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UNDP/GEF PROJECT 00057404 – ENERGY CONSERVATION IN SMALL SECTOR TEA PROCESSING UNITS IN SOUTH INDIA

TERMINAL EVALUATION (TE)

REVIEW REPORT

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Final Report

7 November 2012

Acknowledgement

The Evaluation Team would like to sincerely thank officials of UNDP-India (Mr. Srinivasan Iyer, Dr. S.N. Srinivas, and Ms. Chitra Narayanswamy), TIDE team (Ms. Svati Bhogle and Dr. R Sethumadhavan), Tea Board Executive Director and National Project Director Mr. R. Ambalavanan, and UPASI team (Secretary General Mr. Ullas Menon, Scientist and Technical Advisor & PSC member Dr. G. Rudramoorthy, and experienced project staff Mr. Manigandan), Steering Group members, biomass briquetting factory (Mr. Ravindranathan of Jayshree) and tea producers (Mr. Leonit Shaji and Mr. V. Suresh Menon of Thaymudi tea factory; Mr. Surendra Mohan of Havukal tea factory) for sparing their valuable time and for their assistance during the terminal evaluation mission.

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Abbreviation

Acronym	Meaning
APR	UNDP/GEF Annual Performance Review
APFC	Automatic Power Factor Controller
AWP	Annual Work Plan
BEE	Bureau of Energy Efficiency
BLA	The Nilgiris Bought Leaf Association
CAGR	Compounded Annual Growth Rate
CDM	Clean Development Mechanism
CFLs	Compact Fluorescent Lamps
CTC	Cut- Tear and Curl
DEAs	Detailed Energy Audits
DMT	Drier Mouth Tea
DG	Diesel Generation (Diesel Genset)
Director I&M	Director of Implementation and Monitoring
EC	Energy Conservation
EE	Energy Efficiency
EnConTea	Energy Conservation in Small Sector Tea Processing Units in South India
ESCO	Energy Service Company
FTL	Fluorescent Tube Lights
FW	Firewood
GEF	Global Energy Facility
GEF CEO	GEF Chief Executive Officer
GHG	Greenhouse Gas
GNP	Gross National Product
HAF	Hot Air Fan
HAG	Hot Air Generator
HWG	Hot Water Generator
INR lakhs	100,000 Indian Rupees (1,00,000 INR)
INR crore	10,000,000 Indian Rupees (1,00,00,000 INR)
IREDA	India Renewable Energy Development Agency
KVK	"Krishi Vigyan Kendra" (Farm Science Centre)
MoCI	Ministry of Commerce and Industry
MoEF	Ministry of Environment and Forest
MoP	Minister of Power
MSP	Medium Sized Project Proposal
MT	Made Tea
M&V	Monitoring and Verification
NPD	National Project Director
PEAs	Preliminary Energy Audits
PIR	UNDP/GEF Project Implementation Report
PMU	Project Management Unit
POR	Program Officer Report
ProDoc	Project Document
QPR	Quarterly Progress Reports
QUPDS	Quality Up-gradation and Product Diversification Scheme
RE	Renewable Energy
Rs	Indian Rupees (INR)

RTA	UNDP/GEF Regional Technical Advisor
SEC	Specific Electrical Consumption
SPBP	Simple payback period
STC	Specific Thermal Consumption
TEDA	Tamil Nadu Energy Development Agency
TIDE	Technology Informatics Design Endeavour
UPASI	The United Planters' Association of South India
USD	US Dollar
VFD	Variable Frequency Drive

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I. Executive Summary

1.1 Brief description of project

Tea is one of the popular drinks in the world that is grown in more than 30 countries with an estimated global production of 4,162 million kg in 2010, out of which 966 million kg is produced in India, making it the second largest tea producing country in the world[1]. India has two tea growing regions – North India accounting for 3/4th of the production; and South India, which is the focus of the project, accounting for the remaining 1/4th of the production.

In South India, tea is grown in large tea estates as well as in small farms. Large tea estates have captive tea factories for processing tea; while small farms sell tea leaves for processing bought leaf factories. In all there are 350 tea factories in South India. All these tea factories rely heavily on biomass to meet their thermal energy requirements for tea drying.[2] Tea processing is energy intensive with energy costs contributing to 30-40% of the total production cost, second only to labour costs in tea making.[3]

The goal of UNDP/GEF project 00057404 - **PIMS 3163** Energy Conservation in Small Sector Tea Processing Units in South India is "*to reduce energy consumption from tea processing units in South India, thereby restricting Green House Gases emissions"*; and the project objective is "*to remove barriers and develop replicable strategies for energy conservation and energy efficiency interventions, including renewable energy, in the tea processing industry in South India*" so that large energy saving potential could be realised through the four identified project outcomes:[4]

1. Awareness creation among target sector about energy efficiency and renewable energy (EE /RE) technologies of relevance to tea units and implications of their adoption and their relation to profitability
2. Elimination of financial barriers that inhibit investment in energy conservation equipment
3. Adoption and procurement of EE/RE equipment/practices
4. Learning, knowledge sharing and replication

The project started with the signing of necessary documents by Ministry of Commerce and Industry (MoCI), Ministry of Finance (MoF) and the UNDP/GEF Country Director (CD) on January 18, 2008 with a total project budget of USD 2,050,000 of which, 46% is grant funded by GEF (USD 950,000) and 54% comes from co-financing (USD 1,100,000) from Government of India, tea factories and private sector. The implementing partner for the project is the Tea Board under the Ministry of Commerce and Industry while the responsible party is the Technology Informatics Design Endeavour (TIDE), a Bangalore based NGO.

The primary beneficiaries of the Project involved the tea factories and firms supplying energy conservation related equipment.

[1] Process Document, Energy Conservation in Small Sector Tea Processing Units in South India, June 2012, p. 7.
[2] Ibid, p. 3.
[3] Ibid, p. 20.
[4] Ibid., p. 3.

1.2 Context and purpose of the evaluation

This is a medium sized project with implementation duration of four years funded by the Global Environment Facility (GEF) and has been operational from 18 January 2008. In accordance with UNDP/GEF monitoring and evaluation (M&E) policies and procedures, all regular projects supported by the GEF should undergo a terminal evaluation (TE) at EOP of 31 December 2011, which was extended for six months to July 31, 2012. As per GEF guidelines, the TE should cover the following:

- Evaluate both the Project Formulation and Project Implementation phases of the project.
- Identify the results and outcomes of the project viz. a viz. planned results and outcomes.
- Assess the relevance, performance and success of the project.
- Analyse the project impact and sustainability of results, including its contribution to capacity development, development dividends and achievement of global environmental benefits.
- Identify/document key lessons learnt and provide recommendations that might improve the design and implementation of other UNDP/GEF projects.

The topics of focus of this TE as provided by UNDP-India during the kick-off meeting on August 6, 2012 are as follows:

- How will the processes and its knowledge creation – energy audits specific to tea sector, data collection, and its analysis be taken up once the project closes?
- Are post commissioning measurements, estimates methodologies used to arrive at numbers robust to claim energy savings and derivation of GHG emission reduction?
- Would it affect the rate of adoption of EE measures?
- Would financial schemes (other than Tea Board subsidy) accelerate adoption of EE measures, especially by the smaller, co-operative units?
- Scope for renewable options, how can the current barriers be overcome?
- Is briquette a feasible option for the tea sector in South India?

1.3 Main conclusions, ratings, recommendations and lessons learned

1.3.1 Main conclusions

The project's progress has been ***highly satisfactory*** with respect to meeting the main project objective of removing barriers and developing replicable strategies for energy efficiency and energy conservation interventions, including renewable energy solutions, in the tea processing industry in South India.

- Each of the 266 tea factories in South India have been made aware of energy conservation activities through awareness programs targeted under the project. It has developed a highly informative but innovative tool - Energy Score Card - a framework for the factories to self-assess their performance regarding baseline energy use and communicate their progress to other interested groups.

- The project has been able to introduce a large number of energy efficiency (17 numbers) and renewable energy interventions (7 numbers) to reduce energy use (fuels, electricity) in various sections of tea processing.

- The project target of introducing energy conservation measures in 30 tea factories has also been achieved as energy conservation measures with project support have been demonstrated in 90 units by June 2011. Due to awareness, another 24 factories have adopted energy reforms without project support, bringing to 114 the total number of factories with EC/EE measures.
- Total private investment in EC/EE measures by these 114 factories aggregate to USD 3.0 million of which USD 2.54 million were made by the sector inclusive of the capital subsidy from the Tea Board.
- The cumulative direct CO_2 savings are estimated at 277,255 tons of CO_2 vs. target of 30 factories with cumulative potential savings of 56,925 tons direct CO_2.
- The project was successful in strengthening the supply chain of energy efficient equipment suppliers. Its liaison with key manufacturers to customize equipments to capacities as required for tea sector, has led to acceptance of the equipment suppliers from being mere "salesmen of equipment" to value-adding energy service providers.

