Norwegian University of
Science and Technology

An operational framework for evaluating the potential for technology transfer in energy projects

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Submission date: June 2011
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Oppgavens (foreløpige) tittel **An operational framework for evaluating the potential for technology transfer in energy projects**	
Oppgavetekst/Problembeskrivelse Background: Technology transfer is of major importance in stimulating economic development and growth in developing countries. It is also argued to have great potential as a tool for contributing to mitigation and adaptation to climate change, by transferring environmentally sound technologies. Evaluation of the potential for technology transfer could therefore be of interest both to private companies investing in emerging markets, the World Bank and other regional development banks that requires sufficient technology transfer in projects they support, and to other institutions and NGOs working in the field of economic development and / or climate change. Main Problem: To develop a generic framework, including a set of predetermining indicators, revealing to what extent sufficient conditions to affirm technology transfer are present in the evaluated projects. The framework will be tested and improved subject to the experiences of real ongoing energy projects. The framework should be generic in order to be suitable for projects with differing technologies, locations and environments.	
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Originalen oppbevares på fakultetet. Kopi av avtalen sendes til instituttet og studenten.

Preface

This master thesis is the culmination of the work to obtain our Master of Science degrees in Industrial Economics and Technology Management, within the field of Investments and Finance, at the Norwegian University of Science and Technology.

The process of developing indicators for assessing technology transfer began last autumn in the specialisation project preceding this thesis. The idea of considering technology transfer was suggested by Bente Pretlove and Stein-Bjørnar Jensen in DNV, and the issue immediately intrigued us. The challenging work required that we left campus and came in contact with a broad range of experts and practitioners. We hereby wish to express our greatest gratitude to all who have used of their scarce time and resources to guide us in our work. We especially would like to thank Tore Jørgensen and Tom Solberg at the International Centre for Hydropower, Nils Huseby from SNPower, Anne Rudi from Norad, Hege Brende from Statkraft, and Lin Wu from DNV China. Additionally, we would like to thank the representatives from the organisations participating in our time-consuming survey. The help received from within the university was also highly appreciated. John Hermansen, Ånund Killingtveit, Håkon Hynne, and Ole Gunnar Dahlhaug from NTNU/SINTEF all contributed to increase our understanding.

Finally, we wish to express our gratitude towards our supervisor Asgeir Tomasgard, DNV-representative Bente Pretlove, and co-supervisor Darijus Strasunskas for valuable suggestions, motivation and support throughout the semester.

Trondheim, June 2011

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Abstract

The purpose of this work has been to develop a generic framework with a set of indicators, suited for ensuring that technology will be successfully transferred. It was stressed that the framework should be generic, as it should be suitable for projects with differing technologies, locations and environments.

Methodology

The development of the indicators followed a systematic and rigorous process, starting with formulation of visions, sub-visions and goals for successful technology transfer. The formulation was completed in the specialisation project during the autumn 2010. The indicators were then prepared in response to the formulated goals, and categorized within either the social, institutional, environmental, business or technological dimension. The indicators are for practical purposes gathered in a Protocol, which provides a complete tool for considering technology transfer on the project level. To further operationalize the Protocol, a technology-specific set of indicators was called for. As a response, one indicator set for hydropower, and one indicator set for wind power is prepared.

The indicator development was an iterative process, where the indicators were reviewed by experts and tested on ongoing projects. Firstly, a Delphi Survey was conducted, with academics and practitioners within the fields of international energy production and technology transfer. The survey had 12 respondents from 11 different organisations. Secondly, the validity of the indicator set was attempted indicated by comparing the result of using the Protocol, with the observed technology transfer track record for two operating projects.

Results

The Delphi Survey showed that the experts agreed that the indicators for assessing technology transfer potential in general were of high quality, and their suggestions for further improvements were later implemented. The case studies showed that the results of using the Protocol indeed correlated with the observed technology transfer in both projects. However, this is only regarded as an indication of the validity of the Protocol, not as a rigorous proof.

Conclusion and further work

The work with this thesis has culminated in a Protocol for assessing the potential for technology transfer in energy projects. The indicators are thoroughly reviewed and applied. To further validate the Protocol as a tool predicting technology transfer, an extensive study should be conducted with a large number of projects, where the results from applying the Protocol in the early stages are compared with the observed technology transfer. Additionally, more technology-specific indicator sets could be prepared for other forms of energy production technologies.

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Nomenclature

AWG-LCA	-	Ad-Hoc Working Group for Long-Term Cooperative Action
BSC	-	Balanced Scorecard
CCS	-	Carbon Capture and Storage
CDM	-	Clean Development Mechanism
CICERO	-	Centre for International Climate and Environmental Research - Oslo
CSR	-	Corporate Social Responsibility
DNV	-	Det Norske Veritas
DPSIR	-	Driving force - Pressure - State - Impact - Response framework
DSR	-	Driving force - State - Response framework
EGTT	-	Expert Group on Technology Transfer
EHS	-	Environment, Health and Safety
EIA	-	Environmental Impacts Assessment
EST	-	Environmentally Sound Technology
FDI	-	Foreign Direct Investments
HPL	-	Hydropower Limited
HR	-	Human Resources
IAEA	-	International Atomic Energy Agency
ICH	-	International Centre for Hydropower
IEA	-	International Energy Agency
IFC	-	International Finance Corporations
IGO	-	Intergovernmental Organisations
IHA	-	International Hydropower Association
IO	-	Industrial Organisation
IPCC	-	Intergovernmental Panel on Climate Change
IPR	-	Intellectual Property Rights
ISO	-	Independent Systems Operator
IUCN	-	International Union for Conservation of Nature
MIGA	-	Multilateral Investment Guarantee Agency
MNE	-	Multinational Enterprises
NGO	-	Non-Governmental Organization
NIMBY	-	Not In My Back Yard
NORAD	-	Norwegian Agency for Development Coordination
NOU	-	Norwegian Official Report
NTNU	-	Norwegian University of Science and Technology
OECD	-	Organisation for Economic Co-operation and Development
ODA	-	Official Development Assistance
OLI	-	Operation, Location and Internalisation
O&M	-	Operation and Maintenance
PSR	-	Pressure - State - Response framework

R&D	-	Research and Development
SMART	-	Specific, Measureable, Achievable, Reliable and Time-bound
SME	-	Small- and Medium sized Enterprises
TCAPP	-	Technology Cooperation Agreement Pilot Project
TNA	-	Technology Needs Assessment
TSO	-	Transmission Systems Operator
TT	-	Technology Transfer
UN	-	United Nations
UNCED	-	United Nations Conference on Environment and Development
UNCSD	-	United Nations Conference on Sustainable Development
UNCTAD	-	United Nations Conference on Trade and Development
UNDESA	-	United Nations Department of Economic and Social Affairs
UNEP	-	United Nations Environment Programme
UNFCCC	-	United Nations Framework Convention on Climate Change
US	-	United States
WIPO	-	World Intellectual Property Organisation
WWEA	-	World Wind Energy Association

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PART I:

Background, Theory and Methodology

1 Introduction

Technology transfer is often proposed as a solution for spreading energy technologies, and contributing to economic growth in the developing countries. However, technology transfer is a multifaceted concept, and the term is often ambiguously defined. In this thesis we therefore propose an operational, multidimensional framework for ensuring technology transfer in international energy projects.

The work with the master thesis was a continuation of the specialisation project conducted during the autumn 2010. The objective of the specialisation project was to prepare a methodology for developing a set of indicators. We will reconsider the methodology in this thesis.

1.1 Objective

The purpose of the thesis is thus to develop a generic framework, a Protocol, for making a comprehensive evaluation of the potential for technology transfer. The Protocol is made to be used by a range of different actors interested in successful deployment of an energy technology in a new environment.

Earlier work considering technology transfer has primarily dealt with the concept on an international and governmental policy level, whereas the focus here will be on technology transfer on a project level. Our intention is to operationalise the knowledge gained from literature, interviews and case studies into a set of indicators, used to assess technology transfer performance in energy projects. As the Protocol will include guidance of recommended practices, it could also function as a checklist of "Best Practice" for an organisation intending to ensure successful deployment of technology to a local partner/recipient.

1.2 Limitations

When considering such a multifaceted concept as technology transfer, it is of utmost importance to be able to limit the scope. This thesis only considers technology transfer in projects that are foreign direct investments (FDI), and not through trade, licensing or movement of people.

It is also important to note that the purpose of the thesis is not to "measure" technology transfer. Rather, the Protocol addresses *what actions a project should conduct* for ensuring a large potential for technology transfer. The Protocol is thus intended used in the preparation phase of the project, not in later stages. By giving "Best Practice"-guidance prior to the construction is commenced and the project operates, we argue that the project will be assessed while the most crucial decisions are made.

1.3 The final product

We will propose a Protocol consisting of two parts; a generic set of indicators, and a technology-specific set of indicators. The generic indicators are appropriate to consider for all energy projects, regardless of size, location and choice of technology. As this indicator set alone would be insufficient for addressing all aspects concerning a technology, a specific set is also proposed, which delves into further detail regarding the technology in question. Two types of technologies are addressed specifically; namely hydropower and wind power.

The quality of the Protocol will be ensured by having the indicators reviewed by experienced practitioners and academics. To examine the validity of the Protocol we will apply it on two energy projects, and compare the result with the actual technology transfer observed in these projects.

The complete Protocol will be presented in Appendix 1 of the master thesis. Within the main section we will present the theoretical background, the development process, research, reasoning and justification for our choices. Such a division will ensure that the Protocol is tailored for its users, whereas the theoretical and scientific implications are treated thoroughly in the core of the thesis.

1.4 Structure

This thesis consists of three main parts. In *Part 1* the background, theory and methodology for this thesis are presented. Firstly, the background and context for technology transfer will be outlined. Secondly, the theory section will consider numerous definitions and interpretations of technology and technology transfer. The concept "technology transfer" has a broad meaning, and as it is a key concept we will define it explicitly for our purpose. The different barriers and success criteria for transferring energy technologies are then presented, identified from the literature and case studies. Synthesising our understanding into two models for technology transfer concludes the theory section.

Thirdly, the methodology used will be presented. Here we will reconsider the methodology for developing the set of indicators from our specialisation project. Secondly we will present how we proceed to receive feedback on the developed indicators, through a Delphi Survey. The Delphi Survey is a structured method for obtaining consensus among a group of experts. It was utilised by having experts consider, criticise and agree upon the set of indicators. Lastly, we will outline how the indicators in the Protocol were applied and validated through case studies. We examine and compare the use of the Protocol on two energy projects in developing countries, namely Khimti, a hydropower project in Nepal, and Totoral, a wind power project in Chile. Both projects were developed by Norwegian utilities.

In *Part 2* an overview of the Protocol will be presented. Initially, we will outline the content of the Protocol, and how it is recommended to be used. Then we will perform a thorough presentation of each indicator. For every indicator its relevance for technology transfer will be explained. As mentioned, the complete Protocol, with all its details regarding scoring methodology and detailed user guidance, will be presented in Appendix 1.

In *Part 3* the results from the Delphi Survey are presented, elaborating on how the use of this group decision method influence our final choice of indicators. The insights from the Case Studies are also presented, where the results of using the Protocol is compared with the observed technology transfer in the project. For a consideration of the actual technology transfer the two models developed in Part 1 will be used. Part 3 is finalised with a comprehensive discussion, conclusion, and suggestion for future work.

2 Background

Technology is frequently claimed to be an important contributor to economic growth and development, and thus, technology transfer could be crucial in order to speed up growth in the Third World. Furthermore, it has also been considered to be an efficient tool for spreading environmentally sound technologies and thereby addressing environmental and climate change problems.

In this section we will try to set the scene, and look more closely at why technology transfer is an important issue to study. We will start with a brief discussion of economic and social development, before we continue with an examination of the environmental aspects. Extra attention will be given to climate change, since a technology transfer mechanism is about to be implemented under the United Nations Framework Convention on Climate Change (UNFCCC). This mechanism was also the starting point for our specialisation project. In addition, the close interlinkage between energy production and climate change, and the fact that energy projects are addressed specifically throughout this thesis, makes this an interesting perspective.

2.1 Economic development and social progress

Ever since Robert Solow (1956) presented his seminal article "A contribution to the theory on economic growth", technology and technological change has been seen as an important factor for determining the rate of economic growth in a country or region. Mansfield (1989) states that "the rate of technological change is perhaps the most important single determinant of a nation's rate of growth" (quoted in Cohen 2004, p. 34).

Technology change is therefore not only an issue for developing countries. To sustain a competitive position in an ever more globalised environment, industrialised economies are dependent upon continuous technical progress. This is achieved through a steady focus on innovation and R&D-activities. Likewise, developing countries can experience technological and economic development from their own R&D-activities, but as these countries are likely to occupy an inferior stock of human capital and low innovative capacity, it may not be the most effective way of achieving progress. Moreover, if a developing country does not keep up innovation with the same pace as the developed world, it will see a broadening of the technology gap instead of a reduction of it.

Technology transfer, in its widest meaning, is therefore argued to be a more relevant source for technological change in developing countries, and by most scholars also seen as a necessity. Cohen (2004) argues that developing countries need Western technology to reduce the technology gap, and that a well-functioning system for technology transfer would imply an efficient use of resources. However, most of the world's advanced technologies are generated by private companies' R&D-activities in developed countries. It thus creates an asymmetry between the technology developed and owned privately by firms in the industrialised world, and the technology that can be obtained and utilised by developing countries (UNCTAD 2001b).

Numerous bilateral and multilateral policy initiatives have been taken in response to developing countries stronger call for improved access to foreign technologies. In a survey from 2001, UNCTAD finds more than 80 international agreements and instruments containing some form of measure of international transfer of technology and capacity building (UNCTAD 2001a). Most of these initiatives though, address the issue on a political level. They are normative and encourage the developed countries to diffuse their technologies, but without giving any mandatory obligations for the parties.

In a Norwegian context, technology transfer is also considered to be an important objective of the development policies and bilateral aid (NOU 2008). Norad (the Norwegian Agency for Development Cooperation) has the responsibility for ensuring efficient use of Norwegian bilateral aid. Through its support of energy projects, industrial and commercial development and education, it has been the Norwegian agency most concerned with the issue. Note however, that although technology transfer has been an important objective for the Norwegian development assistance, little documentation and evaluation has been done on this issue per se. This was also confirmed in conversations we had with a Norad representative.

A discussion of whether economic growth is synonymous with economic and social development is outside the boundary of this thesis. However, given that implementation of new technologies create new or better business opportunities and higher employment, it should be safe to say that the society will benefit from the transfer process. Additionally, a higher technological level will require more skilled workers, so over time there is likely to be an improvement in the educational system. For a thorough discussion on technical progress and development, see Thirlwall (2005, Chapter 6).

2.2 Environmental protection and climate change

During the 1970s and 1980s, the concepts of development and environment became closely integrated, through what became known as sustainable development. Acknowledging this relation, the UN called for a mechanism for transfer of environmentally sound technologies at the foundation of the United Nations Environmental Programme (UNEP) in 1972: "it is recommended that the Secretary General of the UN be asked to (…) find means by which environmental technologies may be available for adoption by developing countries under terms and conditions that encourage their wide distribution without constituting an unacceptable burden to developing countries" (UN 1972, p. 45).

In light of the growing concern for climate change, UNFCCC was established in 1992, as a binding agreement for reducing the emissions of greenhouse gases (UNFCCC 1992). Acknowledging that this is a global problem, the UN-report "Promoting Development, Saving the Planet", describes the importance of technology transfer as a part of the UNFCCC: "There is agreement that technology transfer will be fundamental to enabling an effective implementation of the United Nations Framework Convention on Climate Change beyond 2012" (UNDESA 2009, p. 124).

In 1998, UNFCCC requested that the developed countries "take all practicable steps to promote, facilitate and finance" the transfer of environmentally sound technologies to developing countries" (UNFCCC 1998). In 2001 the Parties agreed on a Technology Transfer framework, describing a set of key themes for "meaningful and effective action". This is illustrated in Table 1.

Table 1: The Technology Transfer framework (UNFCCC 2001).

Technology needs and needs assessment
A set of country-driven activities that identify and determine the mitigation and adaptation priorities in developing countries.
Technology Information
Defines the means to facilitate the flow of information between stakeholders to enhance development and transfer of environmentally sound technologies.
Enabling Environments
Focus on government actions that create the environment for private and public sector technology transfer.
Capacity building
A process seeking to develop and enhance technical skills, institutions and capabilities in developing countries.
Mechanisms for technology transfer
In order to facilitate the support of financial, institutional and methodological activities to enhance coordination, engage cooperative efforts through partnerships and to facilitate such projects.

In 2009, the Ad-Hoc Working Group on Long-Term Cooperative Action under the Convention (AWG-LCA) presented a draft paper on the development and transfer of technology prior to the negotiations in Copenhagen. This paper outlined different possible paths for implementing enhanced technology development and transfer as a part of the climate agreement (AWG-LCA 2009). The conference in Copenhagen was perceived as a failure, as the mission of creating a binding agreement ended with the Conference taking a non-binding 'note' of the Copenhagen Accord (UNFCCC 2009a). However, in Cancun 2010, the technology mechanism was established, which consists of a Technology Executive Committee and a Climate Technology Centre and Network. To make the mechanism fully operational by 2012, further cooperation and clarifications are needed, and a new decision is expected at the conference in Durban in December 2011 (UNFCCC 2010).

Summarised, technology transfer is considered to be an important part of the solution to enable economic progress in the developing world, as well as mitigating environmental hazards and climate change. Therefore, the objective of our work has been to contribute to more successful technology transfer, by proposing a comprehensive Protocol for considering the issue explicitly, on a project level.

3 Technology Transfer

Technology transfer is the key concept of this report, and deserves to be adequately examined. Defining central concepts in the outset is always important and clarifying, and especially so when dealing with ambiguous terms as *technology* and *technology transfer.*

We start this chapter by presenting conflicting views and definitions of the concept of technology, before a short discussion on Environmentally Sound Technologies (ESTs) is given. Next, different attempts to define technology transfer in the literature are debated, and it is shown that no clear and well-established definition exists. Prior to formulating a definition that is suitable for our purpose, we will also look at how different disciplines such as economics, sociology and anthropology take an interest in the issue. Before concluding the chapter, the difference transfer, diffusion and spillover effects related to technology will be discussed, and finally different channels of technology transfer are elaborated upon.

3.1 Understanding and defining technology

An understanding of technology itself is fundamental in order to define the concept of technology transfer. However, technology has been defined in numerous ways, depending on the purpose of the definition. Seen from an economics perspective, technology has often been treated as a function, or as a black box, where you put something in (input) and you get something out (output). Technology is then what transforms the input to the output (Maskus 2004). Another economical definition states that technology is "any kind of economically useful knowledge"(Krugman and Obstfeld 2009, p. 166).

In an extensive review on technology transfer, Bozeman (2000) discusses the ambiguity of the term *technology*. He states that technology is often defined as an applied science or a study, however, in works on technology transfer the focus has been on technology either as an entity or as a tool. Sahal (1981) refers to technology as configurations, and claims that simply focusing on technology as a product is not sufficient in order to study transfer and diffusion of technology. There is not merely a product that is being transferred, but also knowledge of the use and application of the technology. These attributes are, according to Sahal, impossible to separate. When a technological product is diffused and deployed, the knowledge surrounding the product is also diffused.

Cohen (2004) emphasises that technology is more a process than a product, and states that technology encompasses both "hard technology" (plants, machinery and equipment), and "soft technology" (training, know-how and more efficient ways to utilise the existing production factors). Furthermore he argues that hard technologies can only be successfully absorbed and developed if the soft technologies are in place. The fact that hard technologies often are implemented prior to the necessary training is given, and institutional capacity and infrastructural support are built, is thus a major constraint to technological development in developing countries. Cohen therefore identifies four "basic components of technology", which are essential to understand when analysing technology transfer (Cohen 2004, p. 90-91):

Technoware
: Object-embodied technology: Tools and facilities, equipment, machinery and vehicles.

Humanware
: Person-embodied technology: Skills, know-how and experimental knowledge, creativity and diligence.

Inforware
: Document-embodied technology: All documentation, facts, figures, procedures, theories and designs.

Orgaware
: Institution-embodied technology: The arrangements and linkages required to effectively integrate technoware, humanware and inforware, e.g. allocations, organisation and network communication.

All four components are required simultaneously for achieving successful technology transfer (i.e., no transformational process can take place in the absence of any of them). This is an important insight when looking at technology transfer, in order to select, implement and adapt a technology to the new socio-cultural and socio-economic environment.

Bosselmann defines technology as: "(…) the complete body of knowledge applicable to human endeavour (as well as the physical embodiments of this)" (Bosselmann 2006, p. 22). A more specific definition, though still acknowledging both the tangible and intangible aspects of technology, is presented by Maskus (2004). He considers technology to be particular production processes, intra-firm organisational structures, management techniques, means of finance, marketing methods, or any combination of these. Technology may here be either codified through blueprints, drawings, and patent applications, or uncodified in the sense of recognising implicit know-how of the personnel (Maskus 2004).

The uncodified knowledge is also known as *tacit knowledge,* a term introduced by Polyani in 1958. Keller (2004) explains the term: "Knowledge is to some extent tacit because the person who is actively engaged in a problem-solving activity cannot necessarily define (and hence prescribe) what exactly she is doing. Technology is only partially codified because it is impossible or at least very costly to fully codify it" (Keller 2004, p. 756). These are the aspects of knowledge that cannot be written down, and must be passed on "by example from master to apprentice"(Polanyi 1958, p. 53). As such, in the terms of Cohen, tacit knowledge is part of 'humanware'. It is therefore understood that uncodified knowledge must be transferred through personal guidance, preferably by face-to-face interaction. This implies that there are substantial costs in transferring uncodified knowledge related to the technology (Keller 2004).

To summarise, an all-inclusive understanding of the term technology should incorporate hardware (the technology as an entity/product), codified software (patents, blueprints, descriptions of methods and processes) and tacit knowledge. In addition, the importance of the organisational arrangements interlinkaging these three components are emphasised. It is acknowledged that in order to have a comprehensive and holistic understanding of the transferred technology, all these aspects should be considered.

3.2 Environmentally Sound Technologies (EST)

UNFCCC emphasises that in the context of achieving sustainable development, the transferred technologies must be environmentally sound. In accordance with the four components of technology, this implies that the technology transferred is a "… total system, which includes know-how, procedures, goods and services, and equipment as well as organisational and managerial procedures. (…) Environmentally sound technologies should be compatible with nationally determined socio-economic, cultural and environmental priorities." (UNCED 1992, chapter 34)

An important aspect to note is that the benefits of different ESTs depend heavily on their context. For instance, the best available EST may be unsuitable for a developing country, lacking institutional capacity or sufficiently competent employees (Aldy et al. 2003, Shepherd 2007). Additionally, both the results and environmental impacts of transferring the same technology to different countries may deviate substantially. Hence, soundness of a specific technology can only be assessed on a case-to-case basis (Verhoosel 1998).

Verhoosel also argues that a definition of EST will be both functional and relative, and since the definition varies with context, the content of an EST transfer-related commitment will also change in accordance. He therefore claims that developed countries will only be able to make commitments and monitor compliance effectively if the technology to be transferred is specific and identifiable (Verhoosel 1998).

A derived insight is thus that the soundness of a specific technology with respect to sustainability must be considered in each case, and, if the transfer of ESTs is to be assessed, the transferred technology must be both specific and identifiable.

3.3 Definition of technology transfer

As stated above, no clear and guiding definition of technology transfer exists. Kline et al. (2004) state that there is little consensus on what technology transfer constitutes, and in many occurrences the idea is not even defined. Wilkins (2002) argues that defining technology transfer is not an easy task, and pleads the complex nature of both the term 'technology' and 'transfer'. Zhao and Reisman (1992) points out that discussions on technology transfer often are hampered by the difficulties in defining the concept of technology. They also note that the definitions of technology transfer differ substantially between disciplines, and claim that in order to understand its broad nature there is a need to solve the definitional problems. This is supported by Cohen who states that although technology transfer has been an important issue in international political economics, major research works are "plagued by a lack of conventions and a certain degree of liberty in the use of terms and concepts" (Cohen 2004, p 103).

In this section we present some attempts to define the concept in the literature, before synthesising the findings into an operational definition.

3.3.1 Input or output approach

Cools (2007) argues that the purpose of measuring technology transfer can vary, and proposes two different points of view. If the objective is to measure to what extent technology transfer occurs in a project, the 'input approach' is suitable. By looking at the inputs to technology transfer, one could state "which conditions that, when met, are sufficient to affirm technology transfer" (Cools 2007, p. 30). Contrary, if it is the further effects and the value of technology transfer that is of interest, the 'output approach' is more appropriate. To measure these effects a broader perspective has to be taken, and one also needs to look at the effects over time. Economic studies typically take the second approach and try to estimate the effect of technology on domestic productivity by using total factor productivity[*] as a proxy. However, it is difficult to separate the effects originating from technology transfer from diffusion and spillover effects. For single projects it will also be difficult to measure the effects on the whole economy.

3.3.2 Practical definitions by the IPCC and the UNFCCC

In a special report to the Intergovernmental Panel on Climate Change (IPCC), Metz et al. (Metz et al. 2000) define technology transfer as:

> "[A] broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions."

[*]**"Total-factor productivity (TFP)** is a variable which accounts for effects in total output not caused by inputs. If all inputs are accounted for, then total factor productivity can be taken as a measure of an economy's long-term technological change or technological dynamism." (Wikipedia 2011)

This is a broad definition, encompassing both the intangible and tangible aspects of technology transfer, taking into account the relation to climate change. The report continues by stating that this definition covers more than any particular description in the UNFCCC (Metz et al. 2000). A definition more in line with the UNFCCC would focus primarily on equipment, and only incorporate know-how and experience to the extent that it is necessary to make use of the equipment (Alfsen et al. 2009). Article 4.5 of the climate convention states that:

> "The developed country Parties (...) shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties" (UNFCCC 1992).

Thus, it seems clear that the Convention acknowledges that technology transfer must include equipment, experience and know-how. However, it has been criticised that the UNFCCC has not defined the term explicitly. In a discussion of how the concept of technology transfer is interpreted among practitioners and negotiators in the UNFCCC, CICERO has not been able to find a precice definition in official UN texts (Alfsen et al. 2009). Neither in the analysis of Technology Transfer in CDM Projects prepared for the UNFCCC, the term technology transfer is defined explicitly (Seres 2008).

3.3.3 Definitions from literature

The Oxford Dictionary of Economics defines technology transfer as:

> "The transfer of techniques from countries where they are more advanced to other countries where they are less advanced. Technology transfer may involve foreign direct investment, transfers of skilled personnel from more advanced countries, training of workers from less advanced countries, or licensing of patents." (Oxford Dictionary of Economics 2003)

This definition takes several aspects of technology transfer into account, including improving skills and capabilities of the local workers. Moreover, the definition stresses the importance of a difference in technological levels between the countries. Although this may be an appropriate definition for theoretical purposes, it is not suited for practical use. Another general definition is given by Roessner, who states that technology transfer is "the movement of know-how, technical knowledge, or technology from one organisational setting to another" (quoted in Bozeman 2000, p. 629). This definition does also accept know-how and knowledge to be part of a technology, and thereby acknowledges that more than just the physical asset is to be transferred. Glass and Saggi summarise this concisely as “any process by which a party in one country gains access to technical information of a foreign party and successfully absorbs it into its production process” (Glass and Saggi 2008, p. 137). Here they also emphasise the need for successful utilisation of the knowledge.

In a more operational context, Wilkins (2002, p. 44) stresses that the term ‘transfer’ should be “regarded as putting the technical concepts into practice locally in a sustainable manner and replicate projects to speed up successful implementation”. In addition, technology transfer should “assist local people in developing skills to choose appropporiate technology (…) and integrate it with indigenous technology”.

Another operational definition is the “three-tiered”-model by Haake (2006), where each tier successively implies stronger forms of technology transfer, as shown in Figure 1. The first tier states “technology transfer to be taking place whenever the ‘hard’ technology originates from a European country”† (as cited in Cools 2007, p. 28). The second tier requires that the technology should not originate from the host country itself. In addition, it should either not be available in the host country before the transfer, or the transfer will implicate an improvement of the technology. The technology should also be “state-of-the-art”, but not so infant that it would make the developing country a testing ground. The last tier calls for capacity building and use of local companies to install and maintain the project. This point strengthens the capacity building criterion, since local participation in the installation process will ensure that they gain the necessary knowledge to maintain the technology on their own.

† Haake studies technology transfer in CDM projects and deals mostly with European investors.

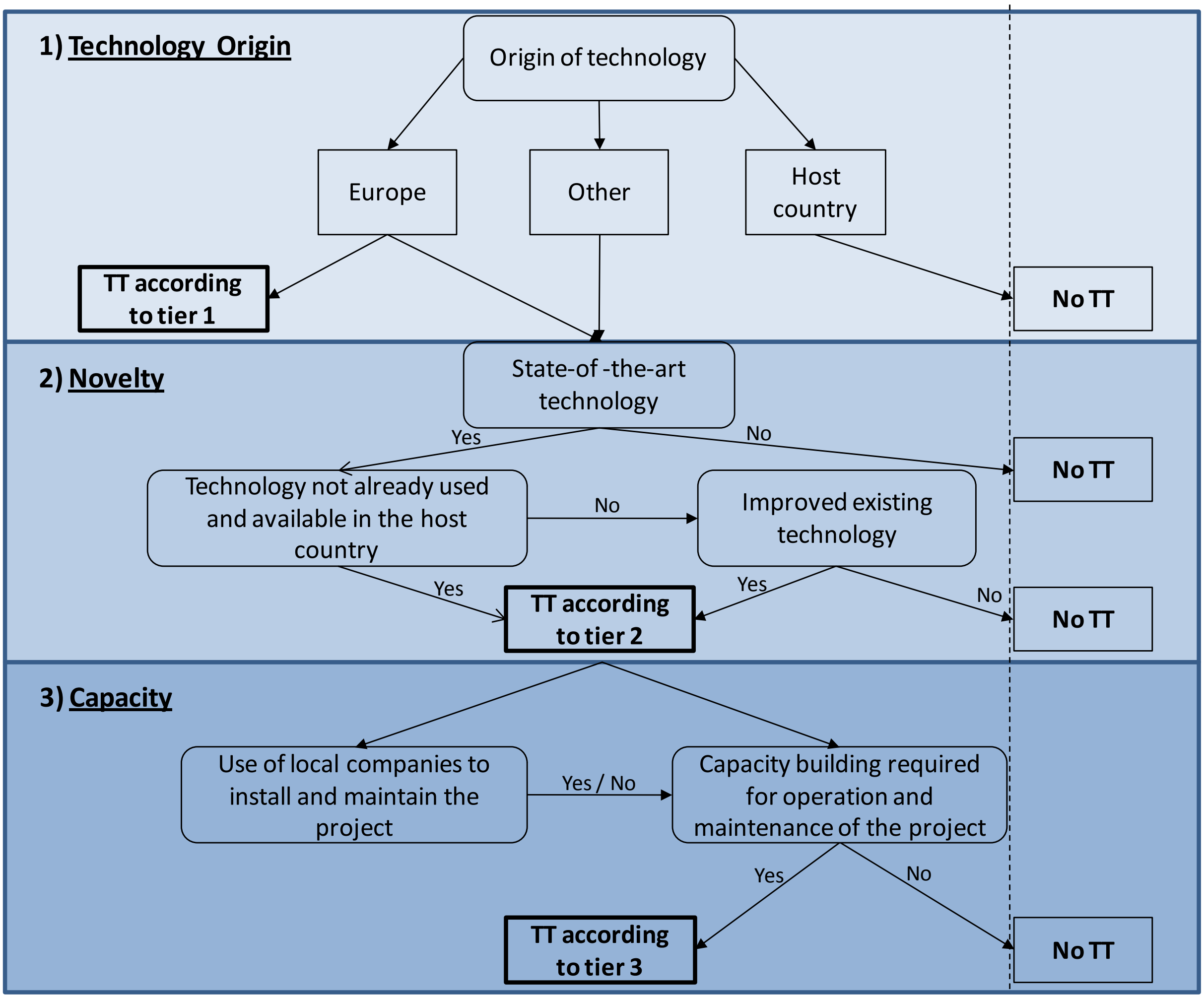

Figure 1: Haakes three-tiered definition of technology transfer (Cools 2007).

Haake's definition represents an operationalisation of the technology transfer concept, and allows classifying how strong the transfer is. However, we do not find the definition especially suited for our purpose. Our critics are both directed towards the different tiers and the model itself. The first criterion, that the technology should originate from Europe, seems unnecessary strict for the purpose of examining cross-country technology transfer. Next, since the framework ranks weak and strong forms of technology transfer, we believe that each successive criterion should be of a higher order than the previous one. In this way a project classified as strong form would also imply that it satisfied the weak form criterion, which is not necessarily the case for Haake's three-tiered definition. The second and third criterion, related to the novelty of the technology and required capacity building, are both relevant for our purpose. However, we do not agree that there is a vital difference in the two criteria in how strong technology transfer they will imply. In our view, both novelty and necessary capacity building have to be addressed before technology transfer will occur, and are thus of equal importance.

3.3.4 Technology transfer in different disciplines

It is also valuable to look at how technology transfer is treated in different academic disciplines. The research field most often concerned with the issue is economics. Economists view the objective of technology transfer as either increased productivity, or the production of specific new goods and services at a social cost. As such, this perspective focuses on a country's technological capacity, expressed in the available range of factor combinations (labour and capital), and technology transfer must be defined as "a transfer of knowledge which improves the country's technological capacity" (Hoffmann 1985).

In opposition to the focus on economic goals in the former perspective, the sociologists are more interested in the effects of the technology transfer process on living conditions and social institutions. In this context the transfer process is considered to be a form of communication (Williams and Gibson 1990), and the success of the process is related to overcoming the barriers to efficient communication. The barriers arise when "individuals use different vocabularies, have different motives, or represent organisations of widely differing cultures" (Cohen 2004, p. 106).

Seen from an anthropological perspective, technology transfer relates to the concept of cultural evolution. A technology is adopted by a new society when this society finds it both possible and advisable to change what they are doing by applying the new technology (Cohen 2004). The anthropologists are thus more concerned with the receiver and what drives their wish for a technology and how it is implemented, rather than the transfer process itself.

3.3.5 Related terminology

The related concepts of technology transfer, technology diffusion and technology spillover are often used interchangeably among academics. To achieve a better understanding of technology transfer, it is helpful to discuss and distinguish the three terms. By explaining what technology transfer *is not*, one also increases the knowledge of what it truly is.

Technology spillover

Keller denotes spillover as a (positive) externality for the surroundings: "technological investments may also create benefits to firms and individuals external to the investor by adding to their knowledge base (the public return). These benefits are usually called knowledge spillovers." (Keller 2001, p. 5) As such, spillover of knowledge can be distinguished from technology transfer, as the latter incorporates some kind of physical equipment or product, and the former does not. Since spillovers are denoted as externalities, they feature only the 'inforware' and 'humanware' components of technology.

The most prominent difference between spillover and transfer of technology is that the transfer happens as a consequence of a purposeful action – a sender can be identified transferring technology to a recipient. Contrary, spillover is an indirect consequence of a transaction, and can be interpreted as a more passive occurrence.

Technology diffusion

The diffusion of technology is related to the geographical dispersal of a technology (Keller 2004). Diffusion incorporates both technology hardware and software. This could be obtained through interaction in the market place, e.g. international trade of goods and services, but it might also be related solely to R&D: "Of course, international technology diffusion is not limited to the channel of trade. In principle, just as researchers today "stand on the shoulders" of researchers of the past, one might expect researchers in one country to directly benefit from research conducted in other countries"(Keller 2004, p. 755). The diffusion of technology thus involves both market transactions and externalities.

The difference between technology diffusion and transfer is that the focus of diffusion is the degree and geographical spread of the technology, rather than focusing on the sender and the receiver. In the long run, diffusion of technology may even occur as a consequence of the technology transfer, through the spread of the deployed technology in the community. Seen from a technology development perspective, diffusion is thus considered as a beneficial feature of the transfer process.

To summarise, the three expressions relate to different parts of the process of transferring technologies. Spillovers are associated with externalities of knowledge, diffusion is the geographical dispersion of all parts of technology, whereas transfer has a unique focus on the sender and receiver.

3.3.6 Our definition

Having discussed both technology and technology transfer, it is now possible to propose a definition suitable for the purpose of this thesis. Recalling that we are looking at international transfer processes, and that we are developing a Protocol for assessing the potential for technology transfer in specific projects, we argue that:

> *"**Technology transfer** is any process by which a developing country party gains access to technological equipment, knowledge and information from a developed country party, and successfully absorbs it into its production process."*

Here *technology* incorporates all the four basic components identified by Cohen (2004), namely technoware (technological equipment and physical machinery), humanware (knowledge, skills and know-how), inforware (technology information and codified descriptions) and orgaware (organisational arrangements needed to successfully integrate the other components). In addition, we require that the technology is mature and properly tested, new to the region, and needed in the host country.

This definition may be considered as in line with those from the economics discipline. However, we acknowledge the need to "open up the black box of technology", and therefore adopt Cohen's four components. This corresponds to the input approach suggested by Cools (2007), which says that it is necessary to consider the inputs in order to assess the potential for technology transfer. Moreover, in order to achieve the objective of successfully absorbing the technology into the production process in the new environment, it will also be necessary to look at social and cultural factors, in accordance with the sociological and anthropological points of view.

