

# **Pilot Projects in the Climate Change Regime and Sustainable Development**

Joyeeta Gupta, Harro van Asselt and Pieter van Beukering (editors)

*Contributing authors:*

Anindya Bhattacharya, Franz Rentel, Han Jingyi, He Guizhen, James Blignaut, Kim van der Leeuw, Lu Yonglong, Luke Brander, Mariamalia Rodriguez, Ma Hua, Pham Khanh Nam, Phung Thanh Binh, Rakesh Jha, Sebastiaan Hess, Shi Yajuan, Shirish Sinha, Steve Mack, Sun Yamei, Tjasa Bole, Tran Vo Hung Son

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IVM  
Institute for Environmental Studies  
Vrije Universiteit  
De Boelelaan 1087  
1081 HV Amsterdam  
The Netherlands  
Tel. ++31-20-5989 555  
Fax. ++31-20-5989 553  
E-mail: [info@ivm.falw.vu.nl](mailto:info@ivm.falw.vu.nl)

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*List of abbreviations*

Acronym	Definition
AEC	Agricultural Extension Centre
AIJ	Activities Implemented Jointly
BOL	Build-Operate-Lease contract
BOL	Build-Operate-Lease contract
BOVS	Baharbari Odyugic Vikas Swavalamvi Shakari Samiti
BPO	Biogas Project Office
BuZa	Ministry of Foreign Affairs, The Netherlands
CAAS	Chinese Academy of Agricultural Sciences
CAS	Chinese Academy of Sciences
CBA	Cost Benefit Analysis
CDM	Clean Development Mechanism
CERs	Certified Emissions Reductions
CO <sup>2</sup>	Carbon dioxide
Crore	Ten million or 100 lakh (Indian measurement unit)
DA	Department of Agriculture (within MARD)
DAFE	Department for Agriculture and Forestry Extension
DARD	Department for Agriculture and Rural Development
DESI	Decentralised Energy Systems India Private Ltd.
DGIS	Netherlands Directorate General for International Cooperation
ECN	Energy research Centre of the Netherlands
FFI	Flora and Fauna International
GDP	Gross Domestic Product
GEF	Global Environment Facility.
GHG	Greenhouse gas
GoI	Government of India
GoN	Government of the Netherlands
GWP	Global Warming Potential
ICE	Instituto Costarricense de Electricidad.
IEP	Integrated Energy Policy
IRPP	Independent Rural Power Producer
ITCR	Instituto Tecnológico de Costa Rica
KWh	Kilowatt hour
Lakh	One hundred thousand (Indian measurement unit)
MARD	Ministry of Agriculture and Rural Development of Vietnam
MCA	Multi-criteria analysis
MIDEPLAN	Ministry of Planning and Economic Policy
MNES	Ministry of Non-Conventional Energy Sources, India
MOEF	Ministry of Environment and Forests, India

*List of abbreviations (Continued)*

Acronym	Definition
MOU	Memorandum of Understanding
MOVASA	Molinos de Viento del Arenal S.A.
MW	Megawatt
NBSC	The National Biogas Steering Committee
NPV	Net Present Value
OCIC	Oficina Costarricense de Implementación Conjunta
PBPO	Provincial Biogas Project Office
PDD	Project Design Document
PLF	Plant load factor
PPAIJ	Activities Implemented Jointly Pilot Programme
PPP-JI	Programme on Pilot Projects for Joint Implementation
RCEES	Research Centre for Eco-Environmental Sciences
RDAC	Rural Development Assistance Centre
REP 2006	Rural Electrification Policy 2006
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RMB	Renminbi – Chinese currency
Rs	Indian Rupees
RVEP	Remote Village Electrification Programme
RZQ	Rijkszwaan Qingdao
SAHDP	Shouguang Agricultural High-tech Demonstration Park
SDERI	Shandong Academy of Sciences / Energy Research Institute
SMAC	Shouguang Municipal Agricultural Committee
SNAC	Foundation for Shandong – North-Holland Agricultural Cooperation
SNV	The Netherlands Development Organisation
UICN	Unión Mundial para la Naturaleza
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VND	Vietnamese Dong
VROM	Netherlands Ministry of Housing, Spatial Planning and the Environment

# Executive Summary

## The problem

The climate change problem calls for intensive cooperation between the developed and developing countries. Under the United Nations Framework Convention on Climate Change of 1992, countries were encouraged to engage in *joint implementation*. This instrument was intended to allow investors in the developed world to invest in Central and Eastern Europe as well as the developing countries in projects that reduce emissions of greenhouse gases. The underlying implication was that in the future the mechanism of joint implementation could develop in such a way that in return for investments, the investors would be given emission credits. These credits could be used in the investors' home countries towards meeting their greenhouse gas emission reduction targets.

The instrument of joint implementation was seen as highly controversial in its early days. Although it could potentially provide new technologies to the developing countries at lower costs, it also provided the developed countries with a way to avoid expensive investments in developing technologies to reduce their own emissions back home. However, over time the developing countries became willing to accept joint implementation in its new incarnation – the *Clean Development Mechanism (CDM)* that was adopted in 1997 as part of the Kyoto Protocol.

A key new element was the need for such projects to focus on *sustainable development*. Given that there is much confusion about the actual meaning of sustainable development, it came as no surprise that the Parties to the Convention and Protocol ultimately agreed that sustainable development is a context related concept and should therefore be defined and decided upon by the host countries themselves.

The Netherlands has been an active proponent of the concept of joint implementation since the early days. Prior to the negotiations of the climate convention, the Netherlands pushed the concept of joint implementation, and long before 1995, it had already initiated a number of pilot projects. Over the years, the Netherlands has been actively participating in such projects. It is presently anticipated that a substantial part of the Dutch target on greenhouse gas reduction will be met by projects in developing countries.

## The research question

Against this background, the purpose of this project is to address the question: “Do AIJ/CDM projects, which are expected to assist The Netherlands in complying with its Kyoto target, contribute to sustainable development in the host countries?” In answering this question, several sub-objectives are addressed. These include:

- What is the contribution of projects in the area of Activities Implemented Jointly (AIJ) to sustainable development according to the host country as well as to the research team perspective?
- Have the goals as listed in the project documents of AIJ projects been achieved?
- Which factors have contributed to the failure or success of the projects?

To address these questions, the project has undertaken several activities. First, a brief literature review on the components of sustainable development was conducted. Second, a methodology was developed for assessing the contribution of AIJ projects to sustainable development. Third, the methodology was applied to projects in five countries: Vietnam, Costa Rica, South Africa, China and India. All the projects that are addressed in the case studies are financed by the Netherlands' Ministry of Foreign Affairs under their pilot project programme on Activities Implemented Jointly (PPP-AIJ).

## Methodology

In developing and implementing an effective evaluation framework for AIJ/CDM projects, four elements were studied:

- The context of the project;
- Project documents and their claimed contribution to sustainable development;
- The host country's position on sustainable development; and
- Project evaluation against the research team's criteria.

This document presents an analytical framework for assessing the sustainable development of the project, focusing on economic, environmental and social sub-criteria. In the process the research team included some of the key elements that arise from the legal principles on sustainable development.

The project assessment is based on information, which has been collected from various sources. First, the context was addressed by studying relevant policy documents of the governments concerned. Second, to gain an insider's perspective of how the projects were carried out, a stakeholder analysis based on interviews with a number of key stakeholders for each case study was undertaken. Third, personal observations were made during site visits to the projects. To avoid a Western/Dutch bias, each project has been analysed mainly by local researchers. To ensure a degree of comparability a Dutch team of researchers worked closely with the partners in each of the countries to ensure that the methods of the projects follow a similar path.

## The case studies reviewed briefly

The above methodology was applied to projects in Vietnam, Costa Rica, South Africa, China and India. The performance of the projects varied widely.

*Tejona Wind Power Project - Costa Rica:* This project focuses on an AIJ wind power project in Tejona in Costa Rica. It involves a Dutch partner – Essent Energie B.V. and the Costa Rican public sector power company – ICE. Although the Costa Rican partner in 1992 initially developed the project, the contract with Essent was signed in 2000 and the project is now in its fourth year. At present the wind park is functioning and providing electricity; however, there are three privately developed wind plants in Costa Rica, which make it difficult to prove that the project is 'additional' at this stage. Further, the plant is not operating in an optimal manner because of poor maintenance, which had resulted from the confusion about who was seen as responsible for such maintenance. The project has reduced the emissions of greenhouse gases when compared to the baseline situation and has minimal other negative environmental impacts, but has also limited contribution to social aspects; though its potential contribution to the economy is higher. As such its contribution to sustainable development is limited.



*Small-Scale Biogas Technology – Vietnam:* This AIJ case study focuses on the large-scale promotion of biogas technology in 12 provinces in Vietnam. The partners in this case are essentially the Vietnamese Ministry of Agriculture and Rural Development and the Netherlands Development Organisation in Vietnam (SNV-VN). The project was negotiated in 2002 and the first phase of the project was completed in 2005 and it is now in its second phase. The project uses technology developed and used in a previous project in Nepal and which has been adapted to local circumstances. Farmers were directly provided with subsidies via the post office system to install the biogas technology. The project is very successful. The number of farmers participating in the programme exceeds the planned amount. The two problems are that richer farmers have also been able to access the subsidies and there has not been optimal use of the gas and slurry. Both problems can be addressed through provision of scaled subsidies and capacity building to help farmers sell or give other local potential consumers the remainder of the gas and slurry. The project has been combined with training and capacity building and has focused on meeting the social, environmental and economic needs of local stakeholders and thus scores quite well on the criteria of sustainable development.

*Mini-hydro plant in Bethlehem – South Africa:* This AIJ project focuses on the development of a mini-hydro plant in Bethlehem in South Africa. The project was developed by E3 an engineering company in collaboration with NuPlanet with offices in both countries. The idea was developed in 1997 and the contract signed in 1990. However, the project has only just been put into operation in end 2006. This is because of the complex nature of the legal permissions required to put up this project. The project demonstrates that the private sector should in the future be able to successfully develop small hydro projects. It is difficult to evaluate the success of this project, because it has just been set up, but one can argue that since it meets the requirements of most national regulations, the project automatically makes some minimal contributions to sustainable development in the South African context.

*Sunny Greenhouses – China:* This project focuses on developing solar technology for greenhouses in Shandong province in China. The project principally involved the Energy Research Centre in the Netherlands, the Ministry of Science and Technology in China, and the Municipality of Shougang in Shandong province. Demonstration greenhouses have been set up, but the on-site visit revealed that these greenhouses are not being used optimally. More importantly, because baseline emissions are close to zero, the greenhouse has reduction potential is negligible. Because the poor design of the project, the absence of real dissemination of the technology, and the limited involvement of local stakeholders in the design and implementation of the project, the greenhouses fail to reduce greenhouse gases as well as to contribute to sustainable development.

*Biomass gasifier in Baharbari, Bihar – India:* This project focuses on the promotion of the use of a biomass gasifier in Baharbari in India; and this is only one of the six biomass gasifiers promoted in the total project. The project was promoted by DESI Power and Development Alternatives, and originally had a Dutch partner – the company NICIS. The contract was signed in 1999. The project reduces greenhouse gases in comparison with diesel generators in the baseline situation, and has made some contributions to the local economy and social context, but to a very limited extent.

The above information can be summed up in the following table:

*Table E.1: Summary of key features of the AIJ projects*

Host country	Costa Rica	Vietnam	South Africa	China	India
Location	Tejona	Across country	Bethlehem	Shandong	Bihar
Foreign investor	Essent, B.V. & Dutch Govt. (PPP-JI)	SNV (PPP/JI)	Nu Planet with offices in both countries	ECN & PPP/JI	NICIS
Host investor	ICE	Ministry of Agriculture and Rural Development	E3	Ministry of Science and Municipality of Shougang	Development Alternatives and DESI
Investment	Wind power	Small-scale Biogas	Mini-Hydro	Sunny greenhouses	Biomass Gasifier
Initial idea developed when, where	Costa Rica, 1992	Vietnam	South Africa, 1997	ECN, Netherlands, 1997	Joint, 1997*
Contract negotiated	2000	2002	2000	2002	1999
Project implementation	2001	Phase 1 implemented (2003-2005)	In 2006; as approval process took time	Expected to be implemented by 2004; still not implemented properly	The last of the six gasifiers was completed in 2001
Current status	Functioning for four years	In Phase 2	Construction completed	Construction complete; non-functional	Provides electricity and supports development; but not to outsiders?
Total project cost	€ 21.9 million	€ 2.1 million	€ 6.4 million	€ 0.8million	n.a.
Dutch contribution	€ 3.5 million	€ 2.0 million	€ 0.8 million	€ 0.5 million	€ 0.7 million
CERs expected	40 Ktonne CO <sub>2</sub>	55 Ktonne CO <sub>2</sub>	33 Ktonne CO <sub>2</sub>	none	n.a.
Investment/tonne CO <sub>2</sub>	€27.5/tonne CO <sub>2</sub>	€1.9/tonne CO <sub>2</sub>	€9.7/tonne CO <sub>2</sub>	n.a.	n.a.

## Contribution to sustainable development

None of the project documents made any explicit reference to sustainable development, although the project documents of the Vietnamese project had explicit reference to 16 indicators that they wished to contribute towards. The others were much more vague with respect to these goals.

The Indian government has clear sustainability criteria for projects but for the other governments this was less clear. The Vietnamese government has criteria for sustainable development in general which are quite stringent. The governments of Costa Rica, South Africa and China are in the process of developing sustainable development criteria.

In relation to the research question whether or not these projects meet the host country's requirements on sustainable development, it should be noted that we were hampered due to the fact that most countries lack a general definition of sustainable development in their national policies, thereby hampering the assessment of the performance of AIJ/CDM projects. Moreover, the five case studies were born during different phases of the climate change regime and therefore needed to meet different requirements, as well as the fact that the projects are in different phases of implementation. This makes comparison more difficult.

Nevertheless, several important observations can be made on the basis of the thorough assessment that was conducted by the teams. Based on a thorough assessment, the research team developed a ranking four case studies that have sufficient information (see Figure E.1). The figure shows the overall result using the assumption that environmental, economic and social impacts are equally important. The figure also shows the ranking for the three categories separately. Vietnam scores best in all three main categories separately and is therefore considered to be the most sustainable project. The Indian project is not performing well in neither of the three main categories and therefore shows up as the least preferred project of the four.

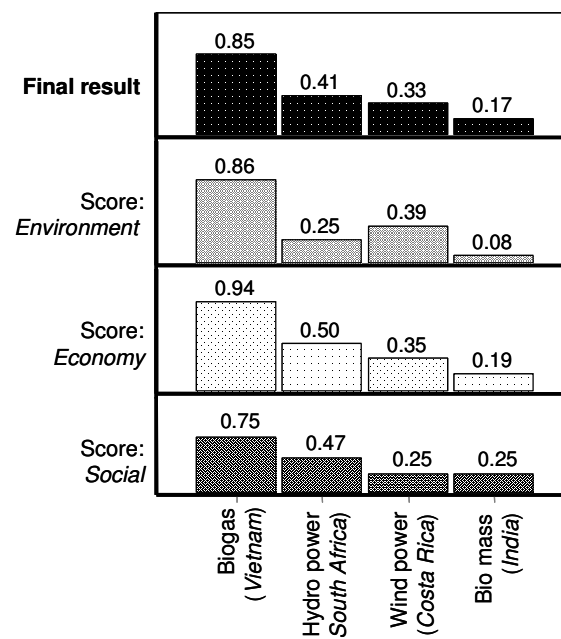


Figure E.1 Scoring and ranking of four case studies on the basis of equal weights for environmental, economic and social impacts.

On the basis of the assessment, several general conclusions can be drawn with regard to whether the projects meet the various criteria of sustainable development. The key common elements between the projects are as follows:

- Four of the five projects contributed to *reducing greenhouse gas emissions*. Only in the project in China reductions were not measured partly due to malfunctioning as well as the absence of a proper baseline.
- All the projects had *low local pollution impacts*, except the South Africa case where loss of one wetland was replaced with the rehabilitation of another wetlands.
- Four of the five projects could have benefited from greater involvement from the local partners in order to define *local benefits* that could have made the projects more socially acceptable and viable. Only the Vietnam project had considerable local participation in the projects.
- All five projects did not generate substantial *local employment*, as this is possibly inherent in the nature of such small-scale projects. Only in the construction phase large number of local workers were employed.
- The projects do not necessarily reveal that women's interests were compromised; yet *gender aspects* were rarely explicitly taken into account. Where the interests of women have been taken into account this has been done because of national legal requirements (the shareholders group in South Africa) or in a way relatively unrelated to the project (women empowerment in India).

#### Towards the development of CDM projects

Sustainable projects may be put up for recognition as CDM projects: Four of these projects are likely to be developed into CDM projects as they possibly meet the criteria for such an evolutionary process. The Costa Rican project is problematic since the private sector has demonstrated that such projects can be financially viable. The Vietnam and South African projects should have fewer problems. While the Vietnam project reveals that such small-scale projects when developed well in conjunction with local partners and stakeholders helps to make non-viable projects affordable to local farmers, the South African project does not necessarily set a precedent. If the research team is right in assuming that transaction costs will come down as the country gets used to private sector electricity projects, then such small hydropower projects may become commercially viable. However, the jury is still out on this point. The Chinese project is unlikely to go through.

#### Critical determinants of success

Despite of the limited number of AII/CDM initiative that have been analysed, some patterns can be observed in the success and failure factors of projects. Lessons learnt can be subdivided into four categories:

- Demand;
- Design;
- Documentation, and;
- Demonstration.

### *Demand*

Demand driven projects are more likely to be successful in terms of promoting sustainable development: There are two key aspects of demand driven projects.

- First, the five projects show that where **developing country partners push projects** there is a greater likelihood of success. The biogas project in Vietnam, the small hydro project in South Africa and the wind project in Costa Rica show that such projects can be successful in terms of avoiding greenhouse gas emissions and to different degrees in terms of promoting sustainable development. Dutch interests probably drove the China project.
- Second, projects with good **involvement of local stakeholders** are more likely to be successful in promoting sustainable development as these ensure that the demand is broadly shared in the context where the project is to be conducted. The projects where the partners have consulted well with the local stakeholders and have tried to meet their needs directly or indirectly are more likely to contribute to sustainable development and are more likely to work well in local contexts. The Vietnamese project is the only one closely linked to local needs. The Costa Rica, South Africa and the India project demonstrate the need to more actively engage local actors in the initial project planning process so that the relevance of the project, technology and usefulness to local development can be enhanced and to have a formal programme for community relations as a way to strengthen local involvement and use of the energy generated in such projects. The China project shows that a top-down approach to project implementation is not likely to be supported at local level. Where local social, economic and environmental interests are taken into account, such projects have a higher chance of promoting sustainable development.

### *Design*

For a project to make a significant contribution to sustainable development, careful design of the project is crucial. A good design is also likely to lead to more cost-effective projects. Our case studies show that the Vietnamese project reduced CO<sub>2</sub> emissions at very low costs while simultaneously generating substantial sustainability effects. In contrast, the Costa Rican project was expensive and had a much lower impact on sustainability. The elements of good design include:

- **Small and relatively affordable renewable projects** are more likely to be successful: Of the five projects, four focus on renewable energy. By definition these forms of energy are likely to enhance rural development and with some subsidies can increase the access to energy of the poor; they have low negative environmental impacts when compared to fossil fuels and, where developed in cooperation with local communities, they can generate local benefits. The solar greenhouse project failed because of the high costs of the solar energy and the poor design of the project. Nevertheless, these are potentially straightforward cases – because they are developed in the direction in which we hope that the energy systems in these countries will further develop in this century. Small, simple and inexpensive technologies can have a major demonstrative effect and can help transform rural landscapes in a sustainable manner.

- Projects where a **baseline** study has been carried out are more likely to be successful than where such a study has not been carried out. This is because such studies are likely to transparently demonstrate that there are real emission reductions. A case in point is the China case study, which demonstrates that merely developing a project based on the notion that solar energy is renewable and hence a good project is not enough for developing a sustainable project. In other words, small-scale renewable energy projects are not necessarily always sustainable.
- Project design should include **clear and verifiable targets** so that it is possible to analyse whether these projects actually meet the goals set in the projects themselves. Most of the projects analysed had vague targets and that made it more difficult to evaluate these projects.
- **Innovative projects put higher demands on project design** than non-innovative projects. Innovative projects are more likely to be sustainable when no assumption is made about the available information for the other party. Even the successful Costa Rican case study shows that the current lack of efficient use of the wind plant due to poor maintenance can be attributed to lack of clarity as to who was responsible for maintaining the mills. Inexperience on the part of ICE concerning wind power sector contracts and the precise definition of 'maintenance' lie at the heart of the problem. Clearly where CDM projects set out to promote innovative ideas in a specific context, no knowledge should be taken for granted. Projects should include systematic reporting to financiers to ensure that the project is working well and should include indicators that can help to monitor the progress of the projects. Investors, especially those from development cooperation ministries, should maintain interest in projects right through their execution phase and possibly thereafter as the India case study reveals. In developing innovative small-scale projects, project plans should take into account possible delays in the institutional learning process and in the process of securing support for such projects.
- **With respect to partnerships**, this research revealed that there is not much difference between whether one deals with government partners or private partners. The key issue is the quality of the individual partner one is dealing with. The government partner in the Vietnamese case was clearly more motivated to work towards sustainable development and community improvement than the government partner in China and Costa Rica. The private partner in South Africa is possibly more motivated than the private partner in India. From the Dutch side, we see that where the Dutch partner is based in the host country (e.g. the Vietnam case study) or has offices in the host country (e.g. the South Africa case study) this has significant impacts on the quality of the project. Where the Dutch partner is interested in the project and follow-up processes either directly or indirectly through the national embassies the quality of the project can be improved.
- **Simple organisational structure, clear division of responsibilities, established communication patterns and a time-line** are necessary features of good project design. The China project has a complex structure, poor division of responsibilities and poor internal communication and as such the project could not really take off. The Costa Rica project had a complex history and structure and the division of responsibilities with respect to maintenance was not very clear.
- Where project involve the use of **higher technologies**, the project design should include technology adaptation to local contexts, capacity building for those using and

maintaining the technologies and for the general public to create greater support for the use of such technologies.

- Where projects involve the disbursement of **subsidies**, simple efficient means of targeting and communicating the subsidies to end-users is vital. In the Vietnam case, the use of the post banks for providing subsidies reduced the transaction costs of the delivery of subsidies.

#### *Documentation*

A successful project is generally accompanied by good quality documentation of the process of design and the results achieved; a monitoring process and processes for constantly improving the projects. Since such projects will be in the public-limelight, it is essential that there is good quality documentation that accompanies the work.

#### *Demonstration*

Four of the five projects have (potential) demonstrative effect. The Costa Rican project took a substantial amount of time to evolve from an idea on paper – in 1992 - into an operational AIJ project, in 2002. In this period, it was overtaken by privately developed windpower plants, coming into operation before the Tejona project. Still, it is difficult to argue that had the state run ICE not invested in this project, private investors would nevertheless have come in. Perhaps the long lead-time to promote wind power in the public sector created the conditions that allowed for commercial development of wind power by the private sector. The Vietnam project is already having demonstrative effect, and since there is some financing required to make the project viable to local farmers, the project itself aims to create the mass participation in such a scheme viable. The biomass gasification project in India has potential for replication, although certain conditions need to be fulfilled when upscaling the technology. The small hydropower project in South Africa is expected to demonstrate that such projects can be feasible. The solar project in China is unlikely to be repeated in the near future.

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# 1. Introduction

*Harro van Asselt and Joyeeta Gupta*<sup>1</sup>

## 1.1 The goal of this report

This report examines the contribution of Activities Implemented Jointly projects developed under the United Nations Framework Convention on Climate Change (UNFCCC) to sustainable development in the host countries. In particular, it presents case studies of five projects funded by the Netherlands government in Asia, Africa and Latin America. The report provides a brief literature review of the evolution of flexibility mechanisms developed to enhance developing country participation in the climate change regime, develops a methodology for assessing the contribution to sustainable development of the projects, presents five detailed case studies on the subject, followed by a comparative assessment, and compiles the conclusions that arise from this research.

## 1.2 From AIJ to CDM

### Activities Implemented Jointly

The climate change problem is being addressed through a framework convention (the United Nations Framework Convention on Climate Change (UNFCCC) adopted in 1992 and a series of negotiated or anticipated protocols (Bodansky, 1993; Maya and Gupta, (eds.)1996; Gupta, 1997; Yamin & Depledge, 2004). In 1997, the Kyoto Protocol to the UNFCCC was adopted. The Protocol includes quantitative commitments for the developed countries and designs mechanisms to help countries achieve their commitments in a cost-effective manner (Oberthür & Ott, 1999; Grubb et al., 1999). The Protocol sets an overall target of a reduction of 5.2% of global emissions by the year 2008-2012.

At the first Conference of the Parties (COP) of the UNFCCC in Berlin in 1995, Parties decided to start a pilot phase of projects that were aimed at GHG reduction and sequestration through the pilot phase of Activities Implemented Jointly (AIJ). The AIJ pilot programme aimed to assist Parties to gain experience in the use of the project-based flexibility mechanisms of the Kyoto Protocol (Michaelowa, 2002). However, the political controversies surrounding this type of investment in the mid-1990s (see e.g. Gupta, 1997; Yamin & Depledge, 2004: 141) led to the decision that AIJ projects would not be eligible for credits during the pilot phase, and any financing of AIJ must be additional to the obligations of Annex I countries (UNFCCC, 1995).

Participation in AIJ is voluntarily undertaken between industrialized (Annex I) parties and other countries. Nevertheless, countries actively involved in AIJ are urged under the UNFCCC to report on their activities using a uniform reporting format. The format must be submitted through the Designated National Authority of one involved party with

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<sup>1</sup> Institute for Environmental Studies, Vrije Universiteit Amsterdam.

proof of concurrence from any other involved parties. The primary criteria that AIJ projects must fulfil are that (UNFCCC, 1995):

- Activities complement existing national environmental and developmental priorities in a cost-effective manner;
- Acceptance of the proposed activity is gained from the governments of the parties prior to project implementation;
- Activities bring about real, measurable, and long-term environmental benefits through climate change mitigation that would not have occurred in the absence of such activities;
- Costs resulting from AIJ are financed in addition to the obligations of developed countries under the UNFCCC, and in addition to official development assistance commitments;
- No credits can accrue to any party as a result of greenhouse gas (GHG) emissions reduced or sequestered during the AIJ pilot phase.

As of the last UNFCCC synthesis report of September 2006 (UNFCCC, 2006), 157 projects were undertaken worldwide, the bulk of which were in East and Central Europe and Central America, as can be seen in Figure 1.1.

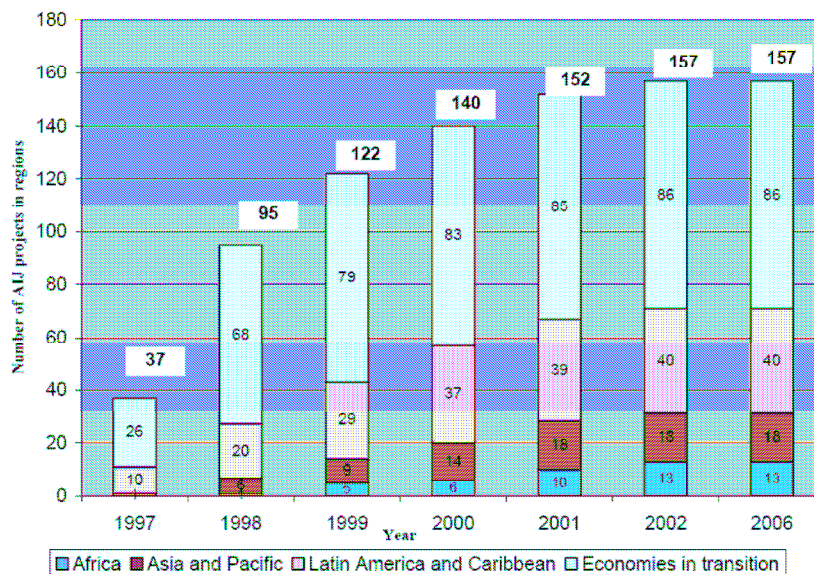


Figure 1.1 Regional distribution of AIJ projects as of September 2006 (UNFCCC, 2006).

The Netherlands is and has been involved in quite a number of AIJ projects listed on the UNFCCC website.<sup>2</sup> However, it should be noted that none of the case studies examined in this report are listed on the website.<sup>3</sup> The AIJ pilot phase has been renewed at the COPs in 1999, 2002 and lastly in 2004.

<sup>2</sup> See [http://unfccc.int/kyoto\\_mechanisms/aij/activities\\_implemented\\_jointly/items/2094.php](http://unfccc.int/kyoto_mechanisms/aij/activities_implemented_jointly/items/2094.php) (last accessed 15 November 2006).

<sup>3</sup> Nevertheless, according to one former official of the Netherlands' Ministry of Foreign Affairs, the projects have been notified to the UNFCCC Secretariat. Personal communication with Mr. Ard Kant, 11 September 2006.

## The Clean Development Mechanism

The Clean Development Mechanism (CDM) is one of the flexibility mechanisms that is expected to be based on the lessons learnt from the experiences in the pilot projects developed under AIJ. It allows for investment in developing countries in return for emission credits calculated against a constructed baseline (Matsuo, 2004; Halvorsen, 2005). Under the CDM, developing (non-Annex I) countries may form voluntary partnerships with Annex I countries to undertake greenhouse gas mitigation projects. The dual purpose of the CDM as outlined in the Kyoto Protocol is to assist non-Annex I countries in achieving sustainable development through using new technologies and efficiency techniques in mitigation projects, while Annex I countries engaged in CDM projects are entitled to certified emissions reductions (CERs) which may be counted against national emission reduction targets.<sup>4</sup>

As the details of the CDM had not been negotiated in the Kyoto Protocol, a framework to operationalise the CDM was launched at the 7<sup>th</sup> COP in Marrakech in 2001. The Marrakech Accords also included a 'prompt start' decision, allowing CDM projects started from 2000 onwards to receive credit retroactively after entry into force of the Kyoto Protocol. To participate within the CDM, both Annex I and non-Annex I parties must have ratified the Kyoto Protocol, and need to establish a Designated National Authority for the CDM. Annex I parties have additional responsibilities involving the development of a system for measuring GHG emissions, the determination of GHG emissions, creating a national registry, and other considerations. Furthermore, specific CDM projects need to fulfil the following conditions (UNEP, 2004):

- *Additionality*: Reductions must be additional to emissions that would have occurred in the absence of the CDM activity; the projects should lead to real, measurable, and long-term benefits related to the mitigation of climate change.
- *Sustainable development*: The host country needs to confirm that the project assists in achieving sustainable development.

While hailed as a breakthrough funding mechanism, it has been argued that developing countries got a rough deal with the 'Kyoto surprise' (Werksman, 1998; Yamin, 1998; Gupta 2001). In particular, it has been argued that its overarching goal of sustainable development is still elusive. Moreover, there are critics who doubt whether the CDM may be capable of contributing to sustainable development (see Section 1.3). The CDM is, hence, one of the key issues in the climate change and sustainable development debate (Michaelowa & Dutschke, 2002; Matsuo, 2003). The growing number of CDM projects only increases the importance of the question whether these projects actually contribute to sustainable development in their host countries and, hence, provide a proper balance between the dual aims of the CDM.

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<sup>4</sup> Art. 12.2 of the Kyoto Protocol.

### 1.3 Problem definition and research questions

#### CDM and sustainable development

Sustainable development is a theoretically challenging concept (see 2.2) and the legal evolution of the concept also demonstrates the ambiguity in defining it (see 2.3 for further elaboration). Within the climate change agreements, the term itself has not been further clarified (see 2.4) and it is now in the process of operationalizing the CDM that there are specific questions being asked as to how best one can define sustainable development; and who is the appropriate actor to define it. Since the evolution of the concept there have been critics who have questioned the ability of an instrument focused on cost-effective emission reduction to be able to meet other local environmental and social objectives. As project results become available, some researchers note that the mechanism's two objectives of sustainable development and compliance with the Kyoto targets are not automatically synergetic, and that it can even be argued that there is an inherent tension between them, inevitably leading to trade-offs (Kolshus et al., 2001). The main criticism can be summarized as follows: the focus is too much on ensuring that Annex I countries can achieve their targets in a cost-effective fashion and too little on ensuring sustainable development in non-Annex I countries.

The Kyoto Protocol's Article 12 could be interpreted in such a way that it does not allow projects that do not contribute to sustainable development to be funded under the CDM.<sup>5</sup> To say which projects contribute to sustainable development is to go down a slippery slope, as the concept is highly subjective and context specific, both in terms of location and in terms of the particular development phase a country may find itself in at a particular moment in time. This is the main reason why the definition of sustainable development is left up to the host countries.<sup>6</sup> Nevertheless, one can indicate which projects are likely to be more beneficial than others. At the very least, one can argue that sustainable development means something more than reducing greenhouse gas emissions. Otherwise, every single project that reduces emissions against a baseline would qualify as a CDM project that contributes to sustainable development. Yet, despite this argument, the reality is different. Many of the CDM resources are flowing to projects with high greenhouse gas emission reduction potential, but little or questionable non-climate sustainable development benefits (Ellis et al., 2004: 32).

The current CDM project portfolio reveals that while most projects are in the area of renewable energy, most of the expected credits until 2012 will be generated through projects that reduce emissions of greenhouse gases with high global warming potential (GWP)<sup>7</sup>, such as hydrofluorocarbons (HFCs), N<sub>2</sub>O, and methane. On 14 September

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<sup>5</sup> This is based on the reasoning that projects that do not contribute to sustainable development are not serving one of the purposes for which the CDM was created.

<sup>6</sup> UNFCCC, 'Decision 17/CP.7, Modalities and procedures for a clean development mechanism as defined in Article 12 of the Kyoto Protocol', FCCC/CP/2001/13/Add.2 (21 January 2002), preamble ('it is the host Party's prerogative to confirm whether a clean development mechanism project activity assists it in achieving sustainable development'), and para. 40(a).

<sup>7</sup> Global warming potential is a way to estimate the relative impact on the climate system by emissions of certain greenhouse gases. See IPCC (2001: 358).

2006, there were a total of 1145 CDM projects at various stages of the CDM project cycle. In numbers of projects, biomass energy (249), hydro (191), wind (140), and energy efficiency in the industrial sector (138) dominate, as compared to HFC (15), N<sub>2</sub>O (6) and landfill gas (88) projects. However, the latter account for almost 55% of the total of generated CERs until 2012 (Fenhann, 2006; see also Ellis & Karousakis, 2006). Although the projects focusing on gases with high GWP may result in considerable emission reductions, “a project’s local impact on sustainable development does not depend on the number of CERs it generates” (Sterk & Wittneben, 2006: 271).

Pearson (2005: 12) submits that: “[t]he question of whether the CDM is promoting sustainable development can be framed primarily in terms of whether it is promoting renewables in developing countries and thus assisting in the transition away from fossil fuels”. Although renewable energy projects are not per se more sustainable than other projects, studies are starting to point out that most of the non-renewable energy projects that are now flooding the carbon market do not score high on certain sustainable development indicators (e.g. Cosbey et al., 2005: 14-15). Looking at indicators for economic, social and environmental development, Sutter and Parreño (2005) argue that the greatest amounts of CERs are going to projects with the lowest or no contribution to sustainable development.

This reveals the problem that there are a number of barriers to the widespread use of the CDM for renewable energy and energy efficiency. This includes additionality, which is a problem for these types of projects, as energy efficiency projects often pay for themselves through reduced energy costs over time (Driesen, 2006). Most countries have policies encouraging the development of renewable energy, even if it is currently not being undertaken. How does one prove that this is additional to a business-as-usual situation? Furthermore, (small-scale) renewable energy projects often generate few credits, which makes it difficult to prove that without the CDM, these projects would not have happened (Burrian, 2006: 64). In contrast, it is currently quite easy to prove additionality for end-of-pipe projects involving gases such as HFCs, N<sub>2</sub>O and methane, especially when there are no national regulations on these gases and when the CERs form the only return on the investment (Ellis & Gagnon-Lebrun, 2005: 11-12). Another hurdle for renewable energy projects is that, in general, these projects require more investment per generated carbon credit than other options (Pearson, 2005). Energy efficiency projects also generate relatively small amounts of CERs (Driesen, 2006). The result is that more and more renewable energy and energy efficiency projects will be ‘crowded out’ by the low-cost, high credit projects (Burrian, 2006: 63).

The conclusion of all the above is that the CDM as it is currently designed has the potential to promote technology transfer and contribute to local development in many ways, but the practicalities of developing such projects might imply that the bulk of the resources go towards projects that aim primarily at reducing greenhouse gas emissions and there are marginal additional benefits. It is more than probable that these projects will be designed more to help Annex I countries achieve compliance with their obligations than non Annex-I countries to achieve sustainable development (see also Baumert, 2006: 388).

## Research questions

Against this background, this project aims to understand the extent to which pilot projects in the context of Activities Implemented Jointly funded by the Netherlands Ministry of Foreign Affairs have contributed to sustainable development. It addresses the question: “Do AIJ/CDM projects, which are expected to assist The Netherlands in complying with its Kyoto target, contribute to sustainable development in the host countries?” In answering this question, several more specific questions are addressed. These include:

- What is the contribution of projects in the area of Activities Implemented Jointly (AIJ) to sustainable development according to the host country as well as to the research team perspective?
- Have the goals as listed in the project documents of AIJ projects been achieved?
- Which factors have contributed to the failure or success of the projects?

It is anticipated that the lessons learnt from an analysis of these projects will help us understand how such projects can be better designed in the future, especially with respect to the sustainability criteria.

## Five case studies

This report adopts a case study approach to answering the above questions. It analyses five cases in considerable detail. All these cases are AIJ pilot projects funded in the context of the Netherlands’ Pilot Projects Programme Joint Implementation (PPP-JI), which was designed to experiment with Activities Implemented Jointly. The aim of AIJ projects was to provide lessons for jointly implemented projects under UNFCCC. The case studies consist of three projects in Asia, and one in Africa and Latin America respectively.

The Department for Inspecting Development Cooperation (IOB) has selected the case studies. All five case studies concern renewable energy projects and, in that sense, all these projects are unlikely to fall into the category of highly risky projects from the perspective of sustainable development. Nevertheless, we expect that research investigating how such projects fare in completely different political and social contexts is likely to be extremely revealing in terms of showing the gaps between intentions and achievements. The case studies selected are listed below:

1. *Tejona Wind Power Project (Costa Rica)*: Building on its relatively high level of economic development and knowledge base, Costa Rica has been on the forefront of creating environmental policy instruments. One such project implemented in Costa Rica is the 20 MW Tejona Wind Power Project, aimed at greenhouse gas abatement through the development of renewable energy. It serves as a pilot study for the coming CDM programme (see Chapter 4).
2. *Biogas Animal Husbandry Industry (Vietnam)*: This AIJ project aims to construct 10,000 fixed dome biogas plants to unlock the potential for biogas production and use for a large number of rural households in Vietnam. The case study provides the relevant background to the use of biogas in Vietnam, before examining the specific project.



3. *Mini Hydro in Bethlehem (South Africa)*: The Bethlehem Hydro project is located on the As river, through which an artificially regulated guaranteed flow runs from a storage in the Lesotho Highlands to Johannesburg where it is used for drinking water purposes. With this continuous flow the Bethlehem hydro project is expected to generate 28.6GWh of power annually, which will be supplied to the town of Bethlehem through a power purchase agreement with the Dithlabeng local council. The electricity supplied by the project will result in an annual reduction of CO<sub>2</sub> emissions by 25,000 tonnes.
4. *Low-energy greenhouses (China)*: In China, the AIJ project of the Shougang Municipal Agricultural Committee and the Netherlands Energy Research Centre (ECN) aims to raise productivity and energy-efficiency of typical Chinese greenhouses, while at the same time promoting Chino-Dutch business cooperation. The project designs and tests improved greenhouses that affordably incorporate renewable energy technology.
5. *Biomass gasifier in Baharbari village (India)*: This project in the extremely poor state of Bihar addresses a number of local problems including the lack of employment and poverty through the development of a biomass gasifier. The plant produces electricity by gasifying locally available biomass and supplies this electricity to local enterprises. In contrast with existing small-scale industries the gasifier provides electricity with up to 80% less greenhouse gas emissions. The Indian company DESI Power has set up the project.

### Collaborative research

This assessment is based on collaborative research between Dutch partners and researchers in the case study countries. There are three key reasons for such a collaborative approach. First, local scholars are often better able to gain access to local documents and information; and are in general far more successful in talking to key stakeholders because of their language skills, and because they are more familiar with the context. Second, a combination of Dutch and local scholars ensures a good mix of cultural sensitivity to the issues that play out at both sides (host and investor countries and investors) of such projects. Third, collaborative research offers opportunities for mutual learning as well, as where appropriate, using and strengthening local capacity. Such capacity can be strengthened through cooperative research. Through North-South collaboration, the project aims to provide a supportive framework in which Southern researchers can apply the skills and techniques acquired in formal documents and Northern researchers can also learn from their Southern partners.

### 1.4 The structure of this report

This report begins with a brief theoretical exploration of the concept of sustainable development (Chapter 2). It then outlines the methodology for the assessment used in this report (Chapter 3). It discusses the results of the five case studies (Chapters 4-8), before engaging in a comparative analysis of the different projects (Chapter 9).

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## 2. A theoretical exploration of sustainable development

*Joyeeta Gupta and Harro van Asselt*<sup>8</sup>

### 2.1 Introduction

This assessment aims to evaluate the contribution of five specific AIJ projects to sustainable development. Based on an examination of the literature, the previous chapter explained some of the complexities of defining and achieving sustainable development in AIJ/CDM projects. This chapter focuses on a more detailed elaboration of the concept of sustainable development and its relation with climate change. It discusses the evolution of sustainable development as a concept, its evolution as a concept in law, the way it is used in the climate change agreements, before finally drawing some conclusions.

### 2.2 Evolution of sustainable development as a scientific concept

The concept of sustainable development can perhaps be traced back to the notion of sustainable society (Brown, 1981). Over the years there has been considerable literature focused on the concept of sustainable development in the context of climate change (Beg et al., 2002; Cohen et al., 1998; Schneider et al., 2000; Banuri et al., 2001; Markandya & Halsnæs, 2002; Metz et al., 2002; Morita et al., 2001; Munasinghe & Swart, 2000; Najam et al., 2003; Smit et al., 2001; Swart et al., 2003; Wilbanks, 2003).

From the literature, a number of insights can be drawn.

First, sustainable development incorporates two concepts:

1. The protection of resources for future generations while still meeting the needs of current generations; and
2. Meeting the social, economic and environmental criteria that are relevant within a specific context.

It is anticipated that if the social, economic and environmental criteria are met that this may be able to ensure that present needs are met without compromising the ability of future generations to meet their own needs.

Second, sustainable development is essentially a vague concept; it is a general notion rather than something that can be specified in great detail. It has many followers precisely because it can mean many things to many people. However, vagueness itself is not necessarily problematic. A number of other legal concepts are similarly vague on the one hand, and open up a world of meaning on the other hand. These include democracy, accountability, legitimacy, equity, etc. (Lafferty, 1996). The key message embodied in the concept is that economic, environmental and social dimensions are interlocked and should not be dealt with differently.

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<sup>8</sup> Institute for Environmental Studies, Vrije Universiteit Amsterdam.

Third, sustainable development has a strong North-South angle to it. For many in the South, sustainable development is about promoting Northern future interests at the cost of current Southern interests. This has often led developing countries to argue that development should precede sustainable development. This can to some extent be related to the environmental Kuznets curve. This curve hypothesizes that as countries become richer on a per capita basis, they are likely to pollute more. However, beyond a critical income per capita, their pollution per capita will begin to decrease possibly because societies devote greater resources to services rather than heavy industry in this development phase and because they are more likely to wish to invest in their environment as basic needs are met. This supported the notion in developing countries that they could postpone sustainable development until after they had developed. However, recent literature tends to show that the greenhouse gas emissions tend to increase with economic development even if not proportionately.