1.3.2 Summary of Conclusions and Ratings

S. No	Criteria	Rating
1	*Project Formulation*	
	a) Conceptualization / Design (R)	Highly Satisfactory (HS)
	b) Country-ownership / Driveness	High degree of country ownership
	c) Stakeholder participation (R)	Highly Satisfactory (HS)
2	*Project Implementation*	
	a) Implementation approach (R)	Highly Satisfactory (HS)
	b) Monitoring & evaluation (R)	Highly Satisfactory (HS)
	c) Stakeholder participation (R)	Highly Satisfactory (HS)
	d) Financial planning	Project was implemented without any cost overruns
	e) Sustainability	Need to make a future implementation plan in utilizing the infrastructure and harnessing expertise developed in the project
	f) Execution and implementation modalities	The UNDP CO, NPD, TIDE, PSC and TAC were highly effective in their tasks leading to quality and timeliness of inputs thus ensuring smooth implementation of the project
3	*Results*	

	Attainment of Outcomes/ Achievement of objectives (R)	
	Outcome 1 - Awareness creation about EE/RE technologies	Highly Satisfactory (HS)
	Outcome 2 - Elimination of financial barriers	Satisfactory (S)
	Outcome 3 – Adoption and procurement of EE/RE equipment and practices	Highly Satisfactory (HS)
	Outcome 4 - Learning, knowledge sharing and replication	Highly Satisfactory (HS)

1.3.2 Recommendations

1. *Organized project follow-up in South Indian Tea Industry*

It is expected that in the post-project period, pro-active market development by equipment suppliers would ensure sustainability of energy efficiency interventions to some degree. A large-scale dissemination of renewable energy technologies is yet to take place. The sustainability of the interventions can be greatly reinforced if an organized way of follow-up and support involving main project implementation partners i.e. Tea Board, TIDE and UPASI can be established. This should involve ensuring sustainability of the fuel test lab cum energy centre which now has been handed to UPASI.

2. *Replication opportunities within the tea industry as well as in other plantation industries*:

The successful project design and implementation has opened many possibilities for replication. UNDP-India, Tea Board and TIDE, are preparing a proposal to support adoption of energy efficiency measures in the tea industry in North India, which is much larger tea growing region than South India. The success of the project has encouraged the Tea Board to look into the possibility of develop similar intervention programmes for water and overall resource efficiency in the South Indian tea industry. Coffee, rubber and cashew are other major commercial crops in South India; there is also a potential to develop similar intervention projects in these plantation industries.

3. *Developing further the concept of zero carbon tea*

The project tried to develop a concept of ‘Zero Carbon Tea’ that would provide global consumers with an environmentally benign tea drink as well as branding (factory, company or country level). It would require a second level of interventions in the form of a) renewable energy sources such as micro hydro, wind and solar tapped for electrical & thermal energy requirements of tea processing

b) new energy conservation interventions in tea processing and transportation. This is a very promising concept and efforts should be made to further develop this concept.

1.3.3 Lessons learned

Some of the best practices which resulted in the successful implementation of the project are as follows:

1. Offering a large bouquet of technical solutions: Unlike several other similar GEF projects which offer only one or a few technical solutions, the tea project offered 17 energy efficiency and 5 renewable energy solutions. The project pro-actively looked for identifying newer options throughout the implementation period. This large bouquet of technical solutions meant that the project had at least one solution for any of the tea factories. Thus project was able to facilitate implementation of measures in all types of tea factories.

2. Ensuring availability of a high quality technical support: The project was able to mobilize a high quality technical team led by Prof. Sethumadhavan. The technical team was based at Coonoor for almost 2 years. During this time period it was easily accessible and was highly mobile which ensured uninterrupted availability of the technical services to tea industry.

3. Effective relationship management by TIDE: Implementation of all UNDP-GEF projects requires working with a wide variety of stakeholders and multi-disciplinary implementation teams. Relationship management to ensure positive and synergetic involvement of stakeholders becomes an important role of the project management team. TIDE played this role effectively.

4. Focus on removing the barrier associated with the lack of access to information and technology: A large number of GEF projects dealing with energy efficiency in small and medium enterprise identify lack of access to finance as one of the most important barrier. The project was also based on this hypothesis. Mid-way through the project, the project team realised that lack of access to information and technology was the major barrier and not access to finance as was understood at the time of project conceptualization. This realization resulted in the modification of the strategy and the project proved that success could be achieved through sustained awareness, technical support and demonstrating proof of concept in a production environment, success can be achieved with minor or no financial incentives.

5. Adaptive management: The PMU with support from the PSC and UNDP was able to take note of ground realities and take actions to adapt action plan and budget to meet the project objectives.

2. Introduction

2.1 Brief Description of Project

Tea is one of the popular drinks in the world that is grown in more than 30 countries with an estimated global production of 4,162 million kg in 2010. Around 42% of production was exported making it a vital contributor to Gross National Product (GNP) of many countries (Table 2.1).

Table 2.1: Major Tea Producing Countries in 2010[5]

Country	Area Covered thousand hectares	Production million kg	Production Share %	Export Share %
China	1,849	1,370.0	32.9	17.45
India	579	966.4	23.2	11.15
Indonesia	127	129.2	3.1	5.03
Kenya	158	399.0	9.6	25.44
Sri Lanka	188	329.4	7.9	17.23
Others	(by difference)	968.0	23.3	
Total		**4,162.0**	**100.0**	

India is the second largest tea producing country in the world producing 870 million kg of tea annually in 2003. Most of the tea is grown in the North East states. South India, which is the focus of this project, has a total of 89,000 hectares under tea cultivation. It produces 203 million kg of tea annually in 2003 which is 24% of the national output. Over a quarter million plantation workers are employed in the tea gardens in South India. Latest information on the North and South India estates suggests a larger area under cultivation, higher tea production and exports share. Total export value is USD 609 million at an average price of 3.16 USD/kg (Table 2.2). Indian Tea Industry turnover, according to ASSOCHAM, is likely to reach Rs 330,000 million by 2015 from the current level of Rs 195,000 million.

Table 2.2: North and South India Tea Industry[6]

Country	North India	South India	Total India
Area in 2008, hectares	459,613	119,740	579,353
Production in 2011, million kg	747.4	240.9	988.3
Exports in 2011:			
Quantity, million kg	107.6	85.2	192.8
Exports as % of production	14.4%	35.4%	19.5%
Value, million USD	430.9	178.5	609.4
Unit Price, USD/kg	4.00	2.10	3.16

During the past two decades, there has been a rapid expansion in the small sector tea industry with large numbers of farmers in the Nilgiris district of Tamil Nadu converting to tea farming. There are 350 tea factories in South India with 125 belonging to the small sector. All these tea factories rely heavily on biomass to meet their thermal energy requirements for tea drying.[7] Tea processing is

[5] Process Document, Energy Conservation in Small Sector Tea Processing Units in South India, June 2012, p. 7.
[6] Ibid., p. 10.
[7] Project Document, Energy Conservation in Small Sector Tea Processing Units in South India, September 2007, p. 3.

energy intensive with energy costs contributing to 30-40% of the total production cost, second only to labor costs in tea making.[8] (Table 2.3)

Table 2.3: Energy Cost as % of Total Production Cost[9]

Havukal Tea Factory	
Energy Cost, Rs/kg tea	6.23
Total Cost of Production, Rs/kg tea	19.39
% Energy Cost	32.13%

Despite rising energy and labor costs, India tea production has steadily risen from 870 million kg in 2003 to maximum level of 986 million kg in 2007, only to falter and decline slightly to 966 million kg in 2010 (Table 2.4). According Tea Board of India Executive Director Rakesh Saini (Times of India, 7 August 2012), tea production in the organized sector is declining in India due to ageing bushes and little investment, and the country may have lost 50 million kg of tea in the past 10 years. At the same time, production is rising in small holdings which account for nearly 28% of the total tea cultivation area and 26% of the country's total production. However, the tea industry has been going through a crisis where the small growers and processors are hardest hit.

Table 2.4: Tea Production by Type in India (million kg)

Category	**2003**	**2004**	**2005**	**2006**	**2007**	**2008 (E)**	**2009 (E)**	**2010 (E)**
CTC		815	849	894	887	875	870	850
Orthodox		71	87	77	89	97	95	100
Green		7	10	11	10	9	14	16
Total	**870**	**893**	**946**	**982**	**986**	**981**	**979**	**966**

SOURCE: Process Document in Energy conservation in small sector tea processing units in South India, June 2012, p. 7.
From Chapter 5, Role of Tea Board in Tea Development in India, 2011-2012.

Initial energy audit data provided in the Project Document (ProDoc) indicates that 0.5 kWh of electrical energy and 1.5 kg of firewood are consumed to produce 1 kg of made tea. This translates to a yearly consumption of 435 million kWh of electricity and 1.3 million tonnes of firewood in the whole of India for tea production in 2003 (ANNEX I, Table 8.3). Energy audit data also suggests that it is possible to save 20% each of electrical and thermal energy, thus having the potential to conserve 87 million kWh of electricity and 0.26 million tonnes of firewood annually.[10]

Preliminary data based (factfiles.pdf) on average of 3 factories (Snowdon, Kaikatty, Thaymudi) suggest a higher specific energy consumption of 0.78 kWh and 1.83 kg firewood per kg of made tea, raising the estimate of yearly consumption to 679 million kWh and 1.6 million tonnes of firewood. At the audit results of 8.2% and 6.2% average savings on electrical and thermal energy, respectively, the potential energy savings are 56 million kWh of electricity and 0.10 million tonnes of firewood annually.

[8] Process Document, Energy Conservation in Small Sector Tea Processing Units in South India, June 2012, p. 20.
[9] Energy Audit Report – Havukal Tea Factory, September 2010, p. 10.
[10] Medium-Sized Project Proposal, Request for GEF Funding, p. 3.