3.4 Channels of Technology Transfer

Defined as any process that gives a developing country party access to a new technology, there exist many ways in which technology transfer may take place. Here we will look at each of these potential channels.

The transfer process can be separated into at least four different channels, namely trade in products, trade in knowledge, foreign direct investment, and movement of people (Hoekman et al. 2005). Of these, the first three channels all look at transfer of a specific technology. From the perspective of the sender organisation, technology transfer is rarely a direct objective for the sender, but more a consequence or a necessity of exploiting a business opportunity in a new market. In this case the company has the opportunity to produce in the home country and export to the new market, or by choosing some way to produce in the new market. Technology transfer may therefore occur between unrelated partners in market-based transactions, or on a non-market basis within multinational firms and joint ventures (Glass and Saggi 2008). The last channel, movement of people, may transfer technical knowledge in a more implicit way.

3.4.1 Trade in products

International trade in both consumption and capital goods bear the potential of transferring technology knowledge and information. A local firm may for instance absorb technological know-how through reverse engineering, just by studying the design of imported consumption goods (Saggi 2002, Glass and Saggi 2008). Empirical studies have shown that trade in capital goods and technological inputs for integration in production processes has a significant positive effect on the total factor productivity (Coe et al. 1997), but this effect depends on how skilled the labour force is and the level of trade with developed countries (Schiff et al. 2002).

3.4.2 Trade in knowledge

Another mode of entering a foreign market is by trade of technology knowledge, through licensing. Technology licensing is a contractual arrangement where a licensee gets access to a licensor's patents, trademarks, copyrights or other intellectual property for an agreed compensation (USDC 1998, WIPO 2004). The licensor provides the production or distribution rights, as well as the underlying technical information and know-how (Hoekman et al. 2005). In return, the licensee will pay either a lump sum or royalties based on future sales.

3.4.3 Foreign direct investment

The foreign company may also choose a mode of entry where it is more directly involved in the production in the host country by setting up a wholly owned subsidiary or entering into a joint venture with a local organisation. Alternatively the company can acquire a local firm. Under all these structures it is assumed that the developing country is provided with more efficient technologies, and that spillovers arise due to demonstration effects, labour turnover, and vertical linkages (Hoekman et al. 2005).

3.4.4 Movement of people

Hoekman et al. (2005) argues that labour flows and movement of people also are important means for technology transfer. Domestic labour turnover from multinational enterprises (MNEs) to local firms can be beneficial for technology diffusion, as long as the difference in technical level between the companies is not severe. Likewise, international movement of people who temporarily study or work abroad, or inward movement of foreign citizens, are potential channels for technology transfer. However, an important challenge to such transfer is that people from the developing country, who are stimulated to go abroad, potentially might stay in the foreign country permanently, and thus the country could experience "brain drain". Another risk is that the foreignly trained personnel upon return undertake work where their increased technical knowledge is of little use, for instance high positions in government agencies.

3.4.5 Choice of mode of entry

A full discussion of the mode of entering a new market is beyond the scope of this thesis. However a short introduction to some theory and empirical evidence is provided, as it helps determine what type of projects that is most relevant to consider for the Protocol.

Industrial Organisation (IO) theory explains international capital movements and foreign direct investments through the lens of internalisation. Companies establishing subsidiaries in foreign countries will face several disadvantages compared to local firms, because of differences in e.g. language, culture and the legal systems. IO-theorists therefore argue that the fact that companies engage in FDI must be due to some firm-specific, intangible advantages that are possible to transfer to a subsidiary and are large enough to outweigh the disadvantages (Moosa 2002). The firm specific advantages are explained by structural market imperfections, e.g. exclusive and permanent control of proprietary technology, privileged access to resources, economies of scale, control of distribution systems, and product differentiation. Internalisation refers to companies that want to retain control to fully exploit these advantages, and thus, choose to invest directly rather than license the technology abroad (see Dunning and Rugman (1985) for a review of Hymer's seminal contribution from 1960, Caves (1971)).

Dunning extends the internalisation theory to include transaction costs in his OLI-framework (Dunning 1988). He presents three key advantages and conditions necessary for direct investment, namely (1) a firm-specific ownership advantage (blueprint, patent, product, reputation, etc.), (2) a locational advantage offered by the foreign market (tariffs, quotas, transport costs, closeness to customers), and (3) an internalisation advantage (e.g. R&D intensive products, favouring setting up a subsidiary rather than producing at arm's length).

If the company only experiences an ownership advantage, the OLI-framework suggests that the technology should be licensed. If both ownership and internalisation advantages exist, the framework suggests that the product should be produced locally and exported. If all three advantages are present, the company should choose to invest abroad directly.

	Ownership advantages	Internalisation advantages	Locational advantage
Licensing	**Yes**	No	No
Export	**Yes**	**Yes**	No
Foreign direct investment	**Yes**	**Yes**	**Yes**

Figure 2: The OLI-framework (Dunning 1988).

In a study of 65 cases where U.S.-based firms transferred technologies abroad, Mansfield and Romeo (1980) found that the mean age of technologies transferred to subsidiaries overseas were lower than the mean age of technologies transferred through licenses and joint ventures. They suggest that this may be due to a greater will to directly control and protect newer technologies than more mature ones. Mattoo et al. (2004) look at what determines an entry of acquisition versus direct investment in a subsidiary. They find that a larger technology gap between the countries that are involved in the transfer imply higher technology transfer costs, and thus makes direct investment more favourable under such circumstances, and especially so for transfer to developing countries. Teece (1977) finds that transfer costs vary a lot, with an average of 20% of total project costs, but ranging from 2% to 59%. He suggests that size, experience with manufacturing, and R&D to sales ratio of the potential take-over firm are determinants to lower costs, however he cannot find unambiguous evidence of this.

3.5 The focus of the Protocol

We have found at least three explanations for when FDI is a preferred mode of entry. Empirical evidence by Mansfield and Romeo (1980) suggests that transfer of less mature technologies favours direct investment, due to better control of intellectual property, while Matooo et al. (2004) finds that a large technology gap between the potential host and sender country implies high transfer costs and thus give preference to FDI. Looking at energy technologies, like hydropower and wind power, through the lens of the OLI-framework, there are clearly both an internalisation advantage (e.g. superior R&D competence, which is important to adapt the technology to a new environment) and a locational advantage (e.g. beneficial tariffs, quotas or tax system).

In addition to the reasons outlined above, the recognition that this thesis focuses on energy technologies, favours FDI. Since these projects require large amounts of capital, both national and international organisations try to leverage foreign private investments (see e.g., Norad 2010a, IFC 2007). Furthermore, we see a higher potential for financing energy projects from foreign investors, than by governments or companies in developing countries. Thus, “trade in capital goods” and “trade in knowledge” is less likely to occur. A reason to look at FDI instead of licensing, is that the energy technologies in question tend to be mature and often without patents. Finally, the focus on the implementation of specific energy projects, also excludes “movement of people” as a relevant channel in this setting.

In this thesis, and subsequently in the attached Protocol, the focus will therefore only be on technology transfer that takes place in projects where the foreign company makes a direct investment in the recipient country. This includes setting up a wholly owned subsidiary or participating in a joint venture.

4 Barriers and success criteria

The discussion in the previous chapter has shown that technology transfer from developed to developing countries is a complex task. It requires a comprehensive understanding of the concept of technology, and a holistic approach in order to deal with all economic, sociological and anthropological factors.

In this chapter the barriers to technology transfer, and criteria for successful implementation of a new technology are considered. As the Protocol shall examine the potential for technology transfer in specific projects, the final indicators must assess how the different barriers have been addressed on a project level. At this stage it is therefore essential to get a good grasp of all the identified barriers, and together with the insights and experiences provided from studying successful projects, this knowledge will be key input to the indicator formulation process.

We start by presenting two models of technology transfer. Next, the barriers to transferring technologies are considered, and then some characteristics of successful technology transfer will be identified.

4.1 Models of technology transfer

A large number of models exist for describing the process of technology transfer. Some examine policy structures (Metz et al. 2000), other assess planning and managing (Ramanathan and Jagoda 2005), or innovation (Krugman 1979). For the purpose of examining barriers, an adequate model would be Dixon's linear process of technology transfer. The rationale behind relating technology transfer to this model is to clarify where the barriers are encountered, and which barriers will be of interest in the context of transferring a technology to another country. (Wilkins 2002)

Dixon's model depicts the various stages of the process of developing, demonstrating and deploying a technology. The model is shown in Figure 3, and it organises the five stages in two overlapping parts. The first part consists of R&D-activities, performed in response to the signals from the market. The technology developed is then tested and exploited. The second part consists of demonstrating the technology to target markets, raising market awareness and knowledge, and enabling market access (Wilkins 2002).

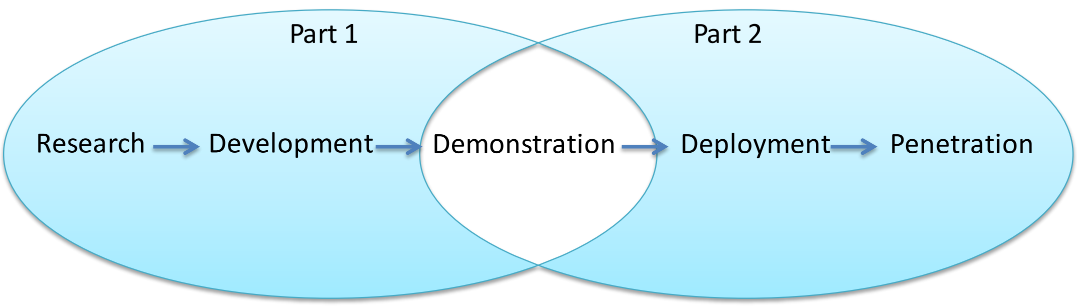

Figure 3: Dixon's model for Technology Transfer (Wilkins 2002).

The important barriers in the context of examining technology transfer in specific projects are constricted to the second part of this process. Regarding the first part, the technology is assumed developed in the sender country, and the R&D-process is relevant in the recipient country only as an adaption to the local situation, or as an indirect response through innovation.

Whereas Dixon's model has a sender perspective, Cohen (2004) presents a model with focus on the receiver side. He presents a technology transfer pyramid, where technological sustainability will be achieved after passing through six stages. Here each stage involves a specific capability. It starts with the assessment and selection of the appropriate technology, followed by acquisition, adaptation, absorption and assimilation, diffusion, and development. As such, this model goes further into analysing how the technological capacity of the receiving country develops as a consequence of the project. The model is shown in Figure 4.

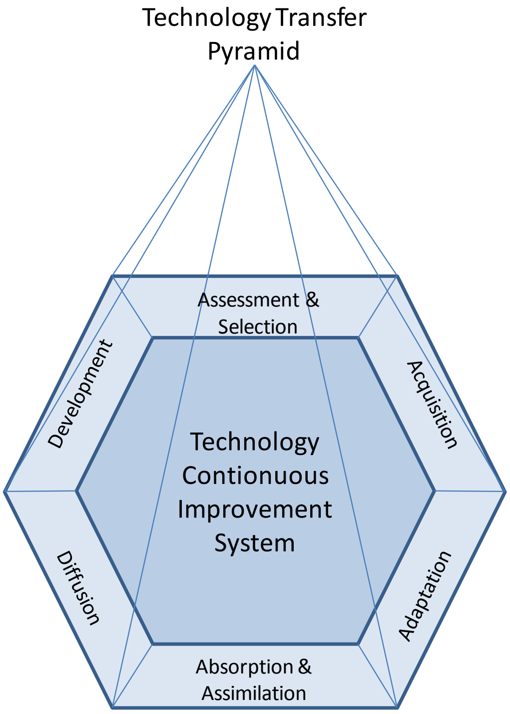

Figure 4: Technology Transfer Pyramid (Cohen 2004).

As the technology transfer pyramid only considers the second part of the linear model by Dixon, it may be seen as a refinement of the part we are interested in.

4.2 Barriers to technology transfer

A barrier can be understood as "something immaterial that impedes or separates" (Merriam Webster Online Dictionary 2011), and in the case of technology transfer, it can be considered either as a market failure, or more broadly as any factor hindering the progress of technology transfer (Wilkins 2002).

In this section we start by looking at barriers as they have been identified by Wilkins (2002) and Bosselmann (2006). Next, we present a summary of the most important barriers found by UNFCCC (2009b), in their review of Technology Needs Assessments (TNAs) for developing countries. Finally, a short summary of the aggregated insights is provided.

4.2.1 Categorisation of barriers

Figure 5 shows a broad range of barriers categorised by Smith and Marsh, and revised by Wilkins (Wilkins 2002). This categorisation shows that barriers can be related either to institutions and policy, the local knowledge and capacity, or financial, technical and environmental aspects. As the figure shows, there might also be linkages between the categories, and this signals that it can be difficult to relate an undesirable effect to only one barrier.

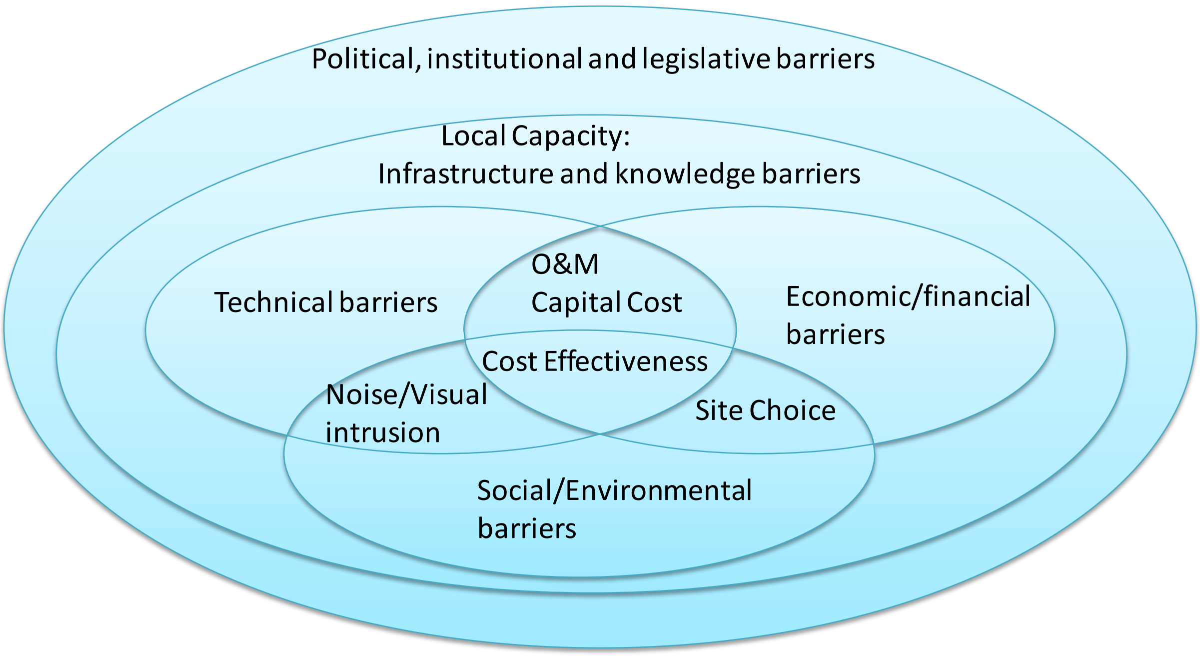

Figure 5: Categorisation of barriers (Wilkins, 2002).

Further, Wilkins stresses the importance of being aware of the range of potential challenges, even though no energy project faces all these barriers. Derived from case studies where renewable energy technologies have been implemented in developing countries, he lists the identified barriers in five main categories, as shown in Table 2.

Table 2: Identified barriers (Wilkins, 2002).

Political, Institutional and Legislative Barriers:

- National policies and programmes
    - Lack of clear plans and targets for renewable energy development
    - Lack of appropriate policies and support mechanisms (taxes, duties etc.)
    - Lack of integrated planning for energy and development
    - Lack of consistent policy
    - Lack of focus and ownership for energy development
- Institutional structures
    - Poor communication between the government departments and utilities/projects
    - Split responsibility between departments
- Intellectual Property and standards
    - Weak or unclear law on Intellectual Property Rights (IPR)
    - Lack of supporting legal institutions
    - Lack of technical standards and quality control

Local Capacity - Infrastructure and Knowledge:

- Access to information
    - Lack of accurate information on energy requirements
    - End users not aware of the services of the technology
    - Lack of information regarding quality and standards
- Skilled labour
    - Lack of local technically trained staff
    - Braindrain of trained employment
- Exchange of ideas and experiences
    - R&D to adapt technology to local conditions is lacking
    - Lessons learned from pilot projects are not disseminated to relevant actors

Economic/Financial:

- Access to capital and investments
    - Credit situation of local installers and end users is strained
    - Attractiveness of local SMEs needed to provide access to clean energy in rural communities is too low
- Subsidies and disparity
    - Unpredictability of local subsidy schemes
    - A need for a critical mass of users, and sufficient scale of the project

Social/Environmental:

- Local acceptance
    - Lack of social acceptance, due to culture or religion
    - Lack of community involvement in planning projects
    - Lack of entrepreneurs can be a significant issue

Technical:

- Competence
    - Lack of understanding local energy service requirements
    - Lack of local skilled labour
    - Lack of access to spare parts, or poor stock control
    - Lack of supporting infrastructure for installation and maintenance

In a study of how changed regimes for technology transfer may contribute to environmental sustainability and poverty alleviation, Bosselmann (2006) identified nine economic, social and legal barriers to transfer of ESTs. These barriers all prevent private companies from investing or undertaking projects in developing countries, and this clearly also affect the willingness to invest in energy technologies (Bosselmann 2006):

- Investment risk
- Culture and language
- No governmental agency to regulate/promote EST
- Lack of technical capabilities in developing states
- Inadequate infrastructure
- Insufficient investments in R&D, particularly technology adaptation
- Vested interests actively opposed to the use of EST
- Inability of developing state consumers to afford ESTs
- Lack of confidence in new ESTs

4.2.2 Barriers identified by UNFCCC

In a report on the technology needs of the different parties of the Convention, UNFCCC (2009b) synthesised the barriers to transfer of technologies related to reduce climate change. These barriers were identified from the recipient side, by going through all the Technology Needs Assessments (TNAs) written by the developing country parties. This information therefore elaborate upon what aspects a potential project has to consider in order to be successful, seen from the receiver side.

The barriers were classified as either economic/market, human, information, institutional, regulatory, policy, technical, infrastructure and other. The different categorisations are shown in Figure 6, where they are ranked based on how frequently they were mentioned in the TNAs.

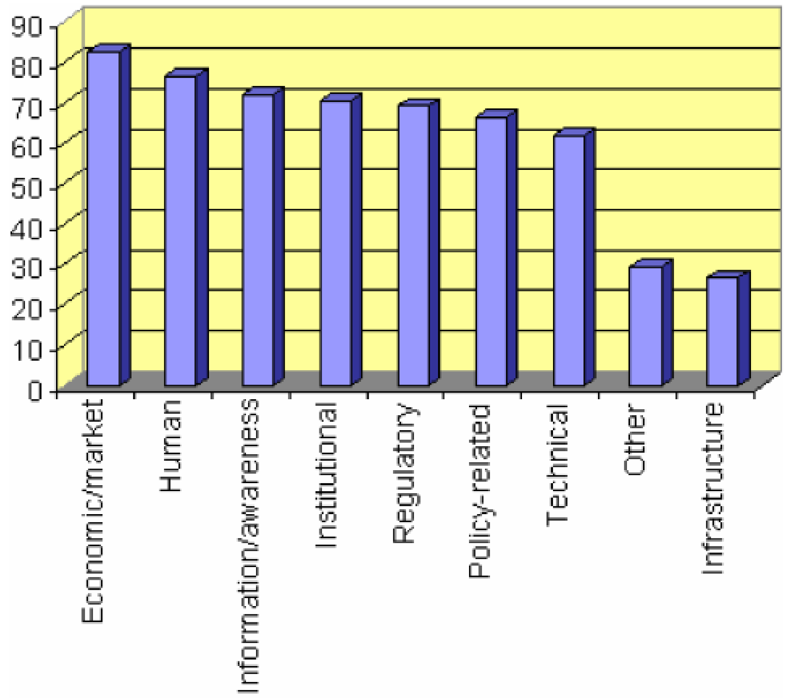

Figure 6: Types of barrier to technology transfer synthesised by the UNFCCC (2009b).

The main barriers were related to economic and market impediments. They include low income among consumers, incompatible prices, subsidies and tariffs, price uncertainty, disturbed or non-transparent markets, and undeveloped economic infrastructure.

Other important barriers with relevance to technology knowledge and understanding were classified as Human and Institutional. The human barriers relates to the lack of skilled personnel for installation and operation of the new technologies, inadequate personnel for preparing projects and lack of social acceptance for the technologies. Institutional barriers include low host-country institutional capacity, and poor coordination between relevant ministries and other stakeholders.

4.2.3 Summary on barriers

There is a large degree of accordance between the barriers identified by Wilkins, Bosselmann and UNFCCC. Since all of them are looking at either renewable energy and / or environmentally sound technologies, this result is just as expected. We find that Wilkins categorisation and list of barriers is the most comprehensive, and that this list covers most of the aspects mentioned by the others. Thus, rather than synthesising the findings, we find it sufficient only to present the most important insights.

We note that the barriers related to economic and market conditions were emphasised by all, in addition to lack of technical capacity in the host country, and the importance of obtaining local acceptance of both the technology and the project. Political and institutional barriers were also ranked as important in all studies, with a special focus on the lack of governmental planning, regulation and cooperation in the energy sector.

Barriers specifically related to FDI are also vital to examine. They include degree of corruption, access to natural resources, social and civil order, difficult start-up procedures, exorbitant permit requirements and time-consuming import and export processes (World Bank 2010, Wilkins 2002).

All the identified barriers should be taken into account when determining both what constitutes successful technology transfer, and what makes up an enabling environment for the process. Although not all of these barriers are likely to affect every energy projects directly, an influence on the surroundings of the project will most certainly affect the suitability of the project as well.

4.3 Characteristics of successful technology transfer

In addition to the study of barriers, one can gain essential insights to what may influence technology transfer positively, by reviewing and learning from the success stories. Here we present some of the results from case studies performed by the UNFCCC, and the "key-role factors" that influence the success of technology transfer, identified by Cohen (2004).

First the experiences of the American bilateral project, TCAPP, are presented. The purpose of this project was to demonstrate how developed countries could fulfil their obligation under the UNFCCC Article 4.5, of promoting, facilitating and financing the transfer of environmentally sound technologies, through a market-oriented approach. The lessons learned from this project are summarised in Table 3.

Table 3: Insights from TCAPP (Kline et al., 2004)

- **Understanding the technology**
  Users need to understand the technology and its applications well enough to have confidence in it, and to ensure technology performance that can be replicated and sustained. This has been addressed in the projects by:
  - Providing technology information in the form of written material, presentations, discussions etc.
  - Assisting in the development of technology standards and certification procedures
  - Facilitating the development of demonstration projects
  - Organising training workshops and study tours for developers

- **Understanding the project opportunity**
  Confident of the performance of a technology, a private actor may be interested in evaluating specific project opportunities that might rely on the technology in question. This is facilitated by:
  - Pre-feasibility and feasibility studies
  - Disseminating information about opportunities to use technology through workshops, presentations etc.
  - Assisting renewable energy resource assessments to identify likely locations for projects, and reduce resource risk

- **Capacity Building**
  As an essential component of technology transfer, capacity building permeates many of the other activities. It includes among others:
  - Training workshops and study tours on specific technologies and applications
  - Training and assistance with business planning
  - Training on standards, testing methodologies, and certification procedures
  - Education on technologies

- **Business/financing networks, and achieving project development**
  Activities like trade mission, development of trade associations, support for conferences, and evaluating financial sources and assisting to secure financing.

- **Market assessment and market conditioning**
  Providing key information about markets, and implementing actions with international partners.

By studying the experiences from TCAPP, we understand the necessity of providing enough training and information to employees and stakeholders throughout all the phases of a project, and in most activities. Sufficient training is especially important to the technical personnel, but capacity building in business planning and managerial tasks is also of importance.

Furthermore, Kline et al. also review technology transfer programs under the UNFCCC. They report that input from, and networks with, the private sector is deemed as crucial in order to understand and remove barriers to technologies. The existence, interest and capabilities of the industry, and the experience of governments in working with it, are noted to be important determinants of the input from the private sector (Kline et al. 2004).

Another point of interest in the context of barriers for specific projects is the importance of having strong support from a variety of stakeholders. In order to remove barriers successfully, it is useful to leverage on a number of stakeholder groups. The ambitions of in-country businesses, financing institutions, local and international organisations as well as businesses seeking global presence, might be closely correlated (Kline et al. 2004).

4.3.1 Key-role factors

Cohen (2004) is also concerned with critical aspects of technology transfer, and presents a number of key-role factors for technology selection, which he argues have the potential of causing a project to succeed or fail. In terms of the technology transfer pyramid (Figure 4), he focuses on the first stage, namely selecting a suitable technology to transfer, but he states that the factors are relevant both for the technology selection (at a national or sectoral level), and technology implementation (at firm or organisational level).

In Table 4 a summary of the most pertinent factors are presented.

Table 4: Key-Role Factors (Cohen 2004)

- **The Intellectual Property System.** While the technology provider's key asset is its intellectual property, the receiver wants to acquire it, and this is likely to cause problems. The task is therefore to maximise the mutual benefits between the two parties, by choosing a legal structure that facilitates the transfer process effectively.
- **Mutual benefits** from the transfer must be assured from both parties. In the receiver country, this requires training of technicians, management and politicians, while the sender country should, in addition to the financial and economical rewards, benefit from technical improvements derived from necessary adaptation and additional R&D in the host country.
- **Government and industrial policies** with importance for technology transfer includes national planning, evaluation, resource allocation, financial support, sales promotion, exports promotion and subvention.
- **Political factors and political stability** has generally been regarded as important for the innovation climate, but also as a determinant for technological, social and economic growth. In this context it greatly affects the investment climate for foreign actors.
- **Local and enterprise culture** are important for the technology transfer process, as cultural values may be negatively affected by the new technology. Therefore, some public acceptance should be gained before implementation, to reduce the chance of conflict. The acceptance must be based on public awareness through information in official and unofficial channels.
- **Ergonomics and the role of human-technology interaction** refer to the "cognitive triangle" of tasks, users and tools. With a high degree of fit between technology, users and the environment, the outcome will be higher productivity, better quality and lower rates of injuries and accidents.
- **Conflicts and resistance to change** should be given proper attention at individual, organisational and societal level, as technology transfer involves both technological and cultural change. As the resistance to change depends on cultural factors, cultural effects should be understood as an important constraint to the process.
- **Environmental aspects** are also necessary to consider for a successful transfer. It should be evaluated prior to the transfer, together with the interrelated components like health issues, social acceptability, technical, economic and financial viability and institutional support.

Compared to the TCAPP insights that provided us with specific advices of what must be present to ensure successful technology transfer in international projects, the key-role factors are more concerned with discussing how and why these issues are important to consider, and consequently they do not give clear guidance to what actions are required. Nevertheless, the key-role factors are definitely something more than just barriers, and they point towards some new important issues. Especially, we note the significance of the "cognitive triangle" and "conflicts and resistance to change", in addition to the more explicit emphasis Cohen has on the role of mutual benefits.

4.4 Conclusive remarks

Following the complexity of technology, there is no surprise that the barriers to transfer of technologies across borders are both numerous and widespread. Covering everything from technical capability, legal structure, political stability and cultural differences, there are many considerations to take, and many traps to be caught in.

It should be safe to state there exist no generalised solutions to overcome the barriers to transfer of technologies in general, or ESTs and energy technologies specifically. The identification and prioritisation of barriers must be done on a case-to-case basis. However, as Wilkins underlines, it is important to identify the most appropriate and effective responses to each of the possible barriers that can be faced (Wilkins 2002). By analysing the success and failure of specific projects, the lessons learned can increase the chances for successful technology transfer in the future.

This is also the approach taken in this thesis – it is vital to acknowledge that there cannot be any catch-all solution to technology transfer, and thus no catch-all assessment system. However, what can be implemented is a system that incorporates the gained experience from the case studies assessing similar projects. The insights from this chapter are therefore important input to both the selection of indicator issues and the formulation of the actual indicators in the Protocol.

To be able to utilise this information in the best way possible, though, it is necessary to relate all these barriers and success criteria to the definitions of technology and technology transfer. Before looking at the indicator formulation process, the next chapter will therefore describe two models based on the synthesised insights from this chapter.

5 Operationalisation of the Theory

Having reviewed the literature on technology transfer, and examining experiences from case studies of barriers and success criteria, it is useful to clarify our conceptual understanding of technology transfer by presenting two models. The models will provide insight into the following two questions:

1. **When is the technology transfer a success?**
2. **What is good technology transfer?**

These questions have been frequently raised in interviews with practitioners and academics during our work, and the two models presented in this section are an attempt to clarify how we deal with these fundamental questions.

The purpose of developing the two models is to have a clear benchmark for observing technology transfer in real projects. Later, the Protocol will be applied to case studies to indicate the expected technology transfer. The results from using the Protocol will then be compared with the observed technology transfer from applying these two models.

5.1 Level Model

The question of "When is the technology transfer a success?" has certainly no straightforward answer – it depends on who decides how and what successful technology transfer is. However, by trying to develop a simple model with different levels, some fundamental aspects of technology transfer in a project are illustrated.

The five-step model proposed by Dixon in Chapter 4.1 depicted the process of developing, demonstrating and deploying a technology, seen from a sender perspective. On the other hand, Cohen presented a model with more focus on the receiver side. This model dealt with the local choice, acquisition, absorption and diffusion of the technology. Here a model with the project's point of view is constructed, by drawing from each of these models.

When defining technology transfer the focus was on *what* should be included in the technology concept, in addition to *where* and *how* the technology is being transferred. Here the focus is on *when* it becomes a success. The Level Model provides an intuitive classification of the success of the technology transfer in a project, in five easily separable steps. A clear partition of the succeeding levels of transfer is made, which helps illustrate how successful a project has been, in terms of transferring the technology.

Figure 7: The Level Model

5.1.1 Planning

The first level of technology transfer in a project is the preparation phase. Before any part of the project has been installed and constructed, technology transfer is limited to cooperative interactions between the sender and the recipient. Whereas a conventional understanding would focus solely on experiences connected to transfer of the hardware, preliminary interaction between the parties would also imply transfer of knowledge and preparatory practices for the technology.

5.1.2 Implementation

The second level of the model is the implementation phase of a project, where construction, transportation and installation activities are taking place. By involving the recipient organisation (or local participants) in the execution of these activities the project supports an increase of the local capacity. Such participation could enable similar activities in future projects to be achieved locally.

5.1.3 Operation

The operation phase of the project is the third level in the model. A proper understanding of the technology must be experienced through operation and maintenance of the machinery. Training and education in utilising the technology, through courses, written descriptions, on-site guidance and own experiences is therefore key to transferring knowledge and competence surrounding the technology (Lasserre 1982, Cobb and Barker 1992).

5.1.4 Long-Term Operation

When the technology has been operating longer and better than the average operation in comparable projects, the technology transfer has reached the fourth level. When observing that a project exhibiting technology transfer lasts longer and perform better than average projects, one can with certainty acknowledge that the project has been "long-term viable", and thus has transferred technology knowledge and experience over time.

5.1.5 Diffusion

As discussed in Chapter 3.4, diffusion is the utilisation of the technological knowledge in other projects, and can be perceived as the continuation of technology transfer. Diffusion could be the replication of technology and absorption of know-how locally, and involves climbing the "technological ladder" (Cox 2010). If the diffusion occurs through the project's ownership this can be beneficial for the project itself, otherwise it could be valuable for the local community in cases where local participants use their acquired knowledge for other purposes.

5.2 Tier Model

The Tier Model addresses the second question: "What is good technology transfer?" When reflecting over this question, we recalled Haake's (2006) attempt to define technology transfer by different "tiers". Each tier successively implied a stronger form of technology transfer. Even though the definition was criticised for its inconsistency in Chapter 3.3.3 the partition in three tiers was so convenient that the approach is adopted here.

The model consists of three tiers, which in descending order reflect the relevance to technology transfer. The content and classification is based on the extensive review of barriers and success criteria. An illustration of the model is presented in Figure 8.

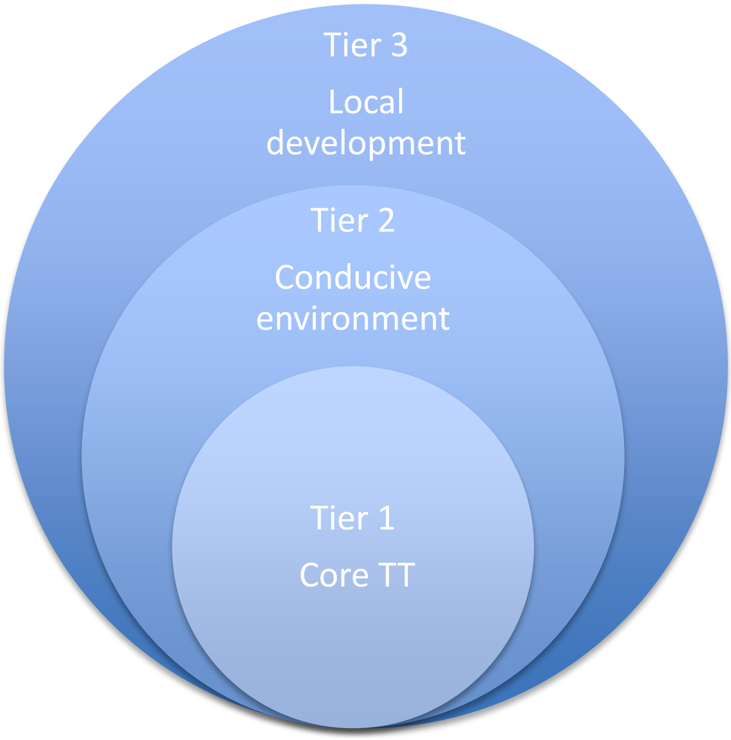

Figure 8: The Tier Model

Tier 1 is the core of technology transfer, and includes what we have identified to be the best practices for achieving technology transfer in a project. **Tier 2** consists of the adaptation to, and contact with, the local environment, and incorporates what actions are needed from the project to ensure that a technology will be a long-term success in the local setting. **Tier 3** goes beyond the notion of technology transfer, and addresses the features of local development. In Figure 9 the detailed content of each tier is presented, elaborating on how "good technology transfer" should be operationalised.

Tier 1 – Core TT

- The transferred technology is in line with local needs
- The project ensures necessary internal capacity building, including:
    - Education for installing and operating the technology
    - Training and assistance with business planning and administration
    - Training on standards, testing methodologies and certification procedures
- The project involves relevant stakeholders and the local community in all stages of the project. Involvement includes:
    - Opportunity to influence the decision making process
    - High degree of local employees
    - Local sourcing
    - High quality information sharing
    - Local ownership

Tier 2 – Conducive Environment

- The project has established close contact with the local and national authorities, Energy Departments, regulators and national embassies.
- The project exchanges experiences with other actors involved in:
    - Transfer of technology to the same region
    - Regional clusters and networks
    - Universities and research institutions
- The project has assessed, and dealt with
    - Political risks (Expropriation, corruption, political unrest)
    - Legal risks (IPR, judicial system)

Tier 3 – Local Development

- The project positively influences the local communities
    - Corporate Social Responsibility
    - Industrial and commercial development
- The project contributes to additional technology transfer and diffusion, by supporting the building of related services and infrastructure
- The project contributes to a better environment locally

Figure 9: Content in the Tier Model

5.2.1 Tier relevance to technology transfer

Tier 1 has its focus on the technology being transferred, and is, as such, directly relevant to technology transfer. This incorporates aspects like increasing technology competence among local participants, disseminating knowledge to local actors, and ensuring that the technology is needed. **Tier 2** ensures that the project addresses the key barriers of technology transfer as identified by Wilkins (2002) and Bosselmann (2006): dealing with political and legal risks, and having necessary contact with actors like local and national authorities and offices, embassy personnel and technology networks. **Tier 3** goes beyond technology transfer as such, and addresses CSR, sustainable development and local behaviour. Such actions are only indirectly relevant to technology transfer, but through performing laudably in the local community the project can overcome the important barrier of lack of social acceptance (Wilkins 2002, Mallett 2007, UNFCCC 2009b).

5.2.2 Conclusive remarks

The Level Model and the Tier Model are conceptualisations of our understanding of technology transfer. The Level Model addresses *when* a project becomes a success, in terms of technology transfer. The Tier Model summarises *how* technology transfer is perceived, based on the numerous case studies examined. Both models will be reconsidered when examining real projects, and used when indicating to what extent technology transfer actually has occurred. This will later be compared with the project's potential for technology transfer, observed by using our Protocol.

6 Methodology

In this chapter the methodology used for developing, improving and testing the Protocol will be presented. Firstly, the framework for developing the set of indicators is reconsidered, which was created during the specialisation project (Kleveland and Sønstebø 2010). We describe the development process and present the final framework. Secondly, the Delphi Survey is presented, which was the feedback process on the developed indicators. Lastly, the attempted approach to verify the validity and usability of the Protocol through case studies is outlined.

