electricity Authority
SAP	Social Action Plan
SEA	Strategic Environmental Assessment
SD	Sustainable Development
UNCED	UN Convention on Environment and Development
UNEP	UN Environment Programme
WCD	World Commission on Dams
WSSD	World Summit on Sustainable Development

1. INTRODUCTION

1.1 Objectives

This dissertation seeks to:

- Test the practical application of the IHA Sustainability Assessment Protocol by conducting a comprehensive audit of two projects: Blanda Hydropower Plant in Iceland and Upper Seti Hydropower Project in Nepal.

- Provide feedback to LV, owner of the Blanda Hydropower Plant, and the Nepal Electricity Authority (NEA), owner of the Upper Seti Hydropower Project on ways to enhance the sustainability performance of their projects based on the audits.

- Evaluate the Protocol using the eight-point framework developed by Fenner et. al. and the sustainable development framework developed by Hacking.

- Provide recommendations to IHA on ways to improve the Protocol.

1.2 Dissertation roadmap

The study is divided into three sections:

i) Sustainable development issues in the hydropower sector. Chapters 2 and 3.
This section attempts briefly to describe the shifts in the development paradigm and how the world of hydropower battled to come to grips with sustainability. It describes the main issues in the present development of sustainable hydropower and introduce the framework for assessing sustainable hydropower.

ii) Application of the Protocol in Iceland and Nepal. Chapter 4.
Findings from the two case studies which were carried out in connection with the research for the dissertation using the Protocol are presented in this section. A summary of the results of the assessment of the Blanda Hydropower Plant in Iceland and the Upper Seti Hydropower Project in Nepal are presented. Recommendations are made to the owners on ways to enhance the sustainability of their schemes and comparisons between the two case studies are made.

iii) Evaluation of the Protocol. Chapter 5.

Evaluation of the Protocol is performed using the eight-point framework developed by Fenner et. Al. and the sustainable development framework developed by Hacking. The two case studies are used in the evaluation.

iv) Recommendations. Chapter 6.

Based on the research, recommendations to made to IHA on ways to improve the Protocol.

1.3 Research methodology

There were two field studies for this dissertation. The first was an audit (24 March to 29 March 2008) in the Blanda Hydropower Plant from in northern Iceland. The second audit was of the proposed Upper Seti Hydropower Project in Nepal (10 May to 17 May 2008). Both audits used the IHA Sustainability Assessment Protocol. All three modes for collecting audit objective evidence were used. Detailed description of the Protocol is given in Chapter 3.

Two sustainability frameworks were applied to evaluate the Protocol: the eight-point framework developed by Fenner et al. and the SD-directed framework developed by Theo Hacking, both at Cambridge University.

Information was compiled using various sources including a research and literature review. The author attended two workshops in connection with the study: a Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL) assessors' training workshop at Loughborough University in the UK in December 2007, and the World Bank's workshop on Nepal Water Resources Mission in Kathmandu, Nepal, In May 2008.

2. HYDROPOWER AND SUSTAINABILITY

2.1 Background

The provision of clean, sustainable energy to satisfy the world's ever-growing needs is one of the most critical challenges facing humanity at the beginning of the 21st century. Modern industrial development requires huge energy supplies. The 9% gross domestic product (GDP) growth in countries such as India and China has accelerated this demand for energy. Their total energy demands alone have been growing at an annual average rate of 6% in India and 4% in China (IEA 2007).

Global climate change, in particular the prospect of global warming, has made us examine our large appetite for fossil fuels, the main source of CO_2 emissions. Studies by the United Nations Intergovernmental Panel on Climate Change (IPCC) have shown that the atmospheric concentration of CO_2 has risen dramatically in the last 200 years. The average global temperature has risen by about 1^0c (Climate Change 2007; Evans 2007).

Rising prices of oil and gas and the threat of climate change underline the urgency of a rapid switch to more renewable sources of energy. It is well known amongst international energy experts that the different renewable energy sources—biomass, geothermal, hydro, solar, or wind—can already provide an essential share of the global energy supply. Reliable technologies are available to harvest these energies at a competitive cost (International Renewable Energy Alliance [IREA], 2006).

Today, not surprisingly, renewable energy figures prominently on political agendas at all levels of government and in international relations. For example, ministers and government representatives from 154 countries gathered in Bonn, Germany for the International Conference for Renewable Energies in June 2004 and reaffirmed their commitment to substantially increase, with a sense of urgency, the global share of renewable energy in the total energy supply, including hydropower.

Hydropower currently contributes one-sixth of the world's electricity generation; this represents five-sixths of the renewables generation portfolio (IHA 2007). See **Figure 2.1** below**.**

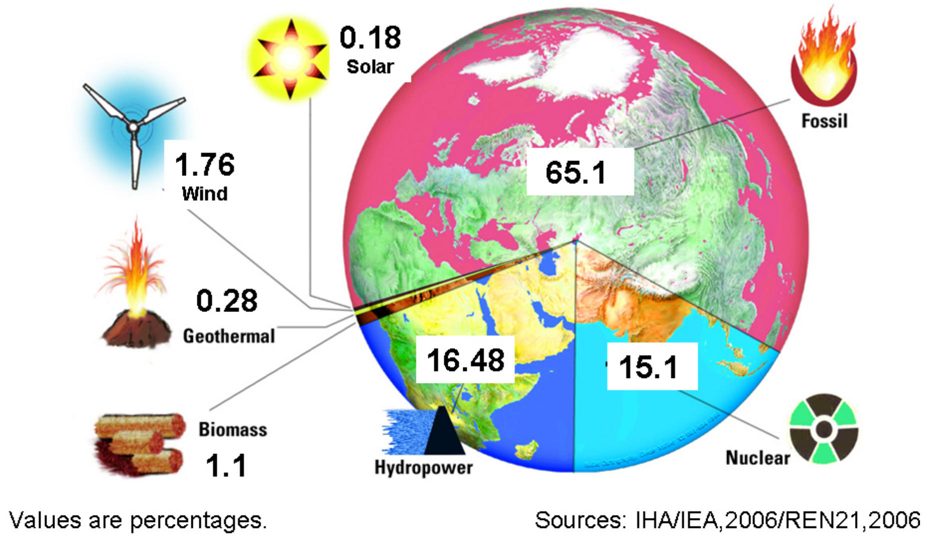

Fig 2.1 Power generation by type

Hydropower's realistic remaining potential is about twice current hydropower production, which stands at 2889 TWh/year (IEA). Increasing concerns over electricity demand, security of supply and climate change have stimulated an extraordinary growth of interest in hydropower investment recently.

Although North America, Europe and Australasia have already developed a high proportion of their economic potential (up to 75% in Europe), South America, Africa and Asia still have significant untapped resources (**Figure 2.2**). Coincidentally, these regions are precisely those where the needs for water and energy services are greatest.

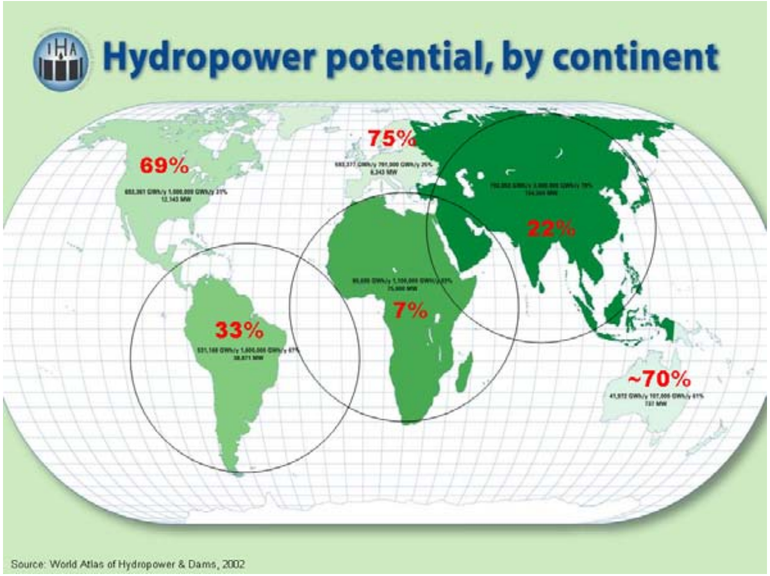

Figure 2.2 Hydropower potential worldwide

Types of hydropower

Hydropower can be classified into three types - run-of-river, storage and pumped storage and three scales - small, medium and large (IHA factsheet). The operational flexibility of hydropower schemes can provide a range of power services: storage schemes to follow peak demands for power, while run-of-river schemes provide the backbone of supply, or ‘base load’. Storage hydro (including pumped-storage) can improve the performance of conventional thermal power plants. In mixed energy systems, storage hydropower can follow rapid changes in demand, allowing conventional plants, including nuclear stations, to operate at their optimum steady state. In the case of fossil-fuel schemes, this reduces both fuel consumption and associated emissions. Besides hydropower, a dam that stores water maybe used for other purposes such as flood control, irrigation, drinking water and recreation.

This study covers two storage projects by pure coincidence. The geographical locations and the status of the projects (Blanda is already in operation whilst Upper Seti is in a planning stage) were chosen deliberately to ascertain the applicability of the Protocol in two different situations.

Role of water storage

As hydropower is intrinsically linked with water storage, it is appropriate to say a few words about dams and reservoirs. Water storage is essential for economic growth; it supports improved food security and plays a critical role in building resilience to water shortages and supporting adaptation to climate change.

Reservoirs have been used to sustain the ever-increasing demand for water and to supply power. In many developing countries, such as Ethiopia, only a tiny fraction of the infrastructure needed to cope with existing climatic variability has been developed. As a result, long-term economic growth is reduced and high short-term economic losses from droughts and floods persist. Lack of water storage is estimated to cost Ethiopia one-third of its potential economic growth. In Nepal lack of water storage has impeded development opportunities for meeting power demand for internal consumption and export to neighbouring countries, not to mention flood control, irrigation, and water supply in dry months.

Although huge hydro resources remain, their exploitation needs to be effected in a sustainable way. Some hydropower projects have not been sustainable in the past, so we need to learn from past experience and try to build all future hydropower projects on a more sustainable basis. There is also scope for us to adopt measures as far as possible to make changes to existing hydropower schemes to make them more sustainable. The case study of Blanda Hydropower Plant in Iceland is a good example of this. In the next chapter, the concept of sustainable development and its influence on hydropower will be discussed.

2.2 Sustainable development and hydropower

Sustainable development is a relatively recent concept that has grown out of concerns about the declining quality of the environment coupled with increasing resource needs as populations expand and living standards rise. Energy production and consumption have significantly contributed to environmental damage, and many in the environmental community believe that the quality of life will also decline unless alternatives are developed (Frey 2002).

The global revolution in environmental impact assessment started in the late nineteen-sixties with Environmental Impact Assessment (EIA) being established as a legal tool in 1969, when the National Environment Policy Act came into force in the USA. Global environmentally oriented conventions contributed to the process of paradigm shift.

In 1987, an influential report entitled, ‘Our Common Future’ (The Brundtland Report) was published by the UN, and it defined sustainable development as: ‘Development that meets the needs of the present without compromising the ability of future generations to meet their own needs**.'** The report recognized that poverty is one of the main causes of environmental degradation and that equitable economic development is a key to addressing environmental problems. The report also emphasized the legacy that the present generation is leaving for future generations.