Fourth, the literature tends to see sustainable development as both an end and a means. Those who see it as an end, tend to see sustainable development possibly as something that cannot be achieved given the limits to society (Dovers & Handmer, 1993; Mebratu, 1998; Sachs, 1999); or as a goal towards which society must continuously strive. Those who see it as a means tend to focus on process – and argue that if there is a right process, sustainable solutions will emerge (see the legal discussion in section 2.3). Others are of the view that if human wellbeing is met then sustainability is likely to follow (Dasgupta, 1993; Sen, 1999).

Fifth, strong sustainability is defined as a situation where all criteria for economic, environmental and social elements are met; while weak sustainability calls for trade-offs between the criteria even if the total capital stock remains the same.

Sixth, most discussions on sustainability tend to focus on environmental and economic aspects and ignore the social and political aspects (Barnett, 2001; Lehtonen, 2004; Robinson, 2004).

### **2.3 Evolution of sustainable development in international law**

In the context of international law developments, the concept of sustainable development emerged with the World Commission on Environment and Development's report *Our Common Future* (WCED, 1987). It defined sustainable development as progress "that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987: 43) and that: "[i]n essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations" (WCED, 1987: 46). The report recommended a range of measures, including a political system that allows citizen participation in decision making, an economic system that generates surpluses and technical knowledge on a self-reliant and sustained basis, a social system which allows for the identification of solutions for societal tensions; a production system that is compatible with the conservation of the resource base; a sustainable international trade and finance system and an administrative system that allows for self-correction (WCED, 1987: 65).

Until that time, although, there was considerable attention paid to economic principles and environmental principles in international law, development principles – such as those proposed by the developing countries within the New International Economic Order discussions leading to the adoption of the NIEA instrument in 1974<sup>9</sup> – were never implemented and were perceived as a neglected element of this law (Garcia-Amador, 1990; Schrijver, 2001). The concept of sustainable development offered the possibility to unite development, economic and environmental principles at the international level.

The concept was adopted as part of the Rio Declaration,<sup>10</sup> the Climate Change Convention, the Convention on Biological Diversity and Agenda 21<sup>11</sup> at the UN Conference on Environment and Development. There was a lot of enthusiasm for the concept because it offered the potential room for prioritising three key concerns of the global community. Despite some critique (Chatterjee & Finger, 1994), the concept provided the setting for North-South dialogue in the last decade of the previous century.

However, the legal implications of the concept are still ambiguous. The Rio Declaration states: “The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations”.<sup>12</sup> The legal instruments that have since been adopted the concept have not really shed any additional light on the subject. Some scholars see the principle as too normative and vague (Sohnle, 1998) or as a conceptual matrix (Dupuy, 1997: 886). The International Court of Justice (ICJ) concluded in the *Gabcikovo-Nagymaros* case of 1997 that sustainable development was a mere concept as opposed to a principle.<sup>13</sup> Although in his dissenting opinion, Judge Weeramantry stated sustainable development was a “part of modern international law”, not only because of “its inescapable logical necessity, but also by reason of its wide and general acceptance by the global community”.<sup>14</sup>

One could submit that in international law, sustainable development calls on states to promote international and intergenerational equity, and to integrate environmental and social concerns in economic activities. Some legal scholars argue that if an organisation and/or state adopts the notion of sustainable development in one way or another, it cannot subsequently argue that not all activities undertaken by that state/organisation are not subject to the principle (Handl, 1998). Judicial reasoning (Lowe, 1999) suggests that judges need to define the concept through a process of balancing different principles and legal articles. The ICJ notes that: “this need to reconcile economic development with protection of environment is aptly expressed in the concept of sustainable development”.<sup>15</sup> But in actual fact, operationalising the principle is very challenging and tends to often lead to trade-offs between different values (Banuri et al., 2001).

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<sup>9</sup> Declaration on the establishment of a New International Economic Order, UN Doc. GA Res. 3201 (1974) and Programme of Action, UN Doc. GA Res.3202 (1974).

<sup>10</sup> UN Doc. A/CONF.151/26/Rev.1 (Vol. I) (1992).

<sup>11</sup> UN Doc. A/CONF.151/26 (1992).

<sup>12</sup> Principle 3 of the Rio Declaration..

<sup>13</sup> Case concerning the *Gabcikovo-Nagymaros* project (Hungary/Slovakia), par. 140, Judgment of 25 September 1997, ICJ: Reports of Judgments, Advisory Opinions and Orders, at 78.

<sup>14</sup> *Ibid.*, at 95.

<sup>15</sup> *Ibid.*, at 78.

The question is – is sustainable development one principle or a bundle of principles? While some see it essentially focused on intra- and inter-generational equity, others argue that such a goal cannot be achieved without seeing sustainable development as a bundle of goals including adapting production and consumption patterns to allow for protection of social and environmental goals (Sands, 1999: 43), the principles of integration, equity and sustainable use and principles like limited sovereignty over natural resources, intergenerational equity, the common but differentiated obligations of countries, the recognition of the special needs and interests of economies in transition and least developed countries, the common heritage and the common concern of humankind, the precautionary principle, the polluter pays principle, public participation and access to information, and good governance including democratic accountability (Schrijver, 2001).

In 2002, the International Law Association adopted the New Delhi Declaration on Principles of International Law relating to Sustainable Development at its 70<sup>th</sup> Conference.<sup>16</sup> This Declaration put all relevant principles together. It reflected the state of legal science based on analysis of international declarations and treaties, the work of jurists, case law and state practice at the point as to which principles should be included as part of the law of sustainable development. It included the duty of states to ensure sustainable use of natural resources, the principle of equity and the eradication of poverty, the principle of common but differentiated responsibilities, the principle of the precautionary approach to human health, natural resources and ecosystems, the principle of public participation and access to information and justice, the principle of good governance and the principle of integration and interrelationship, in particular in relation to human rights and social, economic and environmental objectives. These principles have differing status in international law, but together they are seen to be an elaboration of the emerging law of sustainable development.

Developing countries had been concerned that the concept of sustainable development might push them to adopt unaffordable technologies for their countries. This attempt at codification is likely to ease developing country concerns that sustainable development is not just about adopting unaffordable development patterns for developing countries but also about international equity. In other words, sustainable development is not a principle that will be used to prevent the development of the South; on the contrary sustainable development aims at reducing the inequities globally while protecting the environment.

The legal discussion in many way parallels the discussions in the theoretical worlds (see 2.2). It embodies the notion of intergenerational and international equity; it is vague and yet all encompassing; it has a North-South dimension, it tends to see sustainability more in terms of trade-offs (weak sustainability) than strong sustainability. In the legal and policy worlds too, there has been greater emphasis on the environmental side of the equation than the developmental side. However, a key difference is that in the legal discussions, there is greater focus on process than substance. And of the seven procedural principles in the proposed law of sustainable development, there are three

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<sup>16</sup> Resolution 3/2002 of the International Law Association: The New Delhi Declaration of Principles of International Law Relating to Sustainable Development.



notions that are not necessarily encapsulated in the theoretical discussion on sustainable development – these include the principle of common but differentiated responsibilities, public participation and access to information and justice and good governance. In legal debates there is some discussion about whether sustainable development is a soft law concept or not; and whether if it is a soft law concept this reduces its value. On the other hand, most of international law is not enforceable; there may not be any de facto difference (Campins-Eritja & Gupta, 2005).

Thus from an international law perspective, the key dichotomies are whether sustainable development is one principle or a bundle of principles, and whether it is soft or hard law. It adds the notion of common but differentiated responsibilities, public participation and good governance to the concept.

## 2.4 Climate agreements and sustainable development

The climate change convention is ambiguous in the way it refers to the concept of sustainable development (Arts & Gupta, 2005). On the one hand, it sees sustainable development as both a right and as a goal.<sup>17</sup> But the text in the Convention does not further clarify the situation. It states that “economic development is essential for adopting measures to address climate change”,<sup>18</sup> and therefore to reach sustainable development and at the same time suggests that sustainable development is an alternative to development. In fact, when the treaty was being negotiated, there was a strong argument being made that unlike the rich developed countries, developing countries prioritised development over sustainable development. However, it was precisely to keep the developed countries on board that the Convention stressed the need for economic development in the article that included the ‘aspirational target’ for the developed countries.<sup>19</sup>

Although the Convention is ambiguous, the Kyoto Protocol and the Marrakech Accords of 2001/20 are less ambiguous. The texts in these documents referring to sustainable development are internally consistent. This may reflect the growing general consensus that all countries need to aim at sustainable development. The concept had also apparently become more acceptable to the South as many developing countries accepted (ratified or acceded to) the Protocol. But while the concept became more universally acceptable, the key question remained: how could it be operationalised at international level. In this context, it was argued at the International Court of Justice that such operationalisation “(...) will, of course be a question to be answered in the context of the particular situation involved” as Judge Weeramantry puts it.<sup>21</sup> This sentiment is reflected in the provisions made with respect to CDM, which puts the responsibility of

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<sup>17</sup> Article 3.4 of the UNFCCC states “[t]he Parties have a right to, and should promote sustainable development”.

<sup>18</sup> Article 3.4 of the UNFCCC.

<sup>19</sup> Article 4.2 of the UNFCCC.

<sup>20</sup> UN Doc. FCCC/CP/2001/13 (2001).

<sup>21</sup> Case concerning the Gabcikovo-Nagymaros project (Hungary/Slovakia), Separate Opinion of Vice-President Weeramantry, at 92

determining whether a project meets sustainable development criteria on to host governments as it is seen as primarily a contextual issue.

## 2.5 Inferences

This chapter makes essentially four observations.

First, it submits that the concept of sustainable development has come a long way since 1980 when it was first developed. The theoretical literature focuses on the content of sustainable development, whether its inherent vagueness is problematic or not; the difference between strong and weak sustainability, the challenges from a North-South perspective, and whether sustainable development is an end or a means.

Second, the legal and policy literature focuses on its evolution from soft law documents through adoption in hard law treaties and references in judgements of the International Court of Justice. In many ways this discussion parallels the conceptual debates in theoretical explorations of the concepts, except that it adds the dimension of whether this is a legal principle or general concept and whether it is hard or soft law. It also adds three dimensions to the discussions – the principle of common but differentiated responsibility, public participation, and good governance.

Third, the literature itself and the legal and policy process tend to focus more on the economic and environmental aspects of sustainable development rather than on the social aspects.

Fourth, the climate change treaty is ambiguous about the way it treats sustainable development – on the one hand seeing it both as a right and as a goal, and on the other hand by seeing it as either competing with development or as integrated with development.

When we link these insights with the insights in Chapter 1 (see 1.3.1), we see that this last insight is closely linked with the observation of scientists that CDM projects may favour cost-effectiveness as a driving factor to the additional contributions to social, economic and other environmental issues in the host region.

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## 3. Methodology for assessment

*Tjasa Bole, Pieter van Beukering, Harro van Asselt and Joyeeta Gupta*<sup>22</sup>

### 3.1 Introduction

The former chapter reviewed the literature on climate change and sustainable development. This chapter proceeds by developing a method for assessing the contribution to sustainable development of the AIJ projects examined in this study. It first briefly summarises the methods for assessing sustainable development in the literature, then presents a conceptual assessment approach, and finally provides guidelines on the operationalisation of the conceptual approach.

### 3.2 Literature on sustainable development indicators

In the last fifteen years there have been many attempts to list the relevant indicators for sustainable development. Amongst others, these include Kuik and Verbruggen (1991), Munasinghe (2001), and Markandya and Halsneas (2002). Their research attempts to list criteria for sustainable development. Overall, indicators can be classified based on various dimensions (Boulanger, 2004):

- Sectors;
- Resources;
- Human needs, and;
- Principles and norms.

Attempts to operationalise sustainable development in general include the Action Impact Matrix developed by Munasinghe and Swart (2000). Efforts to develop criteria specifically for CDM projects include the WWF Gold Standard, World Bank Criteria, and research specific criteria developed in a range of projects. The WWF CDM Gold Standard<sup>23</sup> was developed under the auspices of the World Wildlife Fund (WWF) to ensure that the project-based flexibility mechanisms of the Kyoto Protocol “deliver credible projects with real environmental benefits and, in so doing, confidence to host countries and the public that projects represent new and additional investments in sustainable energy services” (Kenber et al., 2004). The Gold Standard criteria are based on the work conducted by SouthSouthNorth and Helio International (SouthSouthNorth, 2005; Thorne & Lebre La Rovere, 2002; Thorne & Raubenheimer, 2001).

The World Bank has assumed an important role in the emerging carbon market through, amongst others, its Prototype Carbon Fund (PCF). The PCF was established in 1999 with the objective of combating climate change, promoting the World Bank’s tenet of sustainable development, demonstrating the possibilities of public/private partnerships, and offering a ‘learning-by-doing’ opportunity.<sup>24</sup> As many CDM projects have been

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<sup>22</sup> Institute for Environmental Studies, Vrije Universiteit Amsterdam.

<sup>23</sup> See <http://www.cdmgoldstandard.org/> (last accessed 15 November 2006).

<sup>24</sup> See <http://carbonfinance.org/Router.cfm?Page=PCF&ft=About> (last accessed 15 November 2006).

financed through the PCF, it has considerable experience in developing sustainable development criteria (Huq, 2002).

Other studies such as Begg et al. (2000), Beuermann et al. (2000), Brown et al. (2004), and Sathaye et al. (1999) have developed a framework to evaluate the contribution to sustainable development of CDM projects in specific cases.

The options available in the ‘sustainability assessment market’ are well documented by Sutter (2003), who summarizes the approaches and methods currently available to conduct sustainability assessments of CDM projects. Essentially, the assessment methods can belong to one of the following groups:

- *Guidelines*: descriptive and qualitative definition of sustainable development aspects to be considered;
- *Checklists*: clearly defined questions with a closed set of predefined answers;
- *Negotiated targets*: the stakeholders and the project developer negotiate ways in which the project can help develop its host region and indicators are developed to monitor the sustainability component.
- *Multi-criteria analysis (MCA)*: define various criteria for several aspects of sustainability and assess the project with regard to each criterion. Some methodologies suggest aggregating the indicators by weighting the respective criteria according to their importance.

Only the last category (i.e. MCA) provides a clear process for sustainability appraisal of CDM projects. Because of these characteristics, multi-criteria is deemed to be the most appropriate approach for evaluation of non-carbon benefits of CDM projects and was adopted as the main assessment method in this research.

### 3.3 Developing a framework for assessment

For this study, an analytical framework has been designed on the basis of the existing indicators and frameworks reported in the literature, as well as a thorough understanding of the case studies. This section presents the generic structure of the case studies, the assessment framework, and the stakeholder analysis that was undertaken in the projects.

#### Analytical elements in case studies

Five analytical elements have been systematically studied.

- First, background information on the country concerned is examined in order to present the *context* in which the project takes place.
- Second, the *history* of the case study is analysed since many of these projects have developed slowly over time. Also, we anticipate that the evolutionary process determines to some extent the degree of success of the project.
- Third, the *project documents* are screened on their expressed intention to contribute to sustainable development.
- Fourth, where possible, the *host government’s criteria* on sustainable development criteria are assessed along with an analysis of whether these have been applied.
- Finally, an *assessment* of the case study project’s contribution to sustainable development based on the assessment framework is made.

## The assessment framework

The project team, in consultation with the local partners designed an assessment framework. Two precautionary remarks should be made up front. First, there are many ways to approach and define what is ‘sustainable development’ (see Chapter 2). At the operational level, there is general agreement that this includes a social, environmental and an economic dimension (see, for example, Kolshus et al., 2001; Najam et al., 2003). Second, this project is not the first to develop an assessment framework. Hence, instead of ‘reinventing the wheel’, the project builds on existing evaluations and assessments, and their underlying criteria.

The assessment combines qualitative with quantitative analysis. Where quantitative information is readily available or can be analysed, this has been done. Where the information is more qualitative in nature, textual and contextual analysis has been supplemented with questionnaires and interviews.

## The scoring system

The selected criteria can be scored or rated based on a qualitative or quantitative judgment. *Quantitative indicators* comprise a clearly defined scale and unit of measure (e.g. number of tonnes of CO<sub>2</sub> equivalent or USD per kWh, etc.). *Semi-quantitative indicators* combine quantitative assessment with qualitative expert judgment. Qualitative indicators are used to assess criteria for which no data has been systematically compiled or only descriptive assessment is sensible.

Many of the assessments found in the literature are purely qualitative (Austin et al., 2002; Kolshus et al., 2001; Mwakasonda & Winkler, 2005), while some attempt to combine the quantitative and qualitative assessment. Qualitative indicators are used to capture impacts that are important and cannot be quantified (UNEP Risoe, 2005). The guidelines of the Commission for Sustainable Development on developing sustainability criteria suggest that many criteria will indeed be qualitative in nature in order to avoid excessive costs of sustainability assessment. However, there is often a large amount of relevant data readily available from Environmental Impact Assessment (EIA) and other studies conducted in order to obtain different licenses. If they are available to the public they constitute an important data source for the evaluators.

## Individual assessments

For scoring the individual indicators the original scoring system designed by the South African NGO SouthSouthNorth was adopted. As shown in Table 3.1, the magnitude of the impact is described by one of the five possible scores.

Table 3.1 Scoring system

Score	Explanation
-2: Major negative impacts	Significant damage to ecological, social and/or economic systems that cannot be mitigated through preventive (not remedial) measures.
-1: Minor negative impacts	Measurable impact but not one that is considered by stakeholders to militate against the implementation if the project activity / cause significant damage to ecological, social and/or economic systems.
0: No or negligible impacts	The stakeholders consider no impact or the impact insignificant.
+1: Minor positive impacts	Measurable benefit to ecological, social and/or economic systems.
+2: Major positive impacts	Significant benefit to ecological, social and/or economic systems.

Source: SouthSouthNorth Sustainable Development Appraisal and Ranking Matrix Tool.

Available at: <http://www.southsouthnorth.org/>.

There are two important features of this scoring system:

- It measures *the relative contribution* of the project to sustainable development. Where sensible, the achievements of the project are measured against the *baseline*, or the continuation of business as usual patterns. The scores assigned therefore represent relative scores, not absolute ones. In view of this, a project of smaller size but with the same improvement over the baseline (e.g. CO<sub>2</sub> emissions per kWh of electricity produced will score the same although the absolute emission reductions are not the same). Although controversial at first glance, this system avoids penalization of small-scale projects on account of their size, which is a situation that should be avoided, since smaller projects generally bring more sustainability benefits.
- Where possible, it allows for stakeholders to help define the magnitude of the impact (minor or major) thus allowing them to fill the part of ‘expert judges’ for addressing semi-quantitative and qualitative indicators. The final scores have been assigned by the evaluator with the support of the expert judges.

Projects of different sizes and scopes will unavoidably have impacts of different magnitude. In view of this, a scoring system that only considers impacts to be minor or major may seem restrictive. The problem with a wider scale is that the more the variety of scores are made possible, the more arbitrary decisions will become in assessing the project or the greater the amount of input required from stakeholders to identify the level of the impact. As it might be reasonable to expect stakeholders to agree about whether an impact is of minor or major importance, it cannot be expected to be so when a decision has to be made on whether a project has, for example, a small, medium-small, medium, medium-large or large impact.

This problem applies to a greater extent to qualitative than to quantitative criteria where comparisons between small and large can be more subjective. However, it must be remembered that here *relative changes* are measured (relative to the baseline), which means that ‘business as usual’ criteria is considered in the local context. A project creating 100 jobs in an area with 50% unemployment will be regarded as having a major



beneficial impact on employment, whereas a project creating 300 jobs in an urban area with 10% unemployment will be seen as having a minor beneficial impact. As will be described further on, this is an important issue to keep in mind also when the aim of the assessment is a comparison between projects.

Defining the score for purely quantitative indicators might also require consultations with experts; however the comparison with the baseline can serve as a good reference point. For example, hydropower electricity generation generally involves zero CO<sub>2</sub> emissions, so compared to coal firing this will clearly be a score of 2.

Because what is scored is actually ‘the magnitude or level’ of the impact and all are assessed with the same scoring system, no standardization is needed and the scores can simply be added up to a total.

### Comparisons

When the aim of the assessment is a comparison across projects, the scoring becomes a two-stage process in order to capture two dimensions of the impacts – the difference between the projects and the difference to its own baseline.

In the first step all effects must be translated on a common denominator, e.g. a unit of investment and then compared. This process allows for comparisons across projects of different size and scope but should not be the only comparison relied upon when choosing the most successful project.

The second dimension is quantified as described for individual assessments. Although at first sight it seems unreasonable to compare a 1.5 MW solar panel installed to provide electricity to a small community with a 15 MW hydropower plant this information is needed to maintain the relationship with the baseline.

This idea can be illustrated through the use of the example of the solar panel and the hydropower station. Both are assumed to generate 10 jobs/100 000 USD invested. However, the solar panel is situated in a rural community with 50% unemployment and the hydropower plant is situated at the outskirts of a prosperous city with 10% unemployment. By comparing the two projects based only on the contribution relative to a unit of investment we would judge the two projects equally cost-effective because the baseline is not considered here. To incorporate the baseline we can either multiply the impacts relative to the unit of investment with the score for the indicator of this impact or consider them separately. Following this logic, our solar panel project would be equally cost-effective as the hydropower plant but would clearly add more value to social sustainability.

### 3.4 Selected sustainability criteria

In line with the traditional definition of sustainable development, the sustainability criteria are subdivided into three main categories: environmental, economic and social indicators.<sup>25</sup> Subsequently each main category is subdivided into subcategories, which in

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<sup>25</sup> For a justification of why these criteria were chosen, see Bole & Rentel (2006).

turn comprises of a number of sustainability criteria. The categorisation is shown in Table 3.2. The definition of the individual criteria is explained subsequently.

Table 3.2 Criteria for evaluating sustainability.

Criterion	Indicators	Score (-2 to +2)
<b>ENVIRONMENTAL SUSTAINABILITY</b>		
Air resources	Air quality	
Water resources	Water quality	
	Water quantity	
	Water management	
Land resources	Land quality	
	Land-use change	
	Land management	
Other resources (_____)	Other resource (_____) quality	
	Other resource (_____) quantity	
	Other resource (_____) management	
Biodiversity & Ecosystems	Biodiversity quality	
	Ecosystem functioning	
Impact on climate change	Reduction in GHGs	
<b>ECONOMIC SUSTAINABILITY</b>		
Financial viability	Return on investment	
Effects on local/regional economy	Energy expenditure	
	Employment (numbers)	
	Impact on economic activity of area	
	Attraction of green investments	
Effects on National economy	Impact on balance of payments	
	Economic growth	
Technological sustainability	Technology transfer and self-reliance	
	Demonstrational effect and replication potential	
	Design and operational efficiency	
<b>SOCIAL SUSTAINABILITY</b>		
Livelihoods of the poor	Poverty alleviation	
	Distributional equity	
	Access to essential services	
	Access to affordable clean energy services	
	Impacts on human health	
Human Capacity	Employment (job quality)	
	Empowerment	
	Gender equality	
	Local skills development / education	
Human environment	Preservation cultural / natural heritage & aesthetics	
	Relocation of communities	

### Impact on the environment

Within the category of “environment”, six sub-categories are defined. These include: air resources, water resources, land resources, other resources, biodiversity and ecosystems, and climate change. In the following, these sub-categories are defined in more detail.

*Air resources*

- *Air quality:* This indicator evaluates the project's contribution to local air quality. Air quality will be measured by comparing the concentration of the most relevant air pollutants other than GHGs (e.g. SO<sub>x</sub>, NO<sub>x</sub>, particulate matter, etc.) generated by the project activity with the baseline.

*Water resources*

- *Water quality:* This indicator evaluates the contribution of the project to local and regional water quality in the area where the project is conducted compared to the baseline. Water quality will be measured using:
  - Concentration of pollutants, BOD, pH levels in any effluents generated by the project activity or
  - Concentration of pollutants, BOD, pH levels of the affected water body and the level of acidification and eutrophication.
- *Water quantity:* This indicator evaluates the impact of the project on water quantity available for all uses (of the project and other). It can be measured as a change in river flows, reservoir levels, groundwater tables etc in comparison with the baseline.
- *Water management:* This indicator considers any plans and projections about future flows and levels of water that will secure the possibility of its long-term sustainable use by the project and allow alternative uses. It should also include mitigation plans for possible pollution, which should be included in the Environmental Management Plan. The difference with the other two water criteria is that they are quantitative criteria related to physical changes of the resource. If a project initially has a negative impact on the water resource this will be reflected in a negative score for water quantity or quality. If the project developers undertake mitigation measures (or a shadow project) that will restore or limit the initial negative impact on the resource this will be reflected in a positive score in this qualitative indicator.

*Land resources*

- *Land quality:* This indicator evaluates the impact of the project activity on local land quality. Land quality will be measured by comparing the concentration of most relevant soil pollutants, loss of topsoil (e.g. erosion), and salinization with the baseline. The impact of waste generated by the project activity and its disposal on surrounding land should also be considered.
- *Land-use change:* This indicator evaluates the impact that the change in land-use has on the area in or around the project activity. A positive score is given if project results in an improvement in land-use for ecological goods and services (e.g. reforestation). A negative score is given if the surrounding area is affected detrimentally (e.g. deforestation).
- *Land management:* The rationale for this indicator is the same as for water management. It considers the results of the planning process for effective land management (mitigation and rehabilitation plans) as well as agreements for on-going land or catchment management, which should be included in the Environmental Management Plan. Management of waste should also be considered here. A negative score will be given if no mitigation and rehabilitation plans are in place for possible negative impacts on land quality and quantity or for irresponsible dumping of waste.

*Other resources*

- *Other resource quality:* The impacts of the project on any other natural resource involved as a production input or sink is considered here. If the project reduces the quality of the resource in any measurable way, it will be scored negatively.
- *Other resources quantity:* This indicator evaluates whether the project reduces the quantity of the resource available for other uses in a significant way. In that case a negative score will be given.
- *Other resources management:* This indicator evaluates the management plans in place to avoid or mitigate negative impacts on the quality or quantity of the resource used.

*Biodiversity & Ecosystems*

- *Biodiversity quality:* This indicator evaluates the contribution of the project to local biodiversity. The change in biodiversity quality is a qualitative assessment based on the destruction or alteration of the natural habitat compared to the scenario without the project. A negative score will be given in case of loss of terrestrial or aquatic biodiversity or by the introduction of foreign species, which will negatively affect the structural aspect of biodiversity. A positive change will be given when species return to recolonize the area as a result of conservation, preservation or protection plans put in place by the project developers or hosting community. Inputs from local communities should be considered as important information.
- *Ecosystem functioning; provision of ecosystem goods and services:* This indicator evaluates the impact of the project on the internal functioning of the ecosystem – the disruption of the regulation function of the ecosystems that relates to the capacity of natural and semi-natural ecosystems to regulate essential ecological processes and life support systems. For example, loss of wetlands can mean a loss of water purification service, flood control, deforestation means loss of air purification etc.

*Impact on climate change*

- *Reduction in GHG emissions:* This indicator evaluates the change in GHG emissions.<sup>26</sup> A positive score is awarded if the project emits no or less GHGs in comparison with the baseline scenario.

**Economic impact**

Within the category of “economic impacts”, four sub-categories are defined. These include: financial viability, effects on local and regional economy, effects on the national economy, and technological sustainability. In the following, these sub-categories are defined in more detail.

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<sup>26</sup> Although AIJ or CDM projects would not qualify as such unless they contributed to the reduction of GHG emissions there can still be significant differences between them in this regard. The score for this indicator can therefore only be positive but not predetermined.

*Financial viability*

- **Return on investment:** This indicator assesses whether the project can generate income flows greater than the costs associated with its construction, operation and maintenance, thereby producing a financial surplus for the project developer and the shareholders.

*Effects on local/regional economy*

- **Energy expenditure:** This indicator measures the change in the energy bill (of the municipality buying energy in bulk from the project developer or direct end users) that occurs as a result of the project activity in comparison with the baseline. The change in cost can result from a change in price or/and a change in energy consumption.
- **Employment:** Net employment generation will be measured by the number of additional jobs directly created by the CDM project in comparison to the baseline. Although permanent jobs are to be strived for, temporary work during the construction phase should also be considered.
- **Impact on economic activity of the area:** This indicator looks at the number of local businesses that will benefit from the services provided by the project activity and by the number of local businesses that will be contracted to service the project during its operational phase, which is to be compared to the number of local businesses benefiting from the baseline situation.
- **Attraction of green investment:** This indicator qualitatively assesses the contribution of the project activity to the attractiveness of the area for green investments (e.g. green-label companies).

*Effects on national economy*

- **Impact on the balance of payments:** Several aspects of the project activity can influence the balance of payments:
  - Sales of services and imports/exports of technology can influence the current account.
  - Sales of CERs, profits, shareholding and financing from abroad can influence the financial account.
  - Net foreign currency savings that may result through a reduction of, for example, fossil fuel imports and direct investment can influence the capital account.
- **Economic growth:** This indicator evaluates the contribution of the project activity on the country's economic growth. It is measured as an increase in GDP/capita in comparison with the baseline.

*Technological sustainability*

- **Technology transfer and self-reliance:** This indicator evaluates whether the project leads to a reduction of foreign expenditure via a greater contribution of domestically produced equipment, royalty payments and license fees. Imported technical assistance should decrease in comparison with the baseline. Similarly a reduced need for subsidies and external technical support indicates increased self-reliance and technology transfer.

- *Demonstrational effect and replication potential:* This indicator qualitatively evaluates the learning curve for both institutional and private agents that a first-of-its-kind CDM projects creates, thereby facilitating future replication of such projects.
- *Design and operational efficiency:* This indicator evaluates the planned designed efficiency of the project's assets (e.g. turbines, solar panels, etc.) and the operational efficiency of the project in the context of the broader system and relevant market arrangements. A positive score will be awarded if the best available technology is being used.

## Social impacts

Within the category of "social impacts", three sub-categories are defined. These include: livelihoods of the poor, human capacity, and human environment. In the following, these sub-categories are defined in more detail.

### *Livelihoods of the poor*

- *Poverty alleviation:* Will be evaluated by calculating the change in the number of people living above the income poverty line compared to the baseline.
- *Distributional equity:* This indicator evaluates the project's ability to integrate as many local people into its activity and to contribute to equal distribution of benefits and opportunity paying particular attention to marginal or excluded social groups.
- *Access to essential services:* These include education, social amenities, water, health services, etc. This indicator will be measured by the number of additional people gaining access in comparison with the baseline.
- *Access to affordable clean energy services:* Evaluates the project's contribution to improving the coverage of reliable and affordable clean energy services, especially to the poor and in rural areas, which can increase household productivity. An increased number of electrified households will be awarded a positive score.
- *Impacts on human health:* This indicator evaluates the health impacts of the project activity on human health. If a project directly reduces health hazards (e.g. by substituting burning coal and paraffin in homes for a clean energy source) it will be awarded a positive score.

### *Human capacity*

- *Employment (job quality):* This indicator evaluates the qualitative value of employment. Job quality is defined as whether the jobs resulting from the project activity are highly or poorly qualified, temporary or permanent in comparison with the baseline.
- *Empowerment:* Evaluates the project's contribution to improving the access of local people to and their participation in community institution and decision-making processes.
- *Gender equality:* evaluates how the project activity requires or improves the empowerment/skills and livelihoods of woman in the community, for example by lessening their burden of daily tasks (e.g. fuel wood and water collection etc).
- *Local skills development:* Assesses how the project activity enhances and/or requires improved and more widespread education and skills in the community.

### *Human environment*

- *Preservation of cultural and natural heritage and aesthetics:* This indicator will compare any loss of scenic beauty, visual disturbances, noise or odour that can negatively affect the living environment of the community compared to the baseline.
- *Relocation of communities:* This indicator evaluates the possibility that communities are forced to relocate due to the project's activity.

## **3.5 Data collection**

To build the assessment on a solid base of information, various methods of data collection have been applied. This section elaborates on these methods for data collection.

### **Content analysis of project documents**

The project partners have examined the project documents in considerable detail in order to be able to understand the evolution of the projects concerned, their goals and their attempts at making some direct or indirect contribution to sustainable development. The project partners collected all available project materials from the archives of the Netherlands' Ministry of Foreign Affairs, as well as all available and relevant documents on the Internet. These documents were complemented with materials obtained during a site visit of the project.

### **Literature analysis of these cases**

Where there has been some published scientific assessments or newspaper publications on the projects concerned, we have undertaken detailed reviews of these cases.

### **Stakeholder analysis**

We have identified stakeholders in these projects by the snowball method, and have in particular interviewed in most, but not all, projects, stakeholders with high stake and less power; but also stakeholders with high power and less stake. We have spoken to people from the different interest categories – those with a direct interest in the project – project developers and project beneficiaries as well as third party interests – those who do not directly benefit from a project but have a role in assessing the project – such as non-state actors, communities, journalists. Interviewees were presented with open-ended questions, based on a well-defined questionnaire, in order to be able to access information about the project and to use this information to triangulate with other sources of information. However, unlike most other applications of stakeholder approaches, these projects were mostly not very much in the public limelight and, as such, the number of stakeholders who were aware about these projects was limited, thus limiting the potential number of interviews undertaken in each country. Interviewees were offered confidentiality and are only referred to in this report as numbered entities.

## Multi Criteria Analysis (MCA)

MCA is a technique used for different purposes. It can help to identify the single most preferred option, rank options, short-list a limited number of options for subsequent detailed appraisal, and it can simply be used to distinguish acceptable from unacceptable possibilities of management alternatives. One of the favourable characteristics of MCA is its quality to combine different types of data such as monetary, quantitative and qualitative information. Several methods of multi-criteria analysis cover a wide range of quite distinct approaches. All MCA approaches make the options and their contribution to the different criteria explicit, and all require the exercise of judgment. They differ however in how they combine the data. Formal MCA techniques usually provide an explicit relative weighting system for the different criteria. The main role of the techniques is to deal with the difficulties that human decision-makers have when handling large amounts of complex information, in a consistent way. Weighted summation is used in this study because it is simple, transparent and well founded in welfare theory. An appraisal score is calculated for alternative by first multiplying each value by its appropriate weight followed by summing of the weighted scores for all criteria. Weighted summation being a discrete quantitative method (Janssen, 1992), judge the attractiveness of alternatives on the basis of two elements: the consequences of the alternatives in terms of the decision criteria and priorities denotes in terms of weights. The software package DEFINITE was used for the application (Janssen et al, 2006).

## Site visits and observation

We have also conducted site visits in each of the project area in order to be able to verify how successful these projects have been in terms of their own goals and in terms of their impacts on the local contexts. During the site visit, the project partners made short video reports on the projects, which form a supplement to this written report.

## 3.6 Inferences

Based on the theoretical and conceptual discussion of the concept of sustainable development in Chapter 2, this chapter has developed an approach to operationalise the concept using a combination of content analysis, historical assessment, multi-criteria analysis and stakeholder analysis. It has elaborated in some detail the indicators of sustainable development and the scoring system.

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## 4. Tejona wind power project (Costa Rica)

*Kim van der Leeuw*<sup>27</sup>, *Steve Mack and Mariamalia Rodriguez*<sup>28</sup>

### 4.1 Introduction

This chapter analyses the Tejona wind power project in Costa Rica. It first presents some background information, then explains how the project has evolved (see section 4.2), analyses the project's contribution to sustainable development (see section 4.3), the possibility that the project may evolve into a CDM project (see section 4.4) and finally draws some lessons learnt (see section 4.5).

### Background

The Tejona project is one of the first wind power plants in Latin America, and is one of four such plants presently operating in Costa Rica. The development of Tejona resulted from the interest of the Instituto Costarricense de Electricidad (ICE), the nation's public electric and telecommunications utility, in diversifying its sources of renewable energy. It was conceived as a pilot project that would test the viability of wind power as a component of Costa Rica's electric system, which is based primarily on hydroelectric power.

Tejona was developed as an Activities Implemented Jointly (AIJ) pilot project under the United Nations Framework Convention on Climate Change (UNFCCC), for which it received a financial contribution from the government of the Netherlands. For the Dutch this presented an opportunity for government and industry to gain experience in implementing projects that mitigate climate change in a developing country. Costs of developing such projects are generally assumed to be lower in developing countries, making them more cost effective (Kuik *et al.*, 1994). Under the Kyoto Protocol to the UNFCCC, similar projects developed under a Clean Development Mechanism (CDM) framework could claim carbon emission reduction credits. AIJ Projects cannot lay claim on these credits.. On the Costa Rican end, participating in this AIJ project was an opportunity to receive valuable technical and financial assistance. Without this, ICE would not have implemented the project.

The other wind power plants in Costa Rica are privately owned and operated, and, in fact, were constructed and producing energy before Tejona became operational in 2002. Their existence was made possible by a law passed in 1990 which authorized ICE to purchase energy from private generators. These plants have been financed entirely by private capital and operate through the sale of electricity to ICE under contract. These plants, which have not received financial assistance under the AIJ framework, provide an interesting point of comparison regarding the development and impacts of the Tejona wind power project.

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<sup>27</sup> Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands.

<sup>28</sup> Centro de Derecho Ambiental y de los Recursos Naturales (CEDARENA), San José, Costa Rica

## Key characteristics of the case study

### *Country context*

Costa Rica is a small country of 51,000 square kilometres, located in Central America. It borders Nicaragua to the north and Panama to the south, and has coastlines on both the Pacific Ocean and the Caribbean Sea. The population of the country is approximately 4.32 million. Costa Rica is a constitutional, representative democracy, one of the oldest and most stable in Latin America. Costa Rica compares favourably to most other developing countries in terms of human development; statistics related to health, education, and economic welfare of the population are relatively good. For example, in 2005, Costa Rica occupied the 47<sup>th</sup> place out of 177 nations listed by the United Nations Development Programme's Human Development Index, which tracks key statistics relating to income, health and education. (UNDP, 2005)

Nevertheless, the Costa Rican economy and society are undergoing significant transformation, placing considerable stress on existing institutions and infrastructure, and inevitably increasing political tensions. Over the past few decades, Costa Rica has evolved quickly from a predominately agrarian society and economy to one that is increasingly urban and globally oriented. Tourism, services, and light, high-tech industry are displacing the traditional economic focus on export crops such as coffee, bananas, sugar and pineapple, although these are still important. While many have benefited economically from these changes, the poverty level in Costa Rica has remained steady at around 20% of the population, increasing to 21.7% in 2004 (Estado de la Nación, 2004). Inflation in the country is high (13.1% in 2005; Estado de la Nación, 2004). Immigration, motivated by economic and political problems in nearby countries, has further challenged the physical and institutional infrastructure of the country. Key services such as energy (both electricity and fuel for transportation), telecommunications, and insurance are state-controlled.

In its development planning, Costa Rica has stressed the importance of conservation and sustainable development. The country is recognized as a world leader in this area, particularly in the conservation of natural resources and biodiversity. Approximately 25% of the country's territory is included in different categories of protected areas, with 12% of lands receiving absolute protection in National Parks (Estado de la Nación, 2004). As a result of protection measures, education, financial incentives for conservation, and changes in land use brought about by a changing economy, Costa Rica has moved from having one of the world's highest deforestation rates to showing a net gain in forest cover in the past 15 years (Estado de la Nación, 2004). Costa Rica's reputation for conservation, combined with its scenic beauty and relatively high level of safety and comfort, has made it a leading eco-tourism destination.

### *Costa Rica's Energy Sector*

By law, the energy sector of Costa Rica is centralized and state-controlled, and since nationalizing the production and distribution of electricity in 1949, Costa Rica has provided over 97% of its population with access to electricity, one of the highest rates in the developing world (Estado de la Nación, 2004). This has primarily been made

possible by exploiting the country's high hydroelectric potential. Presently, over 80% of Costa Rica's electricity is produced through hydropower (Estado de la Nación, 2004).

ICE is the governmental agency primarily responsible for the generation, transmission, and distribution of electricity. Presently, ICE produces almost 80% of the nation's electricity (ICE, 2004). Municipal utilities and regional cooperatives are permitted to produce and distribute electricity under established rules, and are important in distribution of energy to some end users. The dominant role of ICE in energy and telecommunications lies at the heart of the political debate between advocates of free markets and defenders of the traditional Costa Rican development model, with critics charging ICE with inefficiency and inability to adapt to changing conditions, while its defenders cite ICE's critical role in the country's past social and economic development and the need for national control of the energy and telecommunications sectors.

An exception to the public monopoly in the generation of electricity was created with the passage in 1990 of a law authorizing the private generation of electricity (Law 7200, revised by Law 7508 in 1995). This law authorizes ICE to purchase up to 15% of the nation's electricity supply from private generators, under certain restrictions (for example, individual contracts for private generation are limited to projects with a capacity of 20 megawatts). Presently, only approximately 7% of the nation's electricity is produced by private sources, primarily small-scale hydro and wind power (ICE, 2004).

### *Renewable Energy*

In most years, Costa Rica produces over 95% of its electricity from renewable sources (see Table 4.3). The nation has set the goal of obtaining 100% of its electricity from these sources by the year 2021 (Plan de Gobierno: Oscar Arias Sánchez, 2005). While seemingly very close to achieving this goal, several elements combine to make this a difficult challenge. First, as noted, Costa Rica's consumption of electricity is growing quickly, at an annual rate of more than 5%, and renewable energy sources typically require greater planning and investment than those based on fossil fuels (Interview 6, Costa Rica 2006). Second, political opposition to the construction of large-scale hydroelectric dams<sup>29</sup>, combined with growth in demand, will make it difficult for Costa Rica to maintain its historically high proportion of energy produced through hydropower. Third, an unusually dry year would force the country to seek a reliable short term alternative - available on demand - in order to avoid energy shortages. At present, thermal energy, based on the burning of fossil fuels, is the only viable alternative. Fourth, geothermal energy, a very promising source of renewable energy in Costa Rica, is difficult to exploit because the most accessible geothermal sites are located within National Parks, and its further exploitation could require either an unpopular change in law or more costly drilling techniques to access geothermal energy from sites outside park borders. Finally, the impact of the impending integration of the Central American electricity market may affect production and consumption in ways that dilute Costa Rica's high reliance on renewable energy, as its neighbours rely much more heavily on thermal energy sources.

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<sup>29</sup> Opposition to hydroelectric projects has come from environmentalists, from rafters and tour operators, and from indigenous groups whose lands would be flooded by the projects.

Table 4.3 Energy production by source

Sources	Share
Hydro	80.78%
Thermal	0.83%
Geothermal	14.98%
Wind	3.19%
Biomass	0.22%

Source: [www.grupoice.com](http://www.grupoice.com).

### Wind Energy

In this context, wind energy is increasingly viewed an important contributor to Costa Rica's energy portfolio. Costa Rica has very high wind power potential, and fortuitously, the time of greatest and most constant winds is during the dry season (December through May), when hydroelectric potential is at its lowest. Thus, complementarities exist between these two renewable sources of energy. Because wind is both seasonal and variable, it cannot serve as the principal source of energy for the country. However, wind power can avoid tapping into the hydroelectric potential stored as water behind dams, which can therefore be reserved for periods of peak use.

A technical study commissioned by the Dutch Government has shown that wind power has the potential to meet up to 15% of the nation's power needs (Pierik *et al.*, 2003). Presently, it provides roughly 3% of the country's electricity (See Table 5.1).

### Key characteristics of the Tejona case

While this case study focuses on Tejona, it also makes frequent references to the nearby privately developed wind power plants, as these give a valuable point of reference for comparing the impacts of Tejona on the region that they share. Given that these plants did not receive AIJ/CDM funding, this perspective is also helpful in evaluating the extent to which this mechanism promotes the dissemination of wind power technology in Costa Rica. Another important characteristic of Tejona is the length and complexity of the process that led to its implementation. This process, which has been ongoing for over 20 years, has involved a large number of institutions and individuals, and the creation of a complicated institutional framework for the project.