6.1 Development of the indicator set

6.1.1 Frameworks for indicator development

There exists an extensive amount of literature about indicators and how to develop them. However, little research has been done in the area of assessing the degree of technology transfer in specific projects. Therefore, to obtain a theoretical underpinning for the work, we looked at the development of indicators in general, and focused the study in the fields related to ecology and sustainability indicators, as well as key performance indicators for measuring the performance of business organisations. It was also referred to the UNFCCC and the work of the Expert Group on Technology Transfer (EGTT), and their methodology for developing indicators to measure the performance of the technology transfer framework (described in Chapter 2.2).

Altogether, 10 different frameworks for how indicators can be developed were reviewed. In Table 5 a summary is presented, with classification, the main features, the dimensions covered and how technology is treated. For the full review, see the specialisation project (Kleveland and Sønstebø 2010).

Table 5: Classification and features of the frameworks

Framework	Classificatio	Features	Dimension	Technology treatment
(1) UNFCCC	Technology transfer efficiency on framework level	A vision and objectives based framework. Make use of the Bellagio principles.	-TNA -Tech. information -Enabling env. -Cap. building -TT Mechanisms	The framework develops indicators to measure how effective the TT-mechanism is, but no technology specific criteria are mentioned in the framework.
(2) PSR: Pressure-State-Response	Causal chain	Humans exert Pressure that leads to environmental State change, while societal Responses feed back on both the pressure and state.	-Environmental -Societal	None
(3) DSR: Driving force-State-Response	Causal chain	The Driving forces cause changes in the environmental State, which are Responded to by society. 'Driving forces' include human activities, policies and social, economic and cultural factors.	-Environmental As driving force: -Social -Economic	None
(4) DPSIR	Causal chain	Indirect Driving forces and direct Pressures cause changes in the State which Impacts human health and ecosystems. Responses feed back throughout the whole chain.	-Environmental As driving force: -Social -Economic	None
(5) eDPSIR	Causal network	Like DPSIR, but emphasise the interlinkage between the individual indicators.	-Environmental As driving force: -Social -Economic	None
(6) UNCSD	Theme indicator framework	Structure indicators under the four dimensions of sustainable development and 15 main themes. Use an adaptation matrix to determine indicator relevance to a specific case.	-Social -Environment -Economic -Institutional	None
(7) The Wuppertal framework	Theme indicator framework	Develop indicators under the four dimensions of sustainable development, but stresses the importance of interlinkage between the dimensions to get a coherent set.	-Social -Environmental -Economic -Institutional	None
(8) Gent University – Vision matrix	Theme indicator framework	Comparing themes with indicators, and derive intentions. The resulting vision-matrix is thus the policy framework for indicator development.	-Economic -Social -Ecologial -Institutional	None
(9) IAEA and IEA	Causal chain and theme based.	A framework for assessing the interrelations between the sustainability dimensions of the energy sector. Make use of the DSR-framework.	-Social -Environment -Economic -Institutional	Assesses the status for deployment of pollution abatement technology, and examine the energy situation
(10) BSC and Sustain-ability BSC	Perspective driven approach to develop indicators	Focus on developing indicators from four perspectives that ensures balancing short and long-term goals and output and drivers of output. In addition, the Sustainability BSC relates the perspective of sustainability, either as an extra dimension, or as an incorporated perspective.	-Financial -Customer -Internal business processes -Learning and growth	None

For expressing the applicability of the frameworks in a different setting than they initially were intended for, each framework was classified according to how broad focus it had, (how many dimensions were covered), and how specifically it described the development of the final indicators. Some frameworks did only state which factors the indicators had to assess (general approach), while others described in detail how the indicators should be formulated (specific approach). This is shown in the matrix in Figure 10.

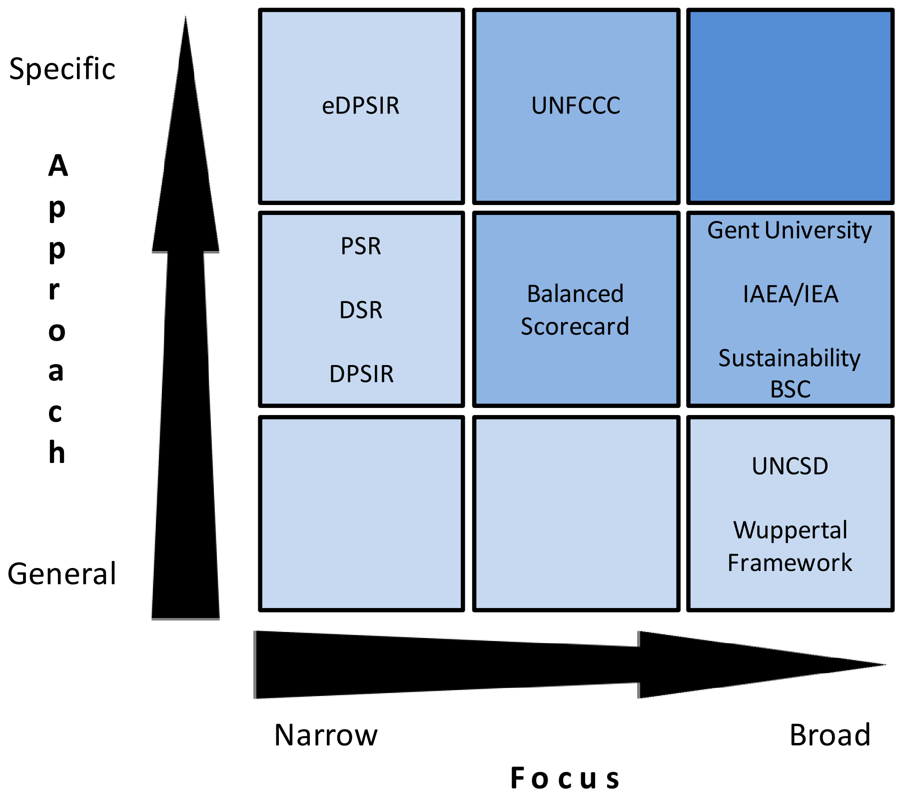

Figure 10: Matrix for classifying the frameworks

As shown by the arrows and colour codes in the matrix, it is argued that for use in the complex environment of international technology transfer, the framework should have a broad scope (horizontal axis) and describe the approach of how to achieve the set of indicators specifically (vertical axis), i.e. the framework should be close to the upper right corner in the matrix.

6.1.2 Our framework

Based on the review of the different frameworks, a new framework was proposed, which synthesises the strengths of the UNFCCC-approach and the theme-based frameworks. The UNFCCC-approach was very specific in describing how the indicators should be developed, and started with a background analysis of the normative frame and the current situation, before formulating a vision and objectives for which indicators could be expressed. Our approach follows this recipe, but in addition it makes extensive use of dimensions and structured themes in order to identify the relevant visions and goals that act as the foundation for the indicator development. The framework is shown graphically in Figure 11.

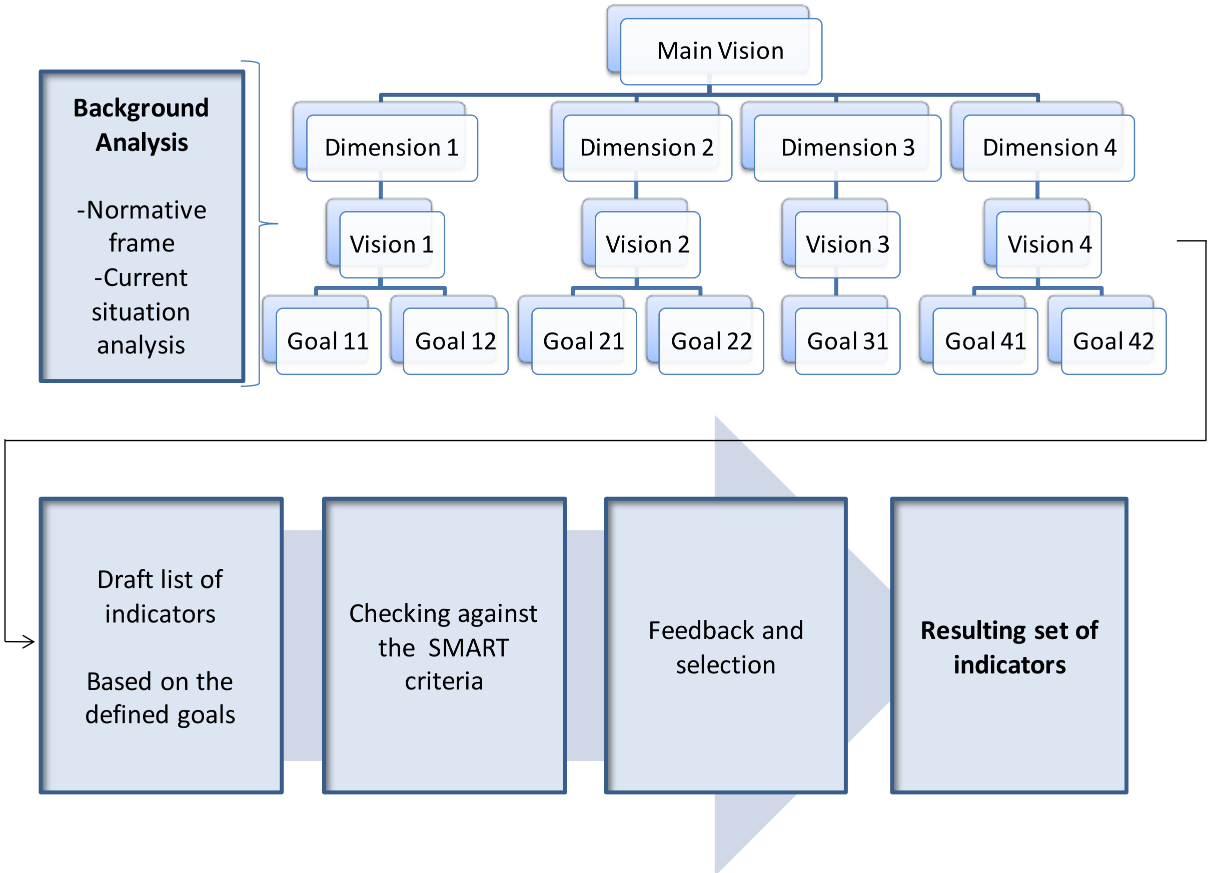

Figure 11: Framework for developing indicators

The first step of this framework is to gain a thorough understanding of the background of what is going to be evaluated. This comprises of an explicit and comprehensive formulation of the normative frame, and an analysis of the current situation. Based on EGTT (2009), the normative frame is defined as the "overall set of principles, goals and definitions that have been accepted by the international community to frame technology transfer". The current situation analysis refers to an analysis of all decisions, reports, papers and articles that is relevant to the problem. It is important to note all research that have been done in the field of interest, and incorporate this knowledge in the work towards the set of indicators. For this work, barriers and success criteria to technology transfer are the most important literature to consider.

The second step of the framework is to define the main vision of the system. This should be a broad vision that covers most areas of international technology transfer. In order to reach this vision, the main dimensions the problem consists of should be identified, and for each dimension a more specific sub-vision is to be developed. With this in place it is possible to state specific goals or objectives under each vision, and subsequently formulate indicators for the different goals. Ultimately, it is argued that several alternative indicators should be proposed for each goal at this stage. Overlaps between both objectives and indicators should be considered, and, wherever possible, the overlapping objectives and indicators should be combined.

The formulated indicators should then be assessed against the well-established SMART-criteria, to check that the indicators are Specific and Measurable, that necessary data is Achievable, that what they measure are Reliable, and that the frame is Time-bound (EGTT 2009). Having formulated all the indicators and applied the SMART-requirements to them, the draft indicators should be presented to a number of stakeholders from various disciplines. This would give feedback on the applicability and quality, and allow for adjustments where weaknesses are identified. Following this framework should therefore ensure that the resulting set of indicators is strong and relevant, and cover all the important aspects of the problem.

6.1.3 Indicator formulation

In this section the actual indicator formulation is discussed. As the final indicators are crucially dependent on the choice of dimensions, this process is considered first. Initially, the four dimensions of sustainability (that is; economical, social, institutional and environmental), was adopted, but as the preliminary study revealed that important aspects of technology were leniently treated in most of the frameworks, it was decided to extend the framework with a technology dimension.

As the focus in the Protocol is on a sender company making a direct investment in a developing country, it was also decided to revise the economic category, to better integrate all the features of concern to businesses. In that way the different choices and opportunities of the organisation transferring the technology are clarified, and the attributes of the recipient organisations may be examined. The important aspects related to local economic development are integrated in the social dimension.

Next, the sub-visions and goals were formulated under each dimension. Based on this work in the specialisation project, our first intention was to make the indicator formulation a quick act, by writing indicators that directly gave answers to whether or not the goals were achieved. An example would be for a goal stating that all local employees should get the appropriate training, the indicator question could be: “Have all local employees been given appropriate training?” Such a binary indicator should be answered with Yes or No.

Although short and concise, this type of indicator gives little guidance for the assessor in what is meant by appropriate training. It says nothing about how the training should be provided, if it is sufficient with only written material, or if teaching face-to-face and interaction between the experienced and inexperienced actor is necessary. For transfer of the tacit component of the technology, which is an important part of our definition of technology, it is definitely required with personal interaction. Furthermore, the simple binary indicator makes it impossible to separate projects that has done a lot in this area from projects that has done "just enough".

It is therefore argued that it is more appropriate to develop broader indicators, with a more detailed scoring guide. While the initial approach emphasised the direct and hierarchical structure between sub-visions, goals and indicators; the new, broader indicator issues are not strictly bound by individual goals. It is thus chosen not to present all the sub-visions and goals that were initially prepared, but instead refer to Kleveland and Sønstebø (2010) for the full review. However, the indicators will still be classified according to the different dimensions. Further details regarding the Protocol are presented in Part 2: "Overview of the Protocol". This also includes a sample indicator and its development.

6.2 Delphi Survey

The framework in Figure 11 postulates that feedback on the indicators should be collected from experienced actors and researchers. For this purpose it was decided to apply the Delphi Method, a systematic tool for collecting opinions and convictions from experts, as a mean of getting feedback to the Protocol from practitioners and researchers in a range of different organisations.

6.2.1 The Delphi Method

The Delphi Method was developed at the RAND Corporation during the 1950s, to obtain a reliable consensus among a group of experts (Dalkey and Helmer-Hirschberg 1962). This is achieved through a series of questionnaires, with controlled feedback to the experts. Linstone and Turoff (1975, p. 3) describes the general features of the method:

> "Delphi may be characterised as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem. To accomplish this "structured communication" there is provided: some feedback of individual contributions of information and knowledge; some assessment of the group judgment or view; some opportunity for individuals to revise views; and some degree of anonymity for the individual responses."

Delphi researchers use the method primarily where judgmental information is indispensable for the subject in question (Okoli and Pawlowski 2004).

6.2.2 Purpose and choice of methodology

Development of the indicators in the Protocol has been an iterative process, where feedback from practitioners and experts, as well as experiences from literature and case studies, acted as continuous input to the process. By using the Delphi Method trustworthy suggestions and input from experts and experienced actors were provided in a rigorous manner.

The purpose of using the Delphi Method in the research has been threefold:

- to improve the developed indicators in the Protocol subject to feedback from experienced practitioners
- to investigate how important each participant considered the indicators to be for assessing technology transfer, as an indication of the validity of the Protocol
- to obtain a consensus among the group of experts in the survey

Although a traditional survey could have been applied to receive input from the respondents, the Delphi Method was deemed to be the most appropriate tool for the following reasons:

- There exist only a relatively limited number of experts with knowledge of technology transfer in energy projects, and the Delphi Method has only modest size requirements. As stated by Okoli and Pawlowski (2004, p. 19) "The Delphi group size does not depend on statistical power, but rather on group dynamics for arriving at consensus among experts."
- For questions requiring expert opinions the averages of individual responses may be inferior to averages from group decision processes (Okoli and Pawlowski 2004).
- As the respondents are anonymous to each other, but identifiable to the researchers, the participants can be subject to follow-up questions, and the surveys can be tailored to each respondent.
- The Delphi Method does not require that the participants meet physically, and enables them to complete the survey when they desire, unlike other group decision processes.
- The Delphi Method is flexible in design, and non-response is typically very low, as respondents have assured their participation, and can be reminded by the researchers.

For a comparison between traditional surveys and the Delphi Method, see Okoli and Pawlowski (2004).

6.2.3 Delphi Survey design

To conduct the Delphi Survey in a systematic way, the research study was designed according to Okoli and Pawlowski's (2004) guidelines, which emphasised the need for a rigorous approach to select experts. This methodology included categorising the experts before identifying them personally, to prevent overlooking any important class of experts. We described the following four categories, which would be of interest:

- Academics
- Government Officials (ministries, government aid agencies)
- Practitioners (sender companies, providers of finance, consultants and advisors)
- NGOs

Next, potential organisations were assigned to each of the categories, before relevant contact persons were identified. This work was conducted with input from our supervisors, in order to broaden the scope of participants in the survey.

Having identified the individuals, each was contacted, informed about the research subject, and invited to participate in the survey. We managed to recruit 12 individuals from 11 different organisations, all with experience from international energy projects, or from research on technology transfer related areas. The organisations were Statkraft, TrønderEnergi, Det Norske Veritas, Norad, Norfund, NVE, IntPow, International Centre for Hydropower (ICH), Industrial Ecology (NTNU), Interdisciplinary Study of Culture (NTNU), and a small consulting company.

The survey consisted of two rounds: In the first round the participants were presented with 17 preliminary indicators developed for the generic assessment of technology transfer. To make the survey as appealing as possible for the respondents, we wanted to limit the length of the survey. The indicators were translated into Norwegian, and the explanations of each of them were summarised in a short paragraph. Scoring points for each of the indicators were also presented. After reading the outline of the indicators the participants responded to the following:

- How important do you think this indicator is for technology transfer (1 to 5[‡])?
- Are any of the scoring criteria unnecessary, if so, which?

Finally the participants were asked whether any aspects had been overlooked, and they were encouraged to give general remarks and suggestions for improvements of the indicators.

As the first round was rather long and time-consuming for the respondents, it was decided to only encourage additional response for the indicators with significant disagreement after the first round. In cooperation with our co-supervisor, we defined the following heuristic rule for assessing inter-rater disagreement: If more than 20% of the responses deviated from the other responses by more than 2 points on the scale from 1 to 5, all respondents were asked to actively revise their position. An example of such disagreement would be if 30 % scored 3, 40 % scored 4, and 30 % scored 5. As more than 20 % deviated with more than 2 scoring-points from each other, the respondents should revise their answers for this indicator.

In the second round the participants with information were presented about their response in the first round, and the mean and standard deviation aggregated from all experts. In addition, for each of the indicators we had prepared two-to-three comments given by the respondents in the first round. These comments were explanations for why

[‡] (1 = No importance, 2 = Some importance, 3 = Quite important, 4 = Important, 5 = Very important)

some experts had chosen to give the score, and acted as a way of sharing the arguments between the participants. In this way the experts could revise their own answer based on the input from other experts. In addition to revising their former response, the participants responded to suggestions of removing indicators, and amending other indicators, based on the response from the experts in the first round. Finally, the respondents were asked to evaluate whom they believed the Protocol would be most valuable for.

The Delphi process is illustrated in Figure 12 below.

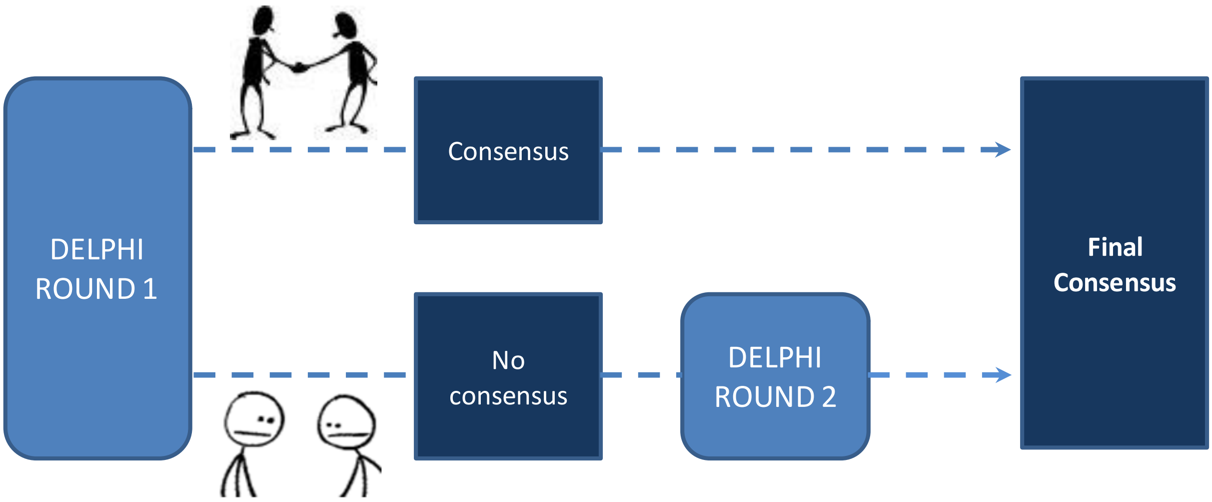

Figure 12: The Delphi Process

6.3 Case Studies

After completing the Delphi Survey, the Protocol was applied to projects in operation, and scorings were assigned for each indicator. By using real-life projects it is possible to investigate how feasible the process of assessing a project would be, and possibly, to find evidence for the validity of the Protocol. As it proved challenging to get access to all the information needed through our collaborator, DNV, we were obliged to seek information about projects from other sources. After considering different suggestions it was decided to examine one hydropower project, Khimti in Nepal, and a wind power project, Totoral in Chile. Both projects have SNPower in Norway as the foreign provider of the technology, and are promising projects.

Due to the lack of access to information about the projects, a complete application of the Protocol would be difficult. Nevertheless, it was attempted to use the information available, in a partial assessment. Written information was collected from online sources, like company homepages, public reports considering the environmental and social performance of the projects, and from newspaper articles. In addition, one interview was held with an important actor in each project, following the structure of the indicators in the Protocol. Together with the written material, this constituted the information used for assessing the projects.

According to the guidelines of the Protocol, the assessment should be conducted during the project's planning phase. However, the objective here is to examine the applicability of the Protocol, and by investigating projects already in operation it is believed that we also can draw on the experiences from the project. If the result of using the Protocol is a generally high score, and the project similarly is observed to have had a track record of transferring technology, it could be an indication of the validity of the Protocol as a measure of technology transfer. When considering the track record, the models developed for understanding technology transfer in Chapter 5 are used. The Level Model shows which levels the projects have attained, whereas the Tier Model shows how technology has been transferred. Further, by examining projects in detail we would be able to improve the Protocol, as additional insight about the recommended practices of transferring technology are gained. This will thus be an additional stage in the iterative process of improving and refining the Protocol.

The interviews for both projects were carried out with senior management. For Khimti, an interview was arranged with Tom Solberg, former general manager of Himal Power Ltd, the single purpose company responsible for the hydropower plant in Nepal (SNPower is the majority owner of Himal Power Ltd). For the wind power project Totoral, an interview was held with Nils Huseby, executive Vice President of SNPower in South America.

PART II:

Overview of the Protocol

7 Introduction to the Protocol

In this chapter we present the Protocol - the synthesis and end product of our master thesis. Firstly, we outline the structure of the Protocol and introduce the scoring methodology. Secondly, a sample indicator will be presented, including the development process from the visions and goals to the final indicator.

7.1 Purpose of use

The Protocol is a stand-alone tool for assessing technology transfer in cross-country energy projects. The use of the Protocol will guarantee that a broad, thorough consideration of the project is conducted regarding its potential for technology transfer. Such a confirmation could be used as a competitive advantage for the provider of a technology when attracting local business partners, when negotiating with host countries, or when justifying grants from national aid agencies and financial institutions. If objectivity is required, a third party could undertake the review. As the assessment should be conducted prior to the implementation and operation of the project, the Protocol will also provide guidance of recommended practices. The Protocol could thereby function as a checklist of "Best Practice" for ensuring successful transfer of technology to a local partner/recipient.

7.2 Generic and Technology-specific indicator sets

The Protocol consists of two main sections; one set of generic indicators, and one set for technology-specific indicators. The generic indicators are suited for assessing all types of energy production technologies on a general level. This includes investigating a range of aspects, like the social influence of the project, the local business implications, environmental impacts, need for technology and the local institutional situation. The generic indicators have in common that they are appropriate to consider for all energy projects, regardless of size, location and technology. As it became evident that a generic indicator set alone would not be satisfactory when considering different types of energy projects, it was decided to further operationalise the Protocol by augmenting the generic indicator set with technology-specific indicators. The specific indicator set goes into more details regarding the technology in question.

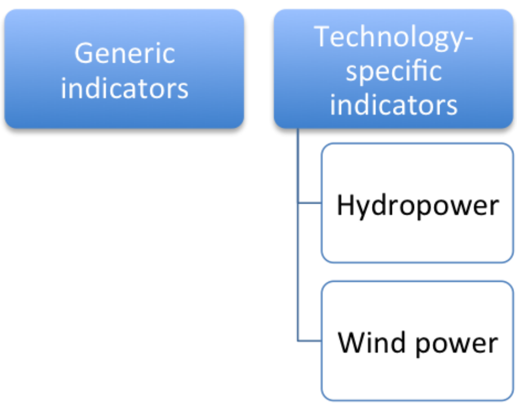

Figure 13: Illustration of different indicator sets

By considering both the generic and technology-specific characteristics, the full assessment will be complete. The intention is that the users utilise both parts of the Protocol when assessing the prospected technology transfer in a project. During the work with our master thesis we have developed two sets of technology-specific indicators: one for wind power projects, and one for hydropower projects. The Protocol can thus be used in completeness for these types of projects, and indicatively for other technologies by making use of only the generic part.

7.3 Wind Power and Hydropower projects

In collaboration with DNV, it was decided to focus exclusively on wind power and hydropower projects in this thesis; however further additions could readily be made for other technologies, e.g. solar, offshore wind, nuclear, or even CCS projects. The main rationale behind the choice of wind- and hydropower projects was that there exist a sufficient amount of international experiences from such projects. As a thorough feedback process was wanted, the competence in Norway generally, and NTNU specifically, made hydropower an obvious choice. This technology has also been transferred through aid assistance for many decades. In addition it would be interesting to examine a more novel technology, and onshore wind power was chosen for this purpose.

The generic part of the Protocol has been considered and improved through the Delphi Study. The technology-specific indicators were also evaluated and reviewed, however not in such a rigorous and exhaustive manner. The indicators for hydropower were considered by professors in hydropower technologies at NTNU, by Statkraft, and by ICH. An experienced expert from DNV China has reviewed the indicators for the wind power projects.

7.4 Project life cycle

When considering the technology transfer in international energy projects it is important to understand how such projects evolve. Inspired by the methodology in the Hydropower Sustainability Assessment Protocol from the IHA (2010), the project is considered to consist of four major stages: Early Stage, Preparation Stage, Implementation Stage and the Operation Stage. The transition of a project through its phases is defined based on easily separable milestones: The Early Stage lasts through the planning phase, until the final investment decision is made. The Preparation Stage continues, and lasts until the construction is commenced. The Implementation Stage lasts through construction, transportation and installation, and ends with the commissioning of the plant. The Operation Stage continues until the project is decommissioned.

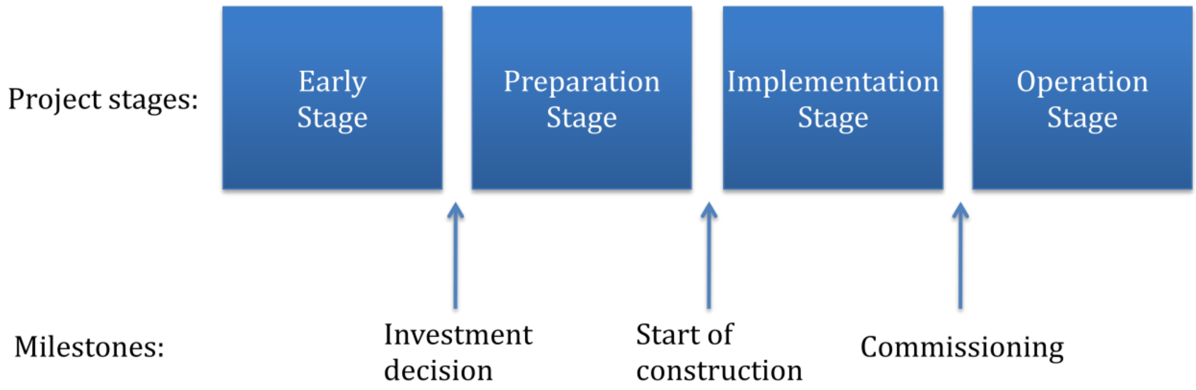

Figure 14: The Project Life Cycle

It is apparently a clear link between the Level Model from Chapter 5.1, and the Project Life Cycle. In the Level Model it was emphasised that the actual technology transfer depends on which level the project has reached, from planning, implementation, operation, long-term operation and diffusion of technology. Note that the Level Model will be used when observing actual technology transfer performance in case studies, as a benchmark to the indications from the Protocol. The Project Life Cycle, however, is used to illustrate *when* the actions in the Protocol should be conducted. As Figure 14 illustrates, the planning phase from the Level Model coincides with the two first stages of the Project Life Cycle; The Early Stage, and The Preparation Stage.

The indicators in the Protocol outline what actions should be taken before the investment decision is made (The Early Stage) and in the preparatory phase before the construction has started (The Preparation Stage). The focus in the Protocol is thus on *what actions should be taken by the project prior to the implementation and operation to ensure technology transfer.* The stage-wise presentation of the indicators in the Protocol emphasises this. By conducting the evaluation of the potential for technology transfer before the construction is commenced, the assessor assures that he considers the project when the most crucial decisions are made. By stating specifically what should be done in this early phase, the Protocol is built on the insight that a thorough planning process is necessary for ensuring technology transfer. It is of course crucial to affirm that the plans are implemented, but the purpose of this Protocol has been to guide the preparatory work.

We have thus separated the generic indicator set into one part for the Early Stage, and one part for the Preparation Stage. To complete a full assessment in the planning phase both parts must be utilised. In addition to the generic indicators for the Preparation Stage, all technology-specific indicators are to be used at this stage. For further details regarding the stage structure it is referred to the user guidance in the Protocol, presented in Appendix 1.

7.5 The Structure of the Indicators

Each indicator in the Protocol is presented with the same structure: First the indicator is introduced with a brief account of what it addresses; then the relevance for the indicator for projects in developing countries is outlined, before the relevance for technology transfer is presented. Lastly, the fourth section presents the scoring used when assessing the project's potential for technology transfer. Two of the levels, "Good Practice" (3) and "Best Practice" (5) go into detail in presenting what is expected by the project to receive this score.

7.6 Scoring Methodology

The indicators are scored on a scale from 1 to 5. Score 3, "Good Practice", and Score 5, "Best Practice" provides specific, achievable and realistic performance measures that a project will be assessed against. Score 1, 2 and 4 are defined according to how much the project's performance deviates from Score 3 and Score 5. This scoring methodology is thus also in line with the Hydropower Sustainability Assessment Protocol provided by the IHA (2010).

The assessor should compare the conduct of the project according to the descriptions in the scoring points for each indicator. The scoring is not assigned until all requirements are fulfilled for this level.

7.6.1 "Good Practice"

Level 3 presents basic recommendations for a project concerning each indicator theme. These recommendations are what is considered to be "Good Practice" for ascertaining that technology transfer will occur during the life of the project. Even when situated in regions with scarce resources and low organisational capacities, the project should attempt to reach the level of "Good Practice".

7.6.2 "Best Practice"

Level 5 represents what is identified to be the most complete and comprehensive guidelines for transferring technology through international energy projects. "Best Practice" is demanding to attain for any given project, but represents the behaviour projects ultimately should strive for, if the purpose is to transfer the technology successfully.

7.7 Sample Indicator

The reason for presenting a sample indicator from the Protocol is to clarify the how the indicators are presented in their final edition, and thoroughly describe the development process for one indicator. For this purpose, the indicator for assessing the level of training for local employees is chosen.

The "Training" indicator is defined and developed under the social dimension. Following the outline in Figure 11, the development process commenced by defining sub-vision and goals for this dimension. The Social sub-vision stated the ultimate social objective for transferring an energy technology as:

> *"The technology transfer in the project should increase the local competence and skills, and improve the quality of life for the employees and the local community."*

Three explicit goals were formulated to operationalise this statement. Only the first goal dealt with the training of local employees. This goal was based on the first part of the sub-vision, to "increase the local competence and skills", and stated:

> *"All local employees should get the appropriate training".*

Summarised, the overarching social dimension led to a sub-vision, which further led to an explicit goal concerning the training of local employees. However, as described and argued in Chapter 6.1.3, the next step of the indicator formulation was changed from an intention of creating binary questions to the creation of broader indicators. The assessment of "Training" therefore includes a detailed description of both the issue's relevance to developing countries and technology transfer, as well as a comprehensive guide for scoring.

The "Training" indicator is presented on the following page, whereas the remaining 20 generic indicators are presented in the Protocol.

P-5 Training

Definition

Training addresses the process of increasing knowledge, know-how and skills of the local workers, and includes both formal and informal education.

Relevance for projects in Developing Countries

The knowledge, skills and experiences of the human resources in the project is the most important asset of the project, and the quality of the training and education of employees is therefore of key importance to the viability of the project.

Relevance for Technology Transfer

Appropriate and extensive training of local employees is crucial in order to ensure a successful transfer of the codified and tacit knowledge surrounding a technology (Kline et al. 2004, Wilkins 2002, Metz et al. 2000). Training activities are examples of internal capacity building, which is a prerequisite for having long-term, sustainable use of a technology in the local environment.

Scoring

1 – The project has not implemented any aspects from good practice.

2 – The project has implemented one or more aspects from good practice.

3 - Good Practice:

The project has plans for:

- providing written manuals or other education material in the appropriate language(s). Note, when local workers are illiterate, information may have to be provided through illustrations or orally.
- giving the local technical employees the necessary relevant education on the installation, operation and maintenance of the technology, through courses, seminars or workshops.
- giving technical employees actual on-site training.
- providing sufficient training to build capacity in managerial areas, e.g. finance and control, management and HR.

4 - In addition to good practice, the project has implemented one or two aspects from best practice.

5 - Best Practice:

In addition to good practice, the project has plans for:

- providing training on standards, testing methodologies and certification procedures.
- providing local employees with formal education like craft certificates and diplomas.
- giving local employees technical training at a regional technology centre, or in another facility operated by the sender organisation.

8 Overview of the Indicators

This chapter will be devoted to present the generic and technology-specific indicators. We have chosen to summarise the core of the issues, their relevance to technology transfer, and the key actions recommended in the Protocol to achieve "Good Practice" and "Best Practice" scoring levels. For each indicator it is outlined whether the scoring should be done in the Early Stage, or the Preparation Stage.

In the Protocol the indicators are presented according to the timing of the assessment. In this summary, however, the indicators are ordered thematically, as illustrated in Table 6 below. The thematic presentation follows the structure of the five overarching dimensions: Social, Business, Institutional, Environmental and Technological. For each of the dimensions an introduction outlines the choice of dimension, and its relevance to technology transfer. After the generic indicators are presented, we move on to the technology-specific indicators. Here the indicators developed for hydro- and wind power projects are presented.

It is advisable to simultaneously look at the indicators in the Protocol in Appendix 1, while reading this section.

8.1 Generic Indicators

Table 6: Overview of generic indicators in the Protocol

Nr	Indicator	Dimension	Early Stage	Preparation
1	Social aspects	Social	X	X
2	Behaviour and CSR	Social		X
3	Local Dialogue	Social		X
4	Local Employment	Social		X
5	Training	Social		X
6	Culture and Language	Social		X
7	Environmental Aspects	Environmental	X	X
8	National policies	Institutional	X	
9	Political and legal risks	Institutional	X	
10	Intellectual Property Rights	Institutional	X	
11	Communication with Officials	Institutional		X
12	Economic viability	Business	X	
13	Financial viability	Business	X	
14	Ownership	Business	X	
15	Sourcing	Business		X
16	Project Management	Business		X
17	Technological needs	Technological	X	
18	Infrastructure	Technological		X
19	Transfer of Experiences	Technological		X

8.1.1 Social Dimension

This dimension consists of the social aspects found to be most relevant for high-level technology transfer. At this stage it is important to remember how comprehensive the process of technology transfer is. Technology transfer will contribute to both socio-economic and socio-cultural changes in the local communities, and social aspects are also determining the development and operation of the project in the first place.

Even though developing countries seek new technologies as a mean for national development, most of them also experience social and cultural problems related to the use, adaptation and diffusion of these new technologies (Cohen 2004). As we know that lack of social acceptance is an important barrier to technology transfer (see for example UNFCCC 2009, Mallett 2007), it is decisive to address these potential problems from the outset to ensure successful implementation. Furthermore, the potential for technology transfer is directly dependent upon social factors such as cultural and linguistic differences, literacy, technically skilled workforce, etc. These issues must also be assessed and understood by the project management, in order to plan the correct amount of training and provide enough and timely information.

