GEF
COUNTRY
PORTFOLIO
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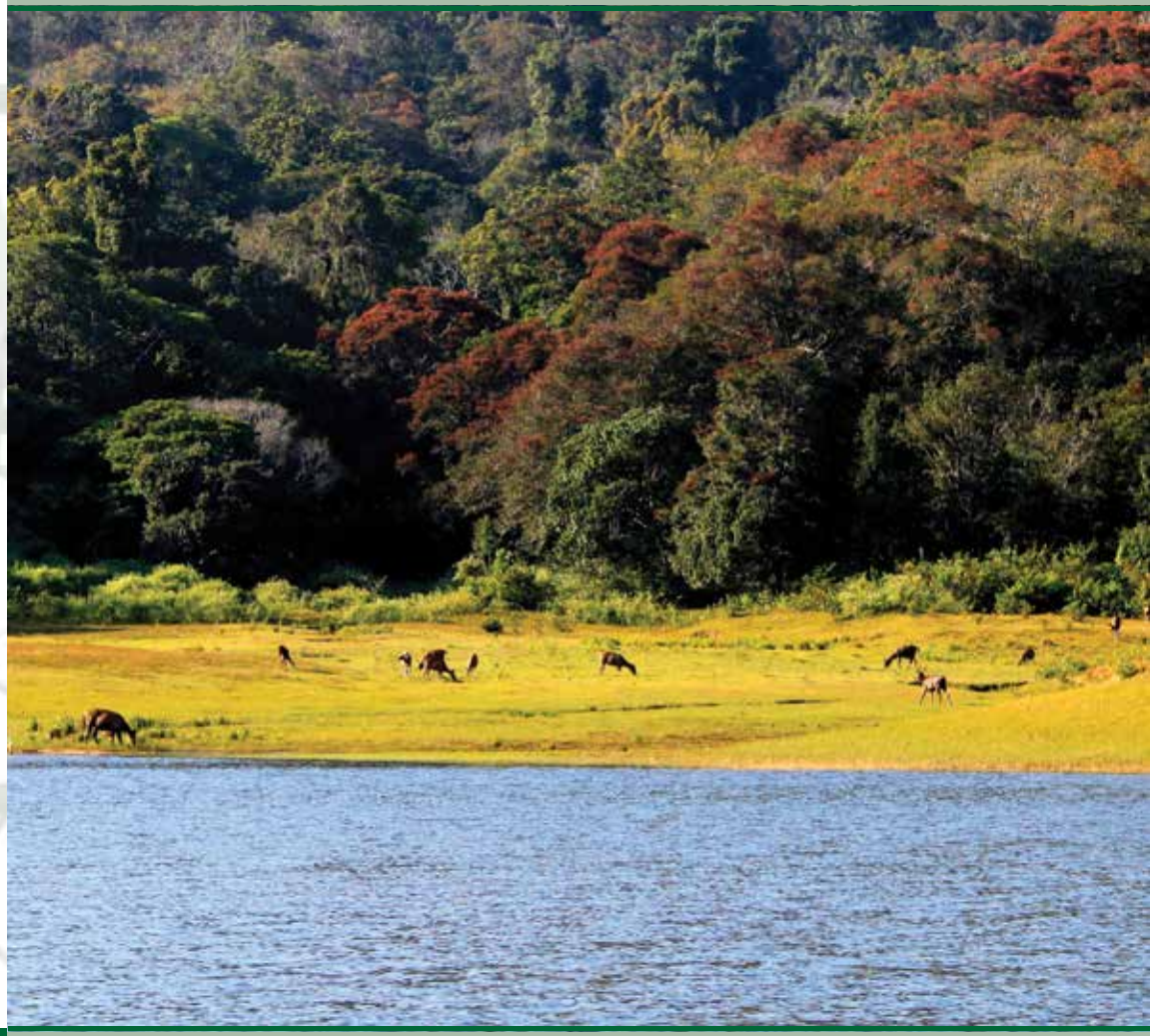
India
(1991–2012)

Volume 2:
Project Case Studies



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Country Portfolio Evaluation: India (1991-2012)

Volume 2: Project Case Studies

Contents

Part 1

INTRODUCTION

1. Background

Country Portfolio Evaluation (CPE) is among the main streams of work of the GEF Evaluation Office. By capturing aggregate portfolio results and performance of the GEF at the country level, country portfolio evaluations provide useful information to the GEF Council and the national governments in the form of an assessment of the results and performance of GEF-supported activities at the country level, and of how these activities fit with the national strategies and priorities, as well as with the global environmental mandate of GEF.

India was selected for a CPE primarily because its GEF project portfolio is relatively large, mature and diverse, and it has not yet been adequately covered by the Evaluation Office through its work. The overall objective of the India Country Portfolio Evaluation (India CPE) was to assess the performance of GEF portfolio in India in terms of relevance, efficiency, effectiveness, and results of the GEF activities and processes in India; and the factors contributing to its performance. The evaluative phase of the India CPE was conducted between April 2012 and February 2013, by an evaluation team comprised of staff from the GEF Evaluation Office and a team of consultants from the InsPIRE Network for Environment. A quality assurance panel provided feedback to the team on quality aspects related to methodology and evaluation products.

The preliminary findings of the evaluation were presented to the national stakeholders in a workshop on 8th of November, 2012, in Delhi. During the workshop several stakeholders, especially the GEF Operational Focal Point, requested the Evaluation Office to also prepare a separate volume to document the experiences of various completed GEF projects that were implemented in the country. The second volume of the India CPE report has been prepared to address this request.

2. Synthesis of findings

Since its inception, the GEF has supported projects in India to generate global environmental benefits. India's participation with the GEF began during the GEF pilot phase in 1991. The World Bank–implemented Alternate Energy project (GEF ID 76) was the first GEF project in the country. The GEF Small Grants Programme (SGP) started its operations in India in 1995. As of July 2012, the GEF had allocated $411.2 million through 55 approved national projects and 319 small grants to India. These activities involved aggregated cofinancing commitments of $3,215 million by partner organizations. India also participates in 16 regional or global projects supported by the GEF, representing aggregate GEF support of $99.2 million and where support incident on India is estimated to be about US $ 26 million.

So far 22 projects within the GEF-India portfolio have been completed. Of these 14 are national projects and 8 are global or regional projects. The completed projects account for US $ 100.8 million in GEF grant. This includes US $ 83.2 million for the national projects, and US $ 17.6 million incident on India of the allocation for these completed regional and global projects.

The selection of completed projects for case studies was based on multiple criteria. Firstly, these projects should be either full sized or medium sized in term of GEF grant. Secondly, in case of regional and global projects a significant amount (US $ 500,000 or more) of physical activity supported through project funds should have taken place within India. In all 11 completed projects were eligible for preparation of case studies. Of these "Development of a National Implementation Plan in India as a First Step to Implement the Stockholm Convention on POPs" project was dropped from consideration. Field verification could not be carried out for this project because the executing agency did not provide timely access to the project activities and staff in the field. Of the remaining 10 projects, two regional projects – Conservation and Sustainable Management of Below-Ground Biodiversity Phase 1 and 2 - that were sequential. Therefore, these were combined into one case study. Thus, in all 9 case studies that cover 10 completed projects were prepared. These 10 projects account for US $ 90 million in GEF grants incident on India.

The case studies draw on the information from various sources including interviews of the key stakeholders, field verification, terminal evaluation, documents submitted for project approval, and – where available – other independent publications. Preparation of each of these case studies required 5 to 10 person-days of field work. The information from different sources was triangulated. Two case studies pertain to the biodiversity focal area. The remaining seven case studies pertain to the climate change mitigation (CCM) focal area. Four of the case studies cover projects that promoted renewable energy. Other CCM issues covered include energy efficiency, capture of coal bed methane, and mainstreaming of CCM concerns in major public events.

A review of these case studies shows that the GEF projects in India have been fairly effective in achieving their expected outcomes. During the post-completion phase the approaches and technologies promoted by several of these projects found traction among the key stakeholders leading to significant progress towards long term impact. Table 1 presents the progress to impact ratings for completed projects.

Progress to impact rating assesses the progress made by a project to its long term impacts of the project. While desk review based progress to impact ratings are based primarily on the information provided in the terminal evaluation, the evaluation team took into account the additional information gathered through field work, interviews and review of documents provided by the executing agencies.

The time elapsed after project completion may be expected to lead to changes in the level of progress – the project may gain traction and make further progress or due to lack of support from other stakeholders and other contextual factors the progress made by the time of project completion may be lost. The findings listed in Table 1 are consistent with this hypothesis. All of the projects that showed significant progress at the point of field verification had moderate progress at the point of project completion, and these projects had been completed more than five years before the verification had been carried out. It also confirms that results of the GEF support are not lost and that the Indian government and other stakeholders build on the progress of the projects supported by the GEF.

Table 1. Progress to impact ratings of completed projects

GEF ID	Project Title	Year of completion	Rating (Desk Review)	Rating (Field Verification)
Biodiversity Conservation				
Conservation in Protected Areas				
84	India Eco-development Project*	2004	Moderate progress	Significant Progress
Targeted field research on biodiversity				
1224 2342	Conservation and Sustainable Management of Below-Ground Biodiversity (Phase 1 and 2)	2013	Unable to Assess	Moderate Progress
Climate Change Mitigation				
Renewable Energy				
76	Alternate Energy Project*	2001	Moderate progress	Significant Progress
112	Photovoltaic Market Transformation Initiative	2010	Unable to Assess	Moderate Progress
370	Development of High Rate Bio-Methanation Processes as Means of Reducing Greenhouse Gas Emissions*	2005	Moderate progress	Significant Progress
386	Optimizing Development of Small Hydel Resources in Hilly Areas*	2003	Moderate progress	Significant Progress
Methane Capture				
325	Coal Bed Methane Capture and Commercial Utilization*	2008	Moderate progress	Moderate Progress
Energy Efficiency				
404	Energy Efficiency*	2008	Moderate progress	Moderate Progress
Mainstreaming CCM in and through Public Events				
4215	Low Carbon Campaign for Commonwealth Games 2010 Delhi*	2010	Moderate progress	Moderate Progress

Notes: *Desk review based Rating based on the status at the year of project completion, Field verification based rating at time of India CPE i.e. 2013.*

Compared to the needs of, and potential for generating global environmental benefits in, India, GEF's support has been relatively very small. In most instances GEF support has been for implementation of activities that demonstrate feasibility of the promoted approach or technologies at a small/local scale. Despite the small scale of GEF support, the case studies demonstrate that GEF projects are generally generating global environmental benefits at a scale higher than what was directly funded through GEF support.

There have been several notable successes. In the biodiversity focal area, the India Eco-development project (GEF ID 84) pioneered a community-based approach to PA management that has gained widespread acceptance across India. Technologies and approaches promoted through the Coal Bed Methane Capture and Commercial Utilization (GEF ID 325) and Optimizing Development of Small Hydel Resources in Hilly Areas (GEF ID 386) projects have been broadly adopted. Experience in India shows that broader adoption of promoted technologies and approaches is aided by successful demonstrations along with proper dissemination, mobilization of appropriate partners, an enabling legal and regulatory context, country ownership, and project relevance to national priorities.

GEF has played an important role in supporting promising new ideas and approaches that are expected to generate global environmental benefits. In most instances, although the GEF has not been the first to come up with a particular idea or approach it has nurtured these by providing support at a substantial scale so that they may be significantly advanced. There are several well-documented examples of innovative elements in GEF projects. These include GEF-led efforts to address concerns related to below ground biodiversity (in the Conservation and Sustainable Management of Below Ground Biodiversity, Tranche 1 and 2 [GEF ID 1224, 2342], promote the capture and commercial utilization of coal bed methane, and facilitate the development of locally suited designs of efficient turbines for the development of small hydel resources in hilly areas.

The case studies also show that the GEF projects have made significant contributions to changes in India's legal, policy, and regulatory framework. Although, given the overlapping and interacting contributions of several other actors and factors, it is difficult to isolate and measure the GEF contributions to India's legal, policy, and regulatory environment, several GEF projects are perceived as having contributed to its development.

The major contributions that may be linked to GEF projects include changes reflected in the country's national planning documents, working plan codes, and legal framework. For example, the eco-development strategy promoted by the India Eco-development project was included in the 10th national Five-Year Plan. This project also inspired an amendment (Amendment No. 38X, 2006) to the Wildlife Act, making it mandatory for all tiger reserves in the country to establish a foundation for management of the reserve. The project on Mainstreaming Conservation and Sustainable Use of Medicinal Plant

Diversity in Three Indian States (GEF ID 1156) is reported to have provided inputs for the development of the National Working Plan Code, which is expected to address the management of medicinal plant resources in forest areas. Another effect of GEF projects such as the Coal Bed Methane Recovery and Commercial Utilization project has been to increase the profile of the addressed concerns and to motivate the government in identifying nodal agencies and establishing mechanisms for further work on the issue.

The GEF projects covered through the case studies are reported to have mobilized US $ 375 million in co-financing compared to US $ 90 million in GEF grant. The national government is the most important contributor of co-financing. Much of its co-financing was financed through loans from the World Bank but it also contributed a significant part from its own internal resources. In addition to providing co-financing, in several instances the government has also funded follow-up activities for completed projects using either its own sources or by partnering with other organizations. Several GEF supported activities that were focused towards capacity development, including development of capacities of government institutions such as the Indian Renewable Energy Development Agency and the Bureau of Energy Efficiency through long-term engagement with them, have helped in sustaining and building on the results of the GEF supported projects.

The completed projects do show several weaknesses. Many of these pertain to low efficiency in project implementation. Several completed, especially those that were approved during the Pilot Phase and GEF-1, experienced delays after project start and were completed behind schedule. The reasons that made extensions necessary include slow start-up, delayed funds flow, overly optimistic estimation of the time required for a particular project activity, inadequate support from stakeholders or suppliers, and issues related to inter- or intra-Agency coordination. For the projects that were designed during Pilot Phase and GEF-1 inadequate attention given to design during project preparation led to start up delays. More recent projects do not show this weakness. During interviews some stakeholders noted that delay in completion of project activities may limit the effectiveness of GEF projects. Among the projects whose effectiveness was reported to have been constrained by delays are the Mainstreaming Conservation and Sustainable Use of Medicinal Plant Diversity project.

The case studies presented in this volume document a wide range of experiences. They illustrate importance of country ownership and adequate support for follow up in sustaining and building on results achieved directly through GEF support. Where applicable, the case studies also list the additional measures that may be required for further progress.

Part 2

BIODIVERSITY CONSERVATION

PROJECT CASE STUDIES

3. India Eco-development Project *[GEF ID 84]*

3.1 Project description

The **India Eco-development Project (GEF ID 84),** a Full-Sized GEF/World Bank project was implemented between December 1996 and June 2004. The project fell under the GEF Biodiversity Focal Area and had an approved GEF budget of US$ 20 million and co-financing of US$ 45 million. The main objective of the project was to conserve biodiversity by implementing the eco-development strategy of the Government of India in and around seven protected areas (PAs). The project was conceived as a pilot to test a community-based approach for a longer program which would be expanded to other PA sites. Accordingly, the project also included support for the preparation of future biodiversity projects.

3.2 Project objectives and design

Long term objectives

The global environmental objective[1] of the project was "*To conserve biodiversity by implementing the eco-development strategy of the Government of India in and around seven protected areas* (PAs)". The long term objectives[2] of the project were:

- To improve capacity of PA management to conserve biodiversity and increase opportunities for local participation in PA management activities and decisions;
- To reduce negative effects of local people on biodiversity, reduce negative impacts of PAs on local people and increase collaboration of local people in conservation efforts;
- To develop more effective and extensive support for eco-development;
- To ensure effective management of this project; and
- To prepare future biodiversity projects.

Theory of change and causal mechanisms

The India Eco-Development project was implemented in seven PAs: Palamau (Jharkhand), Buxa (West Bengal), Nagarhole (Karnataka), Periyar (Kerala), Pench (Madhya Pradesh), Gir (Gujarat) and Ranthambore (Rajasthan). Of the original seven sites, six were accorded an extension, with Nagarhole National Park (Karnataka) excluded. To achieve the intended project outcomes, three strategies were developed which were in line with the project's four components. These strategies were:

- **Improved Protected Area Management**

[1] Implementation Completion Report (World Bank)
[2] Project Document

This strategy focused on effective PA management plans to be developed and managed so that there is increased awareness, and capacity in the forest department along with improved relations with local communities in order to improve PA management. It was also considered to be a very important factor in directly delivering the intended project impact, of conserving biodiversity by implementing the eco-development strategy of the government of India in and around the seven PAs. This strategy was to also lead to the empowerment of local communities, particularly poor groups, by offering voice and choice through participation in planning, implementation and monitoring of eco-development activities.

- **Village Eco-Development**

The village eco-development strategy focused on reducing the negative effect of local communities on PA and to have their increased participation in the collaborative conservation efforts. It reduced the negative effect through the formation of EDCs (Eco-development Committees).

- **Research, Monitoring, Awareness and Capacity Building**

The monitoring, research, awareness and dissemination aspect of the project proved to be very effective in mobilizing relevant stakeholders to participate and contribute towards effective and extensive support to Eco-development. It has been an important aspect, as involving researchers, institutions and also 30 small research projects under the SGP (undertaken by staff from local universities) was successful in strengthening research links to local institutions and enabling park authorities for the effective management and provide adequate data to measure future progress. The project has provided special funding for research and monitoring studies. Under this, the Management Effectiveness Tracking Tool (METT) was used in all the PAs and was moderately successful.

Several PAs ran effective educational and media campaigns including: journalists' camps, campaigns through local cable networks, training for teachers, training manuals, education centers, nature camps, eco-development newsletters, Eco-clubs and national Green Corps in schools, street plays, nature clubs and local language field guides, etc.

Key components

The key components[3] of the India Eco-development project were:

- **Improved PA management:**

The park management component aimed to strengthen park protection and management in seven PAs through (i) improved PA planning processes and building capacity of PA staff (ii) incorporating PA concerns into regional planning and regulation (iii) protecting and managing ecosystems and habitats within the PA and (iv) upgrading PA amenities for field staff.

[3] Project Document

► **Village Eco-development:**

This component was designed to reduce negative impacts of local people on biodiversity and increase collaboration of local people in conservation by: (i) conducting participatory micro-planning and providing implementation support for micro-plans in eco-development villages (ii) implementing reciprocal commitments that foster alternative livelihoods and resource uses, to be financed by a village eco-development program, with specific measurable actions by local people to improve conservation (iii) special programs for additional joint forest management, voluntary relocation, supplemental investments through a discretionary fund for special needs that could not be covered under the routine eco-development activities and a provision for entry point activities though a credibility fund to build initial rapport.

- **Education & awareness and impact monitoring & research**: to develop more effective and extensive support for PA eco-development including: (i) promoting public support for conservation through environmental education and awareness campaigns; (ii) impact monitoring and research to improve understanding of issues and solutions relevant to PA management and interactions between PAs and people.
- ***Preparation of future biodiversity projects*** *including (i) Second Eco-development project (ii) Biodiversity Information project and (iii) Ex-situ conservation project. Additionally, the project included reimbursement of Project Preparation Facility (US$2 M or 3% of total costs; actual expenditure US$ 0.05 M, 0.1% of total costs). This objective was dropped after a mid-term review.*
- **The global objective, to conserve biodiversity in seven critical areas in a mega-diversity country**, was fully consistent with guidance from the Convention on Biological Diversity (CBD) and the GEF Council.

Project design: Salient features

Some of the salient features of the project design[4] were:

- The project addressed key components giving importance to technical and social issues;
- It incorporated a social assessment, a participation plan, and process documentation;
- For the first time, voluntary resettlement in a PA context was considered;
- The project attempted to reconcile the legitimate needs of both conservation and communities (quid-pro-quo linkages between investments benefiting local people and linkages to local people's conservation responsibilities and actions) which required close monitoring of reciprocal commitments and impacts;
- The design was supported by field-oriented assessment of 'indicative' planning;
- The preparation process emphasized client ownership and stakeholder consultations;
- Comprehensive documentation and detailed guidelines were prepared as part of preparation;
- Community contribution of 25% helped in directing the proposed activities to be demand based and led to better accountability of the forest department; and

[4] Implementation Completion Report (World Bank)

- The Community Development Fund (CDF) was an important pillar for local-level Eco-Development Committees' (EDCs) sustainability after the close of the project (as substantial resources are still available to communities for continued development).

Project design assumptions

- ***Local management and Institutional capacity and knowledge built through the project are not lost through the departure of key personnel***.
- The collaboration established during the project between the forest department and local communities in and around PAs will continue to strengthen further.
- ***Local government departments will be interested in continuing regional planning and strengthen it further.***
- ***The community based institutions such as EDCs continue to work after project life*** and that the involvement of community members along with the forest department staff will enhance the PA management. Individual sites have developed strategies to continue and expand eco-development activities through linkages to other state and national government programs (e.g. Forest Development Agency in Nagarahole park, Famine Relief programs in Ranthambore) and/or the establishment of new financing mechanisms (e.g. Periyar Foundation).
- ***Other parks will also conduct research on wildlife and socio-economic aspects for better planning***: The overall project was managed by the Project Tiger Office (PTO) in MOEF. The project made a concerted effort to capture and disseminate lessons learned during implementation. Exchange of lessons learned (from the earlier FREEP project as well as the IEDP sites) among sites and more widely through dissemination workshops was useful.
- ***PAs continue to use METT and it will be further improved and adopted by other PAs:*** PTO has mainstreamed the METT monitoring tool as a part of regular monitoring system for other parks based on this assumption.
- ***The awareness program will continue and will also be effective***: The PAs have been involved in various awareness programs and the dissemination of materials in local languages and also of research findings at a wider level.

3.3 Project Execution

Delivery of project components

The project delivered most of the outputs expected under various project components[5]:

► Improved Protected Area Management

Significant achievements include:

- Preparation of new/revised management plans in all seven sites incorporating zonation, tourism management, environmental education and community participation;

[5] Implementation Completion Report (World Bank)

- Preparation of baseline maps with GIS capability;
- Identification of measures to better integrate PA management with regional planning;
- Development of sustainability strategies at park level;
- Eco-restoration activities (clearance of invasive species, water management);
- Upgrading of park infrastructure (communication systems, staff accommodation, camping/patrol infrastructure and basic field kits);
- Training of park staff (field work, surveys and study tours through cross-site visits and limited overseas visits). Limitations experienced were mainly related to persistent staff vacancies at many sites.

► Eco-Development

Major achievements include:

- Forming and supporting over 580 Eco-Development Committees (EDCs) covering close to 75,000 households (including the formation of innovative groups such as professional groups, user groups and federations);
- Participatory preparation and implementation of micro-plans, benefitting local communities (local infrastructure, irrigation, community facilities, income generation) and individual households (fuel saving devices, skill building, income generation);
- Generation of substantial community development funds (estimated at US$ 4 million) through community contributions for EDC sustainability;
- Community capacity building activities (including exposure visits, EDC management training, skill training).

► Research and Impact Monitoring

Achievements under this component include:

- Some parks (Gir and Periyar parks) undertook highly relevant wildlife and socio-economic research;
- 30 small short-term research projects were supported, focusing on park management requirements;
- The management effectiveness tracking tool (METT) was used to track progress and the refined tracking tool has been mainstreamed by the PTO for other parks; and
- Tools for participatory impact monitoring were introduced.

► Conservation Awareness

Achievements under this include:

- Running of effective educational and media campaigns (e.g. Periyar ran a journalists camp (Ecologue) and Buxa ran programs on PA and biodiversity conservation on local cable networks);

- Training of teachers (e.g. Gir provided training for teachers, providing training manuals);
- Education centers, nature camps and nature workshops for schoolchildren as well as Eco-clubs and national Green Corps in schools (e.g. Gir established 8 education centers in schools);
- Establishment of Eco-clubs in EDC villages (e.g. Periyar has popularized 'plastic free days' and 46 nature clubs);
- Publication of newsletters (e.g. Periyar publishes a regular eco-development newsletter for the EDC confederations);
- Dissemination of information from economic studies on the value of the park to local communities;
- Street plays, processions and wildlife weeks and nature clubs that provided important opportunities to link PAs to local community and culture;
- Preparation of local language field guides on the Birds of North India.

Challenges faced during implementation

Some of the major challenges faced in the eco-development of the PAs were:

- Inability of the forest department to locate support-NGOs with the requisite capacity, skills and knowledge of tribal culture;
- Continued conflict and lack of trust between the forest department and a particular section of the tribal population; andRestrictions on the type of investments permitted inside national parks under the Wildlife Act.
- Towards the end of implementation, some of the project sub-components were reported to have been affected by allegations of corruption and uncertainty about the eco-development strategy.

3.4 Outcomes and impacts

The project's outcomes and impacts[6] have been described at two stages; at the project completion stage and at the post-completion stage:

Achievements at project completion

► Biodiversity Conservation and Environmental Benefits

The project was successful in strengthening protection and management of seven parks and reserves, of recognized global importance for biodiversity (Buxa, Gir, Nagarhole, Palamau, Pench, Periyar, and Ranthambore). It led to improved management effectiveness, clearing of extensive areas of invasive alien species, habitat restoration, improved water and fire management and increases in wildlife populations of key carnivore and prey species. PA monitoring, and participatory monitoring through EDCs, demonstrated significant reductions in

[6] Implementation Completion Report (World Bank)

threats emanating from village activities, for example: reductions in cattle-grazing, firewood extraction, NTFP collection, poaching activities and other infractions.

► Social and Community Benefits

➥ Livelihood Benefits

In particular, community projects have provided wage labor to some of the poorest members of village societies and has generated work for the landless and poor. New employment and market opportunities have been created explicitly to benefit the poorest members of society, for example: tribal trekkers, pepper marketing and Tribal Heritage schemes at Periyar; rope making at Pench; and building of game walls and step well (baori) rehabilitation at Ranthambore. The community (CDF) and village (VDF) development funds, as well as small savings schemes and self-help groups established under the project, provide mechanisms to sustain these benefits beyond project completion.

➥ Empowerment

Mandatory representation of women and landless in EDC committees has strengthened social justice and empowerment of the more marginalized members of society. PRA (Participatory Rural Appraisal) micro-planning exercises were designed to ensure that the less vocal and/or less powerful/dominant village members were able to fully participate. The eco-development funds have increased individual and community choices, helped to reduce debt and reliance on money lenders, and have contributed to citizen empowerment through community-decision making and greater transparency surrounding decisions relating to the allocations of village development funds.[7]

➥ Addressing gender concerns

The project design was sensitive to gender concerns and recognized that the resource and income strategies of women may be different from those of men. Explicit provision was made to include women in decision-making processes in EDCs and executive committees and, as the project progressed, there was a significant increase in the participation of women in project activities.[8]

➥ Benefits to Tribal and Landless People

Although most eco-development interventions were targeted at the village level, landless and tribal villagers benefited most through community investments (e.g. community halls, wells) and through the creation of wage labor, both for work within the PA (fire management, habitat restoration and invasive species clearance) and under EDC priority activities (e.g. creation of water ponds, building of game-proof walls, clearance of invasive species). There were around 8 million person days over the project's duration.[9]

[7] Implementation Completion Report (World Bank)
[8] Implementation Completion Report (World Bank)
[9] Implementation Completion Report (World Bank)

- **Biodiversity Conservation**

The project was able to demonstrate that eco-development and social fencing was an effective tool for PA protection. The impact of village activities on biodiversity in PAs has been reduced through eco-development initiatives and village reciprocal commitments. Simple monitoring systems, involving PA staff and villager participation and self-monitoring, demonstrate measurable decreases in village-generated threats to the PAs.

The project's Implementation Completion Report (ICR) mentioned that the project has achieved its global environmental objective by (i) strengthening the protection and management of 6020 Sq. Km of habitats with recognized global importance for biodiversity; (ii) adding 18.2 Sq. Km of additional PA (Gir Park); (iii) developing new processes, systems and capacity to implement and expand the eco-development model in all 7 PAs and collaborating with local communities.

