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UNDP/GEF Project: Biomass Energy for Rural India (BERI)

(PIMS 598)

Terminal Evaluation Report

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SYNOPSIS

Title of UNDP supported GEF financed project: Biomass Energy for Rural India (BERI)

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EXECUTIVE SUMMARY

Background

The BERI project was conceived in the early 1990s from the Centre for Application of Science and Technology to Rural Areas (ASTRA; now called Centre for Sustainable Technologies), part of the Indian Institute of Science. The project idea was inspired by a number of successful research, development and pilot projects by CGPL-IISc (Combustion and Gas Propulsion Laboratory, Indian Institute of Science) in the early 1990s. The pilot projects focused on de-centralized energy services that were providing reliable energy supplies to rural farmers to irrigate their fields and electricity to local households using small 10-20kW biomass gasifier based power generation system using locally available biomass.

BERI was conceived as a project with GEF funding to create a decentralized and sustainable energy generation and distribution system to provide comprehensive and high quality rural energy services, critical towards promotion of rural development and improving the quality of life in rural communities. The Project aim was to provide a reliable high quality supply of energy for these services for rural populations. The original design of BERI envisaged 60 x 20kW$_e$ biomass gasifier units to supply electricity for 2,500 households in 28 villages belonging to five different talukas (Koratagere, Madhugiri, Sira, Gubbi, and Tumkur) in Tumkur district of Karnataka. To ensure the sustainable supply of biomass fuel to these gasification units, the Project also envisaged promoting energy efficient cookstoves and community biogas plants for biomass conservation as well as building of community capacity for irrigation, generation of cooking fuels, growing plantations.

The intended impact of BERI was to reduce GHG emissions from the primary use of fossil fuels that were used for various household purposes such as cooking, lighting, fans, irrigation pumps and other power applications. The full-scale project started in April 2001 with the signing of the Project Document, with original project implementation duration of 5 years from May 2001 until May 2006; the Project, however, was extended three times with December 31, 2012 as the formal project terminal date for this Final Evaluation.

Context and Purpose of the Terminal Evaluation

The purpose of the Terminal Evaluation (TE) for this Project is to *evaluate the progress towards the attainment of global environmental objectives, project objectives and outcomes, capture lessons learned and suggest recommendations on major improvements.* The TE is to serve as an agent of change and play a critical role in supporting accountability. As such, the TE will serve to:

- promote accountability and transparency, and to assess and disclose levels of project accomplishments;
- synthesize lessons that may help improve the selection, design and implementation of future GEF activities;
- provide feedback on issues that are recurrent across the portfolio and need attention, and on improvements regarding previously identified issues; and,
- contribute to the GEF Evaluation Office databases for aggregation, analysis and reporting on effectiveness of GEF operations in achieving global environmental benefits and on the quality of monitoring and evaluation across the GEF system.

Table A provides a summary of the terminal evaluation of BERI.

Table A: Evaluation Ratings

1. Monitoring and Evaluation	***Rating***[13]	**2. IA & EA Execution**	***Rating***
M&E design at entry	4	Quality of UNDP Implementation	4
M&E Plan Implementation	3	Quality of Execution - Executing Agency	3
Overall quality of M&E	3.5	Overall quality of Implementation / Execution	3.5
3. Assessment of Outcomes	**Rating**	**4. Sustainability**	**Rating**
Relevance	3.4	Financial resources	2
Effectiveness	3.9	Socio-political	2
Efficiency	2.9	Institutional framework and governance	2
Overall Project Outcome Rating	3.5	Environmental	4
		Overall likelihood of sustainability	2

Assessment of Project Outcomes and Sustainability

The overall rating of the project results is marginally satisfactory (MS). This is based on the following outcomes:

- The successful demonstration of the technical feasibility of biomass energy application in a rural setting;
- Successful demonstration of the engagement of local communities to become involved with activities related to the improvement of rural living standards and the provision of modern energy services through biomass (including bioenergy and biogas for cooking);
- Surveys and consultations indicating the willingness of the local community to pay up to Rs 5 - 6 for modern energy services based on their increased earnings from income generation activities from BERI;
- Slow execution of the Project due to institutional arrangements and no presence of the PMU in the targeted communities in Tumkur leading to extensive delays and slow pace of approvals for basic operational decisions;
- Failure to adjust project management arrangements based on recommendations from the MTE that would have accelerated the pace of BERI and strengthened the sustainability of community involvement through its production of biomass to the bioenergy power plants;
- Lack of effort to reduce the cost of electricity production at the Kabbigere plant including the sourcing of locally produced biomass as opposed to a biomass plantation located more than 40 km from the plants;
- Due to the high cost of electricity production, there were no project efforts to create an enabling environment and financing to replicate this model for rural biomass power generation.

[13] 6=*Highly Satisfactory (HS)*: The project has no shortcomings in the achievement of its objectives; 5=*Satisfactory (S)*: The project has minor shortcomings in the achievement of its objectives; 4=*Moderately Satisfactory (MS)*: The project has moderate shortcomings in the achievement of its objectives; 3=*Moderately Unsatisfactory (MU):* The project has significant shortcomings in the achievement of its objectives; 2=*Unsatisfactory (U)* The project has major shortcomings in the achievement of its objectives; 1=*Highly Unsatisfactory (HU):* The project has severe shortcomings in the achievement of its objectives.

The overall Project sustainability rating is moderately unlikely (MU). This is primarily due to the failure to demonstrate a viable business model in a public-sector managed bioenergy generation plant, and the subsequent lack of financial resources available to continue operation of the Kabbigere bioenergy plant after December 31, 2012.

Conclusions

- With BERI terminated as of December 31, 2012:
  - Bioenergy assets were transferred to the GoK;
  - Operational funding for bioenergy assets after December 31, 2012 is uncertain though an exit strategy (contained within this Evaluation) has been prepared for RDPR;
  - A viable business model for BERI biomass energy plants does not yet exist; and
  - Not all bioenergy plants will have been commissioned.

- With UNDP/GEF funds already exhausted, the committed co-financing amounts from the State and Central Government is essential for continuation of BERI project operations and the sustained supply of bioenergy to the grid;

- Expectations of BERI were raised during the community mobilization phase between 2001 and 2005. However, with the strategic shift from off-grid to grid without provision of an "islanding" operation, the community had become increasingly disenfranchised with BERI:
  - Power generated from the biomass power plants was going to the grid, instead of the targeted communities being supplied with generated power from BERI biomass generation assets, mostly notably during grid outages when the entire region is without electricity;
  - There was a loss of pride when the biomass power plants could not even deliver local power to its own communities in the event of grid failure. This is mainly due to the absence of a load shift mechanism that was to provide bioenergy from the BERI generation assets to the local grid and targeted communities;
  - Biomass for Kabbigere bioenergy plant was being sourced from another plantation 40 km from the plant and not from the local plantations.

- With a grid-connected operation, the financial viability of the biomass power plants has become a significant issue since the tariffs from BESCOM were Rs 2.85/kWh and the actual price of electricity production from these plants being more than Rs 7.8/kWh;

- Biomass for the BERI bioenergy plants needs to be sourced from local plantations and from plantations on forest wastelands; this will contribute significantly to the continued and sustained operation of these plants by obtaining the biomass at a reasonable price;

- BERI has delivered to the GoK and the Government of India three rural biomass energy generation assets and lessons on community engagement that have significant potential to improve the living standards of rural India. At this stage, only a small investment is required to reduce the cost of electricity production, improve the operating performance of the Kabbigere plant and to find the means to increase revenue from electricity sales. This will allow the project to continue to the extent that BERI assets would be more financially attractive to external investors.

Lessons Learned

- Careful preparations including a third party assessment of the technology are required for the selection of a technology provider. Any technology selected for pilot operations or demonstration needs to be mature with minimal R&D required. In the case of BERI, it appears that the larger gas engines in the order of 100 to 250 kW_e were not market-ready until 2007. Moreover, the ASTRA technology for the community leaf and litter-based biogas-cum-biofertilizer plant (120 kW_e capacity) to supply power for a domestic lighting load was dropped due to the immaturity of the technology proposed for BERI;

- Public sector implementation arrangements for new technologies need to be simplified to provide the technology developer with the latitude for changes which may be unforeseen. A simplified arrangement would be engaging the technology provider in a turnkey operation and with performance standards. This arrangement would be favored by a technology provider who has a need to protect their intellectual property (IP). BERI did not have this arrangement, and as such, troubleshooting of the technology involved complex contractual arrangements, limited time to troubleshoot, and valuable time wasted in procuring these services. Moreover, O&M functions were outsourced by the Project which would have only attracted a very small number of entities associated or sanctioned by IISc as a means to protect IISc's IP;

- Public sector selection of technology providers for new emerging technologies (with very limited number of suppliers) needs careful selection in that such a selection cannot be procured through a routine (typical government L-1 process) tendered process. This process is not only time consuming but expensive to implement for both government and the bidders who may expend considerable effort to prepare a bid or proposal;

- Complex projects with cross-cutting sectors where there is a lack of baseline activities or baseline data is poor, should be implemented in phases similar to earlier GEF projects. In the case of BERI which started in 2001, the successful completion of one phase would secure funding for the subsequent phase. BERI could have been implemented as a 3-phase project with:
    - Phase I as a planning & community mobilization phase;
    - Phase II as a phase for proof of concept pilots;
    - Phase III for operations and plans for replication.

  The benefit of the phased approach would be the ability of the funding agencies to halt the project after each phase.

- One of the benefits of projects being associated with GEF is the access to foreign expertise. For large GEF projects of long duration that have problems, there is value in having additional and periodic foreign external reviews of projects in addition to the traditional mid-term review and terminal evaluations. Foreign external advice on BERI could have provided a fresh and unprejudiced approach to management arrangements, the technology selection process and advanced global technical advice without being constrained by the structures of normal local practices; as such, BERI would have benefitted from the use of foreign expertise.

Recommendations

With the GEF-funded BERI project terminated on December 31, 2012, the following recommendations are provided in order of priority to Rural Development and Panchayat Raj (RDPR) on actions required to sustain rural development activities of BERI Project in the Tumkur District using continuous running of biomass energy generation:

Recommendation 1: Release committed funds by Government of Karnataka and the Government of India.
The Finance Department has mainly questioned the financial viability of the BERI assets. Noting that the Project was intended to generate information, data and lessons to overcome the aforementioned barriers, the BERI project was funded with firm financing commitments from UNDP, GoK, GoI and ICEF (now closed) at the time of project formulation.

As can be seen from Table B, UNDP/GEF has released most of its committed expenses for the Project implementation with the remaining funds for the Terminal Evaluation. As such, the balance of funds from Government of Karnataka should be immediately released. Any delay will cause irreparable damage to the 10 years of progress which is already sluggish due to numerous delays and the lack of funds.

Table B: Commitment, expenditure, balance left by different donors for BERI project (as of December 2012)

Donor/Details	UNDP/GEF	ICEF	GoI	GoK	Others	TOTAL
Committed(USD)	4,017,000	2,495,000	391,000	1,481,000	239,000	8,623,000
Committed [in Rs][14]	200,850,000	124,750,000	19,550,000	74,050,000	11,950,000	431,150,000
Utilized (USD)	3,900,940	792,792	66,667	277,478	0	5,037,877
Utilized [in Rs]	195,047,000	39,639,600	3,333,350	13,873,900	0	251,893,850
Balance (USD)	116,060	1,702,208	324,333	1,203,522	239,000	3,585,123.00
Balance [in Rs]	5,803,000	85,110,400	16,216,650	60,176,100	11,950,000	179,256,150
% commitment remaining	**2.9**	**68.2**	**82.9**	**81.3**	**100.0**	**41.6**

Over Rs 1 crore of co-financing (in the form of capital subsidy) has been transferred to RDPR from GoI for the commissioning report for biomass gasifier power plants at Kabbigere, Borigunte and Seebanayanpalya. The subsidy for the Kabbigere plant was claimed on the basis of their operations and submitting the plant commissioning reports in the MNRE format. With the current subsidies received, plant operations can continue for another 6 to 12 months and cover costs of improving the operating performance of the plants until an investor can be found to support its operations over the long-term.

Recommendation 2: Establish load shifting mechanism.
The original 2001 project document conceptualized bioenergy as the key to providing reliable electricity to rural areas in a decentralized mode through the exploitation of a local biomass energy resource. Due to a variety of reasons, the number of biomass gasifier plants was changed from 60 small biomass gasifier plants (20kW each) to 6 large biomass gasifier plants with power evacuated to the grid through the establishment of a BERI-supported 11 kV line. When the grid is down (at times up to 4 hours per day), the plant needs to be shutdown

[14] USD 1.00 = Rs 50

resulting in a lower PLF (Plant Load Factor). Exacerbating this situation is that there is no power for local community when the grid is down. The lower PLF results in increased power generation costs and the unit cost of exported electricity. A load shift mechanism can switch over to bioelectricity in case of grid failure, thereby increasing availability of reliable electricity to local rural villages and also increasing the PLF; this arrangement is similar to a captive power house which connects to the grid in normal times but switches to in-house captive power plant in case of grid power failure. The result is a lower unit cost of electricity generation. BESCOM estimated a cost of Rs 50 lakh to install the load shift mechanism and had agreed to carry out the 2-month task almost 18 months ago. The BERI PMU had agreed to provide these funds in the 2011 Annual Work Plan. The installation of the load shift mechanism by BESCOM, however, has yet to be done.

This Evaluation recommends that the load shift mechanism be done at the earliest possible time as it directly addresses the primary objective of BERI project and significantly enhances the community stake back into the Project. Targeted villages in Tumkur would gain confidence in BERI biomass power plants to supply reliable power even during events when there is grid failure. Furthermore, community pride from the generation of their own electricity using locally community-owned biomass resources would resurrect community participation and the income generation activities that were prevalent during the 2001-2005 period of BERI. This in turn would have likely improved the ability of the targeted villages to pay for the electricity from the biomass power plants, further contributing to the economic viability of plant.

Recommendation 3: Ensure obligations of Karnataka forest department and others to provide biomass from project plantations.

BERI has provided support to plantation development. Project reports claim close to 3,000 hectares of plantation was developed, one third each in Panchayat land, bund plantations on farmer's land, and on forest department land. The 2010-11 assessment indicated the average annual yield of 5,000 tonnes against an estimated potential of 12,000 tonnes, sufficient biomass for sustained operations of the biomass power plants. However, at present, the wood is purchased mainly from the Forest Department or from private contractors at locations more than 40 miles from Tumkur. The BERI PMU needs to review the agreements, commitments and obligations, with the Forest Department needing to avail biomass from Project plantations in the forest area at a discounted price considering that the BERI Project made substantial investments in these plantations. Irrespective of the result from this evaluation, it is vital that the wood is made available from local sources so that biomass power plant operations are not hampered. There are obvious community benefits from the procurement of biomass from project plantations that would return money back into the local rural economy, restore community pride and encourage community involvement which has been lost since 2006.

Recommendation 4: Outsource operations to encourage entrepreneurship and increase PLF.

Despite the best efforts of the BERI PMU to operate and maintain the Kabbigere bioenergy power plant, 1.35 million kWh of electricity was generated in about five years. This translates to 20% of its generation potential. In comparison to another similar but privately owned bioenergy plants, the Pointec biomass plant (just south of Bangalore) provides electricity equivalent to 60% of its generation potential. The BERI PMU has attempted to outsource operations through bidding; however, no viable bids were submitted. On the advice of IISc, M/S Pointec submitted a proposal for providing O&M support for the Kabbigere plant consisting of a proposed tariff of Rs 11 per kWh for the first three months of operation, slightly lower than the Rs 14 per kWh as estimated by BERI PMU, but higher than the Rs 8.5 per kWh costs estimated by IIM Bangalore (the basis for this is the 1,000 hours benchmark operation of IISc). This proposal should be

accepted as the outsourcing of these operations to the private sector will provide more precision in the benchmarking of operational costs, and assist entrepreneurs and technical professionals in sub-megawatt scale operations. With M/S Pointec revenue linked to plant operation, it would be in M/S Pointec's interest to maximize plant operations; this would help all stakeholders gain insights from the optimized operations of a rural biomass power plant that enhances the PLF and reduces the unit cost of electricity generation.

Recommendation 5: Review institutional arrangements to operate, manage and replicate the BERI model (BERI – Society under RDPR, KSCST with funds, KREDL or KPTCL).

The Project was conceptualized with close linkages to rural development and, as such, BERI was housed in RDPR. The activities ranged from bioenergy packages such as biogas plants, improved cookstoves, bioelectricity supplies for irrigation coupled with enhanced rural electricity reliability and increase incomes. The BERI PMU was formed to focus on project deliverables as per the BERI project design and in close consultation with RDPR and guidance from PSC. Until June 2012, a full time Project Coordinator (senior officer from GoK) was deputed; after June 2012, only a part time PC was in place. Initially, 3 project officers were assigned to manage three different streams namely power plant operations (technology), biomass supply (plantations/forestry) and rural development initiatives (community). During the early periods of BERI, this arrangement helped to kick start BERI; in December 2012, it appears the efforts made will not be sustained unless continued institutional support is made available. The BERI Society (BERIS) was actually formed with the objective of promoting bioenergy in the State of Karnataka and perhaps to other states. The present set up of BERIS does not have any full time personnel and no concrete activities in hand. Under these circumstances, institutional options in a post-BERI regime are as follows[15]:

- Option 1: Strengthen BERIS by recruiting full time personnel, revitalizing community involvement, identifying gaps to make the interventions feasible and sustainable, and proliferating the BERI model. The BERI project has created unique infrastructure such as biomass power plants, 11 kV lines, plantations, and borewells for drip irrigation. RDPR should consider providing funds to BERIS on a sustained basis, and use it as a training and incubation centre;
- Option 2: KSCST was one of the implementing agencies in the original 2001 project document. Subsequently, they were only included as a PSC member and were not involved in implementing the project. Their main goal is "application of science and technology for the management of resources, improvement of environment, quality of life and socio-economic conditions of the people of Karnataka". They have carried out innovative demonstrations, work in close collaboration with different departments of IISc, and qualify as one of the agencies with the wider vision to implement a post-BERI project. During the TE mission discussions, they showed genuine interest to undertake such programmes provided funding is in place. This is a strong option to consider;
- Option 3: KREDL could own, operate and maintain the plant either directly or through outsourcing. KREDL is currently operating a 1 MW wind power plant with a 7-year agreement with MNRE. However, their core business is facilitation of renewable energy and energy efficiency promotion, and not to operate facilities themselves;

[15] The suggested institutional structure for any of the options is that of the agency to administer the BERI activities through the BERI society, where plant operations are outsourced to a private operator. As indicated in Recommendation 4, it ensures a cost-effective option with increased plant operation and helps enhance PLF which reduces the unit cost of power generation.

- Option 4: KPTCL is the main power transmission company in Karnataka State, and could operate the BERI biomass power plant assets;
- Option 5: The Karnataka State Biofuel Board have funds available to promote bio-energy in the state. They can also operate the biomass power plants and continue community activities after the closure of BERI. A formal request from RDPR needs to be made to initiate an official response from the Board on post-BERI involvement;
- Option 6: RDPR can auction or lease the biomass power plants with conditions to run and operate it for a set duration and sharing plant performance data. To be able to exercise this option, the existing PPA of Rs 2.85 per kWh with BESCOM needs to be annulled. This will then provide the new private operator open access to sell green power at premium price to nearby bulk consumer or wheel the power to corporate clients who can buy power at premium prices. Such an arrangement will help the private plant operator to bridge the prevailing viability gap between cost of power supply and prevailing grid tariff in project area.

Recommendation 6: Develop BERI assets as a national training and incubation centre, that is jointly managed by KSCST and IISc that is 50% self-financing (or financing from other sources) and 50% from GoK

The project assets, especially the gasifier based power plants, biogas plants, and plantations can be showcased as successful working demonstrations for training and capacity building of potential entrepreneurs, operators and other stakeholders. This can help in popularizing technologies, contribute to the collection and sharing of knowledge, and contribute to large-scale promotions that will increase the likelihood of replication.

ABBREVIATIONS

Acronym	Meaning
ADCS	Academic and Development Communication Services
APR	Annual Progress Report
ASTRA	Application of Science and Technology to Rural Areas
AWP	Annual Work Plan
BERI	Biomass Energy for Rural India
BERIS	Biomass Energy for Rural India Society
BESCOM	Bangalore Electricity Supply Company
BETA	Biomass Energy Technology Applications
BIRD-K	BAIF Institute for Rural Development - Karnataka
BTOR	Back to Office Report
BUG	Biomass User Group
CER	Certified Emission Reductions
CGPL	Combustion and Gas Propulsion Laboratory
CDR	Combined Delivery Report
DF	Dual Fuel
DPD	Deputy Project Director
EOP	End of Project
ESCO	Energy Service Company
FIT	Feed-in tariff
FSP	Full Sized Proposal
GE	General Electric
GEF	Global Environmental Facility
GHG	Green House Gases
GoK	Government of Karnataka
GoI	Government of India
GW	Giga Watt
GWh	Giga Watt-hour
ICEF	India Canada Environment Facility
IIMB	Indian Institute of Management, Bangalore
IISc	Indian Institute of Science
IIT	Indian Institute of Technology, Mumbai
KPCL	Karnataka Power Corporation Limited
KREDL	Karnataka Renewable Energy Development Limited
KSCST	Karnataka State Council for Science and Technology
KPTCL	Karnataka Power Transmission Corporation Limited
kWh	Kilowatt-hours
LFA	Log Frame Analysis
LIBERA	Livelihood Improvement through Biomass Energy in Rural Areas
M&E	Monitoring and Evaluation
MDG	Millennium Development Goals
MNRE	Ministry of New and Renewable Energy
MRV	Monitoring, Reporting and Verification
MW	Mega Watt
MWh	Mega Watt hour
MTE	Mid-Term Evaluation

Acronym	Meaning
mTOE	Million tonnes of oil equivalent
NGOs	Non-Government Organizations
NPD	National Project Director
NPM	National Project Manager
OEM	Original equipment manufacturers
PAC	Project Advisory Committee
PC	Project Coordinator
PDF-B	Project Development Fund – Block B
PEC	Project Executive Committee
PG	Performance Guarantee
PIR	Project Implementation Review
PLF	Plant Load Factor
PM	Project Manager
PMU	Project Management Unit
PPA	Power Purchase Agreement
PRDC	Power Research Development Consultants Pvt Ltd
PSC	Project Steering Committee
QPR	Quarterly Progress Report
QWP	Quarterly Workplan
R&D	Research & Development
RDPR	Rural Development and Panchayat Raj
RET	Renewable Energy Technology
RPO	Resource Protection Ordinance
SHG	Self Help Group
SMEs	Small and Medium Enterprises
SNA	State Nodal Agency
SPV	Solar Photo Voltaic
TA	Technical assistance
TERI	Tata Energy Research Institute
TIDE	Technology Informatics Design Endeavour, Bangalore
TOE	Tonnes of Oil Equivalent
TCE	Tata Consulting Engineers
TE	Terminal Evaluation
TIDE	Technology Informatics Design Endeavour
ToR	Terms of Reference
TSU	Technical Support Unit
TT	Technology Transfer
TTA	Technology Transfer Agreement
UNDP	United Nations Development Programme
USD	United State Dollar
VBEMC	Village Bioenergy Management Committee
VESP	Village Energy Security Programme
VFC	Village Forest Committee
WB	World Bank
WUA	Water User Association

1. INTRODUCTION

This report summarizes the findings of the Final Evaluation Mission conducted during December 3-8 2012 for "Biomass Energy for Rural India" (herein referred to as the "Project" or BERI) as implemented by the United Nations Development Programme (UNDP), PIMS 598 and with financing support provided by the Global Environment Facility (GEF) and with the co-financing support of the India-Canada Environment Facility (ICEF) (now closed), Government of Karnataka (GoK), and Ministry of New and Renewable Energy (MNRE). UNDP is the GEF implementing agency, while Department of Rural Development and Panchayat Raj (RDPR) under the Government of Karnataka is the project executing agency. The Project Document (Prodoc) of 2001 provides details to remove key barriers to the use of biomass for energy generation in rural communities. The full-scale project started in April 2001 with the signing of the Project Document, with original project implementation duration of 5 years from May 2001 until May 2006, which was extended three times with December 31, 2012 now being the formal project terminal date.