The Protocol consists of <u>seven</u> indicators under the social dimension. The “Social Screening” and “Social Impacts Assessment” both cover an overall understanding of social aspects in the Early Stage and Preparation Stage respectively, and will be presented jointly here. The remaining issues that will be discussed are “Behaviour and Corporate Social Responsibility”, “Local Dialogue”, “Local Employment”, “Training”, and “Culture and Language”.

1. <u>Social aspects</u>

Social aspects are influential on the success of technology transfer in several ways. The technical skills of local workers impact the need for training (Norad 2010b), cultural differences may complicate foreign and local cooperation, while negative social impacts may reduce the social acceptance of the project. As stated, social acceptance is often cited as an important barrier to technology transfer (UNFCCC 2009b, Mallett 2007).

Wüstenhagen (2007) divides the social acceptance into three refined categories: Socio-political acceptance, community acceptance and market acceptance. Socio-political acceptance is acceptance on the most general level, by the public, key stakeholders, and by policy makers. The changes in attitude towards renewable energy when moving from the global to the local level can be explained in this category. The second perspective is community acceptance, which refers to the acceptance of location decisions and renewable energy projects by local residents and authorities. Here the discussion on NIMBYism (Not In My Back Yard) unfolds, where it is argued that there is high acceptance of renewable energy, as long as it is not located in people’s proximity. However, other argues that this view is an over-simplification, or has even found the opposite effect to be true. The third perspective of acceptance is the market acceptance, which is the process of market adoption of the technology. This is acceptance from the investors, within the project, and from consumers, like the emergence of green power marketing illustrates. (Wüstenhagen et al. 2007)

To overcome the barrier of social acceptance, and ensure that the technology will be accepted and utilised, it is important to involve all relevant stakeholders and the local community in all stages of the project. This should lead to an increase in the community acceptance, through making what is denoted as "procedural justice" (Wüstenhagen et al. 2007, p. 2685).

Scoring

In the Early Stage of the project it is not possible to have extensive interaction with affected stakeholders. The project management should therefore conduct a social screening, to determine severe social risk factors, cultural differences and important stakeholders. It should also ensure that the project can manage the different risks that are identified, which is important to bear in mind before making the investment decision.

In the Preparation Stage, it is necessary to have more direct contact with the stakeholders. Here the project should ensure that no stakeholder groups are severely impacted without being compensated, and special attention should be given to traditionally weaker groups, such as women and indigenous people.

2. Behaviour and Corporate Social Responsibility

The energy sector is considered as one of the most corrupt industries in many countries, with possible attempts of corrupt practices occurring in the whole supply chain, in contact with government officials, and during all phases of the project. However, the pressure for illicit outlays is reduced when a project consistently demonstrates that it will not accept irregular payments (UN Global Compact 2010, Norad 2010b).

To be accepted locally, and give the project legitimacy, it is also necessary that the project behaves responsibly and has a net positive effect on the local community. In a report on CSR to the Norwegian Parliament, it is argued that "Companies should promote positive social development through value creation and responsible business conduct, and by taking the local community and other stakeholders into consideration" (Norwegian Ministry of Foreign Affairs 2009, p. 8). As lack of social acceptance is an important barrier to technology transfer, such ethical and responsible conduct will help gaining public support, improving the reputation locally, and be positive for future recruitment.

Scoring

In the Preparation Stage, a Code of Ethics should be formulated and adopted by all project participants, as a means to ensure ethical behaviour both among the project's own employees and external contractors and suppliers. Participation in the UN Global Compact initiative and incorporation of the ten principles of the Global Compact is also beneficial and gives credibility to the project. Furthermore, it should demonstrate what local benefits completion of the project will contribute to, e.g. improved health services, new infrastructure, better communication and education.

3. Local Dialogue

Local dialogue refers to the importance of two-way communication with local stakeholders. It includes provision of sufficient information, the possibility for feedback from the stakeholders to the project, and proper treatment and follow-up of such contributions. In many developing countries illiteracy is widespread, thus information must be provided both written and orally. Wilkins (2002) argues that if the technology transfer should be successful in the long-run, the project must acknowledge the needs and challenges of the local community. Another barrier to technology transfer that can be dealt with by local dialogue is the challenge of adapting the technology to local conditions (Wilkins 2002, UNFCCC 2009b).

Scoring

In the Preparation Stage it is important that the project provides information on both scope and consequences of the project. Relevant channels are flyers, newspapers, advertisements, presentations and meetings. Contributions should be welcomed during meetings, through written and oral feedback at a local office or to a local representative. The project should establish routines to make sure all suggestions are well handled. Where Internet connection is available to a substantial part of the population, e.g. in Internet cafés, provision of a website with information and an online feedback solution is beneficial.

4. Local Employment

Energy projects might create both direct and indirect jobs. Direct jobs include work in manufacturing, construction, installation, operation and maintenance, while indirect jobs include work in the service sector and the supplier industries producing necessary components and intermediate goods. Such job creation is an important local benefit to the society which will increase the social acceptance and ensure support for the project (ECOFYS 2010, Kline et al. 2004). However, it is also necessary to acknowledge that there is likely to be a lack of technically skilled local labour (Wilkins 2002).

Involvement of local employment is one of the most important criteria for successful technology transfer and thriving operation of the project itself. There are numerous examples of aid supported foreign projects which have failed as soon as the international party has withdrawn all its workers, and left the operation to a local party without sufficient integration of the workers beforehand (Feeney 1998). It is therefore necessary for the project to include the local workers in all activities and in all phases of the project. As a mean of empowering weaker groups, the project should also seek to include women and indigenous people in the working crew. However, as this may not always be possible or culturally acceptable, it is omitted as a distinct scoring criterion.

It is also argued that the project should encourage unionisation by the local workers. Seen from the perspective of the employer, unions strengthen the workers' bargaining power, but it also gives them a common voice that the employer more easily can communicate with. The workers may feel more listened to, which can improve the social acceptance. Sousa (2001) also notes that the presence of trade unions is associated with provision of more training for unskilled workers.

Recall that the Protocol is developed for application of energy projects with technologies either directly or indirectly used for power production. These types of projects are large scale, and have great risk of injuring personnel during all phases and in many kinds of activities. The potential dangers are especially related to electrical, mechanical and chemical work. It is therefore crucial that Environment, Health and Safety (EHS) issues are taken seriously, and that routines for avoiding accidents are put in place from the start. This includes thorough EHS and first aid training of foremen, and also an introduction to EHS thinking for all workers.

Scoring

In the Preparation Stage, "Good Practice" concerning use of local employment requires plans to hire local employees, to as great extent as possible, both in construction, operation and maintenance of the project. It should also be local representation in most levels of the organisation. To mitigate the risk for accidents, EHS routines must have been established. To get a higher score, more local involvement in the planning phase must be demonstrated and local consultants and contractors are engaged where this is possible.

5. Training

The actual hardware in a technology project is useless if the workers are unable to install it correctly or operate it in an efficient way. The definition adopted in this report acknowledges that technology incorporates the equipment (hardware), codified descriptions (software), and know-how (tacit knowledge). Wilkins (2002) identified lack of technically skilled labour as a severe barrier to technology transfer, and in UNFCCC's review of TNAs more than 70% of the countries reported that some form of human barriers were an important hindrance for speeding up technology transfer (UNFCCC 2009b).

As discussed previously, involvement of local employees is important to increase the actual technology transfer in the project, but it is also crucial that sufficient training is given to these workers. While manuals and blueprints may be a good source for transferring the codified knowledge, in-house training and direct integration of foreign and local employees is necessary for transferring the tacit knowledge (Marcotte and Niosi 2005). Note also, that as illiteracy is widespread in many developing countries, basic training to unskilled workers may have to be given orally or through illustrations.

Training of local employees is a necessity to make the project successful. However, extensive training also increases the attractiveness of the trained workforce outside the project, and the project is in the risk of brain drain. It is important to be aware of this risk, and evaluate the possibility of using efficiency wages to provide incentives for the staff to stay (Driesen and Popp 2010).

Scoring

In the Preparation Stage provision of printed instructions (written and graphical), education through courses, seminars and workshops, on-site training by skilled personnel, and training in managerial and back-office services should be provided to receive a "Good Practice" score. "Best Practice" requires additional training on standards and certification procedures, more formal education which gives the staff craft certificates etc., and send technical staff to other facilities to give them hands-on experience and increased tacit knowledge early in the project.

6. **Culture and Language**

Cultural differences are challenging to technology transfer in two ways. Firstly, cultural habits may be important for the social acceptance of the technology. Social practices, beliefs and norms that prevent acceptance must therefore be known and addressed by the project management (Metz et al. 2000, UNDESA 2008). Secondly, cultural differences between the representatives from the sender country and employees from the host country will complicate cooperation and communication. Geert Hofstede identified five dimensions along which cultural differences between countries could be explained, and states that "…these differences affect the validity of management techniques and philosophies in various countries within the functioning and meaning of planning" (Hofstede 1984, p. 81). This is important in the day-to-day activities, but also, and maybe especially so, in the training activities.

The language barrier is closely related to the challenge of cultural differences. Different languages will also impede cooperation internally and make training activities difficult (Agrawal and Mathami 1994, Feely and Harzing 2002). In addition, different languages will make communication with other stakeholders such as officials and those affected by the project more complicated.

Scoring

In the Preparation Stage, an assessment of the culture and languages spoken in the local communities should be undertaken. Key differences between actors should be identified, and project participants should be given information on these differences and how to deal with them. All information and training to local employees and stakeholders must be given in a well-understood language. "Best Practice" will require a more thorough study of Hofstedes' cultural dimensions, as well as attempts to remove language barriers, e.g. by providing language courses.

8.1.2 Environmental dimension

The environmental dimension is included as a superstructure covering the environmental concerns the project needs to focus on. We argue that acceptance of the project in the local community is very dependent upon the environmental performance it exhibits. By making sure that the project has a responsible behaviour, including minimising local environmental hazards, the social acceptance of the project can be sustained. In this manner, the project needs to assess, avoid or minimise the environmental impacts, and compensate those that are negatively affected.

The Protocol consists of <u>two</u> indicators under the environmental dimension. The Environmental Screening" and "Environmental Impacts Assessment" both cover an overall understanding of environmental aspects in the Early Stage and Preparation Stage respectively, and will be presented jointly here.

7. <u>Environmental Aspects</u>

The International Energy Agency argues that a sound energy project must have a net positive environmental effect to avoid degradation of the local acceptance (IEA 2001). Without a true concern about the environment, the project is in great risk of not getting the necessary support from neither local communities nor the local authorities. The energy technologies assessed with this Protocol are likely to contribute to mitigation of greenhouse gases, and could thus provide benefits in a global perspective. However, at the local level, most projects will have some negative environmental impacts as well. It is therefore important to be aware of these impacts, to ensure that the project is perceived as beneficial by the neighbouring community.

All projects partly financed by IFC must conduct an Environmental Impact Assessment (EIA) prior to the disbursement of funds, and most national laws and regulations now demand the same (Norad 2010b, Wood 2003). Local environmental factors that must be assessed include erosion, water usage and quality, biodiversity, ecosystem robustness, pollution, endangered species and vulnerable habitats.

There should also be undertaken an assessment of how the project influences land and natural resources beyond its ownership. Such an assessment includes looking at potential environmental and social consequences on productive resources like agricultural areas or alternative land use, and natural resources like water, rivers, forests and coastal areas. Changed access to such resources may result in the most severe consequences for those affected, and are therefore essential for local acceptance, authority approvals and later access to employment. Large-scale energy projects will make use of land and natural resources that potentially affect local communities or smaller stakeholder groups. Land use is a particular problem in hydropower projects, but can also be relevant when establishing a wind park or other space-requiring energy technologies.

Scoring

In the Early Stage we argue that the project should complete an environmental screening, where the goal is to identify the key environmental risk factors, and demonstrate that it can handle these risks. For "Best Practice" it is necessary to utilise sophisticated risk management tools such as risk matrices.

In the Preparation Stage the EIA must be completed, including the formulation of a baseline which the project's performance can be measured against. The project must also investigate how its conduct will affect land and natural resources beyond its ownership. Routines for continuous monitoring and management of environmental risks must be established. To obtain a "Best Practice"-level, the project must also conduct a life cycle assessment (LCA) and implement an internationally acknowledged environmental management standard reviewed by an independent third-party, such as the ISO 14001.

8.1.3 Institutional Dimension

The institutional dimension incorporates the recommended practices related to national policies, institutions, and the legislative framework. The project needs to address the political and legal risks, the intellectual property regulations, examine the national policies and ensure a well-functioning communication with official institutions and authorities. By making a careful assessment of the local political and legal conditions, and establishing valuable relationships with key actors like energy departments, regulators and the embassy, the project has ensured that it has done its utmost to address the barriers to technology transfer in the institutional dimension.

The Protocol consists of the following <u>four</u> indicators under the institutional dimension: "National Policies", Political and Legal Risks", "Intellectual Property Rights" and "Communication with Officials".

8. <u>National policies</u>

This issue addresses the national policy regime in the host country. National policies include plans and targets set for the energy sector of importance for the project during its preparation, implementation and operation phase. To consider the national policies is crucial, as lack of clear plans and integrated planning for energy development constitutes a severe threat to transfer of energy technologies (Wilkins 2002, UNDESA 2008). DNV's participant in the Delphi Survey also stated that, *"... without necessary political understanding and foundation, there is a great possibility for failing in international energy projects"* (our translation). The quality of national policies and integrated planning influence the development of the whole project, so it is necessary to be aware of and adapt to these conditions. By evaluating potential weaknesses and complexities in the policies and plans, such obstacles can be managed more effectively.

Scoring

In the Early Stage the project should have undertaken a thorough assessment of the national policies including relevant sub-sectors like energy, climate, urban and rural infrastructure planning, land use, water and biodiversity. The plans and targets for the energy sector are also important to consider, and to align the project with. "Best Practice" requires expanding the national policy assessment to include social issues, and ensure that the project is able to manage the risks related to the national policies.

9. Political and legal risks

Political and legal risks affect investments in developing countries significantly, and political risk is ranked as the most important constraint for FDI in developing countries in the medium term (MIGA 2010). The representative from Statkraft participating in the Delphi Survey also stated that *"... this issue is very important for investing in a project, and thereby transferring technology"* (our translation). Energy projects are generally of large scale, and it is therefore essential to understand and manage all major risks as early as possible. This includes the risk of political forces or events influencing its operation, like expropriation, breach of contract by host governments, political unrest and politically motivated interference.

Legal risks include contract and regulatory risks, and it is vital to adequately assess these risks before the investment decision is made (Metz et al. 2000). High contract risks, e.g. through weak legal institutions, might imply that the project will have difficulties recovering costs in the legal system. Regulatory risk includes aspects like licenses, tariffs, taxation, foreign exchange and trade control, and covers both the transparency and enforcement of the regulations.

A thorough consideration of the political and legal risks is deemed very important for successful investments in emerging markets (Wilkins 2002, Metz et al. 2000). Either of these categories of risks have the potential to negatively affect the project throughout its course, thus reducing or even ruining the prospected technology transfer.

Scoring

In the Early Stage of the project the political and legal risks should be considered, including examining the political situation in the country, the position of the legal institutions, laws and regulations and establishing routines for continuous risk management.

10. Intellectual Property Rights (IPR)

The issue of legal rights is augmented with an indicator addressing how Intellectual Property Rights influence investments in developing countries. Intellectual Property refers to creations of the mind, and relates to "items of information or knowledge, which can be incorporated in tangible objects at the same time in an unlimited number of copies at different locations anywhere in the world" (WIPO 2005, p. 3). When introducing a new technology, too soft IPR could impose a threat to the project, by diluting the value of the technology through unauthorised diffusion. Thus, IPR is clearly highly relevant for technology transfer. However, there are conflicting views about IPR and technology transfer in developed and developing countries (UNDESA 2008). Exporters of technology argue that strong IPR is necessary to ensure the rights of the developer, and thereby will support technology transfer. On the contrary, most developing countries want to spread the technology inside their country, and could therefore be reluctant to impose too strong IPR-regulations (Magic 2003).

The importance of IPR hinge on how mature the technology is. OECD (2005) states that many energy technologies are not protected by patents, and thus, IPR is irrelevant. Nevertheless, for technologies that should still be protected, it is necessary to assess the IPR of the host country, and see this in connection with the legal institutions that enforce them.

Scoring

In the Early Stage, the Intellectual Property Rights of the country should be considered. What is imperative here is to assess whether the IPR is sufficient and appropriate for the given technology. Another important aspect to consider is how the national legal institutions actually enforce IPR regulations.

11. Communication with Officials

Communication with Officials explores the challenges related to insufficient communication between government departments and the management in energy projects. Often the responsibility for different aspects relevant for energy projects is divided among several government departments, and communication between these departments may be poor.

Unsatisfactory communication and coordination between involved government actors is detrimental to technology transfer (UNDESA 2008). Split responsibility for renewable energy policy and planning might result in slow implementation of necessary revisions of policies, plans and regulations. It is therefore essential that the project itself is aware of these problems and has established good connections in all relevant official institutions (Wilkins 2002). Additionally, the embassy of the sender country can often be a potential door opener for the project in its communication with the host-country's institutions (Norad 2010b).

Scoring

In the Preparation Stage the Communication with Officials should be started. The relevant official institutions should be identified, the embassy of the sender country should be contacted, and connection with the right officials established. "Best Practice" includes establishing routines for providing information to contacts regularly, and identification and management of risks related to lacking or unclear communication between official institutions, and how this might influence the project.

8.1.4 Business Dimension

The business dimension is an integration of the most important features the sender should consider, related to the economic success of the project. By including the business dimension among the perspectives, we acknowledge the important role economic performance in the private sector has in contributing to technology transfer. Whereas the other dimensions have a primary focus on the project's performance locally (e.g. social and environmental) or the external operating conditions (technological and institutional), the business perspective has the sender as principal. Even though important features of the recipient and the project are considered here as well, the point of view is from the provider of the technology. Such a conscious choice of perspective enables the sender to more clearly appreciate the purpose of the Protocol, as well as acknowledging that the private sector requires economically viable investments.

The Protocol includes the following five indicators under the business dimension: "Economic Viability", Financial Viability", "Ownership", "Sourcing" and "Project Management".

12. Economic viability

The economic viability addresses the long-term economic performance of the project. The technology transfer in a project is dependent on a sound economic situation, both to enable a successful, long-lasting project, but also to be a proof of the feasibility of the technology in the local environment. Recalling the TNA-study in Chapter 4.2.2, it was shown that economic barriers are the most commonly identified impediments to technology transfer (UNFCCC 2009b). The economic viability is also related to the structure of the holding company. Norad (2010b) emphasise that the structure should ensure that taxes are kept at a normal level, free cash flow is assured, and gives good opportunities for exit. The local regulations on proceeds from divestments and repatriation of dividends are also important economic aspect to consider (Norad 2010b).

Scoring

In the Early Stage the project should have conducted the necessary economic analyses, described its intention through a detailed business plan, and examined the national economic characteristics like tariffs, subsidies and taxation to ensure a basic level of knowledge about the project and its economic surroundings. To appropriately deal with the inherent risks, scenario and sensitivity analyses should be used, and tools like the World Bank Group's "Investing Across Borders" could be utilised to identify levels of bureaucracy and legal barriers in the country of interest. The economic analysis conducted prior to the investment decision is crucial for the projects success, and should be continuously updated throughout the different phases.

13. Financial viability

One of the key barriers for successful projects is the lack of access to capital (Wilkins 2002). The issue of financial viability examines the project's need for, and access to, finance throughout the lifetime, and its ability to meet its financial obligations. Energy projects tend to be large-scale, long lasting and with a high initial investment, so financial costs constitute a substantial part of the payable expenses during its lifetime. Projects incorporating the recommended practices of technology transfer will also incur higher initial costs, due to extensive training of local employment, costly routines for cooperation with stakeholders and collaboration with other actors, as well as time-demanding risk assessments. These costs could be justified by the prospected increase in technology transfer they ensure, and thus better performance over time.

Norad's case study (2010b) identified that the by-far most popular form of financing energy projects in developing countries was project finance. The advantages of having project financing were to limit the risk of the equity in the project, making it easier to get support from multilateral banks, and it is a more appropriate form of financing when organising a project as Joint Venture. The advantages of using balance sheet financing are that the economic conditions usually are better, and that it requires less contracts and agreements, entailing lower transaction costs.

To ensure financing from international financing institutions, the lender has to comply with standards and principles as requested from the financier. A large majority of projects financed through project finance is based on requirements from the IFC, and the Equator Principles[§] (Vista Analyse 2011). An extensive and reliable financial analysis is necessary to attract project financiers, and is an advantage in receiving grants and finance from donors and development banks.

Scoring

In the Early Stage the project should therefore perform an assessment of the financial soundness, assess the future cash flows of the project and demonstrate that it can handle its debt under a range of scenarios. Such an assessment should also relate to the choice of ownership structure in the project.

14. Ownership

The choice of ownership structure depends on a range of aspects, including the preferences of the sender and the recipient, local regulations, and requirements from lenders or official development assistance agencies. Another aspect is how ownership structure influences the transfer of a technology. Some have argued that a degree of local ownership is favourable for reducing the barrier of social acceptance, thus enabling technology transfer (Devine-Wright 2005). More local involvement in all phases and at all levels of the project will imply a higher degree of learning for the recipient party in the transfer process. UNDESA (2008) states that technology partnerships between developed and developing country actors have been very effective in technology development and transfer, provided that they include a long-term commitment, in a two-way relationship.

Anderson and Forsyth (1998) have identified that Joint Ventures between a local and an international actor is a very effective form of organisation for technology transfer. Moreover, when choosing an equity partner a reputational due diligence must be performed. Partners without the required ethical standards, or with a bad reputation locally or among development banks, could be detrimental for the success of the project (Norad 2010b).

[§] The equator principles are a voluntary set of standards for managing risks in project finance. It was developed by private sector banks, in collaboration with the IFC, project actors and NGOs. (The Equator Principles, 2011).

There are certain advantages for a sender having a majority share of ownership; it increases control of operation, reduces risk of corruption and ensures control of maintenance and spending (Norad 2010b). Without such a majority position, it is important that the shareholder agreement is strong, the partner has a good reputation and access to necessary information is assured through central positions and veto rights (Norad 2010b).

Scoring

In the Early Stage the structure of ownership is considered, and to enhance the technology transfer related to the project, "Good Practice" requires that there is some extent of local ownership in the project. Furthermore when choosing an equity partner, a reputational due diligence must be undertaken. "Best Practice" recommends establishing the project in a collaborative effort between the sender and a local organisation.

15. Sourcing

The issue of sourcing addresses the purchases of all necessary physical resources throughout the lifetime of the project. Unreliable supply of expendable parts are considered a threat to technology transfer, as it may impede the stability of operations, and possibly cause shutdowns (Wilkins 2002). As reliable supply of key resources is essential to the success of the project, it is important to consider the topic early. Stable, long-term sourcing from local suppliers could be beneficial for the project itself and for technology transfer, through an increase of competence among the suppliers, and as it may improve the existing market or create new markets (UNCTAD 2004). The resources should in any case have sufficient quality, be delivered timely and be procured in a transparent and accountable way. IFC also recommends that when resettling, or otherwise severely affecting stakeholder groups, the project should promote " (…) local enterprise by producing goods and services for their projects from local suppliers." (IFC 2002, p. 38)

Scoring

In the Preparation Stage the project should have considered its expected use of resources throughout its lifetime, and identified and assessed its potential suppliers. It is beneficial for the technology transfer that local suppliers are chosen whenever competitive, and that long-term contracts are established for delivery of the most important resources and spare parts needed throughout the project. Finally, the supply chain risks of the project must be managed satisfactory.

16. Project Management

Project management addresses the developer's ability of managing all activities of the project through its phases. All technology transfer transactions encompass considerable project-based work. Contrary to more conventional projects, an international project exhibiting technology transfer does not end with the hand-over phase, and they are complex and risky containing uncertainty from technological, organisational, social, political and cultural factors (Saad et al. 2002). A holistic and integrated approach taking into account project management perspectives will thus be beneficial.

Scoring

In the Preparation Stage the project should coordinate all activities to meet milestones and critical success factors, and to be able to manage potential delays in components. An integrated project management plan should be developed, including project schedule, estimated effort and resource use, roles and responsibilities, taking all prospected activities into account. Introducing monitoring, evaluation and control systems would enable identification of challenges and delays, and provide guidance in how to intervene for corrective actions, and handle delays.

8.1.5 Technological Dimension

As the mission of the Protocol is to assess the expected potential for technology transfer in a project, it is considered highly important to examine the technological aspects of technology transfer explicitly. For every energy technology a specific set of indicators has to be developed, as we illustrate in this thesis by presenting indicators for hydropower in Chapter 8.1.1 and for wind power in Chapter 8.2.2. These are the so-called technology-specific indicators of the Protocol. However, some technological categories are overarching, and should be considered in all energy projects.

The Protocol includes <u>three</u> overarching indicators under the technological dimension: "Technological Needs", "Infrastructure" and "Transfer of Experiences".

17. <u>Technological needs</u>

The choice between energy production alternatives is an important strategic consideration for a country, with implication for its security of supply, carbon footprint and technological knowledge base. The technology should be chosen based on the priorities and need of the host country, in order to be beneficial in the long term (Wilkins 2002, Kline et al. 2004). Such local benefits, and thus acceptance and utilisation of the technology, are prerequisites for successful technology transfer (Wilkins 2002). This implies that the project should examine and assure that the technology introduced is in accordance with the needs of the host country, i.e. as stated in the country's Technology Needs Assessment (TNA), or national plans and policies. The TNA is the country-driven identification and prioritisation of climate mitigation technologies under the climate convention (UNFCCC 2009b). The investments in energy projects in developing countries will potentially influence the water and energy services nationally, and this influence should be in line with the country's plans of prospected development.

Scoring

In the Early Stage the project should check how the host country prioritises the energy technology in the TNA. Recommended practices require that the energy technology at least is prioritised as a technology of interest, whereas a top score requires a prioritisation among the key technologies. The project should also assess whether the technology is called for in the host country's plans and policies.

18. Infrastructure

Infrastructure refers to the technical structures surrounding the project, e.g. roads, power grids, water supply and telecommunication. These technical structures deliver service by supporting the core production of the facility. When executing energy projects, a well-developed infrastructure is a strong advantage. For power producing facilities and other technologies dependent on secure power connections, the state of the power grid must be examined with scrutiny. A well-functioning infrastructure is more of a prerequisite for successful technology transfer than a cause itself. Albeit, the issue is still deemed important, as it is vital for the operation of most power producing projects to be connected to a well-functioning power grid, and further diffusion of technology is dependent on the quality of local infrastructure (UNFCCC 2009b). Improving the infrastructure would also be beneficial for the local communities (European Investment Bank 2011), thus potentially improving the social acceptance of the project.

Scoring

In the Preparation Stage the project should assess the quality of the power grid, roads, water supply and telecommunication, and examine the plans for national investments in relevant surrounding infrastructure. In addition, supporting necessary upgrading of the infrastructure could be beneficial for the project directly, and also through the potential benefits for the local community.

19. Transfer of experiences

Transfer of experiences include all types of formal or informal exchange of information with external actors involved in transferring and disseminating technology, e.g. exporters of technology, regional technology centres, universities or research institutions.

Wilkins (2002) argues that companies investing in and operating technologies in unfamiliar environments will benefit from cooperation with regional universities and other research institutions. Additionally, such cooperation or partnership could be valuable for diffusing knowledge, using local resources and attracting local educated labour. Contact with other actors with experiences from the same environment will also help to avoid doing typical mistakes. Kline et al. (2004) report that collaboration at many different levels help technology transfer to become more successful. Based on a study of several energy projects, they argue that sharing of experiences with actors facilitating or transferring technologies to the same area will help the project to gain better understanding of the environment. However acknowledging the positive effects of such cooperation, one of the participants of the Delphi study with long experience from the hydropower industry commented, *"... such competence institutions are currently almost non-existent"* (our translation).

Scoring

In the Preparation Stage, the project should have informal contact with universities, research institutions, and with technology networks or clusters (where this exists). Informal exchange could include sporadic conversations, meetings or e-mails. For a score of “Best Practise”, the cooperation with industry networks/clusters and research institutions must have been formalised e.g. through establishing partnerships, or other forms of formal, long-term cooperation.

8.2 Technology Specific Indicators

In addition to the generic indicator set presented above, we have developed two sets of technology-specific indicators. These indicators delve into the technological challenges related to two of the most promising renewable technologies, namely hydropower and wind power.

8.2.1 Hydropower projects

Norway has a long history in hydropower. The Norwegian competence in hydropower technology, through outstanding R&D (NTNU, Sintef), and an experienced hydropower actor in developing countries (SNPower), made it very interesting to look more into the technological challenges in international hydropower projects, related to technology transfer. The indicators presented below show the width of hydropower, through involving a broad range of technical aspects, and the duration of hydropower development, by including issues from all phases of the development process. Note that all these indicators should be assessed during ***the Preparation Stage***.

The following eight indicators are included for hydropower projects: “Hydrology”, “Erosion and Sedimentation”, “Location, Design and Reservoir Planning”, “Resettlement”, “Construction and Installation”, “Grid Integration”, “Downstream Flow Regime” and “Operation and Maintenance”.

Table 7: Overview of hydropower indicators in the Protocol

Nr	Indicator	Technology	Early Stage	Preparation
1	Hydrology	Hydropower		X
2	Erosion and Sedimentation	Hydropower		X
3	Location, Design and Reservoir Planning	Hydropower		X
4	Resettlement	Hydropower		X
5	Construction and Installation	Hydropower		X
6	Grid Integration	Hydropower		X
7	Downstream Flow Regime	Hydropower		X
8	Operation and Maintenance	Hydropower		X

1. Hydrology

Hydrology is the study of movement, distribution, and quality of water, and addresses thus both the hydrological cycle and water resources. The "Hydrology" indicator includes aspects like the availability and understanding of hydrological data, and the reliability of the hydrological resource in a hydropower project. Hydrological information is the basis for planning and design of reservoirs, and for operation planning of the power station (Takeuchi 1998).

Limited hydrological data (stream-flow and precipitation) in developing countries could constitute a severe risk factor in hydropower projects. Efficient operation of the reservoir is an important part of the technology, and in order to ensure successful technology transfer, local employees must be involved and get necessary training in analysing hydrological data. Lack of such competence on the local level could be a challenge in hydropower projects in developing countries (SWECO Grøner 2007). In countries where hydrological data is scarce, the project could also assist national institutions (e.g. meteorological institute) in establishing routines for collecting such data nationwide. Local consulting companies could be included in hydrological analyses for reservoir design.

Scoring

The project should provide training for local employees in analysing the resource availability, and in operation and management of the hydrological resource. "Best Practice" requires engaging local consulting firms in hydrological analyses, and establishing routines for collection of hydrological data in cooperation with the national meteorological institute where this is not in place.

2. Erosion and Sedimentation

Erosion and sedimentation may cause technical and economic challenges such as reducing storage capacity, eroding the blade runner and limiting project lifetime (Gulliver and Arndt 1991, IUCN 1997). It may also have social and environmental implications, through removing sediments in downstream water, thus reducing the depositing of nutrient rich silt potentially important for agriculture (World Bank 1991), and increase erosion in the riverbed below the dam (Breeze 2005). Sediment accumulation in the reservoir may be reduced through cooperation with local communities and authorities to improve catchment management practices (Sustainable Hydropower 2011). Social acceptance of the hydropower project is essential for successful technology transfer, and it is therefore important to assess these topics with respect to environmental and social objectives. The effects of erosion and sedimentation on the project itself must also be assessed, and necessary technical solutions must be implemented.

Scoring

The project should assess issues like erosion from external upstream activities, (e.g. agriculture), evaluate technical solutions to the problems, and assess the consequences for downstream communities. In addition, the project should plan to provide training in operation of technical facilities for sedimentation handling. To achieve "Best Practice" the project should have sought to address the problem of sediment accumulation through cooperation with local stakeholders, seeking Pareto-efficient solutions.

3. Location, Design and Reservoir Planning

The experience of the sender in locating and designing a hydropower station is an important part of the technology transfer to the host country. By involving local employees in the process of choosing location and design, the project could increase the experience level of the local participants. Participation by local employees in reservoir planning would support the building of knowledge and know-how surrounding the construction, filling, maintenance and operation of reservoirs. Stakeholder engagement and use of local employment will provide input about local conditions, in addition to contributing to increased social acceptance (IUCN 1997, p. 31).

Scoring

The project should carry out a thorough location and design process of the hydropower plant with broad consideration, and involve local stakeholder and employees in the process. "Best Practice" includes making use of local employment in all phases of reservoir planning. It also requires introducing and utilising software for modelling and managing reservoirs, and providing training to local employees in using such tools.

4. Resettlement

Resettlement is the process of moving inhabitants to a new place, due to the project. This might occur in hydropower projects with storage reservoirs, as productive areas and villages become flooded or otherwise harmed. The challenges of resettlement are huge, and claimed by World Bank advisors to be "(…) the most serious issue of hydropower projects nowadays" (IUCN 1997, p. 47). It is therefore important to raise the awareness of how to successfully conduct (or preferably avoid) a resettlement. Participation by local employees in the planning process, and engagement from stakeholders in how to properly compensate and ensure future beneficial development for those affected, is a prerequisite for an acceptable resettlement (IFC 2002).

IFC also provides livelihood restoration recommendations, which will affect technology transfer directly, if implemented. For wage earners the IFC recommends that projects with resettlements provide: "Sufficient lead time for training of affected people to enable them to compete for jobs related to the project". The IFC also note that those affected "may benefit from skills training and job-placement, provisions made in contracts with project subcontractors for employment of qualified local workers, unemployment insurance and small scale credit to finance start-up enterprises." (IFC 2002, p. 38) For enterprise-based livelihoods, the IFC recommends promotion of " (…) local enterprise by producing goods and services for their projects from local suppliers." In addition, IFC recommends that established enterprises might benefit from credit or training to expand businesses, thus generating local employment. (IFC 2002, p. 38)

Scoring

The project should prepare a Resettlement Action Plan in line with IFC recommendations, involve local employees in the planning, and engage local stakeholder early in the planning phase to discuss how those affected will become beneficiaries. To achieve "Best Practice" the project should provide affected wage earners with training and job-placement, offer enterprises financing and education to help improve and expand businesses, and give small-scale credit to finance start-up enterprises.

5. Construction and Installation

The installation of a hydropower plant involves technical challenges related to transportation and assembly of equipment, including electrical components, transformers, generators and turbines. Most likely components will need to be imported, and local workers will thus only be involved in parts of the installation. Still, local contractors could contribute in construction and transportation, as well as in necessary improvements of the infrastructure (Wilkins 2002). Knowledge sharing with local participants would also be beneficial for improving technology transfer related to the project (Cohen 2004).

Scoring

The project should include and train local workers in the construction activities of the hydropower plant, use local actors for transporting large components, and hire local contractors to execute necessary road improvements and construction of new roads. In addition, the project should consider arranging for knowledge sharing trough involving local employees in the installation of the technical equipment.

6. Grid Integration

Hydropower stations will normally be connected to the grid when the installed capacity is larger than 100 kW (ClimateTechWiki 2011a). Involvement of local employees in the installation of necessary equipment for grid matching, and provision of appropriate training to control, operate and maintain the equipment is decisive to ensure technology transfer (IEA 2000). Local participation in establishing agreements with relevant authorities (e.g. the energy regulator, Department of Energy and TSO/ISO) allowing the project to connect to the grid, and determining who is paying for the connection lines, would also be beneficial.

Scoring

The project should provide training to local employees in operating and controlling grid matching equipment, and include locals in using such equipment. In addition, the project should include local actors in its communication with authorities, negotiating grid access and compensation for the grid connection.

7. Downstream Flow Regime

Hydropower projects might cause great changes in the flow patterns downstream of the plant, since storage and release are managed based on power demand cycles rather than the hydrological cycles. This may have direct impacts on soils, vegetation, wildlife, fisheries, climate and human population (World Bank 1991). A comprehensive understanding of the effects of alterations in the downstream flow is therefore an important part of a successful hydropower project. In countries where specific regulations on flow regimes exist, the project has to assess and comply with these. However, regardless of regulations, the project has to predict the effects, and create a downstream flow regime in cooperation with the affected stakeholders. The regime should seek to optimise the relation between the benefits of the project and the negative impacts to the stakeholders.

Scoring

The project should undertake an assessment of downstream flow regimes in all affected river courses, the local regulations on flow regimes, and include affected stakeholders in the process. “Best Practice” suggests that the project should include local employees and consultants in the assessment and formulation of the flow regime.

8. Operation and Maintenance

A large part of the technology knowledge and know-how transferred through the project happens in the operation and maintenance-activities, performed by the local participants. The need for trained hydropower personnel and high availability rates, have made training in O&M an extremely important task for producers. In a report on this issue, IEA (2000) concludes by noting the importance of good planning of the training activities, and of the need to evaluate the competences needed for the personnel in their roles of the organisation.

Scoring

Already in the Preparation Stage the project should identify the competences in operation and maintenance needed throughout its existence. It should provide extensive and timely training in operating activities (e.g. facility protection, use of metering equipment, contingency handling and operation strategies) as well as maintenance activities (e.g. inspections, maintenance management systems, maintenance philosophy, rust protection and welding). To achieve “Best Practice”, the project should provide training in international designated facilities for the local personnel.