### The case study

Costa Rica is a small and open country, accustomed to being the object of research by investigators interested in the topic of sustainable development. Thus, it is fairly easy to access persons involved in these projects, from both the public and private sector. Therefore, wherever possible, the principal approach of the research team has been stakeholder analysis. Interviews have been conducted with those persons most directly involved in - or affected by - the Tejona project, including officials of ICE, private developers of wind power plants, international actors involved in the development of Tejona, and representatives of the nearby communities. In addition to their personal insights, these persons provided access to many primary project documents. These sources were supplemented by analysis of published documents and information provided by the Dutch government.

The Tejona case study is structured to analyze in what ways and to what degree the project contributes to the sustainable development of Costa Rica and the region where the project is located. However, because Tejona was not originally developed as a CDM project under the Kyoto Protocol, original project documents make little direct reference to the topic of sustainable development, and contain no specific criteria or baseline in this respect against which to measure progress. As one of the principal promoters of the project stated, “at that time we thought that sustainable development was a yes or no question, and took it for granted that a wind power plant contributed positively to the sustainable development of the country” (Interview 5, Costa Rica 2006).

This case study looks first at the historical evolution of the project, within the context of the development of renewable energy and, specifically, of wind power in Costa Rica. The study also outlines private wind power initiatives as a counterpoint to the publicly implemented Tejona project. It then analyzes the contribution of Tejona to the nation’s sustainable development, using a series of criteria developed by the larger research project as a framework for comparing the impacts of renewable energy AIJ/CDM projects on the sustainable development of each participating country. The study then follows the progress of the project from its original status as an AIJ pilot project, towards its validation and pending registration as a CDM project under the Kyoto Protocol. Finally, the case study concludes with a summary of the achievements and shortfalls of the project, and attempts to draw lessons from the experience for proponents of the development of future CDM projects in Costa Rica and elsewhere.

## 4.2 Evolution of the project

### How the idea was born?

In the 1980’s, ICE began studies to identify the potential of wind power in Costa Rica. These initial studies took place at Tejona, near Tilarán, in the north-western part of the country, an area known for its strong and steady winds. The region was familiar to ICE, which had just completed work on the Arenal hydroelectric complex. Sixty square kilometres were inundated, creating Costa Rica’s largest lake (Tejona is situated on a ridge overlooking Lake Arenal). During the process, about 500 families were displaced. Although ICE indemnified landowners and built new houses for many, whether or not ICE did enough for those displaced, or even whether it complied with the promises it made, is still being debated locally (Interview 11, Costa Rica, 2006).

### *Initial Assessments*

The wind resource studies undertaken by ICE were meant to explore the potential of wind power to serve as a complement to hydropower, on which Costa Rica’s electric power system is based. Because at this time, the early 1980s, ICE had no experience in developing wind power or other alternative sources of energy, it sought third party assistance to conduct these studies and, eventually, to implement and finance the project.

In 1992, the Government of Costa Rica, at the initiative of ICE, submitted a proposal to the Global Environment Facility (GEF) for the creation of a trust fund to develop a wind power plant. That same year, the United States Agency for International Development, financed a viability study of the proposed project. On the basis of this proposal and the

results of the viability study, GEF approved a grant of USD3.3 million to be invested in a 20 MW wind power plant (Global Environment Facility, 1994). In May 1993, the Inter-American Development Bank, the executing agency for the GEF grant, hired an independent contractor, Lynette & Associates, to supplement and complete the viability study. This study entered into greater depth regarding cost of the project, and stressed the need for technical, economic, and environmental support. At this time, the Tejona plant was projected to cost USD30 million over 20 years (Global Environment Facility, 1994).

Over the preceding decades the Costa Rican government had acquired one of the highest levels of debt per capita in Latin America. As a result, the country was subject to strict spending restrictions imposed by the International Monetary Fund as a condition for further financing. Consequently, when ICE sought the permission of the Ministry of the Treasury (*Ministerio de Hacienda*) to obtain a loan to help fund the Tejona plant, the request was denied, even though the GEF grant was pending. After this, the project was temporarily shelved while ICE sought alternative sources of funding (Interview 6, Costa Rica, 2006).

#### *The development of private wind power projects*

Meanwhile, ICE was having difficulty meeting the rapidly growing electricity needs of the country, primarily as a result of the restrictive spending policies. In response, and also as a part of an incipient trend towards the liberalisation of the Costa Rican economy, the government passed a new law in 1990, which created the possibility for private companies to build and operate power plants and sell their electricity to ICE. However, to avoid private domination of electricity generation - which ICE had been created to overcome - the law restricted private plants to an individual capacity of 20 Megawatts and private operators to a total of 15% of the power generated in the country. Companies building these plants are required to be at least 35% Costa Rican-owned (Law No. 7200, 1990). In addition, as a practical matter, these plants can be built only in response to a bidding process initiated and controlled by ICE.

As a result of this limited but very important opening to private initiatives, a number of small hydroelectric power plants were constructed. In addition, the first commercial wind power plants in Costa Rica (and indeed, in all of Latin America) were made operational. Although the ICE Tejona project was conceived as the pioneering wind power project for Costa Rica, it was actually only the fourth such project to be built.

The true pioneer in this respect was Kennetech, a US wind power company that took advantage of the change in law to promote a private wind power plant in Costa Rica, having negotiated what it considered to be a favourable power purchase agreement with ICE in 1994. Although Kennetech went bankrupt before the plant could be built, among its assets were the wind turbines for its Costa Rica plant - already in the country - and its contract with ICE. Kennetech's Costa Rica project manager was able to find investors willing to buy the equipment from Kennetech's liquidators and proceed with the construction of the 20 MW plant, which was completed in 1996. The new owner of the original Kennetech plant (now called *Plantas Eolicas*), is Mesoamerica Energy, a consortium of Central American investors with a strong interest in renewable energy (Interview 7, Costa Rica, 2006).



Two other private plants were also built in the same area soon after. These were a 20 MW plant built by the company MOVASA, with the participation of Italian capital, and a 6.75 MW plant built by Aeroenergia, S.A., with U.S. and European backing. The Aeroenergia plant began operation in the year 1998, and MOVASA in 1999.

### Justification and purpose of the project

Because of the ever-present need to produce more energy, and in light of the pending grant of \$3.3 million from the GEF, ICE continued to look for ways to finance its own wind power project at Tejona. Furthermore, the private plants already in operation were proving to ICE that wind power was more productive and reliable than anticipated, complementary to hydropower, economically viable (although more expensive than hydropower), and technically compatible with ICE's power system. Several wind power companies approached ICE with packages for developing Tejona, each of which would minimize ICE's initial cash outlay. In 1997, the ICE Board of Directors agreed to move ahead with the project, provided that additional grant money was brought in. ICE's primary concern in seeking financial assistance was to bridge what it perceived as the cost difference in producing wind energy as opposed to hydropower (Interview 6, 2006).

### Project organisation

In 1999, ICE opened a bidding process for Tejona. The tender contained two basic criteria for selection: 1) lowest price, and 2) a grant. ICE received five bids, all from international firms.

The winning bid was placed by EDON NV, a Dutch energy firm (which soon after changed its name to ESSENT ENERGIE BV). EDON/ESSENT offered a lower price than the competitors, and furthermore brought an offer of a grant of approximately \$4.2 million from the Dutch government. This grant was made as part of the Netherlands' AIJ pilot project.

Specifically, the ESSENT bid consisted of the following:

- 5 MW, equivalent to 8 wind turbines, to be purchased outright by ICE for the sum of USD 6,532,498.
- 15MW, or 22 turbines, to be leased by ICE for a period of 5 years through 20 payments of USD 636,056 each, with a purchase option at the end of the 5-year term for the amount of USD 3,015,382.
- An "all in" maintenance and operation contract for 5 years, for a fixed price of USD 434,045 per year.
- A donation of USD 4.2 million from the Dutch government's Pilot Project Programme on Joint Implementation (PPP-JI), pursuant to the UNFCCC. This donation brought certain obligations to bear on ICE, such as:
  - The development of an on-site demonstration park on renewable energy for plant visitors.
  - Training for technicians in renewable energy at the *Instituto Tecnológico de Costa Rica*, directed at both ICE staff and members of the community at large.
  - Studies to determine the potential contribution of wind energy in Costa Rica (market penetration study).

A more detailed summary of all actors involved is provided in Box 4.1.

*Box 4.1 Principal Actors Involved in the Tejona Project*

***Instituto Costarricense de Electricidad (ICE)***

ICE is Costa Rica's publicly owned electricity and telecommunications utility. ICE initiated the Tejona project, and is presently supervising the operation of the plant by ESSENT (see below). ICE owns eight of the thirty turbines that comprise the Tejona project outright, and is leasing the rest from Vestas. ICE will assume full ownership of the plant at the end of 2006, and full responsibility for its operation in the second semester of 2007.

***Essent Duurzaam Energie (ESSENT)***

ESSENT is a private Dutch power company, which won the bidding process held by ICE to implement and administer the Tejona Project for the first five years of its operation (until 2006). ESSENT also facilitated the participation of the Dutch government's Joint Implementation Pilot Program, which provided a grant of \$4.2 million for the project.

***Vestas Internacional Wind Technology (VESTAS)***

VESTAS is the Danish manufacturer of the wind turbines utilized in the Tejona plant. VESTAS holds a contract with ICE for the maintenance of the turbines.

***NORDTECO, S.A.***

NORDTECO is a private Costa Rican company that serves as the local representative of ESSENT and VESTAS. NORTECO played a key role in the negotiations leading to the implementation of the project as well as in support of ESSENT and VESTAS since the project began operation in 2001.

***Oficina Costarricense de Implementación Conjunta (OCIC)***

OCIC is the governmental office that serves as the Designated National Authority for the Clean Development Mechanism (CDM) in Costa Rican Rica. OCIC also played an important role in obtaining the Dutch grant for Tejona, and is a crucial actor in obtaining CDM status for Tejona. OCIC is also developing guidelines to evaluate the contribution of CDM projects to Costa Rica's sustainable development.

***Global Environmental Facility (GEF)***

GEF provided a grant of \$3.3 million towards the implementation of the Tejona Project. The GEF grant predated the support of the Dutch government, and was crucial in ICE's decision to proceed with the project. The implementing agency for the GEF grant was the InterAmerican Development Bank.

***Plantas Eolicas S.R.L., MOVASA S.A., and Aeroenergia, S.A.***

These are the three private wind power plants that operate in Costa Rica, all in the immediate vicinity of Tejona. All were in service before Tejona became operational in 2002. *Plantas Eolicas* and MOVASA have structured programmes to support community development in the Tilarán area.

***Municipality of Tilarán***

The Municipality of Tilarán is the local government for the region which includes Tejona.

***Dutch Ministry of Foreign Affairs / Directorate General for International Cooperation***

The project has been supported by a grant of the Dutch Ministry of Foreign Affairs, Department of International Co-operation (DGIS) of USD 4.2 million. The grant was made for the initial purchase of 8 MW turbines. Additionally, several provisions regarding capacity building and technology transfer were made.

***Netherlands Ministry of Housing, Spatial Planning , and Environment (VROM)***

Is currently negotiating the distribution of rights to the CERs produced by the project with ICE and ESSENT.

A framework contract between ICE and ESSENT was signed in April 2000, with two parallel contracts – 1) a leasing contract for the turbines, and 2) a contract for their maintenance and operation –also signed between these parties. ESSENT then entered into subcontracts with VESTAS A/S, for the provision, operation and maintenance of the turbines, and with the Energy Research Centre of the Netherlands (ECN) for technical support and to provide training in wind energy to Costa Rican technicians. NORDTECO, a Costa Rican company, was hired to serve as a local contact and facilitator for ESSENT, VESTAS, and ECN (Van Hulle *et al.*, 2000).

The structuring of the deal as a Build-Operate-Lease (BOL) contract, with transfer of complete ownership and operation to ICE after the first five years of operation, was considered to be ideal given the country's high level of debt (and consequent inability to finance new energy plants) and ICE's initial lack of experience in building and operating wind power plants.

### Project approval

Tejona, throughout its long period of gestation, has been subject to approval by different entities at different stages. Following are the most significant of these instances:

- In 1992, the Global Environment Facility, on the basis of a proposal presented by the government of Costa Rica, approved a grant of approximately USD 3.3 million towards the realization of the project (Global Environmental Facility, 1994).
- In 1997, on the basis of the GEF grant, the ICE Board of Directors approved moving ahead with the project. However, at this time, additional funds needed to move ahead were not available to the institution (Interview 6, Costa Rica 2006).
- In 1999, the project's initial environmental impact statement was approved by the Costa Rican Ministry of Natural Resources, Energy and Mines (Van Hulle *et al.*, 2002).
- In 1999, ICE opened a bidding process for Tejona. The bid submitted by the Dutch firm EDON NV (later ESSENT), included an offer from the Dutch government for a grant of USD4.3 million, as part of its AIJ Pilot Project Programme (Van Hulle *et al.*, 2000)
- In 2000, the framework contract for the realization of Tejona was signed between ICE and ESSENT, and the Netherlands Directorate for International Cooperation formally approved the grant (Van Roekel and Borchgrevink, 2004).

### Current status of the project

Presently, Tejona is in its fourth year of operation, and, as originally agreed to in the agreement between ICE and ESSENT, ICE will buy the remaining machinery of Tejona outright at the end of 2006 for a lump sum of \$3.1 million, and assume full responsibility for the operation and maintenance of the plant in July of 2007. The ICE Board of Directors gave its final approval for the purchase in August of this year. The assumption of the operation of the plant by ICE will be a determinative test of the effectiveness of the training and capacity-building elements of the project, as ICE has no plans to enter into a new contract for this function with a third party, but will assume it directly (Communication 1, Costa Rica, 2006)

Tejona has faced some serious technical problems with its turbines, as well as evident shortfalls in maintenance, which have led to a reduction in its effectiveness. According to ICE's manager of the Tejona plant, the uneven topography of the zone creates a high level of turbulence, which the turbines were not designed to accommodate. This turbulence has damaged the bearings and gears of the turbines, causing a significant amount of down-time for the machines, reducing their output (Interview 14, Costa Rica, 2006). Only very recently has VESTAS agreed to resolve these problems with the turbines, before their operation is transferred to ICE. In addition, the blades, nacelles and towers of the Tejona turbines are noticeably dirty, clearly not receiving the care of those of the neighbouring plants. This circumstance can also reduce the output of the plant (Interview 16, Costa Rica, 2006).

Both the mechanical problems as well as maintenance shortfalls are, according to both the ICE plant manager and a representative of NORDECO, the result of lack of clarity in the assignment of responsibility during the negotiation of the operation and maintenance contract. According to these sources, this was largely a result of inexperience on the part of ICE in negotiating wind power contracts (Interview 5, Costa Rica, 2006).

### **4.3 Contribution to sustainable development**

#### **Sustainable development in project documents**

The Dutch grant towards Tejona was part of the AIJ Pilot Project Programme of the Dutch government, given with the intention of obtaining experience for projects aimed at certified greenhouse gas emissions reductions under the Clean Development Mechanism of the Kyoto Protocol. An important consideration in these negotiations, brought to the table by the developing nations, was to ensure that these projects not only contribute to meeting the emissions reduction obligations of the nation funding the initiative, but also contribute to the sustainable development of the host nation (see Chapter 2). In these cases, "sustainable development" is to be defined by the host country (UNFCCC, 2001).

At the time of the Dutch grant towards Tejona, no official national criteria were in place to help determine whether the project would, in fact, contribute to sustainable development, nor was there mention of the issue in the project documents in other than very general terms. Therefore, there was no explicit pre-existing baseline against which to measure progress or success in this regard. However, the Dutch grant did contain funding for certain activities that could be considered to be contributions to sustainable development above and beyond the construction of the plant, such as building capacity, the transfer of technology, and environmental education (BEMO, 2000).

#### **Host government criteria**

The Costa Rican Office for Joint Implementation (OCIC), which was very involved in securing Dutch government support for Tejona, has since been named the Designated National Authority (DNA) for Costa Rica in questions related to the CDM. OCIC is presently working to develop guidelines for evaluating the contribution of CDM projects to the nation's sustainable development, based on similar guidelines developed by other organisations (IUCN, World Bank) and other countries (Bolivia, Colombia), which it is adapting for Costa Rica. These guidelines, when completed, will be considered in the

nomination and validation of projects implemented in Costa Rica for CDM status, and will address the impact of the proposed project in light of environmental, social, economic, and legal criteria and indicators. OCIC, which has little staffing or resources, has proposed forming an expert committee to review proposed CDM projects in light of these guidelines, with the costs of the review paid by the project promoter (Interview 19, Costa Rica, 2006).

### Social aspects

The section below evaluates the project's contribution to sustainable development based on the methodology presented in Chapter 3.

#### *Poverty alleviation and distributional equity*

Tejona does not share revenues with local communities. As a project implemented by a governmental agency, any earnings generated by the plant are not separated and identified as such, but in a sense are shared with the nation's population at large. With regards to local communities however, contributions to community development in the surrounding areas were not included in the project design beyond those socially directed activities included in the grant agreement with the Dutch government (limited to training and the demonstration project on renewable energy). Besides this, Tejona has little contact with local communities and makes little investment in their welfare. On this point, ICE representatives explained that as a government institution, ICE is strictly supervised by the National Comptroller's Office (*Contraloría General de la República*), and cannot make expenditures that are not strictly justified as a direct cost of the project, or that are not clearly supported by the original project design documents and contracts (Interview 2, Costa Rica, 2006).

By contrast, two of the private plants operating in the area, *Plantas Eolicas* and MOVASA, have structured programmes to contribute to community development, and devote a portion of their annual operating budgets to this end. *Plantas Eolicas* is the most active of the projects in this respect (Interviews 8, 9, 12, Costa Rica, 2006).

#### *Access to essential services*

The area surrounding Tilarán is typical of many rural areas in Costa Rica that are well-integrated into the national economy, with fair-to-very good access to basic services, including electricity, water, telephones, transportation, education, etc., depending on the exact location. In general, this access predates or is unrelated to the presence of the Tejona project. However, ICE's considerable presence in the zone has doubtless contributed to an important degree to improvements in the basic infrastructure of the region.

The project has positively affected the availability of basic services mainly to the extent that access roads to Tejona, which also reach nearby communities and homes, were improved and receive some maintenance from the plant. However, dissatisfaction exists in these communities regarding the frequency of this maintenance (Interviews 1, 11, Costa Rica, 2006).

The private plants have made important contributions to local communities, particularly in the area of education. Rural schools in Costa Rica often have serious deficiencies in buildings, materials, and availability of lunches for students. *Plantas Eolicas* in particular has made this a focus of its local support program. (Interview 9, Costa Rica, 2006).

#### *Access to affordable clean energy services*

The project is connected to the nationwide electricity grid, so it is impossible to determine the extent to which the electricity generated by Tejona is used locally. ICE provides electricity to 97% of the Costa Rican population; only those communities or homes that are in very distant and isolated areas do not have access to electricity. Even in these cases, the Costa Rican government is attempting to provide off-grid energy sources for this portion of the population (micro-hydroelectric power plants or photovoltaic solar panels) through a project with the GEF (Interview 4, Costa Rica, 2006).

#### *Employment (job quality)*

The impact of Tejona and the other wind power plants in the area on local employment are limited by the nature of the operations. Most local jobs created by Tejona and the other plants were temporary, limited to the period of plant construction, and to short-term and seasonal maintenance tasks such as the cleaning of the turbines, towers, and blades. Wind power plants require relatively little human labour for their day-to day operation once they are installed and operating (Interview 9, 14, Costa Rica, 2006). This being the case, it is noted that the private plant operated by *Plantas Eolicas* - the first plant installed - is much more labour intensive, as the wind turbines are of an earlier vintage and require constant maintenance and repair. In addition, because each machine produces less energy than newer models, there are many more of them – 57 turbines versus 30 for Tejona. The private plants enjoy larger freedom in hiring workers from the surrounding communities than ICE, which as a large institution has established policies favouring the employment of workers from within the organisation, regardless of their place of origin. VESTAS, which holds the operation and maintenance subcontract for Tejona, also hires workers directly.

Salaries paid by ICE and the private plants are standard or higher for local conditions. (Communication 1, Costa Rica, 2006).

#### *Empowerment*

ICE claims that the inclusion of communities in project benefits and decision-making is a very high priority for the institution, although it admits that it has come to this position recently, and mostly as the result of having faced strong local opposition to several important energy projects. According to an ICE representative, a structured and highly participatory process now exists to include local communities in planning and decision-making whenever ICE builds a new project, and a formal written policy in this regard is in the process of being developed (Interview 2, Costa Rica, 2006).

In the specific case of Tejona, the dialogue with local communities in the area, if it in fact existed in any meaningful way, was as ICE admits, relatively informal and poorly documented, and there appears to be no clear record of what ICE agreed or did not agree

to do for the community. In fact, Tejona was cited by ICE as a learning experience upon which, combined with other such experiences, it is building a better policy of community relations (Interview 2, Costa Rica, 2006).

### *Gender Equality*

The issue of gender is of less relevance in the Tejona case, because Tejona and the other wind power plants are not developed or implemented by the community, since the project does not by itself make energy more or less accessible in local homes, and since local employment opportunities in the project are very limited (Communication 1, Costa Rica, 2006). Nevertheless, it is worth mentioning that at Tejona, the sole woman employee works as a janitor, while at *Plantas Eolicas*, two women employees work as the plant manager and as the head of procurement, respectively.

### *Capacity Building/Education*

The educational opportunities offered by Tejona have been significant. As part of the Dutch grant, a Renewable Energy Technician Training Programme was implemented with the Costa Rica Institute of Technology (ITCR), which trained personnel of ICE and the other wind power projects in the operation and maintenance of wind power plants, including residents of Tilarán and surrounding communities. A total of 38 persons participated, including some faculty from the ITCR School of Electromechanical Engineering. Participants were graduated as technicians in wind power (Van Roekel, Borchgrevink, 2004).

In addition, a wind energy course was organized, which according to the final project report, “provid[ed] individualized wind energy training to ICE personnel involved with the [Tejona] project, as well as interested participants from other Costa Rican wind power plants, utilities, cooperatives, and municipal public services companies. Training was provided by ECN staff locally in Costa Rica; and at ECN in Petten, the Netherlands, where two members of the ICE staff participated in the annual, two week Implementation of Wind Energy Training Programme.” Approximately 35 persons participated in the course. Also included in the Dutch grant was funding for a renewable energy demonstration project on the Tejona grounds, where ICE staff give talks to visitors, mainly students from throughout the country (Roekel, Borchgrevink, 2004).

It is important to mention that the private wind power plants have also invested in training Costa Ricans in this technology. For example, *Plantas Eolicas* has sent 8 employees to the United States or Europe for formal training (Communication 2, Costa Rica, 2006).

### *Preservation of cultural and or/natural heritage*

Because the local economies of the area in which Tejona and other wind power plants are located are heavily dependent on tourism ((Estado de la Nación, 1998)<sup>30</sup> - based

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<sup>30</sup> According to a survey undertaken of visitors to Costa Rica by the Costa Rican Tourism Institute, during the high season of 1997, 36,4% of those interviewed stated that they had visited the Arenal-San Carlos area, making this the third most visited area of the country. During the low season, the Arenal area was the second most visited area of the country.

largely on the natural beauty of the region - the visual impact of the turbines on the landscape is a very important issue. While no formal survey of the impact of these in the eyes of tourists exists, the project team found little evidence that the turbines negatively affect the tourist industry. In fact, most people interviewed thought that the wind turbines were an attractive component of the landscape, demonstrating Costa Rica's commitment to the environment, and they are clearly a source of local pride. In a few instances, local tour operators have taken interested tourists on visits to the plants. However, mention was made that if a great many turbines were installed in the region, the visual impact could be negative and significant (Interviews 1, 8, 11, 17, Costa Rica, 2006). Whether tourists also see it the way the locals do, is something we were unable to investigate.

## Environmental aspects

### *Resource use*

The smaller-scale wind power plants operating in Costa Rica, including Tejona, have little direct impact on their surroundings once the construction phase is over, and virtually no impact other than through the construction of access roads and the placement of turbine and transmission towers (the lands on which these were built were being used as cattle pastures, deforested many years before, and this activity continues on surrounding lands). In fact, considering that the generation of electricity through wind power to some degree mitigates the need to burn fossil fuels or to build hydroelectric dams (with their potentially very significant impact on water, soils, forests, and biodiversity), wind power plants such as Tejona could be said to reduce pressure on surrounding natural resources to an important degree (Van Hulle *et al.*, 2002).

### *Noise / odour pollution and health*

The turbines do not affect the health of the local population. Although there was some initial concern among communities regarding potential noise levels before the plants were built, interviews revealed that this issue is now of negligible concern to local residents, even those living closest to the turbines (Interview 1, Costa Rica, 2006), possibly because the area surrounding the plants is sparsely populated.

A greater concern is posed by the fact that construction, maintenance and cleaning of the wind turbines, a task which local residents are often hired to undertake, is potentially dangerous due to the heights and adverse weather conditions to which workers are exposed. Tejona has reported two minor injuries to date (Communication 1, CR, 2006).

### *Air and water quality*

Tejona and the other wind power projects have no significant impact on air or water quality. The Tejona project has drilled a well to meet its water needs, which are not extensive.

### *Land quality and land use changes*

The impact of Tejona and the other wind power plants on land and soil quality are also minimal. The installation of the wind turbines required the construction of cement bases and access roads, which represent minimal impacts on the land. The Tejona



Environmental Impact Study analyzed soil types for the area and found little risk of erosion or problems with drainage (Van Hulle et al., 2002).

The impact on land uses is likewise minimal, as these lands were deforested and being used for cattle pasture long before the wind plants were built. Because of the constant and high winds, as well as soil types, these lands are not well suited for agriculture or ranching, or for home sites. In fact, from a socio-economic point of view, the wind plants are probably among the most effective conceivable land uses for these sites. Although land prices in the area have risen significantly since the wind farms were built, this is almost certainly attributable more to the boom in tourism and land investment by foreigners in the area surrounding Lake Arenal than to the presence of the plants.

#### *Waste management*

The principal wastes produced by Tejona are oils and greases used for the lubrication of the turbines, which are collected and sent to *La Colima*, a thermal energy plant operated by ICE, where they are burned. While VESTAS, under the maintenance and operation contract, is presently responsible for disposal of these wastes, this responsibility will be assumed directly by ICE in 2007. ICE is presently preparing a waste management plan for the plant (Communication 1, Costa Rica, 2006).

#### *Biodiversity quality*

The impacts of the project on biodiversity are likewise minimal. Like virtually all of Costa Rica, the area surrounding Tilarán was originally forest, with a very high diversity of species of flora and fauna. The process of colonization and the establishment of cattle ranches resulted in the deforestation of most of the region, including the sites of the wind farms, and the Arenal hydroelectric project flooded a large area. Thus, much damage to biodiversity had already been done before Tejona and the other plants were built, and in comparison, the impact of these on biodiversity is extremely small, limited to the deaths of a small number of birds through impacts with blades or and towers of the turbines or with transmission lines. Several migratory bird species are present, but according to the Tejona project's Environmental Impact Study, these fly at high altitudes and are not significantly affected by the plants (Van Hulle *et al.*, 2002). The project has not resulted in the introduction or spread of invasive species.

#### *Reduction in GHGs*

The original project documents assert that Tejona would avoid the emission of 40,000 metric tonnes of greenhouse gases per year for a period of 20 years by displacing energy that would otherwise have been produced by thermal power plants. A monitoring report submitted to the Dutch government by the consulting firm KEMA found that carbon emissions offset by Tejona were actually greater than projected for the first two years of its operation due to two factors: first, the generation of electricity was higher than expected, and second, the original projections did not anticipate the degree to which wind energy complemented the use of hydropower, enabling the saving of stored water for peak use. Although the Tejona plant has faced technical difficulties that have lessened its output since 2003, the balance in this regard is still positive (Van der Wekken and Vosbeek, 2004).

## Economic aspects

### *Return on investment*

Because Tejona was implemented by a public agency, the profitability of the project was not an issue, although its cost-effectiveness certainly was. In this regard, ICE determined that the construction of Tejona would not be cost-effective unless it produced an internal rate of return (IRR) of at least 12%, which corresponded roughly to the prevailing rate of inflation. An IRR of less than 12% would represent a loss for ICE on its investment. ICE calculated that Tejona would have an IRR of 9%, which led to its determination that it would not build the plant unless it received a donation to close this gap. According to the project design document for CDM status for Tejona, the Dutch donation, combined with the GEF grant, had the effect of raising the IRR of the project from 9% to over 12%. Also figuring strongly into the decision of ICE to not commit to wind power without a donation were ICE's higher calculations of IRR for hydroelectric projects (Bakema *et al.*, 2000).

While in some cases ICE evaluates and, if necessary, revises its initial estimates of IRR once the project has been in operation for a number of years, this has not been done in the case of Tejona (Communication 4, Costa Rica, 2006).

The presence of private wind power plants operating in Costa Rica without the benefit of donations begs the question as to whether the GEF and the Dutch donations to Tejona - and indeed, whether Tejona itself - was strictly necessary for the promotion and establishment of wind power in Costa Rica, and thus, whether such grants to promote wind power within the AIJ/CDM framework would be justified in the future. ICE planners believe that the institution (through inexperience) probably agreed to pay more than it should have for energy produced by the private wind power plants (Interview 6, Costa Rica, 2006), while the private producers, on the other hand, believe that ICE is underestimating the cost of generating electricity in today's economic and political environment (Interview 13, Costa Rica, 2006). The question is thus framed for further exploration.

### *Employment*

According to project documents, the period of highest employment was during the construction phase of the project, when up to 200 workers were employed. Of these, 75% were from Tilarán, and another 16% were from the surrounding province of Guanacaste (UNFCCC - CDM Executive Board, 2004).

As noted, the Tejona project does not contribute significantly to the creation of permanent employment. At present, ICE has 5 permanent workers at the plant, while VESTAS supports between 4 or 5 more. Four of the five ICE workers are from the Tilarán area. When the operation of the plant passes entirely into the hands of ICE, it presently plans to employ a total work force of 18 permanent workers for the plant. However, in contracting these new workers, ICE is obligated to follow its established hiring procedures, which favour hiring workers from within the organisation, without regard to their place of origin. If vacancies are not filled internally, the ICE will consider filling the positions locally (Interview 14, Costa Rica, 2006).

By way of comparison, *Plantas Eolicas* has a total of 23 permanent employees, 20 of whom are from the area of Tilarán (Communication 2, Costa Rica, 2006).

#### *Impact on economic activity in the area*

The level of local purchases and local employment are limited by the nature of the project, which utilizes relatively little in the way of local resources and labour. Regarding the contribution of Tejona to the finances of local government, the Tejona plant, as a project of a government agency, is exempt from paying both income tax (which is paid to the national treasury), or from property taxes (which are paid to the local municipality). ICE is also exempt from paying municipal patents or operating permits, which are required for undertaking economic activities. In short, as was pointed out - with some resentment - by local officials, Tejona and ICE pay no taxes, and do not contribute in other ways to the municipal treasury. The private plants, on the other hand, pay income tax, property tax, and municipal patents (Interviews 8,9,11, Costa Rica, 2006).

#### *Attraction of green investments*

Costa Rica has a strong worldwide reputation for promoting conservation and sustainable development, and as a result, has received a considerable amount of investment in environmentally friendly activities, particularly in the tourism sector. Costa Rica's high reliance on renewable and non-polluting sources of energy has helped build this perception, and this element is now receiving increasing attention. Therefore, it could be assumed that the implementation of clean, high-tech energy projects such as Tejona will only strengthen this reputation and its resultant or related benefits.

#### *Impact on balance of payments*

Because Costa Rica imports all of the petroleum products that it uses, the reduction in their use is clearly the greatest benefit of wind power regarding the nation's balance of payments. In fact, the CDM PDD in 2004 estimated the benefits of the value of the avoided cost of thermal energy produced by Tejona at approximately USD13.9 million over the 20-year life of the plant, based on the lower cost of oil at that time. According to OPEC, average oil price in 2004 was 36.05 \$/barrel. In 2006 this was 61.99 \$/barrel (OPEC 2006). This makes present savings USD23 million, based on this high oil price. To this could be added the approximately USD7.5 million in donations for the plant contributed by the GEF and the Dutch government (UNFCCC - CDM Executive Board, 2004). The value of the equipment imported to implement the project was approximately USD 22.2 million.

#### *Technology transfer, demonstration effect, and replication potential*

Both Tejona and the private plants are contributing to the adoption of new, up-to date, and environmentally friendly technology in Costa Rica, and the investment in training that the plants have made is maintaining the capacity in the country to operate these plants.

Tejona and the private plants have clearly demonstrated that they are technically viable and easily replicable. ICE's expansion plan for the period 2006-2010 provides for the

development of a 50MW wind power plant, to be built and operated privately, and transferred entirely to ICE after a period of 20 years. A bidding process for the implementation of this project has been undertaken, and the winning bid approved by the ICE board. The project is slated for construction in 2008 (Communication 3, Costa Rica, 2006). In addition, the Compañía Nacional de Fuerza y Luz (CNFL), is beginning development of an 18 MW wind power project near the capital city of San Jose. Together, these two projects will double the existing wind power capacity in the country (La Nación, 2006).

#### *Design and operational efficiency*

According to the CDM PDD, Tejona utilizes the best available technology: “The [project] consists of 30 wind turbines, with a capacity of 660 kW each, type Vestas V47. The total capacity of [Tejona] mounts up to 19.8 MW. The wind turbine complies with the “Class 0 Certificates”, which means that the turbine itself satisfies the demands of the wind regime of the zone, to the best extent possible. Besides the normal environmental conditions, the design of the wind turbines and the wind farm takes into account the high average wind speeds, the slightly increased level of acidity, and the risk of earthquakes”(UNFCCC - CDM Executive Board, 2004). However, as discussed above (section 4.2.4), the project has faced serious technical problems and suffered lapses in maintenance that have reduced its efficiency.

#### **Synthesis**

The Tejona wind project clearly contributes positively to the sustainable development of Costa Rica, although this contribution is not as great as it could have been with improvements in the design and organisation of the project (see Table 4.4). Specifically, the project did not seriously address possibilities for contributing to the sustainable development of the region where it was implemented. Had the project considered local needs and incorporated local participation in its design, it could have had a greater important positive impact on nearby communities. The project has also had serious technical and maintenance shortfalls that can be attributed at least in part to lack of clarity in the assignment of responsibilities when the original contracts for the implementation of the project were negotiated. In the areas of community relations and technical efficiency, the private wind power plants have been more effective than Tejona.

As regards the environmental impacts of the project, the nature of the technology utilized has assured that these have been highly positive, due both to minimal adverse effects as well as very important positive impacts through the offset of greenhouse gases produced by thermal power plants, as well as the negative environmental and social impacts often presented by the construction of hydroelectric plants. The economic viability of the plants should be further explored.

Table 4.4 Sustainability scores for Tejona wind power project.

Criterion	Indicators	Score (-2 to +2)
<b>ENVIRONMENTAL SUSTAINABILITY</b>		
Air resources	Air quality	2
Water resources	Water quality	0
	Water quantity	0
	Water management	0
Land resources	Land quality	0
	Land-use change	0/1
	Land management	½
Other resources (_____)	Other resource (_____) quality	NA
	Other resource (_____) quantity	NA
	Other resource (_____) management	NA
Biodiversity & Ecosystems	Biodiversity quality	0
	Ecosystem functioning	0
Impact on climate change	Reduction in GHGs	2
<b>ECONOMIC SUSTAINABILITY</b>		
Financial viability	Return on investment	0
Effects on local/regional economy	Energy expenditure	0
	Employment (numbers)	0/1
	Impact on economic activity of area	1
	Attraction of green investments	1
Effects on National economy	Impact on balance of payments	0
	Economic growth	1
Technological sustainability	Technology transfer and self-reliance	1
	Demonstrational effect and replication potential	2
	Design and operational efficiency	0/1
<b>SOCIAL SUSTAINABILITY</b>		
Livelihoods of the poor	Poverty alleviation	0
	Distributional equity	0
	Access to essential services	0
	Access to affordable clean energy services	0/1
	Impacts on human health	0
Human Capacity	Employment (job quality)	1
	Empowerment	0
	Gender equality	0
	Local skills development / education	0/1
Human environment	Preservation cultural / natural heritage & aesthetics	0/-1
	Relocation of communities	NA

#### 4.4 Evolution to a CDM project

Originally, the funding from the Dutch government for Tejona was granted as an AIJ Pilot Project, not as a CDM project. This means that when the contribution was made the Netherlands received no official credits towards meeting its emissions reduction obligations under the UNFCCC. However, the intention of the parties involved was to design a project that would qualify for eventual certification in this sense. Because the nature of the project was not controversial, there was never much doubt that this would be achieved. Thus the evolution of Tejona from AIJ status towards a CDM project has been natural and straightforward, even though it has not yet been completed.

At the time of the grant agreement, the governments of the Netherlands and Costa Rica signed a Memorandum of Understanding stating that both countries would make “the best joint efforts to achieve CDM status” for the project, “once modalities and procedures for CDM, and its implications for AIJ pilot phase projects are elaborated” (MOU, 2001). More importantly, the Kyoto Protocol, also provided that AIJ projects started after the year 2000 could receive CDM status if certain conditions were met (Kyoto Protocol, 1998). Once this status is achieved, the developers or sponsors of such projects could receive credits for emissions reductions in the form of Certified Emissions Reductions (CERs), the unit established by the Kyoto Protocol for this purpose.

For the project to achieve CDM status, the project must meet conditions established in Article 12 of the Kyoto Protocol. First, as was discussed above, the project must contribute to the sustainable development of the host country, and second, it must contribute to the reduction in anthropogenic emissions of greenhouse gases. According to the Protocol, emissions reductions resulting from these projects must be certified by the Executive Board of the CDM on the basis of the following considerations:

- Voluntary participation approved by each Party involved;
- Real, measurable, and long-term benefits related to the mitigation of climate change;
- Reductions in emissions that are additional to any that would occur in the absence of the project activity.

In addition, such projects must have been validated and registered for the CDM by the end of 2005. The deadline for registration of these projects was later moved to December of 2006, provided that the projects were validated by the end of 2005. (Interview 14, Costa Rica, 2006).

According to OCIC, Tejona was validated as a CDM project in December of 2005 and is ready for registration. However, ICE and the Dutch Ministry of the Environment and Spatial Planning (VROM) have not reached agreement on the distribution of rights to the CERs produced by the project. Without this agreement, the Dutch government will not approve the project, and thus the first of the above conditions – voluntary participation approved by each party involved – will not be met. Once an agreement is reached, the CERs will be distributed between ICE, ESSENT, and VROM.

While Tejona has been validated as a CDM project, the presence of the private wind plants - which received no economic support - raises the question of whether, from a financial point of view, the project meets the third condition set forth above – that the reductions in emissions be additional to those that would occur in the absence of the project.

## **4.5 Inferences**

### **Successful aspects of the project**

In many ways, Tejona has been successful both as an AIJ/CDM project and, independent of the international legal and political context, as a step forward by Costa Rica towards meeting its own firm agenda of achieving a sustainable society. Some of these positive aspects are listed below:

- Because of **the nature of the project**, Tejona would probably successfully have met any eventual guidelines established by the government of Costa Rica for evaluating its contribution to the nation's sustainable development. As an OCIC representative told the project team, their proposed guidelines are of greatest importance and utility in evaluating, in his words, "hard cases," where the contribution of the proposed project to sustainable development is truly in doubt. Tejona, and most wind power projects in general, would probably be "easy cases" (Interview 19, Costa Rica, 2006).
- Tejona has been successful in **meeting greenhouse gas (GHG) reduction targets** set for the project. By displacing the need to burn fossil fuels to generate electricity, Tejona has reduced emissions of atmospheric contaminants such as carbon dioxide, sulphuric oxides, and nitrogen. According to project evaluation documents, Tejona is on target to achieve the emissions reduction goal of 800,000 metric tonnes of GHG set for the project over its projected life span of 20 years.
- The project has been **well-documented** in most areas, although many of the key documents have been prepared by organisations and persons with a close relationship to the project and an interest in its perceived success.
- Tejona is clearly **environmentally friendly**, having no adverse impact on its primary resource input, the wind, and few damaging outputs. In addition, the project, to an important extent, displaces the significant adverse impacts on natural resources caused by energy alternatives such as large-scale hydropower and thermal plants.
- The Project is a successful example of **technology transfer**. Tejona - together with the private wind power plants - has proven the compatibility of wind power with the national electric system, providing a commercial-scale precedent for a new renewable energy source in the country that can be easily replicated in other parts of Costa Rica and Latin America.
- The project has also successfully built capacity through **training and education**. Both Tejona and the private wind power plants have invested in formal training programmes to create wind power technicians. In the case of Tejona, this went beyond the training of its employees to offering training opportunities in wind energy to the broader public. Tejona also included the establishment of a Renewable Energy Demonstration Park to educate regarding these technologies in Costa Rica. As mentioned, the most important test of the success of capacity building will come with the assumption of the day-to-day operations of Tejona by ICE in 2007.

### Less successful aspects

Among the less successful aspects of the project are the following:

- Tejona has had **little positive local impact**, as the project did not consider this aspect in its design. Tejona has contributed little in the way of local employment, primarily because wind power plants are not labour-intensive, but also because ICE's institutional practices favour hiring persons from within the organisation rather than locally. Finally, as a public agency, ICE pays no taxes nor requires municipal patents for the operation of its plants; thus, Tejona contributes little to the finances of local government. Ironically, given that ICE was created to be more concerned with the nation's development than with profit, the private wind power plants in Tilarán have

a more positive image in the community and a demonstrably better record of contributing to local community development than Tejona. There has been little local participation in planning or the implementation of the project. ICE is seen by many in the local community as a faceless and inflexible bureaucracy, that takes much in the form of electric power produced by the region's resources, but returns little.

- The organisational structure of the project is **overly complex**, with unclear distribution of responsibilities. Most seriously, this has led to shortfalls in turbine maintenance, which has significantly affected the efficiency of the plant.
- The **existence of private wind power plants** in the country that received no financial assistance under the AIJ/CDM framework before Tejona became operational raises the question of whether the GEF and Dutch assistance to Tejona was strictly necessary to promote wind power in Costa Rica.

### Lessons learnt

The financial assistance that Tejona received carried with it an obligation to promote sustainable development, beyond that represented by the technology itself. As a project that aspires to CDM status, it should address the social and economic development of the country and region where it is located, as well as be environmentally sustainable. Tejona falls short primarily as regards its contribution to local development. Following are ways in which Tejona, and similar projects in the future, could perform better:

- **Consider contributions to local development in initial project planning.** As a public agency, ICE can only make expenditures on activities that are included and justified in project documents as an integral part of the project. In an organisation such as ICE, subject to strict controls on spending, it is very difficult to justify changes in budgets and priorities once the project is underway, however important and justified they may seem to project personnel.
- **Develop policies and procedures for public participation in project planning and implementation.** Identifying contributions to local development must be done in close cooperation with local communities if they are to be responsive and effective. Such policies and procedures should be written, and provide for the documentation of all meetings, negotiations and agreements. The policies should also provide for monitoring of agreements.
- **Design and implement a formal programme for community relations.** At least two of the private wind power plants have structured programmes of community relations, implemented by personnel based in the field. Donations in support of local development are well justified and well targeted, and results are closely monitored. Not only is such assistance efficient and effective, it is also greatly appreciated, and the companies benefit from very good local relations. One concrete benefit to the companies is high worker morale, particularly where workers are from the area.
- As the Designated National Authority for the CDM for Costa Rica, **OCIC should develop and publish guidelines for project developers** that clarify the expectations of the government of Costa Rica regarding the contributions that these projects should make in the area of social and economic development. In this way, project developers are on notice regarding the importance of this element from the beginning of the process.