1.1 Background

1.1.1 Overview of the Indian Energy Sector

India's per capita energy consumption is very low; as such, its per capita greenhouse gas (GHG) emissions have also been low. However, by virtue of its large population, India is expected to exert a major influence on global energy investments and carbon trajectories. India's rural population as of 2011 was estimated at 742 million comprising 61% of its total population. India's rural households are currently electrified while 88% of urban households are electrified[16]. With an average household size of 4.8 persons, there are an estimated 154 million rural households in India of which 86 million households or 56% do not have access to electricity; most of this segment of India's population has income levels of less than USD 2.00 per day[17]. The Government of India has set an ambitious target of eradicating poverty by 2031 through sustained economic growth of 8 to 10% per year.

To keep pace with its rapidly developing economy coupled with social changes and increased energy demand, India will be facing formidable challenges to modernize its energy infrastructure. In the past 10 years, energy demands have sharply increased; this trend is likely to continue in the short-term given India's strong economic growth, current population growth trends and changing lifestyle patterns. The Planning Commission has estimated that commercial energy supplies will need to be increased at least three-fold by 2031-2032 if India is to sustain the 8% annual growth of its GDP.

Over the past 10 years, India's share of the global commercial energy consumption has increased from 2.9% to 3.8% making it the fifth largest consumer of commercial energy. With more than half the commercial energy supply, coal is by far the most important energy source for India followed by oil, which is mostly imported. Nuclear and renewable energy play a minor role, though its share is projected to increase significantly. Pertinent to this Project is the estimated 72% of rural households in India (139 million of the total 194 million rural households) that use traditional forms of energy such as firewood, crop

[16] Census of India 2011
[17] Ministry of Power data on urban and rural electrification

residue, wood chips, and cow dung cakes for cooking which has not been included here as a source of energy.

1.1.2 Indian Power Market

With India's growing economy, investments into India's power infrastructure have not kept pace, placing major challenges to the GoI with regards to maintaining the quantity and quality of the electricity supply. The most pressing needs of the Indian power market includes the doubling of its total installed capacity over the next 10 years and ensuring a stable supply of fuels from indigenous and imported energy sources. The demand for electricity is mainly driven by economic growth and the improvement in the quality of life. However, the development of new power generation sources will need to be done in a manner that provides cheap power to rural areas, increases access of modern electricity services as a means to eradicate poverty, and increases electricity supplies without adverse environmental impacts and increased GHG emissions.

Total power generation capacity in India in May 2011 was 175,000 MW excluding an estimated 20,000 MW of captive power plant installations. Thermal power (coal, gas, and diesel) still dominates the Indian power sector with installed capacity of 114,000 MW (65.1%) followed by hydro power (38,000 MW, 21.6%), nuclear power (5,000 MW, 2.7%), and renewable energy (18,500 MW, 10.6%). Despite improvements by the GoI to improve energy availability in 2010 and 2011, the energy supply shortages prevailed in the country both in terms of energy and peaking availability. All the regions in the country namely Northern, Western, Southern, Eastern and North-Eastern regions continued to experience energy as well as peak power shortage of varying magnitude on an overall basis. The energy shortage varied from 4.3% in the Eastern region to 13.3% in the Western region.

For rural households, grid connection remains the most favoured approach to rural electrification for the majority of rural households. In 2005, the Ministry of Power had setup the Rajiv Gandhi Grameen Vidhutikaran Yojana (RGGVY), a programme designed to attain the goal of "Electricity for All" through the vast expansion of the existing grid network to reach all villages by 2012. The GoI, however, still faces challenges in meeting the programme goals of complete rural electrification since the real costs of transmission and distribution of rural electricity are higher than the end-user's ability to pay for these services. There are a number of studies where the cost of grid electricity delivery to rural areas can be around three times generation costs[18]. As such, the concept of community-based power generation using biomass has appeared attractive.

1.1.3 Renewable Energy Status

India achieved a cumulative installed capacity of 10,161 MW of renewable energy by the end of the Tenth Plan (2007), and is targeted to achieve a total installed grid-connected renewable generating capacity of over 25,000 MW and 74,000 MW by the end of the 12th and 13th Plans; wind and solar projects are expected to account for more than 80% of the installed renewable energy capacity. Table 1 provides the cumulative & targeted capacities of different renewable energy technologies in India.

[18] Cust, A. Singh and Neuhoff, `Rural Electrification in India, Economic and Institutional Aspects of Renewables` (2008), http://nexus.som.yale.edu/design-selco/sites/nexus.som.yale.edu.design-selco/files/imce_imagepool/IndianRuralElectrification.pdf

Table 1: Installed Renewable Energy Capacity in India

Resource	Estimated Potential (MW)	Cumulative till September 2012
Wind power	48,500	18,192
Small Hydro Power	15,000	3,447
Bio Power (including cogen)	23,700	3,359
Solar Power	20-30 per km^2	1,045

1.1.4 Grid Connection and Status

In March 2009, the Indian power network had a total length of 7.49 million circuit kilometres. In comparison to the power generation sector, investments into the transmission and distribution networks have been on the decline. Though the transmission network has improved considerably, distribution networks remain in a poor state. The current 11th Plan envisions the extension of the high-voltage network by 95,000 circuit kilometres (capacity of more than 178,000 MVA) and 3,253,773 circuit kilometres (capacity of 214,000 MVA) that are to be added in the low voltage area. The latter has gained importance with the "Power for All by 2012" mission, declared by the GoI with an ambitious goal of providing power to all Indian villages by 2012.

1.1.5 Rural Electrification Status

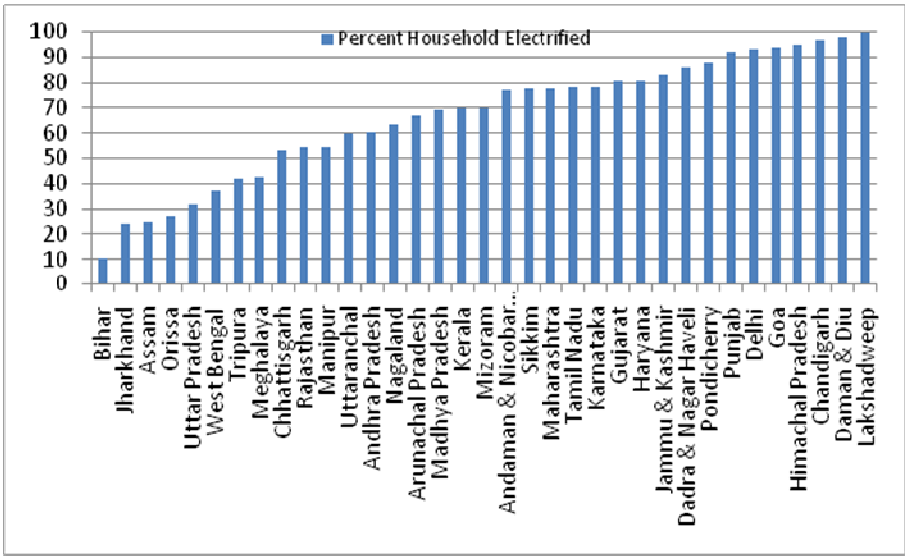
As previously mentioned, the GoI has placed a high priority on rural electrification as a key to sustained rural development. Rural electrification is also considered a basic pre-requisite for all industrial activity that will significantly contribute to increasing agricultural productivity, employment and income generation activities. Several programmes, mainly the RGGVY programme, have been initiated at the national level to promote electrification of rural village households through deployment of various renewable energy technologies (RETs) which include family biogas plants, solar street lights, solar lanterns, solar PV systems, biomass gasifiers and micro-hydro plants. Several programmes and policies have also been initiated that focus on the development of rural energy, economy, and electrification to improve rural livelihoods using locally available sources of renewable energy. Despite these long-running policy interventions, actual performance on rural electricity services continues to be dismal. According to the International Energy Agency, in 2009, more than 288 million Indians did not have access to electricity[19]. Figure 1 provides information on the rates of electrification in different Indian states as of March 2010.

1.1.6 Renewable Energy for Rural Electrification

RETs such as solar energy, biomass, wind, or hydro energy have substantial potential to provide reliable and secure energy supply as an alternative to grid sources or as a supplement to grid power. The major barrier for large scale deployment of renewable energy sources and its utilization for rural electrification is large capital investment, the subsequent higher cost of electricity, and higher subsidized grid tariffs. There is also a large risk of renewable off-grid installations becoming redundant once the grid expands. As such, there is a need to develop policy and regulatory interventions that would address these two primary risks, which is the main objective of this assignment.

[19] http://www.iea.org/media/weowebsite/energydevelopment/WEO-2011_new_Electricity_access_Database.xls

Figure 1: Rural Electrification in India by State



1.1.7 Rationale for BERI

The BERI project was conceived in the early 1990s from the Centre for Application of Science and Technology to Rural Areas (ASTRA; now called Centre for Sustainable Technologies), part of the Indian Institute of Science (IISc). The project idea was inspired by a number of successful research, development and pilot projects by CGPL-IISc (Combustion Gasification and Propulsion Laboratory, Indian Institute of Science) in the early 1990s. The pilot projects focused on de-centralized energy services that were providing reliable energy supplies to rural farmers to irrigate their fields by using small 10-20kW biomass gasifier based power generation system using locally available biomass.

BERI was conceived as a project with GEF funding to create a decentralized and sustainable energy generation and distribution system to provide comprehensive and high quality rural energy services that are critical for promotion of rural development and improve the quality of life in rural communities. The Project aim was to provide a reliable high quality supply of energy for these services for rural populations. The original design of BERI envisaged 60 - 20 kW_e biomass gasifier units to supply electricity for 2,500 households in 28 villages belonging to five different talukas (Koratagere, Madhugiri, Sira, Gubbi, and Tumkur) in Tumkur district of Karnataka. To ensure the sustainable supply of biomass fuel to these gasification units, the Project also envisaged promoting energy efficient cookstoves and community biogas plants for biomass conservation as well as building of community capacity for irrigation, generation of cooking fuels, growing plantations.

The intended impact of BERI was to reduce GHG emissions from the primary use of fossil fuels that were used for various household purposes such as cooking, lighting, fans, irrigation pumps and other power applications.

1.2 Terminal Evaluation

1.2.1 Purpose of the Evaluation

In accordance with UNDP and GEF M&E policies and procedures, all full and medium-sized UNDP support GEF financed projects are required to undergo a Terminal Evaluation (TE) upon completion of implementation of a project to *provide a comprehensive and systematic account of the performance of the completed project by evaluating its design, process of implementation and achievements vis-à-vis GEF project objectives and any agreed changes during project implementation.* As such, the TE for this Project will serve to:

- promote accountability and transparency, and to assess and disclose levels of project accomplishments;
- synthesize lessons that may help improve the selection, design and implementation of future GEF activities;
- provide feedback on recurrent issues across the portfolio, attention needed, and on improvements regarding previously identified issues;
- contribute to the GEF Evaluation Office databases for aggregation, analysis and reporting on effectiveness of GEF operations in achieving global environmental benefits and on the quality of monitoring and evaluation across the GEF system.

This TE was prepared to:

⇒ be undertaken independent of project management to ensure independent quality assurance;

⇒ apply UNDP-GEF norms and standards for evaluations;

⇒ assess achievements of outputs and outcomes, likelihood of the sustainability of outcomes; and if the project met the minimum M&E requirements;

⇒ report basic data of the evaluation and the project, as well as provide lessons from the Project on broader applicability.

TE mission was fielded to India in the city of Bangalore with a field trips to the Project sites in Tumkur District between the 3rd and 8th of December 2012. The Terms of Reference (ToRs) for the TE are contained in Appendix A.

Key issues addressed on this TE include:

- The appropriateness of the BERI concept and design in the context of commercializing biomass based technology in India;
- Implementation of BERI in the context of relevance, efficiency and effectiveness of the activities;
- BERI impacts based on current outputs and outcomes and the likelihood of sustaining project results; and

- The future role of BERI as a "Centre of Excellence" in promoting bioenergy technologies for rural development applications.

Outputs from this TE will provide guidance in charting future directions on sustaining the use of biomass for the generation of electricity in rural areas of India.

1.2.2 Evaluation Scope and Methodology

The methodology adopted for this evaluation includes:

- Review of project documentation (i.e. APR/PIRs, meeting minutes of Steering and Advisory Committees) and pertinent background information;
- Interviews with key project personnel including the Project Manager, technical advisors (domestic and international), demonstration project proponents, potential investors and relevant UNDP staff;
- Interview with relevant stakeholders from Government;
- Field visits to selected project sites and interviews with beneficiaries.

A full list of documents reviewed and people interviewed is given in Annex B (with the list of questions prepared for various government and private stakeholders). A detailed itinerary of the Mission is shown in Appendix C. The Evaluation Mission for the UNDP-GEF project was comprised of one international expert and one national expert.

1.2.3 Structure of the Evaluation

This evaluation report is presented as follows:

- An overview of project achievements from the commencement of operations in May 2001;
- An assessment of project results based on project objectives and outcomes through relevance, effectiveness and efficiency criteria;
- Assessment of sustainability of Project outcomes;
- Assessment of monitoring and evaluation systems;
- Assessment of progress that affected Project outcomes and sustainability; and
- Lessons learned and recommendations.

This evaluation report is designed to meet GEF's "Guidelines for GEF Agencies in Conducting Terminal Evaluations, Evaluation Document No. 3" of 2008:

http://www.thegef.org/gef/sites/thegef.org/files/documents/Policies-TEguidelines7-31.pdf

The Evaluation also meets conditions set by the UNDP Document entitled "UNDP GEF – Terminal Evaluation Guideline" (http://erc.undp.org/resources/docs/UNDP-GEF-TE-Guide.pdf) and the UNDP Document entitled "Handbook on Planning, Monitoring and Evaluating for Development Results", 2009:

(http://www.undp.org/evaluation/handbook/documents/english/pme-handbook.pdf)

and the "Addendum June 2011 Evaluation":

http://www.undp.org/evaluation/documents/HandBook/addendum/Evaluation-Addendum-June-2011.pdf

1.2.4 Project Implementation Arrangements

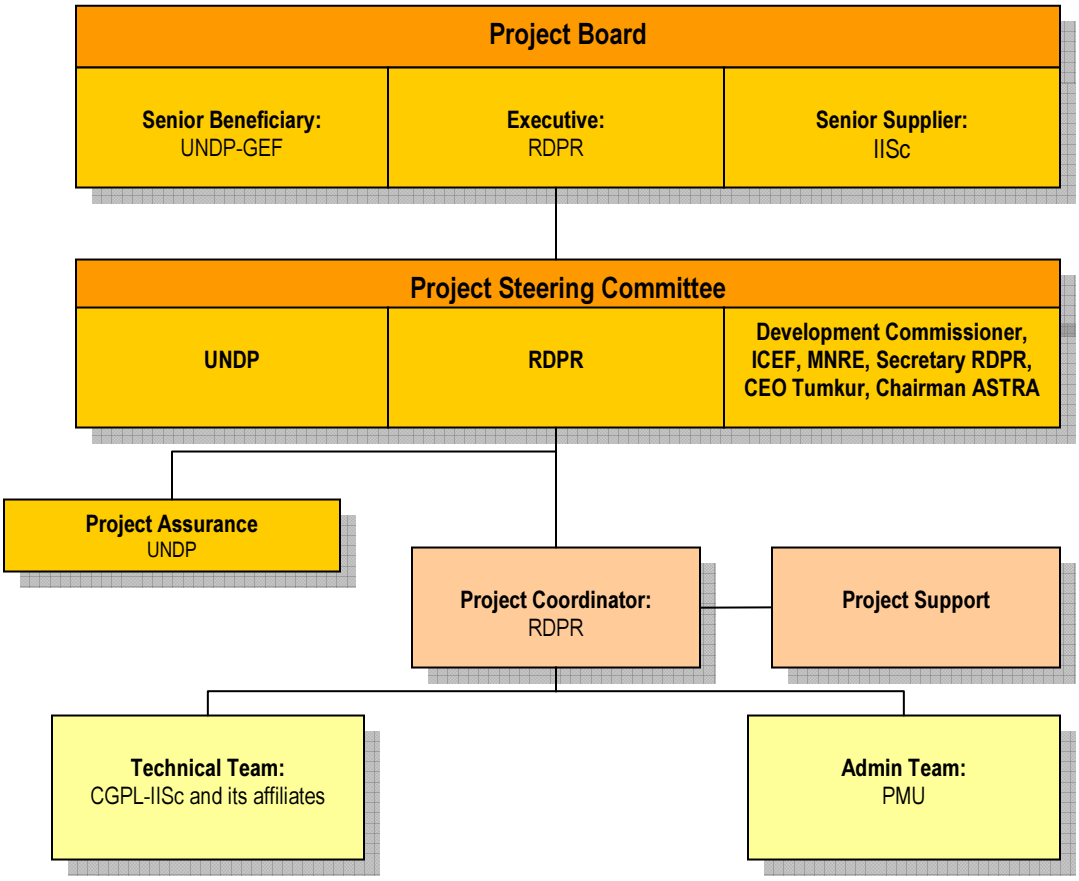
BERI was implemented by the Department of Rural Development and Panchayat Raj (RDPR) of the Government of Karnataka (GoK). Project operations were managed by the Project Management Unit (PMU) under UNDP India from its office in Bangalore. All Project activities managed by the PMU (e.g. Project expenditures and annual work plans) required clearance from RDPR and the BERI's PSC. The Project Coordinator (PC) was assigned from RDPR to provide the overall direction to BERI[20], and as the head of the PMU[21], the PC was tasked with closely coordinating Project activities with all Project stakeholders and providing progress reports to UNDP India. Originally, the PMU was to be located in Tumkur but was finally placed in Bangalore.

BERI's PSC meetings were chaired by the Development Commissioner and included members from UNDP, ICEF, MNRE, MoEF, representatives from Department of Economic Affairs, and senior officials for the GoK including the Secretary, RDPR; Secretary, Energy; Secretary, Finance, and Director, Area Development Programme, CEO, Tumkur, Chairman, ASTRA, and two experts. Apart from this, BERI Project personnel (including PCs and Managers) and invitees (including BESCOM, KREDL, KPCL, KPTCL, CGPL-IISc, and consultants) participated in past PSC meetings as required.

[20] Initially, there were three project coordinators assigned dealing separately for forest, energy and community related activities.

[21] Earlier, there were two committees in addition to the PSC: the Project Executive Committee (PEC that was a subset of the PSC designed for quicker decision-making), and a project advisory committee (PAC) at the district level in Tumkur. Only one PEC meeting took place after which it was effectively dissolved.

Figure 2: BERI Project Implementation Arrangements in 2012



2. BERI DESCRIPTION AND DEVELOPMENT CONTEXT

2.1 BERI Start and Duration

BERI project document was signed in April 2001 with operations commencing in May 2001. While the original project design envisioned a 5-year project, BERI was extended three times to its current terminal date of December 31, 2012.

2.2 Problems that BERI Sought to Address

BERI was aimed at demonstrating the concept of decentralized energy production using renewable biomass primarily to provide reliable energy supplies to rural communities, and secondarily, to promote sustainable rural development and increase local employment opportunities. This concept was to be demonstrated through pilot demonstrations in 28 villages of Tumkur District of Karnataka State. BERI sought to demonstrate this sustainable rural development model where local biomass energy resources could be sustainably harvested from community-managed plantations and utilized to meet local energy demand using various bio-energy technologies. Technologies envisaged on the Project included biomass gasification for electricity generation, and biogas plants (using cow dung and leaf litter) for cooking fuel and household lighting.

BERI sought to overcome the following barriers for the successful implementation of this sustainable rural development model including:

- The technical barrier related to the lack of an appropriate and reliable technology that could successfully demonstrate a decentralized biomass gasification system that would produce power and cooking fuel;
- Institutional barriers related to local community organizations to implement bioenergy projects and services;
- Market barriers related to the inability of the local community to pay for modern energy services;
- Information barriers related to the lack of available information on biomass energy as a viable alternative to improving access to modern energy services for rural communities; and
- Financial barriers related to the perceived technical and financial risks of bioenergy systems and the consequent lack of available capital finance.

2.3 Immediate and Development Objectives of BERI

The Project's development **goal** is to "*reduce CO_2 emissions through the promotion of bioenergy as a viable and sustainable option to meet the rural energy service needs in India*".

The Project's **immediate objective** is *to provide a decentralized bioenergy technology package for the provision of good quality rural energy services for lighting, drinking water supply, cooking gas, irrigation water supply and milling*.

2.4 Main Stakeholders

Aside UNDP/GEF, ICEF, MNRE (GoI), and Government of Karnataka (GoK) who are project co-financers, the main stakeholders of BERI include:

- Department of Rural Development and Panchayat Raj (RDPR) under the GoK, who are the project executing agency;
- CGPL-IISc (Combustion and Gasification Propulsion Laboratory, Indian Institute of Science, Bangalore), who are technology developer and provider of biomass gasifier for power generation;
- Technology Informatics Design Endeavour (TIDE), Bangalore, who are technology provider for improved cookstoves and associated activities for training and capacity building;
- BAIF Institute for Rural Development – Karnataka (BIRD-K), the main NGO involved in training and capacity building as well as community mobilization activities;
- Tumkur Zilla Parishad, and the District level administration (e.g. District Level Forest Division);
- Panchayats from the Project area;
- Village community institutions including Village Forest Committees and Self-help Groups in target communities;
- Three gasifier power plant equipment suppliers: Energreen, NetPro, ASCENT;
- PDRC, a consulting organization involved with preparing DPRs, selection of target villages and the grid integration study;
- Indian Institute of Management Bangalore (IIM) who provided consulting services for the cost benefit analysis of various power generating options;
- Tata Consulting Engineers (TCE) who were involved in preparing DPRs and developing technology specification;
- ADCS, consultants who were involved in preparing a documentary film on BERI Project NGOs that are working in the 5 “clusters” consisting of 28 villages; and
- The Karnataka State Council for Science and Technology (KSCST), who designed the original BERI project in 1999.