Final data at end-of-project (EOP) on the audit of 86 tea factories shows a lower weighted average[11] of 0.478 kWh and 1.372 kg firewood per kg of made tea. The final estimate of energy consumption of the India tea industry is therefore 416 million kWh of electricity and 1.2 million tonnes of firewood. The weighted average savings for CTC, ORTHODOX and all factories were calculated from the 86 factory audits (data received and data projected). Final estimate of energy savings potential is 32 million kWh of electricity and 0.23 million tonnes of firewood. In 2010-2011, net electricity generation in India is 753,106 GWh suggesting its relatively small contribution but nonetheless important to India.[12]

With respect to the South India tea industry with 203 million kg of tea production in 2003, a summary of specific energy consumption, percentage savings, and potential energy savings is shown also in Table 8.4 of ANNEX I. Using the ProDoc data, the potential energy savings were higher at 20 million kWh and 0.061 million tonnes of firewood annually based on 20% savings applied on specific energy consumption of 0.5 kWh and 1.5 kg firewood per kg of made tea.

The preliminary audit results on the average of 3 tea factories showed higher specific energy consumption of 0.78 kWh and 1.83 kg firewood per kg of made tea, but also reported lower energy savings at 8.2% and 6.2% for electrical and thermal energy, respectively. Potential energy savings were lower 13 million kWh and 0.023 million tonnes of firewood annually. As reported in Table A3.5 Performance Studies conducted by TTT at various factories[13], the 3 tea factories (Snowdon, Kaikatty, Thaymudi) implemented only a few of the 12 recommended interventions.

At EOP, the weighted average of CTC (1,072 million kg) and ORTHODOX (266 million kg) tea factories were reported at 0.478 kWh and 1.372 kg firewood per kg of made tea while percentage savings were 7.62% and 19.34% for electrical and thermal energy, respectively.

It appears that estimates made during the ProDoc preparation (20%) were close to actual thermal energy savings (19.34%). However, electrical savings appear to be over-estimated (20% ProDoc vs. 7.62% audit). This suggests the relative importance of thermal energy efficiency vs. electrical energy efficiency in terms of its potential to conserve scarce biomass resources in the whole of India since biomass fuel supply is under stress with prices rising in response also to rising fossil-based fuels and electricity. Future preparation of project document may require some detailed audit on typical tea factory to narrow the gap between planned and actual project implementation.

[11] Weighted average is an average that considers the size or quantity of the contributing item, i.e. wa = (a1 x q1 + a2 * q2 + … + an * qn) / (q1 + q2 + … qn). Normal average is simply the arithmetic average by summing up all items divided by number of items, i.e. na = (a1 + a2 + … + an) / n.

[12] Please refer to http://www.cea.nic.in/reports/planning/cdm_co2/database_7.zip, for more details on power generation of India.

[13] Process Document, Energy Conservation in Small Sector Tea Processing Units in South India, June 2012, p. 98.

To supply this thermal energy on a sustainable basis, the EnConTea audits have also established that quality briquettes and firewood should have an average calorific value of 4,086 kcal/kg (7.8% moisture) and 3,750 kcal/kg (22% moisture), respectively, for stable operation (Table 2.5).

The raw material for briquette is biomass such as rice hull, palm, castor husk, coffee husk, saw dust, jute sticks, bagasse, groundnut shell, etc. Biomass is compressed under heat and high pressure sans any binding chemical to produce briquettes. A briquetting unit (briquetting machine, auxiliary devices, biomass dryer) will cost around Rs 2-3 million depending on production capacity. The cost of biomass raw material ranges from Rs 1,500-2,000 per tonne of saw dust or groundnut shell at Rs 2,000-2,600 per tonne while selling price of briquette is Rs 4,000 per tonne.[14]

Table 2.5: Characteristics of Briquettes vs. Fuel Wood

Fuel Characteristic	Quality Briquette (Average of 24 samples analyzed by lab)	Fuel Wood (Average of 8 samples analyzed by lab)
Calorific Value (CV), kcal/kg	4,086	3,750
Ash content, %	10.68	7.00
Moisture content, %	7.81	22.00
Fixed Carbon, %	18.19	11.44
Fuel Price, Rs/tonne	4,200	3,000
Specific energy consumption, kg/kg tea	0.8	1.5
Fuel Cost, Rs/kg tea	3.36	4.50
Fuel Cost Savings, Rs/kg tea	1.14	
Fuel Cost Savings, %	25.33%	
Energy requirement, kcal/kg tea	3,269	5,625
Energy Savings, kcal/kg tea	2,356	
Energy Savings, %	41.89%	
SOURCE: BRIQUETTE AS RENEWABLE ENERGY SOURCE- A VIABILITY STUDY FOR TEA FACTORIES, by R D Nazeem and R.Sethumadhavan		

Tea industry offers significant potential for energy conservation, energy and process efficiency, and renewable energy interventions. In addition to achieving energy efficiency, the tea industry has also identified quality in all aspects as the key to overcoming the crisis brought about by higher energy costs, scarcity of labor, and declining yields from the ageing tea plants of India compared to other tea producing countries such as Kenya and Sri Lanka. The ageing tea bushes are commercially unproductive and require re-plantation for increasing productivity. [15].

Energy conservation is also a thrust area of the Government of India (GoI). To supplement the efforts of the tea industry, the Tea Board (TB), under the Ministry of Commerce and Industry (MoCI), has launched a Quality Up-Gradation Program to provide subsidy to the tea processing units towards production of good quality tea as well as augmenting processing capabilities by improving packaging standard, product diversification and quality certification.

In general, the project aims to introduce energy conservation measures in the firewood intensive tea sector by addressing awareness, technology and financial barriers that prevent greater

[14] Process Document, Energy Conservation in Small Sector Tea Processing Units in South India, June 2012, pp. 54-55.
[15] Ibid., p. 8

adoption of energy conservation practices and technologies, including utilization of renewable energy. Reducing energy consumption also reduces GHG emissions in tea processing units and also leads to achieving market competitiveness. It will pave the way for replicable strategies for energy efficiency and energy conservation interventions and use of appropriate renewable energy solutions.

The project started with the signing of necessary documents by Ministry of Commerce and Industry (MoCI), Ministry of Finance (MoF) and the UNDP/GEF Country Director (CD) on January 18, 2008 with a total project budget of USD 2,050,000 of which, 46% is grant funded by GEF (USD 950,000) and 54% comes from private sector co-financing (USD 1,100,000). (Table 2.6)

The implementing partner for the project is the Tea Board under the Ministry of Commerce and Industry while the responsible party is the Technology Informatics Design Endeavour (TIDE), a Bangalore based NGO.[16]

Table 2.6: Budget Allocation and Co-Financing[17]

UNDP - GEF Budget Allocation	**Budget**			
	Co-financing ($)	**GEF ($)**	**Total ($)**	**% of Total**
Awareness creation	50,000	233,800	283,800	13.84
Financial barriers	65,000	99,500	164,500	8.02
Adoption of EE/RE equipment/practices	890,000	396,200	1,286,200	62.74
Learning, Knowledge, Replication	20,000	125,500	145,500	7.10
Project Management Budget/Cost*	75,000	95,000	170,000	8.29
TOTAL	**1,100,000**	**950,000**	**2,050,000**	**100.00**
% of Total	53.66	46.34	100.00	
Co-financing Source	**Classification**	**Type**	**Amount ($)**	**% of Total**
Tea Factory Promoters	Beneficiary	Equity	199,375	18.13
Tea Board	Government	Grant	240,625	21.88
Union Bank of India, Coonoor Central Bank of India, Coonoor IREDA, New Delhi	Commercial, Financial Institutions	Commercial Credit	660,000	60.00
TOTAL			**1,100,000**	**100.00**

The project planned "*to support at least 30 factories in South India to adopt EE equipment and practices that would accumulatively save 55,800 tons of direct CO_2. In addition 1,125 tons of direct CO_2 is expected to be saved thanks to reduced consumption of diesel because of reduced vehicular movement as a consequence of reduced consumption of firewood. It is expected that the environment for acceptance of energy usage form created by the project would have a replication effect and momentum to sustain beyond the 4 years of project period. In such a scenario, the*

[16] Midterm Review Report, 8 August 2010, p. 7.
[17] Medium-Sized Project Proposal, Request for GEF Funding, p. 26.

indirect CO_2 emission reduction is expected to be 170,775 tons over the 10 years period of 2007-2017."[18]

Table 2.7: Potential GHG Emission Reduction by the Project[19]