8.2.2 Wind Power

In the World Energy Outlook 2010, IEA estimates that the share of global power production from renewable energy sources will increase from 19% in 2008 to 33% in 2035, and that the highest growth will be in the wind industry (IEA 2010). This highlights the importance of transferring this technology to developing countries, and makes it interesting to extend the Protocol to address wind power explicitly. Lately, we have also seen a greater will to develop wind farms in Norway, and the national competence in this industry is gradually building up. This makes transfer of wind competence from Norway possible, and indeed, in 2010 Totoral Wind Farm was opened by SNPower subsidiary Norvind S.A., as the company's first investment in a wind project.

In this section the technical aspects included in the Protocol related to Wind Power will be discussed. We consider projects that develop, implement and operate sizable grid connected wind farms, and cover the issues that are most important for a successful project. As always, the focus is on technology transfer per se, and explains how local employees and consultants should be included and get necessary training in the different activities. The following five indicators are included: "Wind Conditions and Location", "Social Acceptance of Wind Energy", "Installation", "Grid Integration", and "Operation and Maintenance".

Table 8: Overview of wind power indicators in the Protocol

Nr	Indicator	Technology	Early Stage	Preparation
1	Wind Conditions and Location	Wind power		X
2	Social Acceptance of Wind Energy	Wind power		X
3	Construction and Installation	Wind power		X
4	Grid Integration	Wind power		X
5	Operation and Maintenance	Wind power		X

1. Wind Conditions and Location

Wind conditions are one of the most important criteria when choosing the location for a wind park, and determines the wind turbine suitability, project design and energy projections (DNV 2011). To ensure technology transfer it is therefore of key importance to include local employment in addressing these issues. When making the decision of where to locate the wind park it is essential to have accurate and reliable meteorological data. Initially, computer modelling can be used to detect the sites with the best potential over a large area, while more detailed information need to be extracted from on-site measurements using meteorological masts and remote sensing equipment (Breeze 2005, Gardner et al. 2009, Kelley et al. 2007). Gardner et al. (2009) also states that cooperation with a local meteorological station is necessary for collecting data to prime the computer models.

Scoring

"Good Practice" requires that local workers should be trained to erect meteorological masts and install measurement equipment. Local consultants should be involved in building computer models and analysing data. "Best Practice" additionally requires that local consultants are included in making the decision on location based on wind conditions, and taking social and environmental factors into account.

2. Social Acceptance of Wind Energy

Lack of social acceptance has repeatedly been argued to be an important barrier to widespread deployment of wind power (IEA Wind 2010). This type of power production often has strong public support, but meets opposition from nearby residents to a potential wind farm site, and thus faces the NIMBY-problem. IEA Wind (2010) argues that this resistance introduces extra risk, higher costs, and extends the project development period.

The reasons for the lack of social acceptance is that host communities often feel that they bear more than a fair share of the negative impacts of the project, relative to the benefits. This include visual and landscape impacts, noise, shadow flicker, fear of property value loss and potential wildlife and ecosystem impacts (IEA Wind 2010). In addition, electromagnetic interference with electric equipment may be an issue (EWEA 2009b). Furthermore, the representative from DNV Wind emphasised that fear of harmful electromagnetic radiation must be considered. This challenge can be met by providing sufficient information about the consequence of the technology to the local community.

Potential strategies noted to help reduce these problems include local ownership and consistent information. Some degree of local ownership in the project is argued to be beneficial, as "economic interests foster social acceptance" (IEA Wind 2010, p. 46). Furthermore, technology cooperation studies have shown that high levels of consistent communication increases the social acceptance of a project (Mallett 2007). IEA Wind

(2010) also emphasises the importance of early consultation and communication with stakeholders, reducing the risk of future surprises.

Scoring

Addressing the problem of low social acceptance is a necessity if the project should be implemented successfully. "Good Practice" therefore requires that the project has developed a clear communication strategy, seeking to increase the public understanding of all impacts, and collaborate with stakeholders. To be able to extend a current, or develop a new, wind farm locally in a later period, it is also necessary to involve local employees and management in the practices of increasing the social acceptance. "Best Practice" will additionally require some local ownership.

3. Construction and installation

A wind mill consists of large and heavy components, including the tower, rotor and blades, nacelle with the driving train (gear box, generator, coupling and brakes), and electronic equipment (WWEA 2011). This creates technical challenges when installing the components, regarding lifting and assembling.

If the host country has little experience with wind power, it is likely that most components will be imported. For wind mills it is common that the vendors install the equipment, and local labour will only be utilised in parts of the installation (ClimateTechWiki 2011b). Albeit, Cohen (2004) acknowledges that inclusion of local employees during the installation phase contribute to technology transfer. Further, construction of the foundations, necessary road improvements and construction needed for transportation of the large components, can be conducted by local manpower. The lifting of equipment may also be done by local entrepreneurs specialising in such activities.

Scoring

"Good Practice" requires that local employees are included and provided with training in construction of the tower and tower foundations. The project should also make use of local contractors in the construction of necessary roads and road improvements. "Best Practice" requires that the project arrange for extra knowledge sharing also during the installation phase, through involvement of local workers when technical equipment is being installed.

4. Grid Integration

Connecting a wind park to the grid raises several challenges, including voltage and frequency matching, steady state currents and short circuit currents (Belhomme et al. 2009). Small wind farms often use the grid for stabilising voltage and frequency, but for larger parks this is not sufficient, and technical solutions has to be provided directly (Breeze 2005). The challenges increase with a higher penetration level of wind power, and the impacts have to be managed through interconnection, integration, transmission planning and system and market operations (Holttinen et al. 2009). It is therefore necessary to cooperate closely with the system operator (TSO/ISO) and energy regulator with respect to the design and operation of the power system, grid infrastructure issues, the actual grid connection of wind power, market redesign issues and institutional issues (van Hulle and Gardner 2009).

Scoring

"Good Practice" demands involvement of local employees in the installation of necessary equipment for grid matching, and it is decisive with provision of appropriate training to control, operate and maintain the equipment. "Best Practice" requires that local participants are included in communication with the authorities, negotiating grid access and payment for the grid connection.

5. Operation and Maintenance

Operation and maintenance in wind farms is highly relevant for technology transfer, as on-site presence would be needed for inspections, service and maintenance. Even though turbine manufacturers most often perform the service and maintenance needed throughout the warranty period, parts of the maintenance work could be achieved locally with appropriately trained personnel. Wind turbine manufacturers providing remote-monitoring services have made it possible to centralise operation, monitoring and management of wind farms. However, as Knill and Oakley (2006) argue, hiring small, local Operations Managers could be beneficial. With a greater focus on the individual performance of the facility, gains in long-term generation income might offset losses associated with reduced economies of scale.

The European Wind Energy Association has identified a shortage of skilled workers in the wind sector as it has grown in the last decade, especially within O&M and site management activities (EWEA 2009a). This implies that training and utilising local personnel might be beneficial for the project. However, the manpower needed for maintenance is limited, estimates of the routine maintenance time is approximately 40 hours/year per turbine, with non-routine maintenance being of similar order (EWEA 2009b, p. 105).

Scoring

Regarding O&M, "Good Practice" requires that the project has identified the need for competences in these activities throughout the lifetime, and made plans for using local workers for inspections and basic maintenance. For "Best Practice" there are plans for a decentralised monitoring structure and hiring a local Operations Manager.

PART III:

Results & Discussion

9 Results

The indicator themes presented in part 2 were the result of the full process of developing and reviewing the indicator sets. In this chapter we will first consider the review process of the generic indicators, achieved through the Delphi Survey. Subsequently the outcome of the case studies is presented.

9.1 The Delphi Survey

The Delphi Survey was the structured way of achieving consensus among experts, and gave confidence in the choice of indicators. It also provided valuable suggestions for improvements of the indicators. First we will present the most important results from the Delphi Survey, and outline how these results influenced our work with the Protocol. The results from the remaining questions concerning the development of the Protocol are also considered.

9.1.1 Indicator importance for technology transfer

Altogether there were 12 respondents in the Delphi Survey, from 11 different organisations. Ten participants completed the first round in time, and acted as data basis for the second round. The other two participants also completed the survey, but as their responses were delivered too late, these were not included. However, the comments provided were valuable input to the further formulation of the indicators.

To consider disagreement among the respondents the heuristic rule presented in Chapter 6.2.3 was applied to the following question:

- "How important do you think this indicator is for technology transfer (1 to 5[**])?"

The mean and standard deviation in each Delphi round is presented in Table 9 for reference. For six of the indicators the experts answered more scattered than the rule allowed. These are printed in bold type. As shown in the table the heuristic rule corresponds to a standard deviation above 1,0. The experts revised their scoring for these indicators in the second round, and managed to reach the heuristic agreement outlined for all but one indicator. The "Land and Natural Resources" indicator was not scored in round 2, as it was suggested to merge into "Environmental Impacts".

[**] (1 = No importance, 2 = Some importance, 3 = Quite important, 4 = Important, 5 = Very important)

Table 9: Results from the Delphi Survey

Indicator	Mean Delphi 1	σ, Delphi 1	Mean Delphi 2	σ, Delphi 2
Training	4,8	0,6	4,8	0,6
Political & Legal Risk	4,7	0,5	4,7	0,5
Social Impacts	4,7	0,7	4,7	0,7
Policies & Regulations	4,6	0,5	4,6	0,5
Economic Feasibility	4,5	0,7	4,5	0,7
Local Dialogue	4,4	0,8	4,4	0,8
Environmental Impacts	4,3	0,8	4,3	0,8
Communication with Off.	4,3	0,7	4,3	0,7
Local Labour	**4,1**	**1,2**	**4,2**	**0,8**
Transfer of Experiences	**3,9**	**1,0**	**4,1**	**0,7**
Project Management	**3,9**	**1,0**	**4,0**	**0,8**
Infrastructure	**4,0**	**1,1**	**3,8**	**0,8**
Technology Needs	3,7	0,7	3,7	0,7
Ownership	3,7	0,8	3,7	0,8
Sourcing	3,3	0,8	3,3	0,8
IPR	**3,3**	**1,3**	**2,9**	**1,0**
Land & Natural Resources	**4,0**	**1,1**	**-**	**-**

The results from completing two iterations of the survey were somewhat encouraging for the usability of the Protocol. Most of the indicators were considered by the experts to be important for technology transfer, and the participants managed to reach the heuristic agreement outlined for all but one indicator. As the measure of consensus was almost reached, and the participants were prospected only two rounds, the Delphi Survey was ended after these two iterations. All ten participants completed the second round of the survey.

In Figure 15 the mean importance of each indicator for technology transfer is presented. 11 of the 16 indicators scored more than 4,0 after the second Delphi round, i.e. between "important for technology transfer", and "very important for technology transfer". Three of the remaining indicators got a score of above 3,5 (closer to "important for technology transfer" than "some importance for technology transfer"). The "Sourcing" indicator received a score of 3,3, whereas "IPR" was deemed least important of our indicators, with a score of 2,9 ("some importance for technology transfer").

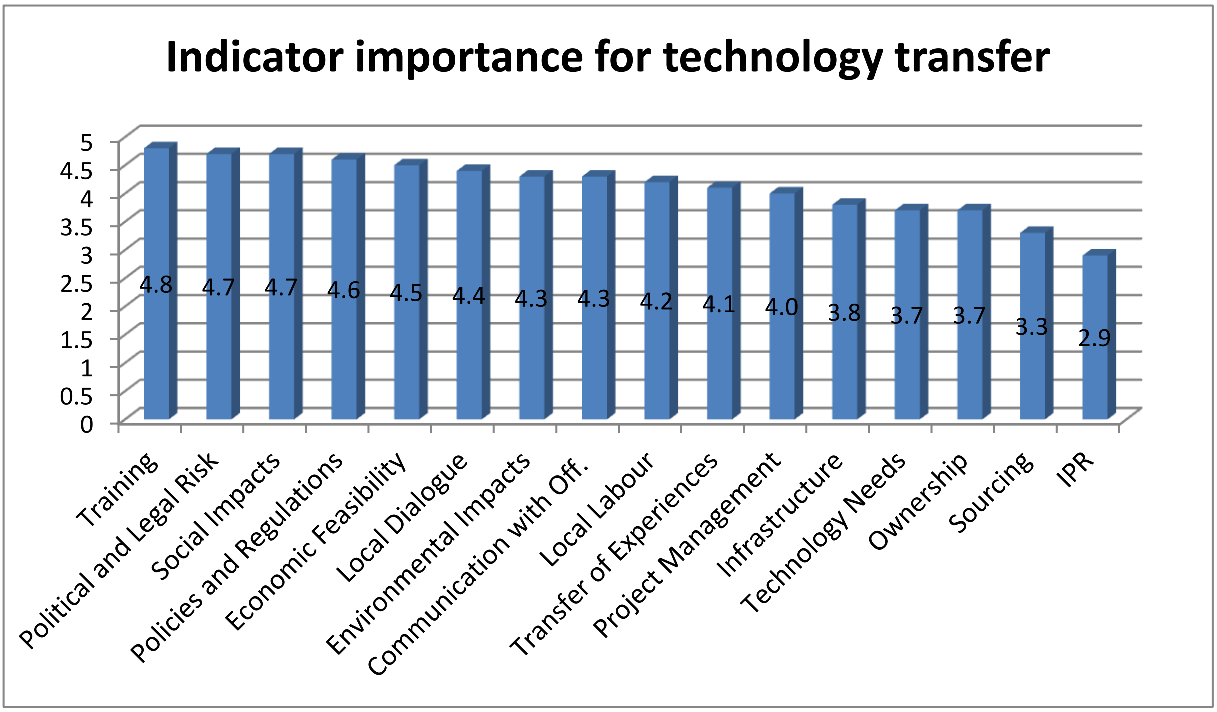

Figure 15: Respondent's assessment of indicator importance

After considering the comments provided by the participants, it was decided to revise the two indicators with the lowest score, rather than removing them from the Protocol. This was justified by noting that some experts stressed that these issues were very important to consider when ensuring technology transfer, and that only minor improvements would be sufficient to increase the quality of the indicators. The following changes were carried out for the two indicators:

- Regarding IPR, the importance of taking necessary action to mitigate the risk of unauthorised diffusion of the technology was emphasised in the scoring point of the indicator. In addition, it was explicitly stated in the indicator that the scoring requirements only are to be considered whenever relevant. This rules out situations where IPR concerns for the technology are negligible (due to e.g. maturity of the technology).
- For the "Sourcing" indicator quality was included as a criterion to be met when choosing a local supplier. In addition, the scoring point was restated such that local suppliers should be chosen whenever they are competitive, or could be expected to become competitive.

9.1.2 Other implications from the Delphi Survey

In the second round of the Delphi Survey the participants were asked to consider suggestions for improvements posed by the other experts in the first round. We asked for a response from all the experts when two or more of the participants had raised the same concern, or given the same suggestion of extension. In this section the most important implications for the Protocol from these considerations are presented.

- In the first round the Protocol included an indicator called “Land and Natural Resources”. However, several participants commented that such an evaluation is already a part of the Environmental Impact Assessment conducted in all large energy projects. After asking for the opinion from the group of experts, they unanimously agreed on including these aspects in the existing indicator concerning “Environmental Impacts”.

- As three of the participants raised the concern of whether the issue of corruption was sufficiently addressed in the Protocol, the experts were asked in the second round to consider whether the issue should be included in a new indicator. As the majority (60 %) of the respondents were in favour of such an amendment, it was decided to elaborate on the issue of corruption in a new indicator. The importance of such a “Corruption” indicator was scored to be 3,7 (On the scale from 1 to 5), when considering the effect on technology transfer. The indicator was named “Behaviour and Corporate Social Responsibility”, and thus also includes other aspects of recommended behaviour from the participants in the project.

- Two of the respondents noted that the important aspects of financing and financial mechanisms were not included in the Protocol. In the second round 70 % of the respondents agreed that financing should have its own indicator. The respondents scored the importance of such a finance indicator for assessing technology transfer to be 4,2 (On the scale from 1 to 5). The indicator was thus developed, and is called “Financial Viability” in the Protocol.

- A suggestion of incorporating all the project’s actions towards minimising challenges related to differences in language and culture, led us to ask the experts whether these issues should be consolidated into one indicator. Again, 70 % of the respondents agreed, and the respondents scored the importance of a “Culture and Language” indicator to be 3,9 (On the scale from 1 to 5) when considering the effect on technology transfer. The indicator was developed and called “Culture and Language”.

The Delphi Survey gave valuable comments to the work with the Protocol, and led to minor changes in many indicators, and total revision of others. The second round gave confidence in omitting “Land Use and Natural Resources” completely, and to expand the Protocol with three new indicators. Thus, after completing the Delphi Survey we were left with the final 19 indicators in the Protocol, all considered and evaluated by the team of experts from the field. Two of these indicators, “Social Impacts” and “Environmental Impacts” should be assessed in both the Early Stage and the Preparation Stage of the project. This implies that a total of 21 generic indicators are considered when applying the Protocol in the case study.

9.2 The Case Studies

Here the assessment of two successful projects with a Norwegian provider of the technology is presented. Even though it proved challenging to complete a full assessment of the projects, we were able to utilise parts of the Protocol, and this provided interesting insights. By using the Protocol on real projects we became aware of the difficulties related to information gathering in the assessment process, but also of the positive implications of its use. The results from using the Protocol are later compared with the observed technology transfer track record, to indicate the validity of the Protocol. First Khimti, a hydropower project in Nepal is considered, before looking at Totoral, a wind power project in Chile.

9.2.1 Khimti

The Khimti I hydropower project was the first private-sector power project implemented in Nepal with a Build-Own-Operate-Transfer (BOOT) structure. The project was initially established in 1993 by Statkraft (majority share owner), and a local partner, Butwal Power Company, through the single-purpose company Himal Power Limited. SNPower later replaced Statkraft as majority owner. The financing of the project was closed in 1996, and the plant has been commercially operating since 2000. Khimti is a run-of-river plant, with five Pelton turbines, producing a total of 60 MW. It has been in successful operation ever since, and the ownership of the project is planned transferred to Nepalese authorities by 2020. In addition to producing electricity, the project has focused heavily on addressing community needs through its CSR-programs. (Himal Power Ltd 2010) (The Himalayan Times 2010)

Assessment of Khimti

The scorings assigned are primarily based on the in-depth interview with Tom Solberg, former general manager of the Khimti holding company (Himal Power Ltd). The remarks about Khimti in the report on Norwegian hydropower investments (Norad 2010b) is also studied, as well as the Himal Power Ltd homepage, reports from the IFC, and social and environmental impacts reports from the project. The main deficiencies in this assessment were that the project was not examined on-site, no internal documents were examined, no locals were interviewed, and no stakeholders were contacted. Moreover, only the generic indicators in the Protocol have been considered, as we only had contact with a former general manager, not with any technical personnel. Note that the Protocol assesses the potential for technology transfer in a project (in advance!), whereas Khimti was in operation at the time of the assessment, which imply certain methodological complications. It was attempted to correct these inconsistencies by having focus on what had been done by SNPower and Himal Power Ltd *prior to* the operation of the project.

The total assessment process took us approximately 16 hours for Khimti. Firstly, the interview was prepared and held, following the structure of the Protocol. Secondly, additional information was identified and considered. Thirdly, the scoring was assigned and justified. The sources used and the reasoning behind the assignments are denoted in

Appendix 2, "Scoring of Khimti". In Table 10 a summary of the scoring is presented. Due to lack of information, some of the indicators were difficult to assign scoring to, and are denoted Not Assigned (NA). However, in a more comprehensive assessment, all relevant indicators should be scored. This will imply that the indicators without appropriate evidence should be assigned a low score. In the case of Khimti, the limitation was the available information, rather than the lack of actions by the project, which justified the NA for five of the indicators.

For Khimti, all the scored Early Stage-indicators were assigned with the score 5, i.e. equivalent with identified "Best Practice". In the Preparation Stage the scorings are more varied, however still with mostly high-scored indicators. Altogether, the project achieved a score on or above "Good Practice" (3) for all but one indicator. A score above "Good Practice" certainly indicates that the project had ensured a large potential for transferring technology in a successful way.

Table 10: Assessment of Khimti

Early stage			Preparation Stage		
Indicator	**Code**	**Scoring**	**Indicator**	**Code**	**Scoring**
Social screening	ES-1	NA	Social impacts Assessment	P-1	NA
Environmental screening	ES-2	5	Behaviour and Corporate Social Responsibility	P-2	5
National policies	ES-3	NA	Local dialogue	P-3	2
Political and legal risks	ES-4	5	Local employment	P-4	5
Intellectual Property Rights	ES-5	NR	Training	P-5	5
Economic viability	ES-6	NA	Culture and language	P-6	3
Financial viability	ES-7	5	Environmental Impact assessment	P-7	4
Ownership	ES-8	5	Communication with Officials	P-8	3
Technological needs	ES-9	5	Sourcing	P-9	4
			Project management	P-10	NA
			Transfer of experiences	P-11	4
			Infrastructure	P-12	5

NA: Not Assigned, NR: Not Relevant

The Khimti assessment process gave some interesting considerations. Even though the Khimti project has been regarded a success, there are some areas of improvement. The scoring of 2 in the indicator "Local Dialogue" corresponds to a lack of ability to manage local expectations in the project. According to Tom Solberg the project created local expectations that were impossible to achieve. This was due to the fact that the community was not involved in prioritising what benefits should be provided, and the local population was not properly informed of what would happen. This led to expectations of additional benefits, like more widespread electricity provision, that would never become a reality. Unreal expectations led to local unrest, which resulted in a critical situation where a group of people physically attacked workers in the project. The project later learned from the riots, and became aware of the importance of expectation management – i.e. informing all parties properly of what will be done. They also established a Village Development Committee consisting of the different local stakeholder groups, responsible for prioritising between the local benefits.

These considerations aside, the use of the Protocol clearly indicated that the project had a large potential for successful technology transfer, when commenced over ten years ago. By comparing this assessment with the real track record of the project one can get an indication of the validity of the Protocol as a preliminary assessment measure of technology transfer.

Track record of technology transfer in Khimti

We argue that the Khimti project has been a success in many ways, also regarding technology transfer. Firstly, according to former General Manager Tom Solberg, the project is astonishingly well functioning, almost without any downtime during the 10 years of operation. The operation and maintenance of the power plant has gradually been transferred to local personnel, and local employees have participated in all stages of the project, and in all levels of the organisation. Extensive training in operation and management of the technology has been provided to the local employees. Parts of the hydropower technology have been diffused, like the sedimentation handling in Khimti (essential for sandy Himalayan rivers), and is now utilised in other projects. Again, according to Tom Solberg, Khimti stands out as well constructed and operated, compared with other hydropower plants in the country.

Beside these directly technology-related aspects, the project has also provided indirect technology benefits to the local population. Karki (2004) states that Khimti's relationship with the local community through CSR-benefits has contributed to cooperation and goodwill from the population. According to Tom Solberg almost all of these CSR-activities have had a focus of building local competence, not exclusively providing aid to the local community. This can be exemplified through the non-formal courses arranged for locals, the financing of local schools (Karki 2004), and free electricity provided from a designated small scale hydropower plant close to Khimti. The latter plant provides electricity to 4500 households, and is driven by a community cooperative, initiated by HPL. The electricity provided from the plant has led to the creation of new local businesses, e.g. a bakery, agro mills and steel mechanic industry. Tom Solberg also stated that the local community experienced road improvements, and they were given access to Internet due to the hydropower project.

Tier Model considerations

Relating this to the Tier Model for technology transfer in Chapter 5.2, it is observed that Khimti has accomplished most aspects in Tier 1: the transferred technology is in line with the local needs, necessary local capacity is built through education, and the local population has been included as employees and beneficiaries. The project has also addressed Tier 2: by establishing cooperation with universities and local businesses, having close contact with local authorities, and dealing with risks concerning regulations and political unrest, like the Maoist uproar in 2002 (Norad 2010b). Tier 3 is accomplished through contributions to the local development: The project implemented a large community development program and supported the local infrastructure extensively.

Level Model considerations

In Chapter 5.1 the Level Model was presented, for assessing *when* technology transfer could be considered a success. Recalling this five-step model, we could evaluate Khimti's performance. Khimti was well prepared (1), implemented (2) and operated (3), and has been operating better than comparable plants in the area during the last decade (4). There are even some examples of the technology being diffused (5) to others parties. It is therefore argued that the technology has been successfully transferred so far in the project. The prospects of the future development are also bright, taking into account the gradual increase of local involvement, and the transfer of ownership back to Nepalese authorities in 2020.

Conclusive remarks, Khimti

Due to this information we claim that the technology has been successfully transferred in the Khimti project. The use of the Protocol also indicated that there was a large potential for technology transfer in Khimti. These two correlating events are certainly not proof for the validity of the Protocol alone – in order to "prove" such a connection numerous projects have to be assessed prior to operation, and later compared with the observed technology transfer. However, by attempting to use the Protocol on an already existing project and compare actual technology transfer track record with this assessment, we are able to both illustrate the use of the Protocol, and postulate how such validity could be considered.

9.2.2 Totoral

Totoral is a wind power project in Chile, developed by Norvind S.A. Norvind S.A. was a special purpose vehicle, established as a Joint Venture between SNPower (80 %) and the local Chilean partner Centinela (20 %) (IFC 2008b). In the spring 2011, SNPower acquired the last 20 % of Norvind S.A. in an asset swap with Centinela, in exchange selling off a controversial hydropower project in Chile (Loge 2011). The wind plant is located in a poor region in northern Chile, and consists of 23 wind turbines with a total installed capacity of 46 MW (Teknisk Ukeblad 2010). As Norvind S.A. was founded in 2007, and the plant was in operation in 2010, Totoral is a relatively recent project. It was accepted as a CDM project under the Kyoto Protocol in December 2010.

Assessment of Totoral

The scoring of the conducted actions for ensuring technology transfer in Totoral are primarily based on the interview with Nils Huseby, executive Vice President of SNPower in South-America. In addition, publicly available information about the project, its Environmental and Social Impacts Assessment, information provided to the UNFCCC and the IFC, as well as newspaper articles have been studied. The deficiencies of the assessment are basically the same as for Khimti; the project was not assessed on-site, internal documents were not available, and no stakeholders were interviewed. Again, only the generic indicators in the Protocol are considered. However, whereas Khimti had been in operation for over a decade, Totoral is a new project, only operating for one and a half years. This made it easier to consider what has been conducted by the project during the preparation; but more difficult to consider to what extent technology transfer actually has occurred.

In the case of Totoral the total assessment process lasted approximately 10 hours. The interview was conducted following the template from Khimti, which saved us some time. The information was then identified and considered, before assigning and justifying scores. The details regarding the scoring assignment are presented in Appendix 3, "Scoring of Totoral". In Table 11 the summary of the scorings are illustrated. As the results show, the general performance of this project is high – only one indicator scores below the "Good Practice" level. However, compared with the results from Khimti, more indicators were assigned below "Best Practice". Interestingly, the indicators "Local Employment" and "Training" were assigned the score 4, compared with "Best Practice"(5) for Khimti. Nevertheless, we argue that a scoring level generally above "Good Practice" is a strong indication that successful technology transfer will occur in the project.

Table 11: Assessment of Totoral

Early stage			Preparation Stage		
Indicator	**Code**	**Scoring**	**Indicator**	**Code**	**Scoring**
Social screening	ES-1	5	Social impacts Assessment	P-1	5
Environmental screening	ES-2	NA	Behaviour and Corporate Social Responsibility	P-2	5
National policies	ES-3	3	Local dialogue	P-3	5
Political and legal risks	ES-4	4	Local employment	P-4	4
Intellectual Property Rights	ES-5	NA	Training	P-5	4
Economic viability	ES-6	5	Culture and language	P-6	3
Financial viability	ES-7	NA	Environmental Impact assessment	P-7	4
Ownership	ES-8	5	Communication with Officials	P-8	3
Technological needs	ES-9	3	Sourcing	P-9	5
			Project management	P-10	NA
			Transfer of experiences	P-11	2
			Infrastructure	P-12	3

An interesting feature of Totoral, was that the project had very limited contact with the local community, especially after the operation began. Firstly, the plant is situated in a semi-desert, far away from the local population. Its local business partner owned the required land area, thus no severe difficulties arose when installing and preparing the wind farm. The low score received for the indicator "Transfer of Experiences" also illustrates this point: Whereas Khimti had a widespread cooperation with local universities and research institutions, Totoral had no such collaborations. While Khimti had challenges regarding the "Local Dialogue", Totoral had no problems, partly because it had very few stakeholders, and had thus an easy task coordinating the communication. It can be argued that limited contact with the local population *per se* could be negative for the technology transfer to a country; however, it certainly prevents low social acceptance from becoming a problem during implementation.

Altogether, the use of the Protocol showed that the project had done a lot to ensure technology transfer. Next, we will examine whether there exists any evidence of technology transfer based on the track record.

Track record of technology transfer in Totoral

Totoral has not been operating as long as Khimti, thus it becomes more challenging to consider to which extent technology has been transferred. By noting what Norvind S.A. has written in the Project Design Document accompanying the application for CDM-registration, technology transfer is denoted as an expected benefit: "By employing a non-conventional technology, the project activity will contribute to technology transfer.

In addition the project will create local "know-how" related to the installation and operation of wind turbines." (Norvind S.A. 2010, p. 2) Later it is stated that: "The project developers expect to contribute to Chiles energy independence by taking advantage of its renewable resource, while developing its own and local experience in wind power." (Norvind S.A. 2010, p.15) These statements are written prior to the actual operation, and should be treated accordingly. However, the contractor Skanska states in a case study that: "The construction of the El Totoral Wind Farm has contributed toward knowledge transfer by training local people to construct, operate and maintain wind turbines. This enhanced local competence may facilitate similar wind farm projects in Chile in the future."(Skanska 2009, p.3)

It is to early to fully judge the success of the technology transfer after only one and a half year of operation, but some indications are presented: The installation and construction of the plant was done primarily by local employees (Skanska 2009). 10 trained employees is performing the operation and maintenance of the plant (IFC 2008b), which raises the experience level in Chile, with only two large wind farms operating at this date. Training has been provided by the turbine manufacturer Vestas (Norvind S.A. 2010), and Vestas retain the responsibility for service and operation the first three years of operation (Skanska 2009). This is a good way of facilitating gradual competence building among the local employees.

The project has also provided indirect benefits to the population, however not in the extent of Khimti. Totoral is established in a poor region of Chile, and has provided local benefits like employment, taxes and fees, and a few CSR-activities, which altogether has ensured a positive attitude to the project in the local community (Skanska 2009, Teknisk Ukeblad 2010).

Tier Model considerations

The experiences from Totoral could again be related to the Tier Model for technology transfer. Totoral has performed according to most of Tier 1: The transferred technology is somewhat in line with the local needs, necessary internal capacity is provided through training, and local employees and stakeholders have been included in the process. However, when it comes to Tier 2 (relation with surroundings) the project performs less satisfactory: it has little contact with universities, research institutions or other actors and it has scarce contact with authorities. The project's considerations of national regulations could also have been more extensive. Tier 3 (the local development) is neither as rigorously addressed: The CSR-activities are few and limited (Skanska 2009), and the relation with local stakeholders and community is negligible in comparison to e.g. Khimti. However, the project certainly contributes to a better environment in Chile, by replacing fossil fuels, and having very limited direct environmental impacts (IFC 2008a).

Level Model considerations

By applying the Level Model for Totoral, it is possible to evaluate the performance of the project so far. Totoral is argued to be well prepared (1), implemented (2), and is operating (3) successfully so far, according to Nils Huseby. Not surprisingly there are not any examples of diffusion yet (5), and the long-term operation (4) should be granted more time before an evaluation is taken.

It is apparent that the technology is functioning and working so far. However, this is also the only conclusion that could be drawn after so short time of operation. The prospects of additional positive effects depend on the functioning of the technology over time, the use of local workers, the quality of the training provided, as well as the amount of cooperation with universities and local companies.

Conclusive remarks, Totoral

Even though there were some mixed indications regarding the technology transferred in the project, the overall deduction is that the process of transferring technology in the Totoral project is evolving. Comparing this result with the application of the Protocol, one can again see that the conclusion is the same. Note we still stress that this is not proof of the validity of the Protocol, but another indication of the possible connection.

Both the average scoring level, and the experienced technology transfer is lower for Totoral than for Khimti. This is in line with the hypothesis of the Protocol assessment validity. However, this result is influenced by the fact that Khimti has lasted longer, and effects could become more evident over time. It is also criticisable that we use input to the scoring in the Protocol as an assessment criteria when examining technology transfer track record. One example is training: A high score for "Training" in the Protocol is also considered as positive for technology transfer *as such* - in the Tier Model. This could be interpreted as a form of circular reasoning – thus a logical fallacy. However, the technology transfer in a new project like Totoral, must be considered by a proxy variable, e.g. the amount of training provided to locals, as it could not materialise in observable technology transfer in other ways.

10 Discussion

The outcome of the work with this master thesis is the Protocol for assessing the potential for technology transfer in specific energy projects, presented in Appendix 1. The rationale of the Protocol has been a wish to develop a structured way of evaluating the complex structure of international technology transfer, on a project level. Whereas most of the earlier work has had a distinct focus on technology transfer on the policy or macro level, this thesis has taken a micro perspective. The purpose has been to see whether or not a project has done what is recognised as "Good Practice" or "Best Practice" with regards to technology transfer, when planning the implementation of a new technology.

The obvious attractiveness of this objective was that it operationalises many of the insights from the macro level; it should be valuable for many different actors, as well as being something all new. At least to the authors' knowledge, no such tool exists today. However, the fact that it had to be developed from the ground up also made it a challenging task, and especially so when dealing with such a comprehensive issue. It required a holistic procedure in order to include all relevant aspects, and it implied some challenges when the Protocol was to be tested.

The realisation that there exists no widely accepted and understood definition of technology transfer did not make the exercise any easier. Firstly, we had to review an extensive amount of literature to be able to grasp the concept, and define it for our own purpose. Secondly, the ambiguity in the concept made it challenging to explain and communicate our understanding to different actors, as each person, and each organisation understands the term differently.

This chapter will discuss different problematic issues arising during the development of the indicators, the reviewing of them in the Delphi survey, and in the testing on operating projects. This discussion leads to an indication of the validity of the Protocol. Furthermore, the purpose and scope of the Protocol will be considered.

10.1 Indicator development

The indicator development was based on a hierarchical visions and goals structure, and started with the process of formulating these in the specialisation project, for the five dimensions identified as the most relevant (social, environmental, institutional, business and technological). The choice of dimensions was based on a revision of the four pillars of sustainability, and should imply that all aspects ensuring a sustainable project were considered, in addition to the technical factors. Since the indicators ultimately were derived from these dimensions, the final outcome could also be critically dependent upon the choice that was made. However, as most input to the indicator selection and formulation process were taken from the review of barriers and success criteria in Chapter 4, the dimensions mainly acted as a mean of structuring the different issues.

The visions and goals were the final outcome of the specialisation project, and represented the knowledge gained at that time. Then it was argued that the assessment should be conducted through short binary indicators, asking whether or not the goal had been achieved. As noted in Chapter 6.1.3 though, because technology transfer is so complex, many of the goals would be difficult to measure directly. Furthermore, the binary indicators would give little assistance to the assessor who should evaluate if the goals were obtained, as nothing was said about how the goal should be reached. A more manageable job is therefore to look at what the project actually has done or has plans to do, and use this information as an indication of whether the goal has been attained. In addition to helping a third-party assessor, such a revision of the structure of the indicators would also benefit the technology provider as a potential user of the Protocol. Giving more information about actions and activities that ensure achievement of the objectives should also increase investors' interest in using the Protocol for consulting purposes.

With a changed focus towards using undertaken activities as indications of technology transfer, it was necessary to restructure the indicators into broader issues, where many of these would encompass more than one goal. Instead of presenting all the relevant goals for each indicator, they were instead provided with a description of how the issue related both to investments in developing countries and to technology transfer. This structure is argued to help the users of the Protocol to clarify each indicator's relevance and importance.

Giving detailed criteria for the scoring of the indicators is an important deviation from the initial approach. This makes it possible to differentiate between high performers and low performers, by assigning different scores according to a project's effort. However, there is also a large degree of uncertainty in this process, with regards to how one should arrange the criteria. A technical choice has been made of assigning all the criteria either to "Good Practice" or "Best Practice" (i.e. 3 or 5), but the division between these two may not be unequivocal. It is not possible to use a standard selection rule, so wherever no stringent relation between the criteria exist (i.e. that one criterion was a stronger form of the other, and thus had to be of a higher order), the classification exercise was rather a qualitative one. Although based on the success criteria from Chapter 4 and related to the developed Tier model, it may rightly be criticised as dependent on subjective measures. Therefore it is also emphasised that the iterative revision process also included a review of the scoring points.

10.1.1 The Delphi Survey

The Delphi Survey was used as a means to accomplish the iterative process of reviewing and refining the indicators. Finding a large number of actors who are experienced in a field related to technology transfer, and able to participate in an extensive survey was assumed to be difficult, and it was therefore suggested to utilise the Delphi method. Since this is a decentralised group decision method, fewer participants are required than in an ordinary quantitative survey, and the respondents do not have to meet physically. To include all types of actors that can give valuable input, the participants were identified and selected in a rigid and systematic way, and grouped into academics, government officials, practitioners and NGOs.