Other stakeholders of BERI include:

- Central Government ministries and departments including:
  - Ministry of New and Renewable Energy (MNRE) responsible for promotion of various renewable technology and systems throughout the country;
  - Ministry of Environment and Forests (MoEF) responsible for environmental issues including GHG emissions, climate change and forests, and serving as the Government’s official focal point for GEF projects;
- Central and State Government ministries and departments including:
  - Karnataka Renewable Energy Development Ltd. (KREDL), a state nodal agency (SNA) of MNRE for Karnataka, and responsible for the promotion of renewable energy in the State;
  - Panchayats (local government) and Zilla Parishads (District Administrations);
  - State level administration including the Department of Rural Development, the Department of Forest and Panchayat Raj;
- Villagers who are the end-users and consumers of biomass energy and beneficiaries of various community development and income generation initiatives;

- Producers and suppliers of village-scale energy technologies, equipment, and services providers; and
- Civil society and NGOs.

2.5 Expected Results

To achieve this overall goal and objective, BERI was designed for the removal of barriers with the following expected **project outcomes:**

Outcome 1: *Technology package is standardized through the following outputs:*

Output 1.1: Gas engines that have been developed, locally available and adapted to use bioenergy feedstock;
Output 1.2: Detailed technical specifications drawn for proposed bioenergy packages; and
Output 1.3: Draft standards for bioenergy technologies.

Outcome 2: *Technology and proof of concept demonstrated*

Output 2.1: Installed 60 - 20 kW bioenergy systems with the recommended specifications and standards;
Output 2.2: 120 kW community biogas-cum-biofertilizer systems for domestic electric load;
Output 2.3: 45 community biogas-cum-biofertilizer for cooking energy;
Output 2.4: Established short rotation energy forest plantations, agro-forestry systems, community forestry, horticulture orchards and high input forestry;
Output 2.5: Lessons in different models of providing the rural energy service package to rural villages.

Outcome 3: *Capacity of relevant project stakeholders and institutions has been strengthened*

Output 3.1: Bioenergy packages for replication in other parts of rural India;
Output 3.2: Database on carbon flows with approach and methodology for monitoring carbon flows in bioenergy projects;
Output 3.3: Training and involvement of women in planning and management of the bioenergy systems;
Output 3.4: Training centre for training entrepreneurs, NGOs and managers on implementation technology and institutional package;
Output 3.5: Training for entrepreneurs, NGOs, technicians and managers in the business skills.
Output 3.6: Infrastructure development for manufacturing, spare parts supply and servicing of bioenergy systems

Outcome 4: *Enabling environment for bioenergy development has been created*

Output 4.1: Fee-for-service approach/framework;
Output 4.2: Policy papers to address the issue of level playing field for bioenergy package;
Output 4.3: Case studies on bioenergy technologies and field implementation;
Output 4.4: Workshops to involve stakeholders to exchange the experiences, study tours and policy research activities;
Output 4.5: Documentation of lessons learnt and sharing of experiences;

Output 4.6: Monitoring and evaluation of the proposed project approach and activities.

Outcome 5: *Information on bioenergy disseminated*

Output 5.1: Information package on bioenergy technologies, manufacturers, technology suppliers, financial mechanisms, technical performance, R & D facilities, and technical experts;
Output 5.2: Methods for project formulation including financial analysis, implementation, and monitoring;
Output 5.3: Promotional modules using audio-visual, print and other media.

Outcome 6*: Financial barriers removed and investment risk fund created*

Output 6.1: Provision of venture capital for franchisers and franchisees as start-up capital;
Output 6.2: Operational revolving fund to offset perceived investment risks;
Output 6.3: Approach involving bidding for concessions to operate future bio energy systems;
Output 6.4: Cost recovery mechanisms to demonstrate economic and financial;
Output 6.5: Demonstration of willingness & capacity of rural households to pay for good quality energy services.

Section 3 will provide details on the actual BERI outcomes and outputs.

3. FINDINGS

3.1 Project Design and Formulation

3.1.1 Analysis of LFA / Results Framework

The LFA for BERI was comprehensive and ambitious in that it was designed to achieve holistic changes to the community over a 4-year period. The LFA included a number of activities designed to strengthen the delivery of rural energy services (through the involvement of the local community to supply biomass as feedstock for energy, and to operate the biomass energy plants) and to create more demand for modern energy services through measures to improve the income generation of targeted communities. In this regard, the BERI design was also complex, addressing a number of cross-cutting issues from agriculture and forestry to power generation to rural development.

In summary, the design of BERI as setup in the LFA is solid and holistic in nature, with logical activities towards an overall goal of delivering modern energy services to rural communities.

3.1.2 Assumptions and Risks

Notwithstanding the strength of the BERI design, it was highly dependent on the success of the biomass gasification demonstration for the generation of electricity to targeted rural communities (Outcome 2). To this extent, the 1999 design of BERI assumed that the biomass gasification technology for electricity generation was mature with minimal R&D required, and was based on biomass gasifier pilot projects on de-centralized power generation using woody biomass deployed at Hosahalli in the Tumkur District by IISc and KSCST in the mid-1990s.

One omission from the Project design was the assumption that demands for decentralized energy services would be sustained throughout the project period. The prevailing mind-set of rural communities during the 1990s and even today has been the preference for grid energy services as opposed to decentralized energy services as envisaged by the BERI design notwithstanding the fact that grid services in general have not recently provided reliable electricity supplies to rural areas. India, in fact, had achieved significant progress on rural electrification throughout the 1900s and 2000s; an example is the State of Karnataka which now has a 78% rural electrification rate, one of the highest in India as shown on Figure 1. The problem with rural electrification, however, has been the efficiency and reliable supply of electricity delivery where rural areas can experience up to 4 hours of daily load shedding.

There were technical difficulties in the implementation of mobile 20kW gasifiers in a rural setting where heavy gasifiers were mounted on tractor trailers and taken to each farmer's field to provide electricity for irrigation. The connection of single or set of larger gasifier plants to the local grid in an "island mode of operation" was found to be not technically feasible due to integration issues with local grids. This forced BERI to shift from a decentralized energy delivery model to a centralized model. The impacts of this shift to the implementation of BERI resulted in changing the required biomass gasification technology from 20 kW to more than 500 kW to suit the needs of a centralized power delivery model, and forcing the Project to deliver electricity through the national grid.

3.1.3 Lessons from Other Relevant Projects Incorporated into BERI Design

The design of BERI was unique in that it was based on pilot projects for decentralized energy services in the Tumkur District in the mid-1990s.

3.1.4 Planned Stakeholder Participation

Delivery of the development and immediate goals of BERI were to be strengthened through the close involvement of the targeted communities that were to be mobilized with BERI resources. The approaches of BERI to mobilize the targeted communities were excellent and included the entire spectrum of stakeholders from local residents and Panchayat officials, to the local Forestry Department, NGOs and various private entities supplying equipment and technical assistance to implement the Project.

3.1.5 Replication Approach

The replication approach of BERI was to demonstrate the development of biomass energy in a holistic manner. This was to be accomplished by providing BERI technical assistance resources to remove technical, capacity, information, market and financial barriers. Information on the successful demonstration of this model would then be disseminated with expected replication of the model in other communities throughout India and globally. The largest risk to this approach, however, was the high dependence on the successful deployment of the gasification technology to deliver rural energy services, and the assumption that modern energy services from decentralized sources would be in demand throughout the Project period.

3.1.6 UNDP Comparative Advantage

The strength of UNDPs involvement to implement BERI is its long-term involvement in providing technical assistance for renewable energy development to developing countries with a focus on poverty alleviation and energy security. With UNDP having implemented more than 2,000 such projects for more than 20 years in a number of developing countries, it has developed strength from an excellent track record of developing local capacity, effectively working with multiple stakeholders from public and private sectors, technical experts, civil society, and grassroots level organizations. In the context of rural development, UNDP has a multi-dimensional development perspective, and an ability to address cross-sectoral issues and inclusiveness in constituency building.

3.1.7 Linkages between BERI and Other Interventions within the Sector

There were several parallel interventions that were undertaken prior to and during BERI project implementation. Parallel initiatives being experimented by various people and organizations within the country with a common aim for promoting renewable bioenergy included:

- In 2002, the LIBERA (Livelihood Improvement through Biomass Energy in Rural Areas) Programme commenced with the concept of promoting biomass as fuel for sustainable rural development. LIBERA was implemented by TERI under its

Biomass Energy Technology Applications (BETA) group and promoted biomass gasifiers for thermal applications in rural SMEs to reduce fuel wood consumption;

- The Village Energy Security Programme (VESP) was implemented by MNRE during 2005-09 with Technical Assistance Support from the World Bank with an objective of exploiting locally available renewable biomass energy resource for energy security of villages. Both electrical and thermal energy was provided to target communities;
- CGPL-IISc and ASTRA developed and promoted gasifier systems prior to and during BERI, for power and process heat applications such as large improved biomass cookstoves for rural enterprises;
- Two grid connected gasifier power plants have been operating over the past several years with mixed results and generating carbon credits through CDM. The first one is the 1.5 MW Aarshi Plant in Tamilnadu based on IISc technology [22] and other one is the 1.2 MW Ankur Gasifier plant recently commissioned at Sankheda, Gujarat[23];
- DESI Power has had a continual involvement in the Baharbari area of Bihar State in promoting biomass energy to improve rural standards of living through successful demonstrations of decentralized power for productive load and sustainable supply of local fast growing wood species called *Dhencha.* DESI has recently launched 100 village programmes using a similar philosophy and seeking carbon financing to enhance its sustainability;
- Husk Power has also had recent successes in promoting rice husk based biomass gasifier power plants by providing residential lighting for a 6-hour period in rural areas in Bihar on a commercial basis in decentralized mode;
- The Government of India between 2000 and 2010 promoted the use jatropha for bio-oil plantations with the objective of demonstrating sustained rural development by utilizing adjacent waste lands, generating local income generation activities, and generating large quantities of bio-oil for conversion to biodiesel.

Since 2000, there have been significant technological advancements for engines fuelled on 100% producer gas from a biomass gasification process. These started with modifications of diesel engine that were converted into a spark ignition engine. IISc collaborated with Cummins Engines on the development of a 32 kW_e producer gas engine which was tested in IIT, Mumbai. The outcome of this development was Cummins providing an after-sale warranty on the engine conditional with gas quality and the guarantee with IISc licensee gasifier manufacturers in 2008. GE-Siemens also initiated work on developing and testing gas engines coupled with gasifier which has made good progress but has yet to be commercialized; CGPL-IISc is planning to collaborate with GE-Jenbacher with their gas engines.

3.1.8 Management Arrangements

The key aspect of BERI's management arrangements is the Project Coordinator (PC) who is a senior officer from RDPR, and the Project's PMU (under the direction of the PC) who prepare plans and monitoring reports as per UNDP-GEF requirements. To strengthen the PC's functions, the BERI management arrangements also had various committees in place (the PSC, PAC, PEC, TSU) that were designed to guide project

[22] Reportedly not operational in 2012
[23] Reportedly operating at a PLF of 30%, quite low and marginally not profitable

activities, closely monitor project progress, support technical activities for the emerging gasifier power generation technology being used on the Project, and augment delivery of BERI outputs and objectives. At the commencement of BERI, KSCST was to be the implementing agency with the advantages that it has a close working association with IISc, the technology provider for power gasifiers installed in BERI.

3.2 Project Implementation

BERI was implemented from 2001 to 2012 over which the implementation can be divided into distinct periods with a listing of major achievements and activities:

Community Development (2001 to 2005):

- Community mobilization (2001-2003);
- Community level activities (2002-2005);
  - Plantations (for sustainable fuel supply);
  - Greening area that is not harvested for fuel supplies (for CO_2 sinks);
  - Drip irrigation (enhancing household incomes);
  - Biogas plants, energy efficient cooker stoves (to reduce deforestation);
  - Community self-help groups and formation of community societies (to accelerate and sustain community transformation activities);

Biomass Energy Development (2006-2009):

- Installation of biomass gasifier based power plants at:
  - Kabbigere (200kW+100kW+100kW+100kW (dual fuel));
  - Borigunte (250kW_e);
  - Seebanayanpalya (250kW_e);
- Commissioning of power plants;
- Overcoming teething troubles with respect to the technology;
- Extension to grid and connectivity to rural end-users.

Power Plant Operations and Exit Strategy (2009-2012):

- Operationalizing bioenergy plants;
- Performance guarantee testing;
- Operating and logging data for long duration;
- Developing benchmarks and technology specifications;
- Improving plant load factors (PLF) and power evacuation capabilities;
- Documentation of project findings;
- Preparing of exit strategies to sustain and replicate project activities.

The major shift in project design was from the off-grid (60 decentralized small biomass gasifier power generating systems of 20kWe capacity each spread over 24 project villages of Tumkur district) at concept stage to a small number of large grid connected systems of ranging from 100 to 250 kW_e capacity at the start of BERI. In addition, the 120 kW_e capacity community leaf and litter-based biogas-cum-biofertilizer plant to supply power for a domestic lighting load was dropped.

The Evaluators observed that BERI was implemented with strong focus on activities that were deemed by Project personnel as high priority with the unfortunate loss of focus on the remaining Project activities:

- During the 2001-2005 period, BERI was focused mainly on community mobilization and plantation activities, improving the capacity of the rural community to pay for modern energy services, and developing sustained local biomass resource supplies for gasifier power plant operation;
- During the 2006-2012 period, BERI focus was primarily on the installation and operation of the three gasifier power plants. This included:
    - plant construction between 2006 and 2008;
    - plant commissioning between 2008 and 2009; and
    - optimizing operations to enhance the PLF to improve operational economics, and to implement a load shift mechanism that enables the plants to supply reliable power to villages during periods when there is an absence of grid power between 2010 and 2012.

The outcome of this was the loss of focus on community involvement to supply biomass to the bioenergy plants and eventual disenfranchising of the community and its plantation and community development activities.

3.2.1 Adaptive Management

Since the commencement of BERI in 2001, the Project has had to adapt to changing circumstances resulting in a number of adaptive management measures being undertaken:

- In 2001, at the commencement of BERI, there was a shift in focus from a decentralized approach (60 - 20kW$_e$ gasifier systems) to a centralized approach (1MW$_e$ in 3 village clusters) based on the recommendations of the PRDC study in 2002, and considering that all targeted villages were already electrified and receiving grid power, though the grid power was not sufficient and reliable. As such, the Project had to adapt to these circumstances by incorporating larger size gas engines in keeping with the objectives of supplying bioenergy to the target communities, albeit through the grid. These issues were further compounded by the lack of an available and mature gas-fired engine until 2006 that could generate power from producer gases from the gasification process;
- During the 2001-2005 period, BERI Project Coordinators focused more efforts on community development activities until the biomass energy technologies were ready for deployment. Community development itself required adaptive management to generate and sustain community interest and involvement on the Project and to prepare them for adopting the new technologies and farming methods designed to improve rural quality of life and increase income generation activities[24];
- During the 2006-2009 period, and with guidance from the 2005 BERI mid-term evaluation, PCs shifted the Project focus to biomass energy plant installations;
- During the 2009-2012 period, PCs were focused on overcoming technical and administrative issues in commissioning the 3 bioenergy plants. As such, BERI

[24] The Project responded to community needs by investing resources into community development initiatives such as borewells coupled with drip irrigation system and irrigation rights to one acre of land; this helped farmers increase their crop yields and increase their earnings to pay for modern energy services. Even landless farmers were given right to irrigate a half acre of land for which they could trade and earn additional income. This raised awareness of the Project, its immediate benefits, and other initiatives such as biogas generation from animal waste and energy efficient biogas stoves.

was extended 3 times during the 2005 to 2012 period to complete the bioenergy plants, and to commission them for operations. During this time, BERI managed through its technology providers and operators to successfully generate 1.5 million kWh of bioenergy into the national grid, a major achievement for a rural grid-connected gasifier power plant. Unfortunately during this period, Project activities:

- primarily focused on the generation of electricity from installed gasifiers;
- disenfranchised the targeted communities since the electricity delivered to the grid did not improve the reliability of their grid electricity supplies. This was due to the lack of a load shifting mechanism that could deliver electricity from the Kabbigere plant to the targeted communities during periods when the grid is down;
- no longer focused on community developmental activities and the incentives for supplying biomass from the local plantations were lost.

3.2.2 Partnership Arrangements

During the initial period of BERI from 2001 to 2006, a number of activities related to community awareness, mobilisation and livelihood improvement activities were implemented. Partnerships that were strengthened during this time included:

- The VBEMC (Village Bioenergy Management Committees) that was established to facilitate participation of the village communities in the decision-making process. The VBEMC was reported to have represented 97% of all households in the targeted communities;
- Local forest officials whose involvement was crucial in facilitating a sustainable biomass supply to the gasifier power plant;
- VFCs (Village Forest Committees) that were formulated to promote afforestation activities and several *bund* plantations (plantations along the borders of farms to minimize the use of cultivable land);
- WUAs (Water User Association) formed to managing drip irrigation using borewells;
- BUG (Biomass User Group) formed to staff biogas plants. At the later stages of BERI, BUGs were no longer functional due to the lack of reliable supplies of cattle waste and a lack of cooperation to manage community plant;
- BIRD-K who were involved in various community mobilization and capacity building initiatives;
- TIDE, an NGO who provided training, capacity building, and technical and implementation assistance in the diffusion of improved cookstoves.

During the latter phases of BERI from 2006 to 2012, major partnerships in the development of the bioenergy technology package included:

- CGPL-IISc as technology developer and provider;
- Energreen Power Ltd., Netpro Renewable Energy India Pvt. who emerged as licensees to supply, install and operate IISc power gasifier equipment;
- PRDC who conducted detailed studies to size the bioenergy plants, reorganize the local grid and to integrate the local power generation sources with the local grid;
- TCE for developing bioenergy system specifications;

- IIMB for conducting comparative cost benefit analysis of various RE options and conventional power generation; and
- Several independent consultants who provided specialized inputs into the bioenergy technology package.

3.2.3 Feedback from M&E Activities Used for Adaptive Management

There is evidence that PSC meetings were the primary means of adaptively managing BERI. The Project also had a number of other committees to be formed such as the Project Executive Committee (PEC) to accelerate executive decisions or the Technical Support Unit (TSU) to overcome technical problems; these committees were never formed as there appeared to be insufficient time to convene their meetings. PSCs, however, were regularly convened, and provided the only forum for decisions on procedures, general strategy and reporting of various events and outputs of the Project.

Initially, BERI had separate PCs looking after key project components such as the plantation and forestry initiatives, community development, and energy-related activities. By 2006, only one PC was assigned to focus on the bioenergy plant installation, commissioning, and operations. Due to the shift in BERI focus away from community development and plantation operations after 2006, other PCs were no longer required. Even GHG mitigation reporting from the BERI-initiated plantations was discontinued when the community lost interest in producing biomass for the power plants.

3.2.4 Project Finance

BERI was planned as a 5-year project; as such, GEF resources of USD 4,082,220 were managed by UNDPs PMU under the management of the PSC and were used for:

- Technical assistance to mobilize target communities to improve their capacities to increase their income levels through improved irrigation techniques, and to cultivate fast-growing trees and shrubs towards a reliable and sustained supply of biomass to the biomass energy plants;
- Technical assistance and capital costs for the installation of borewells for improved water and irrigation supplies, supply of improved and energy efficient cookstoves and installation and oversight of biogas installations and operations training;
- Technical assistance and capital cost of the 3 biomass energy gasification plants; and
- Technical assistance for the commissioning and operations of these biomass energy plants.

The Project co-financing amounts were estimated to be in the order of USD 1.137 million, roughly 28% of the GEF allocation. Prior to the commencement of the Project, co-financing was already committed from ICEF, GoI, GoK and the private sector. During the course of the Project, significant in-kind contributions were provided by GoK, GoI, NGOs and private sector stakeholders.

A summary of BERI expenditures is provided on Table 2. The expenditures provided to the Evaluation Team were from UNDP's "Combined Delivery Reports" (CDRs) that were not broken down into component expenditures. In addition, there were no CDRs provided for BERI prior to 2004. Co-financing details can be found on Table 3.

Table 2: GEF Project Budget and Expenditures for 2001-2012 (in USD as of December 31, 2012)

Outcome	total to 2004	2005	2006	2007	2008	2009	2010	2011	2012	Total Disbursed	Total Remaining
Outcome 1: Technology package standardized	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0	n/a
Outcome 2: Technology and proof of concept demonstrated	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0	n/a
Outcome 3: Capacity of stakeholders and institutions strengthened	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0	n/a
Outcome 4: Enabling environment for bioenergy development created	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0	n/a
Outcome 5: Information on bioenergy disseminated	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0	n/a
Outcome 6: Financial barriers removed and investment risk fund created	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0	n/a
Project Management, M&E	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0	n/a
TOTAL (actual)	$333,858	$744,796	$435,003	$606,781	$1,051,501	$197,498	$163,966	$259,717	$223,880	$4,017,000	$0
TOTAL (cumulative actual)	$333,858	$1,078,654	$1,513,657	$2,120,438	$3,171,939	$3,369,437	$3,533,403	$3,793,120	$4,017,000		
% expended of Total Planned Disbursement	**8%**	**27%**	**38%**	**53%**	**79%**	**84%**	**88%**	**94%**	**100%**		

Table 3: Commitment, expenditure, balance left by different donors for BERI project (as of December 31, 2012)

Donor/Details	UNDP/GEF	ICEF	GoI	GoK	Others	TOTAL
Committed(USD)	4,017,000	2,495,000	391,000	1,481,000	239,000	8,623,000
Committed [in Rs][25]	200,850,000	124,750,000	19,550,000	74,050,000	11,950,000	431,150,000
Utilized (USD)	3,900,940	792,792	66,667	277,478	0	5,037,877
Utilized [in Rs]	195,047,000	39,639,600	3,333,350	13,873,900	0	251,893,850
Balance (USD)	116,060	1,702,208	324,333	1,203,522	239,000	3,585,123.00
Balance [in Rs]	5,803,000	85,110,400	16,216,650	60,176,100	11,950,000	179,256,150
% commitment remaining	**2.9**	**68.2**	**82.9**	**81.3**	**100.0**	**41.6**

3.2.5 M&E Design at Entry and Implementation

Ratings of the Project's Monitoring and Evaluation system[26] are as follows:

- *M&E design at entry – 4*;
- *M&E plan implementation – 3*.

The design of BERI's M&E activities had shortcomings in that assumptions were made that the biomass energy technologies to be deployed were mature and could be successfully utilized for power generation over a 5-year period.