In addition, simple monitoring systems, involving PA staff and villager participation in self-monitoring, demonstrated measurable decreases in threats to PAs as dependence of communities on the PA decreased and their livelihoods were enhanced. The ICR reports that communities became active in conservation activities such as protection against poachers, and that there are some early indications of habitat restoration and increases in wildlife populations.

Progress after project completion

Outputs and outcomes from the India Eco-development project in the two parks visited (Periyar and Pench) for field verification appeared to be sustained due to the persistence of the EDCs that were established during the project and also due to adequate budget being provided for the two parks, post-project. The value of the EDCs as "social fences" for the Tiger Reserves was mentioned as part of the reason for this success. The term "social fences" refers to the function that EDCs play in PA management. The EDCs come from local communities surrounding the parks and are engaged in biodiversity-friendly activities supportive of PA objectives and often have stopped engaging in extractive activities that were negatively impacting biodiversity. Furthermore, PA staffs have often engaged the EDCs as champions of the PA. All of these functions of the EDCs result in their functioning as "social fences" that serve to protect biodiversity through their social commitment to the conservation goals of the PAs.

Some of the key achievements after the completion of project have been:

- Diverse activities in education and public information, resulting in greater public awareness and support for the parks.
- At the national level, the eco-development strategy has been incorporated in the approach to the 10th National Plan documents and eco-development has been institutionalized as a fund delivery and management model both nationally and at the state levels. The commitment and interest of the GOI is also visible through a request for a landscape based follow-on project, which will cover other non-project sites.
- State governments in all states (except Kerala) have issued clear enabling orders for eco-development. These were made open-ended and applied state-wide so that specific site

experiences can be replicated at other PAs. Many of the project activities are already integrated into regular Forest Department operations and the MOEF provides regular funding to finance eco-development activities. These achievements increase the institutional sustainability of the outcomes.

- Ecological sustainability has been built into PA management plans (e.g. zoning for visitor and wildlife management; habitat restoration and water management; clearance of invasive species; recommendations for an expanded buffer zone at Periyar and creation of Meghamalai Sanctuary across the border in Tamil Nadu). The improved relationships with villagers and participatory monitoring show that threats from village use of PA resources have been substantially reduced at all PAs.

With successful demonstration of park management through the Periyar Foundation, the Government of India has made it mandatory for management of all Tiger Reserves to be carried out through the foundation. The success of the Periyar Foundation model informed the amendment in the Wildlife Act (Amendment no. 38X) in 2006, whereby it was made mandatory for every Tiger Reserve in the country to establish a Foundation. This is one of the major contributions of the India Eco-development project.

Periyar was identified as a Field Learning Centre and was funded by the GEF-UNDP Biodiversity project (landscape-wise). Periyar was also deemed as a centre of learning for participatory management.

Factors that affected progress

The various factors[10] that affected the implementation of the project were:

- **Factors outside the control of Government or Implementing Agency:**

Militant activity (mainly in Jharkhand State and to some extent in West Bengal) made working conditions difficult for some forestry staff. Nevertheless, in both states, PA staff was able to build up effective working relationships with local communities and establish effective EDCs. They were able to do so even when other government agencies have not been able to operate, and, in the case of Palamau, with very limited funding for the early part of the project. Severe drought in Ranthambore (Rajasthan) and Gir (Gujarat) impacted on village welfare and slowed down implementation of EDC activities since it was difficult for individuals and communities to raise the necessary 25 percent contributions towards eco-development activities in drought years.

- **Factors subject to Government control:**

- *Delays in the Budget flow* at the state level were a major issue throughout the project with regular delays in budget disbursements and special budgets arriving late in the financial year, limiting their usefulness. Fund flows from state governments were especially erratic in

[10] Implementation Completion Report (World Bank)

Palamau (Bihar) and Ranthambore (Rajasthan) parks but also affected the Gir (Gujarat) park. Fund flows to the Palamau park improved dramatically after the creation of the new state of Jharkhand.

- *Staff deployment and skill need*: In most states, restrictions on new recruitment to replace ageing staff were a continuing constraint for PA management.
- *Contracting*: Clearance delays in processing and approval of consultant contracts, both at central and state levels delayed or prevented implementation of several consulting contracts. The problem was especially acute in Rajasthan where Ranthambore park was unable to benefit from any consulting contracts to assist with management planning, research, eco-development training or to build a new visitor center because of delays and lack of clearances from the state government.

► **Factors subject to Implementing Agency control:**

This was one of the factors causing variance in the performance of various EDCs. In some cases (e.g. Nagarahole park), inability to locate suitable NGOs with requisite skills, capacity and tribal knowledge, adversely affected the quality of *Hadi* (in-park settlement) micro-planning and trust building processes.

► **Costs and Financing:**

Periodic training of project staff in Bank policies and procedures, an essential requisite considering the frequent transfers of government personnel, was also lacking. As a result, there were instances of misclassification of expenditure, claiming of ineligible expenditure, significant errors in preparation of claims, etc. Audit reports were also delayed by some PAs (Rajasthan, Bihar/Jharkhand, Madhya Pradesh, Gujarat), which lead to issuance of warning letters and, at times, temporary suspensions of reimbursement of SOEs during the life of the project. Due to these lapses, the financial management of the project was rated unsatisfactory for some time.

3.5 Progress to impact

Overall, the project made significant progress towards delivering the intended global environmental benefit "To conserve biodiversity in seven critical areas in a mega-diversity country in order to contribute to global biodiversity conservation and to do so in a way that would reduce negative impacts of local people on PAs and reduce negative impacts of PAs on local people".

This project is an example of a turn-around story. The project had a slow take-off and the progress was unsatisfactory during the initial stages of implementation. The developments were further compounded by a lack of continuity in project leadership. At the point the mid-term review (MTR) was conducted, there was a compelling need to restructure the project by revising targets for EDC coverage to realistic levels. Furthermore, given the poor performance at this stage, it was even decided to drop the component supporting the preparation of future

biodiversity projects. Thanks to renewed efforts by all stakeholders (Communities, GOI and PA staff), project performance improved significantly after the MTR, with revised and refocused targets. The ultimate achievement of improved results was also facilitated by extensions of Credit/Grant closing dates based on the performance of the parks on agreed criteria.

Although the project pioneered progress in mainstreaming community based eco-development in the country with further progress likely as explained above, there are certain risks, which could impede further progress to impacts. In the context of an evolving devolution of power (between central and state governments), institutional capacity was over estimated. In hind sight, it would have been useful to:

i. reach more specific agreements on capacity building, streamlining of procedures, delegation of authority, budget flows and specific commitments to time-bound contracting;
ii. tie outside research contracts more rigorously to collecting baseline information and socioeconomic and biological monitoring at specific sites to assess project impacts; and
iii. though the project document identified key risks, it would have been more useful to carry out a site wise segregated risk analysis (instead of clubbing all risks for all sites);
iv. formally institutionalize an organized strategic communication process (though it did stress on the need for communication with stakeholders);
v. Improve criteria for the selection of villages based on distance factor (2 or 5 kms), which did not, at some sites, adequately cover the impact zone.

The selection of multiple sites in different states was both an advantage and a disadvantage. The design offered an interesting opportunity for experimentation and cross-learning; while at the same time, it did diminish statewide engagement of the state forest department. The earlier view that with the funding level being high, the project sites would attract influx from outside, did not materialize. Critics were also skeptical of the voluntary relocation concept in the prevailing context of the Wildlife Act and related Supreme Court rulings. The project did prove, on a limited scale, that subject to a carefully adhered-to process, voluntary relocation could indeed be a feasible alternative. The fear that this project will cause starvation of resources for other wildlife areas in the states also did not become reality.

3.6 Lessons learned

The lessons learned[11] during the course of the project's implementation from various perspectives are presented below:

► Strengthening Park-People Relationships

The project engineered improved relations between forest departments and local people through implementation of the eco-development model. The change in relationships was linked

[11] Implementation Completion Report (World Bank)

to the levels of trust established and the degree of transparency in functioning and empowerment of EDC.

► Village Development Linked to forest Protection

The creation of micro-plans and community funds linked village development to PA protection and provided villagers with choices about livelihood and development options. The internal homogeneity of villages in terms of caste, economic activity or economic stratum can influence the success of EDCs and eco-development activity.

► Sustainability linked to Political Processes

The long-term sustainability and success of the eco-development programs and individual EDCs can be enhanced through linkages to political processes and local and national government programs. For example, Panchayats can enhance the width and success of eco-development programs through the capacity of the Panchayati Raj Institutions to mobilize funds for village level development.

► Overall Project Design

- The need to provide 25 percent co-financing towards eco-development activities led to some village families being excluded from eco-development benefits. For future eco-development projects, it may be more effective to use the simpler model adopted at KMTR, where self-help groups (SHGs) were established first and the project then provided additional co-financing.
- Because of the difficulties in establishing EDCs, not all villages within a 2 km buffer zone were included within the project. Future projects need to deal with all the villages impacting on the PA (whether these fall within the 2 km zone or beyond) and to identify priority target villages, and households, based on levels of forest dependency.
- Relocation of villages located inside PAs needs to be addressed realistically. Usually villagers have greater opportunities for income generation and access to development, education and other government schemes outside the parks. It needs to be voluntary and well-documented but should be available to all families within a social group.
- A key lesson for future projects is the need to have a proactive two-way communications strategy in place from preparation onwards to ensure that (i) good public information is disseminated about the goals and achievements of the project and (ii) constructive feedback influences project interventions.
- Specialist contractual staff are needed to sustain eco-development efforts beyond the project, especially since forest departments are suffering from manpower shortages and non-replacement of older staff.

3.7 Follow up actions

The follow up actions[12] required for enhancing impacts of and/ or reducing risks to 'progress to impact' are as follows:

- The PA management plan should be developed early in the implementation stage to identify management zones and space for eco-development opportunities before detailed micro-planning and/or investment in park infrastructure.
- To sustain effective eco-development programs, Forest Departments need to retain the skills obtained from training from contractual staff such a Sociologists, Ecologists, Specialist NGOs and build additional capacity to develop an eco-development cadre as well as to strengthen links to capable local and national NGOs.
- If eco-development is to continue as a successful and sustainable model, mechanisms need to be put in place to allow fund flows without delays to the PA level, perhaps through lines of special authority as established for FDAs.
- At the central government level, there is a need for an effective and fully-staffed eco-development wing in the MOEF, in order to better support national eco-development programs as well as for overall project coordination.
- Replication, dissemination and outreach strategies need to be built in from the inception of the project. Important lessons should be disseminated widely a) to build capacity and allow replication and b) to create an informed climate of news about successes and issues to address misinformation.

[12] Implementation Completion Report (World Bank)

4. Conservation and Sustainable Management of Below-Ground Biodiversity (Tranche 1 & 2) *[GEF ID 1224* and *2342]*

4.1 Project description

'Conservation and Sustainable Management of Below-Ground Biodiversity (Tranche 1 & 2)' was a Full-Sized GEF-UNEP project[13] that was implemented between December 2001 and August 2010 in two phases, in seven countries. The first phase was under implementation from December 2001 to December 2004 and the second phase was from November 2005 to December 2010. The project was approved and implemented within the GEF Biodiversity Focal Area. The project was unique in the sense that below-ground biodiversity was inventoried simultaneously in seven tropical countries, using the same methods of inventory. In addition, scientific objectives were integrated with the practical objectives of demonstrating that benefits can be derived from management of below-ground biodiversity.

The budget and co-financing details are as follows: GEF grant of US$ 8.2 million and co-financing of US$ 3.2 million for tranche 1; and GEF grant of US$ 10.5 million and co-financing of US$ 6.6 million for tranche 2. Although, specific project activities were undertaken within India the extent to which project funds were used for activities in India is not clear. The focus of this case study remains on activities that were undertaken in India.

4.2 Project objectives and design

Long Term objectives

The project objective found in the Project Document was stated as '*to enhance awareness, knowledge and understanding of below-ground biological diversity important to sustainable agricultural production in tropical landscapes by the demonstration of methods for conservation and sustainable management. The project will explore the hypothesis that, by appropriate management of above- and below-ground biota, optimal conservation of biodiversity for national and global benefits can be achieved in mosaics of land-uses at differing intensities of management and furthermore result in simultaneous gains in sustainable agricultural production*.'

Theory of change and causal mechanisms

The project implemented three distinct strategies to achieve its long term objectives[14]:

[13] Terminal Evaluation Report: Conservation and Sustainable Management of Below Ground Biodiversity
[14] Project Document

- The inventorisation and evaluation of BGBD strategy focused on delivering the first intermediate state "Effective methods for inventorisation and evaluation of BGBD conservation established", which was considered to be an important factor for delivering the intended project impact, i.e. "Enhanced awareness, knowledge and understanding of BGBD and demonstration of sustainable agricultural production in tropical landscapes". The first intermediate state provides the overarching feature to develop internationally accepted standard methods for characterization and evaluation of BGBD, including a set of indicators for BGBD loss.
- The management practices and policy support strategy focused on delivering the second intermediate state "Practical mechanisms for management and policy support of BGBD conservation created and effectively used". This was an important strategy which addresses the policy aspect related to the BGBD in India. Also, documenting and sharing of knowledge with the government departments has led towards the awareness generation.
- The capacity building strategy focused on delivering the third intermediate state "Awareness generation and capacity building of relevant institutions and stakeholders to implement BGBD conservation and management". This was an important aspect, as involving researchers, institutions and students should lead to improved documentation and inventorisation of key elements of BGBD.

Key components

Project Components[15] were defined in terms of Outcomes and included:

- Internationally accepted standard methods for characterization and evaluation of BGBD, including a set of indicators for BGBD loss.
- Inventory and evaluation of BGBD in benchmark sites representing a range of globally significant ecosystems and land uses
- The development of a global information exchange network for BGBD.
- Sustainable and replicable management practices for BGBD conservation identified and implemented in pilot demonstration sites in representative tropical forest landscapes in seven countries.
- Recommendations of alternative land use practices and an advisory support system for policies that will enhance the conservation of BGBD.
- Improved capacity of all relevant institutions and stakeholders to implement conservation management of BGBD in a sustainable and efficient manner.

Project design: Salient features

The project was implemented through seven country programmes (CPs), by a range of stakeholders, including government, research institutes and NGOs. Working groups (WGs), each linked to a major output of the project and with representatives from each of the seven country

[15] Terminal Evaluation Report: Conservation and Sustainable Management of Below Ground Biodiversity

programmes, provided scientific and technical inputs into the project. The WGs were advised on specialist technical matters by scientists from internationally recognized institutions.

Overall, the project supervision was provided by the Project Advisory Committee (PAC). The PAC was comprised of one representative from each pilot country and representatives from international organizations working on the interface between agriculture and environment.

The project, being executed under the responsibility of Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture (TSBF-CIAT), also reported to the Scientific Advisory Committee of TSBF-CIAT. The Project Steering Committee (PSC) has overall responsibility for implementation and execution of the project. The PSC included the Global Coordinator (GC), the project's Task Manager from UNEP/GEF, the Director of TSBF-CIAT and the Country Programme Conveners (CPC). The GC was based at TSBF-CIAT headquarters in Nairobi and was supported for administrative, financial and information management services, together constituting the Global Coordination Office (GCO).

Project design assumptions

- Wider dissemination and documentation of research knowledge generated from the project would enable continuation of the project's outputs even after the movement of trained human resources[16].
- The government will remain committed to the issue of protection and conservation of BGBD.
- The alternate land use practices cater to the income needs of the community.
- The research will continue after the project life, with the support from various institutions.

4.3 Project Execution

Delivery of project components

The project components, the expected outcomes by the end of the second of the two phases[17], i.e. at the end of the overall project, are mentioned below:

- Internationally accepted standard methods for characterization and evaluation of BGBD, including a set of indicators for BGBD loss were developed successfully.
- Inventory and evaluation of BGBD in benchmark sites representing a range of globally significant ecosystems and land uses were carried out and a global information exchange network for BGBD was implemented.
- Sustainable and replicable management practices for BGBD conservation were developed (identified and implemented in pilot demonstration sites in representative tropical landscapes in the seven countries).

[16] Project Document
[17] Terminal Evaluation Report: Conservation and Sustainable Management of Below Ground Biodiversity

- Recommendations of alternative land use practices and an advisory support system for policies that will enhance the conservation of BGBD were developed.
- Improved capacity of all relevant institutions and stakeholders to implement conservation and management of BGBD in a sustainable and efficient manner were developed.

Challenges faced during implementation

According to the TE, the Tranche 1 project had a slow start and initial poor communication which was began to improve in early 2004. It also faced some challenges related to coordination of activities, communication, and disbursement of funds between the Global Coordination Office and the different Country Programs.

The challenges faced during implementation of the Project in the sites in Kerala were[18]:

- **Land use change**: Changes brought about in the land use pattern during the course of implementation of the project affected its implementation since the project activities were based on and limited to the six types of land use systems that had been initially identified.
- **Farmers' interest / attitude change:** Change in the farmers' interests in terms of crops to be sown, or whether to continue to allow the project to demonstrate BGBD interventions voluntarily on their fields was another challenge faced by the project.
- **Socio-economic shift:** With the inflow of funds from Gulf countries, there was a socio-economic shift in the sample population of the target areas where the project had been initiated. This shift led to lesser level of dependence on agriculture as result efficacy of the techniques successfully tested in the research laboratories at KFRI was difficult to establish in the targeted area.

4.4 Outcomes and impacts

Achievements till project completion stage

As per the PIR 2011, all project outputs were achieved completely, although with varying degrees of satisfaction:

- A Manual of the methodologies was published and shared among project and other higher learning institutions' scientists.
- A Handbook for *Tropical Soil Biology: Sampling and Characterization of Below-Ground Biodiversity* was published in 2008 (ISBN No: 978-1-84407-621-5 (Hard Cover); ISBN No: 978-1-84407-593-5).
- Most indicators of BGBD loss were identified, published and shared across partner countries and globally.
- All project benchmark sites were characterised and documented and regions with global similarities were marked for results extrapolation and future validation.
- Demonstration and experimental plots were installed.

[18] Field visit

- Farmers in partner countries demonstrated up-take of knowledge on BGBD interventions.
- Enough information on BGBD was generated and published and is being used by partner countries to streamline BGBD management and conservation into policy frameworks and national legislation.
- Well trained scientists, students, and farmers, NGOs and communities have taken up and are further sharing BGBD knowledge to different target audiences.

Achievements at post project completion stage

The project[19] has explored the hypothesis that through appropriate management of above and below ground biota, optimal conservation of biodiversity for national and global benefits can be achieved in mosaics of land-uses at differing intensities of management. Furthermore, this can result in simultaneous gains in sustainable agricultural production.

The project has focused on the conservation by addressing urgent global biodiversity needs. The project has shown 'Moderate Progress' to enhance awareness, knowledge and understanding of below-ground biological diversity (BGBD), important to sustainable agricultural production in tropical landscapes by the demonstration of methods for conservation and sustainable management.

The project has contributed to mainstreaming soil biodiversity both in research and management areas aimed at improving agricultural production. The demonstrations and experiments have contributed towards the capacity building and knowledge of soil biodiversity in production environments, especially focussing on the use of inoculums for nutrient cycling improvement and sustenance of the productivity of systems, for soil structure improvement that aids in water filtration through the soil surface and use of bacteria and fungi for the degradation of organic biomass into constituent mineral nutrients. The overall research has identified contribution towards the role of BGBD into the sustainable agriculture and production systems.

Advanced research and studies on the topic of BGBD are continuing, with some/much research being conducted at the institutional level by PHD students and researchers in India.

Capacity building activities continue to involve people in BGBD conservation and management. Open composting and pit composting are common in Kerala. Microbes are introduced to reduce the time taken in composting and nutrient content analysis is undertaken to identify combinations that work well. Experiments on these are being conducted in KFRI Nilambur sub-centre. Farmers are brought to the sub-centre for exposure and also provide compost material and Lab-focused activity.

[19] Project Document

All the relevant institutions and stakeholders continue to work well together on BGBD conservation and management. Kerala Forest Department and Agriculture Department have shown interest in BGBD. They have also provided funding and are undertaking demonstration activities. Organic farming has been taken up extensively in the project sites.

Some of the continuing activities of the project team include:

- A book on *Vermitechnology*
- A number of research publications
- A Book on *Tropical Soil Biology* (a global publication) – which provides sampling and characterisation information on BGBD

Factors that affected progress

The various factors[20] that affected the implementation of the project were:

- A sufficient budget and the availability of trained personnel to inventorise BGBD across the diverse globally significant ecosystems and land types/uses. During project implementation, the budget was sufficient to undertake research at the selected pilot sites.
- The policy framework at the national level identifies the need for policy advocacy on BGBD conservation. The Agriculture Department undertakes exposure visits to demonstration projects. With the increasing prices of inorganic pesticides, insecticides, among others, they have started promoting organic agricultural practices to farmers. Examples include the supply of leguminous cover crop seeds and the promotion of soil management.

4.5 Progress to impact

The project has in various ways contributed to mainstreaming soil biodiversity both in research and management directed at improving agricultural production, as well as mainstreaming soil biodiversity as part of research on and management of biological diversity. The handbook on tropical soil biology has been one such attempt. Other attempts include the numerous events organised and presentations given during conferences organised by the CBD (e.g. COP8, SBSTTA14, etc.) and others. These have included professional conferences and international biodiversity days among others.

Though stakeholders have generally shown great interest, country ownership has been limited and has not been relevant as far as the conservation and sustainable management of BGBD is concerned. This is mostly because BGBD does not play any explicit role in the national action plans as far as conservation of biological diversity is concerned. Nor does it factor in policies on combating land degradation, the environmental policy, natural resources management or sustainable agricultural development. Hence, raising awareness is a crucial element and, in this

[20] Project Document

respect, the project has been successful in building interest among some of the most important stakeholders.

The project has left behind a legacy for the interested stakeholders in India, which includes:

- The Importance of BGBD is better-known and understanding has been improved – amongst the community, agriculture department officials, etc.
- Dispelling the myth that the increased yields can only be achieved with the use of artificial fertilizers.
- Cooperative-based marketing of agricultural produce has been initiated but is not successful as only a few enterprising and active farmers took interest in the initiative.

4.6 Lessons learned

The lessons learned[21] during project implementation are outlined below:

- **The BGBD Project Document is strong in substance, but perhaps a little ambitious.** Progress rates have inevitably differed between countries, which may affect overall progress. The positive scenario is where fast-track countries can move on unhampered and perhaps show more output than anticipated. In the more realistic scenario, the slower participants tend to reduce the overall pace. In a multi-continent project, this risk seems to be higher than in a regional multi-country project. The lesson learned is that during appraisal of project tranches of the size and partnership structure of BGBD, great attention should be paid to constraints and opportunities faced by all participants. Project narratives may be too focussed on the technical substance, and may thereby assume a certain minimum level of understanding and/or capacity of participants.
- **The project organogram proved complicated.** The chosen matrix structure did not function as well as it could. That is, the management at country team level had a much stronger position than the management at working group level. Also, distance between participants, poor internet connectivity in some countries, and different progress rates constrained the effectiveness of the working groups. The lesson is that in principle, a matrix structure may work well, but only if the project implementation strategy guarantees that all components of the management structure are efficient and effective.
- **National budgets and expenditure and project activities are poorly linked.** The lesson is that the M&E plan should allow joint monitoring of milestones/outputs and levels of budget expenditure. This will also allow a better estimation of cost-effectiveness of projects.
- **The magnitude of problems faced in data sharing amongst different project teams was underestimated at project inception.** As publications in highly rated international journals and, to a lesser extent, national journals and proceedings, adds considerably to a researcher's curriculum vitae, the concern is understandable. Although the issue of data sharing was mentioned in the Project Document, it apparently takes a considerable time to finalize a joint policy, including the relevant protocols. Although it was expected that academic institutions would have experience in dealing with intellectual property rights and

[21] Terminal Evaluation Report: Conservation and Sustainable Management of Below Ground Biodiversity

related issues, and would be able to come up with a policy quickly, this is not always the case (particularly in the case of multi-country projects). Therefore, more work should be done at the PDF stage or at the appraisal stages to address such issues.

- **A number of constraints, weaknesses and gaps, provided through peer review at AM-05, could have been avoided if proper expertise had been brought on board.** In this sense, the BGBD countries (with the exception of Uganda) may have been too optimistic of their own capabilities when going by the expertise tables in the Project Document.

4.7 Follow up actions

The TE listed follow-up actions[22] required for enhancing the project's impact and/or reducing risks to progress to impact, which were:

- The consultants in the project should work on a specific ToR that stipulates clear and tangible outputs to be realized in a limited timeframe.
- CPC should either step down, supporting BGBD from the side-line, or hand over most responsibilities to a to-be-appointed deputy, who would at least handle financial matters, monitor progress, and prepare for annual meetings.
- CPCs and Country Teams should conduct a full expertise needs assessment (baseline) before the start of the project, and open the doors for broader partnerships as the foci of activities change. The project should move from the inventory of functional groups to demonstration, 'best practices', and influencing policy.
- A strategy paper and plan of action on the added-value of being a global project should be prepared. That is, on how the whole can be made into more than the sum of the 7 parts, and on how to become more successful in realizing and enhancing impact, sustainability, stakeholder participation and country ownership.
- Impact expected from the NPAC should be spelled out more clearly, without aiming to bring all NPACs onto one footing. Also, an exit-strategy should be made explicit during the early stages of the project, showing how BGBD outcomes can be taken on board by the CBD, MDGs, and other international Research and Development (R&D) institutions, programs and conventions.
- CPCs and Country teams should internalize M&E instruments in the work plans. Also on the global information system, clearer performance indicators are needed to measure its impact.
- GCO and CPCs should develop a clear strategy and a code of conduct on securing the quality of outputs, data sharing, and the publication of project outputs.
- Financial statements by Country Teams in the second tranche are consistent, and show relative exhaustion, periodic expenditure, and balances for each budget code. This information should be linked up to work plans and achievements.

Specific to India, some of the other follow-up actions identified are:

[22] Terminal Evaluation Report: Conservation and Sustainable Management of Below Ground Biodiversity

- There is a need for promotion of development research in the area of below-ground biodiversity. The subject has not been accorded much importance within the domain of biodiversity conservation. The project has generated interest among a number of stakeholders (scientists, agriculturalists, government officials, etc.) and has raised awareness regarding BGBD. This interest needs to be capitalised upon in order to sustain and build on the progress made by the project.
- Developing baselines on various land-use systems is important to understand the present situation, as well as to enable estimation of impacts and benefits that could be achieved through further BGBD interventions.
- The involvement from national research institutions, such as Zoological Survey of India (ZSI) and Botanical survey of India (BSI), is required.

Part 3

CLIMATE CHANGE MITIGATION

PROJECT CASE STUDIES

5. Alternate Energy *[GEF ID 76]*

5.1 Project description

The 'Alternate Energy Project' (GEF ID 76, "Pilot phase") was a GEF project implemented by the World Bank. The project aimed at promoting the commercialization of wind energy and solar photovoltaic (SPV) technologies by strengthening the capacity of the Indian Renewable Energy Development Agency (IREDA) to stimulate and finance private investments in the sector. The project was executed by the IREDA. The project fell under the Operational Program 6[23] (*Renewable Energy by Removing Barriers and Reducing Implementation Costs*) of the GEF Climate Change Mitigation Focal Area. The project had a budget of US$ 280 million, including a GEF grant of US$ 26 million and a co-financing of US$ 254 million (from Swiss Development Cooperation, Danish International Development Agency, and International Development Association)[24]. The project started in April 1993, was implemented over a period of eight years and nine months, and completed in December 2001.

5.2 Project objectives and design

Long term objectives [25]

- To mitigate carbon emissions by strengthening IREDA's capacity to promote private sector investments in alternate energy;
- To promote commercialization of renewable energy technologies by strengthening the IREDA capacity to promote and finance entrepreneurial investments in alternate energy;
- To create marketing and financing mechanisms for the sale and delivery of alternate energy systems based on cost-recovery principles;
- To strengthen the institutional framework for encouraging entry of private sector investments in non-conventional power generation; and
- To promote environmentally sound investments to reduce the energy sector's dependence on fossil fuels.