- The other significant problem affecting Tejona has been mechanical problems and shortfalls in maintenance. These have been caused primarily by lack of clarity in the definition and distribution of responsibilities. Therefore, **projects should aim to simplify the organisational structure, and assure that contracts are very clear regarding responsibilities for the repair and maintenance of equipment.**

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## 5. Biogas programme for the animal husbandry sector (Vietnam)

*Pham Khanh Nam*<sup>31</sup>, *Luke Brander*<sup>32</sup>, *Tran Vo Hung Son*, *Phung Thanh Binh*<sup>33</sup>

### 5.1 Introduction

This chapter analyses the impacts on sustainable development of the biogas programme for the animal husbandry sector in Vietnam. The main objective of this project is to further develop the commercial and structural deployment of biogas in Vietnam, and at the same time reduce the use of fossil fuels and biomass resource depletion. The project provides a subsidy to livestock farmers to cover part of the cost of constructing small biogas plants on their farms, as well as administrative and technical support to constructors. The project has largely been funded by the Netherlands Government under its pilot Activities Implemented Jointly (AIJ) programme, and is implemented jointly by the Netherlands Development Organisation (SNV) and the Ministry of Agriculture and Rural Development of Vietnam.

### Background

Vietnam has a population of over 83.5 million people, of which 75% is located in rural areas. Administratively, the country is divided into 64 provinces and each province is again divided into districts (on average 15 districts in each province). The districts are then further divided into villages as local units.

Vietnam's GDP has been increasing each year at around 7.5% over the last five years (GSO, 2005). This is allowing Vietnam to make fundamental economic progress and to tackle rural issues, which include increasing the provision of electricity supplies, solving water pollution from the animal husbandry sector and enhancing options for social choices. Industry is responsible for 40% of the economy, services 38%, and agriculture 22%. The main food crop of Vietnam is paddy rice production. Rice cultivation integrated with animal husbandry is the traditional agriculture production system of the country. The animal husbandry sector, which has 8 million cattle and 25 million pigs and an annual growth rate of 9-10%, contributes about 23.% of total annual agriculture products. The typical scale of animal farms in Vietnam is around 20 pigs, although farms with 100-200 pigs and about 1000-5000 chickens are becoming more common.

Biogas technology was introduced to Vietnam in the 1960s. Since then, the technology has been further developed but despite several projects undertaken by different organisations, widespread adoption of biogas plants has not taken place.

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<sup>31</sup> Environmental Economics Unit, Department of Economics, University of Economics, Ho Chi Minh City, Vietnam.

<sup>32</sup> Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands.

<sup>33</sup> Environmental Economics Unit, Department of Economics, University of Economics, Ho Chi Minh City, Vietnam.

The Government of Vietnam has set the development principle: “high economic growth rate together with implementation of social equity and environment protection”. In other words, Vietnam strives to follow a sustainable development path, which had been committed to under the Agenda 21 in 1992. Vietnam also ratified United Nations Framework Convention on Climate Change (UNFCCC) in November of 1994 and the Kyoto Protocol (KP) in September of 1997.

### The case study

Similar to the other case studies, the project employs a variety of work methods including studying project related documents, interviewing key-persons of the concerned organisations as well as field visits and farmer interviews. Open-ended interviews were carried out on 16 small farms that have had biogas plants constructed under the project in Tien Giang province (70 km south of Ho Chi Minh City), Dong Nai province (30 km north of Ho Chi Minh city), Bac Ninh province (30 km south-east of Hanoi) and Hai Duong province (50 km south-east of Hanoi). In these four surveyed provinces, the most important animal husbandry activity is pig farming. In the selected areas there were both upland (Dong Nai) and wetland ecosystems (Tien Giang, Bac Ninh, Hai Duong). The climate in these provinces varies only slightly between seasons, with about 1,800 mm average rainfall and an average temperature of 27°C in the south and 23°C in the north. The main crops grown in Tien Giang are rice and fruit trees. In Dong Nai it is cassava and cashew. The two northern-provinces are characterised by cultivation of paddy and animal husbandry.

The questionnaire for farmers contains questions on:

- Use of the biogas: cooking parameters, economics of biogas use, use of effluent for fertilizer, fish feed, and other uses.
- Farmers' participation: payment for the biogas plant, comparison before and after biogas use, opinions and suggestions.
- Biogas plant construction: technical problems, when did problems occur, what materials were needed.

The key informant interviews were carried out with experts at the Provincial Biogas Project Offices in Tien Giang, Dong Nai, and Bac Ninh provinces. The interviews covered the historical development of the project, selection and status of farms in the project, problems incurred in the biogas development, contribution of the project to sustainable development in the province, opinions and suggestions.

### Structure of the case study

The remainder of this report is organised as follows: Section 5.2 sets out the historical evolution of the project. Section 5.3 describes the expected impacts of the project on sustainable development and examines the impacts that have been realised. Section 5.4 discusses the potential for the evolution of this project under the CDM. Section 5.5 provides conclusions and lessons learnt.

## 5.2 Evolution of the project

### How the idea was born?

Biogas production was introduced into Vietnam in the 1960s as an alternative source of energy to partially alleviate the problem of acute energy shortage for household uses. Bio-digesters of various origins and designs were tested in rural areas under different national and international development programmes, using household or farm wastes as fermentation substrates. The technology did not, however, become widely used. This raised the policy-relevant question of why biogas production was not used widely given its multiple benefits to many stakeholders. Possible explanations include the lack of biogas expertise in Vietnam, problems with the technology, and farmers' lack the financial resources for investment in biogas. In response it was considered useful to launch a large-scale project providing expertise and financing in order to kick-start the biogas industry in Vietnam.

Fifteen years ago, the Netherlands Development Organisation (SNV) developed in cooperation with national partners, the biogas activities in Nepal. In 2003, the programme was extended to Vietnam.

### Justification and purpose of the project

Vietnam is a nation with a low gross national product per capita. Eighty percent of Vietnam's population lives in rural areas and practices agriculture. The most important animal husbandry activity is pig farming. The development of environmentally friendly, renewable energy sources is important for maintaining agricultural production while meeting energy requirements.

Without support from the Vietnamese government or from international donors, the development of biogas plants had shown slow progress. Only the richest farmers in rural or peri-urban areas can afford the construction of biogas plants. To widely disseminate the biogas technology in rural areas, it is necessary to provide financial and technical support to farmers.

The project assists farmers to substitute biogas for petroleum gas and traditional fuels, such as firewood and agricultural waste, thereby reducing greenhouse gas emissions. The estimated reduction in GHG emissions is 30,600-76,500 tonnes CO<sub>2</sub>-equivalent annually (depending on whether non-renewed biomass use is included in the baseline, how manure is handled in the "without project" scenario, and under the assumption that 85% of the installed biogas plants are in operation).

The overall project objective is "to further develop the commercial and structural deployment of biogas, at the same time avoiding the use of fossil fuels and biomass resource depletion".

The specific objectives are:

1. To develop a commercially viable market oriented biogas industry;
2. To increase the number of family sized quality biogas plants by 10,000 (later increased to 18,000);
3. To reduce greenhouse gases (GHGs) by an estimated equivalent of 30,600-76,500 tonnes CO<sub>2</sub> annually;

4. To ensure the continued operation of all biogas plants installed under the project;
5. To maximise the benefits of biogas plants particularly optimising bio-slurry;
6. To develop technical and promotional capacity for further wide-scale deployment of biogas in Vietnam.

To strengthen and facilitate establishment of institutions for the continued and sustained development of the biogas sector.

### Project organisation

Figure 5.1 represents the project organisation. The key implementing actors are the Department of Agriculture of the Ministry of Agriculture and Rural Development (MARD) and SNV-VN, the Netherlands Development Organisation in Vietnam. The Department of Agriculture (DA) provides the Project Director and two Technical Advisors (part-time basis) to the project. The DA is responsible for embedding the project in the government's legal and policy environment. The Netherlands Development Organisation in Vietnam (SNV-VN) provides the Chief Technical Advisor to the project. SNV-VN carries the final financial and operational responsibility towards the donor. The consulting/advisory board supervise and consult with the project executive board. The advisory board includes representatives of SNV, MARD, public and private sector, and independent consultants. The Biogas Project Office (BPO) is the executive agency for the project. The BPO is responsible for implementation of the project as per approved plans. The BPO reports to both the DA and SNV-VN.

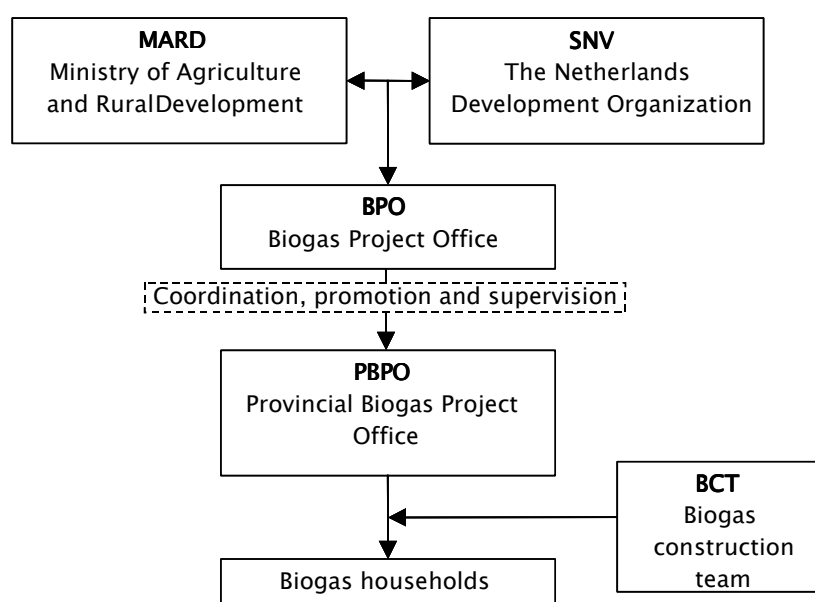


Figure 5.1 Project organisation

Provincial Biogas Project Offices (PBPOs), established in each province, are the provincial counterparts to the BPO. Each PBPO is responsible for the implementation of the project in their provinces. The counterparts of PBPOs consist of the provincial Department for Agriculture and Rural Development (DARD) and the Agricultural Extension Centre (AEC). In phase II (see Section 5.2.5), the project counterparts also include the Provincial Centre for Clean Water and Environment Hygiene and the Centre

for Research and Application of Animal Husbandry Technology. The Provincial Project Guidelines, enforced by the provincial agreement, detail modalities for management, implementation and administration, as well as the support from the BPO. At the district level, one staff member of the Agricultural Extension Centre is trained as a biogas technician. These biogas technicians (almost full time) are responsible for promotion, marketing, selection, and construction supervision.

Biogas Construction Teams (BCT), established at the district level, are private groups responsible for the actual construction and maintenance of the biogas plants. The intention of the project is to assist successful BCTs towards obtaining a full private company status.

The project budget provided by the Dutch Directorate General for International Cooperation (DGIS) is USD 2,482,291. Additional contributions to the budget provided by the provinces of Ha Noi and Thai Nguyen, and Fauna and Flora International (FFI) amount to USD 81,626. By mid-2005 the project was running under budget, with total expenditures of USD 1,392,114. The project provides a flat-rate subsidy of VND 1 million (USD 65) to households that have a biogas plant constructed.

The biogas programme aims to support the development of the biogas sector as a whole, and thus considers all actors in the related areas as potential partners. It is also flexible in focusing on various kinds of actors, depending on changes in real conditions. For example, in the planned phase II of the program, it also includes the Provincial Centre for Clean Water and Environment Hygiene and the Centre for Research and Application of Animal Husbandry Technology, which were not involved in phase I.

#### *Pre-project assessments*

The Netherlands Development Organisation (SNV) is responsible for the investigation of potential for national biogas programs and then for management of the invested project. The pre-conditions for large-scale dissemination of biogas plants are a first requirement for choosing a country. If key pre-conditions are considered favourable, the SNV will undertake a feasibility study, which includes comprehensive contexts and multi-stakeholder analyses.

#### *Time frame*

The first phase of the project (2003-2005) is designed to support the deployment of small-scale biogas plants in 12 out of Vietnam's 64 provinces. These provinces are listed in Annex 5 to this chapter. In addition to these twelve provinces, the project also provides consulting support on the deployment of domestic biogas projects in Cao Bang and Quang Binh provinces.

The target number of biogas plants for the first phase of the project is 12,000. This target has actually been exceeded with the total number of plants constructed reaching 12,201 in the first half of 2005 (BPO 2005). The Netherlands' Government subsequently provided additional funding for 6,000 plants to be constructed in the second half of 2005 – giving a total of 18,000 plants for the first phase of the project.

The bridging phase (2006) aims at preparation for the phase II (2007 – 2010) and smooth transfer from the first phase. It is planned that in the year 2006, almost 9,455 biogas plants will be built in 24 provinces (SNV-VN 2006a).

The second phase of the project has the target of constructing 150,000 plants across 58 provinces over a four-year period. These provinces are also listed in Annex 5.I of this Chapter.

The total estimated budget for the second phase is €48.95 million. €6.1 million is provided by DGIS/SNV, €4.75 million is contributed from participating provinces, and €38.1 million is from biogas users.

### Project approval

In January 2003, the Minister for Development Cooperation of the Netherlands and the Minister of Agriculture and Rural Development of Vietnam signed a Memorandum of Understanding (MoU) for the implementation of a domestic biogas dissemination project. This MoU sets out responsibilities for the project and states that the MARD will ensure that the project is supportive to the national development and development goals of Vietnam. In April 2003, a MoU was signed between the Department for Agriculture and Forestry Extension (DAFE) and SNV-VN on the implementation of the project. A MoU has also been signed to cover the bridging phase in 2006.

### Current status of the project

Once the project had been approved at the national level, the first step was to identify provinces to participate in the program. The criteria for the selection of provinces were:

- Robust animal husbandry development;
- Critical environmental issues related with the animal husbandry sector;
- Representative of a particular economic region of Vietnam;
- Favourable conditions for development of the project.

In the period from 2000 to 2003, all 10 participating provinces were selected. At the end of 2003, the project admitted two more provinces, Hanoi and Thai Nguyen, to participate. These two were not selected in the formal selection but had shown great enthusiasm, which included a significant financial contribution from the provincial budget to the project.

## **5.3 Contribution to sustainable development**

### Sustainable development in project documents

Elements or indicators of sustainable development, which are summarised in project documents, are shown in Table 5.1.



Table 5.1 Sustainable development aspects of the project at various levels

MICRO	MESO	MACRO
<i>Health</i>		
Reduced indoor smoke-induced illness	N.A.	Reduction of illness induced production losses Reduced mortality Reduced health system expenses
Reduced poor sanitation induced illness		
<i>Environment</i>		
Reduced fuelwood collection	Reduced risk of landslides	Improved biodiversity Reduced global warming effects
Reduced weeding	Improved forest quality and quantity	
Reduced soil degradation	Reduced sanitary pollution	
Reduced pollution of surface and groundwater		
<i>Economic</i>		
Increased efficiency of productivity	Improved employment opportunities	Increased agricultural production Increased tax revenues Increased efficiency of productivity Poverty alleviation
Reduced direct medical costs		
Reduced fuel-wood & kerosene expenditures		
Increased opportunity for organic agriculture		
Improved agricultural yields		
Increased family income (time saving on fuel-wood collection)		
Reduced costs on chemical fertilizer		
<i>Social</i>		
Reduced workload for food-preparation (gender)	N.A.	Improved human resource base
Improved opportunity for education		
Cooking biogas more comfortable		

Source: Biogas Project Office/SNV, 2005

### Host government criteria

The views about sustainable development, which are expressed in the documents of the 9th National Communist Party Congress and the Strategy for Socio-economic Development in the period 2001-2010, is “fast, effective and sustainable development, economic growth should occur in parallel with the implementation of social progress and equality and environmental protection” and “socio economic development is closely tied to environmental protection and improvement, ensuring harmony between the artificial and natural environment and preserving bio-diversity”.

The Vietnamese definition of “sustainable development” is quite close to that set out at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 and the World Summit on Sustainable Development in Johannesburg in 2002. It is a development process, which has a harmonious combination of three elements of

development: economic development (especially economic growth), social development (especially social progress, equality, hunger elimination, poverty alleviation, and jobs creation) and environmental protection (especially solving and overcoming pollution, recovering and improving the environment's quality; preventing fire and deforestation; appropriately exploiting and thriftily utilising natural resources). The criteria for assessing sustainable development in general are stable economic growth, good implementation of social progress and equality; appropriate exploitation and thrifty utilisation of natural resources, protection and improvement of the living environment's quality (Vietnamese government, 2004).

## Social aspects

### *Gender equality*

The findings of the interviews in the four provinces show that gender benefits are frequently mentioned and are considered as the most important social benefit of biogas. The use of biogas for cooking is more convenient and less time consuming than using traditional fuels, and allows women more time for other activities. Compared to using firewood, which requires much closer supervision, biogas helps women save time. Our rough estimate of time saving is about 60 minutes per day, including reduction on time used for cooking of meals, cleaning utensils and collecting fuel. Cooking habits and negative rumours regarding the cleanliness of biogas are a potential barrier to the use of biogas for cooking. The results of the survey show, however, that most interviewees use biogas to cook all food items. In a few cases, wood is still used for cooking related to religious worship.

### *Access to affordable clean energy services*

Biogas plants provide a reliable and plentiful supply of clean energy at the farm level. In addition, a free distribution of biogas among neighbours was observed in several places in both Tien Giang and Dong Nai provinces. The excess gas, which is shared for free through PVC-tubes to several neighbours close by, in some ways, actually helps to connect people and then create good social relations.

### *Impacts on human health*

By reducing indoor air pollution, particularly in the kitchen, the use of biogas has significantly improved health conditions in terms of the incidence of eye infections, respiratory diseases, coughing, and headaches. This is particularly beneficial to women, who spend the most time in the kitchen.

### *Local skills and development*

The project has required local people to develop new skills. A comprehensive training programme has been implemented to train people involved in the construction, maintenance, financing, and marketing of biogas plants.

## Environmental aspects

The introduction of biogas plants has had a number of positive environmental impacts.

### *Air quality*

The most frequently mentioned environmental impact of the biogas plants by interviewed farmers is that the use of biogas has significantly helped to improve indoor air quality. Women can now cook in a clean kitchen without smoke and particulates that are harmful to health.

### *Water quality*

The use of biogas plants for processing livestock manure also helps to improve the sanitary conditions in the vicinity of livestock farms. Without a biogas plant, manure is generally disposed of in drainage ditches or the surrounding land, resulting in serious odour and water quality problems. In some cases biogas plants are also used for processing human waste. The biogas system reduces organic pollution in rivers and channels, which is of great importance in provinces that are characterized by wetland ecosystems such as Tien Giang province in the Mekong River Delta.

### *Land-use change*

The reduced use of fuel wood results in lower rates of deforestation and associated soil erosion. In the case of the four surveyed provinces, the impact of biogas on deforestation reduction is not clear. In general, farmers in these provinces do not use firewood taken from forests. The use of biogas plants has also resulted in changes in land use at the farm level. Farmers with biogas plants have generally increased their cultivation of fruit trees and other crops due to the production of bio-slurry that can be used as fertiliser. There has also been an increase in the number of fish ponds due to the availability of bio-slurry as fish feed.

### *Land quality*

The production of organic fertilizer from biogas plants can also lead to an improvement in soil structure and productivity. By offsetting the use of inorganic fertilizers, the project also reduces pollution related to the production of such fertilizers.

### *Reduction in GHGs*

The annual quantity of CO<sub>2</sub>-equivalent emissions reduced by each biogas plant is estimated to be between 2-5 tonnes (depending on baseline conditions). The annual GHG reduction for the project as a whole is estimated to be 30,600-76,500 tCO<sub>2</sub>-equivalent based on the assumption that 85% of plants are operating (SNV-VN 2006a).

## Economic aspects

### *Impact on economic activity in the area*

By substituting biogas for petroleum gas, monthly household energy expenditures can be cut by USD 4-5 (calculated average using data from household interviews). The farmer survey shows that biogas is predominantly used for cooking. A minor share of

households use it for lighting and generating electricity using converted car engines. Most of the surveyed households use biogas for one or two lights, which are in the kitchen or barn. In Xuan Loc district in Dong Nai province, one farmer was surveyed who operates a 10 kwh-electric generator using biogas. The most significant use of biogas for generating electricity was observed in Tien Giang province, where farmers use biogas-lights to warm up newly born piglets. The main reason for the relatively small use of biogas for lighting is the low quality and availability of appliances. Interviewed farmers often stated that the lifetime of biogas-lights is rather short compared with normal ones.

Slurry from the biogas plants can be used for agricultural purposes, such as fertiliser for crops. Livestock farmers can thereby earn extra money and diversify their sources of income. One biogas plant produces roughly 30 tonnes of high quality bio-compost per year and approximately 90% of farmers with biogas plants use this fertilizer, allowing them to reduce or cease their use of inorganic fertilizers.

Slurry can also be used as fish feed. As such, many livestock farmers with biogas plants also enter into or enhance aquaculture on their farms. Especially in Bac Ninh province, farmers even use slurry to feed pigs and earthworms, which is an emerging profitable farming activity in the north of Vietnam.

Although the use of slurry is still limited, there is evidence to suggest that there is great potential for economic development if this resource is used efficiently. Mr. Vo Tien Linh, biogas technician of Tien Giang PBPO, illustrated this point by a case in Go Cong Tay district where a farmer can save about VND 6 million in 3 months by using slurry for feeding a 8,000-square meters pond of breeding fish.

Another household income source from biogas has been emerging in the two surveyed provinces in the north: many households sell their redundant gas to neighbours for around VND 20,000 – 30,000 per month.

### *Employment*

The project also has significant employment effects in terms of generating jobs in the construction of biogas plants. A comprehensive training programme has been implemented to train people involved in the construction, maintenance, financing, and marketing of biogas plants.

### *Synthesis*

The contribution of the project to sustainable development in Vietnam is significant across all three ‘pillars’ of the concept. Regarding *social* aspects, biogas plants provide important benefits to women in terms of reducing time spent cooking, cleaning, and collecting fuel – time which can be spent on other productive or social activities. By sharing excess biogas with neighbours, the project also contributes to social cohesion within the farming community.

In terms of *environmental* aspects, the project significantly reduces greenhouse gas emissions by substituting biogas for traditional fuels. Other environmental impacts include reduced indoor air pollution and associated health problems; reduced water

pollution and odour from disposal of manure; reduced deforestation for fuel wood; and improved soil quality.

There are also multiple *economic* impacts from the project. Farmers reduce their energy costs by using biogas for cooking and in some cases lighting. In addition, slurry from biogas plants can be used as fertilizer for crops and also as feed for aquaculture fisheries. The project has significant employment effects for masons engaged in the construction of the biogas plants.

The impacts of this project on sustainable development are summarised in Table 5.2. The scoring system used is described in Chapter 3.

Table 5.2 Criteria for evaluating sustainability for biogas project

Criterion	Indicators	Score (-2 to +2)
<b>ENVIRONMENTAL SUSTAINABILITY</b>		
Air resources	Air quality	+2
Water resources	Water quality	+2
	Water quantity	0
	Water management	+1
Land resources	Land quality	+1
	Land-use change	+1
	Land management	+1
Other resources (_____)	Other resource (_____) quality	+1
	Other resource (_____) quantity	+1
	Other resource (_____) management	+1
Biodiversity & Ecosystems	Biodiversity quality	0
	Ecosystem functioning	+1
Impact on climate change	Reduction in GHGs	+2
<b>ECONOMIC SUSTAINABILITY</b>		
Financial viability	Return on investment	+2
Effects on local/regional economy	Energy expenditure	+1
	Employment (numbers)	+2
	Impact on economic activity of area	+1
	Attraction of green investments	+1
Effects on national economy	Impact on balance of payments	+1
	Economic growth	+1
Technological sustainability	Technology transfer and self-reliance	+2
	Demonstrational effect and replication potential	+2
	Design and operational efficiency	+2
<b>SOCIAL SUSTAINABILITY</b>		
Livelihoods of the poor	Poverty alleviation	+1
	Distributional equity	+1
	Access to essential services	+1
	Access to affordable clean energy services	+1
	Impacts on human health	+1
Human capacity	Employment (job quality)	+1
	Empowerment	0
	Gender equality	+1
	Local skills development / education	+2
Human environment	Preservation cultural / natural heritage & aesthetics	NA
	Relocation of communities	NA

## 5.4 Evolution to a CDM project

This project is currently being developed into a CDM project. The Biogas Project Office is planning to annually undertake several sample studies to verify the CDM claim. The deskwork related to this objective (i.e. the establishment of a baseline, GHG reduction calculations, monitoring and verification protocols) has begun recently.

At the moment, MARD and SNV have agreed on the joint development of a second phase for the biogas project. One of the main focuses of the second phase is the development of innovative financing mechanisms, including the selling of Certified Emissions Reductions under the CDM.

The biogas project appears to have substantial potential as a CDM project in that it helps to reduce GHG emissions by:

1. Displacing the combustion of fossil fuels and fossil fuel-based grid electricity by supplying carbon-neutral energy to the user;
2. Decomposing animal manure by utilizing an effective and efficient animal waste digestion system to replace traditional manure management systems; and
3. Substituting chemical fertilizer by using biogas slurry.

Two Project Idea Notes (PINs) have been written regarding this project. One covers the first and bridging phases of the project, i.e. the 18,000 biogas plants built between 2003-2006. This PIN has been submitted and endorsed by the DNA in Vietnam. The annual quantity of CO<sub>2</sub>-equivalent emissions reduced by each biogas plant is estimated to be between 2-5 tonnes (depending on baseline conditions). The annual GHG reduction for the project as a whole is estimated to be 30,600-76,500 tonnes CO<sub>2</sub>-equivalent (based on the assumption that 85% of plants are operating). The operational lifetime of a biogas plant is over 20 years but the PIN gives a conservative estimate of total GHG emissions reductions of 428,400-1,071,000 tonnes CO<sub>2</sub>-equivalent based on a period of 14 years. The first Certified Emissions Reductions (CERs) are expected to be generated in 2007.

The second PIN covers the second phase of the project, i.e. 2006-2010, in which 150,000 biogas plants are to be constructed. In this case the annual GHG reduction is estimated to be 255,000-637,500 tonnes CO<sub>2</sub>-equivalent, and reductions over 14 years are 3,456,000-7,328,000. The first CERs are also expected to be generated in 2007.

## 5.5 Inferences

### Successful aspects of the project

The project is widely seen as a success. Several positive aspects are worth highlighting.

- The project has provided the technical and financial support for the construction of 18,000 biogas plants, greatly **exceeding the initial target** of 10,000 biogas plants. The quality of biogas plants under the project is in general very good and they are highly appreciated by biogas users and local authorities.
- The project has been successful in creating a foundation for **commercializing** and **increasing widely** the use of a sustainable energy resource in Vietnam. It is noted that although biogas production was first introduced to Vietnam in the 1960s and has received much attention from the government and international community, its use

was still not widespread until this project. Many biogas technologies have been applied but success remained at a local scale and did not develop into biogas use at the nationwide level. This project, however, has been widely accepted by biogas users and local governments in all project-phase I provinces and is now being extended in phase II to almost every province of Vietnam.

- The project has successfully reduced greenhouse gas emissions and has also had numerous **local positive environmental, social, and economic impacts**. The process to register both the first and second phases of the project under the CDM in order to generate Certified Emissions Reductions (CERs) has been started.
- The **subsidy disbursement mechanism** is inexpensive and effective. Subsidy payments are made directly from the Biogas Project Office to individual biogas users through the money transfer service of the Post Office. The Post Office has a high density of branches allowing easy access in rural areas. The transfer is a simple administrative procedure and takes 3-5 days to complete a transaction. This transfer process was preferred over the potentially more expensive and less popular option for disbursement through the Vietnam Bank for Agriculture and Rural Development (VBARD). This option would have incurred a USD 10 levy per biogas plant and was unattractive from the farmers' point of view due to the lengthy application procedure.

#### Less successful aspects

There are only a few aspects in the project that could be improved upon.

- The **involvement of the private sector** is still limited. Yet, one of the formal aims of the project is to “develop a commercially viable market oriented biogas industry” (BPO 2005). A commercially viable sector bases much on the participation of the private enterprises. Private enterprises in the biogas project, such as biogas construction companies, bio-slurry trading enterprises, or companies that sell biogas generators, biogas lamps, biogas cookers etc., are just in an emerging stage. The next phase of the biogas project needs to assist the PBPOs to set up the full infrastructure necessary to support the private sector.
- The **number of masonry teams is still limited** and generally restricted to one team per district. Limited competition between construction teams does not provide incentives to improve quality and reduce the price of biogas plants. There is a need to allow more firms into the market in order to generate pressure for high quality and lower prices. The prospects for widespread use of biogas would be enhanced once improved quality and reduced costs have been shown.
- The **use of gas from biogas plants is still not maximized**. In the surveyed livestock farms, the amount of biogas produced is often much higher than the domestic demand for cooking and lighting. A similar situation applies for slurry although the project also provides training for farmers on the proper operation of the plants and also the proper use of bio-slurry as organic fertilizer. There is scope for further sharing or trading of biogas and bio-slurry with neighbouring farmers.
- The uptake of the subsidy to construct biogas plants has largely been by **relatively affluent farmers**. The subsidy is a flat rate and the farmers have to pay the majority of the construction costs themselves. As a result, poorer farmers may still find the

costs too high, whereas more affluent farmers who could afford to construct a biogas plant anyway receive an unnecessary subsidy. It may be necessary to provide a scaled subsidy depending on farm income in order to ensure that poorer farmers are also included in the biogas programme.

### Lessons learnt

The success of this project provides a number of useful lessons for future activities:

- The model of **co-finance works well**: the Dutch government, Vietnamese government, and the farmers share the costs and responsibilities that help to ensure that the project develops in a sustainable manner.
- **Simple and inexpensive technologies can be transferred easily** and result in significant positive impacts. The biogas plants are straightforward to construct and maintain and have a lifetime of around 20 years. The plants can be constructed quickly using local materials and labour.
- The dissemination and construction of biogas plants is mainly **successful because it is demand led**. As the benefits of biogas plants become widely known, farmers actively demand access to the technology and contribute the majority of the construction costs – thereby having the largest stake in the project and incentive to use and maintain the plants.
- The **subsidy disbursement mechanism is simple**, inexpensive, and effective. Subsidy payments are made directly from the Biogas Project Office to individual biogas users through the money transfer service of the Post Office. This system ensures that potential participants in the project are not put off by overly bureaucratic processes.
- The involvement of the Agricultural **Extension Centre** as an implementing actor is important. The striking characteristic of the AEC is its (AEC) operating system that branches down to the community unit and is implemented by staff who know each farmer in their area well.

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## Annex 5.I. List of provinces covered by the project

Table V.I Provinces included in Phase I

1	Bac Ninh	7	Thua Thien Hue
2	Hai Duong	8	Binh Dinh
3	Ha Noi	9	Dac Lac
4	Lang Son	10	Dong Nai
5	Thai Nguyen	11	Tien Giang
6	Nghe An	12	Hoa Binh

Table V.II Provinces included in Phase II

1	Ha Noi	30	Quang Tri
2	Hai Phong	31	Thua Thien Hue
3	Vinh Phuc	32	Da Nang
4	Ha Tay	33	Quang Nam
5	Bac Ninh	34	Quang Ngai
6	Hai Duong	35	Binh Dinh
7	Hung Yen	36	Phu Yen
8	Ha Nam	37	Khanh Hoa
9	Nam Dinh	38	Kon Tum
10	Thai Binh	39	Dac Nong
11	Ninh Binh	40	Dak Lak
12	Ha Giang	41	Lam Dong
13	Lao Cai	42	Ho Chi Minh City
14	Bac Can	43	Binh Phuoc
15	Lang Son	44	Tay Ninh
16	Tuyen Quang	45	Binh Duong
17	Yen Bai	46	Dong Nai
18	Thai Nguyen	47	Ba Ria Binh
19	Phu Tho	48	Thuan Vung Tau
20	Bac Giang	49	Long An
21	Quang Ninh	50	Dong Thap
22	Lai Chau	51	An Giang
23	Dien Bien	52	Tien Giang
24	Son La	53	Vinh Long
25	Hoa Binh	54	Ben Tre
26	Thanh Hoa	55	Kien Giang
27	Nghe An	56	Hau Giang
28	Ha Tinh	57	Tra Vinh
29	Quang Binh	58	Bac Lieu



## 6. Bethlehem mini hydropower plant (South Africa)

*Sebastiaan Hess<sup>34</sup>, James Blignaur<sup>35</sup>, Tjasa Bole<sup>32</sup> and Franz Rentel<sup>32</sup>*

### 6.1 Introduction

This chapter reviews the case study of the mini hydropower project in Bethlehem in South Africa. It analyses the (potential) contribution to sustainable development of the Bethlehem Hydro project, which will construct and run two mini-hydropower plants at the Saulspoort Dam and the As River, both near the town of Bethlehem in the local municipality of Dihlabeng.. Through its PPP-JI (Pilot Project Programme Joint Implementation) programme the Netherlands' Ministry of Foreign Affairs (DGIS) has financially supported this project.

#### Background

The Dutch contribution was organised as an Activities Implemented Jointly (AIJ) pilot project under the United Nations Framework Convention on Climate Change (UNFCCC). The actual AIJ project entailed carrying out a detailed feasibility study and drawing up a business plan for its implementation (DGIS project number ZA012502). However this chapter will go beyond the AIJ and discuss the whole Bethlehem Hydro project. Since construction of the two hydropower plants will only start in October/November of 2006, the contribution to sustainable development will necessarily be determined *ex ante*.

As part of this study we consider the causes to the delays in the project and the reasons why implementation has been postponed by up to three years. The use of the funds made available by the Netherlands' Ministry of Foreign Affairs will also be discussed.

#### Key characteristics of the case study

South Africa is an upper middle-income resource intensive developing country with an open economy, which has to find innovative ways to combat poverty, promote economic growth, and reduce resource use intensity simultaneously (Van Heerden *et al.*, 2006). Given these characteristics, South Africa's economy is highly dependent on resource extraction with large activities in the mining, agriculture, and manufacturing sectors, even though the combined contribution of the former two sectors to GDP is less than 10% (SARB, quarterly bulletin, various issues). These sectors are the major employers and they generate much economic activity, such as electricity generation and fuel production, both of which is from coal (DME, 2000).

As evidence for the statements made, South Africa's electricity consumption (93% of which is coal-based) is 3.8 Megawatt hours (MWh) per capita compared to an average of 2.5 MWh for upper-middle income countries. The country's carbon-dioxide emissions lie between that of upper-middle income and high-income countries at 9.1 tonnes (t)

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<sup>34</sup> Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands.

<sup>35</sup> Department of Economics, University of Pretoria, Pretoria, South Africa

carbon dioxide (CO<sub>2</sub>) per capita (see Figure 6.1). There is an urgent need for the reduction of the country's carbon footprint and it is a stated objective of the government to increase the renewable energy supply to the energy supply mix to at least 10% by 2015, which, with the exception of the non-sustainable use of fuelwood, is limited to only self-generation of a small number of industries such as the paper and pulp industry, but is less than 2% of the total mix (DME 2000).

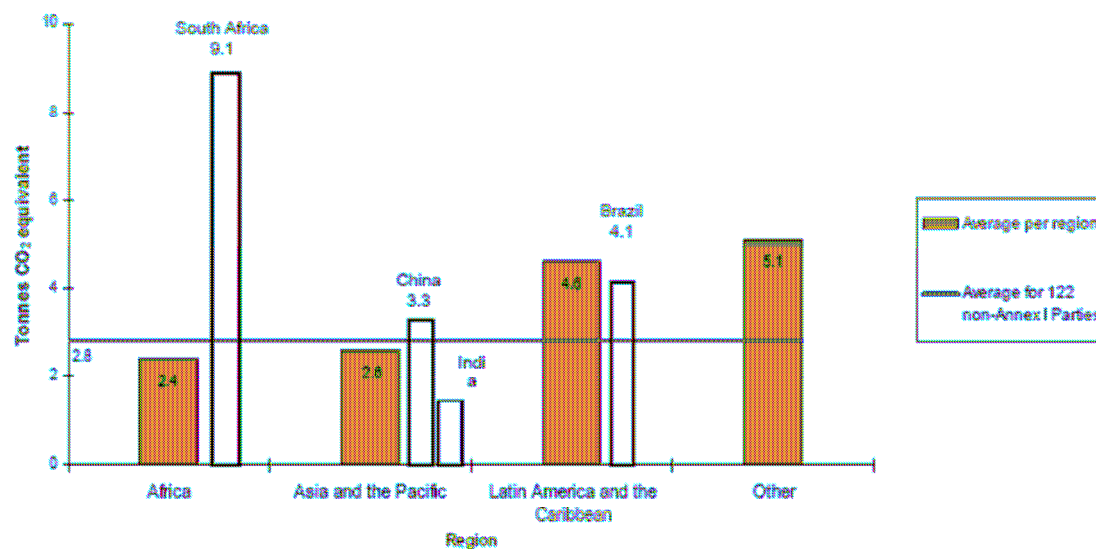


Figure 6.1 Per capita GHG emissions (tonnes CO<sub>2</sub> equivalent) for the year 1994 or the closest year reported for non-Annex I parties

Source: UNFCCC, 2006

The carbon intensity of the South African economy is a direct result of the reliance on coal and very low electricity prices in the country, which are among the lowest in the world as is evident from Table 6.1 below. The reasons for these low prices are numerous, some of which are: i) the fact that the generation capacity of Eskom, South Africa's electricity utility, was built using public money and was exempt from all taxes and dividends until 2000, ii) Eskom has invested in surplus capacity during the 1970s leading to the early amortisation of all capital cost and hence a decline in real prices, and iii) a very low input price for coal being vertically integrated with the coal mining sector – Eskom owns its own coal mines (Van Zyl *et al.*, 2002 and DBSA 2000).

While the country's economy is currently growing strongly, this growth is not benefiting the unemployed and the poor directly through more commercial opportunities. Moreover, this growth depends significantly on the resource sectors (water and energy). The country is seeking ways to grow; ways that will benefit the poor and that will reduce the impact of such growth on the environment and has, therefore, launched a national strategy for sustainable development early in 2006. Also in 2006 the Accelerated and Shared Growth Initiative of South Africa (AsgiSA) was launched (RSA, 2006). This national initiative that aims at attaining 6% economic growth rates over the next 8 years and to halve poverty by 2014 makes little mention of environmental factors and sustainable development. The focus is on economic growth. If this growth is not generated in an environmentally friendly manner, or not channelled to benefit the environment, the probability is high that resource intensity will increase.

Table 6.1 International comparison of retail electricity prices (in 2000USD/kWh)

Upper-income countries			Developing countries		
	<i>Industrial</i>	<i>Household</i>		<i>Industrial</i>	<i>Household</i>
Australia	-	-	Czech Republic	0.04	0.05
Belgium	0.04	0.13	Greece	-	-
Canada	0.03	0.05	Hungary	0.05	0.06
France	-	0.1	India	0.07	0.03
Germany	0.05	0.12	Korea	0.06	0.07
Italy	0.09	0.13	Mexico	0.05	0.07
Japan	0.16	0.23	Poland	0.04	0.07
Netherlands	0.06	0.13	Portugal	0.06	0.11
New Zealand	0.02	0.06	Slovak Republic	0.04	0.05
Spain	0.05	0.12	South Africa	0.02	0.03
United Kingdom	0.05	0.1	Taipei	0.06	0.08
United States	0.04	0.08	Turkey	0.09	0.09
Average	0.06	0.11	Average	0.05	0.06

Source: IEA (2001).

To be able to grow, which is an essential requirement for a developing country, but still strive to achieve sustainability, it is essential to reduce resource intensity. This implies that initiatives such as Bethlehem Hydro contribute a lot not only in MWh generated, but also psychologically to the process of development that is both competitive, environmentally friendly and that promotes growth (Van Heerden *et al.*, 2006).

### The case study

Three main research methods have been applied. First, a content analysis was performed by studying all attainable and relevant projects documents. Most of these were available from the archive of the Netherlands Ministry of Foreign Affairs.

Another major element in the study was a stakeholder analysis of the major parties involved in or influenced by the Bethlehem Hydro project. First, several visits were paid to the general project manager of Bethlehem Hydro and one of the two directors of NuPlanet, Mr. Anton-Louis Olivier. The other major stakeholder is the municipality of Dihlabeng that will enter into a purchase agreement with Bethlehem Hydro for the electricity generated by the project. As the relevant representative for the municipality, Mr. Demetrius Williams, director of public works was interviewed on two occasions concerning the consequences of the project for the town. The major shareholder, the Central Energy Fund, supplying forty-nine percent of the equity capital, was visited as well to get insights into their views of the sustainable development contribution of the project, and of its financial sustainability in particular. As a final direct stakeholder, the views of the owner of the land where the site will be built along the As River were elicited.

Besides these direct stakeholders, the acting director of the South African Designated National Authority (DNA) and the second secretary of the Netherlands Embassy in Pretoria were interviewed to get a clearer picture of the South African situation in which the project operated and the Netherlands' views and contribution to this. The impressions of the project at the Ministry of Foreign Affairs itself were also sought by contacting the

two staff members most directly involved in the Bethlehem Hydro project. All persons interviewed are listed in the references section at the end of the document.

Finally, the information was complemented by site visits to the two locations where the facilities of the project will be built.

## 6.2 Evolution of the project

### How the idea was born?

In the middle of 1997 a mini hydro project was identified in Bethlehem, South Africa by a landowner, C.D. Naudé, and a civil engineering consulting firm, E3. This project initially showed the potential of serving local rural communities with cheaper electricity, while at the same time contributing to the abatement of greenhouse gas (GHG) emissions. The following pre-feasibility study of the project, which was supported by DGIS<sup>36</sup>, underscored this potential and indicated that the hydro project to be broadly feasible. In addition, a 1989 pre-feasibility study on mini hydro at Krokodilpoort showed similar feasible results (MoFA, 2001, p.2).

### Justification and purpose of the project

Even though the pre-feasibility studies showed that these projects might be viable, several constraints prevented realisation of these potentials. These constraints are related to the high sunk cost component in relation to the total investment. This is a well-known characteristic for small renewable energy projects.

Sunk costs comprise the detailed feasibility study, the licensing and approvals processes, the legal process, the general development costs and the design costs. They are typically in the same order as costs for much larger projects. Furthermore, the entire approval process (licensing, etc.) does not differ very much whether the project has a size of 10 MW or 1,000 MW. Obviously this uneven playing field exerts a high pressure on the Return on Investment (ROI) that can be expected from smaller projects. Large investors, as well as large project finance institutions (commercial banks) are confronted with the same dilemma. The necessary due diligence work, which is required to take an investment or loan decision, is expensive in relation to the required debt size. Thus, the potential earnings for the investor or financier are relatively small. This often leads to the financiers setting very high-risk requirements for smaller projects or even a total lack of financing interest.

The result of this is that smaller energy projects typically fail to be implemented unless a mechanism is available to reduce the risk (e.g. a clear and detailed feasibility study, which will be accepted as a bankable document) and to reduce the sunk costs. Typically these mechanisms can be export credit mechanisms, subsidies, concessionary finance, crown or state guarantees or tax incentives. The financing requested under the PPP-JI programme was meant to overcome the above barriers (MoFA, 2001, p.3).

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<sup>36</sup> Under act. nr. ZAO12501

## Project organisation

Figure 6.2 represents the structure of the project. The project ownership lies with Bethlehem Hydro (Pty) Ltd, a company created with the express purpose of constructing and operating the power plant. The project developers are NuPlanet, a company with registered offices in both South Africa and the Netherlands. NuPlanet obtained €0.8million from DGIS as a grant funding at the end of 2001 to pay for the transaction cost (mainly professional fees for technical consultants and project management fees) in developing the project. Given the length and difficulty of the process, the project would not have succeeded without the grant from DGIS (NuPlanet, 2006).