The feedback from the study showed both a generally high approval of the indicators as important for assessing technology transfer, and a generally high degree of consensus among the respondents. After the first round there were only 6 out of 17 indicators that had responses that deviated more than our heuristic rule for consensus allowed. This may result from an actual high degree of agreement, but it could also be due to a too weak consensus criterion in the heuristic rule developed for this purpose. However, acknowledging that for a total of 10 respondents, 8 of them had to agree, the authors believe that the criterion is sufficiently strong.

The composition of participants in the survey is also critical to the final result. As stated above, a rigorous system was utilised to include a broad range of individuals, representing the four identified groups. This was a helpful tool, but in retrospect it could be noted that the group is biased in different ways. First, it lacks the recipient focus as it only includes organisations acting as senders of the technology (Statkraft / SN Power, and TrønderEnergi), or donors, investors and facilitators from the developed country side (Norad, Norfund, ICH and Intpow). As none international actors without a base in Norway has been involved, the group does not mirror the international competence and experience with technology transfer, but rather the Norwegian point of view. Second, the group consisted of individuals experienced in the energy sector, and especially with energy production. This is in line with the focus on energy projects in the Protocol, but an inclusion of people from other sectors as well could have added different perspectives, and potentially other valuable suggestions.

10.1.2 Case Studies

The purpose of applying the Protocol on two cases was to test if it actually could provide a good assessment of the potential for technology transfer in the projects. By comparing the results of applying the Protocol on projects in operation, with their actual track record of technology transfer, one could see if there was conformity between the two assessments. However, this approach requires that the projects have been in operation for years to give a reliable track record. For Khimti this was not an issue, and the high degree of correlation between the track record and the Protocol performance is interpreted as a sign of validity of the Protocol. Also Totoral received a generally high score from the Protocol, but the shorter operation time makes the track record less reliable, even though the first year in operation has been without major problems.

For both cases though, one may criticise that the assessment was undertaken at the wrong stage according to what the Protocol states. Both Khimti and Totoral were in operation at the time of assessment, contrary to being in the planning phase, which the

Protocol suggests. This may affect the result in several ways. First, more information would necessarily be available than during the planning and preparation phase. As such, it will be easier to measure what the project actually has done, rather than what plans it had at the time. Secondly, the project actors that provided insights and experiences through interviews may suffer from "poor memory" and therefore the information is less reliable. This problem should be more severe for Khimti than Totoral, since Totoral has just commenced operation, while the planning of Khimti started already in 1993.

As stated in Chapter 9.2, most of the input used for the assessment was retrieved through the interviews. This also raises another problem of biased information, as we have neither had enough time or resources, nor availability to enough documentation, to confirm or falsify all the information provided.

10.1.3 Validity of the Protocol

The testing of the Protocol on different cases should provide the ultimate check of its validity, and our case study indeed indicated a relationship between the Protocol and the actual technology transfer observed. However, according to scientific method, the conformity between the results of the Protocol assessments and the projects' track records can only be used to conclude that the test at least did not reject the validity. Nevertheless, the structured and meticulous development procedure, together with the generally high importance assigned to all the final indicators in the Delphi Survey, definitely give additional strength to the indication that the Protocol has validity.

10.2 Generic versus technology specific indicators

The discussion so far has dealt with the Protocol without separating between the generic and the technology specific indicator sets. This has been a deliberate choice to avoid misunderstandings and confusing explanations in each section. Though, it is important to consider how the development, revision and testing of the sets differ.

As the generic set is applicable to all energy production projects, it was argued that each technology would require some additional specific indicators. For the two technologies, hydropower and wind power, these specific indicator sets were developed more or less in a similar way as the generic, by studying literature and having conversations with industry actors. However, in the revision phase, it was problematic to conduct a full Delphi Survey on each specific set. One alternative would be to include all the indicators in the Delphi Survey undertaken by all respondents. This would extend the length of the survey substantially, thus risking to detriment the response rate. In addition, it is not likely that all respondents would have the required technical knowledge. The second alternative would be to create two additional Delphi Surveys, and invite participants to each of them according to their technology experience. The latter alternative was attempted, but we did not succeed in recruiting enough experts to perform a full study. The review of the indicators was therefore done without any formal survey, but by having some experienced technologists in each field to revise them.

The test of the Protocol by applying it to cases was also mainly concerned with the generic set. To assess the technological indicators, more information was needed than what was available. The interviews conducted were held with senior management in the projects and not with representatives from the technical staff. Therefore we did not obtain all the required information to assign scores on the technological indicators.

10.3 Purpose

As described in the start of this chapter, the purpose of the thesis has been to develop an operational framework for assessing the potential for technology transfer in energy projects. Even though much work has been conducted on a macro level, and numerous policy initiatives have been in support of increased transfer, the complex and multifaceted nature of technology often causes the transfer process to become a failure. The choice of creating the Protocol was thus based on two desires: Firstly, we wanted to develop a tool that could be utilised to reveal the potential for technology transfer in a project objectively, and secondly, that the Protocol also could be used in a consultative manner to help projects avoid mis-transfer.

Mis-transfer may here be differentiated into three categories (Cohen 2004): *Incomplete transfer* is the failure of not considering all aspects of the technology, (e.g. not transferring maintenance capability); *imperfect transfer* is the failure of not considering human factors and users' characteristics, (e.g. not considering management styles and cultural aspects); and *inadequate transfer* is the failure of not considering environmental conditions in the host country, like climate, finance, infrastructure, technology and culture (e.g. transferring products, like protective clothing, inappropriate to climatic factors, or using colour codes that works differently in the host country). By applying the Protocol it is argued that the risk of mis-transfer is substantially mitigated.

10.4 Potential users

It is believed that possible users of the Protocol would include the sender, official bilateral and multilateral development agencies (ODAs), the technology recipient, and host country authorities. For the sender, the application of the Protocol could have several benefits. Applying the Protocol would ensure that all major barriers are examined, and ways to meet them are suggested. This should secure that all the key components of the technology is transferred to the recipient (technoware, humanware, inforware and orgaware), which is a necessity for the technology to be successful in the long-run. Utilisation of the Protocol will thus be a helpful mean in making cash flows more certain in projects where financial inflows often accrue to the sender late in the operation phase. Secondly, successful application of the Protocol could be a way of attracting local partners and ensuring acceptance by local communities and government. However, a widespread use of the Protocol is not to be expected, unless a financial institution or ODA require that the sender utilise it.

ODAs may apply the Protocol to evaluate how the projects they support contribute to technology transfer, and thus provide information to governmental and intergovernmental organisations (IGOs). By requesting that the projects that receive development aid make use of the Protocol, the ODA will contribute to increase both the quality of technology transfer and the knowledge about the transfer. The recipient organisation may benefit from the Protocol by ensuring that the "Best Practices" are followed and thus transferring the technology in the best possible way. Lastly, the host country authorities could request use of the Protocol when foreign companies invest in the country, to make sure that technology transfer actually will occur. This should explicitly show the positive sides of a collaborative foreign partnership exhibiting transfer of knowledge and skills, compared with, e.g., turnkey projects.

The use of the aggregated results from the Protocol depends heavily on the demands from the different possible users. Some are mostly interested in the details concerning the individual indicators, whereas others would like to compare aggregate scores for different projects. For example, a financial institution could require that a project should achieve at least "Good Practice" (level 3) on all indicators, or achieve a total average of 4, to be eligible for financial support.

Although numerous beneficiaries are identified, the Delphi Survey revealed that it may not be clear to outsiders who the beneficiaries are. On the question of who they believed could be potential users of the Protocol, the respondents' replies were very varying. All of the alternatives (the sender, local partner, international development banks, international and national financing institutions, multinational organisations, ODAs, and host country authorities) were mentioned as possible users by one or more participant. However, no single actor was agreed upon. Therefore, an important task in order to diffuse the use of the Protocol will be to communicate all its benefits to the possible users.

10.5 Scope

The definition of technology transfer used in this thesis stated that: *"Technology transfer is any process by which a developing country party gains access to technological equipment, information and knowledge from a developed country party, and successfully absorbs it into its production process."*

This definition was important for setting the scope of both the thesis and the Protocol. It is an all-encompassing interpretation, which includes the key-components of technology (technoware, humanware, inforware and orgaware). As such, it required that all aspects had to be taken into account when considering the success of technology implementation in a new environment.

This scope may be perceived as too broad, as there is a risk of loosing focus on the most important issues when trying to include every angle of technology. However, we are certain that the Protocol would have been of lesser value with a narrower scope, since the thorough discussion of technology and technology transfer showed the importance of including all surrounding factors.

It was also required that the technology should be mature and properly tested. As such, the special features of new and unproven technologies are not included. The scope is also limited by the notion of only considering the planning phase of the project. There is no doubt that the implementation stage (installation and operation) is where most of the technology transfer actually occurs, but as we have argued, most of the crucial decisions are made in the early and preparatory stage of the project.

11 Conclusion

In this thesis it is argued that the concept technology transfer is important to consider explicitly, not only as an airy notion. Therefore, we have proposed an operational, multidimensional Protocol for ensuring technology transfer in international energy projects. A systematic development process has been undertaken, and the quality of the indicator set has been secured through a comprehensive feedback process, involving numerous experts on the subject. The validity of the Protocol as a measure of ensuring technology transfer has also been indicated through a case study.

11.1 Contribution

By proposing this operational Protocol, we believe various actors are supplied with a useful tool when considering international investments. In a Norwegian context, Norad has been especially eager to assess technology transfer on the project level, and we suggest that they implement the Protocol in their results and performance management practices. Sender organisations could also benefit from utilising the Protocol in numerous ways. However, a widespread use of the Protocol could only be expected if financial institutions or development agencies require that technology transfer considerations are made by projects. The Protocol could thus be used as an inspiration for multinational actors like the IFC and the UNFCCC.

Today IFC requests use of Performance Standards in projects they support, addressing diverse aspects as e.g. social and environmental issues, labour and working condition, cultural heritage and community health and safety. It is suggested that the Protocol could act as a starting point for a similar performance standard on Technology Transfer. Likewise, as the UNFCCC decided on a technology mechanism in Cancun 2010, there is a growing recognition that transfer of energy technologies must be addressed explicitly. One opportunity could be through publishing recommended practices on the project level, or by requiring that projects justify their technology transfer performance.

11.2 Future work

Even though it is argued that the Protocol is fully operational, there are many ways of improving, amending and validating it. Only through widespread use of the Protocol, the requirements in the indicators can be considered over time, and checked against real experiences.

The most urgent task is deemed to be an extensive validity check of the indicator set. Here it is suggested that the Protocol is applied to a large number of projects, and that the results are later compared with the observed technology transfer. Such a comprehensive study must be long-lasting as the Protocol should be used in the early stages of the project, and the actual technology transfer must be observed after years of operation.

During the development process, the technology-specific indicators were not subject to the same scrutiny as the generic indicator set. It is therefore suggested that the hydropower and wind power indicators are more thoroughly considered and quality-tested, through a comprehensive feedback process than what time and resources made possible during this master thesis.

The immense task of developing indicators with such a wide thematic range during a relatively short period, has made it almost impossible to completely avoid mistakes and ambiguities in the Protocol. There are certainly room for further improvements of the indicators, and the authors are supportive to any such attempt.

In addition, it is called for development of additional specific indicator sets for other energy production technologies, e.g. solar power, tidal/wave power and offshore wind power. As this thesis has focus on renewable energy production technologies, these are apparent suggestions, however, the Protocol could also be used to assess international transfer of technology in other energy-related projects, e.g. conventional energy production, energy-efficiency initiatives and Carbon Capture and Storage.

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Part 1
Generic Indicators

Protocol for Assessing the Potential for Technology Transfer in Energy Projects

Appendix A
Master thesis by Kleveland and Sønstebø 2011

Acknowledgements

This protocol for assessing technology transfer in energy projects has been developed as a part of our master thesis in Industrial Economics and Technology Management at the Norwegian University of Science and Technology. The protocol was completed in June 2011, and is the result of intensive research, testing and preparation. The idea of such a protocol was suggested by DNV during our specialization project in the autumn 2010, as a way of examining the potential for technology transfer on a project level. The need for addressing the area of technology transfer specifically was also emphasised in conversations with Norad, the Norwegian Agency for Development Cooperation.

We are profoundly grateful for all the help, corrections and suggestions given by practitioners and researchers during our work. All mistakes or ambiguities in the protocol are entirely the responsibility of the authors.

Morten Rørslett Kleveland and Knut Peter Larsen Sønstebø

Content

Introduction

Technology transfer is frequently considered to be of key importance to increase the economic growth in the Third World. Technology transfer is also considered to be one of the most efficient tools for spreading environmentally sound energy technologies to developing countries, thus providing the technology needed to address the future challenges related to climate change. By providing clean, effective and mature energy production technologies to the countries in the developing world, they could be able to leapfrog the age of polluting energy technologies, and contribute to a sustainable energy production path for the world.

The Protocol is our contribution to better technology transfer in future energy projects. Many international energy projects have failed historically, because they restrict themselves to transferring the technology hardware, like turbines and generators. Especially turnkey projects are infamous for providing poorer countries with a brand new, shiny energy production facility, without caring about the long-run sustainability of the project. Energy facilities should be well operated and maintained over time, and this must inevitably be conducted by the workforce in the country, in due time. To accomplish sufficient technology competence and know-how, the local population should be provided with appropriate and extensive training. However, in order to be able to claim that a technology actually is transferred, the local capacity must be improved in numerous ways. This protocol provides guidelines, or recommended practices, for improving the probability for successful technology transfer in a project.

Development process

The work with the protocol started in the specialization project autumn 2010, where we described a framework for developing a set of indicators for assessing technology transfer (Kleveland and Sønstebø 2010). During the spring 2011 we completed the indicator set, which is presented in this protocol. The protocol consists of two sections: One set of generic indicators for assessing technology transfer in energy projects and one technology-specific set of indicators concerning two technologies: hydropower and wind power. The generic indicators are suited for assessing all types of energy production technologies on a general level, whereas the specific indicator set goes into further details regarding either wind- or hydropower projects. It became clear early in the development process that a generic indicator set alone would be unsatisfactory when considering different types of energy projects. On- and offshore wind, hydropower and different forms of solar power are obviously very dissimilar technologies, and must be treated accordingly. However, as many aspects surrounding the process of transferring a technology are shared, the generic part is a reasonable starting point when assessing technology transfer. By considering the technology-specific characteristics as well, the assessment will be complete. Our intention is thus that the users utilize both parts of the protocol when assessing the prospected technology transfer in a project.

The rationale for choosing to prepare indicators for hydropower and wind power projects was that both these energy production technologies are relatively mature; there exist thus a sufficient amount of experiences from such projects. We wanted to have a thorough feedback process, and the competence on hydropower in Norway generally, and NTNU specifically, made these kinds of projects an obvious candidate. Hydropower technologies have been transferred through aid assistance in many decades, and have a long history. It was therefore interesting to increase the range of study with a more novel technology, and wind power was chosen. On-shore wind power has developed into a mature technology during the last two decades, however the number of international wind power projects incorporating technology transfer is still limited. It would thus be interesting to develop an indicator set tailored to guide the transfer of wind power technologies.

The generic part of the protocol has been reviewed by 12 individuals in the following 11 organizations: Statkraft, TrønderEnergi, NVE, Norad, Norfund, Det Norske Veritas, IntPow, International Centre for Hydropower (ICH), Industrial Ecology (NTNU), Interdisciplinary Studies of Culture (NTNU) and a small consulting company. The indicators for hydropower have been considered by professors in hydropower technologies at NTNU, by Statkraft and by the ICH. A wind power expert from DNV China has reviewed the indicators for wind power projects. After having these experienced practitioners and researchers review the protocol, we improved the indicators according to their suggestions, to as great extent as possible. We hope the protocol will be a valuable contribution for a range of different actors involved in cross-country energy projects.

Purpose and Beneficiaries

The main purpose of the protocol is to provide a tool for assessing the potential for technology transfer on a project level. The use of the protocol will guarantee that a broad, thorough consideration of the project is conducted regarding the potential for technology transfer. A formal confirmation of the expected technology transfer, e.g. through a third party review, could be a competitive advantage for the sender of a technology when attracting local business partners, when negotiating with host countries, or when justifying grants from national aid agencies and financial institutions. As the assessment should be conducted prior to the implementation and operation of the project, the protocol will also provide guidance of recommended practices for transferring a technology through international energy projects. The protocol could thereby be a recipe of "Best Practices" for ensuring successful transfer of technology to a local partner/recipient.

A thorough assessment of the potential for technology transfer in a project would be beneficial for a wide range of actors. Here we describe what different actors will achieve by utilizing (or requiring use of) the protocol.

The Sender

There are numerous benefits for a sender applying the protocol. **First**, utilizing the protocol would imply that the sender examines all major barriers to technology transfer and ways to overcome them, thus securing that the technology knowledge and competence is provided to the recipient/partner. Appropriate and well-functioning technology is a key asset in making cash flows more certain in projects where financial inflows often accrue to the sender late in the operation phase.

Second, applying the protocol, and thereby convincing host country actors about the prospected technology transfer, could be a way of attracting local partners and ensuring acceptance by local communities and government.

Third, official development assistance agencies, multinational energy financing and credit institutions could regard the project's proven technology transfer potential to be an important attribute of the project, and it could thereby act as an advantage in attracting financing and support.

Official Development Assistance Agencies

Official development assistance agencies (ODAs) can use the protocol either as a tool for evaluating different projects claiming to contribute to technology transfer, or as guidelines for recommending "Best Practice" behaviour to supported firms and project developers. In addition, the development agencies can apply the protocol (or the results from applying it) to provide information about technology transfer (on a project level) to governments or intergovernmental organizations (IGOs). By requesting that projects supported by development aid make an assessment of the technology transfer potential in the energy project, the ODAs would contribute to increasing both the quality of technology transfer and the knowledge level surrounding technology transfer to developing countries.

In a report on Home-Country Measures for facilitating technology transfer, UNCTAD (2004) suggests that funding agencies require that supported firms work with local firms in all stages (planning, bidding, management and execution) to facilitate the transfer of technologies, e.g. in complex projects like building hydropower stations. The utilization of our protocol represents a practical pathway for ODAs to actually consider all technology transfer related aspects in a systematic manner.

The Recipient

The recipient would either be a local partner in a joint venture or a locally established project. For local actors a verification of the prospected successful transfer of technology (hardware, software and know-how) will be important input in evaluating the suitability of the project. If such a partnership (or local affiliate) is established, the protocol provides an extensive overview of "Best Practices" of the project's behaviour, when it comes to achieving technology transfer. Following these recommendations would ensure that the project strive for a successful transfer of technology, which is a success factor for any long-lasting, sustainable operation.

The Host Country

Host countries would also benefit from requiring that energy projects include technology transfer. Requesting use of the protocol in such projects would be a way of ensuring that technology transfer actually will occur. By explicitly requiring an assessment of the technology transfer, the host country can have yet another attribute to consider when choosing foreign industry partners. This will explicitly show the positive sides of a collaborative foreign partnership exhibiting transfer of knowledge and skills, compared with, e.g., turnkey projects. The assessment could be conducted objectively and transparently by requiring a third-party verification.

What is technology transfer?

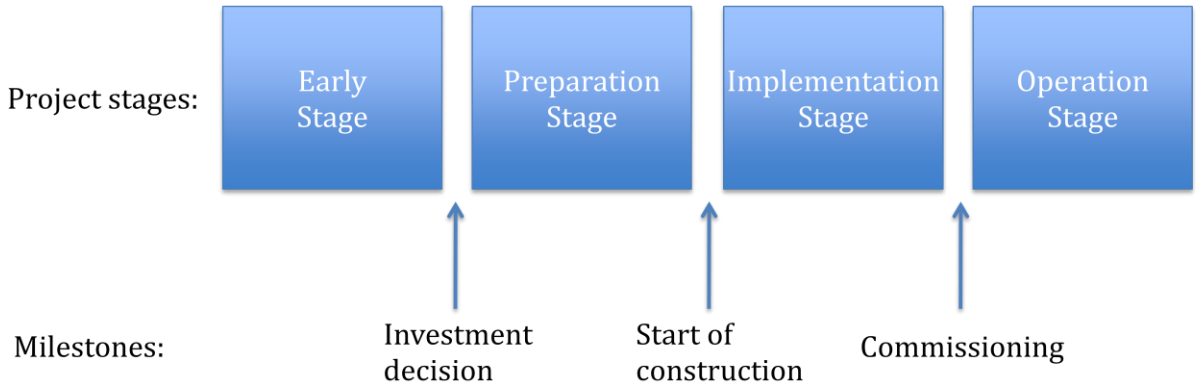
Technology transfer is the key concept of this protocol, and deserves to be adequately defined. For the purpose of this protocol, we define it as:

> *"**Technology transfer** is any process by which a developing country party gains access to technological equipment, information and knowledge from a developed country party, and successfully absorbs it into its production process."*

The term technology is here understood as incorporating all the four components identified by Cohen (2004), namely technoware (physical machinery and equipment), humanware (skills and know-how), inforware (codified descriptions) and orgaware (organisational arrangements needed to integrate the other components). In addition, we require the technology to be mature and properly tested, new to the region, and needed in the host country.

Project Cycle

When considering the technology transfer in international energy projects it is important to understand how the project evolves. Inspired by the methodology in the Hydropower Sustainability Assessment Protocol from the International Hydropower Association (IHA 2010), we consider the projects to consist of four major stages: Early Stage, Preparation Stage, Implementation Stage and the Operation Stage. We define the transition of a project through its phases based on easily separable milestones: The Early Stage lasts through the planning phase, until the final investments decision is made. The Preparation Stage continues, and lasts until the construction is commenced. The Implementation Stage lasts through construction, transportation and installation, and ends with the commissioning of the plant. The Operation Stage continues until the project is decommissioned.



The generic part of the Protocol consists of two sets of indicators: One set for the Early Stage, and one set for the Preparation Stage. Each set is a stand-alone tool, to be applied when the project is in the stage in question. By conducting the evaluation of the potential for technology transfer before the construction is commenced and the project operates, the assessor ensures that he considers the project where the most crucial decisions are made.

The Early Stage

In the Early Stage, i.e. prior to the investment decision, one cannot expect that the provider of the technology has made any actions that may jeopardize the confidentiality of the project. The project may also be only vaguely formulated, thus potentially challenging to investigate. Therefore the Early Stage indicators include requirements and evaluations that may be conducted by the provider of the technology without contact with outside parties. This includes doing a screening of the social and environmental impacts the project will have on the local community. The project should also prepare a thorough review of the national policies and plans, and of the political and legal risks related to the investment. In addition, the Early Stage indicators include guidelines for choice of ownership structure, economic and financial requirements, and provide required practices for considering IPR-protection in the country, as well as the appropriateness of the technology. These Early Stage considerations, i.e. choices that determine the project's structure (e.g. ownership and finance), or attributes of the local situation (e.g. political and legal risk), should be considered before the final investment decision is made.

The Preparation Stage

In the Preparation Stage contact with other actors is both expected and required. The decisions made in the Preparation Stage will influence the technology transfer in the project directly. The indicators in this part of the protocol should be used to assess in which extent the project cooperate with local actors, provide information to stakeholders, utilize local labour, train the workforce, consider differences in culture and language, and communicate with local and national authorities. All the important preparatory requirements should be met during this phase, and plans should be prepared for how to best utilize and train local employees, and for using local resources like consultant and contractors during the project. This part of the Protocol should thus be used prior to, and to inform, the implementation of the project.

Implementation and Operation Stage

Having followed the guidelines of the protocol in the two first stages, the project would be well situated for transferring the inherent technology to the recipient. We have in our protocol decided to focus on the activities conducted in the planning phase of a project. By stating specifically what should be done in this early phase, the protocol is built on the insight that a thorough planning process is necessary for ensuring technology transfer. It is of course crucial that the plans will are implemented, and that the project's performance is reviewed during the lifetime of the project. Many of the aspects assessed in the Preparation Stage will be interesting to reconsider when arriving at the Implementation and Operation Stage. However, as there are large overlaps between the recommended conduct in these last two stages and the Preparation Stage, we have not prepared similar indicators sets for these stages.

Recommendations of Use

It is recommended that both indicator sets are used, in order to have a complete assessment tool. The Early Stage assessment has nine indicators, whereas the Preparation Stage assessment includes twelve indicators. However, as two pairs of indicators overlap, i.e. exist in both the Early Stage and the Preparation Stage, there are altogether 19 unique indicators themes in the generic part of the protocol.

Guidance for Users of the Protocol

Structure of the Indicators

In this section the structure of the indicators is presented. All the generic indicators consists of the following four parts:

Description

All indicators are introduced with a brief account of what the indicator addresses, and what the indicator includes.

Relevance for projects in Developing Countries

This section explains why the issue is important to consider when participating in energy projects in developing countries.

Relevance for Technology Transfer

This section explains why the indicator in question is relevant for technology transfer. Here we refer to literature, case studies and experiences from practitioners to support the argumentation.

Scoring

The fourth section presents the scoring used when assessing a project's technology transfer. Two of the levels, "Good Practice" (3) and "Best Practice" (5) go into detail in presenting what is expected by the project to receive this score.

The indicators are scored on a level from 1 to 5. Level 3, "Good Practice", and Level 5, "Best Practice" provides specific, achievable and realistic performance measures that a project will be compared with. Level 1, 2 and 4 are defined according to how much the project's performance deviates from Level 3 and Level 5. This scoring methodology is thus in line with the Hydropower Sustainability Assessment Protocol provided by the IHA (2010).

Level 3, "Good Practice"

Level 3 presents basic recommendations for a project concerning each indicator theme. These recommendations are what we consider to be "Good Practice" for ascertaining that technology transfer will occur during the life of the project. All projects should strive for Level 3 conduct, even when situated in regions with little resources and low organisational capacities.

Level 5, "Best Practice"

Level 5 represents what we have identified to be the most complete and comprehensive guidelines for transferring technology through international energy projects. "Best Practice" is demanding to attain for any given project, but represents the behaviour projects ultimately should strive for, if the purpose is to transfer the technology successfully.

"Not Relevant"

It may be that an indicator is deemed completely irrelevant for the project in question. In such cases the assessor should assign the indicator "Not Relevant".

The assessor should compare the conduct of the project according to the descriptions in the scoring points for each indicator. The scoring is assigned when all requirements are fulfilled for the level. All further details concerning the scoring are presented for each indicator later in the protocol.

The scoring for an indicator should be assigned based on objective measures presented to the assessor. When the results of an assessment are to be presented to outside parties, it is crucial for the validity of the assessment that the scoring is based on verifiable evidence. However, as some of the considerations are judgemental in nature, the assessor would have to make considerations based on her own opinions and judgements. In order to have an objective assessment it is thus recommended that it is conducted through a third-party verification.

When it comes to outlining what is regarded as objective evidence, we consider the definition from the Hydropower Sustainability Assessment Protocol to be well suited: "Objective evidence can be qualitative or quantitative information, records or statements of fact, either verbal or documented. It is retrievable or reproducible, is not influenced by emotions or prejudice, and is based on facts obtained through observations, measurements, documentation, tests or other means. Personal observations by the assessor counts as objective evidence (…)" (IHA 2010, p. 13).

Glossary of terms

A description of the key concepts is presented at the end of the generic indicator set. When such descriptions are detrimental for the understanding of the indicators and their scoring points, we have amended the indicators with a footnote.

Overview of generic indicators in the Protocol

Early stage		Preparation Stage	
Indicator	**Code**	**Indicator**	**Code**
Social screening	ES-1	Social impacts Assessment	P-1
Environmental screening	ES-2	Behaviour and Corporate Social Responsibility	P-2
National policies	ES-3	Local dialogue	P-3
Political and legal risks	ES-4	Local employment	P-4
Intellectual Property Rights	ES-5	Training	P-5
Economic viability	ES-6	Culture and language	P-6
Financial viability	ES-7	Environmental Impact assessment	P-7
Ownership	ES-8	Communication with Officials	P-8
Technological needs	ES-9	Sourcing	P-9
		Project management	P-10
		Transfer of experiences	P-11
		Infrastructure	P-12

ES-1 Social screening

Description

Social screening is an initial evaluation, assessing expected key stakeholders and social impacts, related to the project in all its phases. It also includes a screening of the level of local competences and skills demanded in the project.

Relevance for projects in Developing Countries

In the Early Stage a social screening should be performed, in order to assess if there exists important aspects supporting or impairing the investment decision. Here, the focus should be on examining the most significant social risk factors, such as dominant stakeholders, cultural differences or severe social impacts. In the Early Stage only these risks should influence the investment decision, but such a review will also provide a helpful starting point for the Social Impact Assessment, and the stakeholder assessment to be conducted in the preparation stage (Indicator P: S-1).

Relevance for Technology Transfer

Employees and their competence are identified as one of the most important success factors when investing in technology in developing countries (Norad 2010). It is therefore essential already in the Early Stage to assess the local competence and skills and the need for training, to account for costs related to this when the investment decision is made. (In addition, it is necessary to ensure that no social risks are so likely to occur and difficult to handle that it imposes a severe threat to the whole project.)

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- conducted an assessment identifying and examining the most significant social risk factors, cultural differences and important stakeholders.
- ensured that these examinations have shown no severe social risks, or such risks are planned mitigated with appropriate level of probability.

4 – In addition to good practice, the project has implemented one aspect from best practice.
5 - Best Practice:

In addition to good practice, the project has:

- conducted a thorough review of the project's social risks, utilizing risk matrices, and / or other sophisticated risk management tools.
- alleged with certainty that there are no significant social risks, or that such risk will be mitigated.

ES-2 Environmental Screening

Description

Environmental screening gives an initial overview of the environmental effects caused by the project, and should include factors like erosion, water use, biodiversity, endangered species and/or vulnerable habitats.

Relevance for projects in Developing Countries

An environmental screening should be conducted in the Early Stage for examining if there exist aspects supporting or impairing the investment decision. In this phase the focus should be on especially significant risk factors that could influence the investment decision. However, this assessment could also provide a helpful starting point for the Environmental Impact Assessment to be conducted in the Preparation Stage.

Relevance for Technology Transfer

Large scale energy technology projects will impact both the local and global environment. This framework addresses ESTs that contribute to mitigation of GHGs, but it is also necessary to assess the local environmental effects. During the Early Stage one should ensure that the technology will not have insuperable environmental effects, and be aware of potential risk factors. If this is not taken seriously, both acceptance from the local communities and authorities will be impaired.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:
- conducted an assessment identifying and examining the most important environmental risk factors.
- ensured that these examinations have shown no severe environmental risks, or such mitigation of risks is planned with appropriate level of probability.

4 - In addition to good practice, the project has implemented one aspect from best practice.
5 - Best Practice:

In addition to good practice, the project has:
- conducted a thorough review of the projects environmental risks, utilizing risk matrices, and / or other sophisticated risk management tools.
- alleged with certainty that there are no significant environmental risks, or that such risk will be mitigated.

ES-3 National policies

Description

National policies and plans addresses national regulations that affect the project, and include sectors like energy, climate, urban and rural infrastructure planning, land use, water and biodiversity.

Relevance for projects in developing countries

This issue addresses the national policy regime in the country where the energy project is being undertaken. It includes policies, plans and targets set for the energy sector, and which could be of importance for the project during its planning, implementation and operation phase. By being aware of potential weaknesses or complexities in the policies and plans, these can be managed more effectively.

Relevance for Technology Transfer

It is important to consider national policies, as lack of clear plans for (renewable) energy development and lack of integrated planning for energy and development constitutes a severe threat to transfer of energy technologies (Wilkins 2002). The quality of policies and integrated planning also influence the development of the whole project, so it is necessary to be aware of and adapt to these conditions.

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good practice:
    The project has:
    - undertaken an assessment of the national policies, including all relevant sub-sectors.
    - examined plans and targets for the energy sector, and ensured that the project is compatible.
    - ensured that weaknesses and complexities in policies and plans can be managed in all phases of the project.
4 - In addition to good practice, the project has implemented one aspect from best practice.
5 - Best practice:
    In addition to good practice, the project has:
    - taken a broader approach in the assessment of relevant policies, plans and targets, including social issues like poverty eradication and food security.
    - demonstrated that the project fits with the national policies, and that it can manage the related risks with certainty.

ES-4 Political and legal risks

Description

Political and legal risks address the possibility for and implications of political forces and events influencing the project, as well as challenges and flaws in the legal system.

Relevance for projects in developing countries

This issue addresses how political and legal risk affect investments in developing countries. Political risk is ranked as the most important constraint for Foreign Direct Investment in developing countries over the medium term (MIGA 2010). Energy projects are generally of large scale, and it is therefore essential to understand and manage all major risks as early as possible. Legal risks include contract, property and regulatory risks, and are vital to adequately assess and mitigate before the investment decision is taken. High contract risks, through e.g. weak legal institutions, might imply that the project will have difficulties recovering costs in the legal systems.

Relevance for Technology Transfer

Assessing the political and legal risks is only indirectly relevant for technology transfer as such, but nevertheless very important for successful investments in emerging markets. Either of these risks have the potential to negatively affect the project throughout its course, thus reducing or even ruining the prospected technology transfer.

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good practice:
  The project has:
  - undertaken an assessment of the political risks in the host country, identifying the most probable and influential possible incidents.
  - assessed all legal institutions and relevant laws and regulations with reference to the project and technology in question.
  - addressed the most critical weaknesses of the judicial system, pointed out risks relevant for the project and how it will manage these.
  - established routines for continuous risk management.

4 - In addition to good practice, the project has implemented one or two aspects from best practice.
5 - Best practice:
  In addition to good practice, the project has:
  - taken a broader approach in the assessment of relevant political risks, identifying all relevant political and legal risks, and how it will manage them.
  - taken a broader approach in the assessment of the legal system. All identified weaknesses of the judicial system have been evaluated, and contractual, property and regulatory risks have been addressed explicitly.
  - developed scenarios to analyze the effects of the most probable risks on the project.

ES-5 Intellectual Property Rights

Description

Intellectual property rights refer to the protection of creation of mind, and this issue looks at how patents, trademarks and other property rights influence the success of projects.

Relevance for projects in developing countries

This issue addresses how Intellectual Property Rights (IPR) affect investments in developing countries. When implementing a new technology in a country, too soft IPR imposes a threat to the project, diluting the value of the technology through unauthorized diffusion.

Relevance for Technology Transfer

Intellectual Property Rights (IPR) is highly relevant for technology transfer. However, there are often opposite views about IPR and technology transfer in developed and developing countries. Exporters of technology argue that strong IPR is necessary to ensure the rights of the developer (sender), and therefore will increase technology transfer. Contrary, developing countries want to spread the technology inside their country, and will therefore be reluctant to impose too strong IPR (Magic 2003).

For given projects, the importance of IPR hinge on how mature the technology is. OECD (2005) argues that many ESTs are not protected by patents, and thus, IPR is irrelevant. Nevertheless, for technologies that should still be protected, it is necessary to assess the IPR of the host country, and see this in context with the legal institutions that should enforce them.

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good practice:
    The project has:
    - made probable that the intellectual property rights are sufficient for the given technology to be transferred.
    - if relevant; assessed how the IPR are enforced by the legal institutions. (See indicator ES: I-2).
4 - In addition to good practice, the project has implemented one aspect from best practice.
5 - Best practice:
    In addition to good practice, the project has:
    - if relevant; undertaken necessary actions to mitigate risk of unauthorized diffusion of the technology.
    - if relevant; assessed how unauthorized diffusion of the technology affects costs and revenues in the project, risk of loss of trained labour, and included this as a scenario in the business plan.

ES-6 Economic viability

Description

Economic viability is the economic soundness of a project. It includes all costs and benefits relevant to the project, and evaluates the net benefit against the required rate of return for the given risk profile of the project.

Relevance for projects in developing countries

Economic viability addresses the net economic performance of the project. It looks at how sound the economic performance is, when all relevant costs and benefits are taken into account. Potential economic risks that may arise throughout the lifetime of the project are also important and need to be considered.

Relevance for Technology Transfer

This issue is highly relevant since successful technology transfer is dependent on a sound economic situation for the project. A thorough economic analysis will also take into account all costs related to education and training of workers, and the economic risks related to potential problems in activities promoting technology transfer.

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good practice:
    The project has:
    - written a detailed business plan, including a market analysis and a thorough cost-benefit analysis.
    - conducted a comprehensive analysis of the economic viability.
    - examined national economic characteristics, such as tariffs, taxations, foreign exchange rates, currency conversion, licenses and trade control, covering both enforcement and transparency.
    - plans for hiring and training a local employee(s) in accounting, finance and control.
4 - In addition to good practice, the project has implemented one aspect from best practice
5 - Best practice:
    In addition to good practice, the project has:
    - included scenario / sensitivity analyses in the evaluation of the economic viability.
    - assessed the Investing Across Borders (IAB) indicators for the host country, to identify aspects of particular relevance to the economic viability of the project.[1]

[1] **Investing Across Borders** is a World Bank Group initiative comparing regulation of foreign direct investment around the world. It presents quantitative indicators on economies' laws, regulations, and practices affecting how foreign companies invest across sectors, start businesses, access industrial land, and arbitrate commercial disputes. (www.iab.worldbank.org)

ES-7 Financial viability

Description

Financial viability is the ability of an entity to continue to achieve its operating objectives and fulfill its mission over the long term. Here it concerns the project's ability to meet its future financial obligations as they fall due.