Theory of change and causal mechanisms

The project was intended to promote commercialization of wind and SPV by strengthening IREDA's capacity to promote and finance private sector investments in the sector. To achieve the long term impacts, the project focused on three strategies – i) institutional strengthening; ii) financing & marketing delivery mechanisms; and iii) broader adoption of technologies by replication and mainstreaming of the sectors.

[23] Project Document
[24] Project Document
[25] Project Document

The "institutional strengthening" strategy[26] of the project was expected to lead to the improved management of institutional capacities and to acceleration in the commercialization of renewable energy technologies in the country. The key expected outcomes of the project were: institutional capacity strengthened to promote and finance entrepreneurial investments in alternate energy; commercialization of renewable energy technologies achieved; and rural/ poor consumers are aware of SPV products, benefits, and mechanisms. These outcomes were expected to strengthen institutional capacity to promote and finance entrepreneurial investments in alternate energy and thereby achieve commercialization of renewable energy technologies. Technical assistance activities of the project were targeted at strengthening IREDA's capacity to promote renewable energy technologies and attract private sector interest; the technical assistance focused on providing technical support and training of IREDA staff, private investors and other stakeholders engaged in renewable energy market development and investment. Investments to be financed through IREDA were expected to impart institutional experience in handling such projects.

The "financing and market delivery mechanisms" strategy was intended to create the intermediate state of "new renewable energy financing companies/ entities play a major role in promoting renewable energy businesses/ investments" and "marketing, sales, and service providers' networks being managed effectively for rural/ poor consumers". This strategy would address the critical market barriers to the promotion of renewable energy products especially in rural and peri-urban areas which existed prior to the project.

The expected outcomes were: a large number of banks, financial institutions, and financial intermediaries actively participated in new renewable energy financing; and, successful marketing and service delivery business models, and innovative approaches are launched and working actively. These outcomes were set out to activate, and provide a level playing role for, banks and financial institutions in new renewable energy financing and successful marketing and service delivery networks' participation in rural areas to address rural credit risks[27].

The "broader adoption of technologies by replication and mainstreaming" strategy was focused at delivering the intermediate state of "Enabling renewable energy policies are in place at national and state level", considered essential for delivering the intended impact. The key outcomes linked to this intermediate state were: a critical shift in the government's approach to renewable energy development- from largely state-owned to a more demand and market-driven approach with active involvement of the private sector[28]; and continued growth in renewable energy investments and industry. The proposed investments in solar, wind, and small hydro were expected to promote a major shift in the government's approach to a more demand and market-driven approach. The business meetings, campaigns, and awareness events were aimed at engaging policy makers and to make them aware of renewable energy business as a means to meet ever-growing power demand.

In addition, the awareness raising events, promotional campaigns, and series of regional business development meetings proposed in the project would facilitate the spreading of knowledge and

[26] Project Document
[27] Project Document
[28] Project Document

information on emerging investment opportunities in renewable energy across the country. The knowledge and information networks would be established among technical consultant firms in the various regions, which would then create lasting improvement and changes in the market by increasing awareness of business opportunities in renewable energy[29].

Key components[30]

- **Technical assistance**

  To strengthen IREDA's capacity to promote renewable energy technologies and attract private sector interest through the provision of technical support and training to IREDA staff, private investors and other stakeholders engaged in RE market development and investment;

- **Investments**

  To finance investments through IREDA for wind farms with an aggregate capacity of 85 MW; a marketing and financing program to support the SPV market, and install 2.5 to 3.0 MW of PV systems; and irrigation-based small hydro projects with an aggregate capacity of 100 MW.

Project design: Salient features

- The investment component of the GEF project involved a significant expansion of IREDA's business portfolio consisting of loans to relatively new entrepreneurs investing in emerging technologies, while at the same time requiring that IREDA's finances remain sound. The technical assistance component supported improvements in IREDA's corporate administrative and financial management systems, and aims to build capacities in IREDA to manage business risks.

- The SPV component[31] focused on developing a marketing program for the initial deployment, for over five years, with a capacity equivalent to 2.5 to 3 MWp, for efficient lighting, water pumping, and rural community services. The SPV component represents the initial phase of a larger program designed to sustain up to 10 MWp of SPV capacity installation by the year 2000. Monitoring of the rate of market penetration under the project was envisaged in the design to determine the appropriate timing of subsequent phases.

- The project targeted the development of grid-interfaced wind farms in states where there are proven wind resources and an established policy framework for private sector participation. For example, Tamil Nadu, Andhra Pradesh, Karnataka, Kerala, Gujarat, Maharashtra, and Rajasthan.

- The project targeted irrigation based small hydro projects ranging from 500 kW to 21 MW in the states of Andhra Pradesh, Kerala, Karnataka, and Tamil Nadu.

- The technical assistance (TA) package involving a total of US$ 5 million[32] provided was allocated with the objective to (a) finance expertise, training and equipment in support of IREDA's project lending, marketing, technology improvement and entrepreneurial promotion functions; (b) establish a comprehensive system of program review at IREDA, including preparation work to sustain the

[29] Project Document
[30] Project Document
[31] Project Document
[32] Project Document

pipeline of wind farm and SPV projects; and (c) support studies on improving the policy environment and introduction of best practices for grid purchases from private small-scale power producers and co-generation systems. A major component of the TA was associated with building up a PV promotions and awareness campaign for rural consumers.

Project design assumptions

- The wind farm technology in 1992 was characterized by a high degree of readiness and implementability, but it was not a cheap technology when compared to conventional grid alternatives; its economic rate of return of 10% was less than the desired rate of at least 12%. The GEF grant was meant to help reduce the project cost comparable to that of conventional alternatives. It was also assumed that the demand for wind farms stimulated by the project will bring down equipment production and installation costs in India by about 15% in the medium term.
- The SPV component had a high potential for replicability and for contributing to the reduction of global warming, but it requires the development of basic marketing infrastructure. It was assumed that GEF financing, together with the additional financing, would attract and create the necessary confidence among PV suppliers to invest in essential infrastructure required to support the sustainable use of PV in the field.
- Suitable policy incentives would be developed and implemented by the state governments for wind farm projects, in order to attract private investment in power facilities and thus ensure the sustainability of investments.
- Similarly, appropriate and affordable applications of SPV systems would be developed through measures such as the establishment of an effective product delivery and maintenance system and the use of economic incentives to promote competitively priced services should help broaden the market for SPV systems. Strengthening the capability of existing and new institutions, enhancing public and private sector cooperation would reinforce the longer term sustainability of the SPV projects[33].
- It was assumed that adequate commercial arrangements for supply and after-sales service would be in place prior to loan approval by IREDA. Firmly establishing the sufficiency of product demand helps to address the risk that the institutional and energy-pricing environment may prevent the SPV systems from becoming affordable.

5.3 Project Execution

Delivery of project components

The project was successful in surpassing the targets set at the design stage for the wind and small hydro sectors whereas it lagged behind, though marginally, for the SPV sector. The technical assistance component accomplished fully the set objectives at the design stage.

[33] Project Document

- **Wind farms**

  A total of 27 sub-projects with an aggregate capacity 87.2 MW were completed compared to 85 MW envisaged at the time of project appraisal. The wind farms installed in this project have shown significant improvement in actual plant load factor and grid reliability. The 27 wind farms generated 144 million kWh per annum with an average capacity factor of 18.8 percent. Individual turbine capacity enhanced from 225-250 kW in the early days to 600-750 kW towards the end of the project. The project also contributed to the development of a robust and growing wind turbine industry in India in the areas of manufacturing, design and engineering, operation and maintenance capabilities[34].

- **Solar PV**

  A total of 78 SPV sub-projects with an aggregate capacity of 2.145 MWp were financed in this project which is slightly below the target of 2.5 MWp. Solar projects financed through the GEF project include: solar lanterns of 5 Wp, PV irrigation pumps generating 900 W, solar power packs of 500-2500 Wp, village power schemes of 25 kWp, and PV grid tied systems of 200 kWp. In addition, IREDA financed 4 MWp of irrigation pumps with MNRE assistance. The 2.145 MWp of PV commissioned under this project generates approximately 3 million kWh annually.

- **Small hydro**

  A total of 35 small hydro projects with an aggregate installed capacity of 117.9 MW were commissioned and financed under the GEF project, exceeding the target of 100 MW. In addition, 17 more hydro projects (with over 35 MW) were commenced under this project and completed under IBRD Loan. During this period, IREDA financed an additional 155 MW using other resources, including domestic market borrowings. The small hydro projects commissioned under this project produced an aggregate annual energy output of 485 million kWh at an average plant load factor of 47%.

- **Technical Assistance**

  The Technical Assistance component supported 51 activities that included technology promotion campaigns, training of IREDA staff and various stakeholders, upgrading IREDA computer facilities, improving IREDA's financial management systems, conducting business meetings, technical reviews of sub-projects, and other important activities[35].

Challenges faced during implementation

The major challenge faced during the project implementation was lack of policy, institutional, technical, and financial support. By 1992, only southern states, namely, Andhra Pradesh Karnataka, Tamil Nadu, Kerala, and Gujarat had announced State-level policies for promoting renewable energy based power generation, while other states were yet to develop such support policies. There was no regulatory framework in place for the implementation of renewable energy projects in the country in a timely manner; the regulations to ensure the reliability and quality of these renewable energy technologies implemented in the country were not in place and this increased the risk of investing in renewable energy

[34] Implementation Completion Report
[35] Implementation Completion Report

technologies. There was a lack of institutional framework for development of private sector participation in the sector.

There was dearth of renewable energy investments in India. The government had shown interest in renewable energy initiatives but nothing concrete had come. Although fiscal incentives for selected renewable energy investments such as wind energy were in place, e.g., availing of 100 per cent depreciation in the initial year of commissioning, the investment community was not aware of the technologies or of their commercial applications. The banks and financial institutions were very reluctant to finance renewable energy projects because of high perceived risks. The demand for finance for renewable energy projects exceeded IREDA's resources.

The limited availability of evacuation infrastructure and grid interconnections was one of the biggest obstacles to harnessing renewable energy potential. Much of the potential of the economically attractive wind and small hydropower still remains untapped due to lack of adequate grid evacuation capacity and approach roads.

5.4 Outcomes and impacts

The GEF project led to substantial capacity enhancement of IREDA in undertaking its dual mandate of technology promotion and financing and strengthening institutional capacity for replication of projects. The project indirectly played an important role in promoting policy and regulatory changes. After the completion of the GEF project, with the enabling and conducive renewable energy policies and regulatory framework in place, institutional support, and active participation of private sector, there has been significant progress to impacts.

Achievements at project completion stage

- **Commercialization**

  The project has led to a robust and growing SPV manufacturing, design and engineering, operation & maintenance capability in India. It contributed to the development of a strong PV manufacturing base with a module/cell production capacity of 20 MW per year (over 20 companies compared to 4 in 1993). There were 45 companies that manufacture systems and export to Asia, USA, and Europe. Retail sales and service networks were set up in 12 states and union territories. By the end of the project, India had an internationally accredited SPV testing center.

  Commercialization had advanced rapidly in the wind power sector with 90% of the installed capacity of 1507 MW implemented by the private sector, compared to 40 MW of state-owned facilities in 1992. By 2002, India achieved installed capacity of 1702 MW and accomplished the position of fifth largest wind power producer in the world. Other financiers began to finance wind farm investments influenced by the GEF financing of wind projects through IREDA. The unit costs (capital costs) compare favorably with international experience. The projects contributed to socio-economic

development in the regions, which is evidenced by increase in rural employment, improved quality and availability of power in rural areas, increase in land prices, and infrastructural development.

In the small hydro sector, there was a significant transformation, with installed capacity rising from 93 MW in 1992 to 1516 MW in 2001. As a result, India rose to the tenth largest user of small hydro power by 2001. Another GEF project "Optimizing Development of Small Hydro Resources in Hilly Areas", also being funded through IREDA, aimed at the promotion of the technology in Himalayan and sub-Himalayan regions, has had a wide-spread impact on as many as 13 states. These two projects combined have helped in the promotion of the technology at the national level.

- **Strengthening of IREDA's capacity**

The GEF project led to substantial capacity enhancement of IREDA in its dual mandate of technology promotion and financing. The project has helped in IREDAs evolution as a matured financial institution specialized in lending for renewable energy projects including SPV. The project enhanced IREDA's capacity by helping it to increase its staff's productivity. As part of the project, IREDA increased its outreach and client support by establishing a cadre of business development agents which then lead to further increases in its loan disbursements. IREDA attracted other international support in excess of US$ 350 million.

- **Establishing marketing and financing mechanisms**

GEF support for financing renewable energy projects helped reduce the perceived risks of solar products thus encouraged other lenders to support the sector. The project led to availability of renewable energy financing from a large number of national and local banks, non-bank financial institutions, cooperatives, foundations/ trusts as well as government-owned financial institutions, including ICICI, IDBI, IDFC, IFCI, HUDCO, PFC, Sundaram Finance, Tata Finance, Syndicate Bank, and State Bank of Hyderabad compared to nil in 1993.

The project helped launch and nurture successful marketing and service delivery business models such as renewable energy service companies; retail companies selling renewable energy products and services to consumers; private power developers selling to captive consumers, third parties and to SEBs; consumer financing offered through rural banks, saving and trading cooperatives, etc. The project helped identify innovative approaches to addressing rural credit risks faced by PV energy entrepreneurs thus opening avenues for PV and other energy supply to penetrate the rural market.

- **Strengthening the institutional framework for private sector investments**

The project helped promote a critical shift in the Government's approach to renewable energy development from one that was largely state-administered to a more demand and market driven approach with active involvement from the private sector. Entrepreneurial, technical, and business development training services sponsored under the project catalyzed new business formation and enhanced the capacity of renewable energy businesses. The project encouraged and led to private sector investments in renewable energy infrastructure and service delivery systems, expanded

modern energy services to under-served rural communities, and support to both local and global environmental improvements.

The GEF project led to the promotion of businesses owned by women and more marginalized sections of society. Positive development impacts from SPV use among poorer consumers included; a five-fold increase in income among farmers using SPV pumps; a 50% increase in net income by traders using solar lanterns instead of kerosene lighting; the income of some rural households raised by around 15 to 30% due to increased home industry output; and longer study hours for children under better lighting conditions.

Achievements after project completion

Since completion of the GEF project, the relevant markets within the country have been moving forward in the intended direction. As time passes by much of this forward movement is difficult to link directly with the project activities. However, the movement in the intended direction and major progress in market transformation is indicative of GEF contributions in the area having been effective in finding stakeholder support for follow-up activities.

► Commercialization

A significant surge in the pace of commercialization has been witnessed in renewable energy sector since completion of the GEF project with significant contributions from the project activities, which are perceived to have facilitated a transformation of the SPV sector. As a result, by November 2012, the installed capacity of SPV (grid interactive plus off-grid) has grown to 1151MW. A large number of SPV projects are being set up under the Jawaharlal Nehru National Solar Mission (JNNSM) scheme of Government of India, which was launched in November 2009 with a set target of 22 GW of solar power by 2022 in three phases. The project activities led to the establishment of a vibrant industrial base for manufacturing of solar cells and modules in India. The industry has been growing steadily since the completion of the project. More than 80 companies with installed capacity of over 1.8 GW produce SPV modules and 15 companies manufacture solar cells – with over 700 MW installed capacity. India is exporting its SPV manufactured modules to Asia, the USA and Europe. Retail sales and service networks have been set up in majority of the states and union territories. With the rapidly growing SPV sector projects and the manufacturing industry, there is increased focus by government on the manufacturing of semiconductors including poly-silicon material which is the basic material for the manufacture of solar cells and remain the main constraint due to heavy dependence on its import.

With regard to the wind sector, the investments financed by the project led to the setting up of wind farms in all the States that have high potential for wind power generation. By 2012, the installed capacity of wind energy surged to 18,321 MW. Similarly the pace of development and growth of the domestic wind turbine industry has increased many-fold since the completion of the GEF project, facilitated by the institutional structures created under project. By 2012, wind turbines are manufactured by 18 domestic manufacturers with about 45 models ranging from unit sizes of 250–

2500 KW, mainly through joint ventures or under licensed production agreements. A few foreign companies have also set up their subsidiaries in India, while some companies are now manufacturing wind turbines without any foreign collaboration. The current annual production capacity of the domestic wind turbine industry is in the range of 3000-4000 MW.

In the small hydro power sector, there has been a tremendous increase in the number of technology providers and local equipment manufacturers. The capacity of the SHP sector in India, both technically and financially, has increased and is still on the path of progress. As of November 2012, the installed capacity of small hydro has increased to 3,465MW. The estimated potential for small hydro in India of 15,000 MW suggests that it can make a significant contribution to India's power mix, especially in remote areas where alternative supply solutions face many challenges.

IREDA, with its strengthened institutional capacity from the project activities and technical assistance program, continued its lending and promotional activities in SPV, wind, and small hydro beyond the project. IREDA's capacity for lending for renewable energy sector has further strengthened since the completion of the project in 2002. IREDA has specialized in lending for renewable energy and has established itself as an industry leader. As a result of the growing demand for lending, the annual loan disbursement level of IREDA has increased to US$ 280 million in 2011-12; with US$ 16 million going to the solar sector and US$ 226 million for the wind sector.

► **Institutional framework for private sector investments; and marketing and financing mechanisms**

The number of banks, NBFCs, rural institutions, cooperatives, NGOs, and MFIs for financing solar projects has increased tremendously since 2002 with a number of new players entering the market. There is tremendous interest from international companies to invest in India.

The GEF project states (e.g. Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat) where state-level policies for RE promotion (policies for licensing, power purchase pricing, alternative power sales arrangements for RE-based generation, etc.) were already in place at the project inception, made significant progress in private sector investments in RE and therefore these states recorded notable RE capacity additions. The remaining states have also introduced RE policies in line with the southern states, the positive contributions of the GEF project encouraged the enactment of RE policies in these states for promoting private sector investments with the government increasingly playing a market-enabling role. Due to the increased generation of renewable energy and its increased share in India's power mix that can be linked to the project, the project is contributing to CO_2 emissions reduction.

The marketing and service delivery business models nurtured during the GEF project have expanded businesses and operations within the GEF states and other states and has thus contributed to faster growth and development in the solar, wind, and small hydro sectors after the completion of the project.

Factors that affected progress

The project has had a positive impact on the renewable energy market in India and has enabled strengthening of the institutional, technical and financial capacity of India in its renewable energy sector. The causal mechanisms through which the results were achieved are highlighted below:

- **Implementing mechanisms & bodies:** Technical assistance activities of the project strengthened IREDA's capacity to promote renewable energy technologies and attract private sector interest; Investments were financed through IREDA, which imparted institutional experience in handling such projects and slowly, IREDA matured as a leading NBFI in funding renewable energy projects.
- **Knowledge generation:** There was significant contribution to knowledge generation and information sharing. The awareness raising events, promotional campaigns, and series of regional business development meetings conducted under the project helped in spreading the knowledge and information on emerging investment opportunities in renewable energy across the country. This has significantly contributed sustaining the progress of the project beyond completion and into the future. The knowledge and information networks that were established among technical consultant firms in various regions have created lasting improvements and changes in the market by increasing awareness of business opportunities in renewable energy.
- **Policy, legal & regulatory frameworks:** The project helped in promoting a major shift in the government's approach to renewable energy development from one that was largely state-administered to a more demand and market-driven approach. There has since been active involvement from the private sector with the Government increasingly playing a more market-enabling role. Policy makers became aware of renewable energy business as a means to meet the ever-growing power demand. Accordingly, in addition to the four states that initially participated in the project, other states set up enabling policy frameworks in support of renewable energy investments.
- **Marketing and financing mechanisms:** GEF financing for renewable energy investments through IREDA helped in reducing perceived risks, thus encouraging other lenders to support wind, solar and small hydro sectors. A large number of national and local banks have entered the market and lending to renewable energy projects. Successful marketing and service delivery business models have been launched; and these models have helped to transform the wind power markets.

While the above factors have contributed positively to progress, there have nonetheless been certain issues encountered during the course of the project, highlighted below:

- The MNRE subsidy programs conflicted with the market-oriented approach of IREDA-financed programs. For example, the MNRE subsidy for solar lanterns directly competed with the more commercial approaches being fostered by IREDA.
- Implementation delays occurred in the small hydro component when the MNRE announced subsidy support which prompted some developers to pull out of IREDA's program. They later returned when the subsidy program did not fully materialize. In contrast, the MNRE and IREDA partnership in financing PV pumps has been more effective in making solar pumps affordable to farmers.

- The land acquisition process and relations with water users delayed the projects. For example, a project in Kuthungal, Kerala where land acquisition took three years due to strikes and court stay orders.
- Evacuation infrastructure and grid interconnections became a major hurdle to the effective implementation of renewable energy projects. Places with high small hydro and wind potential were left out because of a lack of grid availability.
- Existing mechanisms—including single-window clearances, facilitation by state nodal agencies, and simplified regulation for smaller renewable energy projects—proved to be of limited effectiveness. In some cases multiple bottlenecks have been replaced by single, larger, and more powerful roadblocks, and significant delays remain the norm. In addition, speculative blocking of land has become common, leading to unsustainable price increases.

In the more recent years, in order to leverage more investments with its limited budget, MNRE has progressively shifted from extending subsidy grants to providing concessional financing through IREDA. This shift has increased the effectiveness of both MNRE and IREDA support.

5.5 Progress to impact

The factors that could contribute to further progress to impacts and the risks that could impede the progress are discussed below:

- With enabling renewable energy policies and a regulatory framework in place, and with the active participation of the private sector, the targeted renewable energy markets have been transformed. There is increased awareness at consumer level and an appreciation of the benefits which has developed the market-driven approach. The socio-economic benefits are evidenced quite clearly and the global environmental benefits in terms of GHG reduction are significant. Both at the supply side and demand side, there are lasting mechanisms for GHG emission reduction.
- The consultancy industry has developed and grown significantly during the GEF project and presently provides many services for solar, wind, and small hydro projects. These consultancy firms disseminate information and contribute to widespread awareness generation among the private sector aside from technical service provision. The consultancy firms work towards increasing awareness of business opportunities in the renewable energy sector. These firms have gained experience and confidence over a period of time and are contributing to market transformation through knowledge sharing.
- At present, financing for wind farm projects is available from a larger number of national and local banks and non-bank financial institutions. Most of the project states have announced policies conducive to promoting private sector investments in renewable energy. As a result, the private and non-governmental sectors are undertaking the vast majority of renewable energy investments in India, with the government increasingly playing a market-enabling role.
- The new government policies, such as ‘generation based incentives’ (GBI) and the Renewable Purchase Obligation (RPO), are encouraging independent power producers and private investors to establish large-scale, commercial projects that enable solar, wind, and small hydro sectors to become

a more significant part of the power mix. The experiences in other countries show that, both GBIs and RPOs are positive steps towards encouraging the development of renewable energy projects. These can lead to developer investment in more comprehensive resource assessments at the project site and a more optimized plant design.

- Further development of solar, wind, and small hydro is one of the focal areas of the MNRE, and is focussing on reducing the capital costs and enhancing the reliability, plant load factors, and average plant lifetimes. The Indian government aims to achieve the potential through the strengthening of policies, institutional development, and preferential tariffs[36].

Although the GEF project has made positive impacts in the wind, solar, and small hydro sectors, there are still risks to the achievement of intended long term impacts:

- Presently, there is lack of adequate power evacuation infrastructure and facilities for the power generated from renewable energy projects, which could slow down the new capacity addition from RE sector in majority of the States.
- Economic slowdown at global and national levels may hinder the financial performance of IREDA and other financial institutions that are playing major roles in financing and promotion of RE projects, which in turn may reduce the rate of progress of these projects.
- The subsidies from the MNRE may conflict with the market-driven approach of IREDA and other financial institutions, which may slow down growth in the sector.
- The 'cost plus' approach to tariff setting along with the technology-specific focus may lead to incentives that hinder the economic development of India's renewable energy resources. India currently offers a wide variety of incentives, including feed-in tariffs; generation-based incentives; renewable purchase obligations (RPOs); central, state, and regional capital subsidies; accelerated depreciation; and tax incentives. The lack of coherence between incentives and state programs makes it difficult to adopt an economics-based least-cost development approach to tapping the country's renewable energy potential.
- A lack of adequate affordable financing may lead to the degradation of infrastructure built to serve rural PV market and loss of market development momentum.

5.6 Lessons learned

► **Supportive policies and regulatory framework are essential for market development**

Wind and hydro power development has progressed fastest in states with favorable policies and regulations and not necessarily in states with the highest potential. However, it is learned that ad-hoc policy revisions retroactively applied in states – such as a ban on third-party sales, restrictions on captive generation and increased wheeling charges – can discourage potential investors and increase financial risk.

► **Delivering rural PV services needs a partnership among key actors**

[36] India Renewable Energy Status Report 2010- Background Paper for DIREC2010 (page 58)

The GEF project experience shows that, rather than expecting PV suppliers to also be credit suppliers, rural financial institutions may be better placed for delivering credit.

► **Development of renewable energy markets**

Introducing competition among financial institutions may be required for the commercial development of a sector at larger scales. Multiple product and service delivery agents, as well as technology improvements, are also necessary for success. The project experience shows that a longer time frame may be required to accommodate innovative projects (e.g. PV in rural areas) which require more time for capacity building and working with prospective investors. Greater outreach to, and capacity building of, financial institutions mobilizes the additional resources necessary.

► **Financing mechanisms for rural PV systems**

From the GEF project, it is evident that affordable financing for rural consumers is essential for market penetration of PV products in rural areas because more consumers in an area can afford the products. The experience also shows that availability of financing locally is important for expanding rural markets. For example, the rural market for lanterns and solar lighting kits expanded when micro-finance institutions, savings cooperatives, and rural banks that are closer to the customers, began to finance such products.

5.7 Follow up actions

- There is a need to simplify the numerous and overlapping financial incentives into a cogent set of synchronized policies established on sound economic and market evidence. Policies could be based on short- and long- term national targets and broken down into state-level RPOs that are mandatory and enforced. Technology-specific incentives could be supported by earmarked funding and increasingly allocated on a competitive basis.
- Renewable energy development should be given a high priority—as high a priority as village electrification. This is especially true for large-scale renewable energy plants. Dedicated funding should be allocated as part of existing programs – such as the government's rural electrification initiative, Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) – or for new green funds.
- The lack of coordination between incentives and state programs makes it difficult to adopt an economics-based least-cost development approach to tapping the country's renewable energy potential. The policy framework for renewable energy needs to be fine-tuned for the effective usage of the schemes provided by the government.
- Steps also need to be taken to address nonfinancial barriers that increase the cost of doing business. Like information technology and telecommunications, clean technology and renewable energy have enormous growth potential and can transform the trillion dollar energy markets across the world. To realize this potential, state nodal agencies, which are supposed to play a leading role in guiding renewable energy projects through the regulatory maze, need to be strengthened. A comprehensive capacity-building program on emerging regulatory, legal, and financing issues should be developed to facilitate grid-connected renewable energy.

6. Photovoltaic Market Transformation Initiative *[GEF ID 112]*

6.1 Project description

The Photovoltaic Market Transformation Initiative (PVMTI) (GEF ID 112, "Phase 1"), a three country program for India, Kenya, and Morocco, was a GEF project implemented by the International Finance Corporation (IFC) of the World Bank Group. The project fell under Operational Program 6 (*Renewable Energy by Removing Barriers and Reducing Implementation Costs*) of the GEF Climate Change Mitigation Focal Area[37] and had a total project cost of US$ 90-120 million. At project appraisal, the GEF endorsed a grant of US$ 30 million for the three countries – comprising US$ 15 million for India, US$ 5 million each for Kenya and Morocco, and US$ 5 for administration, implementation and supervision of PVMTI – with additional financing of US$ 60-90 million expected from investee companies, commercial debt financing, potential IFC co-financing in selected projects, and other sources[38]. The project started in June 1998, was implemented over a period of twelve years, and was completed in June 2010[39].