In 1992 the UN Convention on Environment and Development (UNCED) held the Rio Earth Summit and in 2002, the World Summit on Sustainable Development (WSSD) took place in Johannesburg. The WSSD identified all forms of hydro as a renewable source of energy that should be supported by the international community. (IHA 2002) . The UNCED Rio Earth Summit and WSSD, along with the water sector (dams), fed their interpretations of the implications of increasing hydro into the World Commission on Dams (WCD), which, in turn, synthesized their findings and provided a major impetus for the necessary changes in project operations. The Millennium Development Goals (MDG) further influenced global decisions for all development projects by setting a target to reduce the number of people below a defined poverty line by one half or more by 2015. Hydropower projects were among the technologies expected to contribute to that goal. (Hjort-af-Ornas 2008).

Technical and economical considerations came to be seen as intertwined with environmental and social issues for the achievement of sustainable development. Traditional sector knowledge was challenged. What used to be a technical water sub-sector in planning became integrated into sustainable development planning. The pressure for sustainable development came from public opinion, non-governmental organizations and political leaders. The role of stakeholders shifted from study objects to actors who could defend their interests in a responsible way. Social and poverty issues became incorporated into a view of the world's that used to be dominated by technical and production economic thinking. Stakeholders would now play a significant role in sustainable development in this new paradigm.

As sustainable development was established as a template, the missing link was how this change in outlook would impact on the implementation of future projects to meet the new criteria. Hydropower planning thus required a new culture that could embrace the sustainable development ethos.

2.3 Sustainability Assessment

The need for robust assessment frameworks is an essential component of our ability to engineer sustainability. However, the formulation of such assessments can be liable to pitfalls and to the dangers of inappropriate methodologies being misapplied in the wrong circumstances with little regard for understanding the wider context of the problem (Fenner 2008). The assessments should, therefore, be objectives-led, rather than merely being a baseline assessment. The traditional EIA is an example of a baseline assessment. Two other assessment techniques are also relevant: CEEQUAL and WCD.

CEEQUAL

CEEQUAL does not directly relate to sustainability assessment in the hydropower sector but was developed for assessment of UK's civil engineering works already in operation. CEEQUAL assesses performance across twelve areas of environmental and social concern. The differences between the various types of projects are taken account of in the scoping-out process carried out at the beginning of each assessment. The process requires the assessor and verifier to discuss and decide whether any individual questions are not applicable or are irrelevant to the project being assessed and these are scoped out (CEEQUAL 2007). The author participated in a CEEQUAL workshop in Loughborough University on assessing projects. The aim was to gain experience from a mature and well functioning system in order to provide input to the two assessments undertaken during this research.

World Commission on Dams

In April 1997 a meeting was convened by the World Conservation Union and the World Bank to discuss the role of large dams in development. The outcome of this meeting led to the WCD. Three years later, the Commission released its final report, 'Dams and Development: a New Framework for Decision-making'. The report received a mixed, deeply divided, response. From 2001 to 2007, the United Nations Environment Programme (UNEP) hosted the Dams and Development Project (DDP). UNEP formulated its own position on the WCD report, stating that it did not endorse the WCD report in its entirety.

There was a lot of discussion about the applicability of the WCD guidelines but very little detailed analysis of the guidelines. R. Fujikara and M. Nakayama conducted a study of the feasibility of the WCD guidelines as an operational instrument (Fujikara 2002) and reported that only six out of 26 suggested guidelines were ready for implementation and concluded that the guidelines should by no means be regarded as a blueprint for future dam construction projects.

WCD was an attempt at creating a tool to address sustainability but the flaws in its process left scope for the IHA to come up with a more effective solution.

IHA Sustainability Guidelines

The hydropower industry felt the need to address the sustainability of its projects. It needed a set of reliable guidelines and a suitable operational tool to accompany it. The WCD process was invaluable in setting the scene for hydropower's sustainability, but as discussed above, the process was flawed. After the completion of the WCD report, IHA launched an initiative to define sustainability criteria and produce guidelines that were hydropower-specific and consistent with the aspects of the WCD report which enjoyed broader consensus among industry, civil society and government agencies, particularly in developing countries. In 2003, the *IHA Sustainability Guidelines* were presented for review at various fora, including the DDP meetings and the Third World Water Forum. In 2004, having passed through several drafts, the *Sustainability Guidelines* were adopted by the Association.

Other guidelines

Several other organizations have developed policies to define sustainable hydropower. These include the Greenhouse Hydro in Switzerland and the Low Impact Institute in the US. They have guidelines which are completely independent from each other.

3. THE PROTOCOL

3.1 Background

While the IHA guidelines were generally welcomed by various civil-society and conservation organizations, the collective message was a call for a compliance mechanism for such guidelines. Subsequently, IHA started work on a Sustainability Assessment Protocol, hence referred to as the *Protocol*. This tool was intended to assist in the measurement of sustainability performance through a scoring system. The Protocol was developed primarily to assist IHA members in assessing performance against criteria described in the guidelines.

The Protocol has three sections. Section A gives an overview of strategic planning in terms of needs, resources and options assessments. Sections B and C are orientated towards a performance assessment of proposed hydro projects and the operation of existing schemes. The author used Section B to audit the proposed Upper Seti Hydropower Project and Section C to audit the Blanda Hydropower Plant. Section A was not used in this study due to time limit.

3.2 Scoring system

In each of these sections, 20 topics are used, covering environmental, social and economic aspects. Each topic is assessed on a scoring system of 0-5, with a score of 3 being considered to be satisfactory and essentially complying with the IHA Sustainability Guidelines. See Table below:

Table 3.1 Description of the scores used in the Protocol

Score	Performance	Description
5	Outstanding / Strong / Comprehensive	• At or very near international best practice. • Suitable, adequate, and effective planning and management systems. • Meets or exceeds objectives and measurable targets.
4	Good to Very Good	• High standard performance. • Generally suitable, adequate, and effective (minor gaps only) planning and management systems. • Meets most objectives and measurable targets including all critical ones.
3	Satisfactory	• Essentially meets the requirements of the *Sustainability Guidelines* (no major gaps). • Generally compliant with regulations and commitments (minor exceptions only). • Some non-critical gaps in planning and management systems. • Some non-critical gaps in meeting objectives and

		measurable targets.
2	Less than satisfactory	• Gaps in meeting the requirements of the *Sustainability Guidelines* • Some gaps in compliance with regulations and commitments. • Gaps in planning and management systems. • Gaps in meeting objectives and measurable targets.
1	Poor / Very Limited	• Poor performance. • Major gaps in compliance with regulations and commitments. • Major gaps in planning and management systems. • Major gaps in meeting objectives and measurable targets.
0	Very Poor	• No evidence of meeting the requirements of the *Sustainability Guidelines*. • Very poor performance or failure to address fundamental issues. • Little or no compliance with regulations and commitments. • Ineffective or absent planning or management systems. • Fails to meet objectives and measurable targets.

3.3 Evidence collection

The scoring system requires supporting objective evidence to substantiate the allocated result for each aspect; both the performance and the related process are evaluated. Provision is made for the audit or the assessment to be conducted by internal staff, specialist consultants and external auditors. (Please note that term auditing and assessment are used interchangeably throughout this study).

There are three different modes for collecting audit objective evidence:

a) Document review - This could include examining plans, procedures and records.

b) Interviews - These could be conducted with responsible staff, management, and contractors. Interviews should be pre-arranged and may consist of numerous separate discussions with individuals or groups.

c) Direct observation - This could involve looking at physical locations and at other activities related to the management of an activity or process.

Demonstration of the use of the Protocol is presented in Section 4. The Protocol is available for downloading from www.hydropower.org

4. CASE STUDIES

4.1 Upper Seti Hydropower Project (Nepal)

Project description

Nepal is located in the Himalayas and is physically very diverse. The lowland south of the country runs from 90m to 300m above sea level, while the almost 8800 m-high Mount Everest is to be found in the in the north, and all within a short 193 km distance. Combined with huge volumes of glacial melt and precipitation, the steep topography creates the perfect condition for hydropower generation. Hydropower potential in Nepal ranks second in the world after Brazil. The estimated potential is 83000 MW out of which 42000 MW can be developed economically.

The proposed project is located in the western development region of Nepal, about 160 km west of Kathmandu (**Figure 4.1**). The project lies in the catchment of the Seti River, a major tributary of the Trishuli River in the Gandaki basin.

The project has an installed capacity of 128 MW and will be able to generate 476 GWh of annual energy. Upon completion, the scheme will be able to provide six hours of daily peaking capacity in winter, which is valuable to the present power system. This proposed project is technically attractive due to its type. It is a storage project and, if built, would become the second storage project in the country. Implementation of reservoir (storage-type) hydroelectric projects is essential to mitigate seasonal imbalances in the demand and supply of electricity services.

15.05.2008 West Seti Headworks Site
(Photo P. Karki)

17.05.2008 The country could prosper if cheap hydroelectricity replaced imported oil.
(Photo P. Karki)

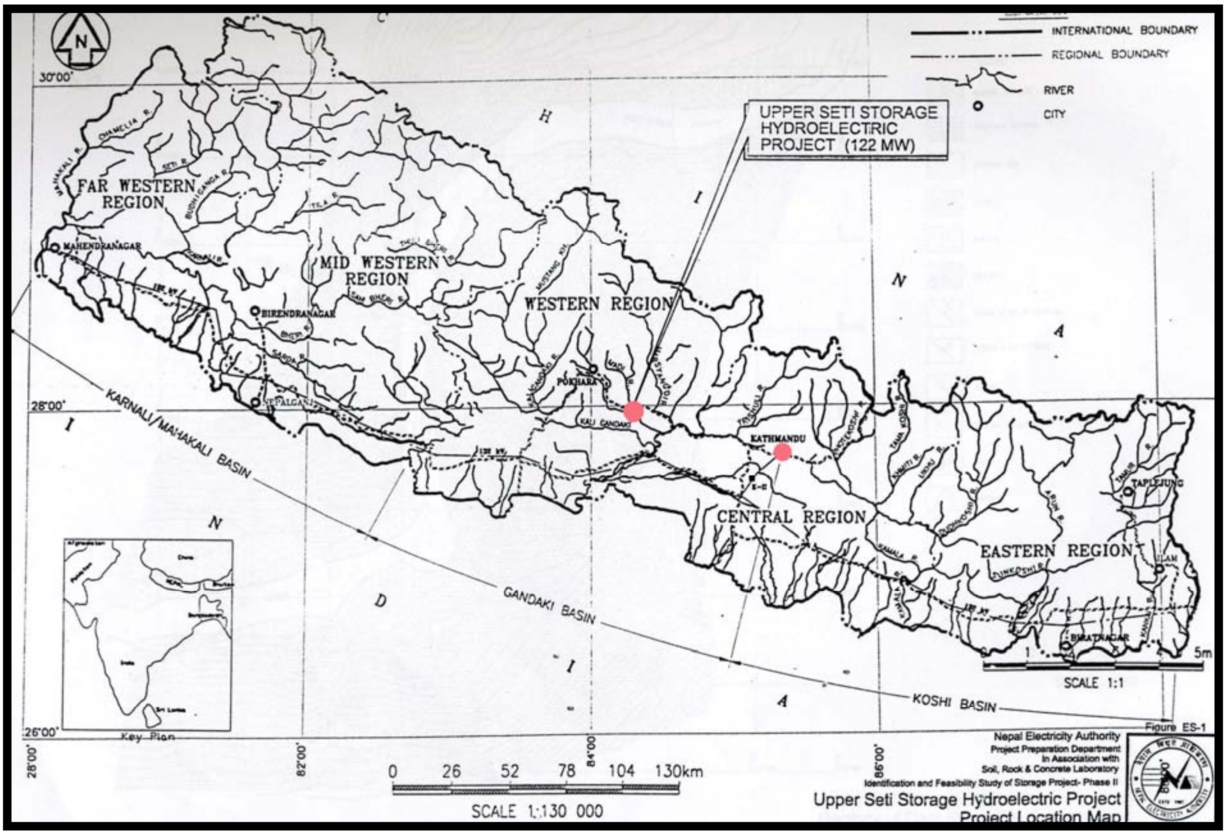

Figure 4.1 The Upper Seti Hydropower Project location map (Source NEA)

Assessment details

The author visited the site from 12th to 17th May 2008. The audit included a site visit to the proposed dam and powerhouse area. The audit also included interviews with key people in NEA's head office in Kathmandu and a few stakeholders at the project site.