Relevance for projects in developing countries

The financial viability addresses the projects need for and access to finance throughout its lifetime, and ability to meet the financial obligations. This issue is highly relevant, as one of the barriers for successful projects is the lack of access to capital (Wilkins 2002). It is therefore important to evaluate all the possible sources of financing, and their costs and conditions. Most energy projects are large-scale, long lasting and with a high initial investment, so financial costs constitute a substantial part of the payable expenses during its lifetime.

Relevance for Technology Transfer

Projects incorporating the good practices of technology transfer might incur higher initial costs related to extensive training of employees, comprehensive routines, and time-demanding assessments of risks. These costs could be justified by the prospected increase in technology transfer they ensure, and thus a better performance in the long-term. An extensive and reliable financial analysis is necessary to attract project financiers, and is also an advantage in receiving grants and finance from donors and development banks.

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good practice:
  The project has:
  - undertaken an assessment of the corporate or project financial soundness, including all project costs and expected revenues, using well established and acknowledged financial models.
  - assessed the cash flows against stability considerations, their sustainability, and the potential for and impact of growth. It has assessed the risks, and included scenario and sensitivity analyses.

4 - In addition to good practice, the project has implemented one aspect from best practice
5 - Best practice:
  In addition to good practice, the project has:
  - undertaken a broader risk assessment and included sensitivity analysis of all possible scenarios.
  - demonstrated that it can handle its debt under all the scenarios, throughout the whole lifetime.

ES-8 Ownership

Description

Ownership refers to the ownership structure between the sender and the recipient organisation, and how this relates to technology transfer.

Relevance for projects in developing countries

This issue addresses how the ownership in the project should be divided between the sender and the developing country party. From the sender's perspective this is a question of how integrated the value chain should be, whereas the recipient involvement is dependent on how strong local anchoring of the project must be.

Relevance for Technology Transfer

Local ownership in the project is by some argued to be favourable for reducing the barrier of social acceptance, thus enabling technology transfer (Devine-Wright 2005). A higher degree of local involvement in all phases and at all levels of the project implies a higher degree of learning to the recipient party of the transfer process. UNDESA (UNDESA 2008) states that technology partnerships between developed and developing country actors have been very effective in technology development and transfer, provided that they include a long-term commitment, in a two-way relationship. Joint Ventures between a local and an international actor have been identified to be the an effective form of organization for technology transfer (Anderson and Forsyth 1998).

When choosing an equity partner a reputational due diligence should be performed. Partners without the required ethical standards, or with a bad reputation locally or among development banks, could be detrimental for the success of the project (Norad 2010). There are certain advantages for a sender having a majority share of ownership; it increases control of operation, reduces risk of corruption and ensures control of maintenance and spending (Norad 2010). Without such a majority position it is important that the shareholder agreement is strong, the partner has a good reputation and access to necessary information is assured through central positions and veto rights (Norad 2010).

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good practice:
    The project has:
    - performed a reputational due diligence when choosing an equity partner.
    - some extent of local ownership in the project.
4 - N/A
5 - Best practice:
    In addition to good practice, the project has:
    - been established in a collaborative effort between the sender and a local organization. The sender has the majority position; alternatively the sender should have ensured that there exists a sufficiently strong shareholder agreement, that it has secured central positions in the project, and necessary veto rights.

ES-9 Technological needs

Description

Technology Needs addresses how well the potential technology to transfer fits with the needs of the host country. The technology should be pursuant to the country's Technology Needs Assessment (TNA), which is a structured way of prioritizing climate change mitigation and adaptation technologies in developing countries.

Relevance for projects in Developing Countries

The choice between energy production alternatives is an important strategic choice for a country, with implications for its security of supply, carbon footprint and technological knowledge base. Investments in technology projects in developing countries will also potentially affect the water and energy services nationally, and this influence should be in line with the country's needs and prospected development.

Relevance for Technology Transfer

As numerous studies have shown (Kline et al. 2004, Wilkins 2002), the technology should be chosen based on the priorities and needs from the host country, in order to be beneficial in the long-term. Such local benefits, and thus social acceptance and utilization, are a prerequisite for successful technology transfer (Wilkins 2002). This implies that the project should examine, and make sure that the technology introduced is in accordance with the needs of the host country, i.e. as stated in the country's Technology Needs Assessment (TNA), or national plans and policies.

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- chosen a technology to transfer that is prioritised as a technology of interest in the host country's TNA.
- chosen a technology that delivers services in accordance with the host country's policies and plans.

4 - In addition to good practice, the project has implemented one or two aspects from best practice.
5 - Best Practice:

In addition to good practice, the project has:

- chosen a technology that is of high priority in the host country's TNA.
- shown that national policies and plans regard the technology in question as a key energy technology.
- shown that implications from the technology, e.g. improved energy services, water supply or flood protection, are denoted as beneficial in national policies or plans.

P-1 Social Impacts Assessment

Description

A Social Impact Assessment encompasses the analysis, monitoring and managing of intended or unintended social consequences, positive or negative, of the planned activities by the project.

Relevance for projects in Developing Countries

Stakeholder assessments, and the examination of social impacts of the project, are of key importance to identify and mitigate the risks related to the social dimension. All negative impacts should be minimized and properly compensated.

Relevance for Technology Transfer

Best practices of technology transfer involve all relevant stakeholders and the local community in all stages of the project – from preparation, through implementation and operation of the facility. An important barrier of technology transfer is a lack of social acceptance (UNFCCC 2009, Mallett 2007, Wüstenhagen et al. 2007). In order to overcome this barrier it is important to ensure that the technology and the surrounding infrastructure and equipment are introduced in cooperation with and according to the needs of the local community.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- conducted a stakeholder assessment, identifying all relevant direct or indirect parties affected by the project. A thorough examination of all the social impacts the project has on the local level has been undertaken. A baseline should be established to compare with later project performance.
- revealed no severe social impacts or any disproportionately large impact on any single stakeholder group, or such impacts have been mitigated, avoided, or properly compensated.
- established guidelines to ensure that weaker groups (women, indigenous people) are not disempowered or negatively influenced.

4 – N/A
5 - Best Practice:

In addition to good practice, the project has:

- conducted a broad assessment of the social impacts on a regional/national level.

P-2 Behaviour and Corporate Social Responsibility

Description

Behaviour and Corporate Social Responsibility addresses how the project influences the local community through its conduct. Corporate Social Responsibility is the concept where companies integrate social issues and concerns in their business operations on a voluntary basis.

Relevance for projects in Developing Countries

A predictable, acceptable and responsible conduct is important for the legitimacy of the project. The energy industry is expressed as one of the most corrupt industry many places, but the pressure for extra payments is reduced when a project demonstrates that it will not accept irregular payments (Norad 2010). It is important that all employees adhere to a code of ethics addressing corruption, antitrust, workers rights and acceptable behaviour. The project should have a net positive effect on the local community, even in cases where the energy is exported from the area.

Relevance for Technology Transfer

Lack of social acceptance is an often-cited barrier to technology transfer, and the behaviour of the project and its employees is thus important for laying a foundation of a project with substantial public support (UNFCCC 2009). Such acceptance will enable local identification with the project, future recruitment of employees and improved reputation among local decision-makers. Benefits from Corporate Social Responsibility actions undertaken by the project, increasing the level of technology understanding and access to equipment, knowledge and electricity, might also increase the technology transfer and diffusion related to the project.

Scoring

1 – The project has not implemented any aspects from good practice.

2 – The project has implemented one or more aspects from good practice.

3 - Good Practice:

The project has:

- formulated a Code of Ethics, to reduce the possibility for corruption.
- ensured that the Code of Ethics has been adopted by the project's participants and employees.
- justified net positive effect on stakeholders and the local community, through local (or regional) services and facilities, such as improved health services, infrastructure, housing, safety, communication, information and education.

4 – In addition to good practice, the project has implemented one aspect from best practice.

5 - Best Practice:

In addition to good practice, the project has:

- incorporated the 10 principles of UN Global Compact in the project's Code of Ethics[2].
- made sure that its suppliers and contractors adhere to the project's Code of Ethics.

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[2] **UN Global Compact** is a strategic policy initiative for businesses that are committed to aligning their operations and strategies with ten universally accepted principles in the areas of human rights, labour, environment and anti-corruption UN GLOBAL COMPACT. 2010. *Overview of the UN Global Compact* [Online]. Available: http://www.unglobalcompact.org/AboutTheGC/ [Accessed at 18.02.2011 2011]..

P-3 Local dialogue

Description

Local dialogue is information provided through meetings, road shows, advertisements and leaflets, or through a website providing updated information. It also includes feedback opportunities for stakeholders to the project management.

Relevance for projects in Developing Countries

Including the stakeholders is vital to encourage dialogue and input from the local community in the different phases of planning and implementation of the project. Additionally, it will pave the way for good, long-lasting stakeholder relations throughout the project. In many developing countries illiteracy is widespread, thus information must be provided both written and orally.

Relevance for Technology Transfer

The dialogue with stakeholders is important, as successful technology transfer must acknowledge the needs and challenges of the local community in order for the project to become socially acceptable in the long-term (Wilkins 2002, Norad 2010). Moreover, such dialogue can reduce the chance of failing to adapt the technology to local conditions (Wilkins 2002, UNFCCC 2009).

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- provided information through newspapers, flyers and advertisements about the project, and its consequences.
- held presentations for stakeholders, to provide information about the project, and encourage the local community to give input to the preparation process.

4 - In addition to good practice, the project has implemented one aspect from best practice.
5 - Best Practice:

In addition to good practice, the project has:

- developed a website (if internet access is widely available locally), providing stakeholders and others with updated information about the project. It is further positive if there is an online feedback opportunity.
- arranged meetings with directly affected stakeholders, where topics of interest for stakeholders are discussed. Potential challenges that have arisen must later have been seriously considered in the decision-making process.

P-4 Local employment

Description

Local employment includes both internal project employees and contracted labour, such as consultants and contractors.

Relevance for projects in Developing Countries

This issue addresses the use of local labour in different phases of the project. Lack of technically trained local workers is identified as a barrier to technology projects (Wilkins 2002), whereas the long-term sustainability of the project depends on the participation and involvement of the local community (Kline et al. 2004).

Relevance for Technology Transfer

A high degree of local participation is of vital importance to ensure a significant transfer of knowledge and know-how surrounding installation and use of the technology. Local participation is necessary in all phases, from preparation, through implementation and operation, in order to increase the local technology competence. Unions may increase social acceptance and is associated with more training of unskilled workers, and could therefore be encouraged. To mitigate the risk of severe accidents, the project should also establish routines for Environment, Health and Safety (EHS), and provide training in EHS and first aid for all foremen.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has plans for:

- hiring local labour in installation and construction.
- mainly employing local labour in the operation of the project.
- having local labour in most levels of the organization.
- establishing routines for Environment, Health and Safety.

4 - In addition to good practice, the project has implemented one or two aspects from best practice.
5 - Best Practice:

In addition to good practice, the project has:

- involved local labour in the planning phase.
- engaged consultants and contractors from the recipient country. This could be accomplished through cooperation with international actors to ensure sufficient competence.
- plans for encouraging a trade union among the local workers

P-5 Training

Definition

Training addresses the process of increasing knowledge, knowhow and skills of the local workers, and includes both formal and informal education.

Relevance for projects in Developing Countries

The knowledge, skills and experiences of the human resources in the project is the most important asset of the project, and the quality of the training and education of employees is therefore of key importance to the viability of the project.

Relevance for Technology Transfer

Appropriate and extensive training of local employees is crucial in order to ensure a successful transfer of the codified and tacit knowledge surrounding a technology (Kline et al. 2004, Wilkins 2002, Metz et al. 2000). Training activities are examples of internal capacity building, which is a prerequisite for having long-term, sustainable use of a technology in the local environment.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has plans for:

- providing written manuals or other education material in the appropriate language(s). When local workers are illiterate, information may have to be provided through illustrations or orally.
- giving the local technical employees the necessary relevant education on the installation, operation and maintenance of the technology, through courses, seminars or workshops.
- giving technical employees actual on-site training.
- providing sufficient training to build capacity in managerial areas, e.g. finance and control, management and HR.

4 - In addition to good practice, the project has implemented one or two aspects from best practice.
5 - Best Practice:

In addition to good practice, the project has plans for:

- providing training on standards, testing methodologies and certification procedures.
- providing local employees with formal education like craft certificates and diplomas.
- giving local employees technical training at a regional technology centre, or in another facility operated by the sender organization.

P-6 Culture and Language

Description

Culture and language includes an assessment of cultural and linguistic differences that can hamper the project.

Relevance for projects in Developing Countries

When participating in cross-cultural projects it is important that the decision-makers have a good understanding of the inherent cultural differences of the project participants. A thorough assessment of the local conditions also includes examining and understanding the language(s) used by stakeholders and employees within the recipient country.

Relevance for Technology Transfer

In order to transfer information and knowledge surrounding a technology, it is important to overcome the barrier a significant cultural gap can constitute (Metz et al. 2000). Additionally, language difficulties might pose a serious threat to the quality of communication in the project.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- conducted an examination of the cultural differences, identifying key differences between the parties.
- identified no significant cultural gap, or remedial action has been undertaken. An example of such action could be to provide education on cultural differences to the project participants and employees.
- examined which languages that are spoken by employees and stakeholders to the project.
- provided information about the project to stakeholders in their local language, and training and education of employees has been provided in an appropriate language.

4 - In addition to good practice, the project has implemented one or two aspects from best practice.
5 - Best Practice:

In addition to good practice, the project has:

- conducted an in-depth study of the cross-cultural differences, e.g. through Geert Hofstede's cultural dimensions, or other cultural assessment tools[3].
- has provided additional cross-cultural enlightenment, e.g. through seminars on cultural understanding or cross-cultural workshops.
- has succeeded in removing language barriers, e.g. by providing language training.

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[3] **Geert Hofstedes™ cultural dimensions** are an attempt to analyze and explain the cultural differences between countries and regions. The five dimensions are: Power Distance, Uncertainty Avoidance, Individualism, Masculinity and Long-Term Orientation. A sixth dimension covering Indulgence versus Restraint has also been suggested HOFSTEDE, G. & HOFSTEDE, G. J. 2011. *Dimensions of national Cultures* [Online]. Available: http://www.geerthofstede.nl/culture/dimensions-of-national-cultures.aspx [Accessed at 25.02.2011 2011]..

P-7 Environmental Impact Assessment

Description

Environmental Impacts Assessment is a thorough investigation of environmental issues related to the project, and requires a description of the project (location, design, size), considerations of alternatives and main reasons for the choice, identification of significant effects, and mitigation.

Relevance for projects in Developing Countries

A thorough assessment of all the environmental impacts the project will impose has been called for in large (energy) projects financed by the IFC, and even in most national laws and regulations (Wood 2003, Norad 2010). It is also deemed beneficial to implement systems to continuously be prepared for emerging environmental risks.

Relevance for Technology Transfer

To use the energy project to develop a sustainable, long-lasting platform for technology transfer, an environmental awareness has to be created and maintained during the preparation and implementation process. A sound energy project should have a net positive environmental effect, to not degrade the local acceptance (IEA 2001).

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- conducted an Environmental Impact Assessment, in order to identify environmental risks and effects of the project. This assessment should include input from appropriate expertise, evaluating the project and primary supplier's impact. A baseline should be established, to compare with later project performance.
- undertaken an assessment of how the project affects land and natural resources beyond its ownership.
- made plans for how to minimize or mitigate the identified negative environmental impacts.
- established management procedures to anticipate and respond to emerging environmental risks.

4 - In addition to good practice, the project has implemented one or two aspects from best practice.
5 - Best Practice:

In addition to good practice, the project has:

- established management systems in line with internationally recognized standards where performance is reviewed by a third party, like the ISO 14001.
- conducted a Life-Cycle Assessment, identifying the most important environmental effects caused by the project throughout its lifetime.
- contributed to mitigate environmental problems beyond what is related to the project.

P-8 Communication with officials

Description

Communication with officials addresses the need for communication with relevant official institutions. Institutions relevant for energy projects include the Energy Department, the Energy Regulator, and the departments responsible for environmental protection, rural planning, electrification and development.

Relevance for projects in developing countries

This issue addresses the challenges related to insufficient communication between government departments and the project management in energy projects. Often the responsibility for different aspects relevant for energy projects is divided among several government departments, and communication between these departments may be poor.

Relevance for Technology Transfer

Poor communication and coordination between involved government actors is detrimental to technology transfer. Split responsibility for renewable energy policy and planning might result in slow implementation of necessary revisions of policies, plans and regulations. It is therefore essential that the project itself is aware of these problems and has established good connections in all relevant official institutions (Wilkins 2002). The embassy of the sender would often be a potential door opener for the project in its communication with the host-country's institutions.

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good practice:
   The project has:
   - undertaken an assessment to identify all the relevant official institutions, and clarified the responsibility for the aspects relevant to the project.
   - established connections with officials at the right level in all the institutions identified as relevant.
   - established contact with the sender country's embassy in the host country.
4 - In addition to good practice, the project has implemented one aspect from best practice
5 - Best practice:
   In addition to good practice, the project has:
   - established routines and assigned responsibility for providing information to all contacts on a regular basis.
   - identified potential risks from unclear communication between official institutions, and how these aspects will influence the project. In addition, it has developed routines to manage and reduce these risks.

P-9 Sourcing

Description

Sourcing addresses the need for reliable supply contracts, and how cooperation with and sourcing from local suppliers is positive for the technology transfer.

Relevance for projects in developing countries

This issue addresses the project's purchase of all necessary physical resources throughout the whole lifetime. As reliable supply of key resources is essential to the success of the project, it is important to understand and consider this topic already in the preparation phase. The resources should have sufficient quality, be delivered timely and be procured transparent and accountable.

Relevance for Technology Transfer

Unreliable supply of expendable parts are considered a threat to technology transfer, as it may impede the stability of operation, even with a possibility for shutdowns (Wilkins 2002). Long term sourcing from local suppliers will therefore be positive for the project itself, through an increase of competence among the suppliers and as it may improve the existing market, or create new markets. When resettling, or otherwise severely affecting local stakeholder groups, the IFC also recommends promotion of " (…) local enterprise by producing goods and services for their projects from local suppliers." (IFC 2002, p. 38)

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good practice:
    The project has:
    - documented the expected required resources in both the implementation and operation phase.
    - assessed the risks related to procurement and supply.
    - identified and evaluated all potential local suppliers, with regard to cost, quality and reliability.

4 - In addition to good practice, the project has implemented one aspect from best practice
5 - Best practice:
    In addition to good practice, the project has:
    - established long term contracts for the most important resources and spare parts it will need throughout the implementation and operation phase.
    - chosen local suppliers in all cases where they are, or might become, competitive.

P-10 Project Management

Description

Project management refers to the coordination of all activities in the project. It includes setting up an integrated project management plan, with schedule, a work breakdown structure, estimated effort and resource use in different activities, roles and responsibilities.

Relevance for projects in developing countries

This issue addresses the developer's ability to manage the project through all its phases. A potentially unstable and unfamiliar environment in developing countries makes it important to coordinate all activities as to meet milestones and critical success factors, and to be able to manage potential delays in any component.

Relevance for Technology Transfer

All technology transfer transactions encompass significant project-based work. Contrary to more conventional projects, an international project exhibiting technology transfer does not end with the hand-over phase, they are affected by interaction with various stakeholders, and they are complex and risky containing uncertainty from technical, organizational, market, social, political and cultural factors. It is also more difficult to measure the success of the project if the goal is technology transfer. A management task of particular importance in technology transfer projects is to ensure compatibility between the technology to be imported, and the recipient environment (Saad et al. 2002).

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good practice:

The project has:

- prepared an integrated project management plan, which includes setting detailed project constraints on scope, time and budget, taking all activity clusters of the project into account.
- set appropriate objectives and defined relevant performance indicators.
- plans for providing training to local employees in project management practices.
- developed a systematic monitoring, evaluation and control system, in order to identify drawbacks and intervene for corrective action.

4 - In addition to good practice, the project has implemented one aspect from best practice
5 - Best practice:

In addition to good practice, the project has:

- developed detailed plans on how to handle delays or other unanticipated occurrences in certain activities and still meet the timetables and budgets.
- included scenario / sensitivity analyses of the construction risks in the construction management plan.

P-11 Transfer of experiences

Description

Transfer of experiences includes all types of formal or informal exchange of information with external actors involved in transferring and disseminating technology, e.g. exporters of technology, regional technology centres, universities or research institutions.

Relevance for projects in Developing Countries

Learning from experienced actors, as well as utilizing regional resources from universities and research institutions, is argued to be positive for companies investing in, and operating technologies in new environments (Wilkins 2002).

Relevance for Technology Transfer

Insights from case studies have shown that technology transfer is more successful when there is collaboration at many different levels (Kline et al. 2004). To gain better understanding of the environment surrounding the technology, it is beneficial to share experiences with actors facilitating or transferring technologies to the same country or region. In addition, a cooperation or partnership with national/regional universities or research institutions could prove beneficial for disseminating knowledge, using local resources and attracting local educated labour.

Scoring

1 - The project has not implemented any aspects from good practice.

2 - The project has implemented one or more aspects from good practice.

3 - Good Practice:

The project has plans for:

- exchanging experiences with actors like regional technological networks or industry clusters, facilitating technology transfer.
- exchanging experiences with actors transferring the same technology, or actors transferring other technologies to the same region.
- exchanging experiences with local/regional universities or research institutions.

4 - In addition to good practice, the project has implemented one aspect from best practice.

5 - Best Practice:

In addition to good practice, the project has plans for:

- establishing partnerships (formal cooperation) with regional networks or industry clusters facilitating technology transfer.
- establishing partnerships (formal cooperation) with local/regional universities or research institutions in the region.

P-12 Infrastructure

Description

Infrastructure refers to the technical structures surrounding the project, e.g. roads, power grids, water supply and telecommunication. These technical structures deliver service by supporting the core production of the facility. For energy projects such infrastructure might be gas pipelines, district heating systems, or the entire electrical power network with electrical main grid, transformers and local distribution network.

Relevance for projects in Developing Countries

When executing energy projects, a well-developed surrounding infrastructure is a strong advantage. For energy producing facilities and other technologies relying on secure power supply, especially the power grid must be examined with scrutiny.

Relevance for Technology Transfer

A functioning infrastructure is more of a prerequisite for successful technology transfer, than a cause itself. However, as it is vital for the operation of most power producing projects to be connected to a well-functioning power grid, and further diffusion of technology is dependent on the quality of local infrastructure (UNFCCC 2009), it is still deemed important.

Scoring

1 - The project has not implemented any aspects from good practice.
2 - The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- assessed the quality of the power grid, roads, water supply and telecommunication.
- examined plans for national investments in relevant surrounding infrastructure.
- supported necessary upgrading of the surrounding infrastructure
- ensured that it does not harmfully affect the surrounding infrastructure, or otherwise necessary remedial action should be set in place.

4 – N/A
5 - Best Practice:

In addition to good practice, the project has:

- supported building and upgrading of local infrastructure not directly affected by the project.

Key concepts

Activity clusters are project components, like design, construction, resettlement, finance, communications and procurement.

Assurance mechanisms are contracts, laws or expectations (formal or informal), which ensure that collaboration or partnerships will provide each party with their desired result.

Baseline is a thorough description of the situation prior to the implementation of the project, which is necessary for measuring progress. The baseline can be set through a feasibility study or a focused baseline study (Norad 2008).

Capacity Building is the increase in skilled personnel and technical and institutional capacity(Metz et al. 2000).

Code of Ethics is a set of designed behavioural guidelines.

Contract risk is the risk and cost of enforcing contractual legal obligations with different actors.

Corporate Social Responsibility is the concept where companies integrate social issues and concerns in their business operations on a voluntary basis.

Cost-benefit analysis is quantification in monetary terms of all costs and benefits that derive from the project.

Energy Services include, inter alia, electricity supply (local, national or regional), grid stability, demand side management and ancillary services.

Environmental Impact Assessments (EIAs) vary between countries and organizations, and for reference EU's EIA is chosen (European Commission Environment 2010). In short EU requires that the EIA incorporates a description of the project (location, design, size), consideration of alternatives and main reasons for the choice, identification of significant effects and data required to assess these effects on the environment and mitigation (European Union 2006).

Environmental Issues in energy project could be, inter alia, biodiversity, endangered species, ecosystem robustness, sensitive habitats, water quality or pollution.

Geert Hofstedes™ cultural dimensions are an attempt to analyze and explain the cultural differences between countries and regions. The five dimensions are: Power Distance, Uncertainty Avoidance, Individualism, Masculinity and Long-Term Orientation. A sixth dimension covering Indulgence versus Restraint has also been suggested (Hofstede and Hofstede 2011).

I**ntegrated project management plan** includes project schedule, a work breakdown structure, estimated effort and resource use in different activities, roles and responsibilities.

Intellectual Property (IP) refers to creations of the mind, and "*relates to items of information or knowledge, which can be incorporated in tangible objects at the same time in an unlimited number of copies at different locations anywhere in the world*" (WIPO 2005). Industrial protect the creators' interests by giving them property rights over their creations, e.g. through patents and trademarks (Wilkins 2002).

Political risk is the probability that political forces or events influence the operation of an international project. This includes, inter alia, expropriation, politically motivated interference, breach of contracts by a host government, political unrest and changes in the host countries' laws and regulations.

Property risk includes the risk of expropriation and confiscation.

Regulatory risk includes aspects as licenses, tariffs, taxation, foreign exchange and trade controls, and covers how clear and transparent these issues are set, and how they are enforced and guaranteed.

Sensitivity analysis measures the extent of which the return varies when there are changes in variables.

Social acceptance is as in Wüstenhagen et al., (2007), divided into three categories: Socio-political acceptance, community acceptance and market acceptance. Socio-political acceptance is acceptance by the general public, key stakeholders and policy makers; community acceptance by the local resident and authorities; and market acceptance from investors, within the project and from consumers.

Social impacts are consequences of the project that are important for human well-being, such as security, housing, education and health.

Stakeholder is any person or organization, which can be negatively or positively affected by the actions, or the lack of action, of an organization, person or project.

Supply chain risk is the inability to meet contract provisions, with respect to cost, time, quality and specifications, corruption and human rights (e.g. child labour, forced labour used by suppliers of suppliers).

Technology Needs Assessment (TNA) is a structured way of prioritizing climate change mitigation (and adaptation) technologies, implemented in developing world countries under the United Nations Framework Convention on Climate Change (UNFCCC 2001).

Transaction costs are the costs of participating in a market, and includes financial costs, time spent in negotiation with other actors, search and information costs and policing and enforcement costs.

UN Global Compact is a strategic policy initiative for businesses that are committed to aligning their operations and strategies with ten universally accepted principles in the areas of human rights, labour, environment and anti-corruption.

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Part 2A
Technology-specific Indicators
Hydropower

Protocol for Assessing the Potential for Technology Transfer in Energy Projects

Appendix A
Master thesis by Kleveland and Sønstebø 2011

Content

Introduction to the Indicators for Hydropower projects

This part contains the set of technology-specific indicators for assessing the technology transfer in hydropower projects in developing countries. Guidelines for use are presented in the generic part, and we refer the reader to the first section of the protocol for the complete introduction, and a presentation of the background and use of the protocol.

Use of Technology-Specific Indicators

The indicators for hydropower are in principle similar to the generic indicators for all energy technologies, however some differences should be commented. These indicators go into much greater detail concerning the technology to be transferred, and is as such a necessary amendment to the generic part. This implies that the evidence to the scoring assignments will need to be provided with help from technical personnel.

Using this indicator set alone will only provide a fragmentary consideration of the technology transfer in the project. However, by using the technology-specific part in addition to the generic part we argue that the assessor gets a comprehensive overview of the technology transfer potential in the project. The generic part ensures that the project takes a holistic approach, considering technological, environmental, social, institutional and business aspects, whereas the specific part ensures a dive into the specialities of the technology in question.

Choice of Hydropower Indicators

The selection of the issues in the hydropower indicators is based on what is identified as the most important actions for ensuring technology transfer in such projects. We have attempted to select them as sensible as possible, and by inviting experts from Statkraft, ICH and the Hydropower department at NTNU to review the issues, and come up with additional suggestions we believe the set of indicators cover the width of such projects appropriately.

Structure

The structure of the indicators is principally identical with the generic part. The most important change is that the section with “Relevance for projects in Developing Countries” is omitted, as the focus here is on technology rather than on developing countries per se. The section with “Relevance for Technology Transfer” is therefore enlarged accordingly.

Assessment Timing

All technology-specific indicators are developed such that the assessment should be conducted in the Preparation Stage of the project. This is analogous with the majority of the indicators in the generic part, and arises from the need to interact with external parties during the process (i.e. after the investment decision is made), combined with the desire to include local actors already in the planning and preparation of the project (i.e. as early as possible). These indicators are therefore prepared such that all information needed is available when the assessment is done during the Preparation Stage.

Glossary of Terms

A description of the key hydropower concepts is presented at the end of the indicator set.

Overview of technology-specific indicators – Hydropower

Preparation Stage	
Issue	**Indicator**
Hydrology	H-1
Erosion and Sedimentation	H-2
Location, Design and Reservoir Planning	H-3
Resettlement	H-4
Installation	H-5
Grid Integration	H-6
Downstream Flow Regime	H-7
Operation and Maintenance (O&M)	H-8

H-1 Hydrology

Description

The **hydrology** issue refers to availability and understanding of hydrological data, and the reliability of the hydrological resource in the project.

Relevance for technology transfer

Hydrological information is the basis for planning and design of reservoirs, and for operation planning of the power station (Takeuchi 1998). Limited hydrological data (stream-flow and precipitation) in developing countries will often constitute a severe risk factor in hydropower projects.

Efficient operation of the reservoir is an important part of the technology, and in order to ensure successful technology transfer, local employees must be involved and get necessary training in analyzing hydrological data. Local consulting companies should be included in hydrological analyses for reservoir design. In countries where hydrological data is scarce, the project could also assist national institutions (e.g. meteorological institute) in establishing routines for collecting such data nationwide.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- provided training for local employees in analysing hydrological resource availability, based on data, field measurements, statistical indicators, simulation tools and hydrological models.
- provided training for local employees in operation and management of the hydrological resource.

4 - In addition to good practice, the project has implemented one aspect from best practice.
5 - Best Practice:

In addition to good practice, the project has:

- helped establishing routines for collection of hydrological data where this is not in place.
- engaged local consulting firms in hydrological analyses for reservoir planning and design.

H-2 Erosion and Sedimentation

Description

Erosion and sedimentation addresses the technical challenges of reducing erosion of the riverbank, and controlling the sediments in the water flow.

Relevance for technology transfer

Erosion and sedimentation cause technical and economic challenges such as reducing storage capacity, eroding the blade runner and limiting the project's lifetime (Gulliver and Arndt 1991, IUCN 1997). It may also have social and environmental implications, through removing sediments in downstream water, thus reducing the depositing of nutrient rich silt potentially important for agriculture (World Bank 1991), and increase erosion in the riverbed below the dam (Breeze 2005). Sediment accumulation in the reservoir may be reduced through cooperation with local communities and authorities to improve catchment management practices (Sustainable Hydropower 2011).

Local acceptance is essential for successful technology transfer, and it is therefore important to assess these topics with respect to environmental and social objectives. The effects of erosion and sedimentation on the project itself must also be assessed, and necessary technical solutions must be implemented.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- undertaken an assessment of erosion and sedimentation issues including erosion that arises from external upstream activities, (e.g. agriculture), and evaluated technical solutions to the problems against environmental and economic criteria.
- planned to provide training in operation of technical facilities for sedimentation handling, where necessary.
- undertaken an assessment of the consequences for downstream communities, and planned sufficient compensations in cases where stakeholders are negatively affected.

4 – N/A
5 - Best Practice:

In addition to good practice, the project has:

- sought to address the problem of sediment accumulation through cooperation with local stakeholders, seeking Pareto-efficient solution (where both parties are better off).

H-3 Location, Design and Reservoir Planning

Description

Location and design is the process of evaluating where and how the project should be, including reservoir, dam, spillways, intakes, power station and surrounding infrastructure. **Reservoir planning** is the preparation and management of considerations relevant to the construction, filling and operation of the reservoir.

Relevance for Technology Transfer

The experience the sender has in location and design of a hydropower station is an important part of the technology transfer to the host country. By involving local employees in the process of choosing location and design, the project contributes to increasing the experience level of the local participants.

Participation by local employees in reservoir planning could contribute to increasing the knowledge and know-how surrounding the construction, filling, maintenance and operation of reservoirs. Stakeholder engagement and use of local employment will provide input about local conditions, in addition to contributing to increased social acceptance (IUCN 1997, p. 31).

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:
The project has:

- carried out a location and design process including technical, economic, environmental and social considerations, with a reservoir planning process with a holistic view of aspects like reservoir design, geology, topography, inundation, dam safety, land stability and multi-purpose use of the reservoir, like tourism, fishing and commercial use.
- involved local stakeholders in location and design of the hydropower station, and in the relevant aspects related to the reservoir planning.
- included local employees in the location and design process, and the construction of reservoirs and dams.

4 – In addition to good practice, the project has implemented one or two aspects from best practice.
5 - Best Practice:
In addition to good practice, the project has:

- decided a power station site and design, minimizing the negative impacts on the local community, like surface area flooded, sedimentation and erosion, impacts on wildlife, natural ecosystems, inhabitants, settlements and cultural heritage sites.
- introduced and utilized software for modelling and managing reservoirs, like e.g. WEAP or Dam Safety Program Management Tools (DSPMT), and provided training to local employees to use the software.

H-4 Resettlement

Description

Resettlement is the process of moving inhabitants to a new place, due to the project. This might occur in hydropower projects with storage reservoirs, as productive areas and villages become flooded or otherwise harmed.

Relevance for Technology Transfer

The challenges of resettlement are huge, and claimed by World Bank advisors to arguably be "(…) the most serious issue of hydropower projects nowadays" (IUCN 1997, p. 47). To transfer the knowledge and know-how surrounding resettlements (or preferably avoiding it) in hydropower projects, participation by local employees in the planning process is important. Engagement from stakeholders in how to avoid the resettlement, or at least properly compensate and ensure future beneficial development for those affected, is a prerequisite for a acceptable resettlement (IFC 2002).

IFC also provides livelihood restoration recommendations, which will affect technology transfer directly if implemented. For wage earners they recommend that projects with resettlements provide: "Sufficient lead time for training of affected people to enable them to compete for jobs related to the project". The IFC also note that those affected "may benefit from skills training and job-placement, provisions made in contracts with project subcontractors for employment of qualified local workers, unemployment insurance and small scale credit to finance start-up enterprises." (IFC 2002, p. 38) For enterprise-based livelihoods, the IFC recommends promotion of " (…) local enterprise by producing goods and services for their projects from local suppliers." In addition, IFC recommends that established enterprises might benefit from credit or training to expand businesses, thus generating local employment. (IFC 2002, p. 38) The goal of dam-induced resettlement is that those resettled should become project beneficiaries (IFC 2002). This implies that the income and standard of living should increase for the large majority to that extent that it is easily observable for the resettled, and for external observers (IUCN 1997).

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:
The project has:

- prepared a methodical Resettlement Action Plan, e.g. in line with the recommendations from the IFC.
- engaged local stakeholders, and those expected resettled, early in the planning phase to discuss how those affected will become beneficiaries.
- involved local employees in the planning of the resettlements.

4 - In addition to good practice, the project has implemented one or two aspects from best practice.
5 - Best Practice:
In addition to good practice, the project has:

- provided the affected wage-earners with e.g. skills training, job-placement, and sufficient time for training to enable them to compete for jobs related to the project.
- supply small-scale credit to finance start-ups enterprises in areas affected.
- provided enterprises in affected areas with credit or training (e.g. finance, technology or management) to help expanding businesses.

H-5 Construction and installation

Description

Construction and installation addresses the challenge of including local employment in construction, transportation and installation activities.

Relevance for technology transfer

The installation of a hydropower plant involves technical challenges related to transportation and assembly of equipment, including electrical components, transformers, generators and turbines. Most likely components will need to be imported, and local workers will thus only be involved in parts of the installation. Still, local contractors could contribute in construction and transportation, as well as in necessary improvements of the infrastructure. Knowledge sharing with local participants would also be beneficial for improving technology transfer related to the project.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has plans for:

- including local employees in the construction activities.
- giving local employees necessary training in the construction activities of the hydropower plant.
- using local actors for transportation of large components (e.g. turbines, generators).
- hiring local contractors in the construction of necessary roads and road improvements.

4 – N/A
5 - Best Practice:

In addition to good practice, the project has:

- arranged for knowledge sharing through involvement of local employees in the installation of the technical equipment.

H-6 Grid Integration

Description

Grid integration addresses the need for providing local employment with necessary training and experience for operating and controlling the grid connection of the plant.

Relevance for technology transfer

Hydropower stations will normally be connected to the grid when the installed capacity is larger than 100 kW (ClimateTechWiki 2011). For such power stations, grid integration is an important part of the technology to be transferred.

In order to ensure good technology transfer, involvement of local employees in the installation of necessary equipment for grid matching, and provision of appropriate training to control, operate and maintain the equipment is decisive. Local participation in establishing agreements with relevant authorities (the energy regulator, Department of Energy and TSO/ISO), allowing the project to connect to the grid, and determining who is paying for the connection lines is also beneficial.

Scoring

1 – The project has not implemented any aspects from good practice.