CTC & ORTHODOX Tea Units	2008	2009	2010	2011	Total	Average	10 years
No. of tea factories	86	86	86	86		86	
Tea Production, million kg	137.0	138.8	132.2	127.1	535.1	133.8	
Specific Energy Consumption:							
Electrical Energy, kWh/kg tea	0.459	0.469	0.485	0.500	0.478	0.478	
Thermal Energy, kg FW/kg tea	1.353	1.355	1.399	1.383	1.372	1.372	
Total Energy Consumption:							
Electrical Energy, million kWh	62.9	65.1	64.1	63.6	255.7	63.9	
Thermal Energy, million kg FW	185.3	188.0	184.9	175.8	734.0	183.5	
million tonnes FW	*0.185*	*0.188*	*0.185*	*0.176*	*0.734*	*0.183*	
Percentage Savings:							
Electrical Energy, %	6.84%	8.82%	6.87%	7.94%	7.62%	7.62%	
Thermal Energy, %	20.64%	20.81%	21.36%	14.26%	19.34%	19.34%	
Potential Energy Savings:							
Electrical Energy, million kWh	4.30	5.74	4.41	5.05	19.5	4.87	
Thermal Energy, million kg FW	38.24	39.12	39.48	25.07	141.9	35.48	
million tonnes FW	*0.038*	*0.039*	*0.039*	*0.025*	*0.142*	*0.035*	
GHG Emission Factor:							
Electrical Energy, kg CO_2/kWh	0.9	0.9	0.9	0.9	0.9	0.9	
Thermal Energy, kg CO_2/kg FW	1.83	1.83	1.83	1.83	1.83	1.83	
GHG Emission Reduction:							
Electrical Energy, million t CO_2	3,870	5,165	3,966	4,544	17,545	4,386	43,862
Thermal Energy, million t CO_2	69,985	71,596	72,244	45,886	259,711	64,928	649,277
GHG Emission Reduction	**73,855**	**76,761**	**76,209**	**50,430**	**277,255**	**69,314**	**693,138**

SOURCE: See ANNEX K for data source and calculation of GHG emission reduction

Based on the actual energy audits of 86 factories (63 CTC and 23 ORTHODOX units) completed at EOP (31 July 2012), and assuming that all were in place from 2008-2011, the project would have cumulatively saved a total 19.5 million kWh and 0.142 million tonnes of firewood with potential GHG emission reduction of 17,545 and 259,711 tons of direct CO_2 from electrical and thermal energy savings, respectively. This aggregates to 277,255 tons of direct $CO_2$with attendant savings in consumption of diesel because of reduced vehicular movement (around 1,125 tons direct CO_2 from diesel use per 55,800 tons of direct $CO_2$from energy savings during the project duration). Average annual emission reduction is 69,314 tons of direct CO_2. Replication beyond the project period is expected to contribute 693,138 tons of indirect CO_2 emission reduction over the next 10 years (see

[18] The logical framework of the project aims to adopt energy efficient equipment and practices in 30 tea processing units in South India within the project period resulting in accumulative savings of 56,925 tonnes of direct CO_2.

[19] Grid emission factor (GEF) provided by UNDP-India in the back of envelope calculation are 0.9 kg CO_2/kWh and 1.83 kg CO_2/kg FW of 3,900 kcal/kg CV. However, the rate promulgated by the CO_2 Baseline Database for the Indian Power Sector published by the GoI, Ministry of Power, Central Electricity Authority, Table S-1 (page 1) with a weighted average baseline emission factor (by net generation) = 0.79 for whole India, 0.72 for South India and 0.81 for NEWNE India.

ANNEX K). In contrast, the ProDoc estimated cumulative GHG emission reduction at 56,925 tons of direct CO_2 during project implementation and 170,775 tons over the next 10 year period 2007-2017.

On the basis of ownership pattern, tea estates or "haciendas" or "plantations" as called in other countries can be classified broadly under the following types:[20]

1) Small holdings, from 1-25 acres (10.12 hectare) owned by proprietors
2) Small gardens, below 200 hectares, owned by a single proprietor or partnership firms:
   a) Tea is cultivated and green leaf is taken to a nearby factor for processing
   b) Tea is both cultivated and processed in the are
3) Estates owned by limited liability companies:
   a) Public Limited Companies
   b) Private Limited Companies
4) Estates owned by big companies
5) Estates owned by government undertakings and cooperatives

This project is devoted to improving the lot of the small sector tea processing units in South India.

2.1 Context and purpose of the evaluation

The UNDP/GEF project 00057404 - **PIMS 3163** Energy Conservation in Small Sector Tea Processing Units in South India is a medium sized project with implementation duration of 4 years funded by the Global Environment Facility (GEF) and has been operational from 18 January 2008. In accordance with UNDP/GEF monitoring and evaluation (M&E) policies and procedures, all regular projects supported by the GEF should undergo a terminal evaluation (TE) at EOP of 31 December 2011, which was extended for six months to July 31, 2012. As per GEF guidelines, the TE should cover the following:

- Evaluate both the Project Formulation and Project Implementation phases of the project.
- Identify the results and outcomes of the project viz. a viz. planned results and outcomes.
- Assess the relevance, performance and success of the project.
- Analyse the project impact and sustainability of results, including its contribution to capacity development, development dividends and achievement of global environmental benefits.
- Identify/document key lessons learnt and provide recommendations that might improve the design and implementation of other UNDP/GEF projects.

The purpose of the assignment is to carry out TE of the UNDP-GEF project *3163 on Energy Conservation in Small Sector Tea Processing Units in South India*.

The TE review team shall comment on specific issues listed in Section 2.1 in addition to project review criteria listed in Annex 1 of the Terms of Reference (ToR) of this TE.

2.2 Key issues addressed

Key issues addressed by the evaluation team as provided by UNDP-India during the kick-off meeting on August 6, 2012 are as follows:[21]

[20] Process Document, Energy Conservation in Small Sector Tea Processing Units in South India, June 2012, p. 10.

[21] Terminal Evaluation focus as provided by UNDP-India (Dr. Srinivas). See mission start-meet-06Aug-Chennai-revCN.pptx

- How will the processes and its knowledge creation – energy audits specific to tea sector, data collection, and its analysis be taken up once the project closes?
- Are post commissioning measurements, estimates methodologies used to arrive at numbers robust to claim energy savings and derivation of GHG emission reduction?
- Would it affect the rate of adoption of EE measures?
- Would financial schemes (other than Tea Board subsidy) accelerate adoption of EE measures, especially by the smaller, co-operative units?
- Scope for renewable options, how can the current barriers be overcome?
- Is briquette a feasible option for the tea sector in South India?

2.3 Methodology of the evaluation

The team conducted a mission visit to Chennai, Coonoor & Valparai (via Coimbatore), to meet with relevant project stakeholders. This visit included meetings with the officials of UNDP-India, the Implementing Agency (Tea Board) at Coonoor, Technology Informatics Development Endeavour (TIDE) as responsible party, energy expert from Anna University, equipment suppliers, stakeholders of the tea industry related to the project and financial institutions. After the initial briefing by UNDP team, the review team met with the National Project Director and officials of Tea Board. (See ANNEX B for mission visit schedule and ANNEX C for list of persons interviewed)

The TE was conducted with a site visit beginning 6 August 2012 by an evaluation team consisting of an International Consultant (IC) as team leader and supported by a National Consultant (NC). A power point presentation on the initial findings was presented on 11 August 2012.

Prior to engagement and visiting the Project Management Office, the TE team reviewed all relevant and available documents including at least: Project Document (ProDoc), Inception Workshop Report, Annual Work and Financial Plans, Annual Project Report/Project Implementation Review (APR/PIR), Quarterly Reports, Minutes of National Steering Committee and Project Steering Committee meetings, Back-to-Office Reports of UNDP Staff, Study reports, conference proceedings, and past audit reports. These documents were either received in advance before the mission visit via email from UNDP-India, downloading the project background and structure from the project's website and subsequent provision of printed and electronic files of technical reports, detailed audit reports of 86 tea factories, newsletters, power point presentations and video films from project team. This TE report will include all such reports in a CD for documentation purposes and reference. (Table 2.8)

Table 2.8: Methodology for Evaluation

Scope of study as given in the ToR	Sources used for verification / assessment	Stakeholders interviewed / key answers sought
Project Background	Internet, website (www.encontea.org)	Downloaded project information
Project Formulation	Project document	Meeting with TIDE and Tea Board
Project Implementation and Results	QPRs, PSC meeting minutes, newsletters, technical reports, process document, project presentations	Meetings with 5 vendors, Visits to 2 tea factories, Meeting with TIDE, UPASI and Tea Board
Policy impact of the project on the decisions	PSC meeting minutes,	Meetings with TIDE and Tea

of Tea Board and/or MoCI, including change in decision making at the MoCI if any happened or envisaged to happen.	newsletters	Board
Whether the performance measurement indicators and targets used in the project monitoring system are accomplished and able to achieve desired project outcomes within July 2012?	QPRs, PSC meeting minutes, newsletters, energy audit reports, process document, project presentations	Meetings with 5 vendors, Visits to 2 tea factories, Meeting with TIDE, UPASI and Tea Board
Did the project made satisfactory accomplishment in achieving project outputs vis-à-vis the targets and related delivery of inputs and activities?	PIRs, CDRs, QPRs, PSC meeting minutes, newsletters, energy audit reports, process document, project presentations	Meetings with 5 vendors, Visits to 2 tea factories, Meeting with TIDE, UPASI and Tea Board

2.4 Structure of the evaluation (Organization and method of the review)

The structure of the evaluation is designed to have an Evaluation Team (now called the Team) which consists of an International Consultant (Engr. Marcial Ocampo) and a National Consultant (Dr. Sameer Maithel). Both the Consultants have many years of experience in the field of industrial energy conservation, energy and process efficiency improvements, and renewable energy. The evaluation mission was conducted from the 6th to 11th of August 2012.

Prior to the mission, the Team was supplied with most of the relevant project documents. The Evaluation Mission started with a meeting with the UNDP Program Officer, Dr. S.N. Srinivas, Programme Associate Ms. Chitra Narayanswamy, Project Manager Ms. Svati Bhogle and Director (Implementation and Monitoring) Prof. R. Sethumadhavan. During field visits, the team was accompanied by an experienced UPASI laboratory project staff Mr. Manigandan.