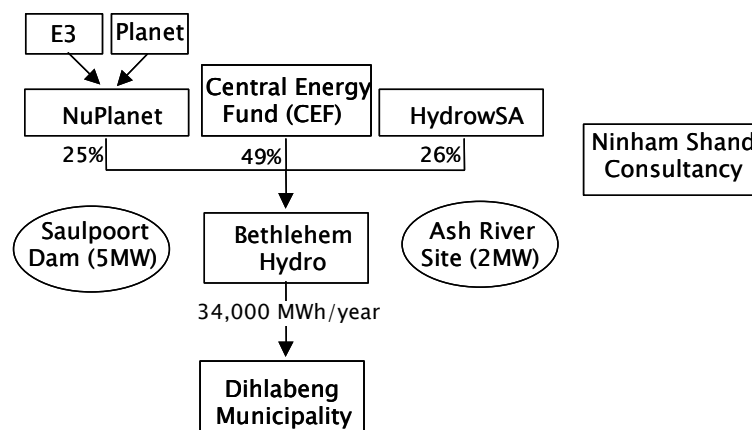


Figure 6.2 Bethlehem Hydro: Project Organogram

To raise the necessary capital for construction (€6.6 million), a portion of the shares of Bethlehem Hydro (Pty) Ltd was sold to the Central Energy Fund (CEF) of South Africa (a private company but fully owned by the government with the aim at developing new forms of energy generation). The company is currently in negotiations to sell further shares to a black women's empowerment group called HydrowSA. NuPlanet took up some minority shareholding as well (see Figure 6.2). This equity capital was used to raise debt finance from the Development Bank of Southern Africa to the extent of approximately €5.9 million (Personal communication 1 and 3, South Africa, 2006).

The main stakeholders during the development phase are the local government (the main client with whom a power purchase agreement had to be signed), the local land owners (with whom land lease agreements had to be signed), the provincial government (from whom a record of decision for the environmental impact assessment had to be obtained), and the national government (with whom a plethora of agreements had to be signed, including a water use licence from the Department of Water Affairs and Forestry, a host country approval letter from the DNA and a land rezoning agreement from the Department of Agriculture and an electricity generation licence from the National Energy Regulator of South Africa).

During the operational phase the complexity will be reduced considerably to operating the plant within the context of all the aforementioned and other agreements. Bethlehem Hydro has contracted Ninham Shand, a South African consulting firm, to execute the environmental scoping report, necessary for the EIA. This consultancy also acted as the consulting engineers for the detailed design of the project and will oversee construction (NuPlanet, 2006).

## Time Frame

One of the key criteria for securing grant finance from DGIS is that PPP-JI only supports mitigation projects that would otherwise not occur (MoFA, 2001, p10). This implies that there is a strong emphasis on additionality. Without the DGIS support, the project would most likely not have happened because of the high sunk costs. In this project this criterion has quite clearly been met. The project developer, NuPlanet had to overcome very large barriers. Not only did the project have to comply with the same regulations as would have been the case for a larger project, it was also the first of its kind in the country and had to do groundbreaking work. We present here an overview of the time frame of the project development process.

The funding proposal for the project was submitted to DGIS in May 2000 and the final commissioning of the civil work occurred in September 2006, a period of 76 months in total (NuPlanet 2006; personal communication 1, South Africa, 2006). Table 6.2 gives the timeline for the development of the project and shows the important dates and decisions based on discussions with interviewees and project documents.

*Table 6.2 Timeline of the project*

Important events/decisions	Date
Proposal submitted to DGIS	May 2000
DGIS approval	December 2001
Record of Decision for the EIA	July 2004
Securing of the DBSA debt finance	January 2005
DWAF water use licence	May 2005
DNA host country approval for CDM status	January 2006
Tendering turbines and contract civil works	September 2006
(Anticipated) commissioning of the civil works	October 2006
(Anticipated) commissioning of the hydro-electric plant	November 2007

The total time from submission of the proposal to commissioning of the plant was about 90 months. This is three times as long as anticipated due to the numerous processes and delays that accompanied each of the phases and licence requirements that are dependent on each other and that cannot run in parallel. For example, before financing could be secured, the EIA and the water licence had to be in place. Likewise, before the DNA approval could be obtained, the project had to be financially secure and viable and therefore project finance was required (personal communication 1, South Africa, 2006).

From the outset the project considered a number of sites. Besides the site at Bethlehem, NuPlanet also considered a site at Krokodilpoort, but the feasibility study showed that it did not meet technical and economic criteria and was, therefore, not further developed. After that a substitute site at Pongolapoort was investigated, but then eliminated from the list due to uncertainties and high project risk due to land tenure ambiguities. In the meantime the estimated capacity of the Bethlehem site increased as investigation continued making it viable in its own right (personal communication 1, South Africa, 2006).



## Project approval

The process of project approval is cumbersome. First, the DGIS had to approve of the grant funding to enable NuPlanet to commence with the project investigation, research and to overcome all the numerous institutional obstacles and challenges. Since the project is so novel and unique within the South African context there were high transaction costs and delays. The text below illustrates that.

The length of the list of approvals that had to be obtained for the project to be finally approved gives some idea to the cause of delays (NuPlanet, 2006, p.13):

- Approval from the Designated National Authority on Climate Change for the approval of the project as a Clean Development Mechanism Project;<sup>37</sup>
- Environmental impact assessment and Record of Decision (RoD) (approval) for the construction and operation of the plants from the Free State Provincial government;
- Environmental impact assessment and Record of Decision (RoD) (approval) for the construction and operation of access roads and power lines in the Free State Provincial government;
- Electricity generation licence from the National Electricity Regulator;
- Water Use Licence from the Department of Water Affairs and Forestry;
- Permission for subdivision of agricultural land from the Free State Provincial Department of Land Affairs;
- Rezoning of agricultural land from agricultural to industrial from the Free State Provincial Department of Land Affairs;
- Licence from the Department of Water Affairs and Forestry Dam Safety Office to construct a power plant adjacent to the wall of the Saulspoort dam;
- Power Purchase Agreement with the Dihlabeng Local Municipality;
- Permission from Department of Water Affairs and Forestry (DWAF) to construct civil works in the DWAF servitude along the As River;
- Land Lease Agreement with the owner of the farm Merino;
- Land Lease Agreement with the owner of the farm De Burg Susan;
- Agreements with 14 individual farmers for the construction of the power lines from the As River site to the interconnection point in Bethlehem;
- Permission from the Dihlabeng Local Municipality to purchase the land at the wall of the Saulspoort Dam for the construction of the plant;
- Permission from the Free State Province Department of Public Works, Roads and Transport for the construction of Power lines adjacent to a public road;
- Agreement with the owner of the Farm Schulpspruit for the construction of an access road to the Saulspoort Dam site;
- Shareholders' Agreement with equity investors in the project;
- Loan Agreement with the Development Bank of Southern Africa for the project's debt; and a
- Contract with consulting engineers for the management of the construction of the project.

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<sup>37</sup> This approval was already necessary before construction could start since the ability to sell emission certificates (CERs) is what makes the project financially viable and was therefore critical in attaining commercial financing.

### Current status of the project

Despite the numerous problems and obstacles, which all have to do with the fact that the project is unique within South Africa being the first privately-owned independent power producer and first hydro-power project since new environmental and water use legislation came into effect during the late 1990s.

As listed in the previous section, the project has obtained a Record of Decision from the provincial Department of Environment Affairs after an independent study was conducted pertaining to the perceived environmental impact of the project. Currently all the agreements with the shareholders and the funding agent are in place, the first interest on the loan is expected to be at the end of 2007. All the hardware for the plant (most importantly the turbines) has been sourced and secured. Additionally, a civil engineering company has been contracted and the commissioning of the civil work is to start during October 2006 (personal communication 1, South Africa, 2006).

A power purchase agreement with the Dihlabeng local municipality in the town of Bethlehem will be secured as well (personal communication 1 and 2, South Africa, 2006). This agreement formed the basis of the loan agreement and the success of the project. The first power sales to the local municipality are expected to take place in November 2007. DNA host country approval has also been obtained, but the project still has to be registered with the executive board and this will be done within the next couple of months once it is sure when the plant will be commissioned. A CER purchase agreement with an independent private Dutch company has also been concluded and the first CER payment is expected early 2009 (personal communication 1, South Africa, 2006).

It should be evident from the above list that the stage is set for implementation. The next section will discuss the project's potential contribution to sustainable development.

## 6.3 Contribution to sustainable development

### Sustainable development in project documents

The main goal of the project has always been the reduction of GHG emissions by broadening the electricity mix in a town, Bethlehem, whose current electricity is exclusively based on coal-fired power generation (MoFA, 2001; NuPlanet 2006). Besides this, the project was expected to deliver several other side benefits. The first was the improvement of air quality and related health issues as a result of replacing some coal-generated electricity, which involves emissions of particulates, SO<sub>2</sub> and NO<sub>x</sub>. As a second benefit it was expected that the hydropower scheme would be able to supply electricity to the municipality at a lower cost than Eskom, which if passed on would benefit the local communities.<sup>38</sup> Third, the project's involvement of local labour, especially in the construction phase of the project, would contribute to the local economy. The project was not expected to have any gender related effects. Lastly, the

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<sup>38</sup> In MoFA (2001) a discount of at least ten percent is mentioned. This expectation was rather ambitious considering Eskom's low generation costs. These low costs are one of the reasons why IPPs have had such difficulty in the South African electricity market.

project would have to be financially sustainable, not being dependent on further development assistance (MoFA, 2001).

### Host government criteria

To get approval for the project from local, provincial and national government institutions the project had to conform to the relevant regulations and apply for the relevant permits and licenses. These have already been mentioned in [section 2.5](#), but those regulations and licences that are related to the three categories of sustainable development (i.e. social, environment and economic) are described here in a bit more detail:

- Obtain a Record of Decision (approval) after completing an Environmental Impact Scoping Assessment (full assessment was not required due to the small scale and limited impact of the project) for the construction and operation of the plants from the Free State Provincial government;
- Obtain Record of Decision (approval) after completing an Environmental Impact Scoping Assessment (full assessment was not required due to the small scale and limited impact of the project) for the construction and operation access roads and power lines the Free State Provincial government;
- Water Use Licence from the Department of Water Affairs and Forestry;
- Permission for subdivision of Agricultural land from the Free State Provincial Department of Land Affairs;
- Re-zoning of agricultural land from agricultural to industrial from the Free State Provincial Department of Land Affairs;
- Permission from Department from Water Affairs and Forestry (DWAF) to construct civil works in the DWAF servitude along the As Rivier;
- Shareholders Agreement with equity investors in the project;
- Loan Agreement with the Development Bank of Southern Africa for the project's debt; and
- Contract with consulting engineers for the management of the construction of the project.

*Environmental impact:* In the Environmental Impact Scoping Assessments (EIAs), the effect of the project on the environment is established, but also, through public participation, the social desirability of the project. As part of the EIA process Nuplanet and the Ninham Shand consultants therefore had to hold a public meeting to inform interested and affected parties about the project and to request the public's views and objections. The public participation process of the EIA is the most important opportunity the public has to voice its concerns, if any, against a project and, if the public does not support the project, an ROD cannot be issued. The public therefore has a legal right and ability to stop a project should the public find it undesirable. The meeting was publicised by advertisements in the local press, poster notices, and directed letters to identified parties, including the appropriate government institutions (Ninham Shand, 2003a). Twelve people attended the meeting, among which were local farmers, government employees, and a number of local people hoping to find employment in the project (Ninham Shand, 2003b). No substantive objections were raised, hence, together with the normal consultant's expert view on the limited impact on the environment, the government could issue the ROD.

*Water use:* The other major legal requirement was the attainment of the water use licence. In South Africa the government is the custodian over all water resources and has to take a macro-view on water allocation. Water has to be allocated fairly and to the most economic advantageous activity taking into consideration future development, economic growth, transformation (distribution of water to those who were formerly excluded from the use of the resource), and the ecological reserve. The ecological reserve is defined as the minimum flow requirement in the riparian system to maintain ecosystem function and domestic consumptive use. The ecological reserve cannot be allocated to industrial use. Before a water licence can be issued the ecological reserve for the river has to be determined and the impact of the application on the overall water yield and potential impact on the ecological reserve determined (DWAF, 1998). This is a cumbersome and long process, but, given the nature of Bethlehem Hydro's activity, it was found that their activity would not jeopardise the integrity of the ecological reserve nor would it influence future water use or allocation and therefore the company was issued a water use licence into perpetuity (personal communication 1, South Africa, 2006).

*Equity capital:* The major shareholder of the project will be the Central Energy Fund (CEF). While being fully owned by the national government, the CEF is financially independent and pays the government a dividend from its profits. This means it only invests in projects that it deems financially viable with the prospect of selling off their stakes at a profit at some future point in time. Besides compliance to the law, the CEF does not require any other SD contributions (personal communication 3, South Africa, 2006). During the late 1990s South Africa has also embarked on a process of active economic transformation through the Broad-Based Black Economic Empowerment Act (BBBEEA) whereby each company that wishes to trade with government (e.g. selling electricity to a local government) has to have a minimum black equity holding of 25.1% (RSA, 2003). Since CEF is the majority shareholder, but, in turn, owned by Government, their equity holding does not qualify under the BBBEEA. NuPlanet is not black-owned either and therefore it was important to draw a black equity partner into the fray, which is HydrowSA (see Figure 6.2). Without this essential requirement fulfilled, the project cannot go ahead since Bethlehem Hydro will not be able to sell its electricity. By fulfilling this requirement the project contributes to the empowerment of South Africa's citizens and the project therefore fulfils an important social contribution. The fact that HydrowSA is a woman's group is an added advantage.

*Loan Agreement:* Even though the name might suggest otherwise, the Development Bank of Southern Africa functions as a commercial bank offering similar terms and requiring similar certainties as other financial institutions. Both the shareholding of CEF and the loan approval by the DBSA imply that the project is commercially viable and financially sustainable on its own.

*The construction work:* For any government tender, the inclusion of black, female, and disadvantaged people is considered in the assignment of the project. The extent to which local workers are employed is also weighed in. Because the contract for the construction of the generating facilities for Bethlehem Hydro is between two private organisations these guidelines do not apply. However, the local municipality did request adherence to the guidelines, which means that local workers will be hired where possible and that thirty per cent of the workforce should consist of women (personal communication 1 and 2, South Africa, 2006).

*CERs:* Since Bethlehem Hydro intends to sell CERs it also had to obtain host country approval from the DNA country office that the project does contribute to the sustainable development strategy of South Africa. At this point the DNA only checks if the relevant permits and licences have been obtained. Basically this means that if a project wants DNA approval it cannot cause significant harm to the environment or have large detrimental social effects, but does not have to significantly add to sustainable development (personal communication 6, South Africa, 2006).

### Social aspects

When describing the contribution to the three building blocks of sustainable development a distinction will be made between the construction and operational phases, where this is relevant since they will have different impacts. Most of the impacts of the construction phase will be temporary. The impacts will be described in terms of the criteria mentioned in Section 6.3. Since at the time of writing, both the construction and operational phases still had to begin, the assessment is obviously of an *ex ante* nature.

#### *Poverty alleviation*

The project will create between 150 and 200 temporary jobs during the construction period and 3 permanent jobs during the operation. In a municipality where 10,000 households live below the poverty line and 40% of the economically active population is unemployed<sup>39</sup>, any new jobs are a positive development. However, since most jobs are temporary, it is unlikely that anyone will be permanently lifted above the poverty line. Those who will acquire new skills during the construction work will have a better chance of finding future employment. Still, on the whole, the project will only have a very minor impact on poverty alleviation. The temporary employment and income will be very important to the 150 to 200 households involved, however.

#### *Essential services*

Since the electricity supplied by Bethlehem Hydro will not connect new households to the grid, but only replace a share of the electricity currently supplied by Eskom, there is no extension of essential services (personal communication 1 and 2, South Africa, 2006). The project will increase the security of electricity supply as there will be two instead of one electricity supplier. It is expected that Eskom will struggle to keep up with rising electricity demand country-wide in the coming years.<sup>40</sup>

#### *Employment (job quality)*

The project will create 40 skilled, and 100 to 160 unskilled job opportunities during the construction phase. This phase will last for around 12 months, starting in October 2006 (personal communication 1, South Africa, 2006). However, most jobs will be for shorter periods. Three full-time permanent jobs will be created once the project is commissioned (personal communication 1 and 2, South Africa, 2006). Since the vast majority of the jobs are of a temporary nature without skills' requirements, the impact on the quality of local employment is considered a very minor benefit.

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<sup>39</sup> [www.statssa.gov.za](http://www.statssa.gov.za), accessed September 2006.

### *Empowerment*

In accordance to the Broad Based Black Economic Empowerment Act (BBBEEA), at least twenty five per cent of Bethlehem Hydro's equity will be held by black people, in this case a black women's organisation. While these are not local people, shareholding among the (female) population will increase, which can be considered a minor positive effect on distributional equity.

### *Gender*

Conforming to a government guideline, thirty per cent of the workforce should be female. This has been agreed upon with the contractor (personal communication 2, South Africa, 2006). Since this is a guideline and not a legal requirement it is hard to predict if this exact share will be reached. In any case it is unlikely that women will take up the skilled jobs in this project. However, it does mean some women will have temporary employment. Besides employment opportunities, twenty six per cent of the shares will be held by (black) women. Since HydrowSA is financing the share purchase with a loan, their income from the project will be limited. However, this group is involved in capacity building projects for women, so some of the financial gains from the project could help finance these activities. This is however uncertain.

### *Local skills development*

It is a governmental requirement that project developers educate their workers on HIV/AIDS through workshops held during their training. The civil engineering company contracted for this work will do likewise. Part of the temporary labourers will be trained in construction activities, which will increase the skills base in the community and the chance of future employment.

## Environmental aspects

### *Air quality*

*Construction:* Some dust may be generated but this is only temporary in nature. Furthermore, due to low population density in close proximity to the construction site the impact is considered to be of low significance (Ninham Shand, 2003a).

*Operation:* Since the electricity produced by Bethlehem hydro will replace coal-generated electricity, there are a number of positive effects related to avoided air pollution. Even though on a national scale these reduced emissions do not amount to much, they do remove fifteen to twenty per cent of the local emissions linked to electricity generation. The emission of particulates will be reduced by almost 12,000 kilograms, Sulphur dioxide (SO<sub>2</sub>) emissions will go down by 270 tonnes and emissions from Nitrogen oxides (NO<sub>x</sub>) by 120 tonnes.<sup>41</sup>

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<sup>40</sup> [www.eskom.co.za/live/content.php?Item\\_ID=1539](http://www.eskom.co.za/live/content.php?Item_ID=1539), accessed September 2006.

<sup>41</sup> These numbers are calculated using average emissions from Eskom's environmental report (2001).

### *Water quality*

*Construction:* Pollutants such as oil, fuel, construction materials (cement, detergents and paints) may find their way into the water. Water pH levels may increase during concrete works. Regarding sedimentation, relatively little of the site would need to be cleared during construction and accordingly relatively little sedimentation should occur. All these impacts will be very localised and brief and thus of low significance. In the environmental scoping report it was advised to re-vegetate the area after the works have been completed. This should mitigate most negative effects (Ninham Shand, 2003a).

*Operation:* The only effects on water quality are also related to the replacement of coal-generated electricity. When coal is mined it is piled before use, causing ground water pollution when substances are leached into the groundwater during and after the rains.

### *Water quantity*

*Operation:* The water use of the hydropower system is non-consumptive, so it will have no negative effect on the stream flow. Just a very short stretch of the river at the As River location will be diverted, but a minimum amount of water will be left for the original route of the river (Ninham Shand, 2003a). The As River has already changed character completely because of the Lesotho highlands water project, changing from a small seasonal river (with a flow between 4 and 12m<sup>3</sup>/sec) into one with a permanent strong stream flow (between 32 and 36m<sup>3</sup>/sec) personal communication 1 and 4, South Africa, 2006). Another effect on water quantity is the water savings again related to the replacement of coal-generated electricity (Eskom, 2001). These water savings amount to more than 41,000 m<sup>3</sup> a year. This is equivalent to the water use of more than 180 average households in South Africa. Considering South Africa's water situation this can be considered a reasonable side-benefit.

### *Water management*

The impact on water quality and quantity of the project will be of low importance in both phases, therefore not many mitigation and rehabilitation measures will be required. The only relevant impact will be on flow variation, which will negatively affect the microhabitat for invertebrates and the marginal vegetation. However, the original flow regime was already severely impacted by the LHWP.

### *Land quality*

*Construction:* There will be limited mechanical removal of topsoil due to the construction of temporary facilities (access roads, construction camp, storage, etc.), which will have a low impact on land quality. However, a large degree of litter and waste could be generated. This will have a low environmental impact if kept under control. There is a risk of erosion of embankments, slopes and topsoil as a result of increased run-off and construction of permanent structures and this impact is considered of medium significance. Overall, construction will have a minor negative effect on land quality (Ninham Shand, 2003a).

*Operation:* The impact of erosion downstream will be decreased due to the removal of high velocity water mass as a result of river diversion (Ninham Shand, 2003a). Overall, the operation phase will have a very small positive net effect on land quality.

### *Land-use change*

*Construction:* The establishment of a construction camp, storage and stockpiling areas and temporary access roads will be necessary. These impacts are considered of low significance.

*Operation:* The land at the Saulspoort dam site is currently owned by the town council and registered as agricultural land although no agriculture is practised there. Even though the formal status of the land will change, there will be no change in the actual use of the land. A very small wetland is situated at the As River site, which has already been significantly affected by the LHWP and agriculture in the area. The establishment of the dam wall and related infrastructure will further degrade it by creating a storage capacity that will result in flooding the wetland (Ninham Shand, 2003a; Site visits, 2006). Considering the small size of the wetland and its already degraded state means that further degradation does not amount to a major impact.

### *Land management*

The EIA suggests several mitigation and rehabilitation measures for each negative impact on land quality and land use change during both construction and operation phases. Thus this can potentially be considered a minor improvement on the negative impacts on land caused by the project activity.

With regard to the most relevant impact on land (loss of wetland) the project developer will pay for the rehabilitation of another degraded wetland at a different site. This will cost around 50,000 to 100,000 rand (5,000 to 10,000 euros) (Ninham Shand, 2003a; personal communication 1 and 4, South Africa, 2006).

### *Biodiversity quality*

The only effects on biodiversity are related to the flooding to the wetland at the As River site. As was explained before, the wetland is very small and already degraded. This, combined with the restoration of another degraded wetland, mean the combined effects on biodiversity are negligible.

### *Ecosystem functioning*

Again, the loss of the wetland at the As River site will be of detriment to the local ecosystem. However, due to the agreed rehabilitation of a wetland of equal or better quality the net impact will be zero.

### *GHG reduction*

In comparison with the baseline (ESKOM coal generated power) where the same amount of electricity that will be produced by Bethlehem Hydro (approximately 34,000 MWh annually) would cause emissions of around 33,000 tonnes of CO<sub>2</sub>, the mini hydro facility will generate power with zero GHG emissions (personal communication 1, South Africa, 2006). In relation to national emissions this mitigation is very small (just 0.02%), but it does reduce Dihlabeng municipality's electricity related emissions by 15-20 per cent, equal to the share of Dihlabeng's electricity that will be supplied.



### Economic aspects

Return on investment for the project is currently estimated to be twenty percent (personal communication 1, South Africa, 2006).<sup>42</sup> As a comparison, long-term bond rates are about 12 to 13 percent. Even though Bethlehem Hydro cannot match the low risk of bonds the ROI is close to twice as high, while the risks are still low to medium.<sup>43</sup> The capital costs are 64 MR (€6.4 million), which is equivalent to one million € per MW.

### *Energy expenditure*

The municipality will save a small amount on its electricity cost of 300,000 - 500,000 R per year. This amounts to about one per cent of Dihlabeng's current electricity costs. Even though Bethlehem Hydro supplies the municipality at the same rate as Eskom, it cannot guarantee continuous peak hour supply and therefore cannot charge peak hour tariffs. Bethlehem Hydro will however almost always supply during the peak hours and that is why Bethlehem municipality will save on Eskoms peak tariffs (personal communication 1, South Africa, 2006).

### *Employment*

150-200 job opportunities (not man years) will be created during construction and 3 jobs for operating the facilities. The contractor will use local labour where possible. Considering the large unemployment in Dihlabeng municipality (approximately 20,000 out of an economically active population of 50,000) every new job is welcome. Due to the temporary nature of almost all the jobs, this can be considered a small benefit.

### *Impact on economic activity of the area*

The civil contract to build the facilities has gone to a contracting company based in Johannesburg. Of the 24 MR contract, 10-15 MR will be spent in the municipality (personal communication 1, South Africa, 2006). Compared to the size of the local economy this is very little. For the local firms that will be subcontracting, this is a medium to large assignment.

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<sup>42</sup> The expected ROI has increased as a result of the expansion of capacity, higher electricity tariffs and the higher price of the CERs.

<sup>43</sup> The risk from hydrological instability is reduced by the Lesotho Highlands Water Project. The project has secured (non-consumptive) water use rights of 24m<sup>3</sup>/sec. If other parties extract water from the river that would reduce the flow below 24 m<sup>3</sup>/sec they will have to compensate Bethlehem Hydro (Olivier, 2006). The two main sources of revenues will be secured shortly. The first, the revenues from the sale of electricity, by the PPA with Dihlabeng municipality, and the second through a purchase agreement for the CERs with a private Dutch trading company. To reduce the risk of default by the Local Council an escrow account will be established into which Dihlabeng's major creditor's (commercial and industrial companies situated in Bethlehem) funds will be deposited (personal communication 3, South Africa, 2006; Nuplanet, 2003a). The credit risk of Dihlabeng will further be mitigated by the debt provision by the DBSA to Bethlehem Hydro. The DBSA as lender to Dihlabeng and is therefore very well informed of the Council's financing and will further ensure that default risk is mitigated. Through the purchase agreement for the CERs, all produced CERs will be bought by the Dutch company, against a fixed price for part of the CERs and a percentage of the market price for the remaining part.

*Attraction of green investment*

The municipality hopes that it can use green electricity as a marketing tool to give it a competitive edge over other locations for attracting firms that consider investing in the area – especially foreign firms (personal communication 2, South Africa, 2006). Since this is not a region where a lot of investment takes place, this expectation seems a bit ambitious.

*Transfer of technology to host country*

The turbines are the only technology being imported into South Africa (personal communication 1, South Africa, 2006).<sup>44</sup> Since this technology is already well established in South Africa, there will be no new technology transfer.

*Demonstration effect and replication potential*

Besides the reduction in CO<sub>2</sub> emissions the demonstration effect is one of the major benefits of the projects. Because it is the first independent hydropower producer in the country since democracy was introduced in 1994, the new laws that apply to such a specific project had not been used before and because of this inexperience it took a great deal of effort and time to receive all relevant licences and permits. Now that Bethlehem hydro can act as an example future projects should have less difficulty attaining the necessary permissions and the related transaction cost should be lower. About twelve new hydropower projects are currently being set up. Nuplanet is involved in 3 or 4 of these. These projects are currently in the pre-feasibility phase. Although in the future it may appear to be simpler to gain access to these licenses, there will undoubtedly be a number of challenges. Some of the necessary licences are provincial and hydropower projects in other provinces will still be new to those authorities. Also land ownership is a major issue for new projects. These kinds of projects can only become viable if the developers can obtain ownership or lease contracts for land adjacent to the water resource during the lifetime of the project. Water in South Africa belongs to the government, but land can belong to anybody. In this case the land belonged to the municipality (at the dam) and a private farmer (at the As River site). Agreements with both parties for land use have to be obtained (a purchase agreement in the case of the dam and a land lease in the case of the river) and a water use licence from the national department to get the right to access and utilise the resource (personal communication 1 and 5, South Africa, 2006).

*Design and operational efficiency*

The capacity of the scheme has risen steadily over the development period. In 2003 the feasibility study anticipated a capacity of 3.9 MW, the final technical report in May 2006 expected 5.5 MW, and the final capacity will now be 7 MW (Nuplanet, 2003a; 2006; personal communication 1, South Africa, 2006). Whether the expected output will be achieved can only be determined once the generators are up and running.

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<sup>44</sup> The main technical components of the turbines are Spanish, but they will be assembled in India and imported from there.

## Synthesis

Scores relating to the magnitude of the effects discussed above have been assigned in Table 6.3.

*Table 6.3 Criteria for evaluating sustainability Bethlehem's hydro project*

Criterion	Indicators	Score (-2 to +2)
<b>ENVIRONMENTAL SUSTAINABILITY</b>		
Air resources	Air quality	<b>0-1</b>
Water resources	Water quality	<b>0</b>
	Water quantity	<b>1</b>
	Water management	<b>Na</b>
Land resources	Land quality	<b>0</b>
	Land-use change	<b>-1</b>
	Land management	<b>+1</b>
Other resources (_____)	Other resource (_____) quality	<b>Na</b>
	Other resource (_____) quantity	<b>Na</b>
	Other resource (_____) management	<b>Na</b>
Biodiversity & Ecosystems	Biodiversity quality	<b>0</b>
	Ecosystem functioning	<b>0</b>
Impact on climate change	Reduction in GHGs	<b>+2</b>
<b>Financial viability</b>		
Financial viability	Return on investment	<b>+2</b>
Effects on local/regional economy	Energy expenditure	<b>0-1</b>
	Employment (numbers)	<b>+1</b>
	Impact on economic activity of area	<b>0-1</b>
	Attraction of green investments	<b>0-1</b>
Effects on national economy	Impact on balance of payments	<b>Na</b>
	Economic growth	<b>Na</b>
Technological sustainability	Technology transfer and self-reliance	<b>0</b>
	Demonstrational effect and replication potential	<b>+2</b>
	Design and operational efficiency	<b>+1</b>
<b>Livelihoods of the poor</b>		
Livelihoods of the poor	Poverty alleviation	<b>0-1</b>
	Distributional equity	<b>Na</b>
	Access to essential services	<b>0</b>
	Access to affordable clean energy services	<b>Na</b>
	Impacts on human health	<b>0</b>
Human capacity	Employment (job quality)	<b>0</b>
	Empowerment	<b>+1</b>
	Gender equality	<b>0-1</b>
	Local skills development / education	<b>+1</b>
Human environment	Preservation cultural / natural heritage & aesthetics	<b>Na</b>
	Relocation of communities	<b>Na</b>

To summarise, Bethlehem Hydro's contribution to sustainable development was from the start seen as coming from the replacement of coal-based electricity generation and the related reduction in greenhouse gas emissions. The project was not set up as a social development project. However, the project does have important side effects that also contribute to certain elements of sustainable development as defined by the framework mentioned in section 6.3.

The project has a few minor social benefits related to the employment opportunities the construction work creates. Another social benefit is the further involvement of women in society, again both by offering them employment, but, perhaps more importantly, by their role as shareholders in the company.

Besides the reduction in greenhouse gas emissions, other important positive environmental benefits of the project are the reduced emissions of particulates, SO<sub>2</sub> and NO<sub>x</sub> linked to coal combustion. While these effects are small on a national basis, the project does make a contribution to cleaner air. The same is true for water consumption, which is also reduced due to the replacement of coal-generated power. The only negative environmental effect of the project is the flooding of a small, already degraded wetland. Since this effect is mitigated by the restoration of another wetland, this negative effect is evened out.

Economically, the project has proven its capability to stand on its own feet. Without financial viability no project can be deemed sustainable. This viability is proven by the Bethlehem Hydro's ability to find – both equity and debt – funding in the commercial market. The other major economic contribution has been the project's pioneer role for other independently operated electricity generation projects, especially for hydropower. By being the first such project in South Africa's new era it has partly paved the way for an expansion of independent hydropower in South Africa. Partly as a result of this, several other hydropower projects are currently being developed.

Other small economic benefits of the project are the temporary employment opportunity it provides for the many unemployed in the area and the small saving on electricity cost by the Dihlabeng municipality.

If we then compare the currently expected and already achieved contributions to sustainable development with the expectations at the beginning of the project, we see that the project has met all of these, although the savings on the electricity costs by the municipality are smaller than expected. Moreover, and very importantly, the project also acts as an example to other mini hydro projects. This is probably its major contribution next to the reduction in greenhouse gas emissions.

## 6.4 Inferences

### Successful and less successful aspects of the project

When discussing the contributions the Bethlehem Hydro project will make to sustainable development, it should be stated that it was never intended as a social development project. The main goal of the project has always been the generation of clean electricity whereby greenhouse gas emissions would be reduced. The project was however expected to have several positive side effects. These have all been attained with perhaps the exception of lower electricity prices.<sup>45</sup>

So far, the project can be considered successful and less successful in a number of ways:

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<sup>45</sup> Even though the municipality of Dihlabeng will save 300,000 to 500,000 R on their electricity bill, the discount of ten per cent on Eskom's rate that was expected in the initial stages of the project will not be met.

- The Bethlehem Hydro project scores **positively on all categories** of sustainable development. The only significant negative impact overall is the flooding of a small wetland, which will be compensated for by restoring another degraded wetland. On all other criteria the project has a neutral or positive score.
- The most important effects are the improvements to the environment, both global through the reduction of **greenhouse gas emissions**, as national or local though reduced air pollution and water usage related to coal generated power.
- In the economic category, the most important elements are the projects financial sustainability and its role as an example to other project developers that hydropower can be generated and sold by independent power producers. After the contribution of the Netherlands Ministry of Foreign Affairs to the transaction costs of establishing the business case for the project, it could find **finances in the commercial market**. The high transaction costs were due to the fact that the relevant legislation had to be implemented for the first time, which took a lot of time. Now that such a project has proved possible and other project developers can refer to the case of Bethlehem Hydro, transaction costs will have been lowered.
- The project only makes a minor contribution to the social element of sustainable development. Most important in this regard is the **skills training** that the construction workers will receive.
- Overall the project promises to have a number of small and a few larger positive side effects. Considering the **multiple delays** in the project it can with hindsight be argued that the upfront expectations were totally unrealistic, as also stated in the final technical report of the project (NuPlanet, 2006, p.10). However, in the end the project objectives that the DGIS contribution intended to support have been achieved. This, together with the move to a viable CDM project, which, through the sale of CERs will make it possible for the project to compete with the national energy's suppliers low electricity prices, makes us conclude that the project has been successful up to now. After the power plants will be commissioned and operations will start, it will be possible to see whether the Bethlehem Hydro project can live up to its promises.

### Lessons learnt

If we take a look at the broader picture of Dutch development aid spending, there are three key lessons that can be learnt from this project.

- First, contributions in the early phases of small clean energy projects can lead to financially viable projects by **taking away the large risk** that such projects are viewed to embody.
- Second, by helping to establish new projects and ideas that are viable without outside assistance but due to inexperience have never been tried before can have **large spin-off effects**, giving the initial contribution a larger effect.
- Last, targeting such projects means that **delays and other problems are inevitable**, and should be taken into account.

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## Internet resources

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- <http://www.statssa.gov.za>

## 7. Shandong improved greenhouses (China)

*Lu Yonglong, He Guizhen, Han Jingyi, Sun Yamei, Shi Yajuan, Drs.MA Hua<sup>46</sup>, Luke Brander<sup>47</sup>*

### 7.1 Introduction

This chapter analyses the impacts on sustainable development of the Shandong improved greenhouses project. The Shandong improved greenhouse project was intended to lead to widespread commercialization of feasible, low-cost, new and renewable energy concepts in the horticulture sector of Shandong province with significant improvement in the quantity and quality of crop yields. In turn, this should reduce the penetration of fossil fuel-intensive glasshouse horticulture in Shandong and, at the same time, reduce emissions of greenhouse gases (GHGs) by this sector.

The project aimed to construct, demonstrate, and compare three types of greenhouse design:

1. The traditional Chinese ‘sunny greenhouse’<sup>48</sup>;
2. The Dutch ‘Venlo’ greenhouse; and
3. A hybrid of these two types with solar heating panels.

This project has been mainly financed by the Directorate General for International Cooperation (DGIS) of the Netherlands’ Ministry of Foreign Affairs and the Government of the Province of North Holland, while counterpart financing was provided by the Ministry of Science and Technology of China, and the Municipality of Shouguang. The project has been implemented under the responsibility of the Energy Research Centre of the Netherlands (ECN) on the Dutch side and Shouguang Municipal Agricultural Committee (SMAC) on the Chinese side. The ultimate Receiving Party is the Shouguang Agriculture Hightech Demonstration Park (SAHDP), Shouguang City, Shandong Province, China.

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<sup>46</sup> Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing, China.

<sup>47</sup> Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands.

<sup>48</sup> The local ‘sunny greenhouse’ in China is a relatively low cost greenhouse, which is just capable of keeping the in-greenhouse temperature above 0°C during winter months. The price of a sunny greenhouse varies from 30,000 to 50,000 RMB depending on the quality of materials used. Its structure consists of a single wall made of clay or brick, which supports arches of metal or bamboo. The clay wall forms the north side of the greenhouse and stretches from east to west. The arches face south and are covered with plastic sheeting. The wall acts as a store of heat, which is released during the night. To prevent large heat loss during the night, the plastic sheeting is covered with a straw mat. The straw mat is rolled down in the evening and pulled up again in the morning. Most sunny greenhouses are dug a little into the ground for additional ‘thermal stabilization’. A large drawback of this design of the greenhouse is the poor ventilation system, resulting in very high humidity levels inside the greenhouse. The high humidity levels make crops vulnerable to diseases and limits the variety of crops that can be grown.

## Horticulture sector in Shandong

China is a traditional agricultural country with a history over 5,000 years. Currently 70% of the Chinese population live in rural areas. At the beginning of the 1980s, the first prototype of the Chinese 'sunny greenhouse' was developed in Shandong Province using local materials only. It is an excellent example of locally developed, relatively simple, low-cost, but quite effective renewable energy technology. The Sunny Greenhouses technology has enabled farmers to grow vegetables and to supply urban markets on a year-round basis. In the mid-1990s, about 20,000 hectares of 'sunny greenhouses' were in use in China, half of which are in Shandong Province. Currently, the area covered by 'sunny greenhouses' is at least 300,000 hectares across China, and about 34,000 hectares in Shandong.

Shouguang City is located in the centre of Shandong Province, which is regarded as the cradle of the Chinese horticulture technology and as a showcase for diffusion across China. At present, the area covered by sunny greenhouses is at least 8,000 hectares. 70% of income for local farmers came from the greenhouse vegetable planting. From the central market of Shouguang, horticultural products are transported nationwide. The annual agricultural exhibition of Shouguang draws visitors from all over China.

The current sunny greenhouse embodies some quite appealing features of passive solar energy application. Prior to 1990, one greenhouse used 5-6 tonnes of coal for heating in winter in Shandong Province. At the present time no substantial additional heating is applied, if at the loss of quantity and quality of crop yields. The main disadvantages of the sunny greenhouses are the unsuitable temperature range for a number of vegetables, the poor humidity regulation for less optimal growth and idle land surface. Though state-of-the-art western horticulture technology could overcome the limiting factors mentioned above, it requires a large investment and substantial additional heating. It may be necessary to improve and introduce western technology and make it affordable and profitable for the Chinese farmers.

## Methodology

In the process of carrying out the case study, a review of project documents, a literature study, interviews, a questionnaire, and a site visit were conducted. All key actors on the Chinese side were interviewed to get information on the project background, implementation, and current status, as well as their opinions of the project. The main questions addressed: Has the project in Shouguang met the goals as set out at the start of the project? What have been the success factors and what have been the failure factors? How did the project contribute to sustainable development? Face-to-face interviews, complemented with questionnaires, were also conducted with local farmers to get their opinions on the project and needs for further development.

## Structure of the case study

The structure of the remainder of this report is as follows: Section 7.2 sets out the historical evolution of the project. Section 7.3 describes the expected impacts of the project on sustainable development and examines the impacts that have been realised. Section 7.4 discusses the potential for the evolution of this project under the CDM. Section 7.5 provides conclusions and lessons learnt.



## 7.2 Evolution of the project

### How the idea was born

In the 1990s, many horticulture-oriented Dutch companies were looking for business partnerships in China and more specifically in Shandong Province. Dutch horticulture companies observed that yields in the traditional Chinese greenhouses were substandard in both quantity and quality terms. The main reason appeared to be the poor control of in-greenhouse climate conditions (i.e. a large temperature range and at times high moisture levels). On the other hand, replacement by advanced western greenhouses would require high capital investments beyond the reach of ordinary Chinese farmers. Moreover, wide-scale penetration of western greenhouses would result in egregious increases in energy demand from Chinese horticulture with associated massive increases in greenhouse gas emissions.

In 1997, ECN was requested to investigate the possibilities in Shandong Province for the application of renewable energy concepts to the 'sunny greenhouse' so as to improve in-house climate conditions for vegetable growing at affordable additional costs. In 1998, ECN submitted the first draft proposal to DGIS to conduct a pilot project to be financed in the framework of the PPP/JI programme as an Activity Implemented Jointly project. The ECN proposal matched perfectly with the ongoing Sino-Dutch business collaboration activities in the horticultural sector in Shandong, while at the provincial level strong support existed on both sides. Moreover, representatives of the municipality of Shouguang emphatically showed their great eagerness to host the proposed project activity. Nevertheless, it took quite some time from the date that the project idea was born to the project start in April 2002.

### Justification and purpose of the project

This project fitted well with the Chinese development objectives and has the implicit approval of local, regional, and national Chinese authorities. China is a signatory of both the Climate Change Convention and the Kyoto Protocol, and is also keen to undertake AIJ projects. Some direct and local benefits expected from the project were:

- Transfer to China of renewable energy technology for improved climate regulation in greenhouses.
- Enhanced local capacity to apply renewable energy technology for horticulture and to monitor the performance of greenhouses.
- Improved competitiveness of the local solar greenhouse technology compared to the state-of-the-art western greenhouse technology, with associated lower investment requirements and more use of local inputs.
- Higher yields per unit of investment, per unit of land, and per unit of labour input.
- Raised horticulture export earnings.
- Raised productive employment opportunities in horticulture and related sectors.
- Lower fossil fuel requirements in the horticultural industry, resulting in lower adverse impacts on the environment.
- Lower GHG emissions in the horticulture industry of China.
- Lower GHG emissions in the construction of components of improved sunny greenhouse, compared to the western greenhouse components (glass, frames).

The objectives of this project also fitted well with the general development objectives of DGIS and Dutch energy policies. The project addressed some of the key issues treated in the Dutch Energy Policy Document “Sustainable Energy Economy” (DGIS 1990).

### **7.3 Project organisation**

DGIS of the Netherlands Ministry of Foreign Affairs and the Government of the Province of North Holland are the main funding sources of this project, while the Ministry of Science and Technology of China, and the Municipality of Shouguang provide counterpart financing. The project has been implemented under responsibility of the Energy Research Centre of the Netherlands (ECN) on the Dutch side and Shouguang Municipal Agricultural Committee (SMAC) on the Chinese side.

A breakdown of total costs and financial responsibilities was clearly illustrated in the project proposal. The total project cost was budgeted as €796,559, comprising €165,338 from the Dutch partners and the remaining €543,188 from PPP-JI programme. In addition, the (in kind) contribution of the Chinese partners was expected to be €88,033 (Appraisal Memorandum DML/KM – 12/01; document available with author).