Unfortunately constraints on space mean it is not possible to present full details of the assessment in this report. A brief summary of the audit notes is presented instead. Samples of the detailed audit notes are presented in the Appendices.

Table 4.1 lists the scores for the project and **Figure 4.2** shows a radar plot of the scores.

Table 4.1 Summary of aspects and scores for Upper Seti Hydropower Project

No.	Aspect	Score	No.	Aspect	Score
B1	Political risk and regulatory approval	3	B11	Safety	3
B2	Economic viability	4	B12	Cultural heritage	4
B3	Additional benefits	4	B13	Environmental impact assessment and management plan	5
B4	Planned operational efficiency and reliability	3	B14	Threshold and cumulative environmental or social impacts	3
B5	Project management plan	3	B15	Construction and associated infrastructure impacts	3
B6	Site selection and design optimization	3	B16	Land management and rehabilitation	3
B7	Community and stakeholder consultation and support	5	B17	Aquatic biodiversity	3
B8	Social impact assessment and management plan	4	B18	Environmental flows and reservoir management	3
B9	Predicted extent and severity of economic and social impacts on directly affected stakeholders	4	B19	Reservoir and downstream sedimentation and erosion risks	3
B10	Enhancement of public health and minimisation of public health risks	3	B20	Water quality	3

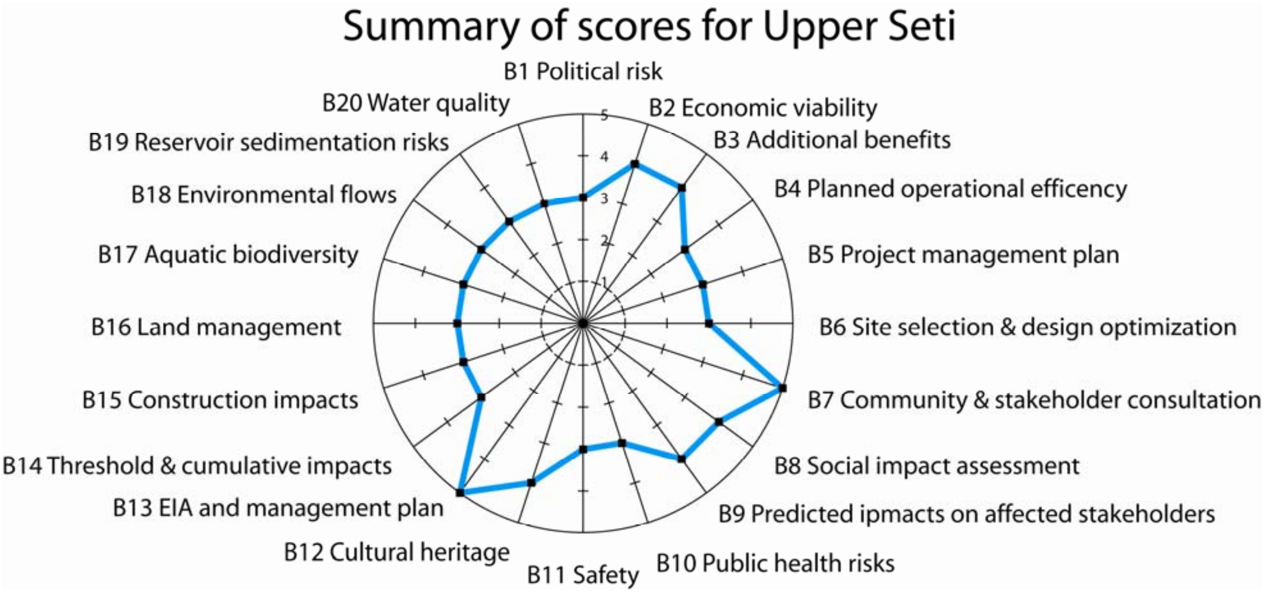

Figure 4.2 Radar plot of scores for Upper Seti Hydropower Project

The average score (mean) of the 20 aspects for which evidence was obtained during the audit was 3.45 out of 5.0, indicating that the plant was satisfactory according to the *IHA*

Sustainability Guidelines. It also implied that from the point of view of internationally recognised best practice the project is found acceptable, based on the information available to the assessor at the time of the audit. A brief summary of the 20 aspects against which the project was audited, is given below.

B1 Political risk and regulatory approval, Score 3

Nepal has been facing political instability since 1996. The lower score was given because confidence in the project being free from political influence was low and timing of regulatory approval was uncertain.

B2 Economic viability, Score 4

Although the financial and economic analysis indicates confidence in the project's economic viability, the cost per KW installed is quite high.

B3 Additional economic benefits, Score 4

All the four additional benefits listed in the Protocol: employment, education/ capacity building, health care, additional economic activities, such as roads and electricity supply, have been adequately addressed but the confidence level in their implementation is low.

B4 Planned operational efficiency and reliability, Score 3

A lower score was given because of some gaps in the analysis of the hydrological resources and in the planning for asset resource management strategies.

B5 Project management plan, Score 3

A score given was no higher than satisfactory on account of some of the gaps in the project management during the design and the construction phases of the project.

B6 Site selection and design optimization, Score 3

The project developers have adequate understanding of optimization requirements and opportunities. The Upper Seti was chosen as the best storage project during the fine screening and the ranking in phase two of the 'Identification and Feasibility Study of Storage Projects'. However, site inspection during the audit revealed relatively inferior site selection for the intake, which is located a few meters below a sharp bend. This could be challenging for sediment management.

B7 Community and stakeholder consultation and support, Score 5

The community and stakeholder consultation process in Upper Seti has followed the national EIA guidelines and was organized in the following manner:

i) public consultation during the scoping phase

ii) public hearing conducted by NEA

iii) three stakeholder meetings were organized at site.

A high score is appropriate for a comprehensive stakeholder consultation process and no significant community opposition.

B8 Social impact assessment and management plan, Score 4

A social impact assessment was undertaken during the EIA studies and has proposed mitigation measures. The study has identified effects of the project on land take, population displacement, social problems due to influx of labourers, and economic spin-offs. There is solid community support for the project.

B9 Predicted impacts on directly affected stakeholders, Score 4

A number of mitigation measures were recommended to deal with negative social and socio-economic impacts, including resettlement and acquisition principles.

B10 Enhancement of public health and minimisation of public health risks, Score 3

The EIA identifies potential health and sanitation concerns arising from construction operations and work camps. Suitable assessment and planning have been done in the project. A score of 3 is given because of the minor to moderate risks.

B11 Safety, Score 3

The construction of the project is planned through international competitive bidding. Therefore it can be assumed that the resource competency will be quite high in terms of recruiting companies that follow health and safety rules. However due to the absence of strong government regulations on health and safety, a lower score was given.

B12 Cultural heritage, Score 4

The EIA reports that there are no sites with unique cultural heritage. The assessments have been done thoroughly.

B13 Environmental impact assessment and management system, Score 5

Upper Seti has properly addressed the mitigation of negative impacts and the optimization of benefits. There is a comprehensive EIA in place. The environmental management plan outlines the mitigation, monitoring, and institutional measures to be taken during both the construction and operational phases of the project.

B14 Threshold and cumulative environmental or social impacts, Score 3

There has been satisfactory assessment covering regulated and any unregulated river systems in the region. This was done during the screening and ranking of the storage projects. A minor degree of uncertainty about the choice of options selected meant that a score of 3 was awarded.

B15 Construction and associated infrastructure impacts, Score 3

The project developer has proposed a comprehensive environmental and social management plan for the construction stage of the project but the study is weak in identifying environmental disturbance and changes to the affected communities, hence the score.

B16 Land management and rehabilitation, Score 3

Watershed conditions, land take and land use in both the construction and operation phase are well described in the EIA. There is minor uncertainty in relation to suitability and appropriateness of actual or planned land or catchment management agreements, hence the score.

B17 Biodiversity and Pest Species, Score 3

The project is likely to satisfy regulators and other stakeholders on most issues but there are minor gaps in plans for understanding of relevant catchment, in-reservoir, and downstream biodiversity issues and this is reflected in the score.

B18 Environmental flows and reservoir management, Score 3

Following two public consultations, the feedback indicated strong community support for the project. There are minor gaps in the plans to research and define environmental (including biodiversity), social, and economic objectives. There is a satisfactory process or planning for identifying stakeholder concerns. However, the score reflects the fact that more studies need to be done on environmental flows.

B19 Sedimentation and erosion, Score 3

Adequate and practicable participation in catchment management planning and implementation is likely. It is also the likely that the scheme will largely meet regulatory requirements and stakeholder expectations. Sedimentation is a serious issue in the

Himalayas and the problem is quite significant in Upper Seti. Although there is a satisfactory understanding of likely reservoir and sedimentation/erosion issues and risks, the score reflects the fact that more studies need to be done to gain greater insight into this problem.

B20 Water quality, Score 3

The EIA report mentions how the water quality will change significantly in the operation phase. There is satisfactory understanding of likely water quality issues. It is probable that the scheme operations will cause only minor water quality deterioration and that there will be some practicable operator influence on the behaviour of other water users to protect water quality. The planning for water quality management programme during construction and operation is scored, therefore, as satisfactory.

Enhancing sustainability performance of Upper Seti

The audit has demonstrated that the project has some non-critical gaps in planning and management systems and some non-critical gaps in meeting objectives and measurable targets. If these gaps are closed, the sustainability performance of the project could be enhanced. The following points need to be addressed by the project developer to enhance the sustainability performance of the project:

i) Cost per KW installed is about USD 2562. Hydropower is competitive at costs up to USD 1500 per KW installed. The high cost maybe attributed to the physical features of the project—it has a relatively low head but involves substantial infrastructure. The recommendation is to investigate these high costs and explore ways to bring them down.

ii) Reservoir sedimentation. There is a general understanding of reservoir sedimentation issues in Nepal, especially after 15 years of operational experience with the Kulekhani Storage Project. Model studies may provide a better picture of the sediments' deposition, especially in view of the dam being located 50 m downstream of a sharp bend in the river. The uncertainty about the reliability performance of the headworks as a result of sedimentation is a critical factor in the operational efficiency of the whole project. This needs to be further investigated.

iii) A comprehensive options assessment covering regulated and any unregulated river systems in the region is missing. It is recommended that the developer looks into an assessment of cumulative and threshold impacts of options.