6.2 Project objectives and design

Long term objectives

The long term objective of the project was to promote photovoltaic systems as an environmentally beneficial alternative for distributed generation in India, Kenya and Morocco, which was to be achieved by stimulating PV business activity and to demonstrate that quasi-commercial financing can accelerate its sustainable commercialization and financial viability in the developing world[40].

Theory of change and causal mechanisms

The program was designed based on the premise that private sector project design and financing on a commercial basis stimulates more sustainable ventures than government or donor financed PV procurements. The project focused on two important strategies: "Develop and support viable business models" and "Information dissemination and outreach". The intended pathways to long term impact and how the project was expected to achieve the impact are discussed below:

The strategy to "Develop and support viable business models" intended to focus on delivering the intermediate state "Grid-tied solar projects being replicated on a large-scale across the country and off-grid solar projects - Solar home systems (SHS), solar irrigation pumps, solar lanterns are replicated on a

[37] Project Document
[38] Project Document
[39] Final Review of PVMTI, Final Report October 2012
[40] Project Document

wider-scale in other states." In order to achieve this objective, the project would identify, support, and finance innovative and replicable business models.

The second strategy "Information dissemination and outreach" aimed to deliver the second intermediate state "Technical inputs, experiences and lessons learnt are integrated into replication strategies/ activities". This is an important strategy for understanding and following good practices while undertaking replication and up-scaling of projects. In order to achieve this goal, the project was to focus on information-sharing opportunities between the investees across different countries.

The causal mechanisms that were identified in the project design are briefly described below[41]:

- **Business models generation**

  The demonstration of successful business models in the PVMTI was expected to facilitate future price reductions and lead to greater long term market penetration. The project was expected to expand commercial activities in potentially large market segments that were in the early stages of development, and to demonstrate alternative models to grid extension. The financial viability of the business models of private companies was expected to provide successful and replicable examples of good business and technical practices.

- **Knowledge and information sharing**

  An enormous amount of knowledge and useful information was expected to be generated through the PVMTI, which was to be disseminated internationally at conferences and seminars, and through print media. The intention was to convey the lessons learned to other potential investors, financial institutions, and donor agencies so that they may better understand the actual risks and rewards of engaging in PV financing. They could then more effectively respond to opportunities to replicate or expand existing PV activities financed through the program.

- **Removal of barriers**

  The higher level of management oversight and technical assistance of PVMTI, the incremental costs compared to commercial investment were considered key to overcoming market barriers and transforming PV business activities towards greater commercialization.

Key components

- Provide solar companies with an appropriate combination of Technical Assistance (TA) and financing;
- Demonstrate the viability of PV systems by supporting companies that distribute and service Solar Home Systems (SHS);
- Encourage other players in target markets to replicate financing models in order to create sustainable markets for these systems; and

[41] Project Document

- Disseminate lessons learned, specifically those that convey good transaction models, in order to encourage other players in the markets to undertake similar activities. Conduct training and marketing throughout the program[42].

Project design: Salient features

At the inception of the Program, the private sector supply market for PV in India was relatively small, weak and lacked professional management. The project intended to identify some successful business models and assist their growth by different means, including the funding and improvement of technical and managerial capacities. The precise objectives identified during the course of the project were the following[43]:

- Identify main barriers preventing the growth of the PV industry
- Develop/ facilitate viable business models for solar firms
- Facilitate the creation for commercial lending mechanisms for PV
- Provide managerial and technical expertise for firms

The potential PVMTI beneficiaries included in-country entrepreneurs who were able to respond to expanded opportunities for organizing PV distribution, assembly and financial enterprises. Another group of potential beneficiaries was the rural energy users that would have access to renewable energy sources without the risks associated with traditional lighting sources (e.g. smoke inhalation and fire from kerosene lanterns).

The PVMTI project introduced an External Management Team (EMT) to manage the project execution. The EMT brought expertise similar to an investment fund and was in charge of identifying potential investments to be validated by an IFC Investment Review Committee (IRC). Impax Capital Corporation (now Impax Asset Management Ltd.) and IT Power, Ltd., both firms experienced in managing small, innovative renewable energy portfolios, were selected to serve as the PVMTI EMT. The EMT also included local partner organizations in each of the countries and IT Power India (a subsidiary of IT Power UK) was the local partner for India. The EMT was responsible for seeking projects, performing technical reviews and due diligence, structuring investments, mobilizing co-finance, recommending investments to the IFC, and working closely with companies once investments were made. The IFC retained the ultimate responsibility for the approval of investments and disbursements[44].

Project design assumptions

The PVMTI was a strategic intervention to accelerate the sustainable commercialization and financial viability of PV technology in developing countries. The key assumptions made while designing the project were[45]:

[42] IGC/ GEF Project Supervision Report, FY05
[43] Final Review of PVMTI, Final Report October 2012
[44] Final Review of PVMTI, Final Report October 2012
[45] Project Document

- The private sector project design and management will result in more sustainable ventures than government or donor financed PV procurements. Previous experiences with highly subsidized or 'give-away' systems had not resulted in system longevity or widespread dissemination of the technology. It was believed that private sector sales would result in more enduring relationships with customers, a stronger sense of ownership on the part of the customer, and would be more likely to require and sustain adequate service infrastructure to assure continued performance of the systems.
- The direct engagement of the private sector and placement of targeted financing from a limited pool of funds was expected to maximize co-financing and result in support for the most sustainable and replicable projects.
- The project was expected to have a definitive impact in increasing sales and assuring the financial viability of a number of beacon companies providing successful and replicable examples of good business and technical practices.
- The incremental, but demonstrable, effects on reducing barriers to market growth and availability of capital were expected to accelerate market development and improve the access of the sector to commercial finance.
- PVMTI funds provided a higher level of management oversight and technical assistance. While these were expected to increase costs above the level normally incurred by a commercial investment fund, these incremental costs were considered key to overcoming market barriers and transforming PV business activities towards greater commercialization.

6.3 Project Execution

Delivery of project components

The actual accomplishments in India fell short of targets, both in terms of the number of installations and aggregate MW capacity. A total of 10.29 MWp solar PV was installed under the project against the target of 12.25 MWp. This comprises off-grid projects of 1.345 MWp by SELCO India, 2.42 MWp by Shell Renewables, 1.425 MWp by SREI; and grid-tied 5.0 MWp solar PV project by Moser Baer. A total of 94,000 installations were made against the target of 198,000 by five organizations and companies under this project in India[46]. The project successfully created information-sharing opportunity between the investees across different countries and facilitated sharing of lessons learnt and experiences. Knowledge management reports, a guide for developers and investors on the large scale solar power plants, case studies, and period newsletters were produced and widely disseminated.

Challenges faced during execution

The project encountered a number of challenges during execution encompassing institutional, policy, technical, and financial aspects, which are highlighted below:

- Market awareness of solar products was low and this segment was only addressed by Non-Governmental Organization (NGOs) and microfinance institutions.
- Technology costs, while declining, were still relatively high. In spite of life-cycle costs that were competitive with power sources such as diesel, the up-front costs of PV were substantial.

[46] Final Review of PVMTI, Final Report October 2012

- Financing for consumer credit or working capital was expensive or unavailable, resulting in customers unable to amortize costs over time and companies without funds to finance expansion of operations. Due to the small scale of the market and lack of familiarity with PV, banks tended to overprice the risk of operating in this sector or did not lend at all. Companies found borrowing costs prohibitive and instead financed growth out of cash flows, which are usually meager in comparison. As a result, financial linkages remained under-developed and consumer credit was generally unavailable.
- Low product volume, combined with the difficulties of developing a consistent supplier-dealer chain, resulted in high unit transaction costs and hindered the expansion of the market. Consumer awareness was also low.
- Managerial and technical skills were limited among many companies selling and installing PV systems, resulting in inadequate business planning and poor cost and quality control. PV manufacturing firms, while often larger and with stronger management, typically lacked the broad market reach to develop consistent and profitable distribution chains. Companies also needed to make investments which can be partly considered as public goods. For example, the benefits of raising consumer awareness or training personnel may not accrue directly to the company making the investment.
- There was a lack of after-sales services and maintenance activities for off-grid solar products.
- Policy barriers remained widespread and created an uneven playing field for PV and other renewable energy technologies. These included market distortions in electricity tariffs, subsidies for conventional fuels, and high import taxes on PV modules, materials, and omponents such as batteries or efficient lighting fixtures.

6.4 Outcomes and impacts

Achievements till project completion stage

Though the project could not fully accomplish the set targets in terms of number of installations and installed capacity of solar systems, the outcomes of PVMTI in India were quite positive in specific strategic areas of capacity strengthening, business model generation, knowledge and information generation and sharing, and removal barriers, which are elaborated on below. The overall results of the project at the global level were moderately unsatisfactory. However, compared to the other countries, the project components in India fared better.

► Capacity strengthening

The project provided support to generate institutional knowledge for the growth of PV sector in India and contributed significantly to capacity building of the private sector. The 5 MW gird-tied demonstration project of Moser Baer was a first of its kind in India and the successful execution of the project helped the company in building the technical and managerial capacity tremendously. Considered as the most successful of the PVMTI projects, the company is replicating projects in Gujarat with 30 MW solar plants using the knowledge and capacity gained in the GEF project and the company has another 480 MW project portfolio in development. The capacity gains and enhancement of the private sector on the off-grid models through this project is significant. For example, Shell Solar India gained a strong foothold in this sector with the experience, knowledge, and capacity built through the PVMTI project. It expanded its

portfolio to include solar water heating systems and is planning further diversification based on the strength of its rural installation and service infrastructure.

► Business models generation

The project with focus on assisting private sector in demonstrating the viability of business models providing solar solutions both for off-grid and grid-tied solutions helped building the capacities of a number of private sector companies in India like Solar Electric Light Company (SELCO), SREI, Moser Baer and Shell Solar, in setting up projects on a commercial basis. While following the business strategies generated during PVMTI, Environ Energy India Limited (EEIL) has expanded its operations to the neighboring states of Bihar and Jharkhand, and Karnataka. SREI installed 24,000 systems (1.425 MWp) against the target of 20,000. Shri Shakti Alternative Energy Ltd (SSAEL) model, which was based on a unique model to leverage the LPG network of its sister company and other gas companies to promote and sell PV products, was less successful compared to other PVMTI activities in India. Some companies have gained significant experience in the PVMTI project on how the business strategies can be designed to adapt to the changing business environment, with the help of EMT. Overall, these models successfully demonstrated that their business models could be financially viable and lead to profitability.

The program demonstrated that successful partnerships could emerge by bringing together FIs and PV installers. The project offered a more extensive range of financial instruments and facilitated greater appetite for risk than a pure debt facility on projects. This had the effect of broadening the way that interested investors looked at project investments. A more user-friendly attitude has created an atmosphere of collaboration and confidence building. This also had an important knock-on effect; investee companies became open to sharing information and developed a “work together” attitude as projects were implemented.

One of the most noticeable impacts of PVMTI in India was raising the awareness of rural banks, cooperatives, micro finance institutions and other rural lenders to PV financing opportunities. Competitors have emerged in the same market segments. Furthermore, consumer finance dedicated to solar loans became more prevalent and is identified as a key step to the development of solar installation network.

► Knowledge and information sharing

The knowledge generation and information sharing under the project facilitated awareness rising and capacity building. A periodic project newsletter “PVMTI News” was published highlighting the project activities, accomplishments, challenges, and lessons learnt, and the copies were widely distributed. The knowledge material[47] published included a guide for developers and investors on the large scale solar power plants, was widely disseminated and referred by many other investors and it was a great success in disseminating the knowledge and information. The Case Studies on off-grid solar projects produced in the project helped to disseminate the success stories and facilitated replication projects by other actors.

► Removal of barriers

[47] TASS Report

Activities were taken up in the project to remove the existing market barriers to the promotion of PV products in India, including: awareness raising activities such as awareness campaigns; solar exhibitions by companies such as SELCO, Shell Solar, SREI, EEIL; joint ventures between micro financiers, PV installers, and system; low cost financing by GEF; and dissemination of knowledge materials created in the project. The Solar guide, case studies, through print media and seminars had a positive impact on the India solar market and led to the minimization of the market barriers.

In the PVMTI, 5.8 MWp of solar Solar Heating Systems and 5.0 MWp of grid-tied power plant[48] have been commissioned. The estimated direct GHG emission reduction from the sub-projects is 266,000 tons CO_2 equivalent over a period of 10 years (200,000 tons from SHS and 66,000 tons from grid-connected projects)[49].

Progress after project completion

The Indian PV market has dramatically transformed 12 years after the launch of the PVMTI project, in terms of business volumes, price reductions, technology development, financial sector and market awareness. Notable progress has been achieved in the solar PV sector in India, especially in grid-tied projects, after the completion of PVMTI in 2010. A significant portion of these achievements can be attributed to the GEF project. The Moser Baer project, designed for demonstration purposes, is operational and the lessons learned from the design, construction, and operation phases have been gathered to facilitate replication efforts. A large number of replication projects in the states of Gujarat, Rajasthan, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, and other states are being set up having witnessed the success of the Moser Baer project. As a result of the project, large-scale solar power plants are now being developed at a fast pace with the support of the Government of India.

Similarly, noteworthy replication projects have been witnessed in the off-grid solar PV arena, after the completion of the GEF project. Several successful PV companies were launched with the help of the project, namely SELCO, SREI, Shell Renewables, EEIL, and Shri Shakti. Some of these companies have been increasing their activities in their states of focus and expanding operations to other states. For example, SELCO is thriving in the sector and SHS installations have increased from 25,000 at the end of the project to 135,000 by the end of 2012 and many new installations are underway[50].

The GHG emission reduction as indirect influence of the project was estimated to be 24,088 tons of CO_2 equivalent per annum. For the estimation of GHG emission reduction, 30MW of grid-connected solar power capacity and an additional 100,000 SHS's have been developed since the completion of the project, as of the end of 2012[51].

[48] Advisory Services Completion Version 1
[49] India CCM Case Study Report, February 2013
[50] SELCO website
[51] The assumptions made for estimating the emission reductions are: **A**. Plant load factor is taken as 0.2 which is same as observed at Moser Baer plant in Tamil Nadu. The units produced by the plant annually are 52,560,000 units per annum. The grid emission factor is 0.79 tonnes / MWh. For the purpose of calculation, indirect influence of the GEF contribution was considered to be 50%[51] and rest can be attributed to government efforts to transform the market. So the total GHG emission reduction from grid-connected solar capacity as a result of GEF influence was 20,761 tonnes of CO2 equivalent per annum. The

Factors that affected progress

Although the GEF support has stimulated the solar PV market, considering the huge landscape of India with its diverse geographical conditions, there is still a number of considerations. The cost-plus approach to tariff setting – along with the technology-specific focus – has led to incentives that hinder the economic development of India's renewable energy resources. India currently offers a wide variety of incentives, including: feed-in tariffs; generation-based incentives; renewable purchase obligations (RPOs); central, state, and regional capital subsidies; accelerated depreciation; and tax incentives. The lack of coordination between incentives and state programs makes it difficult to adopt an economics-based least-cost development approach to tapping the country's renewable energy potential.

6.5 Progress to impact

The project has resulted in transformation of markets for off-grid and grid-tied solar PV projects in India, by removing market barriers and generating awareness, as explained above. This has contributed significantly to progress to impacts. The section below discusses the likelihood of and risks to further progress to impacts:

The present government policies, regulations, and the prevailing business environment suggest that there is likelihood of further progress to impacts. The central Government policy, namely the Jawaharlal Nehru National Solar Mission (JNNSM), combined with the regulations by the national and state regulators for renewable energy purchase and feed in tariffs is expected to result in a favorable environment for the replication of grid-tied PV projects as well as off-grid solar projects, on a large-scale. Although these programs are currently in their infancy, the combination of the significant solar resource available throughout the country and the current Government focus could contribute to further progress to impacts in the solar PV market in India – the stated goal of the National Solar Mission is 20 GW of grid-tied solar power and 2 GW of off-grid solar installed capacity by 2022.

The other central government policies, such as 'Remote Village Electrification' and 'Rajiv Gandhi Grameen Vidyutikaran Yojna'[52], and various promotional programs of the government are aimed at encouraging decentralized generation for the electrification of remote villages using renewable energy sources. These efforts can provide further impetus to the replication of solar PV off-grid projects successfully demonstrated under the PVMTI.

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replication projects aggregating to 30 MW installed capacity are being implemented by Moser Baer after the successful completion of 5 MW project in 2012. **B.** On off-grid front, additional 100,000 SHS have been installed in India after the completion of the GEF project. For a typical 50 Wp PV system, total potential off-set of carbon emissions is considered as 1.83 tons of CO_2 equivalent. The GHG emission reduction is estimated to be 66,536 tonnes of CO_2 equivalent over a period of 10 years. For purpose of calculation, only half of these potential savings are credited to GEF and rest can be attributed to government efforts to transform the market. So the total GHG emission reduction from SHS as result of GEF influence is 33,268 tonnes of CO_2 equivalent over a period of 10 years or approximately 3,327 tonnes of CO_2 equivalent per annum. Hence, the total GHG emission reduction as indirect influence of GEF project comes to be 24,088 tonnes of CO2 equivalent per annum.

[52] India Renewable Energy Status report DIREC 2010

The increased market awareness of solar PV products due to the GEF project coupled with the continuing power sector reforms are expected to create a competitive investment environment resulting in an equal level playing field among energy sources. The availability of affordable financing for rural PV market, active and participation by other financial institutions as witnessed in the project as well as after the project can go a long way in achieving the long term impacts. The effective after-sales services provided by the solar companies and growth pressures in both grid and off-grid sectors to meet the fast growing energy market could also contribute to further progress to long term impacts.

The growth pressures and energy needs in both the on-grid and off-grid sectors, coupled with liberalization of the energy sector and certain budget constraints, continue to offer new opportunities for private, commercial power alternatives such as PV.

Although the PVMTI has had positive impacts in the Indian solar PV sector, there are risks to the full achievement of long term impacts. For example there is still a lack of awareness among remote rural populations on the benefits and opportunities of solar projects; there is a lack of interest for financing these projects by other FIs/ NBFIs; a lack of comprehensive regulatory framework for ensuring compliance; and a lack of capacity in state nodal agencies for the wider replication of solar programs at district level. The other possible factors that may impede further progress to long term impacts are highlighted below:

- Conflicting MNRE subsidies with the market-oriented approach of IREDA and other financial institutions (e.g. solar lanterns).
- Shift in government policies due to political considerations (subsidies vs. concessional financing).
- If adequate affordable financing is not available, there could be degradation of the infrastructure built to serve the rural PV market and a loss of market development momentum.
- Economic slowdown at global and national levels hurting the financial performance of IREDA and other institutions that are playing a major role in financing and promotion.
- Uncertainty faced by the private sector in grid-tied projects due to inconsistency in the regulations and tariffs.

6.6 Lessons learned

A number of important lessons were learned through PVMTI project. Several lessons are also linked to experiences gained in Kenya and Morocco for which information provided in the terminal evaluation of the project has been used as a reference point. The key lessons are:

- The individual program results revealed a significant disparity in the achievements of each country. Projects implemented in India fared better than in Kenya and Morocco. Of the five sub-projects implemented in India, all but one were successful or largely successful. Reasons include the higher population density in India and the more mature market conditions – including a wider range of available financial instruments.

- The project experienced constraints due to emphasis on funding PV projects rather than business entities wanting to diversify existing business into the broader PV sector. Although PVMTI was conceived to develop markets rather than product manufacturing, a more flexible approach that allowed business expansion in other related sectors, would have provided a framework for improved business stability. For example, SELCO Solar, where the company expanded operations into a new geographic zone but then found that solar thermal market opportunities were more robust and a combined service delivery program for PV and solar thermal products made better economic sense. This is also the case in Morocco, with companies like Phototherm and Spotyten who, limited by the barriers of PV, focused on thermal.
- PVMTI's experience shows that there is a need for capacity building and technical assistance. In India, being an entrepreneurial nation and having a more mature market, it was easier to work with and to implement the projects without investing much effort in capacity building. According to documented experiences in Kenya and Morocco, it was relatively difficult to make headway due to low capacities. Thus, a threshold capacity level may be required for a project like PVMTI to find sufficient traction.
- The project experience shows that success in the solar PV business, and the appropriate business model to adopt, depends to a large degree on the enabling environment in which firms operate. India has the largest RE financing effort offered by any developing country. Governmental efforts to promote RE, including solar PV, compete with PVMTI, but also help open up the market and establish solar PV as a viable technology. Additionally, the fact that the population of India is large and densely populated means that service technicians can economically serve a small geographical area – due to it being relatively inexpensive to reach potential clients – with a critical mass of SHS units. Furthermore, favorable tax, regulatory, and grid-extension policies have helped the development of the solar PV market in India. These favorable conditions were not available in Kenya and Morocco.
- PVMTI's experience shows that ensuring high quality products is important to project success and instilling consumer confidence. This was successfully demonstrated in India, where companies like SELCO and SREI have ensured high product quality before installing systems at customer premises by working with reputed system manufacturing companies like Tata BP Solar. The companies have also established Solar Service Centers (SSC) and provided excellent after-sales servicing and guaranteed maintenance of installed systems. This approach has instilled confidence in the consumers and ensured the success of the two projects.
- All of the firms that achieved modest success in terms of utilizing PVMTI resources and drawing down their commitments were already in the solar PV business (SELCO, Shell Renewables etc.), or were seeking to enter the market, when they received funding from IFC. PVMTI found that firms like SREI that provided further value addition, in particular servicing and maintenance, were more successful. Those who moved farther up the value chain, and were involved in the assembly of solar components and the installation of systems, seemed to do significantly better than firms that were merely engaged in consumer or producer financing.

6.7 Follow up actions

Government action in the form of strategic public policies implemented through well-crafted legislation and regulation is required to drive investment in solar PV sector in India. A major challenge for government policy is the need to adapt to changing conditions, most notably the challenges associated with higher market penetration rates of renewables. A comprehensive capacity-building program on emerging regulatory, legal, and financing issues to facilitate grid-connected renewable energy should be structured.

The state nodal agencies should be mobilized to play pro-active role among the stakeholders like the nationalized banks, commercial banks, NGOs and entrepreneurs. The objective will be to engage the bank officials to promote commercial lending for PV projects and mobilize resources for the sector.

The Solar Energy Center (SEC) should be strengthened to cater to various aspects of solar resource utilization and technology development in collaboration with other research institutions, implementing agencies and PV producers. The SEC should act as a leading technical institution for the promotion of solar PVs in India.

7. Development of High-Rate Bio-methanation Processes as Means of Reducing Greenhouse Gas Emissions *[GEF ID 370]*

7.1 Project description

The project "Development of High-Rate Biomethanation Processes as Means of Reducing Greenhouse Gas Emissions" (GEF ID 370) was designed to enable India to contribute to environmental protection at the local and global levels by developing biogas generation facilities to convert waste-to-energy (WTE). The project was implemented by UNDP and executed by the Ministry of Non-conventional Energy Sources (now MNRE).

The total project cost was US$ 10 million with a GEF grant of US$ 5.5 million and co-financing of US$ 4.5 million. The implementation of the project commenced in March, 1994 and was completed in September, 2005.

The project objectives were consistent with OP6 strategy – Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs. It primarily targeted waste management in the GHG producing sectors of the economy by adopting Renewable energy – biogas (biomethanation) technology for climate change mitigation. The project promoted a CCM technology demonstration cycle and innovation chain. The financing approach was to set up funds at IREDA for 50-50 funding from project funds and participating organizations (government agencies or private industries).

7.2 Project objectives and design

Long term objectives[53]

- Develop a national master plan for bioenergy generation based on high-rate biomethanation to reduce methane emissions, generate energy, and improve environmental quality
- To develop commercially viable technology packages for replication
- To promote biogas generation and utilization by disseminating information about these processes
- Capacity building of organisations at national and state levels

Theory of change and causal mechanisms

The project was designed to control emissions of methane in India by applying state-of-the-art high-rate biomethanation technology to a number of waste substrates. It aimed to formulate a national strategy for biogas generation and utilization, demonstrate a variety of technologies through the establishment of 16 demonstration projects, and educate policy-makers, waste generators, agricultural communities, and the public about the environmental and economic benefits of methane recovery from waste. It also aimed

[53] Project Document and Terminal Evaluation Report

at creating an alternative clean fuel source that would result in improvements in the quality of the environment (air and water), especially health and sanitation. The quality of life for women in the rural sector was expected to be enhanced by the substitution of methane for fuel wood, which is traditionally gathered by women[54].

The project design focused on three strategies - institutional strengthening, demonstration and replication & mainstreaming to achieve the intended impacts. The project was designed to develop an institutional framework to promote high-rate biomethanation processes to treat and generate bioenergy. The demonstration projects to ensure the sustainability of the project by proving its viability to the private sector.

To enhance the institutional capability of the country, the project was to develop a national master plan for bioenergy based high-rate biomethanation to reduce methane emissions, generate energy, and improve environmental quality, including investment proposals for treatment of municipal, industrial, and agricultural wastes[55]. It was also to formulate a National Bioenergy Board (NBB) with a network of national laboratories, institutes, and other agencies providing technology and designs for high-rate biomethanation, biogas utilization, training of personnel, and other services. It was expected to strengthen central and state level institutions in order to advise and assist municipal bodies, industry, and communities on high-rate biomethanation of wastes and by-product recovery[56].

A part of the demonstration and replication strategy was to assess proven technologies and designs for waste treatment, and prove the viability of such processes in India. These technology packages can form the basis for national environmental guidelines in the various sectors. The technology developed would also be replicable in other countries, particularly those in the developing countries. It was expected a strategy for commercialization of technology packages through enabling provisions, incentives, and other methods to make investments attractive for private, public, municipal, and other sectors[57].

To encourage private parties to invest in the demonstration projects, the project was designed to share cost of equipment between Government of India, GEF, and the entity selected for the demonstration project. However, while the approach was adopted to mitigate risks involved in the standardization and commercialization of the process, it made it difficult for the project to obtain funds from the usual sources[58].

To mainstream high-rate biomethanation, the project was to develop human resources in bioenergy and microbiology technology, high-rate biomethanation processes, technology development and commercialization, and related areas. In turn, this was to lead to a corresponding enhancement of skills for users of these technologies, thereby promoting their use on a larger scale. It was to establish a network of professionals in India and abroad in bioenergy, biomethanation, microbial technology, waste

[54] Project document (pg. 1)
[55] Project Document (Pg. 19)
[56] Project Document (Pg. 8)
[57] Project Document (Pg. 8)
[58] Project Document (Pg. 16)

management, and related areas to assist in further development in these areas[59]. The awareness of the biomethenation processes was to be disseminated through conduct of workshops and training programs as well as through electronic media campaign[60].

Key components[61]

- **Formulation of a national strategy and master plan.** Preparation of a national strategy and a master plan, along with detailed investment proposals for bioenergy development based on cost-effective technology packages. The focus was to promote bioenergy generation based on high-rate biomethanation.
- **Setting up of 16 demonstration sub-projects.** Demonstration of a variety of technologies available for deployment in industries such as leather, paper & pulp, dairies, municipal wastes, sugarcane and urban waste.
- **Institutional capacity enhancement at various levels.** Development of technical skills and management expertise of key stakeholders of the project to enable them to pursue investments in the advancement of biomethanation processes.
- **Information dissemination.** Development of promotional programs to increase the interest in biomethanation processes among national, municipal, industrial, and agricultural groups.