The ultimate receiving party is the Shouguang Agriculture Hightech Demonstration Park (SAHDP), Shouguang City, Shandong Province, China. Chinese main project partners are listed as follows:

- Shouguang Municipal Agricultural Committee (SMAC) – coordinating party on the Chinese side
- Wanfang Flower Company – initially the receiving party, later was replaced by SHADP
- Shouguang High-tech Agriculture Demonstration Park (SHADP) – the eventual project recipient, replacing Wanfang Flower Company
- SANGLE - solar equipment manufacturer
- Energy Research Institute, Shandong Academy of Sciences (SDERI) – designing solar energy system and in-greenhouse climate monitoring system; supervising greenhouse performance monitoring; tuning joint field activities of Chinese and Dutch partners.
- Chinese Academy of Agricultural Sciences (CAAS) – Chinese counterpart for baseline and monitoring study.

Dutch Partners consist of:

- Directorate General for International Co-operation, the Netherlands Ministry of Foreign Affairs (DGIS).
- Energy Research Center of the Netherlands (ECN) – coordinating party on the Dutch side, main contractor.
- Debets Schalke B.V. – greenhouse builder.
- Rijkszwaan Qingdao (RZQ) – tomato seeds provider during planting experiments.
- ETC – responsible for baseline and monitoring study.

Furthermore, the (Dutch) Foundation for Shandong – North-Holland Agricultural Cooperation (SNAC) played an important advisory role. Other sections in the Shouguang Municipal Government also contributed to the project implementation.

In the project proposal, government agencies received more attention than end-users. There was no adequate analysis of end-users' functions and capacities. Furthermore, there was no effective coordination mechanism among the involved parties, and their assignments and responsibilities in the project were not clearly defined.

### Pre-project assessments

In the project proposal, it is stated "a realistic baseline scenario over the period 2000-2010 for greenhouse-gas emissions by the horticulture industry in Shandong and China without project implementation needs to be developed". In 2004, the consultancy firm ETC conducted a feasibility study for such a baseline and monitoring study. This feasibility study concluded that the baseline and monitoring study should not be continued due to the absence of production data for the 2004-2005 winter cropping season, uncertainties with respect to the base-case and project case, and various cooperation problems encountered (ETC 2005).

### Time frame

The proposed project duration was 28 months with a starting date contingent on project approval. Following signing of the implementation agreement in April 2002, the project was scheduled to be completed by the end of April 2004. However, the parties directly involved in the project were informed with very short notice in advance, and the assignment of responsibilities was not clearly delineated in the agreement document. Draft pro forma subcontracts were not arranged while the broad draft budget had been approved without due consultations. Moreover, individuals and companies that had been involved in writing the project proposal in 1998 had since moved position or lost commercial interest during the four years prior to approval. The project eventually lasted for about 39 months due to two 'accrued' extensions and was finally completed at the end of August 2005.

The project consisted of nine phases with each comprising a number of activities as listed below:

- Inception mission
- Design of baseline scenario
- Design of prototype greenhouse
- Manufacturing and delivery of Dutch components
- Construction of prototype greenhouses
- Performing tests with growing vegetables
- Performance measurements
- Design of business plan
- Preparation of large-scale implementation of the selected greenhouse technology

A detailed project schedule with deliverables and deadlines could not, however, be found from the project documents, or from interviews.

The timeline of main events in the project development is as follows:

- 1997: ECN was requested to investigate the possibilities in Shandong for the application of renewable energy concepts to the local 'sunny greenhouse' so as to improve in-house climate conditions for vegetable growing.

- 1998: ECN submitted the first draft proposal to DGIS to conduct a pilot project to be financed in the framework of the PPP-JI programme as an AIJ project.
- 2<sup>nd</sup> April 2002: The official signing of the agreement on the implementation of the 'JI/Shandong Improved Greenhouses' project at the Dutch Embassy in Beijing.
- July 2002: Subcontract was signed with Debets-Schalke for delivery of greenhouses.
- April 2003: The first container arrived in China.
- August 2003: The second and last container arrived in China.
- August 2003: An official mission from Shandong with delegates of Shouguang municipality visited Holland. A change of recipient, from Wanfang Flower Company to the Shouguang High-tech Agriculture Demonstration Park, was agreed upon.
- Mid-2004: A project extension up to April 2005 was requested and granted by the project-funding organisations.
- August 2004: A mission by Messrs. Zwanenburg and Jansen was fielded by DGIS to make separate arrangements for conducting an AIJ baseline determination and monitoring study. In view of the great difficulties facing the project-implementing organisations, adjusted project scope was approved.
- End of 2005: Construction of experimental greenhouses was completed.
- January 2005: Accrued implementation delays necessitated a request for a second and final project extension until end of August 2005. This request was granted by the project financing agencies.
- February 2005 – August 2005: An experimental in-greenhouse climate measurement programme and an experimental planting and harvest yield measurement programme were conducted during a key planting season.
- October 2005: The project ended with the ECN final report (Jansen et al. 2005).

### Project approval

After lengthy approval procedures, the official signing of the agreement (between Ministry of Foreign Affairs, the Netherlands and Ministry of Science and Technology, China) on the implementation of the 'JI/Shandong Improved Greenhouses' project took place at the Dutch Embassy in Beijing on 2 April 2002 (Jansen et al. 2005).

### Current status of the project

The project witnessed a succession of unexpected adverse events during both the greenhouse construction and planting experiment phases, which negatively affected its implementation. As a result, implementation took much longer than expected. Moreover, the project objectives were adjusted several times and eventually only part of the project work plan drawn up at project inception could be carried out.

## 7.4 Contribution to sustainable development

### Sustainable development in project documents

The sustainable development aspects of the project are not dealt with in much detail in the project documents. Regarding social impacts, the appraisal memorandum (Beoordelingsmemorandum 2001) only states "the project is neutral concerning women and development."

Regarding the economic impacts of the project, the following statements are made:

“If the targeted project results are met, the project will contribute to the growing economic branch constituted by builders and contractors of the greenhouses. Increased labour opportunities may influence local labour market positively. In a general sense it can be said that the project will benefit the lives of the rural population, but the connection is only indirect. The project contributes to the macro-economic development of the country.”

There is a substantial amount of training and transfer of technology and expertise to the Chinese counter-partners. The 28-month project period allows for a complete process of technology transfer. This is a major evaluative aspect arising from our set of sustainability criteria as they have grown throughout the years of experience with technology transfer in the Programme on Pilot Projects for Joint Implementation (PPP-JI). The sustainability of the project is further enhanced by the long-standing involvement of the Province of North Holland in the province of Shandong in China.”

It is noteworthy that the available project documents do not deal with environmental impacts of the project and do not describe a baseline scenario for greenhouse gas emissions in the Shandong horticulture sector. The focus of the project development is clearly on technology development, testing, and transfer and not on the wider potential impacts on sustainable development.

### Host government criteria

Since the promulgation of Agenda 21 by the United Nations in 1992, nations around the world have taken actions to promote sustainable development. Since 1992, the Chinese government has taken a host of actions for bolstering the implementation of Agenda 21. In 1994, the Chinese government formulated and adopted *China's Agenda 21—White Paper on China's Population, Environment, and Development in the 21st Century*, the first country in the world to do so. According to *China's Agenda 21*, the strategy of sustainable development of China consists of three integrated parts - sustainable economy, sustainable society and sustainable environment and natural resources.

According to “*Interim Measures for Operation and Management of Clean Development Mechanism Projects in China*” issued on May 31, 2004, by the State Development and Reform Commission (SDRC), the Ministry of Science and Technology (MOST) and the Ministry of Foreign Affairs (MFA), Sustainable Development Criteria of China in the field of energy also consists of three aspects: social, economic and environmental.

- *Social Criteria*: Improve quality of life; Alleviate poverty; Improve equity
- *Economic Criteria*: Provide financial returns to local entities; Result in a positive impact on balance of payments; Transfer new technology
- *Environmental Criteria*: Reduce GHG emissions; Conserve local resources; Reduce pressure on local environments

Sustainable Development Criteria of CDM projects can also be found in this governmental document as:

- Implementation of national economic and environmental strategy;
- Transfer of technology and financial resources;

- Sustainable ways of energy production;
- Increasing energy efficiency and conservation;
- Poverty alleviation through income and employment generation;
- Local environmental co-benefits

### Social aspects

Local farmers in Shandong have not adopted the improved greenhouse technology. Hence, the impacts on sustainable development of this project are effectively zero. The assessment of sustainable development impacts described below is therefore speculative, and describes potential impacts if the improved greenhouse technology were to be adopted.

#### *Poverty alleviation*

In general, the improved greenhouse designs are not acceptable in rural areas because of their high initial investment costs, which are 10-20 times more than that of the traditional greenhouses. No additional subsidy is provided by the project to local farmers to adopt the new technology. In this case, the project made few contributions towards local poverty alleviation.

#### *Gender equality*

Compared with the traditional 'sunny greenhouse', improved greenhouses have a longer functioning lifespan. In other words, improved greenhouses could reduce time and labour input into greenhouse construction. Therefore, local farmers, especially women, could have more time for education or recreation.

#### *Employment (job quality)*

Improved greenhouses provide a better working environment. Owing to the improved ventilation system, the concentration of gases, e.g. CO<sub>2</sub> and NH<sub>3</sub> (produced because of fertilizing too many Ammonium Acid Carbonates) in improved greenhouses were much lower than that in traditional greenhouses.

#### *Capacity building/Education*

During the construction phase, training or skills development for workers took place. At the same time workers could learn some automatic control technologies from foreign specialists. The training and learning experience contributed to their skills set.

### Environmental aspects

#### *Resource use*

Resources utilisation in the project mainly included glass, steel, aluminium straps, solar collectors, and plastic sheeting. If the improved greenhouse design would become widely adopted it would increase revenues in the related industries and increase job opportunities.

*Air, Water, and Land quality*

The improved greenhouse design has the potential to have several positive impacts on water and land quality.

- In the improved greenhouse design, a dripping irrigation system was adopted, so less fertilizer and pesticide is used and lost. For the same planting scale, 25% less fertilizer is needed in improved greenhouses than traditional ones.
- The project has a potentially positive impact on water quality. It may alleviate the eutrophication because of reduced emissions of Nitrogen and Phosphate.
- The improved greenhouse design could also have lower impact on local land quality, with less soil pollution and salinization.
- Another benefit of using drip irrigation was that it could save 30~50% irrigation water. No big difference has been recorded in usage of pesticide between sunny greenhouses and improved greenhouses.
- Less plastic sheeting is used which reduced “white pollution”. For constructing traditional greenhouses, considerable amounts of plastic sheeting is used and replaced every year. Normally 20% of ground sheeting was left in the soil. Improved greenhouses avoided using plastic sheeting, which could reduce soil pollution.

*Reduction in GHGs*

The expectation that the project could reduce GHG emissions was not verified at the time of assessment.

- An estimation of how much GHG is offset was not made because the baseline emissions were not determined.
- Farmers in Shouguang had virtually stopped using heating systems in sunny greenhouses since the beginning of the 1990s. In other words, there were no emissions of GHGs from sunny greenhouses. The improved greenhouse thus had no obvious advantage in reducing of GHG emissions in this area.

**Economic aspects***Employment*

There were about 17,000 specialized households, associations, combos, vegetable brokers and 100,000 people engaged in vegetable cultivation, transportation, and trading in Shouguang City in 2005. Improved greenhouses could provide increased labour opportunities, including for greenhouse material producers, greenhouse builders, contractors, and market traders.

*Technology transfer*

Improved greenhouse design could improve the quality of agricultural products, which could be sold at higher prices than before. They could also allow the cultivation of a wider variety of crops. Moreover, the technology can be maintained locally. Most of the equipment and parts are available in the local market.

The novel technology was not affordable for most of the local farmers. According to the interview results, 15 out of 27 farmers thought that the greatest barrier for popularising improved greenhouses was its high cost, followed by the complicated maintenance and

management of the improved greenhouses. Most of the sunny greenhouses used by the local farmers did not need heating unless the weather was exceptionally cold. Usually, the period for which heating is necessary is about 10-20 days, and only 200-400 kg of coal was used for each greenhouse. The results of the survey of 27 local farmers indicated that only two people heated their greenhouses during cold winters.

#### *Attraction of green investments*

Improved greenhouses could increase the attractiveness of the local area for green investment.

#### **Synthesis**

The project could potentially have contributed to sustainable development in China in optimal project scenario. However, dissemination of the improved greenhouse design has not taken place. As a result, the project has had a slight and unquantifiable impact on local sustainable development. Several conclusions can be drawn:

- The project has had very limited effects on local sustainable development. The Chinese recipients have become acquainted with the new technology and to some extent the local capacity building was enhanced.
- A baseline study of GHG emissions in the greenhouse sector was not carried out and the potential for GHG emissions reductions from the adoption of the new technology was not assessed. The results of the present study suggest that baseline emissions are close to zero, and the potential for emissions reductions is therefore minimal.

The project brought together the different sectors including technical, economic, energy management and corporations and established a platform for communication and cooperation. The project experienced serious communication problems between Dutch and Chinese partners and can thereby provide lessons for similar future international collaborative projects.

#### **7.5 Evolution to a CDM project**

At the stage of the project proposal, the Ministry of Science and Technology of China has proposed a Steering Committee for monitoring the results related to the rules and regulations stemming from the UNFCCC. By the end of the project, the Ministry of Science and Technology of China has informally indicated clear interest in the development of any commercialisation activity in China of 'improved low energy greenhouse' concepts.

In view of the case study results, it has been shown that the project's contribution to sustainable development is still elusive. Moreover, there is considerable doubt whether the project is capable of achieving GHG emission reductions given that local farmers have almost entirely stopped using fossil fuel heating systems in the traditional greenhouses. The acceptance of this project under the CDM is highly unlikely unless the improved greenhouse technology becomes widely adopted and the baseline scenario for sunny greenhouses involves the use of fossil fuels for heating.

A realistic baseline emissions scenario would need to be developed in order to evaluate the potential GHG emissions reductions. The baseline scenario requires a detailed



understanding of future trends in the use of fossil fuels in greenhouse heating and growth rates for the horticultural industry. Currently very few farmers in Shandong use any form of heating in their greenhouses during the winter and so current baseline emissions are effectively zero. Growing conditions, however, could potentially be improved if farmers did use some heating in cold conditions. At the same time, there is growing demand for higher quality horticultural products. It is therefore possible that the use of heating could become financially feasible, and therefore that emissions could increase in the future. The description of a baseline scenario for greenhouse gas emissions from the horticultural sector would need to consider such future developments.

## 7.6 Inferences

### Successful aspects of the project

Although no one could regard the project as perfectly implemented, we recorded some positive feedback during the case study.

The project **idea was favourable**. A major achievement of the project is the demonstration of an 'improved sunny greenhouse' concept with locally produced solar-water-heating collectors to provide additional heating during the winter vegetable growing season. The introduction of advanced greenhouse technology to China enlightened local farmers on greenhouse design. New greenhouses, which look similar to the Venlo-type, can now be found in Shouguang. During interviews, several local farmers expressed their enthusiasm for a pilot project on the Dutch greenhouse if they can receive adequate subsidy.

The **project site was carefully selected**. Shouguang is the cradle of Chinese horticultural technology. Greenhouse technology has been used and developed for over twenty years. Compared with other places in China, the improved greenhouse technology can be more easily accepted by the local farmers. Shouguang also acts as the horticultural technology showcase for China. Once a new technology has been adopted in Shouguang, greater demonstration effects could be obtained than in other places.

The project **fitted China's energy policy**. China has set goals to increase the share of renewable energy up to 15 percent in total energy consumption by 2020. Reduction of fossil fuel use in the agricultural sector is seen as an important element in achieving this goal. Improved greenhouses used solar energy, instead of fossil fuel, to increase in-greenhouse temperature in winter. This design has good potential to reduce local fossil fuel consumption and GHG emissions.

### Less successful aspects

Flaws in project design and implementation were found in this case study. These shortcomings hindered project process and resulted in the project not achieving its aims.

Bottom-up strategy was not taken into account. A **top-down strategy** was applied during the whole project process. Local people were never included as key actors. Both Chinese and Dutch partners were overly keen on the technological aspects of the project rather than practical applicability. Neither financial affordability nor operation capability of the local people were considered in this project. Local farmers are used to low-cost

and easy-to-operate greenhouse technologies because of their limited income and education levels. Dissemination of the advanced greenhouse technology was almost impossible because it did not fit in with the interests of end users.

**Communication between both sides was not sufficient.** Given the very difficult lines of long-distance communication not least the language barrier, sufficient and effective communication is necessary. This project went through lengthy decision processes at central government levels (1998-2002). The implementing parties were informed of the approval at very short notice in advance. The assignment of responsibilities to the parties involved in the project was not clearly described in the agreement document, and draft pro forma subcontracts were not arranged while the broad draft budget had been approved without due consultations. No fixed and competent translator was appointed. All this caused problems in the implementation process.

Project implementation was **not clearly scheduled**. A well-elaborated project work plan with proper consultations of the partners and conclusion of pro forma project procurement contracts at the start of the project are essential. Unfortunately, there was no clear timeframe in the project proposal. Notwithstanding the detailed project design, milestone deliverables were not determined. As a result, the project was implemented without sound node management and a milestone delivery monitoring system. In this regard, it is not surprising to see the confusion during project implementation.

The project was **poorly managed** by the local partner. A good project management structure with proper provisions to bridge language and inter-cultural communication gaps and a critical minimum of perceived local 'project ownership' are essential. In order to reduce the cost for local project supervision a management-sharing relationship with a related Dutch horticulture-training project in Shandong was reached. In practice, this did not prove successful. One example of this failure is the loss of many tomato plants due to a defective heating pump, causing many plants to be frozen during the following night. The solar collector system had also been out of operation for many days. Adequate management would have reduced the number of days the system was out of operation. Resort to suitable Chinese project representation on behalf of ECN would most probably have been more effective.

There is **no follow-up action**. The experimental greenhouses are left unused. The monitoring system and water tanks have been removed. Some improvements are needed for the greenhouses to work again. It was difficult for the assessment team to obtain further information on the follow-up actions.

### Lessons learnt

The unfavourable outcome of this project provides a number of useful lessons for future development activities:

- Local farmers, as the end-users of the greenhouse technology, should be included as key actors in the design of such projects. The **affordability of the technology** to the local farmers and capability of the local people to operate it should be considered in this type of project.
- A detailed implementation plan and clear schedule is necessary. A **well-elaborated project work plan** with proper consultations with all project partners and conclusion

of pro forma project procurement contracts would have contributed to project success. A clear timeframe, detailed project design, and milestone objectives were not known or achieved by the partners, which resulted in the confusion during project implementation.

- The management process should be enhanced for projects involving international co-operation. A good project management structure with proper provisions to bridge language and inter-cultural communication gaps is essential. There is also a need for a critical minimum of perceived **local ‘project ownership’**. Better management would avoid many misunderstandings, operational mistakes, and improve the performance of the project.

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## 8. Biomass gasifier in Baharbari (India)

*Shirish Sinha, Anandya Bhattacharya, Rakesh Jha and Harro van Asselt*<sup>49</sup>

### 8.1 Introduction

#### Background

The importance of access to electricity in the rural areas as an essential component of sustainable rural development and for seeding social and economic growth has been long recognized in India. The central and state government have over the last five decades implemented electrification programme and renewable energy programme to provide access to electricity in rural areas of India. However, despite these large national and state programmes, electricity is available in only 44% of the rural households and its use for economic activities suffer from chronic shortfall in availability of electricity and poor quality and unreliable electricity supply (Planning Commission, 2002). Limited access to electricity is largely due to the geographical spread and dispersion coupled with the approach adopted to deliver electricity in the rural areas. While India is projected as one of the fast growing developing economies, the magnitude of the task of providing electricity access for all end use by 2012 is enormous. For the period 2001–2025, world economic growth is projected at 3.0% per year, with an annual energy growth at 1.8% (EIA, 2004). The corresponding figures for India, for the same time period, are 5.2% and 3.2%, respectively (EIA, 2004). India's demand for electricity is projected to increase by 3.3% per year over the period 2001–2025. On the other hand, the Indian Central Statistical Organisation in New Delhi projected an economic growth of 8.1% in 2005/06 (GoI, 2006).

The task at hand requires innovations, both in terms of technological solutions that are economically viable and provide affordable electricity, but also institutional solutions that focus on a decentralised approach for making electricity accessible and available. Realizing the role of renewable energy technologies (RETs) in bridging the access gap to electricity in the rural areas, the renewable energy programme has focused on decentralised power generation through biomass and solar energy. The renewable energy programme and the RETs were implemented across the country under subsidies provided by the central government. In order to reduce its fiscal deficit, the GoI initiated measures to phase out subsidies and identify commercially viable technologies. As a result of the reform measures, starting from 1993, there are two parallel renewable energy programmes: (a) a socially oriented programme, supported under the government schemes for dissemination of RETs and capacity building through research and development (R&D) activities and training of beneficiaries and technicians; and (b) a commercially oriented scheme, which aims to commercialise selected RETs such as wind energy, small hydro and solar photovoltaic (Sinha & Ramana, 1997). In the changing energy policy in India, the role of renewable energy has shifted, and there is a

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<sup>49</sup> PricewaterhouseCoopers, New Delhi, India.

strong focus on RETs for electrification<sup>50</sup> of remote villages and through distributed generation for decentralised rural electrification and distribution management (Chaurey et al., 2002).

Biomass, a renewable organic substance of plant and animal origin, can be converted into solid, liquid or gaseous fuels at improved efficiencies for electrical energy production. The total estimated biomass power potential in India is above 1 lakh MW, including includes 16,000 MW grid interactive power from surplus agro residues and wastes from forestry and plantations, 3500 MW through bagasse co-generation and 1 lakh MW from plantation of 60 million hectares of wasteland (MNES, 2006). The nodal agency for the promotion of renewable energy in India, the Ministry of Non-Conventional Energy Sources (MNES) has been implementing the Biomass Power and Cogeneration Programme since 1994. However, over this period only 750 MW have been installed in the country.<sup>51</sup>

Starting from early-1990s, decentralised biomass-based power generation was part of pilot projects mostly implemented for reducing electricity demand in industry. However, most of these initial programmes met with little success and most of the projects failed due to combination of technical and operation reasons (Sinha et al., 1996). Furthermore, until the breakthrough in the year 2002, when 100 per cent producer gas run engines became a reality, the cost of biomass-based generation had not been competitive, especially in the case of dual fuel systems due to the high price of diesel (Kishore et al., 2004). Besides, there are other forms of barriers for more extensive use of this technology, including a lack of knowledge and trust in the technology and its economics; the need for further development of the technology; the absence of institutional structures for deployment in rural areas; the non-existence of programmes aimed at large-scale replication of the technology; a lack of investment capital and/or the willingness to provide loans; and the lack of successful examples (see, for example, Ghosh et al., 2003).

This report looks in detail at the performance of one of the Indian projects involving a small-scale biomass gasifier. More specifically, it looks at the contribution to sustainable development of a project in the village of Baharbari, in the State of Bihar. This project was partly funded under the Netherlands' Pilot Projects Programme Joint Implementation (PPP-JI).

### Rural electrification policy in India

India suffers from chronic electricity shortage, caused by insufficient generation capacity, under-use of existing capacity, huge transmission and distribution losses, and inefficient use of electricity by consumers (GoI, 2004). In order to improve the

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<sup>50</sup> The draft Renewable Energy Policy bill, tabled in 2003 in the parliament, aims to add at least 10 per cent of additional power generation capacity added between 2000 and 2012 from renewable energy resources. Section 5 of the Electricity Act 2003, emphasizes a separate policy for distributed generation including those from renewable energy resources.

<sup>51</sup> Standing committee on energy (2005-06), 14<sup>th</sup> Lok Sabha on the subject 'Biomass Power/Co-generation Programme – An Evaluation' of the Ministry of Non-Conventional Energy Sources.

efficiency and accountability of the system and to increase investment, the government decided to deregulate the sector and allow private sector participation since 1991 (Arun & Nixon, 1998; Dossani, 2004). To meet India’s growth rate, electricity supply needs to increase. A targeted annual growth rate of 8% implies that the demand for electricity will be 12% (GoI, 2004). The government hopes to increase installed capacity by about 100,000 MW by 2012 (Perkins, 2005: 443) and thereby also provide electricity to all villages by 2007 and to all households by 2012 (IEA, 2005).

Identifying the role of electricity in economic and social development of rural areas, the Government of India has accorded rural electrification a high priority through a series of central government assisted programmes over the last six decades. The rural electrification programme included: village and household electrification; electricity for social and public infrastructure such as schools, health centres and public lighting; electricity for irrigation pump sets (and pump set energization); and electricity for small village and cottage industries (Sinha et al., 2003). Figure 8.1 captures the changes in rural electrification since its inclusion as a priority programme for rural development in the first Five Year Plan.<sup>52</sup>

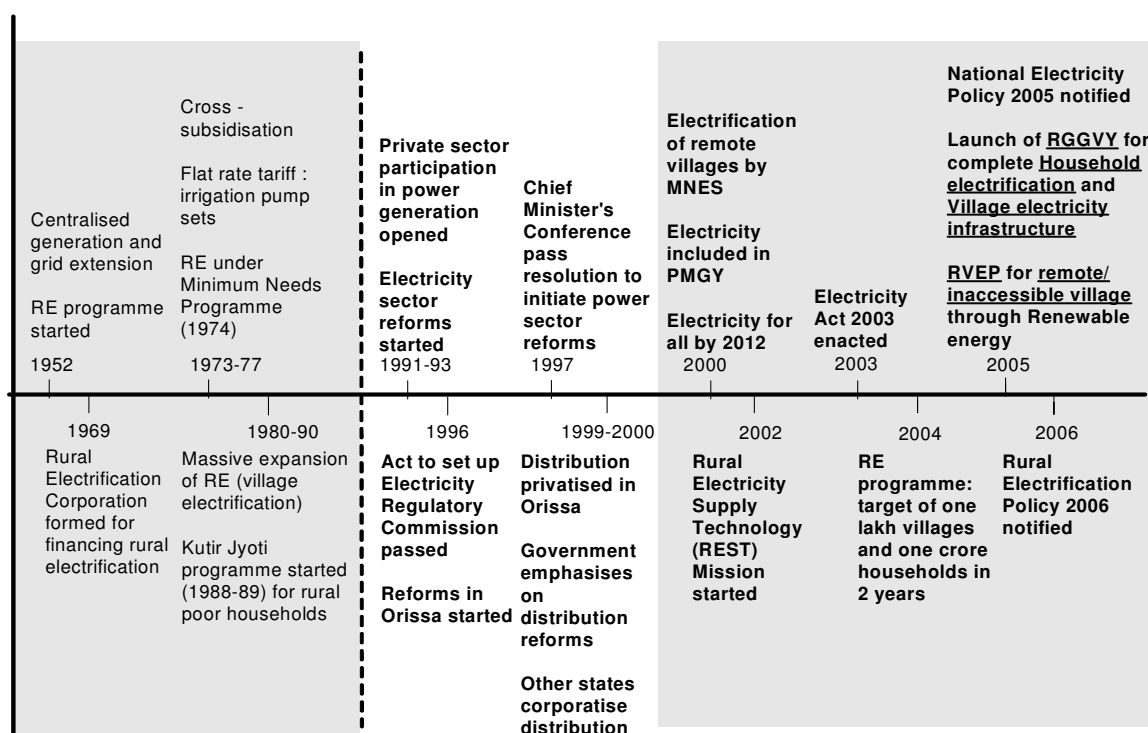


Figure 8.1 Rural Electrification in India

Source: Sinha, 2007.

<sup>52</sup> Five Year Plans are development plans for social, economic and infrastructure sector and are formulated by the Planning Commission and the Government of India. These Five Year Plans form the basis for formulation of priority areas in each sector and also review the performance of different programmes and schemes initiated by the Government of India and the state governments.

Until recently, there was no separate rural electrification policy. In fact, in India there was no integrated energy policy. Rural electrification was a large programme driven both by the central government through funds and schemes and implemented by the state governments. However, the Electricity Act 2003 put in perspective the need for a separate policy for rural electrification and a policy for rural electrification using stand-alone energy systems especially those based on renewable energy systems (Gazette of India, 2003). The National Electricity Policy (NEP), notified by the central government in 2005 in pursuance to the Electricity Act 2003, has identified enhancing of electricity access in the country as a priority area. The challenge of meeting the targets of rural electrification as set forth under the NEP was formulated as a national programme called *Rajiv Gandhi Grameen Vidyutikaran Yojana* (RGGVY). In addition to the NEP, the Government of India has made two significant policy initiatives – the Rural Electrification Policy 2006 and the Integrated Energy Policy (IEP), of which the latter is in consultation stage at the time of writing.

### Rural Electrification Policy 2006

Identifying the role of rural electrification in accelerating rural development and for the provision of electricity being essential to cater for requirements of agriculture and other important activities including small and medium industries, the Government of India has, in accordance with sections 4 and 5 of the Electricity Act 2003, notified a Rural Electrification Policy (REP) in 2006 (Gazette of India, 2006). The goals of the REP are:

- Provision of access to electricity to all households by year 2009;
- Quality and reliable power supply at reasonable rates;
- Minimum lifeline consumption of 1 unit per household per day as a merit good by year 2012.

The REP focuses on providing access to all the households. It focuses on: a) permitting stand-alone systems; and b) rural electrification and bulk power purchase and management of local distribution in rural areas. In the context of the provisions of the Rural Electrification Policy, the scope of RGGVY needs to be revisited to encompass the policy guidelines.

The Integrated Energy Policy, which has made projections for energy demand and energy policy in India until 2032, in its recommendation for the rural electrification programme has made a range of suggestions from basic entitlement for poor households to improving access to electricity to time bound periods of subsidies and a role for decentralized distributed generation to improve access to electricity in remote areas (Planning Commission, 2006). The IEP also recommended that the scope of RGGVY should be revised to cover actual electrification of all households and implementation of business models for RGGVY to make the programme revenue sustainable.

The Remote Village Electrification Programme (RVEP) of the Ministry of Non Conventional Energy Sources, although initiated in 2001 for the provision of basic lighting facilities in un-electrified census villages, only became operational in 2005 (MNES, 2006). The RVEP was set up with a 10th Five Year Plan (2002-07) outlay of Rs 735 crore for lighting, providing electricity in 5000 un-electrified villages, irrespective of whether these villages were likely to receive grid connectivity. The scheme was subsequently modified to cover only those un-electrified villages that were not likely to



receive grid connectivity. The objective is to electrify remote census villages and remote hamlets of electrified census villages through non-conventional energy sources such as solar energy, small hydropower, biomass, wind energy, hybrid systems, etc. By focusing on remote census villages and remote hamlets of electrified census villages, the programme aims at bringing the benefits of electricity to people living in the most backward and deprived regions of the country.

### Key characteristics of the case study

#### *The situation in Bihar*

Bihar is the third most populous state in India. It is situated in the Northeastern part of India, bordering Nepal in the North, and surrounded by three states in other three directions – the state of West Bengal in the East, Uttar Pradesh in the West and Jharkhand in the South. Due to bureaucratic inefficiency and institutional failures, the state has witnessed regressive development over the last 15 years. Recent estimates show that nearly 40% of the state population lives below the poverty line as the per capita income is the lowest in the country at Rs 6300 (2005-2006) (Kang, 2006). During the 1990s (1993-1994 to 1999-2000), the state made modest progress; poverty levels were reduced by 7 percentage points, but the rate of poverty reduction was still well below the national average (GoI, 2005). By current trends Bihar is projected to fall well behind on most of the Millennium Development Goals targets for 2015 (Kang, 2006). The low rate of urbanization has accentuated poverty levels in the state across urban and rural areas. However, poverty is predominantly rural, and is associated with limited access to land and livestock, poor education and health care, low-paid occupations, limited economic opportunities, social status and overall poor infrastructure (Debroy & Bhandari, 2002).

Bihar's economy has experienced little structural changes and is not well diversified. The economy of the state is predominantly agrarian in nature with a small manufacturing base. Industrial development is very limited and its growth has remained nearly the same over a decade. Even in terms of social development, the state has made very little progress. The state has remained on the 15<sup>th</sup> position on the Human Development Index (HDI) for the last 15 years. The literacy level is 48%, and population growth rate at the 2.5% against a national average of 1.9%, and 40% of the people in the state fall below poverty line (highest in India).

#### *The situation in Baharbari*

The Araria district in North Bihar is located in the basin of the river Kosi and in the flood plains of the eastern Indo-Gangetic Basin (see Figure 8.2). The district has fertile land and the main crops grown in the region include jute, paddy and maize. However, despite the growth prospect due to agriculture potential, the district has witnessed negligent economic development and development across infrastructure sectors has remained static. Ninety-four per cent of the people living in Araria district live in the rural areas. Like most of Bihar, agriculture is the main source of income for the vast majority of the population (around 99%).

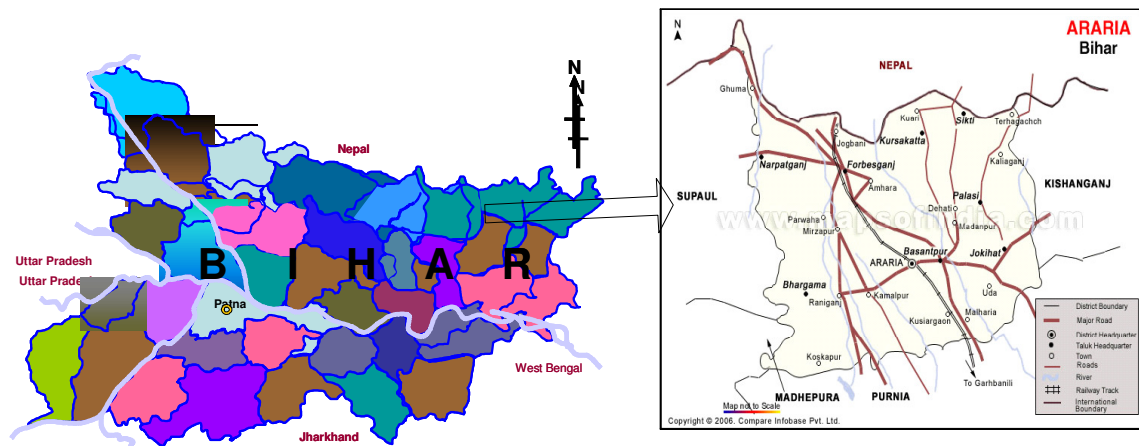


Figure 8.2 Maps of Bihar and Araria District.

Source: Kang, 2006; Maps of India, 2006.

Nestled in the Joki block of Araria district in North Bihar, the village of Baharbari is a typical rural settlement with characteristics and environment (including social and political) similar to most of the rural areas of Northern Bihar. Agriculture is the predominant source of livelihood. However, the economy is influenced by skewed land distribution creating few landlords and large number of small and marginal farmers and equally large number of landless households earning their livelihood through shared cropping.

Baharbari, with a population of 2500 people, does not even have an all-weather metalled road connecting it to the block or district headquarters (Census of India, 2003). Large part of the approach road to the village is un-metalled, and is unmotorable during monsoon. The agricultural economy of the village depends on the monsoon. However, since the village is in the flood plains, it has abundant groundwater resources. Apart from rainwater during monsoon used for Kharif crops, groundwater is used for Rabi and summer crops. Other livelihood opportunities include cottage industries such as rice mills, flour mills, and bitten rice (*chura*) mills.

Officially, Baharbari is an electrified village. The village was electrified in late 1980s as recalled by the local respondents in the village (Interview 2, India 2006). However, the ground realities are different, and Baharbari has no electricity connection. In fact, the electricity distribution infrastructure such as electricity wires and conductors are long gone and what still exist are the barren cement poles. In other words, Baharbari is a de-electrified village.

The lack of access to basic infrastructure such as a proper access road and a large number of sharecroppers has restricted the farmers' access to markets, reducing their opportunities to participate in the market and improve their economic conditions. The poor quality of the connectivity of Baharbari with nearby towns restrains the farmers of the region to go to bigger markets to sell their produce; this results in lower returns from farming. This growing pressure on the land and the limited returns from agriculture has led to a diversification of livelihood options in the village. This happens more in the case

of small and marginal landholding and landless households, where young workers migrate to other towns and states both on a temporary and a permanent basis.

However, despite the odds, Baharbari has appeared on the development and rural energy radar of India. This has been mainly due to a small biomass gasifier power plant which started generating electricity from 2002. The electricity generated from this environmentally benign resource and renewable energy technology, provides a basket of energy services to the local people. Energy services ranges from supplying water for irrigation to processing (milling and grinding) of agricultural commodities – mainly rice and wheat – to even the charging of batteries used by households for operating televisions.

### The case study

For this case study, we used a range of approaches to determine the impacts on sustainable development of this project. The team comprised of a good mix of experienced people from multi-disciplinary background providing diverse perspective to the evaluation approach and methodology. The team had renewable technologies, micro-enterprise and commercialisation of renewable technologies experts along with environmentalist and economist. To start with, the project team collected all available project materials from the archives of the Netherlands' Ministry of Foreign Affairs, as well as all available and relevant documents on the Internet. These documents were complemented with materials obtained during a site visit of the project. A textual analysis was conducted of all the documents directly related to the Baharbari project to get an idea how the project was intended to develop in theory and, to some extent, in practice.

Furthermore, we conducted a brief literature study on topics related to the project, including rural electrification in India, AIJ and CDM projects in India, and biomass gasification technology.

All the stakeholders of the project were approached and their viewpoints about the project were analysed and incorporated in the report. Representatives of the Ministry of Non-Conventional Energy Sources and the Ministry of Environment and Forests, officials of DA, DESI Power, DASAG, Shell Foundation, BOVS, and beneficiaries of the project were contacted and enquired about their perception of the project.

As the practical results cannot simply be obtained by studying project documents, especially if these are not including progress or monitoring reports, a site visit to the Baharbari gasifier was done early August 2006. During the site visit, personal as well as group interviews were conducted with the local project developers, operators of the plant, local farmers, representatives of micro-enterprises, and local women groups. During the site visit, the project team also made a short video report on the project, which forms a supplement to this written report.

In addition to the approach for the fieldwork to understand the impact of the project, we also used a criteria framework for analysis of fixed set of sustainable development indicators.

## Structure of the report

The structure of this report is as follows. Sections 8.2 will provide an overview of the project as it was intended to develop from its inception, and how it has evolved on paper. Sections 8.3 will then describe how the project initially aimed at contributing to sustainable development. Sections 8.4 will explain how the project has developed in reality and to what extent this differs from the initial intention as set out in the project documents. Section 8.5 will then assess how the project has performed with respect to certain criteria for sustainable development. Section 8.6 will provide a discussion of this project's relation to a CDM project which has been proposed. Finally, Section 8.7 will draw some conclusions and lessons learnt from this case study.

## 8.2 Evolution of the project

### How was the idea born?

In 1996, a consortium consisting of Development Alternatives (DA) – an Indian NGO –, along with its commercial wing Technology and Action for Rural Advancement (TARA), and Decentralised Energy Systems India Private Ltd. (DESI Power) – an enterprise set up by DASAG (Switzerland) – established a first biomass gasifier in Orchha, Madhya Pradesh, in order to demonstrate the technological and commercial viability of decentralized biomass gasification.

In 1998, the same consortium planned to further establish a biomass based 50 kWe power plant in Baharbari village in the Araria district in Bihar. Furthermore, a joint venture company naming Desi Power Kosi (DPK) was formed in November 1998 for the management and execution of the envisaged project. DPK identified a local cooperative Baharbari Udyogic Vikas Swablambi Sahkari Samiti Ltd (BOVS) to effectively implement the project. BOVS is an autonomous Panchayat<sup>53</sup> level cooperative, committed to the development of industries in the Baharbari Panchayat.

In July 1999, the project became part of an agreement signed between the Indian and Dutch governments to include 6 biomass gasifiers under the Dutch pilot project programme for Activities Implemented Jointly. Following this agreement, the Dutch Ministry of Foreign Affairs awarded a grant to DESI Power on 9 August 1999.

In January 2001, a gasifier was finally installed in Baharbari. However, the initiative proved to be a costly venture, as the cooperative could not generate the needed demand for the power produced. As a result, the plant load factor (PLF) for the generation unit was very low. The project warranted a few measures to make the operation viable:

- Creating a reliable supply and sustainable source of biomass;
- Creating an optimum load for the plant;
- Making further investments to complete the installation of the 50 kWe plant.

According to the Project Feasibility and Packaging Report of DESI Power of 7 September 2001 (PFPR; DESI Power, 2001), DESI Power geared up to take up the

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<sup>53</sup> A panchayat is the smallest administrative/political unit in India. A panchayat is the smallest administrative/political unit in India.

commissioning, operation and management of the plant, and supply electricity to the customers identified by the cooperative BOVS. BOVS was made responsible for ensuring supply of biomass to the plant, buying electricity, running micro-enterprises, selling water, and providing energy services. To quote from the PFPR: “[t]he project utilises local manpower and resources for the production process and provide people with jobs to generate more money by running micro industry in a simple form. The cooperative provides infrastructure to run the machines.”

The creation of sustainable micro-enterprises is the focus of the project. On the one hand, the enterprise units would make the generation unit financially viable by consuming the power produced by it, and on the other hand the units would provide direct and indirect benefits to the local population. Utilising local resources and manpower, the project envisages carrying out a sustainable development mechanism that could serve as a model and could be further elaborated in the future.

### Justification and purpose of the project

At the conception stage of the overall AIJ project, in 1997, the main objectives were as follows (DESI Power et al., 1997: 2):

- Building, owning and operating Independent Rural Power Producers (IRPPs) at different clusters throughout India;
- Demonstrating the technical, economic, organisational, social and commercial viability of these IRPPs as an essential component of India’s energy and power sector;
- Examining practical implications of fully commercial and semi-commercial operations, and to apply different models of funding;
- Establishing the organisation and systems allowing hundreds of plants to be built;
- Building capacity for managing the IRPPs and setting up a training programme for personnel.

In other words, the project aimed to show the potential of decentralised energy systems using renewable energy technologies, while simultaneously promoting sustainable development at the local level. This was to be done at six sites in different regions in India:

- Bihar (Araria/Baharbari);
- Jamshedpur (2 x);
- Hazaribagh;
- Kodarma;
- Karnataka (Kolar district).<sup>54</sup>

The abovementioned objective is also valid for the Baharbari project. As the project developer puts it, the Baharbari project is “based on DESI Power’s concept of using locally generated electricity supply and energy services using renewable energy resources to run micro-enterprises which do local value addition and provide jobs in villages” (Sharan, undated).

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<sup>54</sup> Note that these are not the same locations as where the plants that have ultimately been installed.

## Project organisation

The following section describes the actors that play or have played a role in either the AIJ project in general, or the Baharbari project specifically, and – to the extent possible – gives an indication about this role.

### *DESI Power*

Decentralised Energy Systems (I) PVT Ltd. (DESI Power) was established in 1996. It is the organisation that has implemented the project from the very early stages. According to its articles of association, its main objectives include:

“To establish, promote, own, build, operate and manage decentralised power stations and energy services in rural areas; to commercialise mature technologies which can save energy, reduce pollution and reduce costs; to commercialise renewable energy technologies; to promote the development and commercialisation of indigenous technologies with the overall framework of the primary objectives; to train villagers to operate, maintain and manage decentralised power systems, energy systems and distribution networks.”

It is difficult to pinpoint the shareholders of DESI Power, as these – as well as their shares – have shifted over time. Initially, the shareholding in DESI Power was envisaged as follows: TARA 26%, DASAG 25%, BKF international 25%, Green Fund Investors 24% (DESI Power et al., 1997: 113). According to documents at the Ministry of Foreign Affairs in The Netherlands, however, in 1999 the division was as follows: TARA 33%, DASAG India 33%, and NICIS 33%.

DESI Power works through local cluster companies that build, own, operate and later transfer the power plants in the villages. DESI Power also provided an equity contribution to the Baharbari project (DESI Power, 2001: 2-3).

### *BOVS*

Baharbari Odyugic Vikas Swavalamvi Shakari Samiti, Ltd. (BOVS) is an autonomous Panchayat level co-operative, which aims to develop local industry in Baharbari. Its objectives include to promote job creation and prevent migration from labourers, and to enhance benefits for farmers. According to the draft biomass supply agreement between DESI Power and the cooperative, BOVS' role was to identify suitable biomass sources, to organise supply up to 20 tonnes per month, and to charge no more than Rs 1500 per tonne to DESI Power. Furthermore, BOVS would need to ensure adequate electrical load, and guarantee that the dues were regularly paid by the electricity purchasers.