4.2 Blanda Hydropower Plant (Iceland)

Project description

Iceland is located in northern Europe, between the Greenland Sea and the North Atlantic Ocean, northwest of the UK. Located on the Mid-Atlantic Ridge, Iceland is volcanically and geologically active on a large scale. The interior mainly consists of a plateau characterized by sand fields, mountains and glaciers. Many big glacial rivers flow to the sea through the lowlands, creating favourable conditions for hydropower development. The Blanda Hydropower Plant is located in northern Iceland, about 270 kms from the capital Reykjavik. The project is located in the Húnavatnshreppur Municipality with a total population of 401.

The Blanda Hydropower Project was designed, constructed and developed by LV, a fully government-owned power company. The project was commissioned in 1991. The layout of the project is shown in **Figure 4.3**.

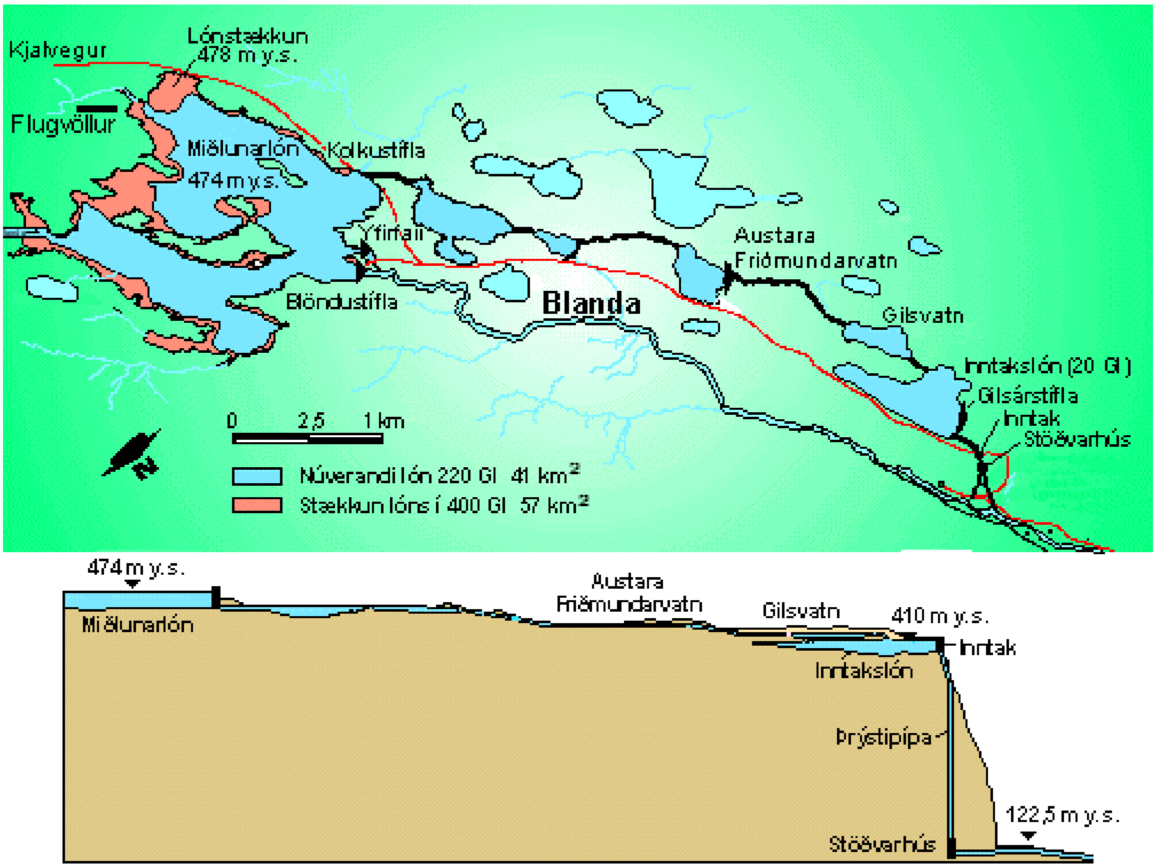

Figure 4.3 Blanda Hydropower Plant layout

25.03.2008 Blanda Visitor's Centre
(Photo P. Karki)

27.03.2008 Aerial view of the reservoir
(Photo P. Karki)

Assessment details

The author visited the site from 24th to 28th March 2008. The audit included interviews with key people in LV's head office in Reykjavik and several stakeholders at the project site. The site visit also included an aerial survey enabling the author to inspect the whole length of the Blanda river. Constraints on space mean that details of the assessment are not given in this report, instead a brief summary of the audit notes are presented. **Table 4.2** lists the scores for the project and **Figure 4.4** shows a radar plot of the scores.

Table 4.2 Summary of aspects and scores for Blanda Hydropower Plant

No.	Aspect	Score	No.	Aspect	Score
C1	Governance	4	C11	Suppliers and service providers	3
C2	Economic viability	5	C12	Cultural heritage	5
C3	Additional economic benefits	4	C13	Social commitments	5
C4	Markets, innovation, and research	4	C14	Directly affected stakeholders (including the local community)	5
C5	Operational efficiency	4	C15	Environmental commitments and management	5
C6	Operational short-term and long-term reliability	5	C16	Reservoir management	5
C7	Community acceptance	5	C17	Environmental flows	5
C8	Dam, power station, and associated infrastructure safety	5	C18	Biodiversity and pest species	5
C9	Employee safety, occupational health, and well-being	5	C19	Water quality	5
C10	Employee opportunity, equity, and diversity	5	C20	Sedimentation and erosion	5

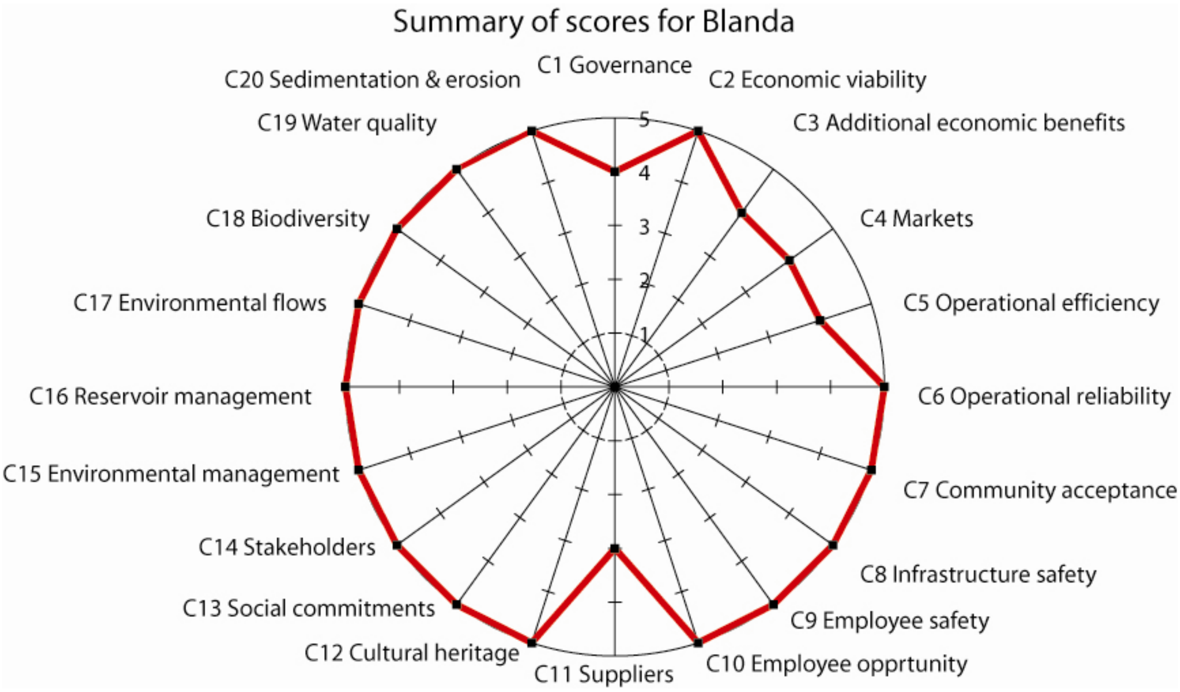

Figure 4.4 Radar plot of scores for Blanda Hydropower Plant

The average score (mean) of the 20 aspects for which evidence was obtained during the audit is 4.7 out of 5.0. This indicates that the plant is “outstanding/strong/comprehensive”, according to the selected international guidelines for best practice in hydropower development. A brief summary of the audit notes is given below.

C1 Governance, Score 4

The plant owner, LV, has a very strong tendency to incorporate sustainability objectives in its strategies and business principles. It also meets relevant international obligations by subscribing to ISO 90001 and ISO 14001. The owner is not, however, strong in sustainability reporting and is generally not good at showcasing the company’s sustainability achievements. For example, the positive role of the Blanda reservoir on flow regulation that helps the local fisheries is not mentioned in annual reports.

C2 Economic viability, Score 5

LV is committed to long term agreements, reliable operations based on solid foundation. The economic viability is scored as very high.

C3 Additional economic benefits, Score 4

The actual additional economic benefits in Blanda have been:

- Commercial fishing activities for the local inhabitants, which the Blanda reservoir has actually helped to create.
- Employment for local youth during the summer.
- Taxes for the project to the local municipality.
- Project access roads creating a “highland pass” much enjoyed by the tourists.
- Around the reservoir nearly 5000 hectares of land have been revegetated.

However, a lower score of 4 is given to the project to encourage the owners to adopt a proper system of identifying and recording the additional benefits to directly affected stakeholders and the broader community.

C4 Markets and innovation, Score 4

LV has a good understanding of the short and long-term market conditions, and has the ability to respond to potential changes in market conditions. A lower score is given to encourage the owners to have a greater understanding of present and likely future market conditions and to encourage frequent identification and application of new solutions to improve performance.

C5 Operational efficiency, Score 4

LV has very good experience, understanding and expertise to run Blanda when it comes to management of hydrological resource, the power station assets, and the network assets. They have attained near maximum efficiency. However, a lower score of 4 was given in order to provide an opportunity to benchmark against optimum standards of efficiency in the management of all the three areas.

C6 Operational short-term and long-term reliability, Score 5

The confidence level in the operational short-term and long-term reliability is very high and the reliability performance of hydrological resource is outstanding.

C7 Community acceptance, Score 5

Strong community support makes Blanda a very successful project. Regular stakeholders’ meetings and the effective consultative processes between LV and the stakeholders guarantee community acceptance and continued support.

C8 Dam, power station, and associated infrastructure safety, Score 5

The actual safety performance of the dam, power station, and associated infrastructure has been outstanding due to a comprehensive safety programme and plan.

C9 Employee safety, occupational health, and well-being, Score 5

The standard for Health & Safety is very high in Iceland and it is regulated by the Icelandic Government and international standards, such as ISO, that LV subscribes to.

C10 Employee opportunity, equity, and diversity, Score 5

LV has a comprehensive system for the training and development of human resources. The LV Integrated Management System features staff training and this is organized in accordance with the company's directives.

C11 Suppliers and service providers, Score 3

This is one aspect where Blanda's score is only satisfactory. Although LV complies with the ISO 9001:2000 Quality Management Systems in procurement, it does not have a policy regarding the actual sustainability performance of its suppliers and service providers. LV is encouraged to adopt a strategy by which it will check upon the sustainability performance of its suppliers and service providers.

C12 Cultural heritage, Score 5

There is a good understanding of the cultural heritage issues. During the EIA for Blanda no significant issues of cultural heritage were identified.

C13 Social commitments, Score 5

LV has a comprehensive social management planning that is independently assessed.