The "3" rating for the M&E plan implementation was based on a review of BERI's AWPs and PSC meeting minutes. There were recommendations made by UNDP-GEF's BERI's 2005 MTE to improve the tools on which BERI project management could be executed, namely the use of schedules and milestone dates; these recommendations do not appear to have been adopted.

The PSC meetings still appear as the main forum on which major Project decisions were made. Information from the PMU and stakeholders was provided for discussion at the PSC meetings notwithstanding the formation of other project management groupings such as the PEC, the TSU and BERIS that were formed to accelerate and provide better information for Project decision-makers. PSC meetings mainly discussed operational issues which had the impact of slowing the pace implementation since the PSC regularly convened twice annually (except in 2002 and 2009 when only one PSC meeting was held). Moreover, discussion of operational issues distracted the PSC from the more important discussions on the strategic directions of BERI; this was likely one of the primary causes of BERI losing its strategic focus on developing of biomass energy and the community's ability to effectively use the energy to improve its quality of life.

[25] USD 1.00 = Rs 50

[26] 6 = HS or Highly Satisfactory: There were no shortcomings;
5 = S or Satisfactory: There were minor shortcomings,
4 = MS or Moderately Satisfactory: There were moderate shortcomings;
3 = MU or Moderately Unsatisfactory: There were significant shortcomings;
2 = U or Unsatisfactory: There were major shortcomings;
1 = HU or Highly Unsatisfactory.

3.2.6 UNDP and Executing Partner Performance

Ratings of UNDP (Implementing Agency) and the RDPR (Executing Agency) performance[27] are as follows:

- *Quality of UNDP Implementation – 4;*
- *Quality of Execution – RDPR – 3;*
- *Overall Quality of Implementation/Execution – 3.*

One aspect of UNDP's performance that could have been improved is on adaptive management. UNDP could have intervened at BERI's critical juncture in 2003 to bring in external (foreign) assistance or an evaluation expert to assess the viability of the bioenergy technology and the progress of the bioenergy demonstration as there is evidence that the selected IISc technology was not mature for demonstration and commercial use. In the absence of this assessment, the Project appears to have been implemented by focusing on community development first with little attention to the power generation aspects until the 2005 MTE which recommended that these activities be addressed; a holistic approach would have addressed bioenergy development in concert with building community living standards.

The performance of RDPR had shortcomings due to its failure to adopt MTE recommendations on improved project management measures that included the PSC making more strategic decisions on BERI as opposed to operational and micro-management issues, and preparing and using detailed work plans with budgets and schedules. Again, the PSC meetings mainly discussed operational issues which had the impact of slowing the pace implementation since the PSC regularly convened twice annually (except in 2002 and 2009 when only one PSC meeting was held).

3.3 Project Results

Assessment of BERI achievements and shortcomings are provided in this section against the 2001 Project log-frame. Each outcome was evaluated against individual criterion of:

- *Relevance* – the extent to which the outcome is suited to local and national development priorities and organizational policies, including changes over time;
- *Effectiveness* – the extent to which an objective was achieved or how likely it is to be achieved;
- *Efficiency* – the extent to which results were delivered with the least costly resources possible.

The Project outcomes were rated based on the following scale:

- *6: Highly Satisfactory (HS)*: The project has no shortcomings in the achievement of its objectives;
- *5: Satisfactory (S)*: The project has minor shortcomings in the achievement of its objectives;

[27] Ibid 26

- *4: Moderately Satisfactory (MS)*: The project has moderate shortcomings in the achievement of its objectives;
- *3: Moderately Unsatisfactory (MU):* The project has significant shortcomings in the achievement of its objectives;
- *2: Unsatisfactory (U)* The project has major shortcomings in the achievement of its objectives;
- *1: Highly Unsatisfactory (HU):* The project has severe shortcomings in the achievement of its objectives.

3.3.1 Overall Results

Development Objective: To reduce CO_2 emissions through the promotion of bioenergy as a viable and sustainable option to meet the rural energy service needs in India.

Immediate Objective 1: To provide a decentralized bioenergy technology package for the provision of good quality rural energy services for lighting, drinking water supply, cooking gas, irrigation water supply and milling.

Intended EOP Outcome:

⇒ Net reduction in carbon-dioxide emission to atmosphere of 7,170 tonnes CO_2:
- Biomass power generation 7,000 MWh
- Efficient energy to facilitate drip irrigation
- 24 biogas cum bio-fertiliser systems in 24 village settlements with a total capacity of 4000 m^3/day (range 25 to 100 m^3/day) for cooking gas and bio-fertiliser production

⇒ 2,996 households in the project villages in 5 clusters having access to bioenergy services:
- 175 households with biogas cooking provided
- 1,500 households with reliable lighting from electricity
- 100 households with reliable drinking water supplies
- 56 borewells for irrigation

⇒ 100% of O&M dues recovered due to demand:
- 100 women employed
- 267 households benefitted by community irrigation
- 30 employment opportunities created by tree-based farming
- 28 village covered by bio-energy needs
- High degree of up-time for bioenergy units
- Average of 1 interruption per day for each plant
- Policy dialogue initiated
- 12 institutions promoting bioenergy
- 15 entrepreneurs involved in establishment of bioenergy systems

Actual EOP Outcome:

⇒ *Net reduction of 67,923 tonnes CO_2 has been achieved up to 31 December 2012 (cumulative) through three interventions (biogas, bioenergy generation and forestry/afforestation) (Assuming that no specific change in net yield & operations of biogas plants)*

⇒ *1,500 households having access to bioenergy services:*
- *175 households with biogas cooking provided through 51 biogas plants – only 4 are functional at this time*
- *Difficult to determine the number of households with reliable lighting from*

bioenergy electricity since the bioenergy electricity is presently evacuated to grid. In Kabbigere cluster 8 village lighting load is 81 kW for 388 domestic connections. Currently, however, there is evening load shedding by BESCOM in region and households do not get any additional reliability of electricity supplies from bioenergy; with the installation of a load shift mechanism, there will be reliability benefits for household lighting

- *Kabbigere cluster has 5 public water supply systems with 27 kW load. Though provision of drinking water is through government schemes with grid power, once load shift mechanism gets installed, it can supply drinking water even during load shedding with locally generated bio-electricity*
- *267 households continued to get benefited from 56 borewells for irrigation*

⇒ *O&M recovery mechanism not yet implemented due to lack of load shifting mechanism*

Rating: *relevance: 3*
effectiveness: 4
efficiency: 3
overall rating: 3.3

Table 4 summarizes the GHG reduction estimates (using GEF guidelines) that were generated during BERI (to its estimated terminal date of December 31, 2012).

Table 4: Summary of CO_2 Reductions from the Project

Direct emission reduction, t CO_2	
From biomass power plant	1,243
From biogas units	539
From forestry plantations	64,741
Total direct emission reduction, t CO_2	**67,923**
Direct post-project emission reduction, t CO_2	
From biomass power plant	0
From biogas units	0
From forestry plantations	0
Total direct post-project emission reduction, t CO_2	**0**
Indirect emission reduction, t CO_2	
Indirect bottom-up emission reductions, t CO_2	**225,663**
Indirect top-down emission reduction, t CO_2	**74,714**

The achievement of the direct CO_2 reduction of 67,923 tonnes CO_{2eq} against the GHG target of 7,170 tonnes of CO_{2eq} at the EOP of BERI, is mainly from forestry and plantation and the extended project duration from 5 to 10 years; CO_{2eq} reductions from bioenergy generation only accounted for 1,243 tonnes CO_{2eq}.

With no guaranteed operational funds available for the three bioenergy plants after December 31, 2012, no direct post-project emissions were forecast. While this could change if the MNRE capital subsidy is budgeted towards plant operations or if a private

sector entity was provided with the opportunity to operate these plants, no such opportunities are foreseen at the time of this evaluation. This post project perception also affects the estimates of indirect post-project emissions; there is a small likelihood that a private sector entity will undertake a community-based bioenergy project similar using the lessons learned from BERI. The uptake of such a project is more likely attributed to other examples of successful bioenergy projects such as the one operated by Pointec, south of Bangalore.

With respect to the forestry activities and biogas development on BERI, there is no evidence of systematic documentation of the plantation with respect to its yield, growth and other factors used to determine carbon sequestration from plantation activities, and most biogas plants are no longer functioning and reducing carbon emissions; hence, there is little confidence that substantial post-project direct and indirect emission reductions are being generated from BERI activities.

GHG reductions were calculated:

- Using a grid emissions factor of 0.90 CO_2/MWh for the Indian electricity grid[28]; and
- Using the GEF method for calculating GHG emission reductions[29].

3.3.2 Outcome 1: Technology package standardized

Intended Outcome 1*:* ⇒ Gas engines that have been developed, locally available and adapted to use the renewable feedstock proposed under the project ⇒ Detailed technical specifications ⇒ Draft technical standards
Actual Outcome 1: ⇒ *Gas engines were developed by IISc in 2006 that can use producer gas from biomass feedstock from the plantations or equivalent* ⇒ *BERI plant was commissioned according to specification developed by technology provider in 2007* ⇒ *Benchmarking exercise was carried out through continuous 1,000 hour plant operation under supervision of technology developer and provider in 2008*

Rating: *relevance:* *5*
effectiveness: *5*
efficiency: *3*
overall rating: *4.3*

A total installed capacity of 1.05 MW_e engines that operate on producer gas was installed at 3 separate plant locations by BERI[30]. This represents a significant achievement for BERI. The Project successfully operated one 200 kW system for 1,000 continuous hours under the supervision of IISc, generating useful performance

[28] Grid emission factors were provided by the GoI's Central Electricity Authority under the Ministry of Power on January 2012: http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver7.pdf
[29] "Manual for Calculating GHG Benefits of GEF Projects: Energy Efficiency and Renewable Energy Projects, April 16, 2008 (GEF/C.33/Inf.18)"
[30] 900 kW of this installed capacity is 100% producer gas consisting of two 100 kW systems, one 200 kW system, two 250 kW systems and one 100 kW dual fuel (diesel & gasifier) system; and five 10 kW dual fuel (diesel & gasifier) systems

information that was placed on a public domain. From these tests, benchmarks were derived and specifications for the technology system were developed.

3.3.3 Outcome 2: Technology and proof of concept demonstrated

Intended Outcome 2*:* ⇒ Installed 60 -20 kW bioenergy systems with the recommended specifications and standards ⇒ 4,800 MWh of bioenergy systems utilized ⇒ 120 kW (3-10 kW each) community biogas cum bio-fertiliser systems generating 346 MWh for base loads ⇒ 24 biogas cum bio-fertiliser systems in 24 village settlements with a total capacity of 4000 m^3/day (range 25 to 100 m^3/day) for cooking gas and bio-fertiliser production ⇒ 452 ha of short rotation forest plantation, 371 ha of agro-forestry systems, 271 ha of community forestry, 471 ha of orchards and 113 ha of high input forestry ⇒ Document on lessons from different modes of providing the rural energy service package to rural villagers, including experience in gaining full cost recovery
Actual Outcome 2: ⇒ *Total 1.05MW cumulative installed capacity installed (11 gasifier systems. 900 kW is 100% producer gas - two 100 kW systems, one 200 kW system, two 250 kW systems and one kW dual fuel (diesel & gasifier) system; and five 10 kW dual fuel (diesel & gasifier) systems.* ⇒ *The cumulative electricity generation from 500 kW of installed gasifiers that supply grid electricity 1,140 MWh on 30 June 2012.* ⇒ *Activity of 120kW leaf-litter based biogas plant was dropped.* ⇒ *51 biogas plants were installed with gas connections with improved cookstoves to 175 households and each unit serving 4 to 6 households. Unfortunately, only 4 of these biogas plants are currently operational for less than 10 households* ⇒ *Energy plantations are active for 2,930 ha of forest land, and 947 ha of tree-based farming. Annual yield from these activities is 5,000 tonnes annually against a target of 10,000 to 12,000 tonnes* ⇒ *Successfully demonstrated:* • *formulation of 81 self-help groups (SHGs), various community livelihood improvement and income generation activities* • *drip irrigation using tube wells (49 tube wells catering 256 families), horti-floricuture crops* • *cost recovery of rural improvement measures such that many farmers took out loans (in exchange for not taking up drip irrigation) that could be repaid within 1-2 years due to increases in income from irrigation. Amongst these farmers, there were no loan defaulters;* • *65% tariff recovery from 11% due to improved income levels but not increased reliability of electricity supplies from the biomass energy plant*

Rating: *relevance:* *4*
effectiveness: *4*
efficiency: *3*
overall rating: *3.7*

This activity sought to demonstrate the model of developing a rural-based biomass power plant that would closely involve the local community in its operations and

maintenance. This component was implemented in two phases: first phase was 2001 to 2005 when community activities were focused on improving community living standards and local income generation as a means of creating more demand for modern energy services from the biomass power plants; the second phase was the completion and operation of the three biomass power plants (Kabbigere - 500 kW, Seebinayanapalaya - 250 kW, and Borigunte - 250 kW).

The community activities were well managed during the 2001-2005 period of BERI with some activities leaving a positive and sustained impact on the lives of a number of community households, notably the improved drip irrigation supplies which allowed local farmers to grow higher cash crops to improve their incomes. However, only 4 out of the 51 community-based biogas plants installed were still operating as the Project had failed to ensure sustained operations of biogas plants; sustained supplies of cow dung appears to be the primary reason for the lack of use of the installed biogas plants. In addition, the anticipated supply of biomass from the local Project plantations was not to expected levels; as of December 2012, the Kabbigere plant received its biomass supplies from private contractors located more than 40 km from the plant at twice the price of locally supplied biomass. The reasons for the lack of local sourcing of biomass at less cost are still not clear.

The operation of the power plants, unfortunately, was not completed as intended; only the Kabbigere plant was able to demonstrate any sustained supplies of electricity to the national grid, albeit with a number of interruptions due to difficulties with the technology. In addition, the plant could not deliver reliable power to the local community when the grid was down; the load shift mechanism was still not in place. Moreover, the power produced from the Kabbigere plant was costly (Rs 7.8/kWh versus a tariff of Rs 2.85/kWh) and generally regarded as being higher than industry norms for biomass energy plants. Primary causes of the high cost of production are traced back to:

- the operational inefficiencies of the plant including a high number of plant personnel;
- the high cost of biomass due its sourcing 40 km from Tumkur at twice the cost;
- low PLF; and
- a high plant parasitic load (which is more related to the technology design as opposed to management of the plant).

The other two plants have not yet been commissioned due to the contractual difficulties of the private sector firms to whom operations of these plants were outsourced.

3.3.4 Outcome 3: Capacity of relevant project stakeholders and institutions has been strengthened

Intended Outcome 3*:*

⇒ Bioenergy packages for replication in other parts of rural India

⇒ Database on carbon flows with approach and methodology for monitoring carbon flows in bioenergy projects

⇒ Training and involvement of women in planning and management of the bioenergy systems.

⇒ Training center for training entrepreneurs, NGOs and managers on implementation of technology and institutional package

⇒ Enterprises for supply, installation, maintenance, repairs, manufacturing, spare parts

supply and servicing of bioenergy systems

Actual Outcome 3:

⇒ *A cost-benefit study of biomass power generation was completed along with other studies that documents the feasibility of reliable and sustained power generation from biomass resources*

⇒ *Technological package on bioenergy (biomass gasifier based power plant) has been developed with reliable performance as per performance guarantee through the 1,000 hours of continual testing and with detailed technical specifications. The process document, the cost-benefit analysis study, and the various papers that have been developed under BERI will serve as the knowledge database for replication in addition to the project website. The BERI project has provided a replicable model for the provision of a reliable and sustained supply of bioelectricity to rural areas of India. Only the completion of a load shift mechanism needs to be completed to showcase the reliable supply of electricity to rural communities during grid outages*

⇒ *A document on Estimation of Carbon Sequestration, Carbon Stock and Flow in Project Area was prepared in May 2007. Later document titled "Biomass Energy for Rural India – Carbon Mitigation Report" was prepared in 2011 on carbon mitigation due to forestry/afforestation, biomass based power generation, biogas plants. The report was thorough and included sampling analyses for determining carbon reduction estimates from forestry plantation activities.*

⇒ *More than dozen women were trained and 3-4 women are being involved in biomass power plant operations. More than 100 women were trained and employed for harvesting and collecting biomass during initial years. Many women are members of VFC, VBEMC, Panchayats and other committees and participate regularly in meetings.*

⇒ *During initial years, a training center was established. Training on bioenergy system was given at CGPL laboratory and later also at project site. However, presently on first level technician training on project site is being continued. Unfortunately, entrepreneurial training was not implemented*

⇒ *Zigma Engineering took the responsibility of O&M of all installed plants. However, no efforts were made to develop enterprises to establish crucial after sale service network, a main barrier in RE deployment in the country.*

Rating: *relevance:* *3*
effectiveness: *4*
efficiency: *3*
overall rating: *3.3*

BERI trained a large number of participants, people from the clusters, on technology, plantation, harvesting and several other aspects. However, the training was discontinued after 2005 resulting in no training center being in place at this time. Moreover, there is no local after-sales service support which remains a major barrier in promotion of renewable energy technologies and systems in the country. This could be attributed to the technology provider of BERI who would only provide certain enterprises and individuals who were licensed to install, maintain, repair, manufacture and service their bioenergy system.

3.3.5 Outcome 4: Enabling environment for bioenergy development has been created

Intended Outcome 4*:* ⇒ A solid rationale and framework justifying the fee-for-service approach of rural energy provision ⇒ Published policy papers to address the issue of level playing field for bioenergy package such as policy analysis for rational pricing of energy ⇒ Documented case studies to highlight successful policy implementation experiences ⇒ Workshops to involve stakeholders especially policymakers to exchange the experiences, study tours and policy research activities ⇒ Documents on lessons learnt and sharing of experiences
Actual Outcome 4: ⇒ *A fee-for-service approach and framework was never completed since the plants are grid connected instead of being off-grid and decentralized as envisaged in the ProDoc* ⇒ *BERI produced published papers including "A study on the cost benefits of Biomass gasification vis-à-vis other renewables and conventional energy", "Rural energy from biomass" which provided lessons learned from BERI, "Feed-in Tariff for biomass power", and "Towards substantial green energy supply in Karnataka 2020/2050"* ⇒ *Audio visual capsules were prepared in 2007 (by PMU in Kannada), 2008 (by UNDP), 2009 (GEF cell and MoEF). An 8-minute documentary on project lessons has been prepared as well as a Project process compendium* ⇒ *Project Coordinator, the BERI PMU and Program Analyst, and UNDP shared BERI experiences in several forums and workshops including GEF empowerment committee meetings, ADB workshop on gender and energy, VESP programme* ⇒ *Over 124 training programs were organized on various technical skills involving 3,742 participants, 159 management training programs involving 2,556 participants, and 109 field trips involving 2,843 participants that disseminated case studies on the 1,000 hour plant operation, grid interactive biomass gasifier power plant. In addition, several studies were undertaken by masters students and post-graduate interns* ⇒ *Fact sheet on plant operation data is available on BERI project website*

Rating: *relevance:* *3*
effectiveness: *3*
efficiency: *3*
overall rating: *3*

Creating enabling polices and framework for promoting renewable energy, specifically biomass energy, and bringing in level field ground to ensure its competitiveness with conventional options was and still is a major barrier. The Project made some efforts in this regard but infrequently and in an ad hoc manner. Moreover, there has been a loss of focus throughout the duration of BERI on providing an enabling environment to promote the use of biomass energy. This has had an adverse impact on its promotion; more vigorous efforts are required to overcome these regulatory barriers considering that changes in policy and regulatory framework with the GoI and GoK is a very slow and difficult process in India.

On the positive side, BERI has provided several documented study reports on gasifier power plant performance and placed it in public domain. This has been a good achievement since the performance of sub-megawatt power plants to service rural energy demands was placed on public domain.

3.3.6 Outcome 5: Information on bioenergy disseminated

Intended Outcome 5*:* ⇒ Available information system on bioenergy technologies, manufacturers, technology suppliers, financial mechanisms, technical performance, R & D facilities, and technical experts ⇒ Available methods for project formulation including financial analysis, implementation, monitoring, for potential replicability ⇒ Available promotional modules using audio-visuals, print and other media
Actual Outcome 5: ⇒ *Document compiling information of various biomass gasifier technology and systems suppliers has been compiled in one booklet.* ⇒ *Financial analysis of the biomass power plants was completed in 2009 and included benchmarking and technical specifications, revenue models based on the 1,000 hr gasifier power plant operation data under CGPL-IISc supervision, and cost benefit and FIT analysis prepared to inform future policies on promoting rural biomass energy plants* ⇒ *An 8-minute documentary film and a book is being prepared and scheduled for completion before Project closure.*

Rating: *relevance:* *4*
effectiveness: *5*
efficiency: *4*
overall rating: *4*

BERI compiled information on gasifier suppliers in India. Similarly, technology specifications and benchmarks for system operations based were developed on the 1,000 hour plant operations under CGPL-IISc supervision and disseminated on the BERI website. The Project also drew the interest of a number of post-graduate students who undertook studies on various aspects of the biomass power plants and their potential to provide sustained energy services to rural communities throughout India. As interesting as this information was to development professionals, biomass energy was still viewed as being not feasible due to the lack of efforts by the Project to find the means to make the biomass power plants more economically viable through other business models such as private sector operations and sale of captive power to an industrial client.

3.3.7 Outcome 6: Financial barriers removed and investment risk fund created

Intended Outcome 6*:* ⇒ Entrepreneurs financed through provision of venture capital for franchisers and franchisees as start-up capital ⇒ Revolving fund to offset perceived investment risks to leverage private investments ⇒ Approach formulated involving bidding for concessions to operate future bioenergy systems in areas targeted for replications ⇒ Cost recovery mechanisms to demonstrate economic and financial viability ⇒ Demonstration of willingness and capacity of rural households to pay for good quality energy services
Actual Outcome 6: ⇒ *Efforts to obtain venture capital for franchisers and franchisees have not been taken up. However, tenders were called for inviting entrepreneurs to run gasifier-based systems that have yet to be finalized*

⇒ *No revolving fund was created.*
⇒ *No approach formulated; however, sufficient information has been generated on benchmarking of fuel consumptions, operation costs and maintenance costs through the 1,000 hr plant operations under supervision of the technology provider.*
⇒ *One tender has been received in early 2012 to operate the Kabbigere plant at Rs 11.25 per kWh, a tariff much higher than the BESCOM PPA price of Rs 2.85 per kWh*
⇒ *Stakeholder consultations have confirmed residents in the target villages were willing to pay up to Rs 5 to 6 per kWh for reliable uninterrupted power. However, since the power is fed into the grid without a load shift mechanism, the issue has become somewhat irrelevant*

Rating: *relevance:* *2*
effectiveness: *2*
efficiency: *1*
overall rating: *1*

The strategic shift of BERI from off-grid decentralized power generation to the centralized grid connected operation has had a significant impact on Project efforts to demonstrate the financial viability of rural biomass power generation. With the failure of the Project to find the means to improve the financial standing of the Kabbigere plant, the outgoing perception of rural biomass power generation has been that it is not financially viable; as such, the required financial resources to replicate the BERI efforts have not been made available, and a revolving fund as planned could not be implemented. The lack of focus during BERI on finding alternative operational arrangements that would make the Kabbigere plant financially viable has contributed to the negative perception of rural biomass power generation. This is unfortunate given that there is excellent potential to convert the current BERI assets into a financially viable business that can be replicated throughout rural India and significantly contribute to the country's energy security.