The mission consisted of visits to selected tea factories (Thaymudi tea factory in Valparai and Havukal tea factory in Coonoor) and briquetting plant (Jayshree Biomass Briquette Factory after Coimbatore along the way to Valparai), meetings with equipment suppliers at Coimbatore (LED, Hot water generator, Flat belt drives, Dual speed motors, ID/FD fan controllers, and SCADA system), and visit to UPASI (Secretary General and fuel testing laboratory). (Please refer to ANNEX B - Evaluation Mission Programme)

The Team was also provided with information and data on technical interventions during the mission. After the mission, the Team carried out the task of analysing the information and data and report writing. Shown in Table 2.9 is the expected timeline for completing the TE report.

Table 2.9: Timeline for the Terminal Evaluation

Deliverable	Timeline
Work Plan	6 August 2012
Presentation on findings	11 August 2012
Draft Report	2 September 2012
Final Report	7 November 2012

The TE team followed the rating chart as per GEF guidelines in rating the progress and performance of this project. The details of the rating system are shown in Table 2.10 (ToR for this project has no rating table; hence, it is presented in this report for reference):

Table 2.10: Rating chart as per GEF guidelines

Highly Satisfactory (HS)	Project is expected to achieve or exceed **all** its major global environmental objectives, and yield substantial global environmental benefits, without major shortcomings. The project can be presented as "good practice".
Satisfactory (S)	Project is expected to achieve **most** of its major global environmental objectives, and yield satisfactory global environmental benefits, with only minor shortcomings.
Marginally Satisfactory (MS)	Project is expected to achieve **most** of its major relevant objectives **but** with either significant shortcomings or modest overall relevance. Project is expected not to achieve some of its major global environmental objectives or yield some of the expected global environment benefits.
Marginally Unsatisfactory (MU)	Project is expected to achieve its major global environmental objectives with **major shortcomings** or is expected to achieve only some of its major global environmental objectives.
Unsatisfactory (U)	Project is expected **not** to achieve most of its major global environment objectives or to yield any satisfactory global environmental benefits.
Highly Unsatisfactory (HU)	The project has **failed** to achieve, and is not expected to achieve, any of its major global environment objectives with no worthwhile benefits.

3. The Project and its development context

3.1 Project start and its duration

The Endorsement Letter for the project was signed by Ministry of Environment and Forest on 19th September 2006. The project got approval from the GEF Chief Executive Officer (CEO) and Chairperson on July 25, 2007. The project started with the signing of the project document by Ministry of Commerce and Industry, Ministry of Finance and the UNDP/GEF Country Director on January 18, 2008. The project is of 4 years duration (2008-2011). The project was due to end 31 December 2011 but was extended for 6 months till 31 July 2012.

3.2 Problems that the project seek to address

India is the second largest tea producing country in the world. South India which produces 203 million kg of tea annually (24% of the national output) is the focus of the project. There are 350 tea factories in South India with 125 belonging to the small sector. Tea processing is an energy intensive process with energy costs contributing to 30-40% of the total processing cost.

Energy conservation is a thrust area of the Government of India. The project objective is to reduce energy consumption of tea processing units in South India, thereby reducing GHG emissions and increasing the profitability of the tea industry. The project seeks to remove barriers (information, technological and financial) via adoption of EE/RE measures by South Indian tea industry.

The common barriers identified during the project preparation phase were:[22]

- **Information barriers** - Inadequate information for informed decision making on factory modernization; little quantified information about equipment specific energy consumption; lack of information about options for thermal energy conservation which constitutes 70-80% of total energy consumption; and absence of a mechanism for information flow about emerging technology options and their performance.
- **Technology barriers** - Poor acceptance of past interventions in renewable energy technology options like solar air preheating and wood gasifiers for not defining the limits of their applicability (e.g. wet wood not suitable for wood gasifiers, solar air preheating not recommended in high mountain ranges with few sunny hours in a day); first air heater operating satisfactorily installed only very recently needing acceptance; and operation & maintenance protocols for optimum use of thermal energy equipment not followed and needs scientifically-designed operator training program.
- **Financial barriers** - Cost of new technology is high (Rs 600,000 -1,200,000, i.e. USD 13,636 - 27,272) with inadequate data on return on investment from energy savings alone, thus creating barriers for financial decision making for acquiring new technology; banks, though willing to lend to the tea sector, are unable to make decisions in the absence of information about the techno-economic feasibility of energy saving equipment.
- **Sector specific barriers** - Crisis in tea industry as a result of low profit margins from tea cultivation and processing thus making energy efficiency not a priority, though the situation has improved and tea industry is now more responsive; current low prices in the sector undervalue

[22] Medium-Sized Project Proposal, Request for GEF Funding, p. 7.

the use of information-based analysis and decision making; lack of necessary infrastructure for repair, maintenance and trouble shooting of new technology; and barriers related to risk perception associated with adoption of energy efficient technology which would then require developing and implementing an innovative risk insurance scheme for new and renewable energy projects.

Another set of barriers (cultural barrier, economy of scale barrier, low profit margin barrier, remote location barrier, quality oriented R&D barrier, labor cost and supply barrier, and biomass fuel supply barrier) was highlighted and discussed in a reference Process Document:[23]

3.3 Immediate and development objectives of the project

The project objective is to reduce energy consumption from tea processing units in South India, thereby reducing GHG emissions. It also aims at removing barriers and developing replicable strategies for energy conservation, energy efficiency and renewable energy interventions in the tea processing industry in South India so that large energy saving potential could be realized through the four identified project outcomes (see section 1.1 of Executive Summary).

The project seeks to improve the profitability of the tea industry, which is the source of livelihood to a large number of small tea growers and workers.

3.4 Main stakeholders

The EnConTea project is an excellent example of multi-stakeholder cooperation. The project stakeholders include:

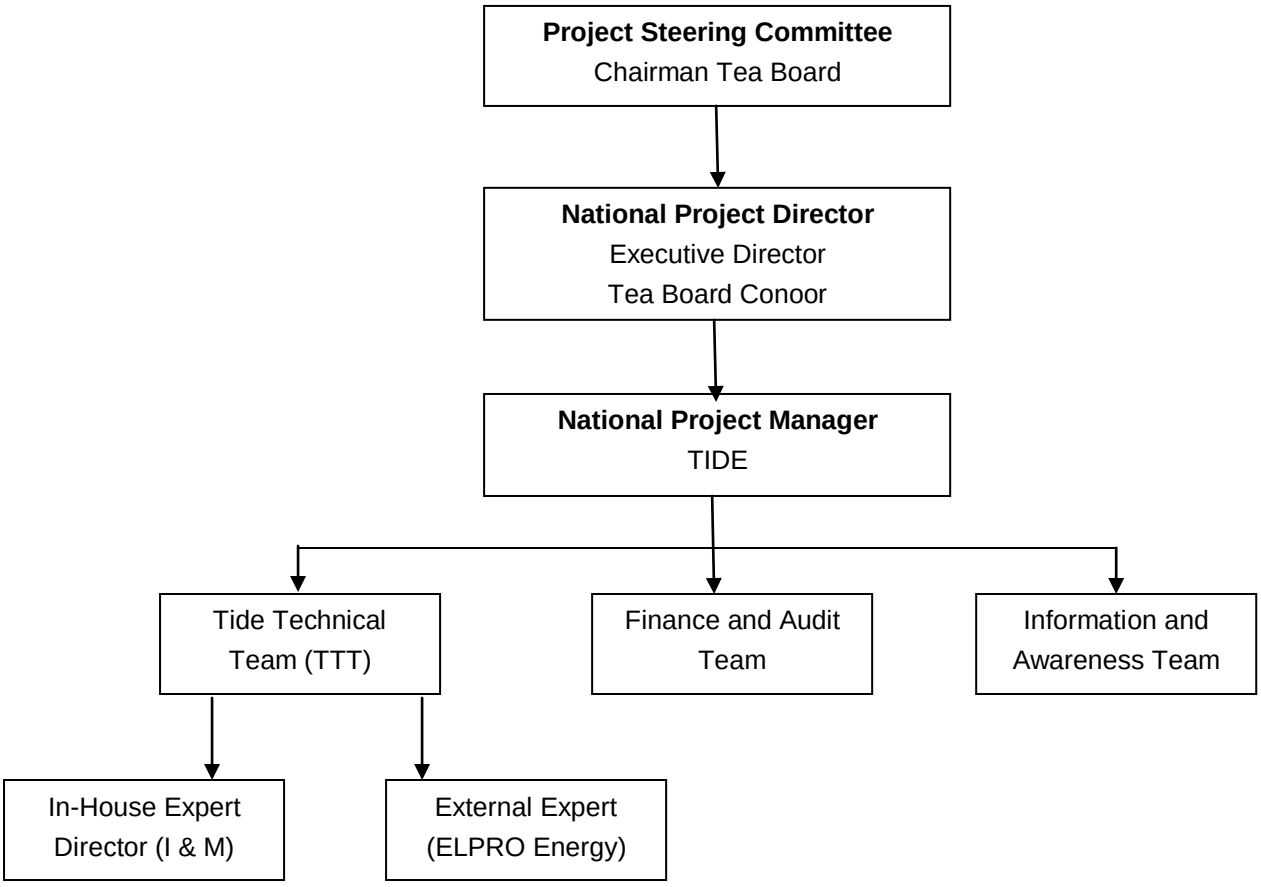
Table 3.1: Stakeholders of the Project

Type	Stakeholders
1. Governmental agencies	• Tea Board of India under Ministry of Commerce and Industry • Tea Board Coonoor represented for the Tea board in South India • Ministry of New and Renewable Energy (MNRE) • Ministry of Environment and Forest • Indian Renewable Energy Development Agency (IREDA New Delhi) • Tamil Nadu Energy Development Agency (TEDA) All of these have a representation in the Project Steering Committee.
2. Industry associations	• United Planters' Association of South India (UPASI) represents all tea planters in South India • The Nilgiris Bought Leaf Association - (BLA) represents 114 bough leaf tea factories in Nilgiris district
3. Tea factories	• One of their representative is a member of the Project Steering Committee
4. University and Research Institution	• Institute for Energy Studies, Anna University • UPASI-KVK "Krishi Vigyan Kendra" Coonoor, (the Tea based Farm Science Centre in India) who are represented in the project Technical Advisory Committee
5. Private sector	• ELPRO Energy Dimensions – an accredited ESCO • EE technology providers like Thermax, Thermo Solutions, ELGI , Concept 4E, etc.
6. NGOs	• TIDE, as project local implementing agency (responsible party)