Institutional arrangements for project execution

The National Bioenergy Board (NBB) was constituted to make policies and procedures for implementation of the project. The NBB was the apex body which provided policy guidelines for development of a national strategy for bioenergy and supervised implementation of the project. It comprised of representatives from various Government ministries and departments, including:

- Ministry of Non-Conventional Energy Sources (MNES)
- Ministry of Environment & Forests (MoEF)
- Ministry of Urban Development & Employment
- Department of Biotechnology
- Department of Economic Affairs
- Ministry of Finance
- Department of Science & Technology (DST)
- Department of Scientific & Industrial Research (DSIR)
- Planning Commission and
- United Nations Development Programme (UNDP)

A Project Management Cell (PMC) was created in MNES for assisting the NBB in the implementation of the project. The PMC was headed by the Adviser (Urban, Industrial and Commercial Applications Group) and the National Project Director (NPD) and assisted by a director and scientific officers. In addition, a few technology institutions such as the Central Leather Research Institute (CLRI), Central Pulp & Paper

[59] Project Document (Pg. 8)
[60] Project Document (Pg. 25)
[61] Project Document (Pg. 8)

Research Institute (CPPRI), National Environmental Engineering Research Institute (NEERI) and IIT Roorkee were associated with the NBB in providing assistance on technology related matters. Financial management for the project was entrusted to the Indian Renewable Energy Development Agency (IREDA).

Project design assumptions

The assumptions made in the project design were as follows:

- Capacity building in technical institutions creates requisite experience to assist in replicating post project activities, i.e. dissemination of technologies, and impart training to other units interested in replication of the design.
- Identification of beneficiary organizations in the public/private sectors, municipal agencies, etc. to set-up demonstration sub-projects, bearing 50% of the total cost.
- Acceptance of imported technologies suiting the Indian conditions in efficiency and reliability.

These assumptions still hold good as these technologies have resulted in increased capacity of technical institutes and the technologies have been successfully deployed at various sub-projects covered under the project and several other projects are being undertaken after the completion of the GEF project.

7.3 Project Execution

Delivery of project components

The implementation target set out during the project design stage has been achieved for most activities. The project contributed significantly to the formulation of a supportive legislative environment. The National Programme on Energy Recovery from Urban, Municipal and Industrial Wastes, the 2000 Municipal Solid Waste Management and Handling Rules and the Electricity Act of 2003 provide an atmosphere conducive to commercialization of biomethanation technologies. A total of 16 demonstration sub-projects were set up in various sectors that produce biodegradable waste. The absorption, modification and standardization of the cost effective technologies and based on the most suitable technology option, size and best use of the generated biogas. The high-rate biomethanation project has had a noticeable impact especially among the industries generating the biodegradable waste. Information dissemination and awareness, e.g. publish quarterly “Bio Energy Newsletter” and the participation of a large number of officials and professionals of national and state level organizations in fellowship training, workshops, meetings and in-house trainings[62].

Challenges faced during execution

The project addressed all the key barriers as far as development of the biomethanation sector is concerned. Nonetheless, the project design was not adequately detailed or clear as uncertainties

[62] Terminal Evaluation report (pg. 32)

remained regarding the institutional setup. The 'wait-and-see approach' of the intended beneficiaries caused much delay during the early years. More than expected time was needed to convince private sector partners and municipalities to invest in technologies, such as biomethanation, that were considered mature at the time but had not been demonstrated yet. However, once these hurdles were addressed, project execution progressed smoothly.[63].

The initial delay of the project's initiation was due to problems in the institutional set-up and arrangements. Delays in the initiation of the sub-projects was attributed to the greater time required to convince beneficiaries (private sector and municipalities) to participate, despite the relatively high subsidy offered (50%). Of the original list of beneficiaries in the project document, only one beneficiary participated, while others adopted a 'wait-and-see-approach'. Some sub-projects faced delays in the technology selection process and procurement of equipment; in some cases, up to one or two years were lost by having to go through subsequent rounds of re-tendering. While some of this delay can be attributed to the procedural system which had to be followed, another factor is the nascent character of biomethanation technology, which is still evolving, implying that the same standards cannot always be applied, as for mature technologies.[64]

Various changes occurred in the institutional arrangements and project management personnel. The involvement of various officials in the project's procedures and the need for clearance slowed down decision making. For example, in terms of time required for approval of financial outlays in the various sub-project proposals. Originally the Project Management Cell (PMC) was set up in the HUDCO (Housing and Urban Development Corporation), but was transferred to MNES in January 1996 and was staffed by the Ministry's own personnel. Apparently, housing the PMC within MNES gave more credibility to the project and helped to generate more interest. This was attributed to project delays caused by administrative procedures[65].

The project document lacked a logical framework of verifiable indicators and, as such, the lack of a monitoring and evaluation framework makes it difficult to assess the project's impacts. A monitoring and evaluation system was not included in the project design, as this was not a requirement for GEF projects at the point the project was approved. Thereafter, no effort was undertaken to systematically monitor project results and impacts[66].

7.4 Outcomes and impacts

Achievements at project completion

The project had the development objectives to develop a National Master Plan (NMP) for the generation and utilization of bio-energy based on high-rate biomethanation processes, to reduce atmospheric

[63] Terminal Evaluation report (pg. iv)
[64] Terminal Evaluation report (pg. 28)
[65] Terminal Evaluation report (pg. 28)
[66] Terminal Evaluation report (pg. 29)

emissions of methane, increased generation of energy/electricity and improvement in the quality of the environment. The project undertook 16 demonstrations in various sectors and developed commercially viable technology packages that were ready for replication. This helped in changing the market for biomethanation at a higher scale.

► **Formulation of a national strategy and master plan**

At the point of project completion, a National Master Plan for development of biomethanation in India was formulated with the focus to promote bioenergy generation based on high-rate biomethanation along with detailed investment proposal for bioenergy development based on cost-effective technology packages. Some of the policy measures suggested by the NMP regarding waste management and methane gas recovery have been accepted and are being used by MNRE in its policies.

The project also supported the preparation of a National Master Plan for waste-to-energy (WTE), under which the potential of WTE projects in various industries and from city waste was estimated for a period up to 2017. This involved a study of waste generation in over 300 cities and 9 major industry sectors that generate biodegradable waste. The NMP also facilitated policy formulation, institutional networking and outreach. The MNES has now formulated incentive schemes for projects on energy recovery from urban and industrial waste for the period 2005-06, including incentives such as a capital subsidy.

► **Setting up of 16 demonstration sub-projects**

A total of 16 demonstration sub-projects were set up in various sectors that produce biodegradable waste. The demonstration sub-projects catered to various sectors, namely: pulp and paper (3 sub-projects), lather and abattoir industry waste (4 sub-projects), vegetable market yard waste (3 sub-projects), municipal wastewater and sewage (2 sub-projects), biogas utilization (2 sub-projects), animal and agricultural residue (1 sub-project), and fruit and food processing waste (1 sub-project). The setting up of various sub-projects has provided a platform for the demonstration of various designs in anaerobic digestion systems and energy end-uses (on-site heat, on-site electricity and electricity fed into the state grid), including both domestically developed and imported technologies[67]:

- UASB (Up-flow Anaerobic Sludge Blanket technology)
- Continuous Stirred Tank Reactor (CSTR)
- Hybrid Up-flow Sludge Media Anaerobic Reactor (HUSMAR)
- BIMA Technology (Biogas Induced Mixing Arrangement)
- Indigenously developed UASB and Fixed Film Technologies
- Indigenously developed biomethanation technology for chrome shavings, H_2S removal system for biogas purification, and gas engines for utilization of biogas for generation of power.

In terms of financial viability, some sub-projects have proven to be commercially viable, while others were not feasible without the 50% capital cost subsidy[68].

[67] Terminal Evaluation report (pg. 12)
[68] Terminal Evaluation report (pg. iv)

By the end of the project, various domestic consultants and technology providers had appeared in India. These technologies started gaining traction in the Indian market and with wide scale adoption, costs began to fall. Inspired by the successful implementation of the demonstrated technologies in the project, several similar projects were being installed across India. As a result, technologies like UASB and BIMA are now being widely used.

MNRE, which had the responsibility to promote renewable energy in the country, also has the responsibility to develop the WTE sector. It was therefore responsible for policy promotion and designing and operating subsidy schemes in the sector. The MNRE WTE program received a boost from the UNDP-GEF project. Following the UNDP-GEF project, the MNRE initiated its own programs on energy recovery from waste. Under these programs the ministry has assisted 14 projects with subsidies of US$ 2.72 million, and two further projects are currently in the pipeline with subsidies totaling US$ 0.48 million.

► **Institutional capacity enhancement at various levels**

The UNDP-GEF project has given several benefits to the MNRE, an important one being building capacity of its officials in technology evaluation, selection, and project promotion. Technical skills and management expertise were developed in the key stakeholders of the project to enable them to pursue investments in advancement of biomethanation processes. The project has promoted cooperation and networking between national laboratories and institutions on the development, modification and standardization of cost effective WTE technologies. Also, suppliers of indigenously developed technologies, foreign technology suppliers and consultancy organizations have developed ties with counterpart Indian engineering or consultancy companies as a result of the project.

By the time of project completion, the technical institutes and nodal agencies were supporting the market with the active participation of IREDA. IREDA, for example, developed flexible financial packages for the entrepreneurs and associations undertaking such projects.

► **Information dissemination**

Promotional programs were developed to increase the interest in biomethanation processes among national, municipal, industrial, and agricultural groups. Some 46 business meetings and workshops were organized with stakeholders from the different waste generating sectors. 9 national training programs were conducted with 71 professionals trained through 12 fellowship programs and 15 study tours organized for 43 government officials from various bodies. The project has facilitated interaction between project developers (municipalities and industry), technology institutions, national laboratories and state nodal energy agencies. A quarterly newsletter, "Bio-Energy News", was also brought out under the aegis of the GEF project[69].

The 16 sub-projects covered under the project had an installed biogas generation capacity of 60,000 m^3/day and the end-usage of the gas varied from electricity generation – 3,749 kW from 8 sub-projects, which includes grid-connected and captive power generation – cooking fuel, lime kiln heat, steam

[69] Terminal Evaluation report (pg. iv)

generation and boiler fuel. According to the terminal evaluation report, GHG emission reductions from the 16 sub-projects implemented in various industries totaled 236,384 tons CO_2 equivalent per annum.

Achievements following project completion

After project completion, due to increase in private sector participation and in initiatives of the government at state and national levels; further growth of the biomethanation sector seems to be ensured. As of November 2012, capacity installed from waste-to-energy projects running across the country for grid connected and captive power are 93.68 MW and 110.74 MW respectively.

Several technology development efforts are noticeable. Domestic technology providers, like Cummins India, have developed their own gas engine for biogas utilization. IIT Roorkee has developed a biomethanation technology to generate biogas from the distillery effluents. Similarly, TERI has developed TERI's Enhanced Acidification and Methanation (TEAM) process for biomethanation, and has successfully put it into practice at Sona Steering, Gurgaon and NTPC, Faridabad.

Several instances of replication of the promoted technology can be seen, such as: the 1.0 and 1.2 MW Cattle manure based biogas projects at Ludhiana, Punjab and Jabalpur, Madhya Pradesh; the 1.5 and 2.5 MW biogas projects based on poultry droppings in Tamil Nadu; two projects of 4.0 MW each, utilizing agricultural wastes and residues in Punjab, are under installation; a project generating 1.5 MW from food processing and sugar industry solid waste; four biogas projects using bagasse / straw wash-water in paper mills; and around 20 projects generating heat and/or power from starch industry effluents. A Biomethanation plant in Lucknow, using BIMA technology, of 5.0 MW design capacity has also been installed.

Various government and private agencies involved in the project have gained experience and technical know-how about the various technologies and now are capable of supporting similar projects. The National Master Plan developed as a part of the project has been helpful in the implementation and further replication of the biomethanation technologies. There has been capacity development in the technical institutes like CLRI, IISC, and NEERI who are now engaged in further research in this field and also providing their expertise in similar projects. MNRE is offering a wide variety of incentives, including: feed-in tariffs; generation-based incentives; renewable purchase obligations (RPOs); accelerated depreciation; and tax incentives. The other financial institutions such as HUDCO, IDFC, IDBI and several nationalized banks are also providing loans for such projects. These institutions provide up to 70-75% of the total project cost at an interest rate of 11-13%. Finance for these projects is available mainly through commercial credit.

The technical institutes strengthened as a result of the project were not fully effective at the time of project completion but are now actively engaged in the promotion of various biomethanation technologies. Research activities are being conducted in these institutes aimed at the development of advanced biomethanation technologies. Nodal agencies like PEDA, TEDA are playing the role of facilitator for such projects. Other financial institutions such as the Housing and Urban Development Corporation

(HUDCO), Infrastructure Development Finance Corporation (IDFC), Industrial Development Bank of India (IDBI) and several nationalized banks are also providing loans for such projects.

The technologies demonstrated by the 16 sub-projects covered under the project have seen wide scale replication throughout the country. India, at present, has an installed capacity of 201.03 MW within WTE projects[70] and the 50% of this is attributed to the GEF project. For the estimation of GHG emission reductions as an indirect influence of the project, the following assumptions have been made

- To estimate current GHG benefits, the installed capacity of 201.03 MW of WTE projects has been taken.
- As per CERC guidelines, the plant load factor has been taken as 0.9, and 12% has been taken as the power used for auxiliary purposes.[71]
- A Grid emission factor has been taken as 0.79.[72]
- The Contribution of the GEF project and government interventions have been factors in the promotion of WTE processes, and their contribution can be considered to be equal.

For the current scenario, the indirect GHG emission reduction as a result of the project has been estimated to be 550,921 tons of CO_2 equivalent per annum, whereas, at the project completion stage the direct GHG emissions reduction from the 16 sub-projects was calculated to be 236,384 tons CO_2 per annum.

Factors that have affected progress

The high cost of the technology and lack of adequate funding structures were hindrances to the development and growth of biomethanation processes. The economic feasibility and profitability of biomethanation projects were demonstrated by the implemented sub-projects. Thereafter, the government decided to promote projects for power generation from the combustion of Refuse Derived Fuel (RDF) which is produced from Municipal Solid Wastes (MSW). Such projects were to be implemented through public private partnerships (PPP) by municipal corporations, government institutions and private developers. The state nodal agencies, municipal corporations or organizations such as IL&FS, IREDA, HUDCO, TCOs, carried out the project development and bidding in fast track mode through a transparent tendering process. Now, several financial institutions like HUDCO, IDFC, IDBI and other commercial banks have come forward to provide loans to such projects at concessional rates. However, the financial market has still not been sufficiently developed for the support of the biomethanation sector. There is a need for more encouragement for financial support to project entrepreneurs in the sector.

IREDA was chosen as the financial institution for allocating project funds. Aside from this, IREDA played a catalytic role in the encouragement of private sector. At project inception, IREDA was the only financial institution available to fund such projects. It has effectively used technical assistance not only to strengthen its own capabilities, but also to develop the sector as a whole and to reach out to rural and disadvantaged communities. IREDA issued their audited annual financial statements in a timely fashion

[70] MNRE Achievements www.mnre.gov.in/mission-and-vision-2/achievements/
[71] CERC guidelines, Annexure 8A, http://cercind.gov.in/2012/orders/RE_35_2012.pdf
[72] CO_2 Baseline Database for the Indian Power Sector, http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver7.pdf

and prepared comprehensive quarterly progress reports to aid project supervision. IREDA was proactive in engaging the Bank in discussions on introducing new procurement methods that could be more effective under the private sector driven approach of the project. These discussions eventually resulted in modifications being made to the legal agreement that had been constraining achievement of the project objectives.

Local Bodies, such as PEDA and TEDA, played the role of mediator between the government and the private sector actors. These nodal agencies signed an Implementation Agreement (IA) with the private actors. These bodies provided assistance to the companies and helped them to get clearances from various agencies. To date, they remain actively involved in the process of technology facilitation.

At project inception, there were no proven biomethanation technologies to deal with various substrates, nor were there enough consultants or technological capacity to promote high-rate biomethanation process. This barrier has been largely overcome by the project. The sub-projects have successfully demonstrated a number of new technologies for treating different kinds of substrates, such as UASB, CSTR and BIMA technologies. The project has promoted cooperation and networking between national laboratories and institutions on the development, modification and standardization of cost effective WTE technologies. As a result of the project, suppliers of domestically developed technologies, foreign technology suppliers and consultancy organizations have developed ties with their Indian counterparts, i.e. Indian engineering or consultancy companies. After project completion, one of the challenges was that most of the technologies used in the sub-projects had been imported from outside and it was therefore difficult to find spare parts and the required technical skills for the maintenance of the equipment. Now, with more government focus on the biomethanation the situation is continuously progressing.

7.5 Progress to impact

The project has played an important role in the introduction of the biomethanation technologies in India. The sub-projects covered under this project have successfully demonstrated the biomethanation technologies in various sectors, including: pulp and paper; municipal waste water/sewage; leather and abattoir; food processing; vegetable waste and animal waste. The technology packages developed have seen replication across the country. UASB (Up-flow Anaerobic Sludge Blanket) technology promoted by the project has become widely popular for the generation of biogas from distillery effluents and about 150 such units have been installed.

In spite of the market transformation witnessed by the success of the project, there still exist some challenges for wider replication of the project. For a fuller development of the renewable energy market in India, power sector reforms and good governance are essential. Tariff rationalization, adoption of appropriate performance efficiency benchmarks, and the opening up of the distribution sector to service providers other than the SEBs will enable the cost-effective renewable energy systems to compete in the power market. Incorporation of renewable energy development in reform planning and ex-ante analyses of the value-added or otherwise of such a program will enable champions of renewable energy to have a place at the table in the sector reform dialogue. Currently, multiple agencies – including MNRE, Ministry

of Power, Ministry of Environment and Forests, Ministry of Rural Development, as well as corresponding agencies in each state – oversee overlapping and uncoordinated aspects in the approval and implementation of renewable energy projects. The Government of India has taken important steps in addressing some of these complexities and barriers.

7.6 Lessons learned

- Technology transfer projects require extensive consultations with government, private sector, beneficiaries and other stakeholders. Detailed discussion with the participating institutions and cooperating partners is necessary early in the process, in order to create ownership of the project. Their readiness to adapt to the new technologies would ensure replication of experiences gained from the project. Therefore, institutional networking with well-defined roles for different organizations is highly beneficial for implementing multi-activity projects.
- More focus is required on indigenous capacity building in terms on technology providers. Major problems with imported equipment observed were non-availability of spares and skilled labor for maintenance of this equipment For example, there was a two-week shutdown at the Haebowal Dairy plant in Ludhiana due to failure of the turbocharger.
- Continuous study of the process is necessary for improvements in the plant e.g. improving the methane content of the biogas. The technology provider must therefore be engaged for a longer period, along with the operator responsible for operation and maintenance. Provisions for this arrangement may be included in later projects.

7.7 Follow up actions

The cost of biomethanation technologies is coming down. This is especially true for domestically developed technologies that work at lower capacities of 30-50 tons of biodegradable waste per day. The power or gas generated at this scale is not very high and is suitable for smaller-scale users. MNES may promote such arrangements, as they are taking shape in various states in the WTE sector.

Neoprene gas holders are also becoming available in India. These developments will bring down the cost per MW or m^3 of gas of the biomethanation plants. The indigenization of various components/ equipment for low capacity (100-500 kW) storage balloons made of neoprene is taking also place. The MNES may take the direction from the NMP and promote this as a package nationwide. [73]

In order to realize the huge business opportunities offered by biomethanation under CDM, it is necessary to expose the stakeholders to developments in the global climate change arena Furthermore, they should be imparted with the methods to develop biomethanation projects that could qualify under the CDM and avail advantages taken form additional financial streams in the form of CDM carbon credits. [74]

It is further recommended that such a study is disseminated through newsletters, international conferences, national workshops organized per sector or per target group (large industry, small industry,

[73] Terminal Evaluation report (pg. 16)
[74] Terminal Evaluation report (pg. 35)

municipalities) and by means of involving sectoral bodies (e.g. National Dairy Board, APMC, industry associations) in the dissemination of information on investment opportunities in waste-to-energy activities.

Steps also need to be taken to address nonfinancial barriers that increase the cost of doing business. Like information technology and telecommunications, clean technology and renewable energy have enormous growth potential and can transform the trillion dollar energy markets across the world. To realize this potential, India needs to streamline bureaucratic processes for clearance and approvals through the use of 'light-touch' regulation. State nodal agencies, which are supposed to play a leading role in guiding renewable energy projects through the regulatory maze, need to be strengthened. A comprehensive capacity-building program on emerging regulatory, legal, and financing issues to facilitate grid-connected renewable energy should be developed.

More similar programs are recommended to further penetrate the market, which still has significant scope for similar projects. Considering the amount of waste to be treated in over 1000 small, medium and large urban local bodies and with limited resources, a menu of technology options including some non-energy options like composting is required. Such technologies could be introduced through follow-up projects to further strengthen the WTE drive in India.

8. Optimizing Development of Small Hydel Resources in Hilly Areas *[GEF ID 386]*

8.1 Project description

The project "Optimizing Development of Small Hydel Resources in Hilly Areas" (GEF ID 386) was designed to assist the Government of India in the optimum utilization of small hydroelectric (hydel) resources in the Himalayan and sub-Himalayan regions. The implementing agency was UNDP and the partners were the Ministry of Non-conventional Energy Sources (now MNRE), the Department of Economic Affairs, and the Ministry of Finance.

The total project cost was US$ 14.6 million with a GEF grant of US$ 7.5 million and co-financing of US$ 7.14 million. The project's implementation commenced in January 1995 (as per its terminal evaluation report) and was completed in January, 2004.

The project's expected outcomes were consistent with OP#6 strategies – *removal of barriers to cost-effective renewable energy technologies* – and primarily targeted energy supply in the GHG producing sectors of the economy and adopted renewable, Hydel Energy (Small Hydel Power), strategies for Climate Change Mitigation (CCM). The project promoted CCM technology demonstration and technology deployment.

8.2 Project objectives and design

Long term objectives

The long term objectives[75] of the project were:

- To reduce global warming though the use of renewable, perennial, non-fossil-fuel energy sources, namely small hydroelectric energy sources
- To protect biodiversity in the Himalayan and sub-Himalayan regions by reducing deforestation.
- To create enhanced economic opportunities locally through the availability of electricity generated by the small hydel projects, thereby reducing migration from these remote areas to urban centres.

Theory of change and causal mechanisms

It was anticipated that small hydel power will emerge as a viable and cost-effective energy option through a multi-dimensional and systematic approach and that the projects would provide electricity to the remote and hilly areas on a stand-alone basis, reduce deforestation, and preserve the ecology and environment of the region[76].

The project focused on three strategies – institutional strengthening, demonstration and replication & mainstreaming – to achieve the intended impacts. It was expected to significantly transform the small

[75] Project Document (pg. 2)
[76] Project Document (pg. 3)

hydel power market to reduce global warming by using renewable, perennial, non-fossil-fuel energy source, namely small hydel power.

As part of the institutional strengthening strategy, the focus was on the formulation and implementation of sectorial promotional policies, institutional and infrastructure development, and research and development of hydel resources[77]. One of the activities was to develop a national strategy and a master plan with detailed investment proposals for the optimum utilization of small hydel resources in the Himalayan and sub-Himalayan regions and to be included in the Ninth Five Year Plan (1998-2002) with the necessary budget provisions. Another criterion was to generate interest from potential international donor agencies, and the commitment of funds for some of the projects included in the master plan. It was planned to review and assess programs and services offered by existing institutions regarding small hydel projects.

It was also envisaged to develop the necessary institutional and human resource capabilities at the local to national levels for the execution and implementation of the project, to foster sustainable development of the small hydel sector in the hilly regions[78]. Technical institutions in three different regions would be selected to support the hydel projects. AHEC would be the apex technical institution for the northern region; the Institute of Science and Technology, Itanagar, for the northeastern region; and the College of Engineering, Jammu, for the northwestern region. These institutions would provide facilities for testing, training, applied research, information, and consultancy project activities covering these regions[79]. The project would successfully establish a team of officials at the national and state levels to handle the planning, design, construction, maintenance, operation, and management of the projects. The project would also have a large number of local people, in village *panchayats* or other local bodies, trained in the management and maintenance of small hydel projects[80].

A part of demonstration and replication strategy was to develop a package of commercially viable and environmentally sound technologies based on the installation of 20 demonstration projects for the generation of hydroelectric power, and to develop appropriate models for ownership, management, and maintenance of small hydel projects through a people-centered and participatory approach. Under the project, 100 watermills in different regions were to be upgraded with new technology. For example, add-on multipurpose devices for electricity generation would act as prototypes for upgrading the remaining watermills in the regions[81]. The project was expected to lead to the adoption and replication of the demonstration projects on a wide scale throughout the hilly regions of India. This would in turn lead to a reduction in the cost of installed capacity per kilowatt, and in the cost of electricity per kilowatt hour and the increased acceptance of end-use appliances by the people. Training of villagers, especially women, in using electric appliances for cooking and heating and encouraging them to convert from fuel wood to electricity for cooking and heating would lead to reduction in environmentally unsustainable practices. The use of irrigation-based cultivation and encouraging villagers to convert from *jhoom* cultivation would also contribute to improved environmental status.

[77] Project Document (pg. 17)
[78] Project Document (pg. 31)
[79] Project Document (pg. 13)
[80] Project Document (pg. 31)
[81] Project Document (pg. 10)

An aim was to develop a strategy and action plan using a market orientated approach and with active private sector participation in order to remove barriers and provide incentives for speedy commercialization. It was likely to organize and conduct a national workshop to develop various models for the operation, maintenance, management, revenue collection, and expenditure for small hydel projects.

The replication and mainstreaming strategy of the project was designed to enhance awareness and understanding of the technologies among the promoters and end-users. It was anticipated that after a six-month evaluation period for the demonstration projects, the private sector would participate in some of them. The government was expected to establish a revolving fund with GEF assistance to provide concessional loans to private investors for procuring equipment for small hydel projects in the hilly regions. The revolving fund, the operational modalities of which were to be determined in consultation with UNDP, were to be administered by IREDA, with AHEC providing necessary technical support. The revolving fund was to be used for setting up projects up to 100 kW capacity, aggregating to 1.0 MW capacity, in clusters for the three sub-regions. The approach was to test the utility of private sector participation in harnessing the vast hydel potential in the hilly regions, which may develop into a large-scale program for utilization of these resources through private sector funding.

Key components[82]

The key components of the project were:

- **Formulation of a National Strategy and Master Plan**: Formulation of a national strategy and a master plan with detailed investment proposals for the development of small hydel power projects, with each project up to 3 MW capacity, for the Himalayan and sub-Himalayan regions
- **Establishment of 20 demonstrable stand-alone small hydel power (SHP) projects for power generation**: Establishment of 20 small hydel power (SHP) projects of total installed capacity of 5.68 MW at various sites to serve as models for replication on wider scale throughout the hilly regions of India. These projects were based on the latest available technologies modified to suit the local conditions.
- **Up-gradation of one hundred water mills**: Up-gradation of one hundred water mills in different locations with the new technology for electricity generation, to serve as prototypes for up-gradation of water mills throughout the country.
- **Institutional and human resource development**: Institutional and human resource development in the sector by strengthening IREDA, technical institutes, state nodal agencies, and government, in order to promote and develop the SHP sector.

Project design: Salient features

The project aimed to develop cost-effective packages appropriate in different topological, social and technological conditions and encourage private sector participation in SHP sector. The project intended to achieve cost reduction by optimizing and standardizing the equipment for SHP projects. The affordability of villagers to access electricity was expected to increase due to reduced cost of electricity generation from SHP projects. Provision of electric stoves and heaters at no cost to the villagers was envisaged by the

[82] As per Project Document

government to encourage a shift towards electrical domestic appliances for cooking and heating. The improved design, standardization, and mass production of these appliances were envisaged to reduce costs and enhance the affordability to villagers.

Funds were provided for agriculture pump sets at ten representative locations to encourage villagers to opt into irrigation based cultivation and abandon the more traditional *Jhoom* cultivation.