3.3.8 Overall Evaluation of Project

The overall rating of the project results is marginally satisfactory (MS). This is based on the following outcomes:

- The successful demonstration of the technical feasibility of biomass energy application in a rural setting;
- Successful demonstration of the engagement of local communities to become involved with activities related to the improvement of rural living standards and the provision of modern energy services through biomass (including bioenergy and biogas for cooking);
- Surveys and consultations indicating the willingness of the local community to pay up to Rs 5 - 6 for modern energy services based on their increased earnings from income generation activities from BERI;
- Slow execution of the Project due to institutional arrangements and no presence of the PMU in the targeted communities in Tumkur leading to extensive delays and slow pace of approvals for basic operational decisions;
- Failure to adjust project management arrangements based on recommendations from the MTE that would have accelerated the pace of BERI and strengthened the sustainability of community involvement through its production of biomass to the bioenergy power plants;

- Lack of effort to reduce the cost of electricity production at the Kabbigere plant including the sourcing of locally produced biomass as opposed to a biomass plantation located more than 40 km from the plants;
- Due to the high cost of electricity production, there were no project efforts to create an enabling environment and financing to replicate this model for rural biomass power generation.

Overall project ratings are provided on Table 5.

Table 5: Ratings for Each Project Outcome[31]

	Relevance	Effective-ness	Efficiency	Overall Rating
Monitoring and Evaluation:				
M&E design at entry	-	-	-	4
M&E plan implementation	-	-	-	3
Overall quality of M&E	-	-	-	3.5
UNDP and Executing Partner Performance:				
Quality of UNDP implementation	-	-	-	4
Quality of Execution - RDPR	-	-	-	3
Overall quality of implementation/execution	-	-	-	3.5
Overall Results	3	4	3	3.3
Outcomes:				
Outcome 1: Technology package standardized	5	5	3	4.3
Outcome 2: Technology and proof of concept demonstrated	4	4	3	3.7
***Outcome 3*:** Capacity of relevant institutions has been strengthened	3	4	3	3.3
***Outcome 4*:** Enabling environment for bioenergy development established	3	3	3	3.0
***Outcome 5*:** Information on bioenergy disseminated	4	5	4	4.3
***Outcome 6*:** Financial barriers removed and investment risk fund created	2	2	1	1.7
Overall Rating:	3.4	3.9	2.9	3.5

[31] 6 = HS or Highly Satisfactory: There were no shortcomings;
5 = S or Satisfactory: There were minor shortcomings,
4 = MS or Moderately Satisfactory: There were moderate shortcomings;
3 = MU or Moderately Unsatisfactory: There were significant shortcomings;
2 = U or Unsatisfactory: There were major shortcomings;
1 = HU or Highly Unsatisfactory.

3.3.9 Country Ownership and Drivenness

The drivenness of the GoK for rural biomass power generation is largely absent due to the perception that the current government-driven business models are not financially viable, something BERI was supposed to demonstrate. Moreover, the government are currently seeking the means to raise the revenue of the current biomass power generation assets in Tumkur that would attract the private sector or other sources of financing.

3.3.10 Sustainability of Project Outcomes

In assessing Project sustainability, we asked "how likely will the Project outcomes be sustained beyond Project termination?" Sustainability of these objectives was evaluated in the dimensions of financial resources, socio-political risks, institutional framework and governance, and environmental factors, using a simple ranking scheme:

- *4 = Likely (L):* negligible risks to sustainability;
- *3 = Moderately Likely (ML):* moderate risks to sustainability;
- *2 = Moderately Unlikely (MU):* significant risks to sustainability; and
- *1 = Unlikely (U):* severe risks to sustainability.
- *Overall rating is equivalent to the lowest sustainability ranking score of the 4 dimensions.*

The overall Project sustainability rating is moderately unlikely (MU). This is primarily due to the failure to demonstrate a viable business model in a public-sector managed bioenergy generation plant, and the subsequent lack of financial resources available to continue operation of the Kabbigere bioenergy plant after December 31, 2012. Details of these ratings are shown on Table 6.

Table 6: Assessment of Sustainability of Outcomes

Actual Outcomes (as of December 2012)	Assessment of Sustainability	Dimensions of Sustainability
Actual Outcome 1: Technical specifications of biogasification technology provider, CGPL and IISc Bangalore has been delivered	• *Financial Resources:* CGPL and IISc Bangalore have the financial resources to continue development and improvement of the technical specifications for biogasification; • *Socio-Political Risks:* There are few risks on the loss of political support for CGPL and IISc, and hence, they will be well supported in continual improvement of their biogasification technology; • *Institutional Framework and Governance:* CGPL and IISc will continue to develop and refine these technical specifications for other bioenergy projects using the lessons learned from BERI. However, there are no regulations mandating the use of biogasification for power generation (though there is RPO for a certain proportion of an energy project to be renewable that is not well enforced for non-compliance) nor are there any financial incentives such as feed-in tariffs to catalyse further investments into biogasification to make it financially viable; • *Environmental Factors:* Biogasification is considered a green technology and beneficial to the environment and reduction of GHG emissions. ***Overall Rating***	4 4 3 4 **3**
Actual Outcome 2: 11 gasifier systems (cumulative installed capacity of 1.05 MW) has been completed in the Kabbigere, Borigunte and Seebanayanpalya Clusters in Tumkur district, Karnataka. They have a generating potential of 4800 MWh of bioelectricity annually	• *Financial Resources:* There is uncertainty in the availability of financial resources within RDPR to operate these plants after the closure of BERI on December 31, 2012; • *Socio-Political Risks:* The GoK and RDPR are not willing to inherit bioenergy assets and continue its operation as it is perceived as a financial burden in the absence of tariff parity. Though making bioenergy generation mandatory with a FIT regulatory framework is not envisaged in the near future, there is some interest amongst the private sector to undertake operations of Kabbigere in the hopes of acquiring the asset; • *Institutional Framework and Governance:* BERIS was supposed to assume oversight management of these plants. At this time, BERIS is a weak entity without development and RDPR served the role of oversight manager of operations up until the closure of the Kabbigere plant on December 31, 2012; • *Environmental Factors:* Biogasification is considered a green technology and beneficial to the environment and reduction of GHG	2 3 2 4

Table 6: Assessment of Sustainability of Outcomes

Actual Outcomes (as of December 2012)	Assessment of Sustainability	Dimensions of Sustainability
	emissions. ***Overall Rating***	**2**
Actual Outcome 3: Capacity building has been partially achieved through the availability of documents on the holistic BERI model delivering 24/365 bioelectricity to rural India, documents on carbon mitigation and on biogasification commissioning; and training for women's groups and plant personnel	• *Financial Resources:* There are currently no financial resources identified at the GoK level or the GoI level to continue with any capacity building or training for more biogasification power projects, women's group or plant personnel at the Tumkur communities • *Socio-Political Risks:* Political decisions cutting off further investment into the BERI bioenergy assets including capacity building have already been made. Furthermore, the targeted communities in Tumkur are disengaged from the Project; • *Institutional Framework and Governance:* Without further support for BERIS, there is no institutional framework for the further management and operation of these plant; • *Environmental Factors:* Biogasification is considered a green technology and beneficial to the environment and reduction of GHG emissions. ***Overall Rating***	2 2 2 4 **2**
Actual Outcome 4: An enabling environment for rural bioenergy development has been created through demonstration of fee-for-service approach for rural energy provision, publishing of FITs and the BERI implementation experience, and sharing information at state, central and international seminars.	• *Financial Resources:* There are no financial resources available within the GoK to development of an enabling environment for rural energy provisions; • *Socio-Political Risks:* There has been no effort to bring in tariff parity by bringing in FIT or another regulatory mechanism and reducing cost of generation. There has also been no effort to operate the system using locally produced biomass and feeding this money to the local community; • *Institutional Framework and Governance:* The GoK needs to create the enabling environment for bioenergy including feed-in tariffs which it cannot do now since there is no demonstration that bioenergy can be produced at a viable cost; • *Environmental Factors:* Biogasification is considered a green technology and beneficial to the environment and reduction of GHG emissions. ***Overall Rating***	2 2 2 4 **2**
Actual Outcome 5: Information disseminated through a bioenergy	• *Financial Resources:* There are no financial resources available within the GoK to continue with the bioenergy website or to continue with the	2

Table 6: Assessment of Sustainability of Outcomes

Actual Outcomes (as of December 2012)	Assessment of Sustainability	Dimensions of Sustainability
website as well as other documentary videos currently now under completion	promotion of bioenergy in Karnataka State; • *Socio-Political Risks:* The GoK has already made a decision to offload BERI bioenergy assets and have solicited bids for Kabbigere. One bid has been received for a 3-month operation; however, the Evaluators do not know if RDPR will execute this proposal; • *Institutional Framework and Governance:* There is currently no institutional framework to continue information dissemination of bioenergy efforts by BERI. There have been discussions with KREDL and KSCST on continuing the promotion of bioenergy and BERI activities. They are willing to do so provided there is funding available; • *Environmental Factors:* Biogasification is considered a green technology and beneficial to the environment and reduction of GHG emissions. ***Overall Rating***	3 3 4 **2**
Actual Outcome 6: Financial barriers to bioenergy still remain and no investment risk fund has been created	• *Financial Resources:* No financial resources are available for replication due to the grid connected Kabbigere bioenergy plant still having a high cost of generation and low grid tariff, and the failure of the BERI pilot plants to demonstrate a viable business model; • *Socio-Political Risks:* The GoK have not made any funds available for the promotion of bioenergy at the time of this Evaluation; • *Institutional Framework and Governance:* KREDL is the State agency responsible for the promotion of renewable energy. KREDL, however, remains a weak agency due to the lack of funding; • *Environmental Factors:* Biogasification is considered a green technology and beneficial to the environment and reduction of GHG emissions. ***Overall Rating***	1 1 1 4 **1**
	Overall Rating of Project Sustainability:	**2**

4. CONCLUSIONS, RECOMMENDATIONS AND LESSONS

4.1 Conclusions

- With BERI terminated as of December 31, 2012:
  - Bioenergy assets were transferred to the GoK;
  - Operational funding for bioenergy assets after December 31, 2012 is uncertain though an exit strategy (contained within this Evaluation) has been prepared for RDPR;
  - A viable business model for BERI biomass energy plants does not yet exist; and
  - Not all bioenergy plants will have been commissioned.

- With UNDP/GEF funds already exhausted, the committed co-financing amounts from the State and Central Government is essential for continuation of BERI project operations and the sustained supply of bioenergy to the grid;

- Expectations of BERI were raised during the community mobilization phase between 2001 and 2005. However, with the strategic shift from off-grid to grid without provision of an "islanding" operation, the community had become increasingly disenfranchised with BERI:
  - Power generated from the biomass power plants was going to the grid, instead of the targeted communities being supplied with generated power from BERI biomass generation assets, mostly notably during grid outages when the entire region is without electricity;
  - There was a loss of pride when the biomass power plants could not even deliver local power to its own communities in the event of grid failure. This is mainly due to the absence of a load shift mechanism that was to provide bioenergy from the BERI generation assets to the local grid and targeted communities;
  - Biomass for Kabbigere bioenergy plant was being sourced from another plantation 40 km from the plant and not from the local plantations.

- With a grid-connected operation, the financial viability of the biomass power plants has become a significant issue since the tariffs from BESCOM were Rs 2.85/kWh and the actual price of electricity production from these plants being more than Rs 7.8/kWh;

- Biomass for the BERI bioenergy plants needs to be sourced from local plantations and from plantations on forest wastelands; this will contribute significantly to the continued and sustained operation of these plants by obtaining the biomass at a reasonable price;

- BERI has delivered to the GoK and the Government of India three rural biomass energy generation assets and lessons on community engagement that have significant potential to improve the living standards of rural India. At this stage, only a small investment is required to reduce the cost of electricity production, improve the operating performance of the Kabbigere plant and to find the means to increase revenue from electricity sales. This will allow the project to continue to the extent that BERI assets would be more financially attractive to external investors.

4.2 Recommendations

With the GEF-funded BERI project terminated on December 31, 2012, the following recommendations are provided in order of priority to Rural Development and Panchayat Raj (RDPR) on actions required to sustain rural development activities of BERI Project in the Tumkur District using continuous running of biomass energy generation:

Recommendation 1: Release committed funds by Government of Karnataka and the Government of India.
The Finance Department has mainly questioned the financial viability of the BERI assets. Noting that the Project was intended to generate information, data and lessons to overcome the aforementioned barriers, the BERI project was funded with firm financing commitments from UNDP, GoK, GoI and ICEF (now closed) at the time of project formulation. At the commencement of BERI, it was not envisaged that the biomass power generation component would be grid-connected.

As can be seen from Table 3, UNDP/GEF has released most of its committed expenses for the Project implementation with the remaining funds for the Terminal Evaluation. As such, the balance of funds from Government of Karnataka should be immediately released. Any delay will cause irreparable damage to the 10 years of progress which is already sluggish due to numerous delays and the lack of funds.

Over Rs 1 crore of co-financing (in the form of capital subsidy) has been transferred to RDPR from GoI for the commissioning report for biomass gasifier power plants at Kabbigere, Borigunte and Seebanayanpalya. The subsidy for the Kabbigere plant was claimed on the basis of their operations and submitting the plant commissioning reports in the MNRE format. With the current subsidies received, plant operations can continue for another 6 to 12 months and cover costs of improving the operating performance of the plants until an investor can be found to support its operations over the long-term.

Recommendation 2: Establish load shifting mechanism.
The original 2001 project document conceptualized bioenergy as the key to providing reliable electricity to rural areas in a decentralized mode through the exploitation of a local biomass energy resource. Due to a variety of reasons, the number of biomass gasifier plants was changed from 60 small biomass gasifier plants (20kW each) to 6 large biomass gasifier plants with power evacuated to the grid through the establishment of a BERI-supported 11 kV line. When the grid is down (at times up to 4 hours per day), the plant needs to be shutdown resulting in a lower PLF (Plant Load Factor). Exacerbating this situation is that there is no power for local community when the grid is down. The lower PLF results in increased power generation costs and the unit cost of exported electricity. A load shift mechanism can switch over to bioelectricity in case of grid failure, thereby increasing availability of reliable electricity to local rural villages and also increasing the PLF; this arrangement is similar to a captive power house which connects to the grid in normal times but switches to in-house captive power plant in case of grid power failure. The result is an improvement in the power plant capacity utilization and a lower unit cost of electricity generation. BESCOM estimated a cost of Rs 50 lakh to install the load shift mechanism and had agreed to carry out the 2-month task almost 18 months ago. The BERI PMU had agreed to provide these funds in the 2011 Annual Work Plan. The installation of the load shift mechanism by BESCOM, however, has yet to be done.

This Evaluation recommends that the load shift mechanism be done at the earliest possible time as it directly addresses the primary objective of BERI project and significantly enhances the community stake back into the Project. Targeted villages in Tumkur would gain confidence in BERI biomass power plants to supply reliable power even during events when there is grid failure. Furthermore, community pride from the generation of their own electricity using locally community-owned biomass resources would resurrect community participation and the income generation activities that were prevalent during the 2001-2005 period of BERI. This in turn would have likely improved the ability of the targeted villages to pay for the electricity from the biomass power plants, further contributing to the economic viability of plant.

Recommendation 3: Ensure obligations of Karnataka forest department and others to provide biomass from project plantations.

BERI has provided support to plantation development. Project reports claim close to 3,000 hectares of plantation was developed, one third each in Panchayat land, bund plantations on farmer's land, and on forest department land. The 2010-11 assessment indicated the average annual yield of 5,000 tonnes against an estimated potential of 12,000 tonnes, sufficient biomass for sustained operations of the biomass power plants. However, at present, the wood is purchased mainly from the Forest Department or from private contractors at locations more than 40 miles from Tumkur. The BERI PMU needs to review the agreements, commitments and obligations, with the Forest Department needing to avail biomass from Project plantations in the forest area at a discounted price considering that the BERI Project made substantial investments in these plantations. Irrespective of the result from this evaluation, it is vital that the wood is made available from local sources so that biomass power plant operations are not hampered. There are obvious community benefits from the procurement of biomass from project plantations that would return money back into the local rural economy, restore community pride and encourage community involvement which has been lost since 2006.

Recommendation 4: Outsource operations to encourage entrepreneurship and increase PLF.

Despite the best efforts of the BERI PMU to operate and maintain the Kabbigere bioenergy power plant, 1.35 million kWh of electricity was generated in about five years. This translates to 20% of its generation potential. In comparison to another similar but privately owned bioenergy plants, the Pointec biomass plant (just south of Bangalore)[20] provides electricity equivalent to 60% of its generation potential. The BERI PMU has attempted to outsource operations through bidding; however, no viable bids were submitted. On the advice of IISc, M/S Pointec submitted a proposal for providing O&M support for the Kabbigere plant consisting of a proposed tariff of Rs 11.25 per kWh for the first three months of operation, slightly lower than the Rs 14 per kWh as estimated by BERI PMU, but higher than the Rs 8.5 per kWh costs estimated by IIM Bangalore (the basis for this is the 1,000 hours benchmark operation of IISc). This proposal should be accepted as the outsourcing of these operations to the private sector will provide more precision in the benchmarking of operational costs, and assist entrepreneurs and technical professionals in sub-megawatt scale operations. With M/S Pointec revenue linked to plant operation, it would be in M/S Pointec's interest to maximize plant operations; this would help all stakeholders gain insights from the optimized operations of a rural biomass power plant that enhances the PLF and reduces the unit cost of electricity generation.

[20] Pointec Pens Pvt Ltd. Regd., 26-A Attibele Industrial Area, Attibele, Bangalore – 562107, Karnataka, India

Recommendation 5: Review institutional arrangements to operate, manage and replicate the BERI model (BERI – Society under RDPR, KSCST with funds, KREDL or KPTCL).

The Project was conceptualized with close linkages to rural development and, as such, BERI was housed in RDPR. The activities ranged from bioenergy packages such as biogas plants, improved cookstoves, bioelectricity supplies for irrigation coupled with enhanced rural electricity reliability and increase incomes. The BERI PMU was formed to focus on project deliverables as per the BERI project design and in close consultation with RDPR and guidance from PSC. Until June 2012, a full time Project Coordinator (senior officer from GoK) was deputed; after June 2012, only a part time PC was in place. Initially, 3 project officers were assigned to manage three different streams namely power plant operations (technology), biomass supply (plantations/forestry) and rural development initiatives (community). During the early periods of BERI, this arrangement helped to kick start BERI; in December 2012, it appears the efforts made will not be sustained unless continued institutional support is made available. The BERI Society (BERIS) was actually formed with the objective of promoting bioenergy in the State of Karnataka and perhaps to other states. The present set up of BERIS does not have any full time personnel and no concrete activities in hand. Under these circumstances, institutional options in a post-BERI regime are as follows[21]:

- Option 1: Strengthen BERIS by recruiting full time personnel, revitalizing community involvement, identifying gaps to make the interventions feasible and sustainable, and proliferating the BERI model. The BERI project has created unique infrastructure such as biomass power plants, 11 kV lines, plantations, and borewells for drip irrigation. RDPR should consider providing funds to BERIS on a sustained basis, and use it as a training and incubation centre;
- Option 2: KSCST was one of the implementing agencies in the original 2001 project document. Subsequently, they were only included as a PSC member and were not involved in implementing the project. Their main goal is "application of science and technology for the management of resources, improvement of environment, quality of life and socio-economic conditions of the people of Karnataka". They have carried out innovative demonstrations, work in close collaboration with different departments of IISc, and qualify as one of the agencies with the wider vision to implement a post-BERI project. During the TE mission discussions, they showed genuine interest to undertake such programmes provided funding is in place. This is a strong option to consider;
- Option 3: KREDL could own, operate and maintain the plant either directly or through outsourcing. KREDL is currently operating a 1 MW wind power plant with a 7-year agreement with MNRE. However, their core business is facilitation of renewable energy and energy efficiency promotion, and not to operate facilities themselves;
- Option 4: KPTCL is the main power transmission company in Karnataka State, and could operate the BERI biomass power plant assets;
- Option 5: The Karnataka State Biofuel Board have funds available to promote bio-energy in the state. They can also operate the biomass power plants and continue

[21] The suggested institutional structure for any of the options is that of the agency to administer the BERI activities through the BERI society, where plant operations are outsourced to a private operator. As indicated in Recommendation 4, it ensures a cost-effective option with increased plant operation and helps enhance PLF which reduces the unit cost of power generation.

community activities after the closure of BERI. A formal request from RDPR needs to be made to initiate an official response from the Board on post-BERI involvement;

- Option 6: RDPR can auction or lease the biomass power plants with conditions to run and operate it for a set duration and sharing plant performance data. To be able to exercise this option, the existing PPA of Rs 2.85 per kWh with BESCOM needs to be annulled. This will then provide the new private operator open access to sell green power at premium price to nearby bulk consumer or wheel the power to corporate clients who can buy power at premium prices. Such an arrangement will help the private plant operator to bridge the prevailing viability gap between cost of power supply and prevailing grid tariff in project area.

Recommendation 6: Develop BERI assets as a national training and incubation centre, that is jointly managed by KSCST and IISc that is 50% self-financing (or financing from other sources) and 50% from GoK

The project assets, especially the gasifier based power plants, biogas plants, and plantations can be showcased as successful working demonstrations for training and capacity building of potential entrepreneurs, operators and other stakeholders. This can help in popularizing technologies, contribute to the collection and sharing of knowledge, and contribute to large-scale promotions that will increase the likelihood of replication.

4.3 Lessons Learned

- Careful preparations including a third party assessment of the technology are required for the selection of a technology provider. The technology being provided needs to be mature with minimal R&D required. In the case of BERI, it appears that the larger gas engines in the order of 100 to 250 kW_e were not market-ready until 2007. Moreover, the ASTRA technology for the 120 kW_e capacity community leaf and litter-based biogas-cum-biofertilizer plant to supply power for a domestic lighting load was dropped due to the immaturity of the technology being used on BERI;

- Public sector implementation arrangements for new technologies need to be simplified to provide the technology developer with the latitude for changes which may be unforeseen. A simplified arrangement would be engaging the technology provider in a turnkey operation and with performance standards. This arrangement would be favored by a technology provider who has a need to protect their intellectual property (IP). BERI did not have this arrangement, and as such, troubleshooting of the technology involved complex contractual arrangements, limited time to troubleshoot, and valuable time wasted in procuring these services. Moreover, O&M functions were outsourced by the Project which would have only attracted a very small number of entities associated or sanctioned by IISc as a means to protect their IP;

- Public sector selection of technology providers for new emerging technologies (with very limited number of suppliers) needs careful selection in that such a selection cannot be procured through a routine (typical government L-1 process) tendered process. This process is not only time consuming but expensive to implement for both government and the bidders who may expend considerable effort to prepare a bid or proposal;

- Complex projects with cross-cutting sectors where there is a lack of baseline activities or baseline data is poor, should be implemented in phases similar to earlier GEF projects.