[23] Process Document, Energy Conservation in Small Sector Tea Processing Units in South India, June 2012, p. 17.

The organizational structure of the project consists of the Regional Technical Advisor (RTA) based in UNDP Bangkok overseeing the project through the Country Office (CO) UNDP New Delhi. Overall project management is provided by the National Project Director (NPD) who is the Executive Director of the Tea Board (TB) based in Coonoor, Southern India. Day-to-day implementation is provided by the TIDE under the guidance of the TB. To ensure that project goals are achieved, implementation strategies are appropriate, project expenditures against activities & outcomes are reviewed, a Project Steering Committee (PSC headed by the TB Chairman) and Technical Advisory Committee (TAC) was established with representatives from the TB, TIDE and local stakeholders. One more important element is Project Management Board which actually is chaired by DEA and UNDP. Here all the UNDP managed projects are members. This help giving overall guidance, information at the GoI level and synergise the experiences of different projects. However, this does not take any project level decisions. Highest body for project decisions is by PSC.

Table 3.2: Organizational Chart of Tea Project



3.5 Results expected

The project is envisioned to support at least 30 factories in South India to adopt EE equipment and practices that would cumulatively save 55,800 tons of direct CO_2 as well as 1,125 tons of direct CO_2 to be saved arising from reduced consumption of diesel because of lower vehicular movement as a consequence of reduced consumption of firewood. It is expected that the environment for

acceptance of energy practices created by the project would have a replication effect and momentum to sustain beyond the 4 years of project period. As a consequence, the indirect CO_2 emission reduction is expected to be 170,775 tons over the 10 years period of 2007-2017.

The expected results are summarized in Table 3.3. (See ANNEX G - Project Planning Matrix or Log Frame).

Table 3.3: Expected Results or Target at EOP

Strategy	Description of Indicator	Target Level at end of project
Objective	To remove barriers and develop replicable strategies for energy efficiency and energy conservation interventions in the tea processing industry in South India	
	30 tea processing units in South India adopt energy efficient equipment and practices within the project period resulting in cumulative savings of 56,925 tons of direct CO_2	1. Project to expose every tea industry in South India to energy conservation 2. To demonstrate replicability by introducing energy usage reform in 30 factories To directly save 56,925 tonnes CO_2
Outcome 1	Awareness creation among the target sector about energy efficiency / renewable energy technologies and their relation to profitability	
	1. Project brochure, publicity material created by the project, brochures of equipment manufacturers, information on Tea Board schemes mailed to each tea factory in South India in the first year	An awareness creation vehicle and strategy that can be used by the industry beyond the project period
	2. Content developed and website of the project launched in the first year	Launch of a project website and its regular update
Output 1.1	Awareness about energy efficiency / renewable energy technologies and relevance to tea units and implications of their adoption.	Demystify energy efficiency / renewable energy technology by demonstration, data collection, analysis and dissemination of information in an organized manner.
Output 1.2	Institutionalized mechanisms for knowledge creation and management.	Create a sustainable institutionalized mechanism for knowledge creation and management that endures beyond the project period and expands to other knowledge gaps.
Outcome 2	Elimination of financial barriers that inhibit investment in energy conservation equipment	
	1. Estimation of extent of new investment in energy efficient technology annually from the second year	Leverage the project to create an atmosphere for easy and attractive access to finance for energy conservation.
Output 2.1	Institutionalization of commercial lending for investments in energy efficiency / renewable energy equipment	Dialogue and motivate financial institutions for developing schemes for energy efficiency that begin with tea but to expand to other industries.
Output 2.2	Development and operationalization of the risk insurance scheme	Conceptualize and operationalize a pioneering risk insurance scheme.
Outcome 3	Adoption and procurement of energy efficient / renewable energy equipment / practices	

Strategy	Description of Indicator	Target Level at end of project
	1. Measurement of the impact of the various market-driven initiatives taken by the project from the second year 2. Number of factories that have invested in energy efficient equipment, nature of equipment and analysis of the same	Facilitate the creation of a market driven enterprise and through its intervention motivate 30 tea factories adopt energy efficient equipment and practices [Note: The target under this outcome is understood as (1) creation of a market driven enterprise; and (2) intervention motivating 30 tea factories to adopt energy efficient equipment and practices. The first part of the target is addressed here.]
Output 3.1	Nurturing the market driven establishment offering all components of	Upgrade and support one or more existing enterprises / energy service providers to offer all energy services required by the tea industry. Sell equipment and services to the industry through this channel.
Outcome 4	Learning, knowledge sharing and replication	
	1. Tea Board imbibes the project methodology and extends the same to other tea clusters 2. Assessment of how the implementing agency has leveraged the project for its own qualitative and quantitative growth	Document the learning, evaluation and adaptive management processes initiated by the project for a larger audience
Output 4.1	Capacity building of agencies involved to replicated of energy efficiency projects in other areas and sectors	Strengthen the institutional mechanisms in TIDE to conceive and implement energy efficiency / CDM projects.

4. Findings and Conclusions

4.1 Project Formulation

4.1.1 Conceptualization/Design (*Highly Satisfactory*)

Overall the project conceptualization and design is highly satisfactory. The selection of energy intensive tea processing industry for intervention is highly relevant as India is the largest tea producer in the world and offers large replication potential. The institutional arrangement concept for the implementation of the project is well designed and has been able to leverage the strengths of an influential sectoral government organisation (Tea Board) and technically capable, field-based NGO (TIDE) working in tandem.

Overall the project outcomes are well designed; except Outcome 2, where the project document had proposed facilitating access to debt funding from banks and a risk guarantee fund to overcome the financial barrier. However, during the project implementation, it was realized that, a large number of tea factories are in a position to fund most of the smaller energy-efficiency investments (in electrical interventions) through equity investments but are more worried about the perceived risk of non-performance of new technology or its negative impact on the tea quality. This led to the change in strategy and more focus on performance audits and a lesser focus on facilitating access to debt finance from banks and risk guarantee fund.

4.1.2 Country Ownership/ Driveness

Government of India has enacted the Energy Conservation Act, 2001 and established the Bureau of Energy Efficiency (BEE) in March, 2002. The Act provides for institutionalizing and strengthening delivery mechanism for energy efficiency services in the country and provides the much-needed coordination between the various entities. BEE is running a large programme on industrial energy efficiency and hence the project is in-line with the Government of India's policy and programme on energy efficiency. The project is also in-line with the renewable energy programmes being implemented by the Ministry of New and Renewable Energy (MNRE).

The project has a high degree of ownership of the Government of India as reflected by the active involvement of Tea Board (Ministry of Commerce) during project formulation. The project is able to successfully leverage Tea Board of India's "11th Plan Tea Quality Up-gradation and Product Diversification (QUPDS) Scheme - Apr 2007-31 Mar 2012".

4.1.3 Stakeholder Participation (*Highly Satisfactory*)

A high degree of stakeholder participation particularly that of the main stakeholders i.e. the Tea Board, Government of Tamil Nadu (Tamil Nadu Energy Development Agency-TEDA), tea industry associations such as United Planters Association of South India (UPASI), technical experts and equipment suppliers has been a key feature of the project formulation. The Tea Board took the initiative to organize a well-attended stakeholder meeting to get feedback from all stakeholders during the project formulation.

4.1.4 Replication Approach

The Outcome 4 (learning, knowledge sharing and replication) is focussed on replication. The project document has recognised the potential of replication within the South Indian tea industry as well as in North-East India, which is a larger tea producing region (almost 3-times production

compared to South India). The capacity building of the Tea Board, documentation of interventions and energy audits, preparation of knowledge products and training programmes have been designed keeping in view the high replication potential in North -East India.

4.2 Project Implementation

4.2.1 Implementation Approach (*Highly Satisfactory*)

The implementation approach of the project has been highly satisfactory.