C14 Directly affected stakeholders (including the local community), Score 5

There is a comprehensive analysis of the social and cultural effects on directly affected stakeholders and active involvement of the local community. The local Húnavatnshreppur municipality receives over 40 million Icelandic kroners (about half a million US Dollars) every year from taxes that LV pays, which are used for local social enhancement programmes.

C15 Environmental commitments and management, Score 5

To comply with original and current environmental commitments, LV has incorporated a quality management system meeting the requirements of ISO 9001 and an environmental management system that meets the requirements of ISO 14001. A monitoring plan has been prepared based on this.

C16 Reservoir management, Score 5

The local community shows strong support for the reservoir. Regular meetings are held with the stakeholders, including the local fisheries industry.

C17 Environmental flows, Score 5

Environmental flows in Blanda relate to fisheries. A minimum release of 10 m^3/s is regulated automatically from the reservoir. LV is directed by the Department of Health, the Administration of Occupational Safety and Health (VER) to perform audits and set requirements regarding the environmental flows regime. The support from the local community for the environmental flow regime is strong.

C18 Biodiversity and pest species, Score 5

There is a comprehensive agreement with regulators and stakeholders on ecosystem values and a comprehensive understanding and programme with clear objectives and targets regarding biodiversity.

C19 Water quality, Score 5

There are no issues with water quality in Blanda as it has a comprehensive water quality management programme in place. This is monitored by government agencies.

C20 Sedimentation and erosion, Score 5

One of Iceland’s most enduring environmental issues is soil erosion caused by high winds and over grazing by sheep. LV has a comprehensive understanding of reservoir and downstream sedimentation and erosion issues and risks. They also have a comprehensive risk management programme in place.

Enhancing sustainability performance of Blanda

The audit helped to identify some of the minor gaps in planning and management systems for Blanda. The author recommends LV to address the following points in order to enhance the sustainability performance of the plant:

i) Sustainability reporting. Landvirkjun does not have a sustainability report although it seems to be managing the plant in a sustainable manner. Community relations are outstanding and the benefits that the local community derive from the Blanda Project are commendable. The fishing industry has gained (See C7 Community acceptance) substantial benefits from the flow regulation from the Blanda Reservoir.

ii) Documenting additional economic benefits. At the moment Blanda does not have a system to quantify and record additional benefits. The additional economic benefits discussed in section C2 are good evidence of LV's sustainability performance.

iii) Measurement of the organization's consideration of sustainability when purchasing goods and services. Section C11 addresses this issue. At the moment Lansvirkjun does not seem to have a process in place to address these issues.

These recommendations were greatly appreciated and accepted by Bjarni Bjarnasson, CEO of LV Power, at a meeting with the author on 31 July 2008 in LV's headquarters in Reykjavik, Iceland.

4.3 Comparison of the two schemes

Sustainability requires the integration of three components: economic development, social development, and environmental protection, as independent, mutually reinforcing pillars (IHA 2003). The Protocol is based on this definition of sustainability criteria.

Each hydropower project is different and it is sometimes challenging to make a direct comparison between two schemes. However, it is important to make relevant comparisons that relate to the basic sustainability of projects. Table 4.3 lists the main differences in the economical, social and environmental issues in the Blanda and Upper Seti schemes. This helps to explain the differences in the results of the audits in these two schemes.

Table 4.3 Direct comparison of the two schemes

		Blanda (Iceland)	**Upper Seti (Nepal)**
Average scores for 20 aspects		**4.55**	**3.45**
Economics	Governance	Stable democracy and political environment; low sovereign risk.	Civil unrest ended in April 2008; unstable democracy.
	Project financing	The country ranks 10th in the world in GDP; project investments come from within the country.	The country ranks 158th in the world in GDP; relies on foreign aid. Project financing is sought internationally.
Society	Existence of socially vulnerable groups in the project area.	None. Wealth is distributed evenly, supported by a social welfare system.	There are various ethnic groups and wealth is distributed unevenly.
	Additional benefits from the project: clinics, roads, schools etc.	Responsibility of the government irrespective of the project.	People rely on the project to bring in the additional benefits.
	National regulations on stakeholders inclusion and public participation	Municipalities require the project to be listed in their internal planning, otherwise permission is not given for any development.	Local governance is weak in terms of granting permission for projects and sharing the benefits.
	Transparency	Highly transparent society.	Corruption is a major problem.
Environment	Climate and weather conditions	Lies near the Arctic circle. Cold and harsh conditions	Has a relatively friendlier climate. Sediments are a big issue.
	Biodiversity	Mainly consists of fisheries.	Has a unique population of flora and fauna.
	National legislation on issues concerning the environment	Model based on the European Union; strong codes on the standards for the construction industry	In a developing phase. Weak legislation.

In the next chapter, the Protocol will be analysed through the lens of other sustainability assessment frameworks.

5. EVALUATION OF THE PROTOCOL

Today, there are many assessment tools existing relating to different industries. The assessment field can be overwhelmed by what has been described as a 'menagerie' of terminology and acronyms (Dalal-Clayton and Sadler 2005). The underlying principle is what matters most, however— that it should encapsulate the three pillars of sustainability. The evaluation of the Protocol is done using two different theoretical frameworks using the two case studies.

5.1 Evaluation using the eight-point framework

To compare results obtained from the Protocol with a different framework, the eight-point framework developed by Fenner et al., Centre for Sustainable Development, Cambridge University is used (**Figure 5.1**).

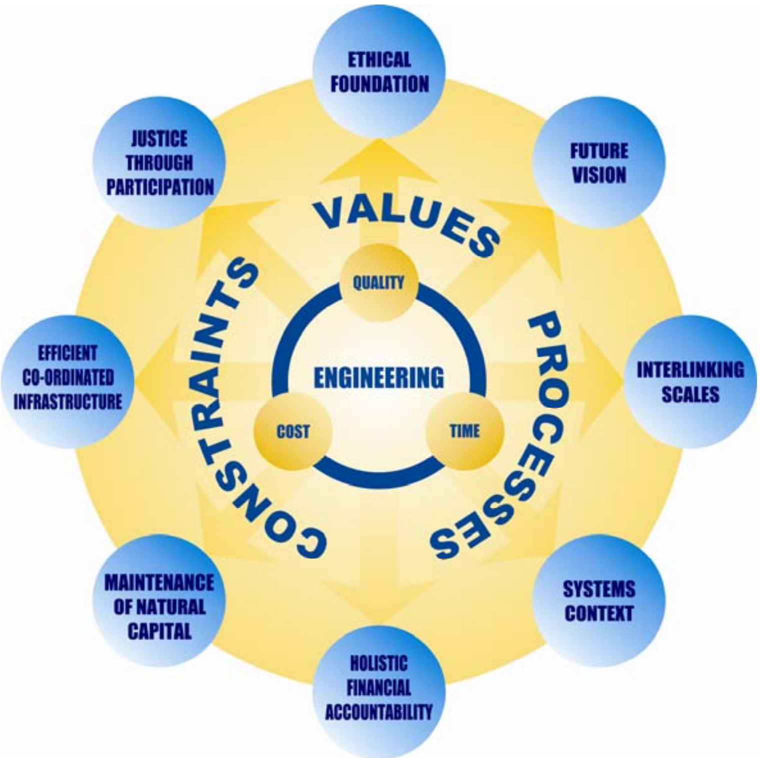

Figure 5.1 The Eight Point Sustainability Framework (adapted from Fenner et. al.)

The Blanda and Upper Seti schemes are compared and contrasted using this framework. This also indicates how close the results are to those obtained using the Protocol. In **Table 5.1** a set of guiding questions derived from the eight-point framework is presented. These questions are taken directly from a paper entitled 'Widening engineering horizons: addressing the complexity of sustainable development' (Fenner et al. 2006). The questions were formulated to enable practicing engineers to be self-critical of their decisions. The questions are then tested on the two schemes.

The results help the reader understand the extent to which solution choices and design details would change if the issues in the eight-point framework were given greater consideration.

Table 5.1 Eight-point framework questions tested against the two case studies

Eight point framework questions		Blanda	Upper Seti
1. Ethical Foundation	How does the engineering project meet clearly defined needs of all project proponents and end users?	Meets them well. The primary need is to fulfil demand for sustainable energy.	Meets them well. The primary need is to meet the peak load demand.
	When was the justification for the scheme or project explored? Has the way in which it fits within the prevailing government policy array been established?	Early in the planning process; fits well with the prevailing government policy array.	During the planning process; fits well with the prevailing government policy array.
	Where and with whom do the benefits of the scheme lie ? Who wins and who loses ?	Both the developer and the local municipality. There are no losers.	Main benefits go to people outside the project area. There are some additional economic benefits. See audit Section B3.
	What clear responsibilities to both the client and to society/environment have been identified ?	Responsibilities well defined; strong legislation and governance guarantee this.	Responsibilities not well defined for various stakeholders, especially developers and contractors.
	In the absence of certainty and with incomplete information, are value judgements based on the precautionary principle ?	Iceland follows European Union law where the precautionary principle is also a general principle of law.	No. Government regulations do not take into consideration precautionary principles.
	In extreme circumstances, is the option to say no retained, so an organization (or individual) will not proceed with corrupt or dishonourable work ?	Transparency International places Iceland in the group of least corrupt countries.	Project decisions taken at higher levels. Corruption is significant so the option to say no is non-existent.
	How has the technical advocacy for pre-determined solutions been avoided?	Through consultations.	Through consultations.

	How has the engineering process shown respect for people and the environment?	Strong environmental impact assessment and mitigation programme in place.	Strong environmental impact assessment and mitigation programme in place.
	How do the drivers for the project match our ethics and values ?	Working for the benefit of the society in delivering sustainable energy.	By meeting energy demands for the benefit of the society.
2. Justice through participation	How has a fair foundation for this scheme been developed with the stakeholders?	Through people's participatory process.	Public consultation during the scoping phase, public hearings and stakeholders meetings.
	Which cultural, religious, ethnic or gender issues may be relevant?	Insignificant. The total project area affects about 400 people who do not live directly in the project area.	• Relocation by dam • influx of workers • illegal activities • disruption in community activities • overburdening of existing social infrastructure such as clinics and schools.
	Have genuine concerns been considered with an openness and willingness to adapt and modify designs?	Significantly. For example, the dam regulation is dictated not by energy demand but by demand from the local fisheries.	The framework of Social Action Plan (SAP) was designed to reverse the impoverishment risks caused by the project.
	How have the interests of those not well represented or not represented at all been recognised and embraced?	The project manager has an official channel to record grievances.	Through appointed representatives.
	What channels have been established for good communication with the public, employees and other professional groups? Is the basis of decision-making established and known to all likely stakeholders at the outset?	• Directly through regular meetings with the Project Manager • through the LV Public Relations Officer.	• Through public hearings (there were three in the EIA phase) • through public consultations • through regular stakeholder meetings • notices and announcements using local papers and radio.