2 – The project has implemented one or more aspects from good practice.

3 - Good Practice:

The project has:

- included local employees in the installation of inverters, rectifiers, transformers, necessary meters and other equipment for matching voltage, phase and frequency from the power station with that of the grid.
- hired or has plans to hire local employees in the operation and controlling of the grid matching equipment.
- given or has plans to give the local employees necessary training in operation and controlling of the grid matching equipment.

4 – N/A

5 - Best Practice:

In addition to good practice, the project has:

- included local actors in the project in conversations with authorities, negotiating grid access and payment for the grid connection.

H-7 Downstream Flow Regime

Description

Downstream flow regime addresses how hydropower production changes the flow patterns of the river. The flow regime is the statistical combination of pattern, volume and water levels of a river or stream flow throughout a year or season, their averaged values and the variability in these values. An agreed upon flow regime may specify minimum and maximum flows in parts of the season, and restrictions on special events like a flushing flow.

Relevance for technology transfer

Hydropower projects might cause great changes in the flow patterns downstream of the installation, since storage and release are managed based on power demand cycles rather than the hydrological cycles. This may have direct impacts on soils, vegetation, wildlife, fisheries, climate and human population (World Bank 1991).

Understanding the effects of alterations in the downstream flow is an important part of a successful hydropower project. In countries where there are specific regulations on flow regimes, the project has to assess and comply with these. However, regardless of regulations, the project has to predict the effects, and create a downstream flow regime in cooperation with the affected stakeholders. The regime should seek to optimize the relation between the benefits of the project and the negative impacts to the stakeholders.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- undertaken an assessment of all affected river courses, and formulated a downstream flow regime, specifying minimum flows in certain periods, maximum flows in certain periods, and restrictions on specific flow events.
- included affected stakeholders in formulating the flow regime.
- assessed local regulations on flow regimes.

4 – N/A
5 - Best Practice:

In addition to good practice, the project has:

- included local employees or consultants in the assessment and formulation of the flow regime.

H-8 Operation and maintenance (O&M)

Description

Operation and maintenance (O&M) is the day-to-day activities of the power station and the work associated with keeping the equipment in good condition.

Relevance for Technology Transfer

A large part of the technology knowledge and know-how transferred through the project happens in the operation and maintenance-activities, performed by the local participants. The need for trained hydropower personnel and high availability rates, have made training in O&M an extremely important task for producers. In a report on training in O&M, IEA concludes by noting the importance of good planning of the training activities, and of the need to evaluate the competences needed for the personnel in their roles of the organization (IEA 2000).

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:
The project has:

- identified needs for competences in operation and maintenance.
- provided extensive and timely training for local personnel in operating activities, e.g. facility protection, use of metering equipment, contingency handling and operation strategies.
- provided extensive and timely training for local personnel in maintenance activities, e.g. inspections, maintenance management systems, maintenance philosophy, rust protection, welding and turning.

4 – N/A
5 - Best Practice:
In addition to good practice, the project has:

- provided training in international designated educational facilities for the local personnel (e.g. through the ICH).

Key concepts - Hydropower

Electric grid is the network supporting generation, transmission and distribution of electricity.

Erosion is the process that moves solids (sediment, soil, rock and other particles) in the natural environment or their source, and deposit them elsewhere (Wikipedia 2011).

Flow regime is the statistical combination of pattern, volume and water levels of a river or stream flow throughout a year or season, their averaged values and the variability in these values. An agreed upon flow regime may specify minimum and maximum flows in parts of the season, and restrictions on special events like a flushing flow.

Hydrology is the study of the movement, distribution, and quality of water throughout the Earth, and thus addresses both the hydrologic cycle and water resources.

Independent System Operator (ISO) is the entity responsible for the balancing activities in the power system, without owning and operating the transmission system.

Resettlement Action Plan is a document specifying what procedures the project will follow, and its actions, to mitigate adverse effects, compensate, and ensure development benefits for those affected.

Resettlement is the process of moving inhabitants to a new place, due to the project. This might occur in hydropower projects with storage reservoirs, as productive areas and villages become flooded or otherwise harmed.

Sedimentation is the process where particles in a fluid settle and deposit at the bottom of fluid, e.g. the river bed.

Transmission System Operator (TSO) is the entity responsible for operation, maintenance and necessary expansion of the transmission system (high-voltage) for electricity, and for the balancing activities.

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Part 2B
Technology-specific Indicators
Wind Power

Protocol for Assessing the Potential for Technology Transfer in Energy Projects

Appendix A
Master thesis by Kleveland and Sønstebø 2011

Content

Introduction to the indicators for Wind Power Projects

This part contains the set of technology-specific indicators for assessing the technology transfer in wind power projects in developing countries. Guidelines for use are presented in the generic part, and we refer the reader to the first section of the protocol for the complete introduction, and a presentation of the background and use of the protocol.

Use of Technology-Specific Indicators

The indicators for wind power are in principle similar to the generic indicators for all energy technologies, however some differences should be commented. These indicators go into much greater detail concerning the technology to be transferred, and is as such a necessary amendment to the generic part. This implies that the evidence to the scoring assignments will need to be provided with help from technical personnel.

Using this indicator set alone will only provide a fragmentary consideration of the technology transfer in the project. However, by using the technology-specific part in addition to the generic part we argue that the assessor gets a comprehensive overview of the technology transfer potential in the project. The generic part ensures that the project takes a holistic approach, considering technological, environmental, social, institutional and business aspects, whereas the specific part ensures a dive into the specialities of the technology in question.

Choice of Wind Power Indicators

The selection of the issues in the wind power indicators is based on what is identified as the most important actions for ensuring technology transfer in such projects. We have attempted to select these indicators as sensible as possible, and by inviting experienced wind power experts from DNVs department in China to review them, we believe they cover all phases of a wind power project appropriately.

Structure

The structure of the indicators is principally identical to the generic part. The most important change is that the section with “Relevance for projects in Developing Countries” is omitted, as the focus here is on technology rather than on developing countries per se. The section with “Relevance for Technology Transfer” is therefore enlarged accordingly.

Assessment Timing

All technology-specific indicators are developed such that the assessment should be conducted in the Preparation Stage of the project. This is analogous with the majority of the indicators in the generic part, and arises from the need to interact with external parties during the process (i.e. after the investment decision is made), combined with the desire to include local actors already in the planning and preparation of the project (i.e. as early as possible). These indicators are therefore prepared such that all information needed is available when the assessment is done during the Preparation Stage.

Glossary of Terms

A description of the key wind power concepts is presented at the end of the indicator set.

Overview of technology-specific indicators – Wind Power

Preparation Stage	
Issue	**Indicator**
Wind Conditions and Location	W-1
Social Acceptance of Wind Energy	W-2
Installation	W-3
Grid Integration	W-4
Operation and Maintenance	W-5

W-1 Wind Conditions and Location

Description

Wind conditions and location addresses the importance of maximizing the length, quality and geographical coverage of the data collection.

Relevance for technology transfer

Wind conditions are the most important criteria when choosing location for building a wind park, and accurate and reliable meteorological data are necessary to understand the wind potential of the site. Initially, computer modeling can be used to create wind atlases or wind maps over larger areas, which help focusing the search for location to the most likely sites. Information that is more detailed will be extracted from on-site measurements using meteorological masts and remote sensing equipment (Breeze 2005, Gardner et al. 2009, Kelley et al. 2007).

To ensure successful technology transfer, local participation in all phases of evaluating the site is beneficial. This includes making use of local labour in erecting meteorological towers and involving local consultants to analyze data and choose the location. Cooperation with local meteorological stations might also be necessary to collect data and build the computer models (Gardner et al. 2009). It is also positive to help establishing routines for continuous measuring of wind data in countries where this is inadequate.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- involved local labour in the initial assessment of wind conditions, including screening of available data and building and analysing computer models.
- included local employees and/or consultants in analysing wind data
- included local employees in installation of meteorological towers and measurement equipment like anemometer, wind vanes and sensors, and possibly remote sensing equipment like SODAR and LIDAR.
- cooperated with a local meteorological station for collecting local data to prime the computer models.

4 – In addition to good practice, the project has implemented one aspect from best practice.
5 - Best Practice:

In addition to good practice, the project has:

- included local employees and/or consultants in choosing location based on wind conditions, taking into account social and environmental impacts.
- helped establishing routines for collection of wind data where this is not in place.

W-2 Social Acceptance of Wind Energy

Description

Social acceptance of wind energy includes how the project addresses societal concerns for landscape and ecosystems, distributions of benefits and cost, and visual impacts (like noise, lights or shadow flicker) (IEA Wind 2010). Other important aspects to consider are impacts on birds, land use and electromagnetic interference (EWEA 2009b).

Relevance for Technology Transfer

IEA Wind emphasise in a recent report that: "lack of social acceptance has the potential to develop into a powerful barrier to wind deployment", and that low levels of acceptance increases the wind energy development costs (IEA Wind 2010, p. 69). In the growing wind energy sector good practices have evolved in how to overcome the barriers. For instance, when a wind project is developed, the developer could benefit from local ownership in the farm to reduce expected local opposition to the project. "It has been shown that economic interests foster social acceptance" (IEA Wind 2010, p. 46). According to technology cooperation studies, high levels of consistent communication has also increased the social acceptance of a project (Mallett 2007).

To be able to extend a current, or develop a new, wind farm in a later stage, and to increase the knowledge base surrounding the wind energy development, the means of increasing the social acceptance should involve local employees and management.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:
The project has:

- involved local employees (line or management) in the process of addressing local concerns.
- developed a communication strategy to increase public understanding of positive and negative aspects of the wind project.
- consulted local stakeholder early in the process of planning the wind farm. (cf. P: S-3)

4 – In addition to good practice, the project has implemented one aspect from best practice.
5 - Best Practice:
In addition to good practice, the project has:

- provided stakeholders with sufficient feed-back concerning how they have revised the project based on the stakeholder involvement.
- some degree of local ownership.

W-3 Construction and installation

Description

Construction and installation addresses the challenge of including local employment in construction, transportation and installation activities.

Relevance for technology transfer

A wind mill consists of large and heavy components, including the tower, rotor and rotor blades, nacelle with the driving train (gear box, generator, coupling and brakes), and electronic equipment (WWEA 2011). This creates some technical challenges when installing the components, regarding lifting and assembling them at the correct height.
If the host country has little experience with wind power, it is likely that most components will be imported and local labour will only be utilized in parts of the installation (ClimateTechWiki 2011). However, it is beneficial with as much local participation as possible. Especially if the project has plans to extend current or develop new wind farms, knowledge sharing during installation is of key importance. For construction of the tower foundations, necessary road improvements and construction needed for transportation of the large components, utilization of local manpower can be a possibility.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has plans for:

- including local employees in the construction of tower foundations.
- giving the local employees necessary training in the construction activities of the wind farm.
- hiring local contractors in the construction of necessary roads and road improvements.

4 – N/A
5 - Best Practice:

In addition to good practice, the project has:

- arranged for knowledge sharing through involvement of local employees in the installation of the technical equipment.

W-4 Grid Integration

Description

Grid integration addresses the need for providing local employment with necessary training and experience for operating and controlling the grid connection of the plant.

Relevance for technology transfer

Connecting a wind park to the grid raises several technical challenges, including voltage and frequency matching, steady state currents and short circuit currents (Belhomme et al. 2009). Small wind farms often use the grid for stabilizing voltage and frequency, but for larger parks this is not sufficient, and technical solutions has to be provided directly (Breeze 2005). The challenges increase with a higher penetration level, and the impacts have to be managed through interconnection, integration, transmission planning and system and market operations (Holttinen et al. 2009). It is therefore necessary to cooperate with the system operator (TSO/ISO) and energy regulator with respect to the design and operation of the power system, grid infrastructure issues, the actual grid connection of wind power, market redesign issues and institutional issues (van Hulle and Gardner 2009).

In order to ensure good technology transfer, involvement of local employees in the installation of necessary equipment for grid matching, and provision of appropriate training to control, operate and maintain the equipment is decisive.

Local participation in establishing agreements with relevant authorities (the energy regulator, Department of Energy and system operator), allowing the project to connect to the grid, and determining who is paying for the connection lines is beneficial for increasing the knowledge level and experience of the local actors.

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:

The project has:

- assessed all aspects relevant to grid integration that may influence the technical solutions and costs.
- included technically skilled local employees in the installation of inverters, rectifiers, transformers, necessary meters and other equipment for matching voltage, phase and frequency from the wind farm with that of the grid.
- hired or has plans to hire local employees in the operation and controlling of the grid matching equipment.
- given or has plans to give the local employees necessary training in operating and controlling the grid matching equipment.

4 – N/A
5 - Best Practice:

In addition to good practice, the project has:

- included local actors in the project in conversations with authorities, negotiating grid access and payment for the grid connection.

W-5 Operation and maintenance (O&M)

Description

Operation and maintenance (O&M) is the day-to-day activities of the wind farm, and the work associated with keeping the equipment in good condition. Wind farms do not necessarily require full-time presence, however site- and turbine inspections must be carried out regularly. Site inspections include inspecting access tracks, fences, gates and electrical infrastructure, whereas turbine inspections include a thorough examination of the nacelle and its components, checking for oil leakages, deterioration and other anomalies. (Knill and Oakey 2006)

Relevance for Technology Transfer

O&M in wind farms is highly relevant for technology transfer, as on-site presence would be needed for inspections, service and maintenance. Even though turbine manufacturers throughout their warranty often perform the service and maintenance needed, parts of the maintenance work could be achieved locally with appropriately trained personnel. Wind turbine manufacturers providing remote-monitoring services have made it possible to centralize operation, monitoring and management of wind farms. However, as Knill and Oakey (2006) argue, hiring small, local Operations Managers could be beneficial. With a greater focus on the individual performance of the facility, gains in long-term generation income might offset losses associated with reduced economies of scale.

The European Wind Energy Association has identified a shortage of skilled workers in the wind sectors as the sector has grown in the last decade, especially within O&M and site management activities (EWEA 2009a). This implies that training and utilizing local personnel might be beneficial for the project. However, the manpower needed for maintenance is limited, estimates of the routine maintenance time is approximately 40 hours/year per turbine, with non-routine maintenance being of similar order (EWEA 2009b).

Scoring

1 – The project has not implemented any aspects from good practice.
2 – The project has implemented one or more aspects from good practice.
3 - Good Practice:
The project has:

- identified needs for competences in operation and maintenance.
- planned to make use of local employees in inspections and basic maintenance.

4 - In addition to good practice, the project has implemented one aspect from best practice.
5 - Best Practice:
In addition to good practice, the project has:

- a decentralized monitoring structure, with operation and monitoring of the wind farm performed locally.
- plans of having a local Operations Manager (either within the project or outsourced).

Key concepts – Wind power

Design and operation of the power system includes reserve capacity and balancing activities, short-term forecasting of wind-power, demand-side management and storage, and optimization of system flexibility (van Hulle and Gardner 2009).

Electric grid is the network supporting generation, transmission and distribution of electricity.

Grid connection includes grid codes, power quality and wind power plant capabilities (van Hulle and Gardner 2009).

Grid infrastructure issues include optimization of existing grid, extensions and improved interconnections (van Hulle and Gardner 2009).

Independent System Operator (ISO) is the entity responsible for the balancing activities in the power system, without owning and operating the transmission system.

Institutional issues related to wind power include stakeholder incentives, non-discriminatory third party grid access and socialization of costs (van Hulle and Gardner 2009).

Market redesign issues include market rules, especially for cross-border exchange and operating the system closer to delivery hour (van Hulle and Gardner 2009).

Stakeholder is any person or organization, which can be negatively or positively affected by the actions, or the lack of action, of an organization, person or project.

Transmission System Operator (TSO) is the entity responsible for operation, maintenance and necessary expansion of the transmission system (high-voltage) for electricity, and for the balancing activities.

Visual impacts are a key issue when building large vertical structures as wind turbines. Mitigation measures could be conscious location and design of the wind farm, anti-reflection paint, neutral colours or underground cables (EWEA 2009b).

Wind atlas is a graphical representation of the mean wind speed at a specified height over a flat, homogenous terrain (Gardner et al. 2009).

Wind map is a graphical representation of the mean wind speed at a specified height, where the effects of the terrain and ground cover have been included (Gardner et al. 2009).

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Appendix B - Scoring of Khimti

Early stage			Preparation Stage		
Indicator	**Code**	**Scoring**	**Indicator**	**Code**	**Scoring**
Social screening	ES-1	NA	Social impacts Assessment	P-1	NA
Environmental screening	ES-2	5	Behaviour and Corporate Social Responsibility	P-2	5
National policies	ES-3	NA	Local dialogue	P-3	2
Political and legal risks	ES-4	5	Local employment	P-4	5
Intellectual Property Rights	ES-5	NR	Training	P-5	5
Economic viability	ES-6	NA	Culture and language	P-6	3
Financial viability	ES-7	5	Environmental Impact assessment	P-7	4
Ownership	ES-8	5	Communication with Officials	P-8	3
Technological needs	ES-9	5	Sourcing	P-9	4
			Project management	P-10	NA
			Transfer of experiences	P-11	4
			Infrastructure	P-12	5

NA: Not Assigned, NR: Not Relevant

Early Stage

Social Screening:

For this indicator we had not the information needed to assign a score. Not Assigned.

Environmental Screening:

Prior to the investment it was conducted a thorough risk analysis process, including environmental risks. Sophisticated methods were utilized, and no significant risks were found. (TS) We therefore assign the score 5.

National Policies:

For this indicator we had not the information needed to assign a score. Not Assigned.

Political and legal risks:

Tom Solberg (TS) states that a designated risk assessment group has conducted a thorough risk analysis. They have utilized risk matrices, and other sophisticated risk analysis tools. This is also emphasised in Norad's report of investments in developing countries (2010). This corresponds to the identified "Best Practice". We therefore assign the score 5.

IPR:

This was not a concern for Statkraft/SNPower, according to TS. We therefore assign Not Relevant (NR)

Economic Viability:

For this indicator we had not the information needed to assign a score. Not Assigned.

Financial Viability:
The project was financed with Project Finance, and external financing provided by IFC, ADB, Nordic development fund, and GIEK, which was later followed up by Norad. The project complied with the standards required by these organizations. Later SNPower became IFCs preferred partner in hydropower projects (TS). The details of the financing is presented in the report from Norconsult (Norad 2010). According to this report all servere financial risks were meticulously investigated prior to the investment. We therefore assign the score 5.

Ownership:
SNPower (Earlier Statkraft) was the majority owner of HPL, a single purpose company for Khimti. It was an early example of BOOT (Build, Own, Operate, Transfer) and had a local partner (16,8 %) in the partly government owned BTC. TS emphasized that this cooperation had been a success, and the ownership structure appropriate for the project. He also stressed the importance of having a local partner, and ensuring that they share values with the sender. As we consider both scoring level 3 and 5 complied with, we assign the score 5.

Technological needs:
The TNA-system was not in place when the project was considered, but hydropower is certainly a key energy technology for Nepal. The need for energy was also evident locally, where there was not access to electricity at all. We therefore assign the score 5.

Preparation Stage

Social Impacts Assessment:
For this indicator we had not the information needed to assign a score. Not Assigned.

Behaviour and CSR:
According to TS the project managed to avoid corruptive behaviour, and had successfully implemented a Code of Conduct that had to be followed by suppliers, and sub-suppliers. They also had assigned a responsibility to follow-up on the other parties' behaviour. In addition, through numerous records of CSR, a net positive benefit for local stakeholders are identified (TS) and (Karki 2004). We therefore assign the score 5.

Local Dialogue:
According to TS one of the biggest challenges was the information provided to the population. Here the project was not sufficiently competent. They provided e.g. benefits to parts of the local community without a close dialogue. The benefits were just provided, without a clear statement of why, what and where. This led to challenges regarding local expectations, which skyrocketed. Their lessons learned was that they should be careful to inform prior, that this is what we do, and not more. This would ensure that protests will not arise as easily. Thus the project had attempted to fulfil what we regard as Good Practice". However, as they did not provide sufficiently good information, we consider that "Good Practice" not was attained. We therefore assign the score 2.

Local Employment:
For the assessment of local employment in the Protocol the considerations were easy, as not only does plans for hiring exist, evidence exists for the number of personnel employed, according to geographical origin. According to (Karki 2004) there existed a employment priority for the local population:

a. Category I: Directly effected families: Those who lost their land and residential houses were given the first priority for any upcoming suitable employment.
b. Category II: Project area VDC - People residing within the project area VDC:
c. Category III: People from Ramechhap and Dolakha Districts.
d. Category IV: From other parts of Nepal.
e. Furthermore, the Project Owner decided to hire all technical operators only from Category I, II and III.

During the peak construction period, the total number of work force reached as high as 4000. Employment under various categories (discussed in Section 2.5) during peak construction period were as follows:

a. Category I - Directly affected families : 6%
b. Category II - People residing within the project area: 23%
c. Category III - People from Ramechhap and Dolakha Districts: 43%
d. Furthermore, 25 personnel were hired from Categories I, II and III, three years prior to the commissioning of the plant and trained in technical schools to become KHP-I plant operators. The operators completed their scheduled training course about a year earlier than the commissioning of the plant. Until the commissioning of the plant they were absorbed by various contractors.

Source: (Karki 2004)

According to Tom Solberg HPL have steadily down-scaled the Norwegian expatriation employees, and today only the manager is Norwegian. I.e., there exist local employment on all levels of the organization. In addition, the project has established good routines for HSE (TS), and used local contractors in the construction phase (part of civil design and electro-mechanical workds). (Himal Power Ltd 2010) All in all, the project have utilized local employment in a extraordinarily good way: <u>We therefore assign the score 5</u>

Training:
For the training of local employees HPL have achieved a lot, according to both TS and Karki (2004) 25 personnel were trained in technical schools to become plant operators, according to Tom Solberg many local employees were also on excursions to Norway and other countries with hydropower experience. They have also conducted training of administrative staff, among other things as "trainees" at SNPower, Statkraft and BKK in Norway. They also continuously arrange courses in Norway, and through the ICH for the local employees. In addition to training the employees, the project has supported schools in the vicinity to the project, and non-formal education through courses etc. These educational activities specially addressed empowering of women (Karki 2004). All in all, we consider that the project has successfully conducted all scoring requirements: <u>We therefore assign the score 5.</u>

Culture and Language:
The Khimti project experience was mixed regarding culture and language. The project had provided extensive language training (English) for workers (TS), in addition to providing literacy training for local population (Karki 2004). However, we did not find any evidence that the potential cultural challenges were examined, or provided remedial action. According to TS the challenges were dealt with when they occurred. Due to this mixed experience, we identify a potential for improvement regarding cultural assessment. However, the language barrier was appropriately dealt with. We therefore assign the score 3.

Environmental Impacts Assessment:
According to a case study concerning water infrastructure consequences of Khimti (Karki 2004), HPL conducted a thorough EIA, in line with the requirements set by donor organizations like IFC, Norad, ADB (Asian Development Bank) and the Nepalese Government. Based on the EIA it was decided to establish an Environmental Mitigation and Monitoring Plan (EMMP) for the construction phase of the project (Karki 2004). Land owners were assessed and properly compensated (Karki 2004). In a report examining the ecological impacts of Khimti (Sharma et al. 2007), the consequences of the project are deemed to be minimal. What we could not find evidence for was a contribution to mitigate environmental problems beyond what is related to the project. We therefore assign the score 4

Communication with Officials:
Here we were not able to identify whether the scoring points were met prior to the project, but we were provided with information regarding how some of the actual communication was conducted. They had a established contact with the Norwegian embassy, though avoided to "misuse" the embassy to much, when they had difficulties with customs/attempts of corruption, etc. (TS) They also had contact with official authorities, however we did not get the impression that this contact was done routinely. We therefore assign the score 3.

Sourcing:
According to TS all that could be sourced locally was sourced locally, as far as the quality and quantity requirements were met. TS said that about 10 % (possibly) of the revenue from Nepalese Electric Authorities was provided in local currency, and this amount was used mostly on local parts, works etc. Here we do not have the information needed to say whether all scoring points for "Good Practice" were filled, however as the "Best Practice" points were partly complied with, we assign the score 4.

Project Management:
According to company home pages (Himal Power Ltd 2010) "(…) a consortium of Statkraft Engineering and BPC Hydroconsult had carried out the project management on behalf of HPL." The Details of this indicator is not provided, so we cannot score. Not Assigned.

Transfer of Experiences:
According to TS, HPL had cooperation with two of the universities in Nepal, where they together created a copy of the entire hydropower plant, and contributed to the turbine lab at Kathmandu University. They also contributed to supporting research through a master degree cooperation between Nepal and Norway. The project also exchanged experience with e.g. ICH, and other

similar actors. As the company had formal cooperation with a university, but not a cooperation with any other actors involved in technology transfer in the region, <u>we assign the score 4.</u>

Infrastructure:

Here the project contributed to the local infrastructure through the use of advanced telecom systems, which also benefited the local population. When it came to roads, the responsibility was on the local authorities, and a road with low standard was provided in the vicinity to the hydropower plant (TS). The projects involvement also gave access to electricity, and power grids locally. As the scoring points for both levels are filled, <u>we assign the score 5.</u>

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Appendix C - Scoring of Totoral

Early stage			Preparation Stage		
Indicator	**Code**	**Scoring**	**Indicator**	**Code**	**Scoring**
Social screening	ES-1	5	Social impacts Assessment	P-1	5
Environmental screening	ES-2	NA	Behaviour and Corporate Social Responsibility	P-2	5
National policies	ES-3	3	Local dialogue	P-3	5
Political and legal risks	ES-4	4	Local employment	P-4	4
Intellectual Property Rights	ES-5	NA	Training	P-5	4
Economic viability	ES-6	5	Culture and language	P-6	3
Financial viability	ES-7	NA	Environmental Impact assessment	P-7	4
Ownership	ES-8	5	Communication with Officials	P-8	3
Technological needs	ES-9	3	Sourcing	P-9	5
			Project management	P-10	NA
			Transfer of experiences	P-11	2
			Infrastructure	P-12	3

NA: Not Assigned, NR: Not Relevant

Early Stage

Social Screening:

One of the positive sides of the location of Totoral was that it was placed in an uninhabited area in Chile, thus with little social challenges. According to Nils Huseby this influenced the decision of developing the project. The social screening process clarified that there were no significant social risks, and this was also supported by the fact that the local regional authorities were very interested in the project. As no social risks were identified, we consider that both the "Good Practice" and "Best Practice"-requirements are filled for the social screening, <u>and assign the score 5.</u>

Environmental Screening:

The information needed has not been available, and is therefore denoted <u>Not Assigned (NA).</u>

National Policies:

The national regulations regarding wind power energy were relatively new when investments were considered. Nils Huseby stated that SNPower had been involved in the preparation of the new renewable energy framework. According to the projects Project Design Document (PDD) provided to the CDM Executive Board, there are considered certain regulatory modifications regarding requirements of renewable energy in the electric system. It is still uncertain how this change will be implemented in practice. It seems clear however, that the project has undertaken a thorough assessment of the policies and plans for the energy sector. We consider that all "Good Practice" requirements are filled, <u>and assign the score 3.</u>

Political and legal risks:
According to Nils Huseby the political and legal risks were considered closely before investing, however, as SNPower already was present with a wind farm a lot of knowledge was already there. The situation in Chile was regarded as relatively stable, as was illustrated through the fact that Chile has had investment grade rating from credit agencies in many years, unlike many neighbouring countries. Different types of regulatory and contractual risk had also been considered, during the planning of the investment. We did not get the impression that all political risk and legal risks were considered in meticulous detail, however. As we consider all important "Good Practice" requirements, and some "Best Practice" requirements to be fulfilled, we assign the score 4.

IPR:
The information needed has not been available, and is therefore denoted Not Assigned (NA).

Economic Viability:
A comprehensive presentation of the economic viability is found in the Project Design Document (PDD) provided to the CDM Executive Board. In this document they publish a thorough economic review of the project, with sensitivity analyses for important variables, national economic characteristics. This is regarded as a comprehensive analysis of the economic viability to the project. (We have no further information regarding the details of the economic assessments, therefore the scoring is only based on the PDD.) We consider all important "Good Practice" and "Best Practice" requirements to be fulfilled, and assign the score 5.

Financial Viability:
The information needed has not been available, and is therefore denoted Not Assigned (NA).

Ownership:
Initially, Norvind was established as a Joint Venture between SNPower and a local partner. SNPower, following a former cooperation in hydropower development in the country, already knew the partner, which were an advantage. The cooperation ended in spring 2011, however, we argue that the benefits of such a cooperation materializes during the planning and construction. This type of ownership structure, with initally some extent of local ownership, a good overview of the reputation of the local partner, and being established in a collaborative effort corresponds to fulfilling "Good Practice" and "Best Practice" requirements. We therefore assign the score 5.

Technological needs:
The project has chosen a technology which is considered of interest in the countries Technology Needs Assessment (Deuman Ingenieros 2003), and through Nils Huseby we found that wind power is considered a interesting alternative to fossil fuels and hydropower in Chile. This is also exemplified through his expectation of the beneficial future renewable tariffs. This corresponds to "Good Practice", and we therefore assign the score 3.

Preparation Stage

Social Impacts Assessment:

The social impacts have been addressed through the environmental and social impacts assessment, as presented by the IFC (Norvind S.A. 2008), and in Spanish (Norvind S.A. 2008). No severe impacts were found, and all considerations were addressed. Guidelines for weaker groups are addressed through the Code of Conduct. By completing the social impacts assessment according to IFCs recommendations, we consider all "Good Practice" and "Best Practice" requirements to be fulfilled, and assign the score 5.

Behaviour and CSR:

SNPower has implemented a "Code of Conduct", which also apply for Norvind. Regarding contractors, The IFC (2008a) states that the lead contractor Skanska is globally certified, and has incorporated its requirements into the company "Code of Conduct". According to Skanska (2011), positive effects has occurred for the local population through direct and indirect employment, training, contribution to the economic development through permits fees, and strengthening the Chilean wind energy industry. In addition there were charitable donations, and according to Nils Huseby, provision of books to the local school library. Regarding gender equality, several women held management positions during construction, including the Quality manager and the Field Operation Manager (Skanska 2011).

As Code of Ethics/Conduct are incorporated and adhered to, and net positive benefits can be justified, we consider all "Good Practice" and "Best Practice" requirements to be fulfilled, and assign the score 5.

Local Dialogue:

According to Nils Huseby the project held information meeting presenting the project to the local community in the population centre close to the plant. These were held with the local community and local authorities. On direct question, Huseby stated that no important decisions were influenced by the feedback received from these meeting. From the (IFC 2008a) we found that Norvind hired a local member of the community as a full-time relations representative, in order to establish formal and informal channels of communcation, and act as a local liason.

The stakeholder meetings are presented in the project PDD (Norvind S.A. 2010). Public concerns raised at the meeting included opportunities for employment, gender equality and wildlife disturbance, all of which were addressed by the representatives. No severe negative feedback concerning the project was given, and most responses to the project had been positive. The positive reception is also emphasized in a news article (Teknisk Ukeblad 2010), as the local population received benefits like direct and indirect employment. As information has been provided, stakeholder presentation with feedback opportunity has been held, and information about the project is available on the internet, we consider all "Good Practice" and "Best Practice" requirements to be fulfilled, and assign the score 5.

Local Employment:

In the Social and environmental assessment it is stated: "Norvind will contractually ensure that hiring of local labour is maximized particularly for semi-skilled and unskilled work. Influx of labourers will be actively managed to avoid burdening of local services and infrastructure" (IFC

2008a). It is also stated that additional labour capacity, especially for skilled labour, will be employed from other regional communities. Skanska (2011), the contractor of the plant, states that approximately 230 persons worked on the construction, and that local workers were prioritized. Around 60 % of the construction workforce was from immediate surrounding areas (Skanska 2011). For the operation stage, it was planned to contract ten employees (IFC 2008b).

According to Nils Huseby from SNPower "international" companies performed the work with the turbines. Danish Vestas delivered the turbines, and the supplier therefore performed most of the work with the installation and preparation. According to the social and environmental assessment appropriate routines for EHS (Environment, Health and Safety) were at place, and routines had been established for the local personnel (also employed by the contractors). We could not identify that local labour were included in the planning phase, or widespread use of recipient country consultants and contractors. As all of the "Good Practice", and most of the "Best Practice" scoring points are filled, we assign the score 4.

Training:
According to Skanska (2011) training was provided to the local personnel to compensate for the lack of local relevant skills concerning the construction, maintenance and operation of wind farms. Training days were held to educate the Chilean project workers on how to operate the SCADA power generation system, in addition to training in service and maintenance of the turbines (Skanska 2011). The SCADA training is provided through the contract with Vestas (Norvind S.A. 2010).

The IFC-summary of environmental and social impacts refers that Norvind S.A. will ensure that the contractors and suppliers (Skanska, Burger and Vestas) include EHS training programs and procedures for all workers. During the operation phase, Norvind states that they will ensure person responsible for the implementation of the operational phase management programs are on EHS requirements (IFC 2008a).

In the Project Design Document (PDD) provided to the CDM Executive Board, it is stated that the turbine generator, Vestas, will be in charge of the Totoral service and maintenance during the first 3 years. During this service period, people from the project may learn from Vestas experience. In the same PDD it is mentioned among the risks identified, that as only two wind projects are currently in operation, it is difficult to find trained staff for operation and maintenance (O&M). This might incur extra costs related to either importing staff, or training staff abroad. (Norvind S.A. 2010)

What we have not found examples on, are provision of formal education to local employees, or technical training in technology centres, or similar. (Training might however be expected provided abroad it local personnel are hired.) As all of the "Good Practice" requirements are filled, and the "Best Practice" scoring points are partially filled, we assign the score 4.

Culture and Language:
According to Nils Huseby there were not any severe challenges regarding differences in culture and language. Regarding how such gaps were examined and mitigated, it was responded that the project manager was Chilean, and NH did not mention any problems arising. We acknowledge that as information, training and education had been provided in the appropriate language, no

cultural gaps were identified, we consider the “Good Practice” requirements are filled, however none of the “Best Practice”-requirements. <u>We therefore assign the score 3.</u>

Environmental Impacts Assessment:
As referred over, an environmental impacts assessment had been conducted (according to IFC-standards), and no significant gaps were found. The project was regarded as beneficial due to its renewable energy production, and little environmental impacts. Procedures for management and management systems had also been established (IFC 2008a). We did not however, identify that the project contributed to mitigating additional environmental problems, beyond what’s related the project. As all of the “Good Practice”, and most of the “Best Practice” scoring points are filled, <u>we assign the score 4.</u>

Communication with Officials:
According to Nils Huseby the project has had a unproblematic cooperation with the authorities in the region and Chile. He emphasized in our conversation that Chiles economy is driven by market economy principles, and that the authorities had little practical role as most of the sector is completely privatized. However, they project had cooperated with the authorities in creating a framework for renewable energy production, and had given input in the creation of national laws.

Nils Huseby also stated that even though they had been in contact with the Norwegian embassy in Chile, they had not needed help and consultancy, only to add prestige to openings, etc. As we interpret the information provided, we believe all “Good Practice” requirements have been met, however, as the project did not report of providing information regularly, or had focused on potential risks related to insufficient communication no “Best Practice” scoring requirements are filled. <u>We therefore assign the score 3.</u>

Sourcing:
Nils Huseby explained that the Project had attempted to source locally, as much as possible during the project. However, the main specialized parts of the wind farm are imported from abroad, as the wind power supply sector is quite specialized, and it is a novel technology. Some examples of local sourcing were food to the construction workers, and hired basic services.

According to Skanska (2011), the project strived to source locally manufactured materials where possible, including electrical structures and scaffolding. However, due to the unavailability of sufficient quantities of construction materials of steel and cement, some of the materials were sourced as far as 290 km from the site.

From the projects PDD it is reported that one of the risks identified are the risk of mechanical and/or technological problems arising during the operation. In order to repair a malfunction, technicians and replacement parts must be expected imported from abroad. The non-availability of spares parts for the critical components is another important risk, that can result in the shutting down of the wind turbines, with severe economic consequences. (Norvind S.A. 2010)

It seems like the project has to its best abilities assessed and identified possibilities of local sourcing, and considered the related risk. Even though risks are identified, the project is regarded as appropriately complying with the guidelines for sourcing in the Protocol. We consider all “Good Practice” and “Best Practice”-requirements to be filled, and assign the score 5.

Project Management:
The information needed has not been available, and is therefore denoted Not Assigned (NA).

Transfer of Experiences:
According to Nils Huseby the project has not had any cooperation with universities or research institutions in Chile. This also applies for its hydropower projects in the region.

However, according to the environmental impact assessment (IFC 2008a) it is denoted that a cooperation with Endesa regarding bird protection is planned implemented. This is regarded as a example of an attempt on exchanging experience with other actors transferring similar technologies. As it in the same assessment is stated that the relationship with Endesa is good, there may be examples of other cooperations. All in all this is considered as one example of cooperation sufficient for the scoring level “Good Practice”. However, as not other scoring points are filled, we assign the score 2.

Infrastructure:
As the project is implemented in a uninhabited area, the roads needed for transporting the wind mills had to be built (approximately 16 km) (Norvind S.A. 2008). In addition, necessary upgrading of the electrical grid had to be done. However, we did not find that any of these infrastructural improvements had any additional effect for the population in the area.We consider “Good Practice” to be upheld, and assign the score 3.

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