Key highlights of the implementation approach are as follows:

- *Effective institutional arrangement for project implementation*: The Tea Board being the policy making and implementing agency responsible for the development of tea sector, provided project team the credibility and access to tea industry as well as acted as a strong anchor in the sector. TIDE along with Anna University, were able to put together a strong, motivated, technically competent local team for implementation. Project Steering Committee and Technically Advisory Committee representing all major stakeholders met regularly and were able to provide necessary steering, technical advice and guidance to the project. Tea Board provided a regular oversight on implementation while useful periodic oversight was provided by UNDP.
- *Adaptive management*: The PMU with support from the PSC and UNDP was able to take note of ground realities and take actions to adapt action plan and budget to meet the project objectives. The decision to implement energy efficiency measures in a large number of tea factories instead of 30 tea factories as targeted in the project document; timely action taken to strengthen the technical team at Coonoor; focussing on removal of technical barriers instead of financial barriers as envisaged in the project document; use of a non-ESCO entity to continue the conduct of energy audits using the technical team from TIDE, Anna University and UPASI, continuous evolution of energy efficiency and renewable energy options (biogas and solar-powered LED instead of less-effective solar air preheating, solar water heater and solar timber kiln), are some of the examples of the adaptive management which led to the success of the project.
- *Effective management of relationships among key stakeholders*: Project management was successful in not only identifying and bringing together a number of key stakeholders (government, equipment suppliers, plantation association, estate and bought leaf tea factories, technology experts, etc.) but was also able to effectively manage relationships so that all the stakeholders worked towards achieving the objectives of the project.
- *Strong technical leadership*: Strong and committed technical leadership displayed by the project through Prof Sethumadhavan and TIDE technical team was critical in gaining the confidence of the tea industries and in successful implementation of energy efficiency measures.
- *Inclusive technology approach*: The project displayed an inclusive technology approach as it offered a large set of energy-efficiency and renewable energy options, ensuring that there was some option(s) applicable to each tea factory. The options being offered ranged from simple no cost or low cost housekeeping measures to capital intensive options like Hot Water Generators. By EOP, the project was offering 17 energy efficiency measures (10 electrical and 7 thermal)

along with over 5 renewable energy measures (See Table 4.1). This approach helped the project in reaching-out to a large number of tea factories in South India.

Table 4.1: Electrical, Thermal and Renewable Energy Interventions

	Type of EE/RE Intervention
A	**Electrical Interventions**
1	Installation of section-wise energy meter
2	Use of maximum demand controller
3	Use of automatic power factor controller
4	Use of automatic Star-Delta-Star starters in motors
5	Replacing V-belt with Flat-belt drives
6	Direct mounting of fans and use of nylon blade instead of aluminum blade fans in the Withering section
7	Installation of energy efficient motors
8	Reduction of fan operating speeds
9	Use of Star connection in lowly loaded motors
10	Installing energy efficient lighting
B	**Thermal Interventions**
1	Use of closed shed for storing fuel wood
2	Use of Splitter for fuel wood
3	Downsizing of Induced Draft Fan (ID)
4	Use of Forced Draft Fan (FD)
5	Use of variable frequency drive of dual speed motor for speed control of ID flue gas fan
6	Recirculation of Dryer exhaust for Withering
7	Use of Hot Water Generator (HWG) instead of Hot Air Generator (HAG)
C	**Renewable Energy Interventions**
1	Briquetting Units to replace/augment fuel wood
2	Gasifier to convert biomass (briquettes, fuel wood, rice husk) to combustible gas for use in a burner or fed into an engine genset for power generation:
2a	*Thermal gasifier for green tea panning*
2b	*Combined Heat and Power (CHP) gasifier to meet all heat and electricity needs of tea factories through captive biomass-based power including waste heat recovery*
2c	*Use of gasifiers with ancillary equipment to produce ultra clean producer gas that could be directly fired in the same manner as CNG*
3	Biogas Plant - anaerobic digest than can convert organic wastes into methane-rich biogas through bacterial action
4	Energy Plantations - to overcome fuel stress faced by the tea sector due to issues on supply and rising cost of fuel wood
4	Solar Energy:
4a	*Solar air preheating systems*
4b	*Solar timber kiln for wood drying (reduce moisture)*
4c	*LED lighting powered by solar PV panel*
5	Hydro Power

- *Use of innovative tools and approaches*: The project developed innovative tool like “Energy Score Card” which helped the factories to self-assess their performance regarding baseline energy use. This Score Card made the task of communicating the results of energy audits to tea industries easier for the project team (See Table 4.2). Another innovation was in the form of

conducting "Performance Studies"[24]. Performance studies were carried out to demonstrate to the tea factories the benefit of actual implementation. The project installed the new equipment or made required retrofit/replacements and operated the intervention for some time at the factory and monitored the saving in energy consumption and associated economic benefits. Results of such studies led to convincing the factory management about the effectiveness of the interventions. The management then placed orders to buy new equipment. The Tide Technical Team (TTT) assisted in the procurement process to ensure implementation. The equipment temporarily installed was then moved out to another factory for demonstration.

Table 4.2: Energy Scorecard Point System

	Category	Credits
A	General	**33**
B	Day-to-day operations	**48**
	Withering	7
	C T C	14
	Fermentation	3
	Dryer	13
	Sifting / Packing	4
	Reconditioning	3
	Illumination	4
C	Housekeeping	**19**
	TOTAL	**100**

4.2.2 Monitoring and Evaluation (*Highly Satisfactory*)

The Project Steering Committee (PSC) played an important role in monitoring and steering the implementation of the project. The Project Steering Committee (PSC) was comprised of designated representatives from the Ministry of Commerce, Tea Board, Ministry of Environment and Forests, UNDP, TIDE and other important stakeholders. The PSC met regularly at an interval of six- months (9 times) during the project. A review of the minutes of the PSC meetings show that almost all the PSC meetings had participation of senior officials of the Tea Board, Tamil Nadu government, UPASI and UNDP. Several of the meetings were also attended by other important stakeholders such as, MNRE, BEE, etc. The PSC meetings followed a well-defined agenda, which consisted of reporting on action taken report on the minutes of the previous PSC meeting, report on the work progress since the previous PSC, action plan for the future period, discussion and decision on high-value expenditure items, sustainability of the project intervention, etc. The PSC meetings usually had duration of 2 to 3 hours, which provided sufficient time to discuss the important issues.

The Executive Director, Tea Board played a key role in providing regular monitoring of the project. As the project office was located in the office of the Executive Director, Tea Board at Coonoor, it resulted in close monitoring of the project implementation. UNDP officials not only participated in the meetings of the PSC and Technical Advisory Committee (TAC) but also undertook regular field visits (3-4 visits per year) to Coonoor as well as to tea factories to monitor the implementation of the project. As a part of the regular monitoring process, Quarterly Progress Reports (QPRs), Annual Work Plans (AWPs), and Annual Audit reports were compiled regularly. The mid-term review (MTR) of the project by two independent consultants was conducted in 2010 and made seven recommendations. These recommendations were discussed in the following PSC meeting and

[24] Ibid., p. 29.

suitable actions were approved. The advisory and monitoring role of RTA, UNDP, Bangkok also played a key role especially while taking a decision to shift focus from addressing financial barriers to nonfinancial barriers.

4.2.3 Stakeholder Participation (*Highly Satisfactory*)

The project has been a good example of multi-stakeholder cooperation with UNDP --Tea Board (Govt.) -- UPASI (Plantation Association) -- Bought Leaf Association -- TIDE (NGO) -- Anna University (Academic institution) -- Private industry working together on the ground for project implementation. Stakeholder participation has been very strong both at the implementation level as well as at the level of project steering through PSC and TAC.

The stakeholder participation in PSC has already been discussed in the previous section. The TAC which brought together a wide-array of technical experts having expertise in tea processing as well as energy technologies. The experts belonged to academic and research institutions (PSG College of Technology, Anna University, UPASI), tea industry, UNDP and TIDE. TAC was responsible for advising the project team on technical matters, review of energy audits and data management, advice on technology selection and suggesting policy issues of relevance to technology adoption. It provided a platform where detailed discussion among various stakeholders on technology choices can be made. This helped the project in taking informed decisions on technology choices.

At the implementation level the stakeholder interaction took place in three forms:

a) Participation in project events: The project organized or facilitated around 35 events, which consisted of technical seminars, meetings, training programmes, exposure visits, buyer seller meets, exhibitions, etc. These events brought together representatives of tea industry, equipment suppliers and experts and provided a platform for stakeholder participation. Apart from project events, the project participated in other sectoral or thematic events such as the India International Tea Convention, the Tea and Tourism Carnival, UPASI Annual Conferences, and the International Renewable Energy Expo and Conference. The participation in the UPASI annual conferences was particularly of importance as the event is attended by a large number of tea factories. The project used the participation in UPASI conferences to launch knowledge products. While the “energy score-card” was launched during the 117th UPASI conference in 2010, a CD “Destination Efficiency” was launched in the 118th UPASI conference in 2011.

b) Energy audits and performance studies: During the process of conducting energy audits and performance studies, which spanned over several days, the project technical team had intense interaction with the technical and managerial staff of the tea factories

c) Newsletter and project website: The project quarterly newsletter, apart from providing information on the implementation of the project also carried articles from the tea industries and equipment suppliers thus promoting stakeholder participation. Fifteen newsletters have been published and they have been widely distributed amongst tea factories and are also available on the project website. The project website (http://www.encontea.org/) has useful information in the form of project documents, presentations, newsletters, addresses of equipment suppliers, etc.