In the case of BERI which started in 2001, the successful completion of one phase would secure funding for the subsequent phase. BERI could have been implemented as a 3-phase project with:

- Phase I as a planning & community mobilization phase;
- Phase II as a phase for proof of concept pilots;
- Phase III for operations and plans for replication.

The benefit of the phased approach would be the ability of the funding agencies to halt the project after each phase.

- One of the benefits of projects being associated with GEF is the access to foreign expertise. For GEF projects of long duration that have problems, there is value in having additional and periodic foreign external reviews of projects in addition to the traditional mid-term and terminal evaluations. Foreign external advice on BERI could have provided a fresh and unprejudiced approach to management arrangements and advanced global technical advice without being constrained by the structures of normal local practices; as such, BERI would have benefitted from the use of foreign expertise.

APPENDIX A – MISSION TERMS OF REFERENCE FOR PROJECT FINAL EVALUATION

Post Title: International Consultant to conduct Terminal Evaluation (TE) as per the UNDP-GEF guidelines for the project "**Biomass Energy for Rural India (BERI)**"

Organization: GEF-UNDP **"Biomass Energy for Rural India (BERI)**"

Supervisor: Head/Programme Analyst of Energy and Environment Unit, UNDP, New Delhi

Duration: Maximum of 21 working days (over a period of 45 days)

Duty Station: Home based consultancy and travel to Bangalore and various Project Sites in Tumkur district of Karnataka State, as part of the assignment.

UNDP strives to have a workforce which reflects diversity and gender balance, and applies an equal opportunities approach. UNDP does not solicit or screen for information in respect of HIV or AIDS status. All selection is on merit.

I. Background

In accordance with UNDP and GEF M&E policies and procedures, all full and medium-sized UNDP support GEF financed projects are required to undergo a terminal evaluation upon completion of implementation. These terms of reference (TOR) sets out the expectations for a Terminal Evaluation (TE) of the Biomass Energy for Rural India (PIMS #598).

The essentials of the project to be evaluated are as follows:

PROJECT SUMMARY TABLE

Project Title:	Biomass Energy for Rural India (BERI)			
GEF Project ID:			*at endorsement (Million US$)*	*at completion (Million US$)*
UNDP Project ID:	#00013002	GEF financing:	4,017,000	4,017,000
Country:	India	IA/EA own:		
Region:	Asia and Pacific	Government:	1,872,000	785,714
Focal Area:	Climate Change	Other:	2,734,000	
FA Objectives, (OP/SP):	CCM-3: Renewable Energy (GEF 5)	Total co-financing:	4,606,000	
Executing Agency:	UNDP	Total Project Cost:	8,623,000	8,623,000
Other Partners involved:	N/A	ProDoc Signature (date project began):		3rd April 2001
		(Operational) Closing Date:	Proposed: May 2006	Actual: 31st December 2012

Objective and Scope

The rural population in India consumes about 40 percent of the total energy generated, of which irrigation accounts for the highest consumption. Even though over 85 percent of the villages are connected to the electricity grid, less than a third of rural households are electrified. The available electricity supply is characterized by erratic supply, fluctuating voltage and shortages. Furthermore, the dependence of the rural population is on biomass for cooking using inefficient cookstoves and the associated drudgery. The environmental implications associated with current energy use are, such as deforestation, land degradation, GHG emissions, water and air pollution, and the consumption rate of fuel wood in rural areas. Renewable energy sources such as solar, wind and biomass provide a large potential towards addressing this scenario, meeting cooking and irrigation energy requirements of the rural population in order to achieve sustainable development.

Biomass Energy for Rural India (BERI) project is funded by GEF with the co-financing support of Indo Canadian Environment Facility (ICEF) (now closed), Government of Karnataka (GoK), and Ministry of New and Renewable Energy (MNRE). UNDP is GEF implementing agency, while Department of Rural Development and Panchayat Raj (RDPR), Government of Karnataka is the project implementing agency. BERI Society has been formed to take forward the agenda of promoting bioenergy, and an institution responsible to take over the activities initiated under the project after the closure of GEF-UNDP funding. This is a full sized project (FSP) with original project implementation duration of 5 years from May 2001 until May 2006.

This project aims at developing and implementing a bioenergy technology package to reduce GHG emissions and to promote a sustainable and participatory approach in meeting rural energy needs. The project is being implemented mainly in a cluster of about 24 villages of Tumkur district in Karnataka. The project goals will be achieved through (i) Demonstrating the technical feasibility and financial viability of bioenergy technologies on a significant scale, (ii) Building capacity and developing appropriate mechanisms for implementation, management and monitoring of the project. (iii) Developing financial, institutional and market strategies to overcome the identified barriers for large-scale replication of the bioenergy package for decentralized applications and (iv) Disseminating the bio-energy technology and information package on a large scale. The project aims to remove key barriers to large scale adoption and commercialization of bioenergy technology packages. Project activities are further described at the project website:- www.bioenergyindia.in

In order to achieve the project objective, the project key Components and Outcomes are as follows:

Component 1. Technology package Standardization
Outcome 1.1: Development adaptation and resulting availability of gas engines which are available locally to use the renewable feedstock proposed under the project
Outcome 1.2: Detailed technical specifications will be drawn for the proposed bioenergy packages in selected areas
Outcome 1.3: Draft standards for bioenergy technologies for use in activity 2 to test their sustainability for wider applications

Component 2. Technology demonstration and proof of concept (response to technical barriers)
Outcome 2.1: In place of 60 units of 20 kW each cumulating to 1.2 MW, 11 gasifier systems cumulating to 1.05 MW have been installed. These have the generating potential of 4800 MWh of bioelectricity annually. (revised)
Outcome 2.2: Activity was dropped
Outcome 2.3: Install 51 group biogas plants. The installed capacity of 51 biogas plants is approximately 400 m3 per day in 31 village settlements covering 175 households (revised).
Outcome 2.4: Establish 452 ha of short rotation forest plantations, 371 ha of agro-forestry systems, 271 ha of community forestry, 471 ha of orchards and 113 ha of high input forestry
Outcome 2.5: Lessons in different models of providing the rural energy service package to rural villages, including experience in gaining full cost recovery. (Note: The configuration of project has been changed from electricity provision directly to the community to selling power to the BESCOM. Hence, the full cost recovery directly is not relevant.)

Component 3. Capacity Building (response to institutional barriers)
Outcome 3.1: Bioenergy packages for replication in other parts of rural India
Outcome 3.2: Approach and methodology for monitoring carbon flows in bioenergy projects
Outcome 3.3: Training and involvement of women in planning and management of the bioenergy systems
Outcome 3.4: Training centre for training entrepreneurs, NGOs and managers on implementation technology and institutional package
Outcome 3.5: Training for entrepreneurs, NGOs, technicians and managers in the business skills required for making a success of the rural bioenergy development institutions
Outcome 3.6: Infrastructure development for manufacturing, spare parts supply and servicing of bioenergy systems

Component 4 Enabling activities (response to the market barriers)
Outcome 4.1: A solid rationale and framework justifying the fee-for service approach for rural energy provision
Outcome 4.2: Policy papers to address the issue of level playing field for bioenergy package such as policy analysis for rational pricing of energy
Outcome 4.3: Case studies to highlight successful policy implementation experiences
Outcome 4.4: Workshops to involve stakeholders especially policy makers to exchange the experiences, study tours and policy research activities
Outcome 4.5: Documentation of lessons learnt and sharing of experiences
Outcome 4.6: Monitoring and evaluation of the proposed project approach and activities

Component 5. Information dissemination (response to information barriers)
Outcome 5.1: Information system on bionenergy technologies, manufacturers, technology suppliers, financial mechanisms, technical performance, R & D facilities, and technical experts
Outcome 5.2: Methods for project formulation including financial analysis, implementation, monitoring, etc. for potential replicability.
Outcome 5.3: Promotional modules using audio-visual, print and other media.

Component 6. Removal of financial barriers and creation of investment risk fund (response to the financial barriers)
Outcome 6.1: Provision of venture capital for franchisers and franchisees as start-up capital
Outcome 6.2: Creation of revolving fund to offset perceived investment risks
Outcome 6.3: Formulation of a approach involving bidding for concessions to operate future bio energy systems in areas targeted for replications
Outcome 6.4: Demonstration of economic and financial viability through creation of cost recovery mechanisms
Outcome 6.5: Demonstration of willingness and capacity of rural households to pay for good quality energy services

The project at the concept stage was envisaged to establish 60 nos. of 20 kW biomass gasifier systems spread over 24 project villages of Tumkur district in Karnataka. Later, this was subsequently changed to less number of systems with larger system capacities ranging from 100 to 250 kW in three clusters. The project has now established 1 MW biomass gasifier power capacity in three village clusters - 500 kW in Kabbigere (3 nos of 100 kW systems out of which one of them is dual fuel engine and one 200 kW), 250 kW in Borigunte and 250 kW in Seebanayanapalya. Similar developments could be seen in the biogas cum bio-fertiliser systems. So far, the project has received three project extensions and is operationally to close as of 31st December 2012.

The TE will be conducted according to the guidance, rules and procedures established by UNDP and GEF as reflected in the UNDP Evaluation Guidance for GEF Financed Projects.

The objectives of the evaluation are to assess the achievement of project results, and to draw lessons that can both improve the sustainability of benefits from this project, and aid in the overall enhancement of UNDP programming.

II. Functions and key results expected:

The International Consultant will be the team leader and will be responsible for the quality of the report and timely submission. The National Consultant will provide supportive roles in terms of professional inputs, knowledge of local policies, local navigation, translation / language support, etc.

A. The review team is expected to prepare an Evaluation Report based on the outline listed in Annex II while specifically including the following aspects:
   1. Adequacy of the overall project concept, design, implementation methodology, institutional structure, timelines, budgetary allocation or any other aspect of the project design that the evaluation team may want to comment upon.
   2. Extent of progress achieved against the overall Project Objective disaggregated by each of the individual Outcomes, Outputs and Activities (including sub-activities); as against the Impact Indicators identified and listed in the project document. Extent of the incremental value added with project implementation.
   3. Performance in terms of in-time achievement of individual project activities as well as overall project in terms of adherence to planned timelines.
   4. Relevance and adequacy of mid-course changes in implementation strategy with PSC approval, if any and the consequent variations in achievements, if any.
   5. Extent of effectiveness of awareness generation activities by way of quality of promotional packages / awareness material, number of Awareness Programmes,

Trainings undertaken and level of awareness created. Quality of documentation, if any, produced under the project like quarterly newsletter, project website, brochure, etc. should also be considered

6. Pattern, in which funds have been leveraged, budgeted, spent and accounted for in the project.

B. The team should also focus their assessments on project impacts as listed:
   a) Perceptions on the "Situation at the end of the Project" as it seems to the review team at the terminal review stage
   b) Nature and scale of the policy impact made by the project, if any, on relevant line departments of the Government or other policy making bodies
   c) Extent of effectiveness of capacity building initiatives undertaken under the aegis of the project
   d) Appropriateness and effectiveness of the institutional arrangement deployed in the project with alternative scenarios, if any
   e) The effectiveness of current monitoring and overseeing systems such as Project Steering Committee and suggestion on improvements if any

Annex II contains guidance on the GEF Project review criteria and explanation of terminology provided in the GEF Guidelines to Evaluations.

III. Cross Cutting Issues:

Considering that UNDP is concerned about poverty reduction, local governance and promotion of gender equity, the team may look at these cross-cutting issues and comment if the project had any linkages and any achievement on these objectives has been through.

At its discretion, the team is free to include any other additional comments that are felt worth reporting.

IV. Products Expected from the Review

The total duration of the review and the finalization of report is 45 days, in which the Team Leader (IC) is expected to put in a level of effort equivalent to 21 days of professional inputs, the Team Leader will submit and present, his/her preliminary findings in the form of a presentation, to a group of select officials from UNDP,), Implementing / Partnering Agencies and/or other members of the Project Executive Committee / Project Steering Committee and incorporate their comments in the draft report. Thereafter, the draft report will be submitted by the deadline set by the UNDP after sharing of the preliminary findings. This draft report will also be shared with UNDP's Regional Coordinating Unit, GEF M&E office, in addition to UNDP for comments. After incorporating the comments from all avenues, the team leader will submit the final report to UNDP, New Delhi (including an electronic copy). The length of the main report should not exceed 50 pages, in total. In no case should the formal submission of the final report take place after expiry of 45 day deadline from the start date of the assignment. Report should be submitted as (i) 5 hard copies each signed by the TR team, (ii) soft copy of the report and of all documents reviewed for the TR by the team in CD – 5 copies.

If there are discrepancies between the impressions and findings of the evaluation team and any of the stakeholders of the project, these should be explained in a separate sheet to be attached to the final report.

The Evaluation Report Outline should be structured along the following lines:

1. Executive Summary
2. Introduction
3. The project and its development context
4. Findings and Conclusions
   - 4.1 Project formulation
   - 4.2 Implementation
   - 4.3 Results
5. Completed tracking tool
6. Recommendations
7. Lessons learned
8. Annexes

V. Methodology or Review Approach:

The review approach will combine methods such as documentation review (desk study); interviews; and field visits. All relevant project documentation will be made available by the project management team, facilitated by UNDP. After studying the documentation the team will conduct interviews with all relevant partners including the beneficiaries. Validation of preliminary findings/reports with stakeholders will happen through circulation of initial reports for comments or other types of feedback mechanisms.

The consultants should provide details in respect of:

- Documents reviewed and brief summary of them in an annexure;
- Interviews and brief summary wherever relevant;
- Field visits and brief summary in annexure or where relevant;
- Questionnaires, if any;
- Participatory techniques and other approaches for gathering and analysis of data; and
- Participation of stakeholders and/or partners.

VI. Implementation Arrangements:

Management arrangements:

Throughout the period of the review, the review team will liaise closely with the UNDP Country Director/ACD/Programme Analyst, the concerned agencies of the Government, any members of the international team of experts under the project and the counterpart staff assigned to the project. The team can raise or discuss any issue or topic it deems necessary to fulfill its task, the team, however, is not authorized to make any commitments to any part on behalf of UNDP/GEF or the Government.

Time-frame: As already described.

The team shall include eight days of site visits, the details of which can be worked out with the mission in due course. This visit will also include meetings with the officials of the Implementing Agency (BEE) and other stakeholders (ICPCI, NFTDC, etc.) to the project and UNDP officials.

After the initial briefing by UNDP Country Director/ACD/Programme Analyst, the review team will meet with the National Project Director, the officials of ICPCI and NFTDC and GEF Focal Point as required.

VII. Educational Qualification & Years of Experience

Essential: Graduate in engineering with a minimum of 10 years of relevant experience in industrial / academic/ policy experience in project management/ monitoring and evaluation/ energy efficiency. *Desirable:* Post graduate/doctorate in engineering/ certification in energy auditing/ management.

Competencies:

1. Demonstrated skills and knowledge in participatory monitoring, review and evaluation processes;
2. Extensive experience in monitoring, review and evaluation of technology transfer projects, supported by major donor agencies;
3. Familiarity with GEF rules, regulations, project reviews and evaluations;
4. Proficiency in energy efficiency in small & medium sectors (SME)
5. Knowledge of energy efficiency policies/conditions in India and abroad through management and/or implementation or through consultancies in evaluation of donor funded projects.
6. Proficient in writing and communicating in English. The consultant to bring his/her own computer/laptop and related equipment.

Annex D: Rating Scales

Ratings for Outcomes, Effectiveness, Efficiency, M&E, I&E Execution	***Sustainability ratings:***	***Relevance ratings***
6: Highly Satisfactory (HS): no shortcomings 5: Satisfactory (S): minor shortcomings 4: Moderately Satisfactory (MS) 3. Moderately Unsatisfactory (MU): significant shortcomings 2. Unsatisfactory (U): major problems 1. Highly Unsatisfactory (HU): severe problems	4. Likely (L): negligible risks to sustainability 3. Moderately Likely (ML):moderate risks 2. Moderately Unlikely (MU): significant risks 1. Unlikely (U): severe risks	2. Relevant (R) 1.. Not relevant (NR) ***Impact Ratings:*** 3. Significant (S) 2. Minimal (M) 1. Negligible (N)
Additional ratings where relevant: Not Applicable (N/A) Unable to Assess (U/A		

Annex F: Evaluation Report Outline[22]

i. Opening page:

- Title of UNDP supported GEF financed project
- UNDP and GEF project ID#s.
- Evaluation time frame and date of evaluation report
- Region and countries included in the project
- GEF Operational Program/Strategic Program

[22]The Report length should not exceed *40* pages in total (not including annexes).

- Implementing Partner and other project partners
- Evaluation team members
- Acknowledgements

ii. Executive Summary
- Project Summary Table
- Project Description (brief)
- Evaluation Rating Table
- Summary of conclusions, recommendations and lessons

iii. Acronyms and Abbreviations
(See: UNDP Editorial Manual[23])

1. Introduction
- Purpose of the evaluation
- Scope & Methodology
- Structure of the evaluation report

2. Project description and development context
- Project start and duration
- Problems that the project sought to address
- Immediate and development objectives of the project
- Baseline Indicators established
- Main stakeholders
- Expected Results

3. Findings[24]
(In addition to a descriptive assessment, all criteria marked with (*) must be rated[25])

3.1 Project Design / Formulation
- Analysis of LFA/Results Framework (Project logic /strategy; Indicators)
- Assumptions and Risks
- Lessons from other relevant projects (e.g., same focal area) incorporated into project design
- Planned stakeholder participation
- Replication approach
- UNDP comparative advantage
- Linkages between project and other interventions within the sector
- Management arrangements

3.2 Project Implementation
- Adaptive management (changes to the project design and project outputs during implementation)
- Partnership arrangements (with relevant stakeholders involved in the country/region)
- Feedback from M&E activities used for adaptive management
- Project Finance:
- Monitoring and evaluation: design at entry and implementation (*)
- UNDP and Implementing Partner implementation / execution (*) coordination, and operational issues

3.3 Project Results
- Overall results (attainment of objectives) (*)

[23] UNDP Style Manual, Office of Communications, Partnerships Bureau, updated November 2008

[24] At its discretion, the evaluation team is free to include any other additional information that is felt worth reporting. Considering that UNDP is concerned about poverty reduction, local governance and promotion of gender equity, the team may look at these cross-cutting issues and comment if the project had any linkages and any achievement on these objectives. This may also include contribution to "development dividends", which may refer to ways in which a project contributes towards: (a) Achievement of the MDGs, (b) Improvements to people's livelihoods, (c) Inter-generational poverty reduction, and (d) Improvements in the quality of life. Such development dividends can be accrued either locally or nationally.

[25] Using a six-point rating scale: 6: Highly Satisfactory, 5: Satisfactory, 4: Marginally Satisfactory, 3: Marginally Unsatisfactory, 2: Unsatisfactory and 1: Highly Unsatisfactory, see section 3.5, page 37 for ratings explanations.

- Relevance(*)
- Effectiveness & Efficiency (*)
- Country ownership
- Mainstreaming
- Sustainability (*)
- Impact

4. Conclusions, Recommendations & Lessons

- Corrective actions for the design, implementation, monitoring and evaluation of the project
- Actions to follow up or reinforce initial benefits from the project
- Proposals for future directions underlining main objectives
- Best and worst practices in addressing issues relating to relevance, performance and success

5. Annexes

- ToR
- Itinerary
- List of persons interviewed
- Summary of field visits
- List of documents reviewed
- Completed tracking tool
- Evaluation Question Matrix
- Questionnaire used and summary of results
- Evaluation Consultant Agreement Form

APPENDIX B – MISSION ITINERARY (FOR DECEMBER 3-8, 2012)

The evaluation mission was comprised of an international consultant Mr. Roland Wong and national consultant Dr. Sanjay Mande in accordance with the objectives of the evaluation and obtained data relevant for making judgments regarding Project success and lessons learned.

***December 2, 2012** (Sunday)*			
#	**Activity**	**Stakeholder involved**	**Place**
	Arrival of Mr Roland Wong / Dr Sanjay Mande		Bangalore
***December 3, 2012** (Monday)*			
1	Briefing with Mr Sunil Arora and Ms Chitra Narayanswamy, UNDP	UNDP India	Bangalore
2	Viewing draft documentary on BERI, Mr Bhaskar	ADCS	Bangalore
3	Discussions with Mr Aklavya, CEO Netpro (now with DESI Power)	NETPRO	Bangalore (by phone)
4	Discussions with Mr Krishnaswamy, MD Energreen	Energreen	Chennai (by phone)
5	Discussions with Mr Sudindra, Sr Engr-TCE	TCE	Bangalore (By phone as on travel)
6	Discussions with consultant Mr S C Rajsekhar	SRA Consulant	Bangalore (by phone as on travel)
***December 4, 2012** (Tuesday)*			
	Travel to BERI Project sites , Tumkur		
7	Visit to BERI Kabbigere power plant	BERI Project	Tumkur district
8	Visit to BERI Borigunte power plant	BERI Project	Tumkur district
9	Meeting with Mr G R Chadrasekhar, Superident Engineer	BESCOM	Tumkur
	Travel back to Bangalore		
***December 5, 2012** (Wednesday)*			
10	Meeting with Prof. V Ranganganathan, IIMB	IIM, Bangalore	Bangalore

11	Meeting with Prof S Dasappa	CGPL-IISc	Bangalore
12	Meeting Prof H S Mukunda	CGPL-IISc	Bangalore
13	Meeting with Mr Venkatesh, Mr Guptha, Mr PS Jagganatha, Mr Bharath, RDPR	PRDC	Bangalore
December 6, 2012 *(Thursday)*			
14	Meeting with Dr S N Srinivas	UNDP	Bangalore
15	Meeting with Mr G S Prabhu	Addn Principal Chief Conservator of Forest (Project Coordinator)	Bangalore
16	Discussions with Dr Butchaiah Gadde	UNDP Bangkok	Bangkok (SkyPe)
17	Discussions with Ms Preeti Soni	UNDP	New Delhi (by phone)
18	Discussions with Mr Srinivasan Iyer	UNDP	New Delhi (by phone)
19	Ms Nayanika Singh	GEF	New Delhi (by phone)
20	Discussions with Dr M H Swaminathan	Chief Conservator of Forest (Project Coordinator)	Dehradun on travel (by phone)
21	Discussions with Dr S C Khuntia	IAS (First Project Coordinator)	New Delhi (by phone)
December 7, 2012 *(Friday)*			
22	Meeting with Mr Prithviraj, KSCST	KSCST	Bangalore
	Preparation of mission de-briefing preparation		Bangalore
23	Meeting with Ms Rashmi, Deepa Cholan, RDPR	RDPR (Project Director and Project Coordinator)	Bangalore

24	Mission de-briefing presentation and viewing documentary made by ADCS	RDPR, BERI, UNDP, ADCS	Bangalore
December 8, 2012 *(Saturday)*			
	Departure of Dr Sanjay Mande		Bangalore
December 9, 2012 *(Sunday)*			
	Departure of Mr Roland Wong		Bangalore

Total number of meetings conducted: **24**

APPENDIX C – LIST OF PERSONS INTERVIEWED

This is a listing of persons contacted in India (unless otherwise noted) during the Final Evaluation Period only. The Evaluators regret any omissions to this list.