	With whom has the extent to which participation can and will affect decisions been determined and agreed? Who carries responsibility for explaining what cannot be altered and why?	The Blanda Project Manager and the LV Public Relations Officer.	NEA Project Manager, Environmental and Social Monitoring. Officer.
	What are the steps in the process for managing disagreement, and with whom are these discussed?	Through committees and the Project Manager.	NEA Project Management Office.
	Who is involved in establishing a base of agreed positions (fact as well as aspirations)?	Blanda Project Manager in consultation with the Head Office.	NEA Project Management Office.
3. Efficient co-ordinated infrastructures	What opportunities for environmental enhancement (as well as mitigation) have been sought?	Reservoir creates favourable conditions for fisheries.	A comprehensive analysis was done during the EIA stage. NEA Environmental Management group addresses these issues.
	Are adverse impacts accepted only reluctantly?	National legislation, both the Ministry of Environment and the Planning Agency require all impacts to be studied in detail.	National environmental protection rules require the developer by law to conduct due diligence.
	At what stage is an appropriate balance between form and function of engineered systems explored and defined ?	During the detailed project planning stage.	During the detailed project planning stage.
	What flexible and adaptable designs have been developed to allow for extended useful life?	Information not available.	Information not available.
	How much flexibility of operation can be permitted to allow for future change?	Control of reservoir levels allows flexibility in power generation.	Details to be worked out during the detailed planning stage.
	To what extent do designs contribute to social cohesion and inclusion, and human wellbeing and welfare?	In Blanda, the main beneficiary is the fisheries on account of flow regulation in the reservoir.	Site selection and design optimization will focus on practicable maximisation of opportunities.
	Does the engineering product provide value and satisfaction to meet the needs of end users and the general community?	The product is electricity and hydropower generation benefits the community.	The immediate need is to develop storage power projects to meet the peak load demand.

	What safeguards ensure the performance of the scheme is taken into account over ALL its stages, including its design, construction, operation, decommissioning and disposal?	Government regulations and company policy.	Government policy is relatively weak; the developer will take the main responsibility.
	Have plans and proposals been prepared that reflect the true position and not an idealised one?	Blanda has been generating by meeting all the targets.	The Feasibility Study, EIA and project documents indicate that this is the case.
	How is the welfare of the workforce ensured and who has responsibility for highlighting safety issues?	Government regulations, company policy.	Weak government regulations; contractors' responsibility.
	Has an extended range of options been examined? How have these been documented ?	The National Energy Authority develops scenarios for future energy needs and production.	The generation expansion plan study; identification and feasibility study of storage projects.
	How do choice criteria required to evaluate decisions reflect sustainability issues?	Comprehensively.	Partially.
4. Maintaining Natural Capital	How is resource and energy efficiency optimized over the whole life of the project?	Higher confidence level in comprehensive assessment of power station and network asset efficiency and hydrological management systems.	Confidence in comprehensive assessment of power station, network asset efficiency, and hydrological management systems.
	What steps are actively taken to minimise pollution arising and negative value impact?	Environmental Management System.	Environmental Management Plan.
	How is careful and informed material selection ensured and over-specification avoided?	National building codes based on European standards.	National and international building codes.
	What opportunities are sought for re-use (e.g. of land, materials and building stock)?	Considered as contractor's responsibility.	Not considered at all; purely a question of finance.
	Is a formal environmental management system adopted ?	Yes.	Proposed.
	To what extent is any natural capital lost as an integral part of the scheme sought to be replaced and replenished?	Mitigation measures aim at strict policy to replace or replenish.	National EIA Guidelines dictate mitigation measures.
	What distinction is made between actions that lead to large, irreversible and uncertain impacts (e.g. climate change) and smaller reversible ones (recognising not all impacts carry the same weight or significance)?	Benefits of hydropower help maximise renewable energy and minimise dependence on fossil fuels.	Benefits of hydropower help maximise renewable energy and minimise dependence on fossil fuels.

5. Holistic financial accountability	To what extent are transparent business practices audited externally and how is risk managed?	International best practice; KPMG is the company auditor.	Audited internally; low transparency.
	How do costs reflect environmental and social externalities and at what intervals are these embraced and reported?	At the project level costs do not reflect environmental and social externalities.	At the project level costs do not reflect environmental and social externalities.
	What methods are used to assign other than monetary value to natural assets and social gain (by scoring qualitative components where feasible)?	National heritage and independence form oil imports.	Independence from foreign oil imports; local capacity building etc.
	How are costs external to the scheme included in consideration of alternatives?	Not considered.	Not considered.
	What steps are taken to seek long-term relationships with clients and suppliers ?	Internal procurement policy.	Not really practiced.
	How is it recognised that best value is not always lowest cost ?	LV's long term sustainability policy.	Costs determined by the project.
	Are costs minimised only where all costs over whole life are included?	Information not available.	Whole life not considered.
6. Systems context	What agencies and other organizations are involved in adapting a coordinated approach to infrastructure provision?	National Planning & Energy Authority, relevant ministries.	Hydro development has been on a project to project basis.
	How is the relationship with other professionals and special interest group managed (start e.g. planners, politicians, civil society, global corporations, individual stakeholders, etc.)?	Well defined process managed by the Project Manager and the Public Relations Officer.	There is a Public Relations Officer but he is not very effective.
	Who has responsibility for seeking integrated solutions (e.g. between hard (build) and soft (non- build) measures)?	In Blanda it is the Project Manager.	No responsibility defined.
	How are impacts that go beyond the site boundary identified and what measurements are made?	Government regulatory bodies monitor and regulate.	No identification is made for impacts outside project boundary.
	How is cradle to grave life-cycle thinking adopted and a systems engineering approach followed?	No systems engineering approach followed.	No systems engineering approach followed.
	How is complexity recognized and uncertainty managed? Are the inter-relationships between system components understood?	Uncertainty is managed through risk analysis; little evidence of understanding of inter-relationships between system components.	Not considered at all.

7. Interlinking scales	Are global challenges appreciated and how do these influence the conception of local solutions (i.e. by acting as if local actions WILL have a wider influence)?	The potential for hydropower to meet the local sustainable energy demand while helping the global climate change problem is appreciated.	Signatory of Kyoto Protocol; has set national targets for reductions of GHG.
	Over what operational timescales are schemes considered and how is their influence on future generations provided for?	30 years; meeting the power demand in the country.	20-30 years; helps reduce the power crisis and load shedding.
	How is the exploitation of distant resources and people minimised (e.g. by adopting fair trade practices)?	Sustainability of suppliers is not questioned; see Section C11 in the Protocol.	Weak government and company policy in addressing these issues.
	How are the interests of communities beyond the immediate scope of the scheme considered ?	By bringing in improved fisheries and tourism.	Minor issues such as clinics and schools.
	What protocols exist for actively managing the supply chain?	LV Subscribes to ISO 9001 and ISO 14001.	None except the contractors' obligations.
8. Future Vision	How commonplace is it to take action BEFORE legislation and regulation requires change?	It depends on the type of action. Compared to Nepal there is more flexibility.	In the hydropower sector in Nepal this is not common as decisions are taken at higher levels.
	What assumptions are made regarding increasing levels of regulatory control over emissions, waste, natural resources and increased costs and declining availability of energy?	The argument is that energy intensive industries such as aluminum smelters are better placed in Iceland than elsewhere because they will be driven by clean energy.	Being a developing country, the priorities are different. Basic energy supply plays an overriding role in the planning process.
	How are methods such as scenario planning used to explore a range of futures and to ensure real needs are served through careful problem formulation?	The National Planning Agency gives advice on scenario planning and assists in preparing and reviewing spatial plans; it also oversees the implementation of the EIA Act and provides guidelines in accordance with it.	The National Planning Commission is weak at implementation and scenario planning is seldom used to explore a range of futures.
	What ambitious goals and targets are set that stimulate creativity and allow innovation ? How regularly are they revised?	As a government utility, there are no ambitious goals and targets.	None whatsoever. Creativity and innovation is seldom rewarded.

	Which long-term aims are considered as important drivers as responding to today's immediate problems?	Climate change; renewable energy; dependence on national resources.	Reliable supply of energy; dependence on national resources; renewable energy and climate change.
	How is performance benchmarked as a precursor to seeking continual improvement?	By following international standards such as ISO 9001/1400.	No formal processes in place; individual initiatives are taken but go unnoticed by the authorities.
	What formal requirements are there to analyse past performance and to learn and capture (tacit) experience?	There are no formal requirements but the management has procedures for reviewing performances.	There are targets that the management tries to follow.
	What mechanisms are used to encourage creativity and innovation?	Personal reviews by management.	Non-existent.

Summary of key points

Ethical Foundation

Concerning the ethical foundation of the schemes, the Upper Seti Project scores lower than Blanda. The main reason is that transparency is higher in Iceland, precautionary principles are also a general principle of law in the country. According to Transparency International, transparency is weak in Nepal. Governance is also a serious problem, following the civil unrest. Responsibilities are not well defined. The Protocol does not cover this question and the eight-point framework has been valuable in pointing up this inadequacy in the Protocol.

Justice through participation

Generally this resolves into the basic questions: is there strong community support for the project and has there been a comprehensive stakeholder consultation process? Both Blanda and Upper Seti performed quite well in that stakeholder engagement has been strong in these projects. The Protocol is quite strict on this aspect and Section B7 specifically deals with community and stakeholder consultation and support.

Efficient co-ordinated infrastructures

The fundamental question under this point is whether the optimization process guarantees that electricity generated from the projects will benefit the community. In both Upper Seti and Blanda options assessment and design optimization help meet the targets. The difference lies governance issues. In Upper Seti, weak government regulations are not able to protect the welfare of the workforce and the contractor has total freedom to manipulate this. In Blanda the regulations are stricter. The Protocol addresses this point in aspects B6 Site selection and design optimization.

Maintaining Natural Capital

This issue generally resolves into one basic issue: sustainable use of water for electricity generation. Both Blanda and Upper Seti have strong environmental management plans aimed at minimising pollution and negative impacts. The protocol is very strong on this For example, sections B13 addresses EIA and management plans.

Holistic financial accountability

In both Blanda and Upper Seti, the costs do not reflect environmental and social externalities. The standard financial processes of cost benefit, Internal Rate of Return, Net Present Value are used to justify the projects. The Protocol does not address this point.

Systems context

No systems engineering approach was followed in either of these projects. The cradle to grave life-cycle thinking was not adopted. There is generally a poor understanding of interrelationships between system components. The Protocol does not touch upon systems engineering and the whether it is needed for assessment of hydropower projects, more research is needed.

Interlinking scales

Interlinking scales were not explicitly considered. Blanda scored low in assessing sustainability performance of their suppliers and service providers. The Protocol addresses this issue directly in Section C11.

Future Vision

Blanda is in a stronger position in this respect, owing to resources available and the willingness to embrace sustainability. Resources are available for adopting international best practice and LV subscribes to ISO 9001 and 14001. In West Seti, the pressing need is to quickly generate energy to meet the peak demand and future vision is not really a priority. Cumulative impacts are not considered.

From the above discussion it can be concluded that there are some points in the eight-point framework which are not covered in the Protocol, and these form part of the recommendations in Chapter Six. Furthermore, the framework is in agreement that Blanda scores higher than Upper Seti in sustainability assessment. In the next section the Protocol will be judged using the Hacking-Guthrie SD-directed assessment framework.