Technical institutions from three different regions were selected to support the projects; Alternate Hydro Energy Center (AHEC) for northern region, the Institute of Science and Technology, Itanagar for north-eastern region; and the College of Engineering, Jammu for the north-western region. These institutions provided facilities for testing, training, applied research, information, and consultancy services.

The MNES, the implementing agency, appointed a National Project Director who was assisted by a National Project Coordinator. A Project Implementation Committee (PIC) was set up with the Secretary, MNSE as its Chairperson and the National Project Director as its Member Secretary. The Committee consisted of representatives from government departments such as the Department of Science & Technology (DST), the Ministry of Environment & Forests (MOEF), the Central Electricity Authority (CEA), the Planning Commission, the Department of Economic Affairs (DEA), Non-governmental Organizations (NGOs), Indian Renewable Energy Development Agency (IREDA), Alternate Hydro Energy Center (AHEC) and private enterprises. The PIC monitored the project activities and provided directions and guidance for project implementation. While IREDA managed the financial aspects of the project and administered the revolving fund, AHEC extended technical support to MNES.

The demonstration of SHP projects and the up-gradation of water mills were carried out by the state nodal agencies under the guidance of the National Project Director.

Project design assumptions

The key assumptions made while designing the project were as follows:

- Small hydropower projects would provide renewable, perennial, and non-fossil fuel based energy in the hilly regions
- Energy produced through the projects can meet local needs for lighting, heating, cooking, agricultural and commercial needs
- Local people would switch over from fuel wood to electricity for cooking and heating, and accept low-wattage appliances
- The projects would help reducing carbon emissions, and preventing deforestation in ecologically fragile areas in Himalayan and sub-Himalayan regions
- The projects would contribute to sustainable human development by creating local employment opportunities
- The projects would generate sufficient interest and confidence in the private sector and the State Government(s) to set up more SHP projects
- The MNES and State Government(s) would consider decentralized SHP projects as one of the options for electrification of remote and isolated villages

8.3 Project Execution

Delivery of project components

It is evident that the implementation target set out during the project design stage has been largely achieved, and upgraded watermills have exceeded the target.

- **Renewable Energy (SHP)**: 20 SHPs with a total installed capacity of 5.68 MW were installed in the high lands of Himalayas and Sub-Himalayas area: Himachal Pradesh (3.5 MW), Uttarakhand (1.2 MW) and others states (980 KW). Thus, the project target of 20 SHPs was met.

- **Water mills**: Under the project, 143 water mills were upgraded for electricity generation and multi-purpose devices were installed for 24-hour operation. The demonstration of these water mills inspired the government to take on a full-fledged program to promote water mills. Thus, the project target of up-gradation of 100 water mills was exceeded.

Challenges faced during implementation

The project was highly successful in promoting small hydel power projects in hilly states of Himachal Pradesh and Uttarakhand but the performance in other hilly states was not at par with these states. While States such as Himachal Pradesh and Uttarakhand, located in the Western Himalayas and with geographical proximity to Delhi, demonstrated a fairly high degree of commitment, others that are located in the Eastern and North Eastern Himalayas showed lower levels of commitment. Although, among the Eastern and North Eastern states, West Bengal and Assam do come across as partial exceptions as the project received greater commitment from the governments in these states. This varying commitment may have been conditioned by the relatively greater access and interaction with the Central Executing Agency as well as the locational and logistic support received by some of them from the only Technical Institution namely the AHEC, Roorkee that was located closer to these two States. Moreover, the State Nodal Agencies (SNAs) in the more committed States were also relatively more developed and supported by the respective State Governments as compared to others. Due to these reasons, the project generally failed to make a significant impact in most of the Eastern and North Eastern States, though most of these are substantially endowed with small hydel potential.

It was observed that even though the Project Management Cell did establish mechanisms for monitoring and reporting with the various field level agencies actively engaged in the implementation of the project, they did seem to have faced several difficulties in obtaining timely and relevant information and feedback from these various sources. This was mainly on account of the absence of a state level Project Coordinator who could be made clearly responsible and empowered with adequate powers and facilities for providing this information to the NPC.

The training component and related inputs of the project were of fairly high quality. Several training fellowships and national training programs and workshops were organized although some weaknesses in targeting were also noted. The low levels of deliberation in the identification of persons to be trained may have affected the end results of the activity. Moreover, while training inputs were substantial for those posted in senior positions in the implementing agencies more training inputs could have been provided to those at the middle and lower levels who would ultimately operate and maintain the sub projects.

The electro-mechanical and control equipment finally procured for the demonstration sub-projects was observed to be lacking in several respects. The problems of frequent breakdown and the non-availability of spares and replacements was significant at the sub-project level, discussed later. It may be mentioned that equipment-related problems have been more frequent in the case of larger sub-projects in the capacity range of 400 KW to 1 MW.

One of the major challenges faced in the project was involvement of local communities and people's participation in setting-up small hydel power projects. While all efforts have been made to involve local people in the construction of SHP demonstration projects, the financial contribution from local communities could not become feasible. However, the local communities were keen to get involved in the operation and maintenance of the projects. In the water mill activity, the local beneficiaries were able to contribute towards civil works to set up the water mills.

8.4 Outcomes and impacts

Achievements till project completion stage

The project targeted SHP development in Himalayan and sub-Himalayan States and successfully commissioned 20 SHP projects aggregating to 5.68 MW. The project also supported development of 143 water mills, as compared to the target of 100. The project served as a demonstration of the technical and economic feasibility of new technologies and this has paved the way for replication of projects by private developers. .

- **Policy, legal & regulatory frameworks:** The National Strategy and Master Plan developed in the project formed the basis of the national strategy to achieve the capacity addition target of 130 MW during the Ninth Five Year Plan (1998–2002). The Government of India enacted a number of policies and incentives including feed-in tariffs; generation-based incentives; renewable purchase obligations (RPOs); central, state, and regional capital subsidies; accelerated depreciation; and tax incentives coupled with the village/ rural electrification targets, and annual and Five-year Plan targets for installed capacity of SHP power projects. 15 States in India – namely, Himachal Pradesh, Uttar Pradesh, Uttaranchal, Punjab, Haryana, Madhya Pradesh, Chhattisgarh, Karnataka, Kerala, Andhra Pradesh, Tamil Nadu, Orissa, West Bengal, Maharashtra and Rajasthan – announced policies for setting up of commercial SHP projects through private sector participation.

- **Technology advancement:** AHEC, Roorkee one of the three institutions selected from the three regions developed and patented the designs for water mills. Participation of local people in the ownership, management and maintenance including collection of revenue and expenditure was encouraged. Over a hundred technology providers and turbine manufacturers have since appeared in India, highlighting the enhanced interest in the sector.

  The project successfully created and enhanced capabilities and facilities for testing, training and applied research at AHEC. The project also encompassed the training of a core team of personnel from MNES, IREDA, AHEC, State agencies, private actors, NGOs, and manufacturers for skills and knowledge support. The revolving fund of USD 1.4 million was created at IREDA to assist private sector participation. The fund was used effectively to promote the development of the sub-projects, from which up to 2004 USD 0.4 million had been used to leverage private sector participation. As a result, apart from state nodal agencies, 6 private players – A Power Himalayas, Indu Sree Power,

Sycotta Tea Estate, Bio Tea Estate, MKB Private Limited, ASTEC and an NGO named Sai Engineering Foundation – had setup their small hydel plants.

The technologies for small hydel power generation were not proven and not established at the time of project inception. The project was successful in demonstrating the state of the art technologies and sub-systems like Coanda screen intake structures, SCADA (Supervisory Control and Data Acquisition) system for automatic control and monitoring, and load diverters, by replacing mechanical and other conventional equipment in small size projects. This generated interest among many private developers. The designs of water turbines and water mills developed and used in the demonstration projects were replicated by many project developers. Another GEF project, "Alternate Energy", implemented during 1994-2001 also contributed to overcoming barriers at the national level.

The project strengthened the capacities of IREDA, State nodal agencies, technical institutes, and commercial banks in technical expertise and project management in the SHP sector. The revolving fund created at IREDA was made available to the private sector and NGOs to implement SHP projects. During the project period, IREDA financed SHP projects with an additional 155 MW capacity from other resources, including domestic market borrowings.

The project developed the domestic market of small hydro equipment and promoted growth of local manufacturers and consultants. By 2001, 16 small hydro equipment manufacturers, including international joint ventures (compared to 10 inactive firms in 1991) were operational in India.

- **Implementing mechanisms & bodies:** The project helped strengthening the capacity of IREDA, state nodal agencies, technical institutes, and commercial banks in technical expertise and project management in SHP domain. AHEC emerged as the National Resource Centre for small hydel development. The project helped in enhancing IREDA's technical, financial, and institutional capabilities to evaluate and finance SHP projects. With the successful demonstration of the projects, other financial institutions and commercial banks also began providing loans for SHP projects.

  The Ministry stepped up its efforts to closely interact with the States and emphasized the need to establish a method of regular project-based monitoring. The Ministry had set up a working group under the Chairmanship of the Adviser (SHP) of MNRE and drawing members from the Central Electricity Authority, Ministry of Power, Central Water Commission and States like Karnataka, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, and Meghalaya for reassessment of the available SHP potential in the country.

- **Removal of barriers:** At the inception of the project, lack of financing for SHP projects was a major barrier as banks and financial institutions felt it was a high risk sector. The success of the projects financed by IREDA led to national level financial institutions, commercial banks, and cooperative banks coming forward to provide lending and this resulted in the development of a robust financing network in the country. On the other hand, State nodal agencies like Himachal Pradesh Energy Development Agency (HIMURJA) provided the much needed technical guidance to private developers and helped overcoming the problems related to clearances and lack of technical capabilities. The project led to replication of projects by private developers across the country. Technology was a big barrier at the inception of the project but successful demonstration of the technologies led to increase in technology suppliers.

- **Skills building:** Specialized training was provided to technical officers and personnel drawn from various State nodal agencies and NGOs for small hydro development. Extensive training for small hydro development in areas such as preparation of DPRs, surveys and investigation, identification of sites and water mill development, was undertaken. 59 officials from the Central and State governments, and private players and NGOs attended the fellowship programs held abroad. 160 Technical Officers and other personnel drawn from various state nodal agencies, NGOs and local bodies like HIMURJA, Uttarakhand Renewable Energy Development Agency (UREDA), etc. were trained under National Orientation Programs up until December, 2003.

- **Information sharing & access:** Master Plans, a database of potential SHP sites, and the software developed had facilitated the setting up of SHP projects in other non-participating states. HIMURJA in association with AHEC developed the zonal plan using HydrA Software to assess the parameters of each potential site. HIMURJA offered over 400 SHP sites to the private sector for development of SHP projects. North Eastern Electric Power Corporation Limited (NEEPCO) extensively used zonal plan database for short listing potential sites for village electrification in North-Eastern States. Computer modeling and the GIS database for potential SHP sites were used extensively by States for identifying and allocating sites for the implementation of SHP projects.

- **Replication and mainstreaming:** The technologies were demonstrated successfully, paving the way forward for replication of projects and supporting services for SHP and water mills. Efforts were made for enhancing awareness and understanding of the technologies among the promoters and end-users. Also, the project led to the provision of funds by donor agencies for replication of these projects. The Master plan and zonal plans prepared under the project assisted in preparing the national strategy for development of the SHP sector. The MNES played a proactive role in encouraging states to develop their own policies. As a result, state governments came up with policies with financial incentives and other promotional packages such as help in land acquisition, getting clearances etc. These profitable demonstrated projects attracted private sector and NGOs to setup similar projects, expand modern energy services to under-served rural communities, and supported local and global environmental improvements. To attract more investors, some states supplemented the incentives offered at the national level, with generous state-specific incentive packages, including deferral of tax payments. The result was that the incentives provided higher financial gains for investors. Commercial banks came forward to lend for such projects and adjusted the rate of interest on such loans to attract the investors. This played a major role in the spread of the promoted technologies in the Himalayan and sub-Himalayan regions.

The estimated direct GHG emission reduction from the sub-projects - 5.28 MW installed under the project – was 1,887.3 tons CO_2 equivalent per annum at the time of project completion. Indirect GHG emissions reduction due to GEF's influence was 4.02 million tons CO_2 equivalent per annum, as of December 2012.

Key assumptions made to assess the CO_2 reduction at the project completion stage are:

- Plant Load Factor (PLF) is 40%
- 12 sub-projects (out of 20) were considered to save fuel wood and 6 sub-projects were considered to save diesel
- Half of the electricity generated is utilized for cooking and heating applications and replaces fuel wood
- One unit of electricity replaces 0.54 kg of fuel wood
- One litre of diesel replaced saves 2.73 kg of CO_2.

Achievements at post project completion stage

After project completion (January 2004), the national strategy and master plan were already developed and 15 State governments had announced polices for the setting up of commercial SHP projects through private sector participation. The completion of the project saw AHEC emerge as the National Resource Centre for small hydel development. As such, it provided technical support to and enhanced IREDA's technical, financial, and institutional capabilities to evaluate and finance SHP projects in the future. The demonstrated new SHP technologies generated confidence and experience among various stakeholders and the government had taken proactive steps to promote power generation through SHP systems. The Government allocated Rs. 53.15 million for the SHP program during the Eleventh Five Year Plan (2007-2012) and Rs. 16,000 million is expected to be spent during the Twelve Five Year Plan (2012-2017) for installation of 2,100 MW in SHP capacity. About 3,000 MW during the Thirteenth Five Year Plan period are planned which would take the total installed capacity from SHP Projects to around 8,500 MW (about 60% of the existing potential) in the year 2021-22.

IREDA, now a leading financial institution, has financed SHP projects to the tune of US$ 31 million as of 2011-12. The nodal agencies and technical institutes are actively involved in promotion of SHP technology all over the country. The agencies and institutes such as HIMURJA, UREDA, WBREDA and AHEC had gained knowledge and enhanced their capacities to implement SHP projects. The small hydro design, engineering and construction capacity has improved. About 65 percent of the small hydro electromechanical equipment is sourced locally. There has been a positive impact observed on the local communities around the projects. With access to electricity, people are getting more job opportunities, technical exposure, and access to education and are moving towards better standard of life.

In Himachal Pradesh, 497 private projects with a total capacity of 1,280 MW and 10 government projects with a total capacity of 2.80 MW have been allotted for implementation. Out of these, 45 projects with an aggregate capacity of 177.55 MW have been commissioned. A goal of 1,000 MW through Small Hydel Projects in Himachal Pradesh by the end of Twelve Five Year plan has been set. In Uttarakhand, with a potential of 1,600 MW, small hydro projects of about 135 MW have so far been set up. The State has allotted 36 projects aggregating to around 370 MW to the private sector. It is expected that projects with a combined capacity of 500 MW will be completed by the end of Twelve Five Year Plan. Similarly, the southern states of Tamil Nadu, Kerala, Karnataka and Andhra Pradesh have also increasedtheir SHP capacity substantially. At present, around 2,000 water mills are being run across the country.

The GHG emission reduction as an indirect result of the project has been re-estimated (See table) considering add-on SHP gird-connected capacity in hilly and non-hilly states after project completion. The GEF contribution is assumed to be 0.8 and 0.4 for hilly and non-hilly states. The earlier assumption regarding the replacement of fuel wood with generated electricity was not accounted for as all the SHP projects were grid-connected. Assumptions made for assessing indirect GHG reduction during re-evaluation (during December 2012) are:

- Installed SHP grid-connected capacity in the hilly and non-hilly states is 933.38 MW and 2109.54 MW (as on March 2011) respectively.
- SHP capacity installed under this project (5.68 MW) is deducted from the total hilly states SHP capacity and the net SHP capacity comes to be 927.7 MW.

- Capacity Utilization Factor (CUF) for hilly and non-hilly states is 0.45 and 0.3 respectively and auxiliary power consumption of 1% is considered as per the CERC guidelines.[83]
- Grid emission factor is taken as 0.79 (as per the CEA guidelines[84]).
- GEF contribution to the SHP is substantial in transforming the SHP market in hilly and non-hilly states and favourable market conditions have also favoured the same. Hence, GEF contribution is assumed to be 0.8 and 0.4 for hilly and non-hilly states respectively.
- As the SHP capacity is grid-connected, a grid emission factor is taken into account and the replacement of conventional sources of energy is not considered.

Project	Capacity MW (March 2011)	CUF	Units (MWh)	Auxiliary Consumption (%)	Net Units	Grid Emission factor (t CO_2/ MWh)	GHG emission (t CO_2 p.a.)	GEF Contribution	GEF reduction (t CO_2 p.a.)
Hilly	927.70*	0.45	3,656,993	1	3,620,423	0.79	2,860,134	0.8	2,288,107
Non-Hilly	2109.54	0.30	5,543,871	1	5,488,432	0.79	4,335,861	0.4	1,734,344
Total	**3042.24**		**9,200,864**		**9,108,855**		**7,195,995**		**4,022,451**

** SHP capacity installed under this project 5.68 MW is deducted from 933.38 MW.*

The mechanism for the continuation of such activities is in place and significant progress to impact can be observed easily.

Factors that affected progress

The active involvement and development of the three national technical institutions for capacity building, testing, research and consultancy was vital for the success and sustainability of the project. However, AHEC was the only institute which actively participated in the project and non-participation of other institutes was a major drawback for the project, which constrained the development of SHP sector in other participating States and slowed down the pace of project implementation. The two other Technical Institutes that were involved were the Institute of Science & Technology, Itanagar and the College of Engineering, Jammu. They were initially involved for testing, training, applied research and consultancy for north-eastern and north-western regions respectively[85] but soon lost interest; as a consequence, they were not able to proceed as envisaged.

The stakeholders who participated actively in the project were the state nodal agencies, the State power utilities, institutions such as AHEC, a few NGOs and some private developers. However, the local population and their representative organizations particularly women, for whom a major stakeholder role had been visualized and articulated in the project document were hardly involved in the management or monitoring of the projects and therefore never developed a sense of ownership or involvement in the projects. This non-involvement of the local population was a setback for the timely and effective implementation of the project and ultimately diluted the impact of the project.

[83] http://cercind.gov.in/2012/orders/RE_35_2012.pdf Page 36
[84] http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver7.pdf
[85] Project Document

8.5 Progress to impact

The project resulted in the development of an enabling environment for the promotion of the SHP. The existing enablers to the growth of the sector are; increase in efforts from the government both at national and state level, increase in technology access to the people, increase in capacity of nodal agencies, technical institutes, IREDA and other stakeholders in managing such projects, increase in financial support from banking and non-banking financial institutions and increase in private participation.

In future, involvement of local people in the construction, operation and maintenance of the SHP projects would lead to job creation and income generation at local level, which was not feasible under this project. With increase in the local production capacity of the SHP equipment, the cost is deemed to decrease and will further attract the local people to take up such projects. In the water mill activity the local beneficiaries are able to contribute towards civil works to set up the water mills.

Many barriers to market transformation were overcome by this project. But still, a few barriers remain that need to be addressed for further growth of the sector.

- **Problems in land acquisition**: The Majority of these projects lie in mountainous regions deep inside the restricted land area. The acquisition of such land from authorities and use of forest land for non-forest interests is still difficult.
- **Adequate power evacuation infrastructure and grid connectivity:** It is one of the biggest obstacles to harnessing SHP potential. Most economically attractive small hydropower potential remains untapped because of lack of adequate grid evacuation facilities and approach roads.
- **Lack of coordination among stakeholders:** The commissioning of SHP projects and their successful running involves a lot of stakeholders such as developers, technology providers, financial institutions, state electricity boards, local bodies and governmental bodies. Coordination among these stakeholders is essential for the proper management of the projects. The closing-down of the Daragaon project was as a result of lack of coordination among the stakeholders. For the same reasons, many potential projects in Himachal Pradesh and other regions lie untapped.

8.6 Lessons learned

- The lack of adequate transmission and distribution infrastructure in the target areas was a major problem for the development of SHP projects. Adequate financial provisions must be earmarked so that the State Electricity Boards are enabled to actively participate in the small hydel initiatives in future.
- A project of this nature, which involves a multiplicity of inputs from and concurrence and coordination of several agencies requires a lot of management attention during preparation and implementation.
- Training support should be available until the project is completed to enable fine-tuning. Greater emphasis on hands on or shop floor training and apprenticeships are vital for building capacities at the operational level.
- The National Project Coordinator also held the post of Director (SHP) in MNES, which helped to draw government attention to SHP. Thus, involvement of institutions and key persons in projects helps in mainstreaming project activities.

8.7 Follow up actions

The stakeholders may take up the following actions to enhance further progress to impacts:

The government needs to **dovetail and coordinate SHP projects** with other development activities in the area. By combining programs – such as those related to employment, entrepreneurship development, water supply and sanitation, village infrastructural asset creation, horticulture and minor irrigation – with such hydro projects, the impact on the ground and for the targeted beneficiaries can be substantial in terms of achieving the employment, livelihood and regional development objectives of the project.[86]

Efforts are required to develop the technical institutions in the Eastern and North Eastern regions so that the vast small hydro potential there can be effectively exploited with greater participation by private developers and others.

There is need for **inter-institutional coordination** to promote the small hydel power projects. It is imperative to have a smooth and speedy communication between ministry, state governments, nodal agencies and developers so that the policies and incentives given by various bodies can be fully utilized and hence contribute to SHP development. The government must, therefore, formulate a comprehensive policy for the development of the SHP sector, encompassing all the key aspects and promoting cooperation among various agencies and bodies. The policy should be prepared in consultation with the State Governments.

The availability of evacuation infrastructure and grid integration is essential for the development of small hydel power projects. The development of evacuation infrastructure and provision for connectivity to the grid for SHP sources is considered the responsibility of the transmission utility. However, the distribution licensees also have a major role to play in evacuation of SHP generation, as many SHP sources are often connected at distribution voltages. There is a much stronger need for co-ordination and consultation between the state electricity boards, state transmission units and the nodal agency responsible for development of Renewable Energy at the state level for the development of transmission infrastructure for SHP projects that are in the process of being allotted for development or are likely to be bid out in the near future.

[86] Terminal Evaluation Report

9. Coal Bed Methane Recovery and Commercial Utilization *[GEF ID 325]*

9.1 Project description

The "Coal Bed Methane Recovery and Commercial Utilization" Project (GEF ID 325) was a GEF project implemented by UNDP. The project was approved under Operational Program 7 – *Reducing the long-term costs of Low Greenhouse Gas Emitting Energy Technologies* – of the GEF Climate Change Mitigation Focal Area. There was an approved budget of US$ 19.04 million[87], including a GEF grant of US$ 9.20 million and co-financing contributions of US$ 9.84 million. The project commenced in June 1998 and was completed in December 2008. The project was executed by the Ministry of Coal (MoC). The Central Mine Planning & Design Institute (CMPDI), a subsidiary of Coal India Limited (CIL), and Bharat Coking Coal Limited (BCCL), another subsidiary of CIL, were responsible for executing specific project activities.

9.2 Project objectives and design

Long term objectives

The global environmental objective[88] of the project was '*to reduce methane (CH_4) emissions by beginning the process of capturing methane gas from being released into the atmosphere at various stages of mining activities*'. The development objectives[89] of the project were:

- To reduce the potential adverse social, environmental and economic consequences of global climate change;
- To improve the health and safety of underground miners who are required to mine coal from gassy coal deposits;
- To improve the local and regional environment by introducing technology to recover and use an otherwise wasted clean energy source that is presently being vented to the atmosphere; and
- To promote the development of indigenous enterprises engaged in recovery, transportation, conversion, and use of coal mine associated coal bed methane.

Theory of change and causal mechanisms

The project intended to demonstrate the economic viability of harnessing coal bed methane in the Indian coal mining sector[90]. In order to achieve this goal, the project focused on three strategies – capacity building; establishing techno-economic feasibility of the promoted

[87] Project Document
[88] Project Document
[89] Project Document
[90] Proposal for Review, UNDP

technologies; and promoting broader adoption through replication & mainstreaming, to achieve the intended impacts.

For capacity building[91], the focus was on strengthening and increasing national capacity on coal bed methane recovery and utilization through training and experience; establishing coal bed methane Clearing House and institutional set up to disseminate information, educate, promote, and facilitate interaction with potential investors; and setting up of coal bed methane Information system and the Intranet system. Organizations, namely, CMPDI, CIMFR, ISMU, Directorate General of Mines Safety (DGMS), MoC, CIL, and BCCL were involved in training and capacity building activities.

The techno-economic feasibility strategy[92] emphasized preparing and executing demonstration projects at the Moonidih and Sudamdih coal mines located in the Jharia coalfield in Jharkhand State, for recovery and utilization of mine associated coal bed methane in the Jharia coalfield using three different drilling technologies; demonstration of use of methane gas recovered from successful execution of the above projects for vehicle refueling and electric power generation.

The strategy on "broader adoption of technologies by replication and mainstreaming", aimed at achieving the objective "Coal bed methane capture and utilization is national planning and policy agenda", which was considered as the important ingredient of the project to deliver the intended impact directly. This strategy focused on developing an action plan to be adopted by the Ministry of Coal for the replication of successful aspects of demonstration projects, setting forth an agenda, and to recommend policy promoting sustainable recovery of coal bed methane[93]. The coal bed methane Clearing House was to disseminate information and facilitate interaction with potential foreign investors and the relevant Indian entities.

Key components

The key components[94] proposed in the project design are:

- To Strengthen and increase the capacity of the Central Mine Planning and Design Institute Ltd. (CMPDIL), Bharat Coking Coal Ltd. (BCCL), Indian School of Mines University (ISMU), Central Mining Research Institute (CMRI), Central Institute of Mining and Fuel Research (CIMFR), Ministry of Coal (MoC), Coal India Ltd (CIL), and the Ministry of Environment and Forests (MoEF) were expected to develop and support mine associated Coal bed Methane (CBM) recovery and use projects, through training and experience in identification, design, and implementation of programs to recover and use coal bed methane in a safe, cost effective, and environmentally acceptable manner

[91] Project Document
[92] Project Document
[93] Project Document
[94] Project Document

- Preparation and execution of demonstration projects at the Moonidih and Sudamdih coal mines located in the Jharia coalfield in Jharkhand State, for recovery and utilization of mine associated coal bed methane in the Jharia coalfield. Designing and execution of coal bed methane resource recovery programs using three different drilling technologies at the two proposed demonstration sites.
- Use methane gas recovered from successful execution of the above for electric power generation and vehicle refueling.
- Develop and adopt action plan for replication of successful aspects of demonstration projects. Use the coal bed methane Clearinghouse to disseminate information, educate, promote, and facilitate interaction with potential foreign investors.

Project design - Salient features

The project was designed to address the key issues that presented barriers to adopting measures that effectively drain, recover, and use methane during mining[95]. The key issues at the project inception stage were: lack of latest available technology; lack of expertise and experience; and a pervasive perception that commercial viability of exploitation and utilization of methane is problematic.

The project targeted specific markets where coal bed methane occurs in mines; this is generally limited to areas where bituminous coals exist. In India, such areas are located in coalfields of Damodar Valley; namely Raniganj, Jharia, and East Bokaro. Accordingly, two mines were selected for demonstration, which are located in Jharia coalfields.

The project considered three different strategies and drilling technologies for developing the coal bed methane resources associated with mining, and these were:

- To drill ahead of mining by a number of years to pre-drain the gas that has existed in the coal seams where mining is planned, by vertical drilling;
- To recover methane from the surface by vertical drilling into the gob areas, which can recover a large volume of high quality gas if appropriate monitoring and quality control systems are in place; and
- To recover methane gas in the inseam by long-hole horizontal drilling

The selection of the representative mines was undertaken to reflect pre-mining and post-mining recovery methods from room and pillar and 'longwall' methods of mining. The combination of sites, technologies and stages of a mine's life were reflected in the sample chosen and are representative of the underground mining conditions for gassy mines existing in India, thus increasing the likelihood of replication elsewhere as ever-deepening underground mining becomes more prevalent[96].