1) Mr Sunil Arora, UNDP, Delhi
2) Ms Chitra Narayanswamy, UNDP, Bangalore
3) Mr Bhaskar, ADCS, Chennai
4) Mr Aklavya, CEO Netpro (now with DESI Power)
5) Mr Krishnaswamy, MD Energreen
6) Mr Sudindra, Sr Engr-TCE
7) Mr S C Rajsekhar, SRA Bangalore
8) Mr Rangraju, Project Officer, BERI, Kabbigere
9) Mr G R Chadrasekhar, Superident Engineer, BESCOM, Tumkur
10) Prof. V Ranganganathan, IIMB
11) Prof S Dasappa, CGPL-IISc, Bangalore
12) Prof H S Mukunda, CGPL-IISc, Bangalore
13) Mr Venkatesh, Mr Guptha, Mr PS Jagganatha, Mr Bharath, RDPR, Bangalore
14) Dr S N Srinivas, UNDP, New Delhi
15) Mr G S Prabhu, Former Project Coordinator
16) Dr Butchiah Gadde, Regional Technical Advisor, UNDP, Bangkok
17) Ms Preeti Soni, UNDP, New Delhi, Former EE Unit head
18) Mr Srinivasan Iyer, UNDP, New Delhi
19) Ms Nayanika Singh, GEF Focal point
20) Dr M H Swaminathan, Former Project Coordinator
21) Dr S C Khuntia, Former Project Coordinator
22) Mr Prithviraj, MD, KSCST
23) Ms Rashmi, RDPR, Project Director
24) Ms Deepa Cholan, RDPR, Present Project

APPENDIX D – LIST OF DOCUMENTS REVIEWED

1. UNDP-GEF "Bionenergy for Rural India", Project Document, March 2001;
2. BERI Project AWP s from 2003 to 2012
3. BERI Project CDRs from 2004 to 2012
4. BERI Project PIRs from 2005 to 2012
5. BERI Project QPRs from 2008 to 2012
6. BERI Project PSC meet minutes from 2002 to 2012
7. UNDP Mission Summary Reports, BTORs (2002 and 2012)
8. BERI Memorandum
9. PPA between BESCOM and BERI and Grampanchayat
10. BERI project DPRs
11. BERI Carbon mitigation report by Darshini Ravindranath
12. Directory of service providers of biomass gasifier based systems (technology and manufacturing)
13. Various BERI agreements
14. Specification for biomass gasifier and engine system prepared by TCE
15. Research paper by CGPL on 1000hr operations of Kabbigere power plant
16. Cost benefit analysis of biomass gasifier based electrification by Prof Ranganathan
17. Mid-term Evaluation of the UNDP-GEF-ICEF project "Bio Energy for Rural India" (IND/99/G32/A/IG/99)
18. Various study reports on BERI Project

APPENDIX E – COMPLETED TRACKING TOOL

Tracking Tool for Climate Change Mitigation Projects (For Terminal Evaluation)

Special Notes: reporting on lifetime emissions avoided

Lifetime direct GHG emissions avoided: Lifetime direct GHG emissions avoided are the emissions reductions attributable to the investments made **during the project's supervised implementation period**, totaled over the respective lifetime of the investments.
Lifetime direct post-project emissions avoided: Lifetime direct post-project emissions avoided are the emissions reductions attributable to the investments made outside the project's supervised implementation period, but supported by financial facilities put in place by the GEF project, totaled over the respective lifetime of the investments. These financial facilities will still be operational after the project ends, such as partial credit guarantee facilities, risk mitigation facilities, or revolving funds.
Lifetime indirect GHG emissions avoided (top-down and bottom-up): indirect emissions reductions are those attributable to the long-term outcomes of the GEF activities that remove barriers, such as capacity building, innovation, catalytic action for replication.
Please refer to the Manual for Calculating GHG Benefits of GEF Projects.

Manual for Energy Efficiency and Renewable Energy Projects
Manual for Transportation Projects

For LULUCF projects, the definitions of "lifetime direct and indirect" apply. Lifetime length is defined to be 20 years, unless a different number of years is deemed appropriate. For emission or removal factors (tonnes of CO2eq per hectare per year), use IPCC defaults or country specific factors.

General Data	Results at Terminal Evaluation	Notes
Project Title	Biomass Energy for Rural India (BERI)	
GEF ID	10	
Agency Project ID	598	
Country	India	
Region	SAR	
GEF Agency	UNDP	
Date of Council/CEO Approval	December 1, 1999	Month DD, YYYY (e.g., May 12, 2010)
GEF Grant (US$)	4,213,000	
Date of submission of the tracking tool	February 13, 2013	Month DD, YYYY (e.g., May 12, 2010)
Is the project consistent with the priorities identified in National Communications, Technology Needs Assessment, or other Enabling Activities under the UNFCCC?	1	Yes = 1, No = 0
Is the project linked to carbon finance?	0	Yes = 1, No = 0
Cumulative cofinancing realized (US$)	1,136,937	
Cumulative additional resources mobilized (US$)	-	additional resources means beyond the cofinancing committed at CEO endorsement

Objective 3: Renewable Energy		
Please specify if the project includes any of the following areas		
Heat/thermal energy production	1	Yes = 1, No = 0
On-grid electricity production	1	Yes = 1, No = 0
Off-grid electricity production	0	Yes = 1, No = 0
Policy and regulatory framework	1	0: not an objective/component 1: no policy/regulation/strategy in place 2: policy/regulation/strategy discussed and proposed 3: policy/regulation/strategy proposed but not adopted 4: policy/regulation/strategy adopted but not enforced 5: policy/regulation/strategy enforced
Establishment of financial facilities (e.g., credit lines, risk guarantees, revolving funds)	4	0: not an objective/component 1: no facility in place 2: facilities discussed and proposed 3: facilities proposed but not operationalized/funded 4: facilities operationalized/funded but have no demand 5: facilities operationalized/funded and have sufficient demand
Capacity building	3	0: not an objective/component 1: no capacity built 2: information disseminated/awareness raised 3: training delivered 4: institutional/human capacity strengthened 5: institutional/human capacity utilized and sustained
Installed capacity per technology directly resulting from the project		
Wind		MW
Biomass	1.05	MW el (for electricity production)
Biomass		MW th (for thermal energy production)
Geothermal		MW el (for electricity production)
Geothermal		MW th (for thermal energy production)
Hydro		MW
Photovoltaic (solar lighting included)		MW
Solar thermal heat (heating, water, cooling, process)		MW th (for thermal energy production, 1m² = 0.7kW)
Solar thermal power		MW el (for electricity production)
Marine power (wave, tidal, marine current, osmotic, ocean thermal)		MW
Lifetime energy production per technology directly resulting from the project (IEA unit converter: http://www.iea.org/stats/unit.asp)		
Wind		MWh
Biomass	1,381.00	MWh el (for electricity production)
Biomass	-	MWh th (for thermal energy production)
Geothermal		MWh el (for electricity production)
Geothermal		MWh th (for thermal energy production)
Hydro		MWh
Photovoltaic (solar lighting included)		MWh
Solar thermal heat (heating, water, cooling, process)		MWh th (for thermal energy production)
Solar thermal power		MWh el (for electricity production)
Marine energy (wave, tidal, marine current, osmotic, ocean thermal)		MWh
Lifetime direct GHG emissions avoided	67,921	tonnes CO2eq (see Special Notes above)
Lifetime direct post-project GHG emissions avoided	-	tonnes CO2eq (see Special Notes above)
Lifetime indirect GHG emissions avoided (bottom-up)	225,663	tonnes CO2eq (see Special Notes above)
Lifetime indirect GHG emissions avoided (top-down)	74,714	tonnes CO2eq (see Special Notes above)

APPENDIX F – EVALUATION QUESTION MATRIX

Evaluative Criteria	Questions	Indicators	Sources[38]	Methodology[39]
Relevance: How does the project relate to the main objectives of the GEF focal area, and to the environment and development priorities at the local, regional and national levels?				
• Is the project relevant to National priorities and commitment under international conventions?	• Is the project country-driven? *Yes; however, GoI influence is not strong as BERI is more driven by the State of Karnataka.*	• RGGVY rural electrification programme	• National policies and strategies	• Data analysis
	• Does the project adequately take into account the national realities, both in terms of institutional and policy framework in its design and its implementation? *Yes. Rural power generation projects were a relatively new phenomena in 2001; this project contained assistance towards the pilot demonstration of a new gasification technology intended for more widespread use in rural communities*	• Design documents, APRs and PIRs	• PIRs and project reports	• Document analysis
	• How effective is the project in terms of supporting and facilitating energy industry in moving towards low carbon pathways through increased use of renewable sources of energy specifically biomass energy? *The Project was technically effective in facilitating a low carbon pathway for rural power generation. The Project, however, was not effective in facilitating further investments in bioenergy plants.*	• Functioning bioenergy plants and replication plans	• PIRs, project reports and site visits	• Document analysis, site visits, interviews with stakeholders
	• What was the level of stakeholder participation in project design and ownership in project implementation? *Recipient community participation was extensive during the 2001-05 period of the Project. After 2006, communities were not as engaged due to Project focus on ensuring the bioenergy plant is operational with the exception of a few jobs created in the bioenergy plant.*	• Low amount of biomass sourced for bioenergy plant	• PIRs, project reports and site visits	• Document analysis, site visits, interviews with stakeholders

• Is the project internally coherent in its design?	• Are there logical linkages between expected results of the project (log frame) and the project design (in terms of project components, choice of partners, structure, delivery mechanism, scope, budget, use of resources etc.)? *Yes. The BERI log-frame has a logical design in terms of Project components and delivery mechanism on condition that the biogasification technology selected was ready for deployment. Hence, the choice of technical partner was not logical for the project design in that IISc did not have a technology that could be replicated during BERI until 5 years after the start of the project, and that one of IISc's primary concerns during the Project was to protect their intellectual property of their gasification technology. This limited the number of suppliers, operators and service providers who could provide support for the deployment of their technology, an aspect that was not the intent of BERI.*	• Virtually no replication of bioenergy systems and no private investment into more bioenergy systems based on BERI pilot projects	• PIRs, ProDoc and stakeholder interviews	• Document analysis, site visits, interviews with stakeholders
	• Even after three extensions, does the project achieve its expected outcomes? If not, enumerate the reasons. *BERI has not achieved its expected outcomes due to unavailability of a gasification technology until Year 5 of the Project, the slow pace of deployment of the technology due to a small number of entities that were closely allied with IISc, the high cost of production of power from the Kabbigere plant, and a lack of strategic leadership in implementation to address both community and bioenergy development in concert.*	• No further private investments by enterprises • No households that have reliable electricity from the bioenergy plant • Only 4 households using biogas	• PIRs, ProDoc and stakeholder interviews	• Document analysis, site visits, interviews with stakeholders
	• Did the project make satisfactory accomplishment in achieving project outputs vis-à-vis the targets and related delivery of inputs and activities? *Most project outputs were delivered according to the set targets. There were, however, a number that were not delivered including a low number of*	• No entrepreneurs financed • No loans disbursed for other bioenergy plants	• PIRs, ProDoc and stakeholder interviews	• Document analysis, site visits, interviews with stakeholders

	enterprises involved with the IISc bioenergy plant, and a lack of availability of capital funds to replicate the Tumkur bioenergy plants.	• No replicable approaches formulated • No private investments for bioenergy by enterprises		
• Does the project provide relevant lessons and experiences for other similar projects in the future?	• Has the experience of the project provided relevant lessons for other future projects targeted at similar objectives? State the lessons. *Lessons learned are listed in Section 4.3 of this TE report.*	• n/a	• n/a	• n/a
Effectiveness: The extent to which an objective has been achieved or how likely it is to be achieved?				
• Does the project been effective in achieving the expected outcomes and objectives?	• Whether the performance measurement indicators and targets used in the project monitoring system are accomplished and able to achieve desired project outcomes within December 2012? *BERI has been effective at delivering of functional bioenergy systems (Outcomes 1 and 2). It has not, however, removed the financial barriers to further investments into rural bioenergy and the creation of a bioenergy investment risk fund*	• No entrepreneurs financed • No loans disbursed for other bioenergy plants • No replicable approaches formulated • No private investments for bioenergy by enterprises	• PIRs, ProDoc and stakeholder interviews	• Document analysis, site visits, interviews with stakeholders
• How is risk and risk mitigation being managed?	• How well are risks, assumptions and impact drivers being managed? *Poorly. This is explained in Sections 3.2.3, 3.2.5, and 3.2.6.*	• n/a	• n/a	• n/a
	• What was the quality of risk mitigation strategies developed? Were these sufficient? *Poor. This is explained in Sections 3.2.3, 3.2.5, and 3.2.6.*	• n/a	• n/a	• n/a
	• Are there clear strategies for risk mitigation	• n/a	• n/a	• n/a

	related with long-term sustainability of the project? *No. This is explained in Sections 3.2.3, 3.2.5, and 3.2.6.*			
• Consideration of recommendations and reporting of information	• Did the project consider Midterm Review recommendations conducted in September 2005 and reflected in the subsequent project activities? *It did not adopt the most important recommendations including the moving of the Project office to Tumkur and the setup and use of a proper project management system to track expenditures against progress.* • Effectiveness of reporting electricity generation data (specific to gasifiers) & operational costs of the biomass energy systems data on the BERI website? *There are no data on electricity generation from the Kabbigere bioenergy plant on the BERI website: http://bioenergyindia.kar.nic.in/*	• Lack of detailed project expenditures by component • No electricity generation data on BERI website.	• PIRs and stakeholder interviews	• Document analysis, interviews with stakeholders
• What lessons can be drawn regarding effectiveness for other similar projects in the future?	• What lessons have been learned from the project regarding achievement of outcomes? *Lessons learned are listed in Section 4.3 of this TE report.*	• n/a	• n/a	• n/a
	• What changes could have been made (if any) to the project design in order to improve the achievement of the project's expected results? *Different arrangements with regards to the technology provider and the owner of the bioenergy plant would have likely improved the results of BERI. A technology provider should have been selected on the basis of a performance contract with conditions to protect the provider's intellectual property. If there was an arrangement whereby the Government could have issued a concession for bioenergy generation in Tumkur, a privately operated bioenergy plant would have had more success in a successful demonstration of rural community-based bioenergy generation.*	• n/a	• n/a	• n/a

Efficiency: Was the project implemented efficiently, in-line with international and national norms and standards and delivered results with the least costly resources possible?				
• Was project support provided in an efficient way?	• How does the project management systems, including progress reporting, administrative and financial systems and monitoring and evaluation system were operating as effective management tools, aid in effective implementation and provide sufficient basis for evaluating performance and decision making? *There is evidence of a lack of project management systems on BERI. See Section 3.2.3.*	• Content in the PSC reports where most Project decisions were made	• PSC reports and PIRs	• Document analysis, interviews with stakeholders
	• How effective was the adaptive management practiced under the project and lessons learnt? *See Sections 3.2.1 and 3.2.3.*	• n/a	• n/a	• n/a
	• Did the project logical framework and work plans and any changes made to them used as management tools during implementation? *The log-frame was used to monitor the production of outputs on BERI.*	• PIR reports	• PIRs	• Document analysis
	• Utilization of resources (including human and financial) towards producing the outputs and adjustments made to the project strategies and scope. *An external strategic review of Project implementation should have been conducted in 2003 to recommend how to proceed with the development of rural-based bioenergy vis-à-vis technology selection and anticipated delays*	• n/a	• PIRs • CDRs • PSC meeting notes	• Document analysis
	• Details of co-funding provided (ICEF, GoK, GoI and others) and its impact on the activities. *Refer to Table 3 (page 21) of TE report.*	• n/a	• n/a	• n/a
	• How does the APR/PIR process helped in monitoring and evaluating the project implementation and achievement of results? *PIRs and APRs were the main tool to monitor the progress of BERI. The PSCs also provided progress details and implementation issues.*	• n/a	• n/a	• n/a

• How efficient are partnership arrangements for the project?	• Appropriateness of the institutional arrangement and whether there was adequate commitment to the project? *The institutional arrangement did not allow the biogasification technology to flourish under BERI. With complex procurement procedures and the lack of entities qualified to work with IISc's technology, the likelihood of widespread use of IISc's technology during BERI was limited. As such, a different arrangement to procure new technologies for bioenergy in India in the future needs to be formulated, and managed by the private sector.*	• n/a	• n/a	• n/a
	• Was there an effective collaboration between institutions responsible for implementing the project? *Collaboration was poor, most notably in the operations of the Kabbigere plant where operative expenditures and routine repair and maintenance expenditures needed to be approved by the PSC and PDPR. Another example of poor collaboration is the installation of the load shift mechanism which was requested by RPDP to BESCOM but was never executed during BERI.*	• n/a	• n/a	• n/a
	• Is technical assistance and support received from project partners and stakeholders appropriate, adequate and timely specifically for BERI PMU and BERI Society? *BERIS received poor support from the GoK to the extent that it can no longer exist after the BERI terminal date of December 31, 2012.*	• n/a	• n/a	• n/a
Sustainability: To what extent are there financial, institutional, social-economic, and/or environmental risks to sustaining long-term project results?				
• Will the project be sustainable on its conclusion and stimulate replications and its	• How effective is the project in terms of strengthening local capacities in the installation and operations of gasifier based power plants, biogas cum bio-fertiliser systems, and energy plantations as well as improving energy access	• n/a	• Kabbigere power plant personnel	• Interviews with plant personnel

potential?	for rural areas in India? *Project has been adequate in strengthening local capacities to operate gasifier-based power systems and manage energy plantations. It has not yet demonstrated an improvement in energy access for rural areas due to the local utility failure to install a load shifting mechanism during BERI.* • Assess the suitability and sustainability of energy plantations as fuel linkages for the Kabbigere power plant. *The fuel linkages between the energy plantations and the Kabbigere plant are very suitable. The problem has been their sustainability due to the shift in the sourcing of biomass (for unknown reasons) from the local plantations to a source over 40 km from Tumkur, for a much higher cost.*			
	• Comment on the exit strategy being implemented by the project and provide a commentary on the "Expected situation at the end of the Project" as envisioned at the time of terminal evaluation. *The exit strategy is contained in Section 4.2 in Recommendations 1 to 6.*	• Exit strategy as prepared by Evaluators and Project Personnel that was requested by RDPR	• Aide Memoire of Exit Strategy dated December 12, 2012	• Discussions with Project personnel
	• Appropriateness of the institutional arrangement and whether there was adequate commitment to the project. *The institutional arrangement in implementing the bioenergy plant was poor and caused it to be implemented in a very slow manner. This is due to the fact that RDPR does not implement or manage bioenergy plants. There should have been a mechanism whereby RDPR could provide a private sector concession to operate a bioenergy plant.*	• n/a	• n/a	• n/a
Impact: Are there indications that the project has contributed to, or enabled progress towards maximizing environmental benefits?				
• What was the project impact	(a) Technology package Standardization (b) System demonstration & proof of concept	• See Section 3.3	• PIRs, Project Reports and	• Document analysis and

under different components	(c) Capacity building (d) Enabling activities (e) Information dissemination (f) Removal of financial barriers and creation of investment risk fund *See Section 3.3 for Project results and impacts*		stakeholders	stakeholder interviews
	• What was the additional co-financing amount that was leveraged by the project and mobilized investments for BERI in India? It can include investments in the gasifiers for power generation and biogas for cooking, similar to the concept of BERI. *See Table 3 (Page 21) of TE report that indicates only 25% of committed co-financing was realized. Most of this was from a bilateral donor, ICEF, and very little from GoK.*	• Co-financing reports from Project personnel	• Project personnel	• Examination of co-financing figures
• What are the indirect benefits that can be attributed to the project?	• Spinoffs created by the project, if any, as a result of the project, the linkages brought with other partners/Ministries and their impacts on the overall outcomes: • Have Green jobs been created through a project such as BERI, and if such projects have the potential of effective training of local capacities in the operations of gasifier based power plants? *Green jobs were created during BERI. The problem is that these jobs were terminated after the completion of BERI as the RDPR did not want to continue operations of the Kabbigere plant.*	• No funds available after BERI for the operation of Kabbigere bioenergy plant	• Project personnel	• Interviews with Project personnel
• Impacts due to information dissemination under the project	• Assess the use of electronic information and communication technologies in the implementation and management of the project such as impact of the UNDP CO and BERI project websites. *Adequate. The BERI website has not been updated since 2009; however, it does contain some information that would be used in the development of another rural bioenergy project though the layout of the website can be improved to find the information*	• Content on the BERI website	• http://bioenergyindia.kar.nic.in/study.htm	• Examination of the website

APPENDIX G – LOGICAL FRAMEWORK MATRIX

NARRATIVE SUMMARY	OBJECTIVITY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	CRITICAL ASSUMPTIONS
I. Development Objective (Impacts)			
To reduce CO_2 emissions through the promotion of bioenergy as a viable and sustainable option to meet the rural energy service needs in India.	Extent of energy needs met by bio-energy Reduction in use of non-renewable energy sources	Adoption of bioenergy packages in other parts of rural India	Globally, bioenergy package will continue to be one of the key climate-mitigation options and the government is committed towards the reduction in GHG emissions. Provision of good quality bioenergy services will improve the quality of life, and thereby lead to it replication in other parts of rural India. Large scale use of bioenergy will lead to reduction in GHG emissions.
II. Immediate Objective (Outcomes) / Purposes:			
Immediate Objective 1: To provide a decentralized bioenergy technology package for the provision of good quality rural energy services for lighting, drinking water supply, cooking gas, irrigation water supply and milling.	% of households having access to bioenergy services % Functional bioenergy systems meeting the % energy requirements	Per capita bioenergy consumed	The findings of survey undertaken as part of PDF activities hold good
Activity 1: Technology Package Standardization			
Output 1: Development; adaptation; and resulting availability of gas engines—which are available; locally – to use the renewable feedstock proposed under the project	No. of systems installed	Evaluation of performance of gas engines	Introduction of gas engines will improve the efficiency and use of 100% renewable resources and lead to reduction in costs of services.
Output 2: Detailed technical specifications will be drawn for the proposed bioenergy package in selected	Report on recommended specifications	Evaluation report of technical specifications	The technological components are well known and trouble free and could be adopted and modified and put together to suit local conditions without a large effort in R & D.