5.2 Analysis of the Protocol using Hacking's and Guthrie's SD-directed assessment framework

Hacking and Guthrie from the engineering department's Centre for Sustainable Development at Cambridge University have suggested a way of representing what effective sustainability assessments should achieve. See **Figure 5.2.**

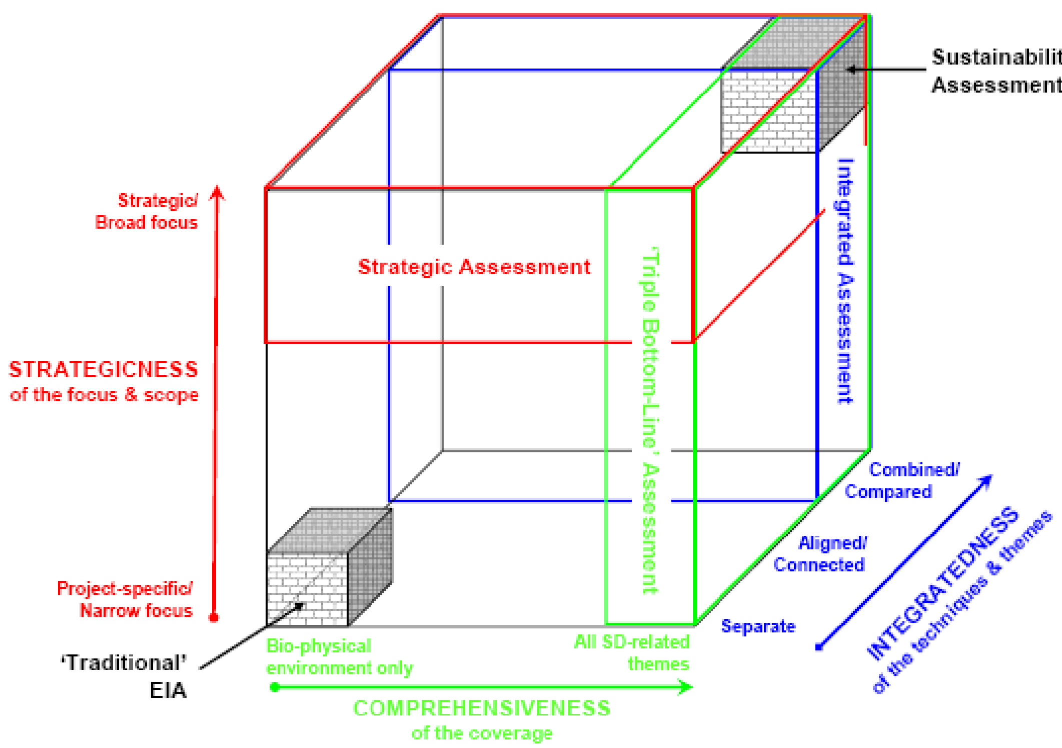

Figure 5.2 The SD-directed assessment framework (Source: Hacking and Guthrie)

They developed a framework which captures three distinguishing characteristics of SD-directed assessment:

- Expanding the thematic coverage - *Comprehensiveness*
- Greater integration of the themes and techniques - *Integratedness*
- Adopting a more strategic perspective – *Strategicness.*

The three axes of the cube show the extent to which any methodology embraces the strategicness of the focus and scope of an assessment, the integratedness of the techniques and themes employed, and the comprehensiveness of the coverage achieved. Proponents of sustainable development-directed assessment promote varying degrees of movement along one or more of these axes (Fenner 2008). The SD-directed assessment framework was used to test if the Protocol covered the three characteristics.

Comrehensiveness

The SD-directed assessment features include coverage of themes relevant to sustainable development, which usually means including non-biophysical / 'neglected' themes such as assessment of social/socio-economic impacts that address cultural, health impacts, vulnerable groups, local benefits, and governance issues. Both the Bland and the Upper Seti projects have very strong coverage of governance, community and stakeholder consultation, social impact assessment, public health, cultural heritage, EIA and management plan, community versus reservoir issues. (See audit notes for Upper Seti and Blanda). For example, Section B9, Predicted extent and severity of economic and social impacts on directly effected stakeholders, has a strong emphasis on vulnerable social groups. It can be safely concluded that the Protocol scores quite high in terms of comprehensiveness.

Integratedness

This characteristic addresses the integration of established thematic, analytical, strategic and process techniques. Traditionally most of the hydropower projects in the world follow conventions such as the EIA, Socio-Economic Impact Assessment, Health Impact Assessment, Risk Assessment and Cost Benefit Analysis. Non traditional methodologies such as Life-Cycle Analysis (LCA), Strategic Environmental Assessment (SEA) and Multi Criteria Analysis (MCA) are new to the hydropower world. Out of these, SEA is increasingly being promoted by international organizations such as the Asian Development Bank and the World Bank. LCA and MCA are still in an experimental stage.

Integratedness also involves considering indirect effects on communities that result from biophysical impacts. As shown in the audit notes above, Both Blanda and Upper Seti have strong impact assessments addressing this issue. Impacts due to the influx of migrant workers and people are strongly featured in the Protocol. Health and safety issues are covered in Sections B10 and B11. Economic viability including Cost Benefit Analysis is a strong feature in the Protocol, Section B2. Hacking mentions analysis of the acceptability of tradeoffs by including multi-stakeholder and public meetings. The multi-stakeholder engagement has received great attention in the Protocol under Sections B7, Stakeholder consultation and support, Section C7, Community acceptance, and Section C14, Directly affected stakeholders. Finally, Hacking mentions the feature of pursuit of ‘win-win’ outcomes, where hydropower generated resources are used to contribute to improved management of the biophysical environment, and socio-economic uplift in the region. The author concludes that comprehensiveness is well addressed in the Protocol.

Strategicness

Strategicness, simply explained, deals with sustainability development that is broad and forward-looking.

Hacking recommends use of a spatial planning model and assessment of long lasting impacts. This was missing in both Blanda and Upper Seti. Broad energy option assessment (system-wide planning) should be the responsibility of national/regional governments (IHA 2006). The problem is that in many developing countries, the governments may not have adequate resources to address this issue and project developers do not consider this to be in their remit. The Protocol covers energy option assessment only in Section A, and when a project is assessed using Section B in isolation, the deficiency becomes apparent.

In system-wide planning, multiple projects and water/energy management functions need to be considered simultaneously. This planning can potentially be achieved within a comprehensive Strategic Environmental Impact Assessment (Harrison et al. 2007).

The Protocol needs to carefully address this issue, especially the interlinking between section A and B in terms of strategic planning.

In **Figure 5.3** below, the author has made an attempt to place the Protocol in Hacking’s cube in relation to the traditional EIA using the SD-directed assessment framework. Although the Protocol occupies a higher position in terms of comprehensiveness and integratedness, it occupies a relatively lower place in terms of strategicness. This conclusion is somewhat different from earlier studies, where the Protocol was rated much higher in terms of strategicness.

The conclusion of the evaluation is that the Protocol does not fully address the strategicness issue.

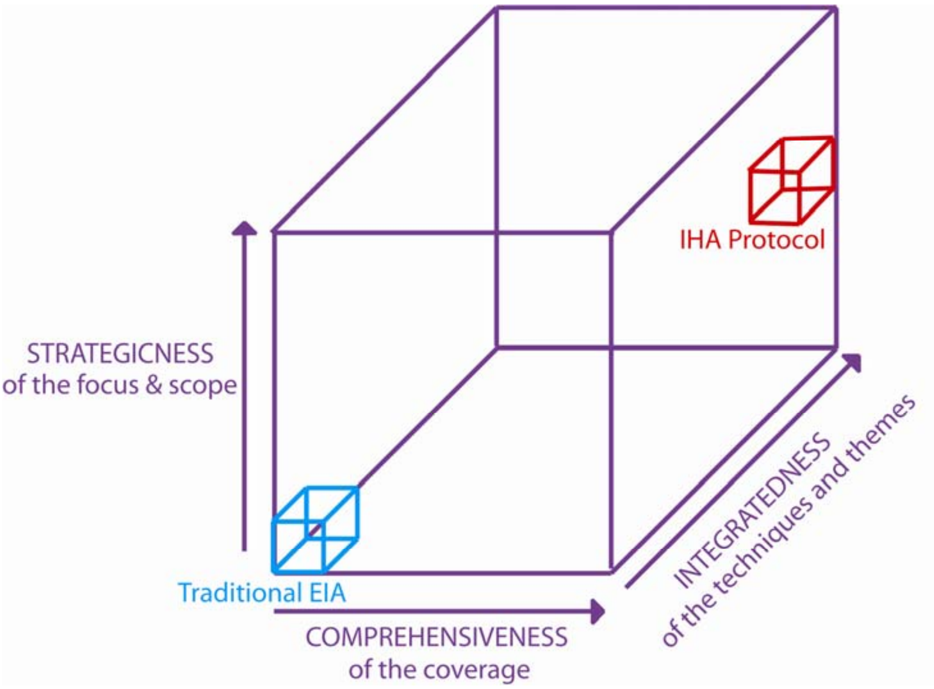

Figure 5.3 Position of the Protocol in Hacking's cube

The diagram above reinforces the urgency with which strategic planning needs to be integrated into comprehensive planning across sectors, environmental flow regimes, and using ecological blueprints to designate protected areas. Until all hydropower developers, water managers, and other stakeholders come together to provide leadership for a truly system-wide plan, real sustainability may remain an elusive and immeasurable goal (Harrison et al. 2007).

6. RECOMMENDATIONS

6.1 Recommendations

The recommendations have compiled after analysis using the two frameworks and observations using the two case studies in the previous chapters. These recommendations are addressed to IHA, in the hope that they will help enhance the Protocol.

Recommendations based on the eight-point framework developed by Fenner et. al.

1. Ethical Foundation. The Protocol does not address the issue of corruption and transparency. In the case of hydropower, corruption can lead to the loss of environmental sustainability and amplify the adverse effects of hydropower projects on ecosystem services, which many people at subsistence levels rely on for their daily livelihoods and health. Chronic corruption also ultimately undermines public trust and the political sustainability of hydropower as an option for societies to consider; it leads to conflict, corruption in land allocation and deters investors and financiers concerned about their reputation, risk and other costs (Transparency International 2007).

2. Benefits sharing and direct benefits to the local community. Although section B9 addresses the predicted extent and severity of economic and social impacts on directly affected stakeholders, the discussion is weak on direct benefits to the local community. At present the benefits vary around the world. For example, in Brazil, a certain percentage of the income must go to the local community. This is an area that could be further considered in the Protocol.

3. Holistic financial accountability. The costs (or benefits) associated with externalities (e.g. the cost of natural resource depletion, pollution and other environmental and social factors) do not enter standard cost accounting schemes (Fenner et al. 2006). It is recommended that the Protocol address this issue when discussing Economic viability, Sections B2 and C2.

4. Systems context. The premise that hydropower projects are not dealt with in isolation but solutions are conceived against a wider understanding of the overall systems response

is being appreciated increasingly throughout the world. Efforts should be made to understand all the system components and their inter-relationships (Fenner et al.).

Recommendations based on Hacking's sustainable development directed framework

5. Strategicness. The Protocol has touched upon the assessment of cumulative impacts in Section B14. In this context, it is recommended that the Protocol address the issue of system-level planning, using tools such as SEA, and considers cradle to grave life-cycle thinking. As mentioned before, the demonstrated need for the project should also be addressed in Section B of the Protocol.

Recommendations based on the testing of Bland and Upper Seti projects

6. Scoping out. Each hydropower project is unique. The differences between the different types of hydropower projects should be taken account of in the scoping-out process carried out at the beginning of each assessment. In CEEQUAL, for example, the scoping-out process requires discussion on whether any individual questions are not applicable or irrelevant to the project being assessed and so should be scoped out. The author identified the following issues:

- The Protocol puts emphasis on reservoirs projects. Aspects pertinent to run-of-river schemes are missing. For example Section B19 deals exclusively with reservoir sedimentation. Discussion of sedimentation in run-of-river schemes is absent. The fact that many hydropower projects in the Himalayas and Andes are being planned and developed as run-of-river projects requires greater emphasis on sustainability in terms of sediments management.
- In countries with cold climates such as Iceland, ice can significantly affect the sustainability of the project in terms of operations. The Protocol does not address this issue.