[95] Project Document
[96] Project Document

Project design assumptions

The assumptions made in the project design[97] were as follows:

- Lack of latest technology and expertise will be remedied through acquisition of the appropriate technology and expertise through the GEF project. The sense that commercial viability is problematic can be mitigated by a full-scale demonstration.
- Technical, managerial, institutional capacity and knowledge enhanced and built in the CMPDI, CIMFR, ISMU, and BCCL would not be lost with the departure of key personnel and would be propagated down the line and across other relevant institutions, organizations, and private actors.
- Robust arrangements for continuation of activities would be in place after GEF support ended.
- The Project's accomplishments will convince the Government of India to create a more enabling policy environment for wider adoption of coal bed methane in India
- The demand for cleaner fuel such as natural gas would increase rapidly outstripping the supply scenario in India and therefore the coal bed methane will augment the supply of natural gas from other sources

9.3 Project Execution

The extent of delivery of project components ranged from fully accomplished to partial delivery. By virtue of its technology-intensive nature and being the first of its kind in India, the demonstration project encountered several challenges during execution, which are discussed below:

Delivery of project components

The project achieved mixed results in the delivery of project components[98]. The project was successful in strengthening the capacity of national institutions and in the preparation of an action plan for the replication of technologies. However, the project only achieved partial success in the demonstration of drilling and gas utilization technologies. The component-wise achievements are discussed below.

► Strengthen and increase capacity of CMPDI, BCCL, CIMFR, MOC, CIL & other stakeholders

Project personnel from CMPDI and BCCL were trained in the USA on various aspects of drilling, drilling technology, gas utilization, and prediction of gas production parameters. The project personnel were also trained in India on development of coal bed methane technology, reservoir engineering, drilling technology, and soil chemistry. The coal bed methane information library, coal bed methane intranet, and coal bed methane Clearing

[97] Project Document
[98] Terminal Evaluation Report, July 2009

House were established at CMPDI, Ranchi to disseminate information and facilitate interaction with potential investors. Additional and advanced courses on coal bed methane were introduced at graduate and post-graduate level at ISMU as part of the dissemination of knowledge on coal bed methane.

- **Execute coal bed methane gas recovery demonstration projects in the Jharia Coalfield**

The scope of the project in terms of number of wells was downsized due to budgetary constraints, difficult site conditions, and delays in project implementation. Under this component, a fully trained unit for undertaking vertical well drilling was established. This included competence to locate and drill future boreholes. Two vertical wells were drilled and methane gas was recovered at the Moonidih mines[99]. The drilling of the third vertical well was under way at the time of project completion. BCCL acquired the full know-how, knowledge and experience for recovery of methane gas, which made BCCL capable of executing coal bed methane replication projects. However, drilling in gob areas in Moonidih and horizontal drilling in Sudamdih could not be accomplished due to difficult site conditions and failure of equipment respectively.

- **Use coal bed methane gas recovered from the wells for power generation and vehicle refueling**

The surface gathering and pipeline systems for vertical wells, underground systems and gas re-fuelling stations were commissioned. Electricity generation capacity of 500 kVA was established and demonstrated by using the recovered methane gas at Moonidih mines by installing two generator sets of each 250 kVA, and has been operating since June 2008. The electricity generated was supplied to mine workers' colonies, for street lighting, and for water pumping. However, use of recovered methane gas for vehicle fueling could not be demonstrated due to the non-functioning of horizontal drilling equipment in Sudamdih mines.

- **Action plan for replication and coal bed methane Clearing House**

Analysis of production data and estimates of methane gas content in the coal seams of Moonidih and Sudamdih, as well as cost-benefit analysis and impact analysis, including greenhouse gas emission reduction estimates were prepared. The cost of power generation using the recovered methane gas (estimated at USD 0.08 per kWh) compared favorably with the grid tariff of the local power utility[100].

An action plan was developed for up-scaling coal bed methane activities in the project areas and replication to other areas, including involvement of the private sector. To strengthen coal bed methane Clearing House, a collaboration agreement was signed with the United States Environmental Protection Agency (USEPA). The Coal bed methane website was

[99] Terminal Evaluation Report, July 2009
[100] Terminal Evaluation Report, July 2009

created (www.cmmclearinghouse.cmpdi.co.in) to enhance outreach and dissemination of information. Project results were disseminated through publications, workshops, conferences, and newsletters. Additional courses on coal bed methane were added and integrated in mining engineering course materials at ISMU.

Challenges faced during execution

Several challenges[101] were faced during execution of this project, which are presented below:

- The review of budgetary cost estimates of the coal bed methane equipment indicated gross under provisioning in the equipment budget of the original UNDP-GEF project documents. As a consequence, the decision was taken to shelve procurement of some non-essential equipment.
- The project suffered long delays primarily due to under provisioning in the budget, long delays in procurement of equipment from international market, and procedural delays in obtaining sanctions at various stages.
- The horizontal drilling program at Sudamdih mines could not be completed due to malfunctioning equipment (steering tool), whereas drilling in GOB areas could not be undertaken due to challenging site conditions.
- Due to non-functioning of horizontal drilling equipment and associated equipment meant for demonstration of gas utilization for fueling, mine vehicles were left idle in the project site.

9.4 Outcomes and impacts

The project has enhanced the national capacities in coal bed methane recovery and utilization technologies and has been able to clearly establish that coal bed methane recovery from Indian coal mines is commercially viable. Since the completion of the project in 2008, notable progress has been made through replication of projects, knowledge sharing, and policy development.

Achievements till project completion stage

The GEF project was successful in addressing the key challenges facing the coal bed methane industry through technical assistance and in-country capacity building for expanded methane recovery and use. Through representative demonstration plants, the project introduced advanced techniques for gas resource assessment and recovery and utilization methods appropriate for Indian mining conditions. The lack of knowledge and expertise was addressed through training and skill building activities.

► Institutional capacity

Institutional capacity of the CIL subsidiaries, CMPDI and BCCL, was strengthened in identification, design, and implementation of coal bed methane recovery and utilization

[101] Terminal Evaluation Report, July 2009

projects, allowing mines to operate in a safe, cost effective, and environmentally friendly manner. Expertise was built in the CIL, CIMFR and ISMU for providing technical assistance to such projects in new areas. The coal bed methane Clearing House established at CMPDI disseminated information, promoted, and facilitated interaction with potential foreign investors. Information and Communication Technology (ICT) infrastructure was established at CMPDI, which facilitated information sharing, knowledge dissemination, and communication.

- **Techno-economic feasibility**

The demonstration project allowed stakeholders to see the commercial viability of coal bed methane recovery in the Indian mining environment. The CMPDI and BCCL acquired the know-how for recovery of gas and its utilization for power generation and are now capable of executing replication projects in India. Demonstration of commercial viability of recovery of coal bed methane using vertical drilling into coal seam and its utilization for electricity generation instilled confidence in the private sector for investing in coal bed methane projects. The mine workers' families started receiving uninterrupted and reliable power supply from a clean energy source for domestic lighting, water pumping, and street lighting.

- **Replication and mainstreaming**

The success of the project influenced the Ministry of Coal which developed a policy that CMPDI should prepare plans for the identification of blocks in CIL leasehold areas for the recovery of coal bed methane in a commercial manner and replicate such projects which would also be entitled for carbon credits. The mines under CIL, which contribute to 85% of total coal production of the country, were the main focus of the Ministry for setting up coal bed methane projects. The project also raised awareness among the owners of captive coal mines on commercial viability of coal bed methane, who began to consider more favorably about exploring coal bed methane projects in their mines. The techno-economic feasibility of coal bed methane projects became quite attractive, and are likely to offer an internal rate of return (IRR) of the order of 25-40% with a payback period of 2.5-4 years[102]. It shows that the power generation costs can drop significantly in replication projects due to lower capital costs and hence become even more attractive when compared to grid supply.

There has been an overwhelming positive response from local communities and mine workers in acceptance of the coal bed methane projects. This is important for sustainability of efforts for the industry.

The direct GHG emission reduction of the project is estimated to be 14,292 tons per annum since the commissioning of the vertical wells and the power generation plant at Moonidih in

[102] Terminal Evaluation Report, July 2009

June 2008. It translates to an aggregate GHG emission reduction of 64,314 tons up until December 2012.

Achievements at post project completion stage

The GEF project was successful in addressing the critical market barriers and contributed to market transformation, which occurred at different levels as explained above in section 4.1. The coal bed methane industry in India has made notable progress since the completion of the project; new projects have been identified for replication by CMPDI and DGH; the central government is working on a new policy aimed at promoting this sector; the key institutions continue to render technical assistance, training, and information dissemination services; and there are indications of private sector engagement in the industry, which are discussed below:

- The coal bed methane Clearing House established during the project has been significantly contributing to knowledge sharing with potential investors. The e-library and intranet/internet gateway at CMPDI are being effectively utilized for facilitating effective interaction between the government agencies. BIS is working on the development of standards for technologies and specifications. CMPDI is providing services ranging from conceptualization of coal bed methane recovery projects through planning, staging, performing drilling, testing, evaluation and development of coal bed methane deposits. ISMU and CIMFR have been actively pursuing further research and development activities for cost reduction, higher yield, and ease of operation.
- Drilling of more vertical wells has been under way in Moonidih. The Government of India had extended the GEF project supported activities after operational closure of the GEF project, from January 2009 till June 2010. It has invested its own funds and carried out the remaining activities, completing the drilling of the third well. The drilling activities in the fourth well in BCCL's Moonidih coal mines are being planned.
- After the GEF project, CIL appointed CMPDI as the nodal agency for coal bed methane development in the CIL leasehold areas. CMPDI has now identified 5 blocks having a coal bed methane potential of 29.72 billion cubic meters and has invited international tenders. The total coal bed methane production in the country has increased to 0.32 mmscmd (million metric standard cubic meters per day), which is expected to rise to 7.4 mmscmd by the end of 2014.
- The Directorate General of Hydrocarbons (DGH), under the Ministry of Petroleum & Natural Gas (MoPNG) allocated 33 coal bed methane blocks with a total coal bed methane potential of 1,810 billion cubic meters to private actors, namely RIL, GEECL, Arrow, GEO, Essar, Dart Energy, ONGC, and BPE. As part of this project, over 130 wells[103] were drilled by GEECL in Raniganj South Block in West Bengal state and coal bed methane production of 0.20 mmscd was achieved. GEECL signed franchisee agreements with oil companies such as IOC and BPC for the sale and distribution of gas. ONGC and ESSAR are the other private sector companies actively engaged in development of coal bed methane projects on a commercial basis.

[103] www.geecl.com

- All the players in the coal/gas sectors of the country are positive in their approach to coal bed methane recovery. CIL is actively considering extending coal bed methane recovery projects to more areas under its control and also the new coal block owners. Encouraged by the success of the GEF project, the Government of India is working on a new coal bed methane policy, which is aimed at accelerating the commercialization of the coal bed methane industry in India.For indirect GHG emission reduction, the project by GEECL is considered, which was commissioned in 2007 in Raniganj South Block (West Bengal) with the current methane gas production estimated at 0.2 million m^3 per day. This accounts for 1.0 million tons equivalent of CO_2 reduction per annum. Considering an adjustment factor of 0.5 as the GEF contribution, the indirect GHG emission reduction due to the influence of the project is estimated to be 0.5 million tons of CO_2 equivalent per annum (2.5 million tons over the lifetime period of 5 years)[104].

Factors that affected progress

- The project suffered delays due to under-provisioning in the budget, procurement of project equipment from the international market and in obtaining sanctions at various stages. The under provisioning had to be met by downsizing the requirement of the project equipment as well as work programs. The downsizing of equipment led to restricting the number of vertical wells in the project and in turn affected the gas production and its gainful utilization for power generation. Also, due to malfunctioning of one of the pieces of equipment for horizontal drilling, neither the drilling technology nor the gas utilization for fueling mine vehicles could be demonstrated. This has also significantly affected progress as there are merits to horizontal drilling such as higher productivity and reduced land acquisition problems.
- The use of coal bed methane recovery and utilization for the first time in the country needed a lot of work in updating the safety regulations and equipment approval procedures, which were yet to be established.
- There was also considerable difficulty in acquiring land for coal bed methane wells. This may be attributed to inflated claims for compensation and jobs. The problem of payment of compensation intensifies in laying pipe lines and road construction where several plots of land are involved.

9.5 Progress to impact

The project has made notable progress to impact since its completion in 2008, contributed to by replication, policy push, knowledge sharing, and institutional support. The coal bed methane industry is expected to grow further in future given the awareness in the stakeholders on benefits and opportunities for coal bed methane, and presence of institutional capacities to

[104] India CCM Case Study Report

make things happen on ground. However, there are risks for further progress to achieve full expression of long term impacts such as lack of policy support and regulatory mechanisms for pricing of gas. The likelihood of further progress to long term impacts is discussed below:

- Inspired by the success of the GEF project, BCCL is continuing its drilling activities and recovery of methane in Moonidih by drilling new wells. The preparations are in progress for the fourth well. New sites have also been identified for drilling new wells for gas recovery.
- CMPDI, the nodal agency appointed by CIL for coal bed methane development in the CIL leasehold areas, has concrete plans to implement replication projects on a large-scale. Five blocks have been identified by CMPDI having a gas potential of 29.72 billion cubic meters[105], for which international tenders are invited. These projects can significantly add to gas production in the country
- The new government policy[106] expected to be released soon may allow CIL to extract coal bed methane from its vast leasehold areas soon, and to open new business avenues for CIL. This will have significant positive affect on coal bed methane industry in India. The new policy which is being formulated is aimed at accelerating the commercialization of the coal bed methane industry in India particularly focusing on the private sector.
- There is a significant increase in methane production in India due to efforts of government and other stakeholders, and the current total production is estimated to be 0.32 mmscmd. The gas production is expected to increase manifold to 7.4 mmscmd[107] by the end of 2014.
- The Directorate General of Hydrocarbons (DGH) has been working closely with the private actors to enhance the gas yield from the 33 coal bed methane blocks allocated with total estimated coal bed methane resources of 1,810 BCM[108].

Although notable progress has been made in the coal bed methane sector and further progress is likely to take place, there are several risks that could impede further progress:

- Lack of standardization of technologies, technical specifications, and technology packages for local conditions may affect private sector investments.
- Lack of technology choices for gas recovery (using drilling in GOB areas and horizontal drilling) and gas utilization (for fueling vehicles) may discourage investors and affect the pace of replication of projects in India.
- A comprehensive policy at national level for coal bed methane exploration encouraging private sector investments is yet to be evolved. Also, there is lack of clarity on roles and responsibilities of different Ministries and agencies involved.
- The awareness and capacity of banks and financial institutions to appraise and finance coal bed methane projects is limited.

[105] Closure Report of coal bed methane Recovery and Commercial Utilization Project, CMPDI, August 2010
[106] www.financialexpress.com
[107] www.financialexpres.com
[108] www.geecl.com

- The lack of appropriate gas pricing mechanisms for the sale of recovered coal bed methane is a major deterrent for new projects as well as existing projects.

9.6 Lessons learned

The lessons learned during the course of the project implementation from different perspectives, are presented below:

- The project experience shows that adequate preparation – based on field assessment of the specification of equipment, international marketing scenarios, and a realistic assessment of time schedule would avert many problems and considerably improve the efficiency of project implementation.
- The project experienced long delays due to under provisioning and improper costing of equipment which led to the downscaling of equipment and activities. The project experience shows that adequate provision for budget revision and/or cost escalation in the event of delays in procurement would be useful for highly specialized niche equipment, particularly in long gestation projects.
- The analysis of delays in implementation of the project shows that adoption of even handed procurement procedures, while remaining open and fair, may be an effective way to deal with delays by suppliers. For example, including a suitable penalty clause for non-serious suppliers may be considered for avoiding delays in procurement phase.
- The project shows that training consultants who are then deployed until the full completion of the project would enable the fine-tuning and improved effectiveness of the training and capacity building activities as the project progresses. Much greater interaction of these consultants with the technical institutions needs to be ensured for better results in this regard. Greater emphasis on hands-on or shop-floor training and apprenticeships at the sub-project level are vital for building operational capacities.

9.7 Follow up actions

The follow up actions required for enhancing impacts of and/or reducing risks to progress to impact are as follows:

- Demonstration of techno-economic feasibility of vertical drilling in Gob areas and underground directional drilling into coal seams should be taken up. The successful demonstration of these technologies will provide a range of technology options for investors, which they may choose depending on site conditions, financial/ economic factors, and other pertinent parameters.

- Demonstration of commercial utilization of recovered methane gas from mines for fueling vehicles should be carried out. The successful demonstration of this would encourage promoters to invest in profitable projects.
- Standardization of technologies and development of technical specifications and technology packages for drilling, gas recovery, and utilization should be taken up by bringing together international and national experiences. The availability of standards and technical specifications would minimize risks and instill confidence among the investors.
- Raising awareness and building the capacity of commercial banks and financial institutions for appraising and lending to coal bed methane projects may be considered. The enhanced knowledge and capacity of banks and financial institutions will enable adequate funding for such projects and encourage the private sector.
- Formulation of a suitable framework and mechanism for fixing the gas price for the sale of recovered methane gas should be considered.
- Comprehensive coal bed methane policy making the roles and responsibilities of the concerning ministries and agencies is needed for smooth and time bound implementation of projects.

10. Energy Efficiency Project *[GEF ID 404]*

10.1 Project description

The "Energy Efficiency Project" (GEF ID 404) was designed to enhance and sustain improved end-use energy efficiencies to reduce carbon emissions. The implementing agency was the World Bank and the project was executed by the Indian Renewable Energy Development Agency (IREDA). The project primarily targeted energy supply in the GHG producing sectors of the economy and adopted Operational Program 5 strategy (Removal of Barriers to Energy Efficiency and Energy Conservation) of the GEF Climate Change Mitigation (CCM) Focal Area. The project promoted CCM technology demonstration, technology deployment cycle and innovation chain. The financing approach was to set up funds at IREDA as the financial intermediary and to lend the proceeds from the Bank loan and International Development Association (IDA) credit to the participating agencies (private developers and state-owned corporations). The total project cost was US$ 47.23 million with a GEF grant of US$ 5.0 million and co-financing of US$ 42.23 million. The implementation of the project commenced in January 2001 and it was completed in March 2008.

10.2 Project objectives and design

Long term objectives[109]

The global environmental objective of the project was to enhance and sustain improved end-use energy efficiencies with consequent reduction in carbon emissions. The Development Objective of the project was to promote energy efficiency and demand side management (DSM) investments. The key project concept was to facilitate development of the energy efficiency services industry in India by addressing market development barriers and helping develop entrepreneurial initiatives including the formation of Energy Service Companies (ESCOs).

Theory of change and causal mechanisms

The project anticipated on removing market barriers to large scale application and implementation of energy efficiency services, products and technologies. The project focused on three strategies i.e. capacity strengthening, removal of barriers, and replication and mainstreaming to achieve the intended impacts.

The capacity strengthening strategy focused on delivering the state where practical mechanisms for promotion of energy efficiency in industries were created and effectively managed and there is increase in awareness and capacity for the promotion of EE technologies. The thrust was aimed at strengthening national capacity and increasing the energy efficiency sector; enhanced policy environment and institutional support for energy efficiency; and training of personnel at IREDA, nodal agencies and other

[109] Project Document (pg. 2)

stakeholder institutions. The intent was to ensure that the activities undertaken as part of the project are sustained after project completion. Under the technical assistance component of the project, assistance was provided to BEE for various activities related to energy efficiency. The activities like preparation of investor manual, EE information manual and development of codes and standards for performance evaluation of industrial equipment were aimed at identifying the potential areas in energy intensive sectors that need to be targeted for energy efficiency.

The 'removal of market barriers' strategy focused on providing the EE technologies to the industries and facilitating deployment. It aimed to reduce barriers such as the perceived risks of technologies, commercial viability, and cost effectiveness that were hampering adoption.

The replication and mainstreaming strategy focused on ensuring that the Energy Efficiency is the preferred strategy among industries to conserve energy and/or generate captive power to augment their energy supply, which is considered the vital ingredient of the project to deliver the intended impact directly. Successfully implemented EE sub-projects were to act as showcase models for replication by other industries in the same sector and these also encouraged commercial banks to provide financial packages for adoption of energy efficient technologies.

Key components[110]

The GEF funding focused primarily on energy efficiency issues. The project had two components: (a) the energy efficiency/DSM component, and (b) the technical assistance component. Of these, the energy efficiency component was financed through co-financing, whereas the technical assistance component was financed through the GEF grant.

The energy efficiency/ DSM component was designed to provide financing for energy efficiency as a new line of lending business that would complement IREDA's renewable energy financing activities. This component covered a wide array of approaches including: (i) design, development and implementation of integrated energy management services operated by Energy Service Companies (ESCOs) and end-users on a performance guarantee basis; (ii) end user purchase and installation of energy efficiency and/or load management devices and systems; (iii) production of energy efficient equipment; and, (iv) end-user participation in State Electricity Board (SEB) and other utility-sponsored DSM programs. This component was closely linked with the GEF funded technical assistance component.

The Technical Assistance (TA) component was designed to support IREDA's efforts in the new area of energy efficiency by financing: (i) pre-investment activities to develop a sustainable pipeline of energy efficiency investments, preparation of standard bidding documents for procuring ESCO services, operational and business development modules and information dissemination; (ii) establishing in-house capacity within IREDA to appraise, supervise and promote energy efficiency services and schemes; (iii) assisting participating states in promoting end-use efficiency including the development of appropriate

[110] Project Document (pg. 6)

policy incentives; and, (iv) training of public and private sector energy and industry officials and staff on energy conservation and DSM. This component was primarily financed through GEF resources.

Although, initially GEF funding was to be matched with US$ 2 million co-financing from IREDA, IREDA's financial contributions were not needed as several other partner organizations provided support for the intended activities, notably USAID's Energy Conservation and Commercialization project that financed US$ 25 million during 2000-2008.

Project design - Salient features

The project aimed to strengthen the national energy efficiency program by providing capital for energy efficiency services, equipment and devices and promote business arrangements that would lead to reduced transaction costs and risks. Specifically, the project was designed to help overcome the barriers to investment in energy efficiency by: (i) improving domestic capacity to promote and implement private sector initiatives in energy efficiency; (ii) mitigating the costs and risks of developing and investing in smaller projects; (iii) disseminating information on best practices in implementing energy efficiency services, technologies and cost recovery mechanisms; and (iv) providing medium-term loan and lease facilities.

The project targeted three primary stakeholders in the EE and ESCO sector: the end-use industry, energy auditors, and the banks and financial institutions. The sub-projects covered were used to demonstrate technology options like waste heat recovery systems in the Small and Medium Entrepreneurs (SMEs) and demonstrated the financial and economic viability of such projects. The TA design was appropriate for enabling greater awareness about energy efficiency in Indian industry, examining and testing different approaches for financing efficiency investments, and in creating and strengthening capacities in the market generally and in IREDA to finance energy efficiency investments. Another focus of the project was to build capacity within IREDA to finance energy efficiency projects. Institutional strengthening initiatives directly benefited IREDA which had no previous experience with lending for energy efficiency and was able to gain experience in providing finance for these types of investments.

The flexibility adopted for different types of energy efficiency interventions eligible for support proved to be a crucial factor in allowing for implementation of approaches that worked in the Indian context. The TA design was appropriate for enabling greater awareness about energy efficiency in the Indian industry, examining/testing different approaches for financing efficiency investments, and in creating and strengthening capacities in the market at large and in IREDA to finance efficiency investments. The TA design was revised at mid-term review to focus on short term market opportunities and reduced its emphasis on certain policy aspects, given the creation of the Bureau of Energy Efficiency (BEE) which assumed the lead role in Energy Efficiency Policy work.

Project design assumptions

The key assumptions made while designing the project were as follows:

- Private investments will improve quality and efficiency of energy supply and services in India

- Reform initiatives in the power sector would gain further ground
- Shortfall in grid supply will prompt industries to search for and invest in short-gestation and alternative sources of reliable power and in energy conservation schemes
- Operational delivery/sales agreements with states/SEBs are viable
- Policy incentives would be adequate and Government and IREDA clearances are streamlined to attract private investors
- Appropriate technology, equipment and service infrastructure are available
- Energy efficiency systems and products perform as designed and at expected cost
- Perception of business risks among commercial banks are reduced
- Various stakeholders – end-users, EE industry, financial sector, utilities and government – experience tangible benefits from the investments
- Pipeline of financially viable and bankable projects are generated
- Procurement process is well-managed
- IREDA maintains its capacity to manage, multi-task, and run the multi-year TA program

10.3 Project Implementation

Delivery of project components

Overall the project satisfactorily achieved the intended impacts for all three strategies i.e. capacity strengthening, removal of barriers, and replication & mainstreaming. Energy efficiency projects included in the portfolio at the time of project closure financed by the project and IREDA's own resources have resulted in over 90 MW in additional capacity and avoided peak demand. The project resulted in a favorable environment for energy-efficiency measures and the sub-projects inspired many other players in similar industries to adopt the demonstrated technologies. Although quantitative data for energy saved by energy efficiency technologies in India is not available, it is evident that due to the change in policy and financial structure brought by this project, there is an increase in investment in energy efficiency technologies in the industries.

The industrial plants in sponge Iron, cement, steel and sugar sectors were able to purchase and demonstrate new technologies that met stringent energy efficiency norms. The success stories developed under the World Bank Line of Credit (LoC) has paved the way for advanced energy efficient technologies in many of the Indian industrial plants e.g. in the cement plants, the energy efficiency norms are comparable to the best energy efficient plants in the world. Furthermore, some of the steel plants and sugar plants are already undergoing processes of modernization and adopting more energy efficient practices. BEE's recent study of the pulp and paper sectors has indicated that these sectors have also responded positively and have implemented technology up-gradation plans. Use of efficient thermal systems (like co-generation with gas turbine and methanation, fluidised bed boiler, steam drives, and economizers) and efficient electrical systems (like variable frequency drives, energy efficient pumps, fans, compressors and cooling towers) are widely employed in Indian industries. Interactions with industry experts indicate that over the years, there has been a significant reduction in investment costs of EE equipment given their increased demand and scale of manufacturing.

Challenges faced during implementation

At the time of project appraisal, GOI support for energy efficiency was focused on provision of support for energy audits and information dissemination programs in the industrial sector by public sector institutions including the National Productivity Council, the Petroleum Conservation Research Association, the Industrial Development Bank of India (IDBI) and the Energy Management Center (EMC). These efforts lacked a unified approach to overcome market barriers to energy efficiency, especially on financing identified efficiency investments.

Large companies with access to information, technical consultants and finance found it less difficult to implement the EE projects as compared to the SME sector, who have not undertaken energy efficiency initiatives on account of several constraints. These included:

- Lack of data on energy consumption, including measurement and verification (M&V) available with SMEs;
- Lack of trust on technical capabilities of external energy auditors;
- Lack of either guarantee from the consultants for minimum savings or absence of demonstration of savings in other similar types of plants in vicinity;
- Non-availability of turnkey solutions from concept to commissioning from one single source;
- Non-availability of simple financing schemes for implementing EE projects on normal terms, preferably from the same bank from which it has availed working capital requirement;
- Last but not least, the burden of upfront transaction cost of carrying out energy audits.

10.4 Outcomes and impacts

Achievements till project completion stage

The project targeted the promotion of energy efficiency and demand side management investments and by the close of the project 17 energy efficiency projects – at various stages of implementation - were included in the portfolio. These were financed by IREDA's own resources and represented over 90 MW in additional capacity and/or avoidance of peak demand. Based on IREDA's experience in energy efficiency financing, several banks have also launched loan programs for energy efficiency. Ministry of Power had planned to establish Bureau of Energy Efficiency (BEE) to monitor various energy efficiency programs under the Energy Conservation Act, 2001. The implementation of the project has significantly addressed barriers to the targeted industries at the national scale.