NARRATIVE SUMMARY	OBJECTIVITY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	CRITICAL ASSUMPTIONS
areas			The industry will favour high quality standards and adhere to the standards while producing these equipments.
Output 3: Draft standards for bioenergy technologies for use in Activity 2 to test their suitability for wider applications	Established technical standards	Findings of the proposed monitoring activities	Standards will enhance the reliability and confidence level of the customers
Activity 2: Technology Demonstration and proof of Concept (response to the technical barriers)			
Output 1: 1.2 MW biomass gasifier (60 units of 20 kw capacity) based power plants with a generating potential of 4800 MWh of bioelectricity annually.	Number of installed bioenergy systems having the recommended specifications / standards Capacity utilization of installed systems	% increase in area under bioenergy irrigation and corresponding outputs Quantity of fossil fuel substituted	Increase in incomes lead to demand for good quality energy services There will not be any conflicts arising out of sharing of irrigation water.
Output 2: 120kW (3-10 kW each) Community biogas cum bio-fertilizer systems generating 346 MWh for base loads	No. of households connected to biogas	% of household having access to lighting services	Rural communities aspire for better quality of life
Output 3: 24 Biogas cum bio-fertilizer systems in 24 village settlements with a total capacity of 4000m3/day (range 25 to 100m3/day) for cooking gas and bio-fertilizer production	No. of households connected to biogas electricity	Reduction in fuelwood consumption and fertilizer sales	The targeted beneficiaries of the project will prefer bioenergy services than conventional forms of use of energy
Output 4: Establish 452 ha of short rotation forest plantations, 371 ha of agro-forestry systems, 271 ha of community forestry 471 ha of orchards and 113 ha of high input forestry	Area covered under forests	Overall increase in forest area	There will not be major land tenure issues and the stakeholders' cooperation is guaranteed. The communities will participate in the sustainable forestry activities
Output 5:	Case studies documented	Review of project	Bioenergy services would not become

NARRATIVE SUMMARY	OBJECTIVITY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	CRITICAL ASSUMPTIONS
Lessons in different modes of providing the rural energy service package to rural villages, including experience in gaining full cost recovery.		implementation results	financially less attractive due to pricing policies of competing energy service utilities. People will actually pay fee for services utilized.
Activity 4: Enabling activities (response to the market barriers)			
Output 1: A solid rationale and framework justifying the fee-for-service approach of rural energy provisions.	Framework for fee for services established	Framework for fee for services adopted	Relevant government and private stakeholders' actively participate in developing appropriate policies.
Output 2: Policy papers to address the issue of *level playing field* for bioenergy package such as policy analysis for rational pricing of energy	Policy papers published	Changes in relevant policies	Relevant government and private stakeholders' actively participate in developing appropriate policies
Output 3: Case studies to highlight successful policy implementation experiences	Case studies documented	Case studies disseminated	The project will be closely monitored and regular feedback will be provided
Output 4: Workshops to involve stakeholders especially policy makers to exchange the experiences, study tours and policy research activities	Extent of participation and recommendations	Extent of recommendations accepted	The recommendations will provide key basis to some of the intended policy changes – such as level playing field for bioenergy services
Output 5: Documentation of lessons learnt and sharing of experiences;	No. of cases documented		
Output 6: Monitoring and evaluation of the proposed project approach and activities	Quarterly reports Annual reports	Progress made in the implementation of the project	All stakeholders will provide inputs to the monitoring team in addition to their direct feedback to the implementing agency.
Activity 5: Information dissemination (response to the information barriers)			
Output 1:			Awareness modules will reach the targeted

NARRATIVE SUMMARY	OBJECTIVITY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	CRITICAL ASSUMPTIONS
Information system on bioenergy technologies, manufacturers, technology suppliers, financial mechanisms, technical performance, R & D facilities and technical experts			beneficiaries/users
Output 2: Methods for project formulation including financial analysis, implementation, monitoring, etc for potential replicability			
Output 3: Promotional modules using audio-visual print and other media.	Case studies, video films, Software packages developed	Extensive use of promotional modules	
Activity 6: Removal of Financial Barriers and Creation of Investment Risk Fund (response to the financial barriers)			
Output 1: Provision of venture capital for franchisers and franchisees as start-up capital;	Number of entrepreneurs financed	Enterprises / Rural Energy Service Company (RESCO) operating successfully	There will be sustained demand for good quality bioenergy services
Output 2: Creation of revolving fund to offset perceived investment risks;	Loan recovery rate Private investments leveraged	Revolving Fund mechanisms in place	
Output 3: Formulation of a approach involving bidding for concessions to operate future bioenergy systems in areas targeted for replications	Replicable approaches formulated	Replicable approaches adopted	Other areas would be receptive to the recommended approaches
Output 4: Demonstration of economic and financial viability through creation of cost recovery mechanisms	Private investments by the enterprises	Institutional networks for funding in place	Other financing institutions provide loans for bioenergy technologies and services
Output 5: Demonstration of willingness and capacity of rural households to pay for quality energy services	Loan recovery rate Increase in demand for good quality energy services	Agencies providing credit to households for bioenergy services	Other financing agencies, NGO's etc., to provide credit for bioenergy technologies and services

APPENDIX H– EVALUATION CONSULTANT AGREEMENT FORM

Evaluators:

1. Must present information that is complete and fair in its assessment of strengths and weaknesses so that decisions or actions taken are well founded.
2. Must disclose the full set of evaluation findings along with information on their limitations and have this accessible to all affected by the evaluation with expressed legal rights to receive results.
3. Should protect the anonymity and confidentiality of individual informants. They should provide maximum notice, minimize demands on time, and respect people's right not to engage. Evaluators must respect people's right to provide information in confidence, and must ensure that sensitive information cannot be traced to its source. Evaluators are not expected to evaluate individuals, and must balance an evaluation of management functions with this general principle.
4. Sometimes uncover evidence of wrongdoing while conducting evaluations. Such cases must be reported discreetly to the appropriate investigative body. Evaluators should consult with other relevant oversight entities when there is any doubt about if and how issues should be reported.
5. Should be sensitive to beliefs, manners and customs and act with integrity and honesty in their relations with all stakeholders. In line with the UN Universal Declaration of Human Rights, evaluators must be sensitive to and address issues of discrimination and gender equality. They should avoid offending the dignity and self-respect of those persons with whom they come in contact in the course of the evaluation. Knowing that evaluation might negatively affect the interests of some stakeholders, evaluators should conduct the evaluation and communicate its purpose and results in a way that clearly respects the stakeholders' dignity and self-worth.

6. Are responsible for their performance and their product(s). They are responsible for the clear, accurate and fair written and/or oral presentation of study imitations, findings and recommendations.
7. Should reflect sound accounting procedures and be prudent in using the resources of the evaluation.

Evaluation Consultant Agreement Form[40]

Agreement to abide by the Code of Conduct for Evaluation in the UN System

Name of Consultant: Roland Wong

Name of Consultancy Organization (where relevant)**:** _____

I confirm that I have received and understood and will abide by the United Nations Code of Conduct for Evaluation.

Signed at *Surrey, BC , Canada* on *March 11, 2013*

Signature: 

Evaluation Consultant Agreement Form

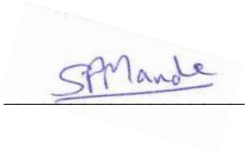
Agreement to abide by the Code of Conduct for Evaluation in the UN System

Name of Consultant: Sanjay Mande

Name of Consultancy Organization (where relevant)**:** _____

I confirm that I have received and understood and will abide by the United Nations Code of Conduct for Evaluation.

Signed at *Delhi, India* on *March 11, 2013*

Signature: 

Directions:	Read GEF CO2 Calculation Manual before attempting to use the spreadsheet
	Follow the steps on the left hand side of the spreadsheets
	Yellow squares require input
	Blue squares represent automatic outputs
	Tan squares are the instructional steps to follow

GHG Benefits of GEF Projects: Carbon Dioxide Calculator

Step 1 Insert Project Title. The results and key data tables will update automatically once all spreadsheets are complete.

Project Title
India: Biomass Energy for Rural India (PIMS 598)

Results	t CO2e
Direct emissions reductions	1,244
Direct post project emissions reductions	-
Indirect bottom-up emissions reductions	1,244
Indirect top-down emissions reductions	-

Key Data	
Annual electricity saved / generated (MWh)	555
Emissions factor (T CO2 e / MWh)	0.90
Useful Investment Lifetime (years)	2.49
Revolving Fund Size ($)	-
Revolving Fund turnover factor (t)	-
Replication Factor	1.00
P10 (t CO2)	-
GEF Causality Factor (%)	20

Step 2 Enter Project Components leading to direct and indirect emissions reductions

Enter Project Components (Commensurate with the Log Frame)

Activities Contributing to Direct Emissions Reductions

1) Forestry plantations
2) Biogasification of animal waste for cooking fuel
3) TA towards implementation of bioenergy plants
4) -
5) -

Activities Contributing to Indirect Emissions Reductions

1) Forestry plantations not harvested for feedstock for bioenergy plants
2) Lessons learned from implementing BERI bioenergy plants
3) -
4) -
5) -

Step 3 Move to the 'Direct' sheet

India: Biomass Energy for Rural India (PIMS 598)

Activities contributing to direct emissions reduction will automatically be copied into the table opposite from the cover page

	Activities Contributing to Direct Emissions Reductions
1)	Forestry plantations
2)	Biogasification of animal waste for cooking fuel
3)	TA towards implementation of bioenergy plants
4)	-
5)	-

Step 4 Determine the Baseline

Enter Description of the Project Baseline

Use of local biomass for cooking and electricity from the national grid

Step 5 Determine the GEF Alternative

Enter Description of the GEF Alternative Scenario

Growth of shrubs and trees for carbon sequestration and biomass supply for bioenergy plant, biogas for cooking fuel from animal waste and electricity from bioenergy plants

Data Required:

Step 6 Enter the **annual quantity** of electricity generated by low GHG technologies in stalled, or energy saved through EE measures after all project investments have been made.

A) Annual Electricity Saved / Generated (MWh)

555

Notes: **No funds are available after EOP to operate bioenergy plants**

Assumptions: Bioenergy generated after EOP only if operational funds are made available

Step 7 Enter the Emissions Factor of the marginal technology or national grid. Refer to IEA documented national emissions factors.

B) Emissions Factor (t CO2 / MWh)

0.9

Notes: Indian grid emissions factor can be found on:

Assumptions: http://www.cea.nic.in/reports/planning/cdm_co2/user_guid

Step 8 Enter investment lifetimes. **See table below for standardized suggestions**. Projects technology may differ from these suggestions. If entering a non-standard useful investment lifetime, please provide justification in the assumptions box.

C) Average Useful Investment Lifetime

2.49

Notes: **The bioenergy plant is not functioning as of January 1, 2013, the date when BERI funds were exhausted**

Assumptions: Useful life of bioenergy plant was assumed to be 3 years. Private funds are being sought to continue its operation but will be done with little influence of BERI (other than the requests by BERI to invite private sector firms such as Pointec to operate the plant

Standardized Suggestions

Technology	Average Useful Investment lifetime (years)
BIPV	10
Wind farm	20
Small Hydro	15
DH Improvement	15
EE lighting and appliances	5
Green buildings	30
cogeneration	10
Network upgrade	20
power plant retrofitting	20
Industrial Processes	7

Step 8 Sense check results

Results: Direct Emissions Reductions (A*B*C)

1,244	**tons CO2 e**
1.24	KT CO2 e
0.00	MT CO2 e

Step 8 If the project includes a fund that will continue to operate after the project close, move to 'Direct Post Project' sheet. If it does not move directly to the 'Indirect Sheet'

India: Biomass Energy for Rural India (PIMS 598)

Only fill in this spreadsheet of the project contains a fund that will operate after the project close. If the project conations a different component contributing to post-project emissions reductions, include calculations on a blank sheet. Activities contributing to direct post project emissions reductions are automatically copied from the cover sheet. Please refer to section 2 (d) of the Manual for further guidance.

	Activities Contributing to Direct Post Project Emissions Reductions
1)	Forestry plantations
2)	Biogasification of animal waste for cooking fuel
3)	
4)	-
5)	-

Data Required

Step 9	Enter the number referring to the relevant activity (the project fund) from the table above. If more than one activity contributes to direct post project reductions, copy this sheet, and be sure to sum all results.	9) **Relevant Activity (from table above)**	**none**
Notes:			
Assumptions:			
Step 10	Enter initial Fund Size	10) **Fund Size ($)**	-
Notes:			
Assumptions:			
Step 11	Enter Average Duration (in years)	11) **Average Loan Duration**	0
Notes:			
Assumptions:			
Step 11	Enter Fund Operation Period during project Implementation (in years). Average total fund operation (including before implementation and post project period) is recommended to be 10 years	11) **Fund Operation During Project Implementation (years)**	0
Notes:			
Assumptions:		**Fund operation after project close (years)**	
Step 12	Enter the prost project fund leakage rate. Please refer to section 2 (d) of the Manual for further guidance. A simplified cash flow of the fund's operation over 10 years is presented below, and used to calculate the turnover factor (t)	13) **Post Project Leakage Rate (%)**	0
Notes:			
Assumptions:		**Annual Defaults after project close ($)**	0
		Direct Emissions Reductions (t CO2)	1,244

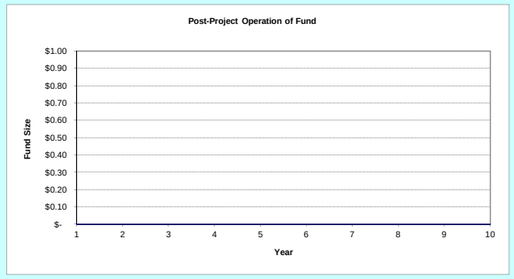
Year	1	2	3	4	5	6	7	8	9	10
Fund Size ($) (beginning of year)	$ -	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Annual Investment During Project Total ($)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Annual Reflow of Original Investment ($)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Leakage ($)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fund Size ($) (end of year)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Results:

Fund Investment After Project Close ($)	
Turnover Factor (t)	

Step 13	Sense check automatic results	**Direct Post Project Emissions Reductions**	**0 tons CO2 e**
			- KT CO2 e
			- MT CO2 e

Post-Project Fund Graph



Step 14	Move to 'Indirect' Sheet

India: Biomass Energy for Rural India (PIMS 598)

	Activities Contributing to Indirect Emissions Reductions
1)	Forestry plantations not harvested for feedstock for bioenergy plants
2)	Lessons learned from implementing BERI bioenergy plants
3)	-
4)	-
5)	-

Indirect Bottom-up

Step 15	Enter Replication Factor. Please refer to section 2 (e) in the Manual for further guidance. Also see table below for standardized suggestions. Not all projects will fit these suggestions, if using a different replication factor explain rational in the assumptions box.	
15)	**Replication Factor**	**1**
Notes:	Bioenergy plants not operational after EOP until operational funds are available	
Assumptions:	Replication factor based on the assumption that private sector entities will want to replicate using lessons learned from BERI experience	
	Direct Emissions Reductions	1,244

Standardized Suggestions

Project Type	Suggested Replication Factor
Solar Home Systems	2
ESCO	2
Market transformation and demonstration capital	3
Credit and guarantee facilities	4

Step 16	Sense check automatic results	
16)	**Results: Indirect bottom up-emissions**	**1,243.76 Tons CO2 e**
		1.24 KT CO2 e
		0.00 MT CO2 e

Indirect Top Down

Step 17	Enter 10 year market potential	
17)	**Enter P10 (Tons CO2 e)**	**-**
Notes:	There is market demand for community-based power generation. BERI has set some examples and provide lessons learned in terms of how to implement this.	
Assumptions:	Based on private sector wanting to replicate BERI experience and improve it with lessons learned	
Step 18	Enter GEF Causality Factor. Please refer to section 2 (e) in the Manual for further guidance. Also see table below for standardized suggestions.	
18)	**Enter Causality Factor (%)**	**20**
Notes:	BERI demonstration works but appears too costly to operate. Ponitec has made a bid to operate Kabbigere for 3 months.	
Assumptions:	Entrepreneurs are willing to try to operate Kabbigere and others may be willing to build a new bioenergy plant using BERI lessons learned	

Standardized Suggestions

Pick Causality Factor	%
Level 5 - "Critical"	100
Level 4 - "dominating"	80
Level 3 - "substantial but modest"	60
Level 2 - "modest"	40
Level 1 - "weak"	20

Step 19	Sense check automatic results	
19)	**Results: Indirect top-down emissions**	**- Tons CO2 e**
		- KT CO2 e
		- MT CO2 e

Sense Checking Results

	1) Direct Emissions Reductions
Description	Direct emissions reductions are calculated by multiplying together the annual quantity of electricity generated with low carbon technology or saved through energy efficiency measures, by the carbon intensity of the country or marginal technology. This resultant figure, which represents the total annual emissions reductions cause by the project's investments, is then multiplied by the average useful lifetime of these investments to give the total direct emissions reductions.
Problem	The annual quantity of electricity generated or saved is entered incorrectly.
Check	Be sure the MWh figure entered refers to the **annual** figure after **all** project investments have been made.
Problem	The carbon intensity of the marginal technology is entered incorrectly
Check	Make sure the carbon intensity of the marginal technology (i.e. the technology that would have been used to generate electricity / energy in lieu of the project) is used.
Problem	The useful investment lifetime is entered incorrectly
Check	Useful investment lifetimes may be different from physical lifetimes. Typically this value is overestimated, leading to higher than expected C02 results.
	2) Direct Post Project Emissions Reductions
Description	Direct post-project emissions reductions typically stem from an investment fund that continues to operate after the project has closed. The 'Direct Post Project' spreadsheet is set up to simulate this type of fund. If the project activity leading to direct post project reductions is different, please include the emissions calculation on a new blank spreadsheet.
Problem	The project does not have a fund that operates after the project close.
Check	Re-examine the project to see if it actually catalyses direct post project emissions reductions. If there is no fund that operates after the project close, the project may not create emissions reductions in this category.
Problem	The project does not have a revolving fund, but it does in include an activity after the project close that will lead to direct post project emissions reductions.
Check	See the instructions at the top of the 'direct post project' spread sheet - if this is a case, please present the estimation of direct post project emissions reductions on a new black spreadsheet.
Problem	The fund will operate for more that 10 years in total.
Check	To be conservative, the spreadsheet is set up to fix a maximum of a ten year fund life time.
Problem	The fund leakage rate is not known
Check	Check that a suitable assumption had been made - leakage rates are typically in the range of 5-15% depending on the fund.
	2) Indirect Emissions Reductions
	Bottom-up
Description	The bottom up methodology essentially attempt to capture the replication effects caused by the project.
Problem	The bottom-up estimate seems to high, especially in comparison with the top-down estimate
Check	Check the assumed replication factor - typical replication factors range from 1 to 3.
	Top-down
Description	The top down methodology aims to provide an estimation of the total market size for the technology or area the project addresses. As GEF projects' aim to remove barriers to market development, it is assumed that a successful project helps the market along towards the its maximum possible size in the ten years that follow the project close. Once the total market size is estimated, emissions are then modified downwards by the GEF causality factor.
Problem	The top-down estimate seems inconsistent with the bottom-up.
Check	Erroneous results can be caused by errors in the estimation of the total market potential (or **P10**). Make sure this figure represents only possible growth for the **10 years** immediately following the project. Errors can also be caused by picking an inappropriate **causality factor**. If the top-down emissions reduction is very different, or even below the bottom up estimate, check these two key assumptions.

Definitions (from Manual for Calculating GHG Benefits for GEF Projects)

Type of GHG emission reduction	Direct	Direct post-project	Indirect
Example component of a GEF intervention that can cause this type of GHG emission reduction	Demonstration projects and investments leveraged during the projects supervised implementation	Investments supported by mechanisms (e.g., revolving funds) that continue operating after the end of the project	Policy framework, standards and labels
Logframe level	Output	Not on logframe level	Outcome/ impact on level of Global Environmental Objective
Quantification method	Similar to CDM projects	Similar to CDM projects, based on assumptions of functioning post project mechanisms	Bottom-up or top-down
Quality of assessment	Highest level of certainty and accuracy	Reasonable level of accuracy, medium level of certainty	Low levels of accuracy and certainty

Emission reductions are calculated in the following way:

1. Direct emission reductions for each demo project

Number of CMR rotors in use during the Project period	
Since CMR technology was not commercialized during the Project period, direct ERs were assumed to be zero for the Project	

2. Direct post-project emission reductions

None assumed as there are no project funds to promote the sale of CMRs	

2. Indirect emission reductions

Assumptions on weighted average motor size, reduction of energy consumption from a CMR are contained in the "ER Timelines" worksheet	"ER Timelines" worksheet
"Direct emission reductions" were assumed in the calculation as the ERs generated from the commercialization of the CMR technology in 2018, and a market share of 20% (or 4 million rotors) 10 years after completion of the Project	"ER Timelines" worksheet

Other Assumptions

Assumed service life of CMR rotors	10	years
Emissions factor for 1 MWh from Indian grid	0.900	tonnes CO2 eq.
Period of indirect impacts	10	years
Assumed GEF causality factor (top down approach is assumed to be weak as compliance is difficult for SME end users)	0.2	

Emission Reduction Description	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Forestry		11,581	26,580	26,580	25,783	25,009	24,259	23,531	22,825	22,140	21,476	20,832	20,207	19,601	290,404
Biogas		151	240	148	0	0	0	0	0	0	0	0	0	0	539
Bioenergy	248	345	276	374	0	0	0	0	0	0	0	0	0	0	1,243
Total Emission Reductions	1,646	12,077	27,096	27,102	25,783	25,009	24,259	23,531	22,825	22,140	21,476	20,832	20,207	19,601	293,584

BERI Terminal Date →

Assumptions:

1. Total project direct emission reductions are estimated to be	67,921	tonnes CO_{2eq}		
2. Direct emission reductions from bioenergy plant are	1,243	tonnes CO_{2eq}		
3. Direct emission reductions from biogas installations are	539	tonnes CO_{2eq}		
3. Direct emission reductions from forestry activities are	64,741	tonnes CO_{2eq}		
4. Indirect emission reductions from forestry are	225,663	tonnes CO_{2eq}		
5. Energy produced by bioenergy plants as follows (MWh):	275	383	307	416
6. Total direct energy produced by bioenergy plants (MWh)	1381	MWh		
7. 10-yr market potential for bioenergy plants	0	tonnes CO_{2eq}		

Lifetime direct GHG emissions avoided	67,921	tCO_2
Lifetime direct post-project GHG emissions avoided	0	As there are no financing instruments (revolving fund or LFG etc.)
Lifetime indirect GHG emissions avoided (bottom-up)		
Replication factor	3	
Lifetime indirect GHG emissions avoided	225,663	tCO_2 (bottom-up)
Causality factor	15%	Depending on the level of replication of BERI concept in the country - a guess could be somewhere around 10%
Lifetime indirect GHG emissions avoided	74,714	tCO_2 (top-down)