7. Clearer guidance on assessment procedures. The author feels that there should be clearer guidance on some of the aspects of the Protocol, especially on the timing of the project. Projects can be in various stages of development: pre-feasibility, feasibility or design phase, and may not be ready to supply all the answers to the audit. For example, answers to questions relating to Section B11, Safety, maybe a bit early to ask in a project at a pre-feasibility/feasibility stage. There must be better guidance on how this should be addressed when conducting an audit.

8. Reporting format. There have been several audits around the world since the Guidelines were accepted in 2004. Each audit has used a different format and there is little consistency in reporting the findings. It is highly recommended that a standard format be used for data collection and report writing.

Other comments

10. Local capacity building. As mentioned earlier, the world's remaining hydropower potential is in developing countries, where the need for water and energy is the greatest. The expertise required for developing these resources is limited. Worldwide, hydropower expertise is dwindling and there is a general trend for developed countries to absorb expertise from many developing countries. This problem, combined with general lack of resources, creates a vacuum in local capacity building for many developing countries. The question of whether a particular project helps national capacity building must be addressed in the Protocol because sustainability is also about building local expertise and relying less on foreign assistance. For example, the Chilime project in Nepal has cost USD 1100 per kW which is half that of projects built through international financing because local expertise was used to develop the project.

11. Quality of auditors. The two audits in geographically and culturally different parts of the world have shown that the auditing requires certain sensitivity towards language and culture. Because hydropower involves so many disciplines, it is necessary that an auditor has substantial experience in the hydropower sector. Broad and long-term experience is preferred to narrow specializations and experience of a short duration.

12. Knowledge base. Lessons learnt from past audits, final audit reports, and continued improvements in the Protocol need to be compiled and stored in one place. This could be in the form of a database hosted on the Internet. The Internet can be used to provide guidance to future assessors. The pitfalls and challenges of an audit can be recorded in the knowledge base.

6.2 Concluding remarks

Since its approval by the IHA members, the Protocol has proved useful in several applications. In collaboration with UNESCO, IHA awarded the Blue Planet Prize to six hydropower projects in recognition of their outstanding performance in sustainable management. The judging panel used the Protocol to assess the winners. The Norwegian Government, Ministry of Finance used the Protocol to assist them in their decision to purchase the CDM/JI quota for the Dahuashui Hydropower Project in China in 2008 and the Protocol was used to assess sustainability of this project.

In 1997 a study was commissioned by the Mekong River Commission on environmental criteria for hydropower development in the Greater Mekong Subregion. The study reviewed several international environmental criteria frameworks. The IHA Guidelines were reported to appear to be the most comprehensive and a possible best starting point for the Mekong basin.

The IHA has encouraged its members to test the Protocol on their current projects and existing schemes. Field-testing continues in collaboration with third-party assessors, especially to refine the assessment process. IHA is also conducting training courses to increase understanding of the initiative and to empower members in the application of self-assessment trials within their own organizations.

IHA is also entering into a formal expert appraisal of the Protocol, with a view to reviewing proposed refinements of the current draft and to explore endorsements of the Protocol by key external organizations. This appraisal will be conducted under the project name Hydropower Sustainability Assessment Forum (HSAF), www.hydropower.org

The need to define sustainable hydropower in practical terms remains the greatest challenge today as ever. As Albert Einstein said ‘Not everything that can be counted counts, and not everything that counts can be counted. The goal of being fully ‘sustainable’ will remain aspirational in value. No hydropower project is likely to be 100% sustainable. The quest to improve sustainability of hydropower projects will be ongoing (Harrison et al. 2007).

It is hoped that the findings of this research will be of some value in this quest. Especially it is hoped that the study will contribute to the future work of the HSAF in developing a multi-stakeholder driven set of guidelines that will help advance sustainable hydropower all over the world for the benefit of humanity.

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APPENDICES

Sample of the detailed audit notes for Upper Seti

B4	**Aspect: Planned operational efficiency and reliability.**	
Assesses the planned operational efficiency of the project in the context of the broader system and relevant market arrangements. The assessment looks at three specific areas: 1. Planned management of the hydrological resource; 2. design efficiency of the power station assets (e.g., turbines); and 3. Planned and/or existing efficiency of the network assets. It also assesses the likely reliability of the power scheme in the context of the broader system and includes short-term and long-term reliability of the hydrological resource, power station assets (e.g., turbines and generators), and network assets.		
Sustainability Scoring: Assess both columns. If a column has more than one point, all criteria must be met for a score to be awarded. The aspect score is the lower of the two column assessments.		
Score	**Likely level of performance**	**Process**
5	• High likelihood of optimum practicable efficiency in management of the hydrological resource, the power station assets, and the network assets. • High likelihood of outstanding reliability performance of hydrological resource and assets on both a short-term and long-term basis.	• High standard analysis of the hydrological resource and likely future efficiency and reliability of assets. • Planning for comprehensive asset and hydrological resource management strategies/systems (including emergency preparedness programme).
4	Likelihood of good efficiency and reliability performance and only minor uncertainties in relation to this continuing over the long term.	• Good analysis of the hydrological resource and likely future efficiency and reliability of assets. • Planning for good asset and hydrological resource management strategies/systems (including emergency preparedness programme).
3	Likelihood of satisfactory efficiency and reliability performance and some uncertainties in relation to this continuing or being improved over the long term.	• Some gaps in the analysis of the hydrological resource and likely future efficiency and reliability of assets. • Some gaps in the planning for asset and hydrological resource management strategies/systems (including emergency preparedness programme).
2	Likelihood of less than satisfactory efficiency and reliability performance and some uncertainties in relation this continuing or being improved over the long term.	• Large gaps in the analysis of the hydrological resource and likely future efficiency and reliability of assets. • Large gaps in the planning for asset and hydrological resource management strategies/systems (including emergency preparedness programme).
1	Likelihood of less than satisfactory efficiency and reliability performance and likelihood that this will continue or worsen over the long term.	• Limited analysis of the hydrological resource and likely future efficiency and reliability of assets. • Major gaps in the planning for asset and hydrological resource management strategies/systems (including emergency preparedness programme).
0	Likelihood of near worst practice for efficiency and reliability performance and likelihood that this will continue over the long term.	• No analysis of the hydrological resource and likely future efficiency and reliability of assets. • Absence of planning for asset and hydrological resource management strategies/systems (including emergency preparedness programme).
Comments	Sediment transport is a natural phenomenon in the Himalayas. Extreme events capable of triggering sever sedimentation in the reservoirs is possible as was the case with the Kulekhani reservoir. Seti River carries substantial sediment load and the recommended suspended sediment yield for design purpose is 6497 t/km^2/year and the sediment trap in the reservoir each year is 6788 t/km^2/year including bedload. Total sediment volume deposited at the reservoir stretch after 25 years in 154 Mm^3. A hydraulic model study may provide a better picture of the sediments deposition, especially in view of the dam being located 50m downstream of a sharp bend in the river. The uncertainty with the reliability performance of the headworks due to sedimentation is a critical factor in the operational efficiency of the whole project. The percentage of live storage encroachment is 60% after 25 years.	
Evidence	Feasibility Study, Upper Seti Storage Hydroelectric Project.	

Sample of the detailed audit notes for Blanda

C17	**Environmental flows**	**Measures the effectiveness of the environmental flow regime to meet agreed environmental, social, and economic outcomes.**

SAP Requirements and Questions	**Observations, Comments, Opportunities for Improvement**

Performance: Meeting environmental, social, and economic objectives for the environmental flow regime.			
1.	Have all environmental, social, and economic objectives for the environmental flow regime been met or exceeded? How is this measured		All the environmental, social, and economic objectives for the environmental flow regime have been met. A minimum release of 10 m^3/s is regulated automatically in the system and is monitored constantly with an ultrasonic meter. **EVIDENCE** C17-1 Reservoir Levels
2.	What are your environmental, social, and economic objectives for the environmental flow regime?		Document C17-1 specifies the water levels in the reservoir and the discharge for power generation. 10 m^3/s is the minimum flow release. The main objective of the minimum flow is to sustain the local fisheries in the Blanda system.
3.	How were these formulated?		These were formulated according to the best judgement of the planners in close consultation with the stakeholders. The design discharge was formulated by the scientists of the Environment Agency of Iceland.
	5	All met or exceeded	
	4	All met or on target to be met	
	3	All major objectives met or on target to be met	
	2	Gaps in meeting OR gaps in plans to meet	
	1	Major gaps in meeting OR major gaps in plans to meet	
	0	None met	

Performance: Level of community and regulator support (or opposition) for environmental flow regime.			
4.	What is the level community and regulator support (or level of opposition) for the environmental flow regime?		There is a strong support from the community and the regulator for the environmental flow regime.
5.	How is this measured? How often? What is done with the results of these measurements?		The Department of Health and other official supervisory bodies are informed of any changes in the environmental flow release plans. The Department of Health also issues operation permits to address possible accidents that could happen in the river while people are fishing. VER also looks after safety of people in the area. An external audit is performed annually by VER and spot checks are done. **EVIDENCE** C17-2 Status Report on Fisheries
	5	Strong support or no significant opposition	
	4	Good support or very minor opposition	
	3	General support or minor opposition	
	2	Partial support or moderate opposition	
	1	Limited support or significant opposition	
	0	No support or major opposition	

Score for **Performance** (enter a number from 5 to 0)➔	**5**

Process: Level of research and definition of environmental, social, and economic objectives for environmental flow regime.			
6. What is the process for researching and defining environmental (including biodiversity), social, and economic objectives for the environmental flow regime?			The process for researching and defining environmental (including biodiversity), social, and economic objectives for the environmental flow regime is managed by Veideimalastofnun, the Institute of Freshwater Fisheries. It is supervised by external independent consultants VER and Heilbrigdiseftirlit. They verify that standards have been followed. **EVIDENCE** C17-2 Status Report on Fisheries
7. How comprehensive is this process?			Very comprehensive.
	5	Thoroughly researched and defined	
	4	Well researched with most defined	
	3	Minor gaps or programme partially defined / completed	
	2	Less than satisfactory research with gaps in plans	
	1	Limited research with major gaps	
	0	No research, or absence of plans	

Process: Level of process for identifying stakeholder concerns.			
8. What is the process for identifying stakeholder concerns? How comprehensive is this process?			If the water level fluctuates in the reservoir, the fisheries are affected. Water levels in the reservoir and flows for power generation are specified in Document LEI 73. As per this document, $10 m^3/s$ is the minimum flow release. **EVIDENCE** C15-1 LEI73 Flow Control in Blanda
9. How are stakeholder concerns managed?			It forms part of the quality system.
	5	Comprehensive process	
	4	Good process	
	3	Satisfactory process	
	2	Less than satisfactory process	
	1	Weak process	
	0	No process	

Score for **Process** (enter a number from 5 to 0)➔	**5**

Overall comments:
Environmental flows in Blanda relate to fisheries. A minimum release of $10 m^3/s$ is regulated automatically from the reservoir. LV is directed by the Department of Health, the Administration of Occupational Safety and Health (VER) to perform audits and set requirements regarding the environmental flows regime.

Assessment Participants:	**Assessor(s):**	**Date:**
Guðmundur R. Stefánsson, Manager Blanda Power Station	Pravin Karki	27.03.08 **Score for this section:** 5