► Policy, legal & regulatory frameworks

Under the TA component of the project, assistance was provided to BEE for various activities in regard to energy efficiency. The activities like preparation of investor manual, EE information manual and development of codes and standards for performance evaluation of industrial equipment aimed at identifying the potential areas in energy intensive sectors that need to be targeted for energy

efficiency. They also contributed in developing the strategic plan for implementation of Energy Conservation Act, 2001[111].

National Mission on Enhanced Energy Efficiency (NMEEE) is an Indian government initiative proposed to address national problems of inefficient energy use and is based on the Energy Conservation Act of 2001. This Act sets out a comprehensive strategy aiming at promoting ESCOs, preparing structured programs to leverage international financing instruments including Clean Development Mechanism (CDM), promotion of energy efficiency financing platform, setting up of partial risk guarantee funds and adoption of robust and credible monitoring and verification protocols.

► Implementing mechanisms & bodies

The project has strengthened IREDA for financing and technology promotion in the energy efficiency sector and has enhanced IREDA's institutional capabilities in resource mobilization, disbursement and maintaining portfolio quality. The competition from the commercial banks has tested IREDA as an institution, and proved ultimately useful by forcing IREDA to take several steps to improve the attractiveness of its loan offerings, such as revising loan terms and conditions, implementing several actions to streamline its business procedures and reducing documentation requirements. Based on IREDA's experience in energy efficiency financing, several nationalized banks have also launched loan programs for energy efficiency. Five banks, namely State Bank of India, Canara Bank, Union Bank, Bank of Baroda and the Bank of India, have launched new lending schemes for energy efficiency[112].

There had been an increase in the number of ESCOs in the country. From about 4-8 ESCOs in 2002, the number of ESCOs has increased to 89, as accredited by BEE. There has been an increase in availability and utilization of energy efficient products and equipment and of ESCO services. The industrial plants in sponge Iron, cement, steel and sugar sectors were able to purchase and demonstrate new technologies with excellent energy efficiency norms. The success stories developed have paved the way for advanced energy efficient technologies in many of the Indian industrial plants e.g. in the cement plants and fertilizer industry, the energy efficiency norms are comparable to the best energy efficient plants in the world.

► Energy Efficiency Investments

The sub-projects covered were used to demonstrate technology options like waste heat recovery to the Small and Medium Entrepreneurs (SMEs) and demonstrated the financial and economic viability of such projects. The main project beneficiaries were the industries, commercial establishments, communities and other electricity consumers who realized energy cost savings and productivity gains as a result of energy efficiency and DSM investments. Economically feasible technology packages were developed to encourage energy efficiency. The project successfully promoted energy efficiency and demand-side management (DSM) investments which further augmented power supply. Seventeen energy efficiency projects included in the portfolio at the time of project close are in

[111] Implementation Completion report (pg. 24)
[112] Implementation Completion report (pg. 23)

various stages of implementation, financed by the project and IREDAs own resources representing over 90 MW in additional capacity / avoided peak demand. These projects have been financed by over US$ 36 million directly disbursed for EE investment at the time of project close. The total amount of investment for IREDA's energy efficiency loan portfolio, including sponsor's equity contributions and other co-financing, will exceed $74 million once final commissioning is complete. Twelve of these projects have been commissioned at the time of project close, and the estimated savings projected for these projects is 249 million kWh equivalent per year[113].

► Removal of barriers

The projects financed under this World Bank Line of credit were aimed at addressing the three primary stakeholders in EE and ESCO business, namely the end-use industry, energy auditors, and the banks and financial institutions. The sub-projects covered were used to demonstrate technology options like waste heat recovery to the Small and Medium Entrepreneurs (SMEs) and demonstrated the financial and economic viability of such projects. The TA design was appropriate for enabling greater awareness about energy efficiency in the Indian industry, examining/testing different approaches for financing efficiency investments, and in creating and strengthening capacities in the market at large and in IREDA to finance efficiency investments. Up until project completion and at present, Energy Efficiency has garnered interest in almost all the industries. Schemes like energy certificates under 'Perform Achieve Trade' (PAT) have created awareness in the industries and this approach has picked up significant pace now. There has been a significant reduction in investment costs of EE equipment given their increased demand and scale of manufacturing.

► Knowledge generation

The demonstration projects covered under the project showcased the promoted technologies to the private investors, industries and government agencies. The enhanced knowledge and awareness on the technologies and its performance increased in private investments EE technologies. SME cluster-based activities were undertaken in the textile, hotel, cement and paper sectors to increase lending for EE.

► Skills building

The project provided training to IREDA and other stakeholders on issues regarding critical EE issues, training programs were also conducted on environmental and social impact assessment issues. Support was provided to BEE for (i) analytical work on the Indian experience with the ESCO mechanism in the public sector, to support BEE-ESCO programs, and (ii) pilot handholding to support the design and procurement of ESCO-delivered efficiency services in eight hospitals and government buildings. The government made several policies and programs for the development of the technologies. A major program to enhance energy efficiency of SMEs was launched, focusing on SME clusters, and the development of local consultants, equipment vendors, and financial institutions through replicable pilot projects.

► GHG Emissions Reductions

[113] Implementation Completion report (pg. 23)

At the start of the project the total GHG emission reduction from the energy efficiency portfolio was expected to be 0.67 million tons of CO_2 equivalent (as per Project document) over a period of 10 years. However, at the completion of the project, the GHG reduction estimation was increased up wards to 9.3 million tons of CO_2 equivalent (as per Terminal Evaluation report) over a period of 20 years; 0.47 $mtCO_2e$ per year.

Achievements after project completion stage

The various technologies demonstrated by the project such as efficient thermal systems (like co-generation with gas turbine and methanation, fluidized bed boiler, steam drives, and economizers) and efficient electrical systems (like variable frequency drives, energy efficient pumps, fans, compressors and cooling towers) are now widely deployed in Indian industries. The industry experts indicated that over the years, there has been a significant reduction in investment costs of the energy efficient equipment given their increased demand and scale of manufacturing. Apart from that, many commercial banks have come up with attractive and flexible financial packages for such projects.

The Government's emphasis on energy efficiency has enhanced policy environment and institutional support after the project completion. The Energy Conservation Act, 2001, was a critical milestone for energy efficiency in India. The Bureau of Energy Efficiency (BEE) was established as a statutory body under the Ministry of Power to plan, implement and monitor the various programs under the Act, including standards and labeling programs, certification and accreditation for energy managers/auditors, energy efficiency policy research, awareness and development and implementation of energy efficient building codes, among other activities. The Planning Commission's Integrated Energy Policy Report (2006) and energy efficiency missions proposed in of the National Action Plan on Climate Change (2008) were major steps forward. National Mission on Enhanced Energy Efficiency came into effect on April 1, 2010. The mission seeks to upscale efforts to create a market for energy efficiency and create a positive regulatory and policy regime to foster innovative and sustainable business models to unlock this market. As a result, it is estimated that by 2015, about 23 million tons oil-equivalent of fuel savings - in coal, gas, and petroleum products - will be achieved every year. There is also an expected avoided capacity addition of over 19,000 MW and consequential carbon dioxide emission reductions of an estimated 98.55 million tons annually.

Since project completion, the government has made several policies and programs for the development of the technologies. Government policies and measures now include:

- Setting industry standards for energy consumption, demanding regular energy audits and offering energy manager training.
- Increasing consumer awareness by offering a five-star rating system for appliances.
- Active demand-side management to reduce peak power demand and the development of business models for Energy Service Companies (ESCOs).

The government focused on a major program to enhance energy efficiency of small and medium enterprises is also being launched, focusing on SME clusters, and the development of local consultants,

equipment vendors, and financial institutions through replicable pilot projects. There is an increased awareness among the stakeholders about the benefits of these technologies.

BEE and implementation of policies such as National Mission on Enhanced Energy Efficiency (NMEEE) are playing an active role in the promotion of energy efficiency in India. The certification of energy managers by BEE has helped create a cadre of around 10,000 Energy Auditors and Energy Managers in the past few years. Various steps taken in this direction include promotion of ESCOs by accreditation and rating undertaken by market rating agencies, announcement of the Partial Risk Guarantee Fund and Venture Capital Fund by BEE. Under the Perform, Achieve and Trade (PAT) scheme, 467 industrial units from 8 sectors have been declared as Designated Consumers. Together they account for about 35% of the total energy consumption in India. Each designated consumer has been prescribed a target percentage reduction in its specific energy consumption to be achieved by 2014-15. Those who exceed their targets would receive tradable Energy Saving Certificates for their excess savings, which could be used for compliance by other designated consumers, who find it expensive to meet their targets through their own actions.

Factors that affected progress

For a significant part of the project duration (about two and a half years) the position of Managing Director (MD) of IREDA was vacant. This affected the overall governance arrangements at IREDA, hampering institutional responsiveness in an increasingly competitive market. However, in June 2007 the MD post was elevated to that of Chairman and Managing Director (CMD) and the acting MD was formally appointed to this post. Soon after, the vacant post of Director (Technical) was also filled, and three Independent Directors were appointed to the IREDA board. This was a positive step in increasing IREDA operational independence from the Ministry of New and Renewable Resources, which continues to be the principle shareholder of IREDA. With these changes, the IREDA governance structure is much improved and business oriented.

The widespread penetration of the ESCO model as a delivery mechanism remained limited as there were limited numbers of firms offering ESCO services, lack of familiarity of enterprises with the ESCO approach, and financing barriers which inhibit ESCO access to capital.[114].

10.5 Progress to impact

The project resulted in the promotion of energy efficiency and demand-side management investments to enhance and sustain improved end-use energy efficiencies with consequent reduction in carbon emissions. The enablers to the growth of the sector are: enhanced policy environment and institutional support for energy efficiency, commercial bank lending in energy efficiency, increased availability and utilization of energy efficiency interventions, and energy efficiency investments as demonstration sub-projects.

[114] Implementation Completion report (pg. 28)

There is a need of more investment in the field of EE to remove the existing bottlenecks. The government should take measures to develop database of energy consumption and the energy efficiency potentials in SMEs. There is a need to develop in-house pool of certified auditors and consultants who could assist SMEs in implementing energy conservation measures and help them in attaining energy efficiency targets. Financing schemes for the implementation of the energy efficiency projects also need to be made flexible and borrower-friendly to facilitate easy access to the industries.

While the initial project included a specific focus on ESCO development, this mechanism has not achieved widespread success in the Indian context. ESCOs in India face a number constraints including inability to prepare bankable projects, limited legal and contractual capabilities, poor contract enforcing environment, poor balance sheets and limited experience and expertise in structuring projects with adequate payment structures. Nevertheless, the ESCO activities under this project have provided valuable initial experience, and will support future BEE programs in this area.

10.6 Lessons learned

- **Financial Intermediation projects which fund EE should allow for development of different business models:**

  The GEF project experience shows that different energy efficiency business models should be tried out to allow maximum flexibility in achieving desired outcomes given the constant shifts in market conditions. End-user implemented approaches were more successful when compared to ESCO and DSM type approaches.

- **Smaller EE projects face different market barriers and may be best reached through alternative instruments:**

  Unlike larger firms with access to technical and financial resources, smaller energy efficiency projects with SMEs face several additional market constraints and barriers and may be best reached through decentralized means such as working through local financial institutions.

- **Technical assistance to commercial financial institutions is an important element of building institutional capacity to mainstream knowledge regarding clean energy market development:**

  In order to adequately scale-up lending for energy efficiency, the local banking sector must be an active participant. Therefore, awareness and capacity building of commercial financial institutions for clean energy market development projects should be incorporated into initial project designs, even when primary lending activity is channeled through a single intermediary.

10.7 Follow up actions

BEE has emerged as a powerful institution for promotion of EE in India. The GEF needs to strengthen its support and cooperation to BEE to implement its EE activities in a more fruitful manner. Their partnership can remove the remaining barriers to the promotion of EE in India.

There is a need for further financial support to IREDA at this critical juncture as it forges new partnerships and pursues larger projects, which could be an opportunity for a new engagement between the GEF and IREDA. While the Indian market for commercial finance for clean energy investments has experienced rapid expansion, there remain several areas which are not being served by the commercial finance market. These areas including geographic zones such as in the Northeast where the level of private sector investment in EE is low, new business models that have the potential to become commercial, and more complex project and financial structures. The GEF should engage with IREDA and the Government to discuss and develop possible options for a new operation aligned to the new IREDA business strategy and changing investment climate for clean energy.

Further, more support is needed to promote ESCOs in India. More EE projects can be funded through ESCO mechanism to enhance their legal, contractual and managerial capabilities. There is a need to provide regulatory as well as financial support to further develop ESCO mechanisms in India. Providing funds and guarantees for projects, knowledge generation and awareness building for ESCO activities are some areas where GEF can provide support.

11. Low Carbon Campaign for Commonwealth Games 2010 Delhi *[GEF ID 4215]*

11.1 Project description

The project "Low Carbon Campaign for Commonwealth Games 2010 Delhi" (GEF ID 4215) was designed to "develop and promote a low carbon campaign for the 2010 Commonwealth Games as a means of inducing a behavioral change amongst the citizens, athletes and visitors for the adoption of environmentally sustainable practices". The implementing agency was UNDP and the implementing partners were the Commonwealth Games Organizing Committee, Government of NCT of Delhi, Ministry of Environment and Forests, and the Government of India. The total budget of the project was US$ 4.25 million, out of which the GEF contribution was US$ 0.75 million.

The project primarily targeted forestry in the GHG producing sectors of the economy and adopted Climate Change Mitigation strategies. The financing approach was to be set up by Public Private Partnership and Co-financing by the Government Ministries.

11.2 Project objectives and design

Long Term objectives

The overall project objective[115] was "the development and promotion of a low carbon campaign for the 2010 Commonwealth Games as a means of inducing a behavioral change amongst the citizens, athletes and visitors for the adoption of environmentally sustainable practices".

Theory of change and causal mechanisms

The development of the "Low Carbon Campaign for Commonwealth Games 2010, Delhi" project's outcomes-impacts theory of change was based on review of the project documentation and was validated in consultations with key stakeholders in New Delhi. There were two key strategies that were followed as causal mechanisms for the desired outcome of the project:

- **Awareness Creation and Mainstreaming**

  This institutional strengthening strategy focuses on an increased awareness and understanding among various stakeholders about low carbon practices. The extent people are motivated to follow these practices was considered to be an important requisite for the

[115] ProDoc, Part A pt. 6; UNDP GEF Terminal Evaluation Review Form, section 2a

direct delivery of the intended project impact, i.e. "promotion of low carbon approach among the citizens, athletes and visitors".

► **Sustainability Mechanism**

The financing and market delivery mechanisms strategy focuses on the mechanisms to continue similar activities under a broad framework for undertaking greening initiatives for future sporting events. This is an important strategy which focuses on creating a long term, durable and effective mechanism for future projects.

Key components

The key components[116] of the Project were:

- Enhanced public image of the GEF as a global entity to support environmentally sustainable development;
- Awareness created among the public, students, athletes, visitors, facility managers and media on low carbon practices;
- CWG participants, Delhi residents, and visitors begin to take steps to reduce their carbon footprint; and
- Assessments and guidelines for "greening" future sporting events in the country developed.

Project design - Salient features

The project aimed at using the CWG 2010 as a platform to launch ´green campaigning´[117]. By targeting such a major sporting event as a catalyst, the outreach programs promoted under the project aimed to raise awareness - of the athletes, visitors, media, and other participants of the CWG and the general public - about low-carbon options to reduce the human impact on the environment, much more than a stand-alone campaign on ´green lifestyles´ would have done. It would have been otherwise impossible to have such a number of well-known people (sports people, artist, politicians) together in a limited time. In this sense, the project was well-conceived.

Given the time constraint in project design and implementation, the focus was on designing the campaign around the CWG, held in October 2010, but this led to less attention to a) monitoring and measuring of impact and b) sustainability and replication.

Project design assumptions

There were four main assumptions[118] for the success of this project:

[116] Project Document
[117] UNDP Terminal Evaluation Report
[118] Project Document

- It was expected that the government will prepare a road map and plan that is clearly understood by the stakeholders and other participants.
- There will be continuing commitment from government and private sector participants to implement low carbon practices and other associated resource conservation programs.
- The various campaigns planned under the project should result in actual behavioral change by the public.
- For this program to be effective and achieve its objectives, it was assumed that there is readily available information and data from the stakeholders and the market.

11.3 Project Execution

Delivery of project components

The accomplishments of the various components of the projects briefly described are[119]:

- **Enhanced public image of the GEF as a global entity to support environmentally sustainable development**

  As part of the project, about 30 AV profiles and 10 *shera* pop-ups were developed and aired on TV channels, websites, flights and CWG game venues during the period Sep-Oct 2010; although radio messages were developed, they were not aired. Five low-carbon fairs were organized in Shimla, Hyderabad, Shillong, Port Blair and Trivandrum. Two Green Concerts were organized in Kolkata and Pune. Around 150,000-160,000 saplings were planted to (partly) offset greenhouse gas emissions associated with the CWG. Plantation along Queen's Baton Relay (QBR) route by State Forest Departments (SFD) as well as by the SGP was done along with education activities.

- **Awareness created among public, students, athletes, visitors, facility managers and media on low carbon practices**

  Toolkits were printed and disseminated and 2 workshops were held for the promotion of the toolkit and CEE and Nehru Foundation for Development (NFD) had printed toolkits for future distribution to 85 NGOs, 28 institutions, 11 companies, 11 CEE offices, Government departments and individuals.

- **CWG participants, Delhi residents, and visitors begin to take steps to reduce their carbon footprint**

  The company, Forbes Technosys Ltd. (FTL), developed and designed a carbon footprint calculator kiosk for providing information and general awareness to people. The low-carbon promotion kiosk comprises of touch screen, CPU, modem and carbon calculator software with SMS, mail or print-out of information generated. The Calculator software calculates the carbon footprint for the household´s energy and water consumption and transportation needs based on Indian lifestyles. Twenty low carbon promotion kiosks were designed and

[119] UNDP Terminal Evaluation Report

developed, of which 6 were installed at games venues and later transferred to museum and educational institutes.

► **Assessment and guidelines for "greening" future sporting events in the country developed**
A report "Assessment of Low Carbon Practices followed during Commonwealth Games 2010 and Guidelines and Best Practices for Greening Sporting Events in India" was prepared with the following main elements:

- ➥ Overview of "green initiatives" proposed for CWG 2010
- ➥ Estimate of carbon emissions associated with the CGW 2010
- ➥ Guidelines and "best practices" for greening sporting events

Challenges faced during implementation

Reporting requirements established by the project did not allow for meaningful monitoring beyond the short-term. In addition, the TE suggested that the surveys should have been carried out to determine the extent of awareness on environmentally sound practices. Furthermore, they refer to a study conducted by subcontractor Enzen (2011) to sustain their assertion that outcomes associated with the "green" measures undertaken during the Commonwealth Games (e.g. CO_2 emissions reductions) could not be appropriately quantified "due to the lack of reliable documentation on baseline".

The project excessively focused on the "organization of last-minute events such as greening opportunities rather than on developing a long-term vision. To this regard, there was no real follow-up or monitoring built into project design, and that no post-project action plan was devised. This was considered particularly detrimental to the project's purported objectives of behavioral change promotion and awareness-raising.

11.4 Outcomes and impacts

The Terminal Evaluation had deemed that the project implementation had been highly satisfactory overall, and that "most outcomes" were achieved. A post-project assessment by the CPE Evaluation team deemed the project implementation to have been satisfactory, but in the absence of any post-project follow-up, it is difficult to ascertain the sustainability of most of the project outcomes. Outcomes and achievements have been categorized in two, up until project completion[120] and after completion[121]. These are discussed below:

Achievements at project completion stage

- ➥ About 30 AV profiles and 10 *shera* pop-ups on low carbon practices were developed and aired on TV channels, websites, flights and CWG game venues during the period Sep-Oct

[120] Project Document
[121] Project Document

2010 which were aimed at creating awareness among the CWG participants, visitors and local residents.

- 10 radio messages on resource conservation (energy and water), renewable energy, waste recycling, use of public transport, and local biodiversity conservation were developed, but not aired (due to cost and organizational considerations)
- Five low carbon fairs (comprising of documentary screening, workshops, exposure trips and competitions) were organized to create awareness on low carbon practices especially among school and college students in Shimla, Hyderabad, Shillong, Port Blair and Trivandrum in the period 30 June to 7 October 2010.
- Two Green Concerts were organized. The First in Kolkata on July 31, 2010 and the second in Pune on September 4, 2010.
- Sapling Planting along Queen's Baton Relay (QBR) route by State Forest Departments (SFD), as well as by SGP, was done along with education activities.
- About 90,000 toolkits were printed and disseminated, along with 2 workshops for the promotion of the toolkit and about 10,000 were kept at offices of CEE and Nehru Foundation for Development (NFD) for future distribution to 85 NGOs, 28 institutions, 11 companies, 11 CEE offices, Government departments and individuals.
- Twenty low carbon promotion kiosks were designed and developed, of which 6 were installed at games venues and were later transferred to museums and educational institutes.
- Independent assessment of the low carbon practices were undertaken.
- Developed 'guidelines and best practices manual' for greening future sporting events in the country.
- Developed and disseminated training kits for Training of Trainers (ToTs).
- Trained trainers in low carbon practices chosen amongst CWG volunteers; 300 trainers selected and trained on low carbon practices.
- Trained CWG volunteers in low carbon practices; 29,700 volunteers from Delhi and NCR trained.

Achievements at post project completion stage

The project was successful in bringing together various Government Ministries and agencies, such as the OC CWG (Sports), MoEF (Environment), BEE (Energy Efficiency) and MNRE (New and Renewable Energy).

The AVs developed during the project were remodelled and used during DIREC 2010 for awareness generation. The shelf-life of these AVs continues even today for all the 3 Ministries.

At one of the Green Concerts in Pune, the Indian Hockey Team had pledged to walk to the stadium once a week. The team is still continuing the practice.

The 'Low Carbon Lifestyles' Toolkit is one of the most appreciated contributions of the project. During the project, 100,000 copies were printed and distributed – in Hindi and English. However,

post-project, 350,000 copies were re-printed in Malayalam (funded by Arcelor-Mittal Foundation). There was also a reprint of 4,000 copies of "*Energy conservation in Foundry sector*" for the foundry industries. Dissemination of the same in the foundry sector started in the Punjab cluster, expanded to Delhi, and is now beginning in the Maharashtra and Chennai clusters.

Factors that affected progress

Prior to discussing the factors that affected progress to impact for the project, it is imperative to note that this was an opportunistic project. The opportunity was to make significant impact over a short period of time without much scope for expansion as the activity around which the project was developed is one-off and very sporadic.

The project design was focused on designing the campaign around the CWG (held in October 2010). It lacked adequate attention to sustainability of the project activities post-project. No evidence of any such arrangements being in place was observed for any progress after the project. The project design lacked a post-project action plan. Spectators, athletes and other CWG participants and the public at large were exposed to slick campaigning, but it has also been a one-time effort. This has the danger that the message will be quickly forgotten if not repeated. A lot of excellent material has been developed, but it is feared that the entire set of highly creative, effective and impressionable material, produced at considerable expense, may never get a chance to create the kind of impact it has the potential to create amongst the public and remain underutilized in the years to come. However, design and application of a post-project action plan would have entailed additional costs.

Selection of national level institutions and organizations as project partners helped in sustaining some of the project initiatives, even after the life of the project. For example, The 'Low Carbon Lifestyles' Toolkit that was reprinted in Malayalam post-project (funded by Arcelor-Mittal Foundation). There was also a reprint of 4,000 copies of "*Energy conservation in Foundry sector*" for the Foundry Industries.

11.5 Progress to impact

The project has made moderate progress to impact (intended global environmental benefits) as there is evidence that short term outcomes[122] of the project in the impact chain of causality have been achieved fully or significantly.

► **Various campaigns planned under the project resulted in actual behavioral change by the public**

Well-known artists, sports icons as well as local and state-level government officials attended the concerts and shared their endorsement of low carbon lifestyles by taking the

[122] UNDP Terminal Evaluation Report

'green pledge'. There were 2.2 million pledges proposed in 16 languages including Hindi, English, Bengali, Tamil, Oriya, Kannada, Punjabi, Urdu, etc.

- **Institutional capacity and knowledge built through the project is not lost through the departure of key personnel**

  There is a proper documentation of the training provided, which will prevent the loss of institutional capacity and knowledge through the departure of key personnel.

- **Green practices supported by the project are being adopted**

  While 1.9 million saplings have been planted directly or associated with the CWG 2010 Low Carbon Campaign project, it is assumed that these will be taken care of for the next 10-30 years by NGOs and SFDs. However, it would have been useful to have some documentation on how their monitoring would take place by the implementing partners to ensure high tree survival rates, such as appropriate systems put in place to ensure that the planted saplings survive and their growth is monitored over the years. No follow up action has been taken to support the initiative. However, establishing a monitoring system for the plantation would have entailed high costs, especially since the activity was taken up in a wide area that covered a number of schools along the QBR.

- The project has been quite instrumental in providing a boost to ´green lifestyles and low-carbon options´ by using the CWG 2010 as a platform to provide messages in printed form, AVs, campaigning and events and training.

11.6 Lessons learned

Major public events hosted by developing countries, such as CWG, Olympics and soccer World Cup can serve as a catalyst and platform to promote environmentally sound technologies and practices, by:

- **Campaigning for and demonstrating 'green' technologies, practices and lifestyles in front of a national and global audience:**

  Mega sport events are well suited for promoting energy-efficient and low carbon emission practices and lifestyles before and during the event as a platform for a number of awareness-raising activities that inform decision-makers, spectators and the general public on how to reduce their environmental footprint.

- **Building environmentally sound infrastructure to support an influx of millions people in the host cities that will continue to use the infrastructure and environmentally sound practices after the event:**

  Construction and infrastructure improvements taking place in preparation of the sports event as well as energy consumption during the event, present a substantial opportunity for energy savings and related carbon emission reductions.

Some specific lessons learnt out of the project are:

- Making a firm commitment to reduce the environmental impact at inception or bidding stage, to highlight the importance of implementing sustainable practices to all stakeholders involved in the planning and organization of the event.
- To establish a team at the inception stage of the event dedicated towards developing clear targets of environmental performance for each of the activities/components that go into the planning conduct of the event. This team should establish environmental reference baselines at the inception stage for both "owned" and "associated" emissions before, during and after the event. These reference baselines would be ideally audited externally for greater credibility.
- To develop action plans based on the techno-economic feasibility of each of the measures, which are context- and site-specific. These action plans are to be developed in collaboration with appropriate stakeholders and should be integrated into the planning and execution of the activities.
- To devise a clear cut and measurable monitoring plan to track implementation and collect data on the actual environmental performance at appropriate time intervals. Protocols for these data to be communicated to the Environment Team need to be established and agreed upon by each of the responsible stakeholders.
- The project would have benefitted from having included an activity to ensure sustainability and replication, for example, by means of a post-project action plan with recommendations to the various Indian partners.

11.7 Follow up actions

The project's potential has been shown by demonstrating green technologies, practices and lifestyles in front of a national and global audience. The potential follow up plan for the project may be that other global events hosted by developing countries, like the 2010 Commonwealth Games, can also serve as catalysts and platforms to promote environmentally sound technologies and practices. The aim being for those host cities to continue to use the infrastructure and environmentally sound practices, even after the event is over.

The lessons learnt from the project in terms of greening of sporting events may be applied to the other domestic championships organized for various sports – such as the Indian Premier League, Indian Hockey League, Indian Badminton League – each of which also enjoys high viewership and would hence help in further promoting green lifestyles and generating awareness. The strong network of school children sensitized towards 'green lifestyles' as part of the project may be engaged into spreading the awareness in their surroundings, through school or zonal level initiatives. Additionally, the extensive resource material developed as part of the project – including the 'Low Carbon Lifestyles' Toolkit, AVs, etc. – may be used by the various agencies at other events attracting mass attendance. These could include award functions, entertainment events, etc., and not necessarily only sporting events.

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