Figure 8.3 shows the model for the relationship between DESI Power and BOVS.

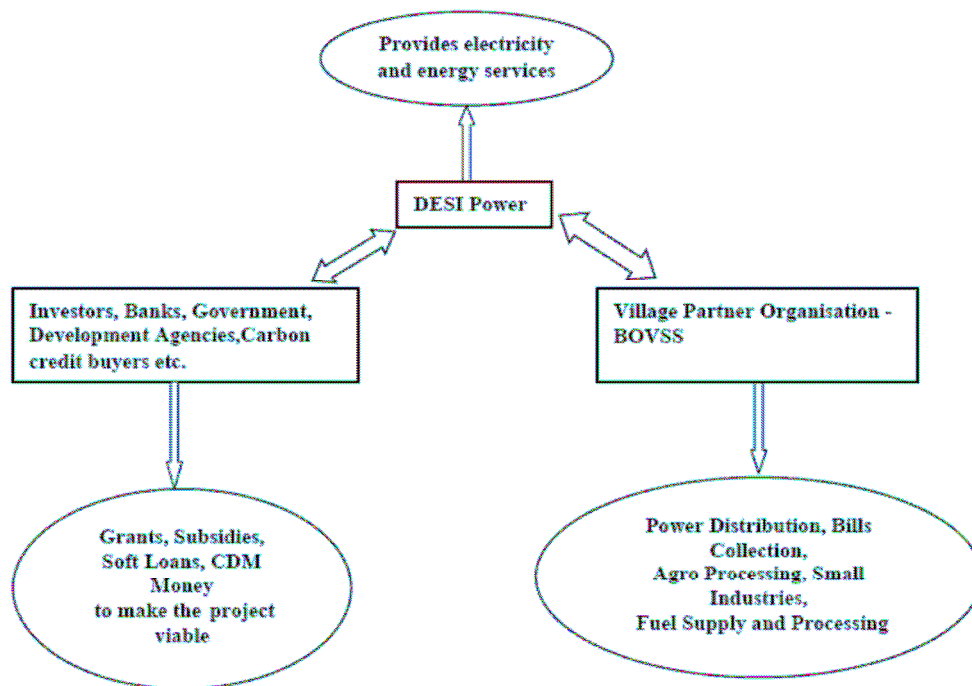


Figure 8.3 BOVS model

Source: Kumar et al., undated: 60.

#### DPK

The joint venture company DESI Power Kosi Pvt. Ltd. (DPK) was established in 1998. It is a so-called cluster company of DESI Power. Its main role was to install, operate and maintain the plant in Baharbari. DPK transferred the gasifier to DESI Power in 2001.

#### Development Alternatives/TARA

Development Alternatives (DA), in association with its commercial wing Technology Actions for Rural Advancement (TARA) was involved in setting up the first experimental biomass gasifier in Orchha, India. DA is a NGO and according to documents at the Ministry of Foreign Affairs in 1999 holds a 33% share in DESI Power. The Orchha project was established by DA, DESI Power, FRENED (Switzerland) and the local organisation DESI Power, Orchha, and operated and managed by the latter.

#### BuZa

The Netherlands' Ministry of Foreign Affairs (BuZa), through its Pilot Projects Programme Joint Implementation (PPP-JI), funded an important part of the initial costs of the Baharbari project. In 1999, it decided to award a grant to DESI Power of approximately € 643,000. In 2000, it commissioned a study conducted by Ecofys on baseline development for biomass projects in India, with the DESI Power AIJ project as a case study. It also commissioned an external accountant (Ferguson) to perform a financial audit of DESI Power in 2002.

*Government of India: MOEF and MNES*

At least two Ministries were involved in India in the stage of project development: the Ministry of Environment and Forests (MOEF) and the Ministry of Non-Conventional Energy Sources. MOEF affirmed that the project conformed to the Indian AIJ conditions, and then handed the project over to MNES who signed the Letter of Intent with the Government of the Netherlands.

*JIRC*

According to the Letter of Intent signed between the Government of India and the Government of the Netherlands, the Joint Implementation Registration Centre (JIRC) in the Netherlands would be responsible for determining the amount of actual emissions reductions (verification).

*NETPRO*

NETPRO Renewable Energy (India) Pvt. Ltd., in cooperation with IISc (see below) designed and manufactured the gasifier that is used in Baharbari. NETPRO supplied the gasifier in January 2001. NETPRO is chaired by Hari Sharan.

*DASAG*

DASAG India, according to documents at the Ministry of Foreign Affairs in 1999, holds a 33% share in DESI Power. Together with NETPRO and IISc, DASAG was responsible for developing the gasifier. Hari Sharan is the chairman of the mother company Dasag Renewable Energy AG, Switzerland.

*NICIS*

Netherlands-India Co-operation in Sustainable Development (NICIS) B.V., a Dutch consultancy for micro- and small-scale industries, held a 33% share in DESI Power in 1999 according to documents at the Ministry of Foreign Affairs. The same documents indicate that NICIS consisted of a cooperation of BKF International (40%), S.K. Gupta (30%) and Hari Sharan (30%). NICIS left DESI Power in 2002.

*BKF International*

BKF International, a Dutch company, held 40% of the shares in NICIS in 1999. Its contribution to the DESI Power projects was to produce interactive computer based video training, which could be used for educating villagers involved in the operation of the power plants.

*Ferguson*

A.F. Ferguson & Co. (New Delhi) was involved as an external accountant that performed a so-called 'quick scan' of DESI Power in 2002, after the Netherlands' Ministry of Foreign Affairs started to suspect that there might be some management problems in DESI Power. After 2002, Ferguson was involved in the financial control of DESI Power with regard to the AIJ project.



*IISc/CGPL*

The Combustion, Gasification and Propulsion Laboratory (CGPL) of the Indian Institute of Science (IISc) developed an open top gasifier technology in cooperation with DASAG.

*Ecofys*

At the request of the Ministry of Foreign Affairs, Ecofys, in cooperation with the IISc conducted a study on baseline development for biomass projects in India, with the DESI Power AIJ project as a case study. The final report (Bode et al., 2001) provides a basis for developing baselines for DESI Power-type projects.

*IISc*

The Centre for Ecological Sciences/Centre for ASTRA of the IISc worked together with Ecofys on the baseline development study mentioned above. It should be noted that the Centre for Ecological Sciences/Centre for ASTRA has no direct relation to the IISc's CGPL, which is involved in developing the gasifier technology.

Figure 8.4 provides an overview of these actors and their interrelations. The part in blue highlights the main actors related to the AIJ character of the project, the part in red highlights the main actors in the Baharbari project.

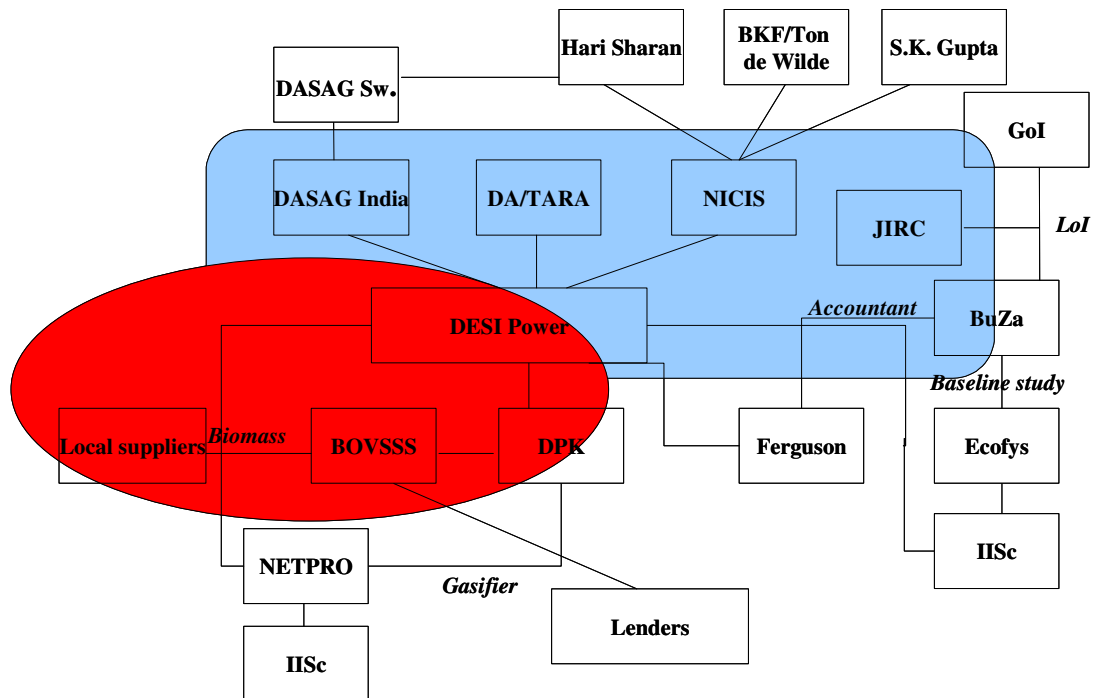


Figure 8.4 Project organisation of the DESI Power Baharbari project. NB: the blue part represents the actors directly related to the AIJ project; the red part represents covers the actors directly related to the Baharbari project.

## Funding

In its decision of 9 August 1999, the Ministry of Foreign Affairs granted around € 643,000 to DESI Power for the six biomass gasifiers. Of this amount, around € 250,000 were intended as a specific loan for investment, and approximately € 393,000 for overhead costs, equity and training costs. According to documents at the Ministry, over € 693,000 were spent eventually. No records are available that indicate the percentage of funding of the total project by the AIJ grant.

## Time frame

The Ministry of Foreign Affairs in The Netherlands first received the application for AIJ funding of DESI Power's project in May 1997. In February 1998, the proposal of DESI Power was approved by the AIJ Task Force of the Indian Ministry of Environment and Forests. In the course of 1998, a Letter of Intent between the GoI and GoN was drafted. However, this was only signed on 23 July 1999, thereby giving the green light for the AIJ project.

Out of the project sites that were part of the AIJ project, Baharbari was the last one where a gasifier was installed. In January 2001, the gasifier was supplied by NETPRO. The actual operation started in 2002 (Interview 2 India 2006). During 2002, it became clear that there had been a delay in the execution of the AIJ project as a whole. Nevertheless, early 2003 DESI Power communicated to the Ministry of Foreign Affairs that all projects had been successfully commissioned and by the end of June 2003 the AIJ phase of the project formally ended.

## Project approval

In 1998, the Government of the Netherlands sent two experts to India to review the project in detail (Interview 11 India 2006). Following this visit, the scope of the whole AIJ project was reduced from 20 biomass gasifiers to 6.

On 23 July 1999, a Letter of Intent was signed between the Minister for Development Cooperation of the Netherlands and the Indian Ministry of Non-Conventional Energy Sources (MNES). The Letter of Intent describes the project, and states that it aims to reduce greenhouse gas emissions through using renewable energy sources. In the Letter, MNES approves the project by stating that it "is in accordance with national policies on development of renewable sources of energy and protection of the environment and forests in India, and that the project is in accordance with the legal framework". According to one of the project developers, there were no problems at all in obtaining this approval from MNES (Interview 10 India 2006). The approval was based on the recommendations of an AIJ Task Force that examined all AIJ proposals submitted to the GoI (see Hambleton et al., 1999).

As a part of the Letter of Intent, it was agreed to quantify the emission reductions. This was to be verified by the Dutch Joint Implementation Registration Centre (JIRC), in cooperation with the Indian Ministry of Environment and Forests (MOEF). It was also agreed to communicate the results of this to the UNFCCC Secretariat.

Following the Letter of Intent was a formal Decision of the Netherlands' Ministry of Foreign Affairs to award DESI Power a grant on 9 August 1999.

### 8.3 Contribution to sustainable development

#### Sustainable development in project documents

In the Project Feasibility and Packaging Report (DESI Power, 2001), the project developers state that the Baharbari project could “effect reduction of CO<sub>2</sub> on one hand [sic] and the creation of local jobs and the upliftment of the village on the other”. This upliftment of the village was related to the intention of BOVS to set up certain micro-enterprises in the village, which could be supplied with electricity and at the same time could ensure a reasonable plant load factor. Specifically, the gasifier could help through providing electricity to telephone booths, briquetting machines, the installation of agricultural water pumps, battery lighting systems, rice hullers, etc.

As for the economic impacts and financial viability, the PFPR expresses the expectation that the plant will have a reasonable plant load factor year through. Other calculations in the PFPR show that the project was expected to be “profitable and bankable”. The PFPR also briefly examines some of the potential socio-economic and environmental impacts of the project. It states that the project would not result in the displacement of any villagers, and that the gasifier, energy plantation and the micro-enterprises would altogether provide direct employment to some 15-20 people. Moreover, the project would include training for the operators of the plant, such as training for operating the plants but also training in management and financial control.

Regarding the environmental impacts, the PFPR notes that the water use for the plant does not conflict with other uses, and that the wastewater treatment conforms to Indian and European standards. As for CO<sub>2</sub> emissions, the PFPR indicate that a dual fuel diesel engine will be used, resulting in the substitution of diesel by 70-80%. The estimated reduction of CO<sub>2</sub> emissions was 90-170 tonnes per year with a plant load factor ranging between 25-40%. For NO<sub>2</sub> emissions, the project would meet Swiss standards.

#### Host government criteria

According to two of the project developers, and the Ministry of Environment and Forests, the Government of India used the same criteria for AIJ projects as they do now for CDM projects (Interview 9, 10 India 2006). These are:<sup>55</sup>

- *Social well being*: The project should lead to poverty alleviation by generating additional employment, removal of social disparities and contribution to provision of basic amenities to people leading to improvement in the quality of life of people;
- *Economic well being*: The project should bring in additional investment consistent with the needs of the people;
- *Environmental well being*: Including a discussion of impact of the project on resource sustainability and resource degradation; biodiversity friendliness; impact on human health; and the reduction of levels of pollution in general;
- *Technological well being*: The project should lead to transfer of environmentally safe and sound technologies that are comparable to the best practices in order to assist in upgradation of the technological base. The transfer of technology can be within the country as well from other developing countries also.

<sup>55</sup>

See [http://cdmindia.nic.in/host\\_approval\\_criteria.htm](http://cdmindia.nic.in/host_approval_criteria.htm) (accessed 7 September 2006).

## Social aspects

### *Poverty alleviation*

The prevalence of diesel pump sets in the village prior to the presence of electric pump sets limits the hypothesis that the income level of farmers has risen significantly after the energization of the six pump sets. While the input costs of irrigation have been reduced, this has not necessarily resulted in increased earnings for the farmers.

There has been a significant change in the lives of the people that were employed through the project, and that receive a salary in the range of Rs 500-3200 per month. The lower range of salary is for non-technical staff and the person that gets Rs 3200 is responsible for operation and maintenance of the generation unit. Salary of non-technical staff falls in the range of Rs 500-1200 per month. The income level of these people has certainly gone up and the quality of life has seen a positive change. According to the project developer, all the direct and permanent employees belong to the poorest class and the lower castes (Interview 12 India 2006), and they include a polio afflicted handicapped girl. As one of the women employed by the plant mentioned during the discussion with the staff, her income has increased since she started to work for BOVS and she can use the spare time to market food items such as puffed rice in the local market (Interview 5 India 2006).

Farmers who sell the biomass used (Daincha) to the plant appear to be getting less when compared to the existing market price. In the market farmers sell ten bundles of Daincha weighing approximately 16 kg for Rs 30 (dry condition), whereas they are paid only Rs 0.35 per kg (wet condition) by BOVS (Interview 3, 7 India 2006).

The rice husking and flour milling provided for by the micro-enterprises is used by all classes, including women from the poorer classes who benefit as they do not have to waste as much time as before by walking 6-10 km to the market places (Interview 12 India 2006).

### *Distributional equity*

BOVS consists of a six-person Board of Directors, as well as nineteen members, who are collectively supposed to take decisions and strategise for the co-operative's work plan. While few of the individuals from the village are part of the BOVS, most of the decisions related to BOVS and the power plant are taken by the project developers.

As mentioned earlier, the electricity generation unit and the micro-enterprises are owned by one entity – BOVS. Revenues generated under the project are supposed to be distributed among the 19 cooperative members. In the absence of balance sheets, the performance of the unit cannot be substantiated. From the discussion with the Board of Directors it followed that BOVS is still in loss; hence, the question of distribution of revenues does not arise (Interview 6, 11 India 2006). According to the project developer, when this will change, BOVS will pay an annual dividend, and DESI Power will reinvest its profits in more job creation activities (Interview 12 India 2006).

### *Empowerment*

The project's contribution towards empowerment has been fairly dismal. Village level meetings had been conducted during the project's initiation. However, successive structural villager's involvement in the decision making process has not taken place (Interview 4, 8, India 2006).

Nevertheless, the project arguably has made some of the poorer villagers more self-reliant and independent of the richer farmers who previously dominated the village (Interview 12, India 2006).

Furthermore, according to the project developers, a positive development has been through DESI Power villagers have been able to obtain loans through the State Bank of India for either agricultural activities or micro-enterprises, as DESI Power guarantees power supply, training and support services (Interview 12 India 2006).

Households have brought forward their demands for household electrification, which was one of the expectations of the people at the start of the project (Interview 2, 8 India 2006). However, a firm decision has not yet been taken by BOVS in this regard. Even the Gram Panchayat Pradhan<sup>56</sup> expressed that the project needs to expand its activities and provide additional services to people. On the other hand, villagers feel that the presence of BOVS in the village has resulted in an increased level of public awareness about electricity and other development issues.

#### *Access to essential services*

The project does not address access to essential services such as health, social amenities and water. While electricity does have direct linkages in facilitating these services, these are not integral to project.

#### *Access to affordable clean energy services*

The Baharbari project does not provide reliable and affordable clean energy services to the villagers directly. Especially, it does not provide lighting to the people in the village or to the poor. In the process the project has restricted the opportunity for people to increase their household productivity. One of the reasons for this is that the costs of doing so are still too high, in part because the plant is still based on a dual fuel engine, and in part because of a lack of additional funding possibilities. This makes it unviable to provide electricity to villagers at an acceptable cost (Interview 13).

#### *Impacts on human health*

The impact of the project activities on human health has not been addressed by this project. Instead, the project allows people to use charcoal, a residue from the plant as a fuel for household cooking and thereby increasing the risk of indoor air pollution.

#### *Employment (job quality)*

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<sup>56</sup> Gram Panchayat is a village level tier of governance structure. The Gram Panchayat is an elected body and its activities are managed by an elected representative called the Gram Pradhan. Both the Gram Panchayat and the Pradhan are elected for a period of five years.

The project aimed to create economic opportunities in the village. It is worth mentioning that the project has improved opportunities for employment, especially those who are engaged as technical staff (Interview 5 India 2006).

### *Gender equality*

One form of empowerment of women has been through formation of a women's organisation named Sakhi Saheli by BOVS. The objective of Sakhi Saheli is to empower women and making them aware of their rights. Sakhi Saheli has succeeded in mobilising women – a majority of which are illiterate and belong to disadvantaged communities – to become member of the organisation. Sakhi Saheli has also organised the group into a women Self Help Group (SHG).<sup>57</sup> The formation of Sakhi Saheli or the SHGs had no connection with the gasifier or the AIJ project. Nevertheless, these organisations use a common platform, generally offered by BOVS, to raise their respective issues. For example, when the District Collector<sup>58</sup> of Araria was invited by BOVS, both Sakhi Saheli and the SHGs put forward their proposals to take ownership and management of the village's Primary Health Centre (PHC) and also suggested that the government should engage SHGs in the disbursement of development funds (Interview 4 India 2006).

### *Local skills development/Education*

The project has resulted in the improvement of local skills by employing local people in the mainstream activities of electricity generation, and operation and maintenance of the plant and other enterprises. Under the project, two local male youth of which one belongs to Baharbari village was sent for technical training to Indian Institute of Sciences (IISc), Bangalore, and they were also trained by DESI Power and the technology supplier. At present, there are two more male local youths who are undergoing training: one at the Baharbari power plant and another in the DESI Power Kosi office in Araria. Apart from these, the plant and BOVS has enhanced the skills of local women in the operation and management of enterprise activities. Most of the women were already engaged in similar activities; however, these were confined to the part of domestic activities and un-paid labour. By engaging women in these enterprise activities, BOVS has been able to engage women in productive and paid employment activities.

### **Environmental aspects**

From the outset, limited information has been available that enable a proper assessment of the actual impact of the biomass gasifier project on air quality, water quality and any impact on land use changes. Therefore most of the interpretation is based on observations and discussions, but cannot be fully supported by quantitative data.

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<sup>57</sup> Self Help Groups are village level organisations comprising of a group of 10-20 individual members, mostly women, and are formed with the objective of encouraging wealth generation by the deposit of small shares of daily/weekly income. SHGs maintain a bank account where the money is deposited and it give credit to members with low interest rates.

<sup>58</sup> The District Collector is the administrative head of the district with the responsibility of overseeing the implementation of programmes.

### *Air quality*

In terms of air quality, while this project uses biomass fuel and is based on a renewable energy technology, it continues to use diesel as a fuel (see Section 3.4.4 for the amounts of diesel saved). The plant operates for a fixed period each year. During the site visit, the plant was closed for maintenance because of the monsoon season.

With regard to irrigation, there are only six pump sets that are powered by the clean energy. As a result there are other service providers, such as chura (bitten rice) mills running on diesel and those who rent out diesel pumps sets for providing energy services. In principle, the project has been able to make some impact on the air quality, especially on NO<sub>x</sub> and CO emissions. However, these improvements are not significant, particularly as there are no other major sources such as industries and other energy uses causing of air pollution in this area.

Burnt biomass residues in the filters are used for making charcoal. These are either used by the employees of the power plant for use in domestic cooking or are sold in the market. Use of charcoal adds to indoor air pollution and is not the best fuel to use, and one of the key challenges from an environment perspective for this project will be finding solution for the safe disposal of charcoal in future as it becomes a producer gas based gasifier.

### *Water quality*

Wastewater (water contaminated by the producer gas) that is used in the plant is cleaned by charcoal/activated carbon and reused until it cannot be used further (normally after 700-800 hours; see Gantenbein, 2005: 23). At this stage, wastewater is channelled in the small piece of land in the power plant complex, where BOVS grows vegetables, and where the residual impurities are absorbed by the plants (Interview 12 India 2006). Given that the treatment of wastewater is not yet optimized (Gantenbein, 2005), there will be some adverse effects on the ground water quality. However, given the overall water aquifer of the region and the high recharge due to its location in the flood plains of the Kosi River, the treated wastewater disposal is not expected to have a negative impact on the groundwater quality or on quality of land. At the same time the volumes of wastewater that are being disposed are also not significant. Finally, wastewater has good manure qualities. Furthermore, according to the project developer, tests have been done in Switzerland and are being repeated in Bangalore to quantify the cleaning effect of the plants (Interview 12 India 2006).

### *Biomass resources used*

Since its inception in the year 1999 the project has identified a reliable source of biomass in the form of Daincha (*Sesbania sesban*), which is grown as a crop in the region. Daincha is the primary fuel used in the power plant. Since biomass management is the key to the sustainability of the plant, the use of Daincha as biomass has enabled the project to create a sustainable supply of biomass. Daincha is a seasonal crop that is widely grown by the farmers of the region. As a result, the project does not disturb the ecological balance of the region. Since the supply of biomass to the power plant is the responsibility of BOVS, the cooperative has attempted to promote cultivation of *Ipomoea Carnea* (Besharam) – a wild plant, however, with little success. The project was mandated to take up energy plantation

towards creating a sustainable fuel supply for the plant. In the long run, since there is proposed plan to shift to a 100% producer gas based power plant, BOVS has started planning for energy plantation. Some of its past initiatives include cultivation of drumstick plants and few other locally grown biomass species, these attempts, however, have not been very effective (Interview 6 India 2006).

#### *Impact on climate change*

Use of biomass fuel and renewable energy technology has assisted in replacing the use of diesel for enterprise activity and irrigation pump sets. The initiative has resulted in CO<sub>2</sub> emission reductions by replacing diesel. Most of the farmers in the region hire diesel run pump sets for irrigation. The project has installed 6 electric pump sets with a catchments area of around 400 acres. Furthermore, micro-enterprise units established by BOVS are also energised by the power plant and thus contribute to CO<sub>2</sub> emission reduction in comparison to the baseline condition of these units being operated by diesel. Therefore, the project can claim to reduce CO<sub>2</sub> emissions. According to data provided by DESI Power, increasing emissions reductions were realised (see Table 8.1). Combined with data on units of electricity generated over the years, the data result in an emission reduction factor of 0.73 kg CO<sub>2</sub> emissions avoided/kWh (Interview 12 India 2006).

*Table 8.1 Diesel and CO<sub>2</sub> emissions saved by the Baharbari power plant.*

Year	% diesel saved (theoretically)	CO <sub>2</sub> emissions saved (kg/year)
2001-2002	20	1668
2002-2003	50	5850
2003-2004	60	5467
2004-2005	69	4709
2005-2006	79	7618
Total	56% (average)	25311

Source: Interview 12 India 2006.

According to the information provided by the project developer, the number of avoided greenhouse gas emissions depend on whether the baseline situation is taken to be connection to the grid (leading to emission reductions in the range of 0.8-1.1 kg/kWh, depending on the fuel mix of the grid) or small diesel engines with a low PLF (leading to emission reduction factor of 2.4 kg/kWh). Looking at the situation in Baharbari, the ideal baseline comparison would be a small diesel engine. However, as no baseline study has been undertaken to quantify the expected emission reductions, this is difficult to verify.

#### **Economic aspects**

##### *Financial viability*

The Baharbari project is financed through a combination of funds, including the AIJ component. As mentioned earlier, management of the power plant rests with BOVS. Functionally, BOVS is an independent entity, which is procuring power from the biomass based power plant owned by DESI Power and performs all the downstream activities. BOVS basically operates and maintains the power plants on behalf of DESI Power. However, given the meshing between BOVS and the power plant, it is difficult to ascertain whether it is the viability of the power plant or the viability of BOVS that one



needs to consider. Based on the discussion with the Board of Directors of BOVS, it is clear that BOVS has not yet attained financial viability.

Data provided by DESI Power show a number of trends that hint at the problems in terms of financial viability. First of all, the running hours of the gasifier are relatively low. Currently, the plant is not operational during the monsoon season. However, also outside the monsoon season the running hours are far from being optimal. This was especially the case in the fourth year of operation of the Baharbari plant (2004-2005), mainly because of a mini-drought causing the biomass to become more expensive, as well as personnel issues (Interview 12 India 2006). As a result of the low number of running hours, the total amount of units of electricity generated are also relatively low. Around 87% of the total amount of generated electricity was sold to BOVS, the remainder was used for internal consumption by DESI Power.

An important indicator of the viability of a plant is the plant load factor (PLF). For the Baharbari plant, the PLF has remained very low, with an annual average staying below 10%. An explanation for the low PLF is the lack of capital to invest in business units, and more energy services that could have increased the profitability of the plant. Furthermore, the project developers indicated the responsibility of BOVS to maintain a minimum number of jobs was one of the reasons (Interview 12 India 2006).

Another explanation is the diesel use of the gasifier. As the existing plant is based on a dual-fuel technology, and continues to use diesel, it is economically not viable in the current diesel price regime to operate the plant constantly. Diesel prices in India were regulated until 2002, when the Administered Pricing Mechanism was dismantled and prices were linked to import parity price. Diesel prices in India have constantly increased with rising crude oil prices in global market. As can be seen from Table 8.2, the price of diesel when the project was implemented was Rs 16.92 per litre, and has now almost doubled to Rs 32.87 per litre, therefore affecting the cost of generating electricity. Besides, there is no constant demand for energy services, which would justify the plant operation. The peak demand period for the plant is between November and February, which coincides with the post-harvest Kharif crop requiring agro-processing provided by the BOVS and irrigation requirement for Rabi crops (Interview 5 India 2006).

*Table 8.2 Increase in the price of diesel.*

Year	Kolkata (Rs/litre)	Delhi (Rs/litre)
01-Apr-98	10.55	10.25
01-Apr-99	10.18	10.03
01-Apr-00	14.2	14.56
01-Apr-01	16.92	17.06
01-Apr-02	16.97	16.6
01-Apr-03	23.51	22.11
01-Apr-04	23.99	21.73
01-Apr-05	28.72	28.22
01-Apr-05	32.87	30.45

Source: MoPNG, 2006.

In addition to this, there is scattered demand for electricity for different services in the remaining months and the plant does not operate between June and October. During this period the plant goes through annual maintenance. As a result, the energy services from the plant and BOVS are not available throughout the year. This is an important aspect, as most people stated that the services provided by BOVS are far superior when compared to the other processing units in the village.

Table 8.3 provides the procurement price of biomass by BOVS and the power plant. Daincha cultivators in the village sell the crop to the unit, but the procurement price appears to be on the lower side. BOVS purchases Daincha at the rate of Rs 0.35 per kg in wet condition whereas price in the open market is in the range of Rs 1.60-1.80 in dry condition.<sup>59</sup>

*Table 8.3 Procurement price biomass*

Biomass	BOVS's procurement rate (Rs/kg)	Power plant procurement price (Rs/kg)
Ipomoea	0.50	1.50
Daincha	0.35	1.25
Rice husk briquette	N/A	2.10
Firewood	N/A	1.25

Source: Interview 6 India 2006. NB: N/A means 'not applicable'.

The electricity rate (Rs/kWh) at which electricity is purchased by BOVS from the power plant has not remained stable over time. The electricity tariff was Rs 4.50 per unit when the project started. However, over the last two years, the electricity tariff has been revised to Rs 6.50 per unit and then further to Rs 7.50 per unit. These rates appear to be on the higher end. Such a situation is likely to arise only due to high consumption of diesel and lower diesel efficiency replacement.

#### *Impact on economic activity in the area*

The project has benefited the villagers by:

- Offering employment in the power plant and micro-enterprise units;
- Purchasing biomass, especially Daincha from farmers;
- Offering the services of the micro enterprises; and
- Selling water for meeting irrigation needs.

The few discussions with villagers during the evaluation visit indicates that the energy services which BOVS provide to farmers (irrigation) and households (other energy services) are valued by them. While some of the existing services provided by BOVS were already available in the village, BOVS has also added the services such as the battery charging station and a welding unit – and in the process has reduced the time and distance households had to travel.

<sup>59</sup> The procurement price of Daincha by BOVS is written on the Notice Board of BOVS. Prices were confirmed during interviews nr. 3 and 5. Market prices were confirmed during Interview 7.

The impact of this project on the local economy is fairly dispersed. Most of the farmers who draw irrigation water from the pump sets in the village are those who do not own land themselves, rather they cultivate on hired land belonging to large land-holding farmers. In other words, these are sharecroppers who get into an agreement in which the labour cost is to be borne by the sharecropper, the cost of inputs including water is equally divided and the yield is shared in a 1:1 ratio (Interview 2 India 2006). BOVS has installed 6 pump sets in the village, and these pump sets supply water to the land owned by the project developers/BOVS. According to data provided by DESI Power, a total area of 405 acres has been irrigated over the years, which amounts to about 25% of the total farming land in the village (Interview 12 India 2006).

The current rate for hiring a diesel pump set in the village is Rs 50-60 per hour whereas BOVS charges Rs 48 per hour to the farmers (Interview 5, 7 India 2006). There are 118 farmers that are purchasing water from the cooperative; more than two-thirds of these are sharecroppers (Interview 2 India 2006). While there is a benefit for the farmer in terms of reduced input cost for irrigation, the benefit is equally drawn by the project developers/BOVS. Since most the beneficiaries of the reduced irrigation cost are sharecroppers, it must be kept in mind that these benefits for sharecroppers are temporary and transitory in nature, as it depends on who obtains the right to cultivate the land. So, while there is an economic benefit for the farmer, there is no assured economic benefit.

Rural micro-enterprises such as rice mill, *chura* mill, rice paraboiling, rice dehusking, welding, briquetting, and battery charging station have been set up by the BOVS within the vicinity of the generation unit. According to the project developer, around 400 different batteries have been brought for charging from five villages (Interview 12 India 2006). Furthermore, the other enterprises have resulted in an average of around 17,640 kg/year wheat processed, 57,600 kg/year paddy processed, and 29,920 kg/year paddy processed (Interview 12 India 2006).

The preparation of para-boiled rice is not directly linked to the power plant. The units are owned and run by the BOVS with the help of regular and temporary employees. These micro-enterprise units provide services to the villagers which are consumptive in nature. Except for some improvement in the quality of *chura* and rice, people are not able to differentiate the services of BOVS' owned enterprise units in comparison to other similar services providers (Interview 4, 7 India 2006). The real economic benefit of these micro-enterprises on the local people would have been in a situation when these enterprises would have been owned by individual entrepreneurs.

#### *Employment generation*

According to a group interview with employees, the project provides employment to about 15 people, including four permanent labourers. These permanent employees are trained technicians. The remaining staff is employed seasonally (Interview 5 India 2006). However, data provided by DESI Power, there are 19 direct employees in total, of which 13 permanent (see Table 8.4). Two points should be made in this regard. First, the employees mentioned in the first group (Total Team) are mainly based in the nearby town of Araria. Second, we have not been able to verify the number of employees that are permanently employed.

Table 8.4 Employment provided through the Baharbari power plant, October 2006.

Organisational status	No.	Part time/Full time
Total Team DESI/BOVS, Baharbari		
Office in charge	1	Part time
Office in charge	1	Full time
Projects trainee	1	Full time
Projects trainee	1	Part time
Projects trainee	1	Part time
Head Accountant	1	Part time
Assistant to Accountant	1	Part time
Cleaning staff	1	Part time
Micro-enterprises		
Executive Trainee	1	Full time
Executive Trainee	1	Full time
Projects trainee	1	Full time
Site in charge (Power plant and business units)	1	Full time
Power plant in charge	1	Full time
Power plant operator 1	1	Full time
Power plant operator 2	1	Full time
Operators of business units	4	Full time
Total	19	

Source: Interview 12 India 2006.

During the non-operational period, there are about 7 employees who are engaged as regular staff. Contractual labourers are hired at a rate of Rs 50 per day. Regular employees are paid in the anywhere in the range of Rs 500-3200 per month (Interview 5 India 2006). BOVS has also employed a physically handicapped girl to perform basic set of activities at the rate of Rs 500 per month (Interview 5 India 2006).

Apart from direct employment in the plant, any other marked contribution of the project on the economic development of the people has not been found. Villagers certainly are getting services from the BOVS, but they do not benefit directly in the form of monetary gains, as BOVS and the power plant falls short to provide or facilitate livelihood options for them. The power plant unit does not provide electricity to the people, thereby limiting their opportunities to use electricity for productive use and enhancing their quality of life.

#### *Attraction of green investments*

The project has been effective in securing green investment as a result of successfully demonstrating the workability of a decentralised biomass gasifier project. The Baharbari experience has provided a platform for DESI Power to upscale the project in 100 new villages and has even managed to secure funding for this expansion (see chapter 4). The Baharbari experience has also been recently awarded by the World Bank under the Development Market Place Award.<sup>60</sup>

<sup>60</sup> See <http://www.desipower.com/project1.htm> (accessed 8 November 2006).

*Demonstrational effect and replication potential*

The project has been effective in demonstrating the replication potential of such initiatives in a region where electricity supply is unreliable and the costs of un-served energy<sup>61</sup> due to owning own power generation are high. However, not every village will be like Baharbari. One of the reasons that the Baharbari project succeeded was the strong roots of BOVS and DESI Power in this village. In order to upscale, the initiative warrants more value addition in terms of services it provides and would have to include energy services for consumption.

The project can be made more accommodating for local people by offering them electricity for lighting and providing electricity to individual micro-enterprises instead of these services being provided to one single entity. Such an initiative would result in greater distribution of revenues. A significant change could be brought about by providing electricity to the households, creating an enabling environment for economic development and also improving the quality of life of people. However, affordability of cost of electricity is one of the major concerns. Electricity is sold at Rs 7.50 per unit to the cooperative, which is a single buyer and there no costs associated with distribution of electricity. Selling electricity to households requires investments in distribution infrastructure such as electricity poles and wires, and should also take into account the technical and commercial losses incurred in distribution. Therefore the delivered cost of electricity to a consumer will be higher than Rs 7.50 per unit.<sup>62</sup> This is extremely high when compared to the average tariff of Rs 1.00 per unit for a domestic consumer in rural areas by grid electricity.<sup>63</sup> While the comparison between two tariffs is not completely fair, the tariff of Rs 7.50 per unit from the existing dual fuel plant in Baharbari would make electricity unaffordable for most of the rural households in the village.

On the other hand, there are energy entrepreneurs in the region, who sell electricity to commercial consumers in rural areas, and domestic and commercial loads in urban and semi-urban areas. Diesel-based generators are used by the entrepreneurs and electricity is provided in the evening for 3-4 hours at the rate of Rs 5-7 per light point per day. Growth of the diesel generator based electricity market bolster the possible efficacy of the Baharbari experiment in other parts of Bihar.

The Baharbari pattern of energisation can be replicated in other areas if some necessary modifications are made. BOVS or similar entities can take up the role of energy generator and supplier only, and could encourage local people of the area to start entrepreneurial ventures using their electricity. Banks and other financial institutions can be engaged to extend financial assistance to the entrepreneurs. Furthermore, local people can be identified for the distribution of electricity in such project areas.

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<sup>61</sup> The costs of un-served energy refer to additional costs incurred by households and other users due to the absence of existing energy supplies.

<sup>62</sup> Since in most of the rural electrification projects, distribution infrastructure cost is included in capital expenditure, it would be impossible to indicate the additional per unit cost exactly unless the extent of distribution (in terms of number of consumers to be connected and length of distribution lines) is established.

<sup>63</sup> Tariff Order 2005-06. Bihar State Electricity Board, Patna.

## Synthesis

The Baharbari biomass gasifier power plant had been in operation for close to four years at the time of study in August 2006. Against the broader concepts of *empowerment* and *sustainable development* of the local communities through developing sustainable livelihood model supported by an off-grid power plant the project has made an impact. However, the progress is not very significant on a number of sustainable development indicators.

Sustainable development of the local community was one of the main objectives of this project. It was envisaged that the project would bring about sustainable livelihoods and empowerment to the local poor people who are mostly below the poverty line. DESI Power believed in the principle of creating the demand for energy – especially for electricity – first rather than supplying power to individuals for home lighting. This is the main conceptual difference of the Baharbari decentralized power project when compared to overall rural electrification goals in the country and other decentralised power plants. While conceptually the approach is different and is one of the means for improving access to energy services, in the village there is a growing demand for electricity for lighting, which the capacity of the power plant is unable to provide.

From an economic perspective, the project has successfully demonstrated the effect of the availability of electricity in a small village, especially in terms of assured irrigation and providing avenues for the development of entrepreneurship. With the establishment of micro-enterprises, people have benefited from access to energy services, however, most of these services – except for irrigation – are of a consumptive nature. The project does not create livelihood options and opportunity for people to improve their living conditions. The social aspects of this project are its weakest link. Since the project has catered to the energy needs of a few and a larger group of people, its impacts on improving the livelihoods of the poor (poverty alleviation) and its ability to influence human needs are limited.

The micro-enterprises directly connected to the power plant were approached with the objective to create a constant demand for the power plant, which is technically absolutely required for plant operation. The enterprises were also envisaged to create employment opportunities for the local people. However, since the existing plant is based on a dual-fuel technology, and continues to use diesel, it is economically not viable in the current diesel price regime to operate the plant constantly. In addition to this, there is scattered demand for electricity for different services in the remaining months and the plant does not operate between June and October. During this period the plant goes through annual maintenance. As a result, the energy services from the plant and BOVS are not available throughout the year. This is an important point, since most of the people identified that the services provided by BOVS are far superior when compared to the other processing units in the village.

Unfortunately, not much can be said about the project's environmental impacts. For the main environmental indicator, the reduction of GHG emissions, it is barely possible to verify the impacts, as no baseline study has been conducted, and no information on the actual emissions savings was available. For the other indicators, limitations were caused by a lack of (usable) information. However, given the small size of the project, any positive or negative impacts on the environment are likely to be negligible.

Scores relating to the magnitude of the effects discussed above have been assigned in Table 8.5.

Table 8.5 Criteria for evaluating sustainability of biomass gasifier project.

Criterion	Indicators	Score (-2 to +2)
<b>ENVIRONMENTAL SUSTAINABILITY</b>		
Air resources	Air quality	0
Water resources	Water quality	0
	Water quantity	0
	Water management	Na
Land resources	Land quality	0
	Land-use change	0
	Land management	Na
Other resources (_____)	Other resource (_____) quality	0
	Other resource (_____) quantity	+1
	Other resource (_____) management	0
Biodiversity & Ecosystems	Biodiversity quality	Na
	Ecosystem functioning	Na
Impact on climate change	Reduction in GHGs	+1
<b>ECONOMIC SUSTAINABILITY</b>		
Financial viability	Return on investment	+1
Effects on local/regional economy	Energy expenditure	0
	Employment (numbers)	+1
	Impact on economic activity of area	0
	Attraction of green investments	+2
Effects on national economy	Impact on balance of payments	Na
	Economic growth	Na
Technological sustainability	Technology transfer and self-reliance	Na
	Demonstrational effect and replication potential	+1
	Design and operational efficiency	Na
<b>SOCIAL SUSTAINABILITY</b>		
Livelihoods of the poor	Poverty alleviation	-1
	Distributional equity	-1
	Access to essential services	-1
	Access to affordable clean energy services	0
	Impacts on human health	0
Human capacity	Employment (job quality)	+1
	Empowerment	0
	Gender equality	0
	Local skills development / education	+1
Human environment	Preservation cultural / natural heritage & aesthetics	Na
	Relocation of communities	Na

#### 8.4 Evolution to a CDM project

The Baharbari project is important from a CDM perspective, as it more or less provides a template (including some lessons learnt) for developing a larger scale CDM project. The following section does not intend to evaluate the proposed CDM project, but mainly aims to show what has followed after the Baharbari project.

Desi Power, together with Women for Sustainable Development has drafted a project design document (PDD) for a small-scale CDM project, in which it is proposed to bundle around 100 Baharbari-type projects, all of which are located in the Araria district.<sup>64</sup> This project, entitled '100 village biomass gasifier based power plants totalling 5.15 MW for Decentralised Energy Systems India Pvt Ltd. (DESI Power)' is now at the validation stage. Although the PDD argues that sales of certified emission reductions (CERs) are required for the project, the sales of carbon credits are expected to cover only a part (around 1/3) of the total funding (Sharan, 2005). These sales include expected sales in the form of verified emission reductions (VERs), which are different from CERs, the units that can be traded under the CDM.

The CDM project will install mainly 50 and 100 kWe biomass gasifiers, which will operate outside the main grid. For five villages, activities are starting in September 2006 (3 x 50 kW, 2 x 100 kW), after the monsoon period. Table 8.6 shows the amount of CO<sub>2</sub>-emissions that are expected to come from the project. This is calculated on the basis of a baseline scenario in which diesel power from <15 kW diesel generator sets is used in the villages.

*Table 8.6 Expected emission reductions of the 100 village CDM project*

Years	CO <sub>2</sub> emission reductions (tonnes)
2007-2008	1,250
2008-2009	5,210
2009-2010	11,785
2010-2011	26,424
2011-2012	43,750
2012-2017	54,310
<i>Total</i>	<i>359,969</i>

Source: DESI Power, 2006

The PDD shows some improvement in comparison with the Baharbari project:

- It is proposed to use more up-to-date technology. Rather than replacing 75-80% of the diesel by producer gas, the PDD proposes to completely replace diesel oil, thereby ensuring additional GHG emission reductions.
- It is envisaged that the plants will also supply electricity to individual households. No house-to-house supply is envisaged. Instead, one person per village hamlet would be appointed, who would be responsible for further distributing the electricity and collecting the bills (Interview 1 India 2006).
- The requirements for baseline setting and monitoring are much more strict under the CDM. If the CDM Executive Board approves the project, this means that any progress with regard to both GHG emissions and sustainable development should be better monitored. The PDD provides details on how to monitor the avoided CO<sub>2</sub> emissions, by metering the amount of kWh generated.

<sup>64</sup> See DESI Power (2006). The latest version of the PDD can be obtained through the website of the validating company, Det Norske Veritas (DNV), at [www.dnv.com](http://www.dnv.com). Note that the Baharbari gasifier is not a part of the CDM proposal, as it is not allowed to sell emission reductions from AIJ projects.



## 8.5 Inferences

Is small always beautiful? The broader ideology behind the Baharbari project with a decentralised, environmentally friendly, small (50 kWe) biomass project has been to show that small capacity plants can result in transforming livelihood opportunities in rural areas and usher a range of social and economic changes. While this project has made certain contributions to the social, economic and possibly even environment, it is not possible to say that this project has in any significant way contributed to sustainable development. To a very large extent this is due to the fact that we are blindfolded in our understanding of sustainable development in the context of climate change projects. Do we refer to sustainable development at the global level by means of GHG emissions reductions, or to sustainable development at the local level in terms of social, economic and environmental benefits?

The Baharbari project has made its own contribution, which is unique given the conditions in which the project operates and where it is located, but it is not practical to expect a 50 KWe biomass gasifier project to have contributed to sustainable development. In our overall assessment we have been at times extremely stringent in assessing its sustainable development impact, but at the same time it is also true that this project has done little to improve electricity access and reduce vulnerabilities associated with limited or no access to electricity. In other words, the scale of this project is too small to provide a significant contribution to sustainable development.

### Successful aspects of the project

The first and foremost contribution is this project's ability to **demonstrate that decentralised renewable energy project** can be made to run successfully with a commercial orientation. In the 1990s, when efforts to commercialise renewable energy technology were at their peak, one of the main barriers was a lack of appropriate entrepreneurial-based models for off-grid renewable energy projects (Ahluwalia, 1997; Sinha & Ramana, 1997). The Baharbari gasifier project has successfully demonstrated such a model. Even the local people had expected that similar to other initiatives in the past including a cooperative, the biomass gasifier project would not be successful. However, BOVS' management of the power plant and its provision of services over the last four years have been able to dispel the associated fears.

Another successful aspect of the project has been in **providing local employment**, although this is still predominantly seasonal. Yet another benefit is in terms of improved quality of services which people are able to receive today. This is either due to the volume of water that can be pumped or the output quality of food grains processed. The project has successfully demonstrated the effect of electricity, especially in terms of assured irrigation and providing avenues for entrepreneurship development. With the establishment of micro-enterprises, people have experienced the benefit of the electricity generation unit and potency of collective initiatives.

Apart from the direct and indirect benefits of electricity, the existence of BOVS has also been able to **trigger other forms of development in the village**. A notable outcome of the advocacy is the ongoing brick road construction and existence of Sakhi Saheli – a women's self-help group – which has been able to influence the need for addressing women's need for basic services such as health, education and empowerment.

### Less successful aspects

While the project has demonstrated the viability of decentralised renewable energy projects, the very concept of captive generation and utilisation of electricity has **reduced its impact on improving livelihoods** and addressing aspects of social development. The problem is further aggravated by the way the benefits and transformations that the project has created have been scaled up by the project developers. The project has resulted in providing employment to local people, but one need to consider that any other project with or without a renewable energy angle to it would have also provided similar jobs. The successful aspect is that the project has resulted in making few more local youths employable.

One of the other less successful aspects of the project is its **inability to provide electricity for lighting to the households**. The approach of creating demand for energy and ability to afford electricity is fine in principle, but the development is not a step-by-step process. Instead, it is multi-faceted, and the need for change varies from one section of society to another. Global experiences on impact of access to electricity in developing countries have shown that one of the most desired expectations from electricity access is for improved lighting (Barnett, 2000). The project does not address this need. It rather focuses on creating a demand for electricity and improving the paying capacity of the local population, before providing electricity for consumption use such as lighting and individual household economic development. The problem is that this goes tangent to the conventional wisdom of benefits that people attach to lighting. This is even more important in a village that is not electrified. As a consequence, the energy services are localised and most of the economic benefits out of selling these services and buying these services are accrued by the BOVS, with no redistribution.

Also, in the process the project has by very **limited means been able to enhance income generating capacity of local people**. As mentioned in the earlier section, the real beneficiaries of the project are promoters of DESI Power and BOVS, ownership of which are intertwined. Therefore there is no redistribution of income, however, given the nature of the project and the way electricity is used, there should also be no redistribution.

Finally, some of the beneficial elements of the project have been magnified by DESI Power and BOVS, but **cannot be found to the same extent at the ground level**. A key example is the practice of cultivation of Daincha. As mentioned earlier, the crop was already cultivated in the region, initially as organic manure and more recently as a fuel for household cooking use or for selling in the market, since other biomass resources have dwindled and there is no penetration of other fuels for cooking. Farmers do not find it financially attractive to sell Daincha at the rate BOVS purchases and therefore they prefer to sell in the market. Therefore, most of the Daincha supplies actually originate from land belonging to DESI Power/BOVS. A similar issue is related to selling water for irrigation. As mentioned earlier the pumps are located on the land belonging to DESI Power/BOVS, and therefore, while there is a benefit for sharecroppers, the benefit is equally shared by DESI Power/BOVS. Last but not the least is the issue of replication, as the conditions which exist in Baharbari are very favourable for DESI Power/BOVS and similar conditions are not likely to exist in other villages.

## Lessons learnt

The AIJ project in Baharbari provides us with a few important lessons.

First, **better and more systematic reporting** of projects funded by the Netherlands' Ministry of Foreign Affairs is needed. There was little data available for the Baharbari project, and the data that was (made) available was not sufficient to provide a full assessment of the sustainability aspects of the project. It is difficult to provide an assessment of the project's contribution to the essential indicator of avoided emissions if there is almost no information on: a) baseline scenarios; b) the exact amount of diesel used; c) greenhouse gas emissions associated with the remaining diesel use. None of this information was available in documents recovered from the archives, and also at the site visit we were not able to obtain this information. This is rather odd for a project that is explicitly related to greenhouse gas emission reductions under the AIJ guise.

Moreover, the assessment in this report was not only concerned with the impacts on greenhouse gas emissions, but also with broader sustainable development effects. From the available documents, it was not possible to provide robust statements on a number of sustainability indicators. This made interviews and a site visit indispensable. Systematic reporting on a (limited) number of indicators by the project developers to the Ministry could avoid this situation to a large extent, although we feel that **conducting a site visit and interviews remains an essential element** of any assessment of the contribution to sustainable development of any such project.

From our interview with a representative with the Netherlands' Embassy in New Delhi it was clear that **there might be a role for embassies** in this regard. Because of their close connection to the host countries, embassies might provide support to the monitoring by conducting site visits or by talking to the project developers – something that may be too costly or time-consuming to arrange from the Netherlands. Although the role of embassies could be enhanced, this does not provide a panacea for the monitoring issues.

A second point – which is related to the first – is that, apparently, the **Ministry of Foreign Affairs lost interest in the project** after the AIJ phase ended in 2003. This research constitutes the first effort to assess how well a project is doing after the funding period. This means that a project could do fairly well during a certain period, but that its long-term sustainability could be uncertain without the original funder knowing it. This runs against the long-term nature of the concept of sustainable development.

Third, the **absence of clear and verifiable goals** of the project made it difficult to measure its performance. Although the initial project documents certainly provide some indication of the intentions of the project developers, it is hard to check to what extent for example “the upliftment of the village” has been realized. This is not to say that all goals of a project should be quantified – for some aspects (e.g. empowerment) this is seemingly impossible – but where goals are quantifiable, this should not be shunned.

Finally, the Baharbari case study shows that **good ideas are not always sufficient**. The logic behind the project is clear. There is a need for electricity in rural villages in India that are not connected to the grid. Biomass gasifiers could supply this electricity in a way that results in less greenhouse gas emissions than the diesel engines otherwise used. If combined with the creation of small-scale business activities, this could result in reliable demand as well as the creation of local employment. Until here, this sounds reasonable.

However, our analysis shows that for such an idea to work in practice, **there are many conditions that need to be fulfilled**. This does not only include the financial viability of a project, although the Baharbari case shows how difficult this may already be. Additionally, a project should bear in mind which people need electricity. This does not only include the entrepreneurs that use the electricity for their micro-industries, but also the villagers that need electricity for lighting, televisions, etc. Moreover, local conditions for biomass gasifiers might not always be as convenient as in the Baharbari case. Here, the village situation was quite clear for the project developers, as they were very familiar with the village itself. If gasifiers are installed in different villages, there may be different stakeholders that could make it more difficult to ensure biomass supply, electricity demand, etc. Especially if you want to provide lighting, the biomass needs will increase, and it may not always be possible to fulfil these needs. In any case it requires proper planning for the resource sustainability.

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## 9. Comparative analysis of the case studies

*Joyeeta Gupta and Pieter van Beukering*<sup>65</sup>

### 9.1 Introduction

The previous chapters examined case studies of renewable energy projects in several developing countries that have been financially supported by entities in the Netherlands. This chapter presents a comparative analysis of these studies with the aim of improving our understanding of the factors leading to the success or failure of these Activities Implemented Jointly/Clean Development Mechanism projects in contributing to sustainable development. It should be noted that all five projects were born during different phases of the climate change regime and therefore were required to meet different standards. For example, some of the projects were not required to directly meet broader sustainability criteria, which nowadays is a compulsory condition for CDM projects. Furthermore, the comparison is complicated by the fact that all five projects are in different phases of implementation.

This chapter first present a brief description of each of the projects (see 9.2), analyses some background information per project (see 9.3), looks at the evolution from idea to contract (see 9.4), examines the interpretation of sustainable development in the project documents (see 9.5), looks at how host countries evaluate sustainable development (see 9.6), the contribution of the project to the host country in terms of sustainable development (see 9.7), the factors that contribute to the success of the project (see 9.8) and lessons learnt from these projects (see 9.9).

### 9.2 An overview of the case studies

#### Tejona wind Power project (Costa Rica)

This project focuses on an AIJ wind power project in Tejona in Costa Rica. It involves a Dutch partner – Essent Energie B.V. and the Costa Rican public sector power company – ICE. Although the Costa Rican partner in 1992 initially developed the project, the contract with Essent was signed in 2000 and the project is now in its fourth year. At present the wind park is functioning and providing electricity; however, there are three privately developed wind plants in Costa Rica, which make it difficult to prove that the project is ‘additional’ at this stage. Further, the plant is not operating in an optimal manner because of poor maintenance, which had resulted from the confusion about who was seen as responsible for such maintenance. The project has reduced the emissions of greenhouse gases when compared to the baseline situation and has minimal other negative environmental impacts, but has also limited contribution to social aspects; though its potential contribution to the economy is higher. As such its contribution to sustainable development is limited.

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<sup>65</sup> Institute for Environmental Studies, Vrije Universiteit, Amsterdam.

### Small-scale biogas technology (Vietnam)

This AIJ case study focuses on the large-scale promotion of biogas technology in 12 provinces in Vietnam. The partners in this case are essentially the Vietnamese Ministry of Agriculture and Rural Development and the Netherlands Development Organisation in Vietnam (SNV-VN). The project was negotiated in 2002 and the first phase of the project was completed in 2005 and it is now in its second phase. The project uses technology developed and used in a previous project in Nepal and which has been adapted to local circumstances. Farmers were provided with subsidies via the post office system to install the system and use it. The project is very successful and many farmers participate in the programme. The two problems are that richer farmers have also been able to access the subsidies and there has not been optimal use of the gas and slurry. Both problems can be addressed through provision of scaled subsidies and capacity building to help farmers sell or give other local potential consumers the remainder of the gas and slurry. The project has been combined with training and capacity building and has focused on meeting the social, environmental and economic needs of local stakeholders and thus scores quite well on the criteria of sustainable development.

### Mini-hydro plant in Bethlehem (South Africa)

This AIJ project focuses on the development of a mini-hydro plant in Bethlehem in South Africa. The project was developed by E3 an engineering company in collaboration with NuPlanet with offices in both countries. The idea was developed in 1997 and the contract signed in 1990. However, the project has only just been put into operation in end 2006. This is because of the complex nature of the legal permissions required to put up this project. The project demonstrates that the private sector should in the future be able to successfully develop small hydro projects. It is difficult to evaluate the success of this project, because it has just been set up, but one can argue that since it meets the requirements of most national regulations, the project automatically makes some minimal contributions to sustainable development in the South African context.

### Sunny greenhouses (China)

This project focuses on developing solar technology for greenhouses in Shandong province in China. The project principally involved the Energy Research Centre in the Netherlands, the Ministry of Science and Technology in China, and the Municipality of Shougang in Shandong province. Demonstration greenhouses have been set up, but the on-site visit revealed that these greenhouses are not being used optimally, there are no reductions of greenhouse gases as baseline emissions are close to zero, and there is no real dissemination of the technology. Because of the low involvement of local stakeholders in the design and implementation of the project, and the poor design of the project in terms of taking into account the baseline situation, the project fails to both reduce greenhouse gases and to contribute to sustainable development.

### Biomass gasifier in Baharbari, Bihar (India)

This project focuses on the promotion of the use of a biomass gasifier in Baharbari in India; and this is only one of the six biomass gasifiers promoted in the total project. The project has a Dutch partner – the company NICIS, Development Alternatives and DESI



Power. The contract was signed in 1999. The project reduces greenhouse gases in comparison with diesel generators in the baseline situation, and has made some contributions to the local economy and social context, but to a very limited extent.

### 9.3 Background Information

A brief comparative overview of the key issues in the case studies is provided in Table 9.1. The Netherlands has financed all projects to some degree but is not always the direct investor. The projects are located mostly in rural areas and are spread through out the continents in the developing world and are in both relatively small countries and very large countries. The projects focus mostly on renewables. The total project costs range from 0.8 million in China to 21.9 million in Costa Rica (data for India unavailable). The Dutch contribution ranges from a fraction of 0.7 million for India (there are six gasifiers financed in India and only one is the focus of this research) to 3.5 million in the case of Costa Rica. We expect that the emission reductions generated will range from none in the case of the Chinese project to upto 55 kilotonnes CO<sub>2</sub> in the case of Vietnam. Nevertheless, there is a wide variation in cost efficiency, in terms of investment per tonne CO<sub>2</sub> reduction, ranging from €1.9 in Vietnam to €27.5 in Costa Rica (data for China and India not available). Note that cost-efficiency was the main driver for AIJ projects to be initiated.

Table 9.1 Background information

Host country	Costa Rica	Vietnam	South Africa	China	India
Location	Tejona	Across country	Bethlehem	Shandong	Bihar
Foreign investor	Essent, B.V. & Dutch Govt. (PPP/JI)	SNV (PPP/JI)	Nu Planet with offices in both countries	ECN & PPP/JI	NICIS
Host investor	ICE	Ministry of Agriculture and Rural Development	E3	Ministry of Science and Municipality of Shougang	Development Alternatives and DESI Power
Investment	Wind power	Small-scale Biogas	Mini-Hydro	Sunny greenhouses	Biomass gasifier
Total project cost	€ 21.9 million	€ 2.1 million	€ 6.4 million	€ 0.8million	n.a.
Dutch contribution	€ 3.5 million	€ 2.0 million	€ 0.8 million	€ 0.5 million	€ 0.7 million
CERs expected	40 <i>kilotonne CO<sub>2</sub></i>	55 <i>kilotonne CO<sub>2</sub></i>	33 <i>kilotonne CO<sub>2</sub></i>	none	n.a.
Investment/tonne CO <sub>2</sub>	€27.5 per <i>tonne CO<sub>2</sub></i>	€1.9 per <i>tonne CO<sub>2</sub></i>	€9.7 per <i>tonne CO<sub>2</sub></i>	n.a.	n.a.

## 9.4 From idea to contract

Climate change projects in developing countries are a relatively new and innovative instrument. In examining such an instrument, it is important to analyse how these projects have evolved over time, especially as there are high transaction costs in such a process. Table 9.2 sums up the process.

*Table 9.2 The timeline of projects.*

	Costa Rica	Vietnam	South Africa	China	Bihar
Initial idea	1992		1997	1997	1997
Developed where	Costa Rica	Vietnam	South Africa	ECN, Netherlands	Joint*
Contract negotiated	2000	2002	2000	2002	1999
Project implemented	2001	Phase 1 implemented (2003-2005)	In 2006; as approval process took time	Expected to be implemented by 2004; still not implemented properly	The last of the six gasifiers was completed in 2001
Current status	Functioning for four years	In Phase 2	Construction completed	Construction complete; non-functional	Provides electricity and supports development; but not to outsiders?

\* In the initial years; now the project is mainly 'owned' by Indians.

Table 9.2 shows that in some cases the project took a long time to mature. That is definitely the case for the project in Costa Rica. Here we see that a commercially non-viable project design in 1992 is seen in 2006 as commercially viable, since the competitors can commercially produce electricity from wind plants. This lag time has had an influence on the "additionality" of the project. A similar delay is noticeable in the China case study, during which partners lose interest and the design of the project and project documents are weak as a result. In the case of the South Africa, the delay was related to an innovative project design for which it was not always clear how many permits had to be obtained from the government, and the sequential nature of acquiring such permits means that the whole process was delayed substantially – adding considerably to the transaction costs of such projects.

## 9.5 Sustainable development in project documents

As mentioned earlier, most of these projects were developed as AIJ projects and there was no explicit requirement that these projects should meet sustainable development criteria. Nevertheless, we have examined the extent to which these documents have referred explicitly or implicitly to sustainable development.

In the *Costa Rican project*, the documents did not mention sustainable development. However, the Dutch grant for the project referred to capacity building including environmental education and technology transfer.

In the *Vietnamese project*, a number of elements were explicitly taken into account that go beyond the issue of climate change and control of greenhouse gases. These can be seen as the implicit contribution to sustainable development in this project. These focus on social aspects including health issues, environmental issues and economic issues and these were relevant at micro, meso and macro level (see Table 5.1 in Chapter 5).

The *South Africa hydro project* in Bethlehem did not explicitly refer to sustainable development but included other indicators such as environmental issues (improved local air quality and hence better local health), and economic issues (lower costs of electricity; and employment of local people).

The *Chinese project* documents do not really refer to sustainable development, although the relevant Dutch documents argue that the project has no negative impacts on women and development. It was expected that a successful project with demonstrative impacts would contribute to the local economy and the macro economic growth of the country and that there would be technology transfer.

The *Indian project* focused on the possibility of raising employment, improving the quality of labour through training and improving the local economy. The project was expected to meet national standards with respect to wastewater treatment.

One can conclude that the Vietnamese project took a number of additional indicators into account, while the South African project also did so. The other projects had minimal additional requirements (see Table 9.3).

*Table 9.3 Implicit references to possible indicators that can be seen as a contribution to sustainable development in project documents.*

	Implicit references to	Evaluation
Costa Rica	Capacity building including environmental education and technology transfer	+
Vietnam	Social issues including health; environmental and economic indicators; a total of 16 indicators	+++
South Africa	Environmental indicator (lower local air pollution and hence improved health), economic indicators (lower costs of electricity and some local employment)	++
China	No negative impacts on women and development; positive impacts for local economy and macro economic growth and technology transfer	+
India	Improved employment and local economy; wastewater treatment in accordance with national standards.	+

## 9.6 National policies on sustainable development

Most of the host countries are part of international agreements that promote the notion of sustainable development and, as such, one can argue that these countries support the concept. But given the complexity of the issue (see Chapter 2), how do most of these countries interpret sustainable development if at all?

The *Costa Rican government* does not have general references to sustainable development, but the Costa Rican Designated National Authority (DNA) is presently engaged in the task of identifying criteria that would allow CDM projects to be seen as contributing to sustainable development in the country.

The *Vietnamese government* focuses on sustainable development and defines sustainable development as including economic development, social development (social progress, equality, hunger elimination, poverty alleviation, and jobs creation) and environmental protection in terms of improving the environment and resource use. All projects need to ensure that they meet national regulations and some of these regulations focus on sustainable development such as those on environmental impact scoping assessment, water use licenses, permission for land use and for the construction of civil works and issues related to project financing.

In *South Africa*, which has defined sustainable development with respect to several sectors, sustainable development is seen as implicitly meeting national regulations on environmental impact assessments, water use, equity capital, loan agreements and agreements on the construction work. The DNA in South Africa is satisfied that a project meets sustainable development criteria if all licenses are obtained.

In *China*, criteria for sustainable development related to CDM projects were issued in 2004. These criteria address accordance with national economic and environmental strategies, transfer of technology and financial resources, sustainable energy production, energy efficiency and conservation, poverty alleviation, and local environmental benefits.

The *Government of India* has definitions for sustainable development and AIJ/CDM projects are evaluated against the criteria that the projects should contribute to social, economic, environmental and technological well-being.

What we can thus see from the case studies is that in most countries, meeting national regulations is seen as an implicit contribution to sustainable development, while India and Vietnam require, at least on paper, a little more proactive contribution to social and environmental well-being (see Table 9.4).

*Table 9.4 National definitions of sustainable development as applied to AIJ/CDM projects at present.*

	DNA definition	National definition of sustainable development as	Requirements
Costa Rica	Being defined	-	Not clear yet
Vietnam	Being defined	Economic, social and environmental progress; and operationalises it through the request that projects should conform to national regulations on these issues	Heavy
South Africa	-	Meeting national rules on environmental impact assessments, water use, equity capital, construction agreements.	Medium
China	-	Meeting national regulations	Low
India	Has been defined and is being applied	Meeting national regulations and contributing proactively to social and environmental issues.	Heavy

## 9.7 Contribution to host country's sustainable development

Where projects are approved by host countries, they are by definition sustainable: All the projects studied were approved by host country governments. However, only when these projects are prepared as CDM projects, will host country approval indicate that these projects are sustainable.

In examining the contribution of the five projects to sustainable development, the authors of the chapters have assessed, on the basis of document analysis and stakeholder analysis, whether the criteria listed in Chapter 3 have been met. The main messages emerging from the chapters based on a qualitative analysis is that the project in Vietnam has made a major contribution to sustainable development, while the project in China has not. The other three projects have had limited contributions to the sustainable development of the regions in which the projects were developed.

### Quantitative comparison

Using the multi-criteria analysis approach, referred to in Chapter 3, we can rank the four case studies. Figure 9.1 shows the overall result using the assumption that economic, environmental and social impacts are equally important. The figure also shows the ranking for the three objectives separately.

The project in Vietnam scores best in all three main categories separately and therefore shows up by far as the most sustainable project. In second place follows the project in South Africa which scores particularly well in the economic and social domain, but less in the field of environment. Besides the Vietnam project, Costa Rica scores well in the field of environment. The Indian project is not performing well in none of the three main categories and therefore shows up as the least preferred project of the four. The project in China is non-functional and is therefore not represented in the comparative analysis.

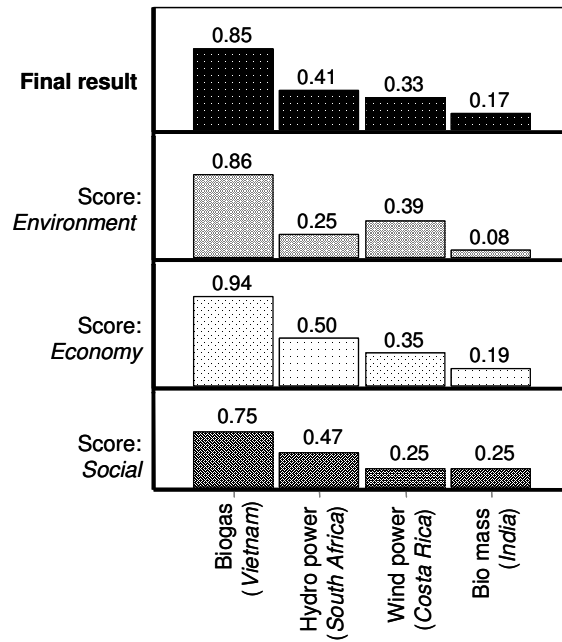


Figure 9.1 Scoring and ranking of four case studies on the basis of equal weights for environmental, economic and social impacts.

Clearly, assuming an equal weighting between the impact categories “environment”, “economy” and “social” is totally arbitrary. Host countries may consider one category more important than the other. This problem can be addressed by undertaking a sensitivity analysis. Figure 9.2 shows that the results as gained from Figure 9.1 are rather robust, and therefore the ranking does not change considerably by changing the weights.

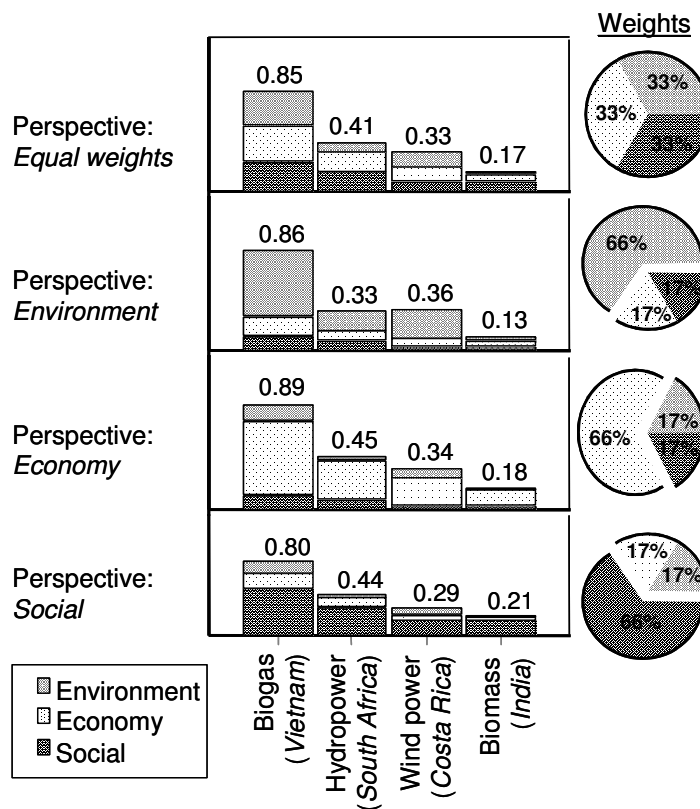


Figure 9.2 Scoring and ranking with varying weights

Another way of comparing the projects is to examine the relationship between the cost efficiency of the projects in terms of CO<sub>2</sub> reduction versus the level of sustainability that is achieved by the projects. As argued in Chapter 1 on the basis of Sutter and Parreño (2005), it is generally found that projects that score well in terms of sustainability, are less effective in reducing CO<sub>2</sub> emissions, and vice versa. Unfortunately, the comparison by Sutter and Parreño included 16 projects while our usable data points are limited to five projects only.<sup>66</sup> Therefore, no robust lessons can be drawn from such a small sample size. Another limitation of our study is that we do not know the additional costs specifically required for the reduction of greenhouse gas emissions. The only financial information is the level of investment of the project.

Nevertheless, it may still be worthwhile to verify whether investing more in the project per reduced greenhouse gas emissions also leads to less generation of sustainable development. In contrast to Sutter and Parreño (2005), our comparison shows a reverse relationship (see Figure 9.3). While the project in Vietnam reduces greenhouse gas emissions at very low levels of investment, it is also by far the most sustainable project. The project in Costa Rica requires both high investments and is less productive in terms of sustainable development. One possible explanation could be the fact that because of the generous support of the Dutch government for the project in Vietnam (i.e. 95% of the total costs of the project), the project implementers are able to take all the measures needed to be sustainable, while projects that have other funders are more pressured to do the bare minimum in terms of sustainability.

We stress again, however, that these limited observations are an insufficient basis to draw definite conclusions about the relationship between investment and cost-efficiency and the level of sustainability of the projects.

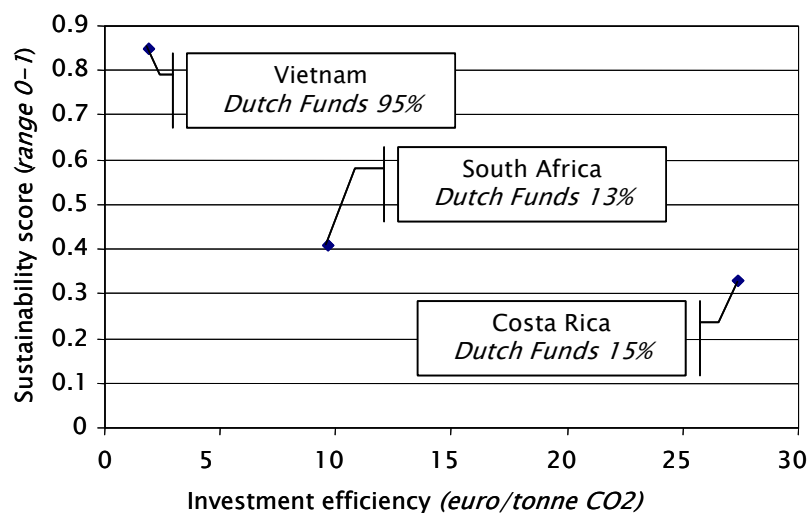


Figure 9.3 Relationship between cost efficiency and sustainable development.

<sup>66</sup> Note that the project in China did not truly reduce emissions and the project in India did not provide the team with the necessary data.

### Qualitative comparison

Three other reasons can explain the high rank of the Vietnamese project and the low rank of the project in Costa Rica. First, most of the host countries, except India and Vietnam, do not have a general definition of sustainable development in their national policies. Second, most of the host countries have not yet defined when a project meets sustainable development criteria except India. The Costa Rican government is presently engaged in such an analysis. Third, we would expect that most small renewable energy projects are likely to meet any host country's definition of sustainable development since a) their low greenhouse gas emissions b) their relatively low negative environmental impacts, and c) they can, if located in rural areas, in theory contribute to local social and economic development. Furthermore, because these are small-scale projects, they are unlikely to cause major disruptions to existing social structures or displacements. This would not however explain why the project in India performed poorly. This may have to do more with the poor project design, poor documentation, and the very small size of the project and the very low financial contribution of the Dutch government in the project.

### Common elements

The key common elements of the projects are:

On environmental aspects:

- Four of the five projects contributed to reducing greenhouse gas emissions except in the China case where the baseline was not clear.
- All the projects had low local pollution impacts, except the South Africa case where loss of one wetland was replaced with the rehabilitation of another wetlands. The Vietnamese project was proactive in addressing local pollution, while in the case of India and South Africa, the project had to meet national rules and regulations.

On social aspects:

- All five projects could have benefited from greater involvement from the local partners in order to define local benefits that could have made the projects more socially acceptable and viable. Had the local involvement and input been higher then the benefits for the local communities would have been greater. Having said that, the Vietnam project had considerable local participation in the projects.
- The projects do not necessarily reveal that women's interests were compromised, but few gender aspects were taken into account. Where the interests of women have been taken into account this has been done because of national legal requirements (the shareholders group in South Africa) or in a way relatively unrelated to the project (women empowerment in India).

On economic aspects:

- The five projects did not generate much local employment, as this is possibly inherent in the nature of such small-scale projects; and much of the participation was focused on the construction phase.
- Four of the five projects have in some way contributed to the local economy, although to differing degrees. The Vietnamese projects has probably contributed the most, followed by Costa Rica and India. The South African project is likely to contribute more in the future as the plant moves into an operational phase.



## Evolution to CDM projects

Next, the question that arises is: Are these projects likely to become CDM projects? The research shows that:

- Four of these projects are likely to be developed or are being developed into CDM projects as they possibly meet the criteria for such an evolutionary process. The Costa Rican project is problematic since the private sector has demonstrated that such projects can be financially viable. The Vietnamese and South African projects should have less problems. The Vietnamese project reveals that such small-scale projects when developed well in conjunction with local partners and stakeholders helps to make non-viable environmentally friendly projects affordable to local farmers; the only problem being that part of the subsidy was accessed by richer farmers for whom such projects are viable. The South African hydro project is interesting because it demonstrates that an off grid small scale hydro plant can be developed by private parties and although there were substantial transaction costs this time round in terms of securing permission to set up the plant; in the future the time incurred may be somewhat lower and the processes can be built into the planning process. The Indian project has thus far few benefits, but if it can be incrementally improved to meet local social, environmental and economic goals this too could possibly qualify. The Chinese project is unlikely to go through because the reduction in greenhouse gases is unclear.

## 9.8 Success factors

Let us now evaluate the factors that have been seen to contribute to the success of these projects. A summary of the success factors has been provided in Table 9.5. All projects focused on renewable energy and this per se is successful in terms of low environmental impacts. However, where the baseline is not clear the actual emission reduction may be limited (e.g. China).

The *Costa Rican Tejona project* clearly contributes to reducing emissions of greenhouse gases as it is compared to a baseline situation in which more fossil fuels would have otherwise been used to generate electricity. The project is supported by good quality documentation, which keeps the institutional memory alive. There is a successful transfer of technology in this project, which can easily be replicated in other parts of the country and elsewhere. Part of the success can be attributed to the associated capacity building focusing on training to personnel and general awareness building to the public. However, inadequate involvement of local stakeholders has meant that the contribution to the local setting is low. The organisational structure is very complex and the distribution of responsibilities were not always defined

Table 9.5 Factors influencing the success of projects.

	Costa Rica	Vietnam	South Africa	China	India
Renewables and hence by definition good	++	++	++	++	++
Project documents	Good	Good		Not very good	Not very good or unavailable
Technology	Good	Good		Possibly not relevant to the context – too expensive	Good
Technology transfer and adaptation	Good	Good		Yes, but not used	Yes
Replication	Good	Very good		?	Good
Capacity building	Good	Good		Poor	Medium
Organisational structure	Complex	Very good; including delivery of subsidies to small farmers		Poor	Complex
Division of responsibilities	Not always clear- e.g. maintenance	Very good		Poor	-
Internal communication	Assumed to be good	Assumed to be good		Poor	-
Local involvement	Poor	Very good		Poor	Medium
Optimal use	Medium, because of poor maintenance	Good but could be better if gas and bioslurry that is not used is marketed; and if scaled subsidy is provided		None	Medium because of lack of demand
Additionality	Questionable now, although not when the project was conceived	Yes; project is not economically viable for small farmers		?	-

The *Vietnamese project* has been highly successful in promoting a mass process in Vietnam in the small-scale biogas sector. The technology developed is seen as highly appropriate for the context and although it is not financially viable yet for the small farmers, the subsidy provided them with the incentive to use this extremely environmentally friendly source of energy. The institutional support mechanisms are very good. On the one hand these include the offices all over the country that are engaged in implementing the project, and on the other hand, the mechanism for disbursing the subsidy is inexpensive and effective going through the postbank. However, the slow entry of the private sector has possibly slowed down the process of making these projects commercially viable for the small farmers. The number of masonry teams is low and restricts the speed of implementation. There is room for greater optimisation of the gas from these plants and the bio-slurry through links to neighbours. The flat subsidy has been used more by relatively richer farmers than poorer farmers and a scaled subsidy could possibly address this problem.

The *South African Bethlehem Hydro project* is in initial stages but success factors include that both partners supported the idea. The delay in getting the project off the ground because of the various permits that were needed was a critical problem for the viability of the project.

The *China project* although developed jointly was pushed initially by Dutch enterprises and is a failed project in that it is neither economically viable, nor environmentally sound as there is no clear baseline to compare it with, nor is it socially relevant. Despite the fact that there were strategic reasons for developing and locating the project, the lack of consultation with local actors before developing the project has led it to be more or less a white elephant. Apart from being able to demonstrate that solar water heating collectors can be useful, the project failure can be attributed to lack of communication between the project partners, between the partners and the local stakeholders, a poor implementation schedule and organisational structure, poor planning and management.

The *India project* focuses on one of six biomass projects. This project is operational and shows that a small scale off grid renewable energy project can be successful in rural contexts and in providing local people energy. The success of the project can be attributed to the ownership of the project at the Indian end, and the ability of the project to help modify the local economy. But the small-scale nature of the project and the lack of demand for the energy show its limited use at present.

## 9.9 Lessons learnt

Despite of the limited number of AIJ/CDM initiative that have been analysed, some patterns can be observed in the success and failure factors of projects. Lessons learnt can be subdivided into four categories:

- Demand;
- Design;
- Documentation, and;
- Demonstration.

### *Demand*

Demand driven projects are more likely to be successful in terms of promoting sustainable development: There are two key aspects of demand driven projects.

- First, the five projects show that where **developing country partners push projects** there is a greater likelihood of success. The biogas project in Vietnam, the small hydro project in South Africa and the wind project in Costa Rica show that such projects can be successful in terms of avoiding greenhouse gas emissions and to different degrees in terms of promoting sustainable development. Dutch interests probably drove the China project.
- Second, projects with good **involvement of local stakeholders** are more likely to be successful in promoting sustainable development as these ensure that the demand is broadly shared in the context where the project is to be conducted. The projects where the partners have consulted well with the local stakeholders and have tried to meet their needs directly or indirectly are more likely to contribute to sustainable development and are more likely to work well in local contexts. The Vietnamese project is the only one closely linked to local needs. The Costa Rica, South Africa and the India project demonstrate the need to more actively engage local actors in the initial project planning process so that the relevance of the project, technology and usefulness to local development can be enhanced and to have a formal programme for community relations as a way to strengthen local involvement and use of the energy generated in such projects. The China project shows that a top-down approach to project implementation is not likely to be supported at local level. Where local social, economic and environmental interests are taken into account, such projects have a higher chance of promoting sustainable development.

### *Design*

For a project to make a significant contribution to sustainable development, careful design of the project is crucial. A good design is also likely to lead to more cost-effective projects. Our case studies show that the Vietnamese project reduced CO<sub>2</sub> emissions at very low costs while simultaneously generating substantial sustainability effects. In contrast, the Costa Rican project was expensive and had a much lower impact on sustainability. The elements of good design include:

- **Small and relatively affordable renewable projects** are more likely to be successful: Of the five projects, four focus on renewable energy. By definition these forms of energy are likely to enhance rural development and with some subsidies can increase the access to energy of the poor; they have low negative environmental impacts when compared to fossil fuels and, where developed in cooperation with local communities, they can generate local benefits. The solar greenhouse project failed because of the high costs of the solar energy and the poor design of the project. Nevertheless, these are potentially straightforward cases – because they are developed in the direction in which we hope that the energy systems in these countries will further develop in this century. Small, simple and inexpensive technologies can have a major demonstrative effect and can help transform rural landscapes in a sustainable manner.

- Projects where a **baseline** study has been carried out are more likely to be successful than where such a study has not been carried out. This is because such studies are likely to transparently demonstrate that there are real emission reductions. A case in point is the China case study, which demonstrates that merely developing a project based on the notion that solar energy is renewable and hence a good project is not enough for developing a sustainable project. In other words, small-scale renewable energy projects are not necessarily always sustainable.
- Project design should include **clear and verifiable targets** so that it is possible to analyse whether these projects actually meet the goals set in the projects themselves. Most of the projects analysed had vague targets and that made it more difficult to evaluate these projects.
- **Innovative projects put higher demands on project design** than non-innovative projects. Innovative projects are more likely to be sustainable when no assumption is made about the available information for the other party. Even the successful Costa Rican case study shows that the current lack of efficient use of the wind plant due to poor maintenance can be attributed to lack of clarity as to who was responsible for maintaining the mills. Inexperience on the part of ICE concerning wind power sector contracts and the precise definition of ‘maintenance’ lie at the heart of the problem. Clearly where CDM projects set out to promote innovative ideas in a specific context, no knowledge should be taken for granted. Projects should include systematic reporting to financiers to ensure that the project is working well and should include indicators that can help to monitor the progress of the projects. Investors, especially those from development cooperation ministries, should maintain interest in projects right through their execution phase and possibly thereafter as the India case study reveals. In developing innovative small-scale projects, project plans should take into account possible delays in the institutional learning process and in the process of securing support for such projects.
- **With respect to partnerships**, this research revealed that there is not much difference between whether one deals with government partners or private partners. The key issue is the quality of the individual partner one is dealing with. The government partner in the Vietnamese case was clearly more motivated to work towards sustainable development and community improvement than the government partner in China and Costa Rica. The private partner in South Africa is possibly more motivated than the private partner in India. From the Dutch side, we see that where the Dutch partner is based in the host country (e.g. the Vietnam case study) or has offices in the host country (e.g. the South Africa case study) this has significant impacts on the quality of the project. Where the Dutch partner is interested in the project and follow-up processes either directly or indirectly through the national embassies the quality of the project can be improved.
- **Simple organisational structure, clear division of responsibilities, established communication patterns and a time-line** are necessary features of good project design. The China project has a complex structure, poor division of responsibilities and poor internal communication and as such the project could not really take off. The Costa Rica project had a complex history and structure and the division of responsibilities with respect to maintenance was not very clear.
- Where project involve the use of **higher technologies**, the project design should include technology adaptation to local contexts, capacity building for those using and

maintaining the technologies and for the general public to create greater support for the use of such technologies.

- Where projects involve the disbursement of **subsidies**, simple efficient means of targeting and communicating the subsidies to end-users is vital. In the Vietnam case, the use of the post banks for providing subsidies reduced the transaction costs of the delivery of subsidies.

#### *Documentation*

A successful project is generally accompanied by good quality documentation of the process of design and the results achieved; a monitoring process and processes for constantly improving the projects. Since such projects will be in the public-limelight, it is essential that there is good quality documentation that accompanies the work.

#### *Demonstration*

Four of the five projects have (potential) demonstrative effect. The Costa Rican project took a substantial amount of time to evolve from an idea on paper – in 1992 - into an operational AIJ project, in 2002. In this period, it was overtaken by privately developed windpower plants, coming into operation before the Tejona project. Still, it is difficult to argue that had the state run ICE not invested in this project; private investors would nevertheless have come in. Perhaps the long lead-time to promote wind power in the public sector created the conditions that allowed for commercial development of wind power by the private sector. The Vietnam project is already having demonstrative effect, and since there is some financing required making the project viable to local farmers, the project itself aims to create the mass participation in such a scheme viable. The biomass gasification project in India has potential for replication, although certain conditions need to be fulfilled when upscaling the technology. The small hydropower project in South Africa is expected to demonstrate that such projects can be feasible. The solar project in China is unlikely to be repeated in the near future.

### **9.10 Conclusion**

This chapter has comparatively assessed the results of the five Activities Implemented jointly projects and their contribution to sustainable development. While it is clear that from the perspective of the host countries, all five projects met the criteria of sustainable development at the time of project development, only the Chinese project is unlikely to do so at present. When we analyse the projects on the basis of criteria that we developed from the literature, we see that the ranking in order of contribution to sustainable development is as follows. The Vietnamese project performs the best and is followed by South Africa, Costa Rica and then India. The key reason that the Vietnamese project scores highly is that it attempts at meeting economic, social and environmental criteria and in that sense does well. Even if we give different weights to the different elements of sustainable development, we observe that the ranking remains the same.

It is curious to note that the contribution to sustainable development appears to be proportional to the amount and proportion of financial assistance provided by Dutch funds. The highest funding went to Vietnam, followed by South Africa, Costa Rica and India. This would imply that Dutch funds have been used to not only steer projects in non-commercial rural energy projects but also have been used to promote the sustainable

development aspects of the project. Possibly if these funds from the Ministry of Development Cooperation (DGIS) were not available, there would have been a lower focus on sustainable development and a greater focus on cost-effectiveness. We conclude by expressing our believe that funding of CDM projects by the Dutch government, in princliple, seem a worthwhile activity, especially when the lessons learnt in the five case studies are taken into account.