4.2.4 Financial Planning (Financial Management) and Co-Financing

The project has been successful in completing all major activities and achieving major outcomes within the allocated budget. As shown in Table 4.3, overall disbursement was 92.6% at EOP. Outcome 3, which has the largest allocation of GEF funds (USD 396,200), its disbursement was

very close to the target at 98.7%. The PMU expenses remained within the allocated budget. The disbursement for Outcome 2 exceeded the budget by almost 50% because of larger allocation of funds for providing additional subsidies for briquetting plants and HWGs during 2010 and 2011. The disbursement of funds for Outcome 1 and 4 were marginally lower compared to the budget (66.8% and 68.9%).

Table 4.3: Budget Utilization of UNDP-GEF Funds (in USD)

UNDP - GEF Budget Allocation	Budget As per ProDoc		Actual from CDR As of 30 June 2012	
	USD	% of Total	USD	% of Budget
Outcome 1: Awareness Creation	233,800	24.6	156,210	66.8
Outcome 2: Financial barrier removal	99,500	10.5	149,334	150.1
Outcome 3: Adoption of EE/RE equipment/practices	396,200	41.7	391,237	98.7
Outcome 4: M&E, Knowledge Sharing and Replication	125,500	13.2	86,468	68.9
Project Management Unit (PMU)	95,000	10.0	96,565	101.6
TOTAL	**950,000**	**100.0**	**879,813**	**92.6**

Co-Financing	Project Budget as per ProDoc	% of Total	Total spent to date	% of Budget
Tea Factory Promoters	199,375	18.1	294,671	147.8
Tea Board	240,625	21.9	2,705,329	1,124.3
Union Bank of India, Coonoor Central Bank of India, Coonoor IREDA, New Delhi	660,000	60.0		
Total Co-Financing	**1,100,000**	**100.0**	**3,000,000**	**272.7**

The year-wise expenditure (Table 4.4) has been well spread over the project duration indicative of sound planning and execution of yearly commitments during implementation. Unfortunately, the TE team has no information on actual year-wise co-financing investments from equity of factory owners, subsidy from Tea Board and loan approvals from financing institutions The co-financing shown below are programmed investments in the ProDoc (MSP, page 31).

Table 4.4: Year-Wise Overall Utilisation of GEF Funds (in USD)

Overall GEF Fund Utilisation (from CDRs)	Project Budget as per ProDoc	Fund spent in 2008	Fund spent in 2009	Fund spent in 2010	Fund spent in 2011	Fund spent up to 30 June 2012	Total spent to date	% Fund Utilization
Outcome 1: Awareness Creation	233,800	52,463	65,557	11,188	26,269	733	156,210	66.8
Outcome 2: Financial barrier removal	99,500	16,308	12,128	57,368	46,369	17,160	149,334	150.1
Outcome 3: Adoption of EE/RE equipment/practices	396,200	86,527	25,291	131,586	110,938	36,894	391,237	98.7
Outcome 4: M&E, Knowledge Sharing and Replication	125,500	15,636	27,255	24,319	9,745	9,513	86,468	68.9

Project Management Unit (PMU)	95,000	33,953	11,746	27,486	14,036	8,052	95,274	100.3
TOTAL	**950,000**	**204,885**	**141,707**	**249,084**	**212,646**	**71,219**	**879,541**	**92.6**

Co-Financing (ProDoc, page 31)	**Project Budget as per ProDoc**	**Fund spent in 2008**	**Fund spent in 2009**	**Fund spent in 2010**	**Fund spent in 2011**	**Fund spent up to 30 June 2012**	**Total Budget**	**% Share of Budget**
Tea Factory Promoters	199,375	39,875	59,812	59,813	39,875		199,375	18.1
Tea Board	240,625	72,000	48,312	48,313	72,000		240,625	21.9
Union Bank of India, Coonoor Central Bank of India, Coonoor IREDA, New Delhi	660,000	231,000	99,000	99,000	231,000		660,000	60.0
Total Co-Financing	**1,100,000**	**342,875**	**207,124**	**207,126**	**342,875**		**1,100,000**	**100.0**

4.2.5 The cost-effectiveness of achievements:

The next Table 4.5 shows the cost effectiveness of the project in terms of reducing both direct and indirect CO_2 emissions at 19.42 and 14.06 USD per ton of CO_2, respectively. However, using the audit results from the 86 tea factories yields a more cost-effective reduction during the period of direct and indirect emissions after the EOP at 3.89 and 2.83 USD per ton of CO_2 removed. (Table 4.6)

Table 4.5: Cost Effectiveness of Investments in Reducing CO_2 Emissions (ProDoc)

Using ProDoc Data	**Cumulative Reduction, tons direct CO2**	**Co-Financing* Investment, USD**	**Investment Cost per CO_2 reduction, USD/ton CO_2**
EE Equipment Installed and operating during project period	55,800		
Reduction in consumption of diesel due consumption of firewood	1,125		
Total Direct CO_2 reduction, tonnes/yr	56,925	1,100,000	19.32
Direct CO_2 reduction (10 years)	569,250		
GEF Causality Factor (%)	30%		
Total Indirect CO_2 (10 years)	170,775	(Tea Board & Banks)	
Annual Indirect CO2, tonnes/yr	17,078	240,160	14.06
* Assuming zero cost of escalation of equipment			
SOURCE: Mid-Term Report of Energy Conservation in Small Sector Tea Processing Units in South India, 8 August 2010, p. 30 (also found at page 32 of Project Document)			

Table 4.6: Cost Effectiveness of Investments in Reducing CO_2 Emissions (Audit)

Post Audit Data of 86 factories	**Cumulative Reduction, tons direct CO_2**	**Co-Financing* Investment, USD**	**Investment Cost per CO_2 reduction, USD/ton CO_2**

EE Equipment Installed and operating during project period	277,255		
Reduction in consumption of diesel due consumption of firewood**	5,590		
Total Direct CO_2 reduction, tons/yr	282,845	1,100,000	3.89
Direct CO_2 reduction (10 years)	2,828,452		
GEF Causality Factor (%)	30%		
Total Indirect CO_2 (10 years)	848,536	(Tea Board & Banks)	
Annual Indirect CO_2, tons/yr	84,854	240,160	2.83
* Assuming zero cost of escalation of equipment ** Assumes the same ratio of (1,125 diesel savings / 55,800 energy savings) x 277,255 = 5,590 SOURCE: See ANNEX K for data source and calculation of GHG emission reduction			

4.2.6 Sustainability:

The successful implementation of the project would ensure sustainability of the interventions after the end of the project as manifested by results:

- A large body of experience now exists in South Indian tea industries on adoption of a wide variety of energy efficiency and renewable energy options. The barrier linked with perceived risk of non-performance of several types of new technologies, such as, hot water generators, energy efficient motors, has been successfully overcome, which will ensure replication. The meetings of the TE team with equipment suppliers confirmed this observation.
    - Thermo Solutions (India) Pvt. Ltd, a supplier of Hot Water Generator, informed that the company has bagged order for 4 new Hot Water Generators, post project. During the project period the company had supplied 2 Hot Water Generators.
    - ELGI ULTRA Industries Ltd, supplier of flat belts informed that they expect annual sales of around INR 20 million/year from tea industry in 2012
- The tea industry has become more open to trying out new energy-efficiency and renewable energy technologies. During the visit to Thaymudi tea factory in Valparai, the TE team learned that the factory is constructing a large 400 m^3 biogas plant for energy generation utilizing bio-degradable waste from the tea factory. Havukal tea factory informed that they are trying out solar PV pumps for irrigation. Both the factories attributed their decisions to the exposure they got to new technologies during the project.
- Number of equipment suppliers active in the tea factories has increased. While at the beginning of the project only one supplier of Hot Water Generator, now there are at least 4 suppliers. Due to project interventions, new suppliers of LED lights, ID/FD fan controller, energy-efficient motors, improved fans, etc. have become established in the tea industry and their activities will ensure further expansion of the market of EE products in the tea industry.
- Tea Board has realized the importance of energy efficiency and renewable energy. The Executive Director of the Tea Board informed the TE team about this. He also informed about the decision of the Tea Board to opt for LED lights in the office to show-case their commitment to energy efficiency. He also informed that Tea Board would like to utilize this experience to launch new initiatives in water and overall resource efficiency in tea industries.

- TE team was informed that the Tea Board, UNDP and TIDE are in an advanced stage of developing a similar energy efficiency project to be funded by the Government of India for the tea industry in north-eastern India. As the production of north-eastern tea industry is almost 3 times that of the south Indian tea industry, such an initiative will greatly add to the replication impact of the project.

Though the overall outlook for sustainability looks very positive, there is still some lack of clarity about the sustainability of the laboratory and energy efficiency equipment/services developed during the project and now transferred to UPASI. It is suggested that Tea Board, UPASI and TIDE should come to an agreement on a sustainable business plan for the laboratory at UPASI.

4.2.7 Execution and implementation modalities

The execution and implementation modalities of the project have been satisfactory. As explained earlier, the project was guided by a well-functioning PSC and a regular oversight by the Tea Board and UNDP ensured timely implementation of the activities. The project document provided for 96 weeks of staff-consultancy by international consultants, though the actual number of inputs sourced from international consultants was much lower, and the project relied more on services provided by the Indian consultants.

4.3 Results

4.3.1 Description of project results

- The project conducted around 35 awareness seminars, training programmes, 15 meetings with associations to address information barriers and was able to reach out to almost all 266 tea factories in Coonoor region. During the project period 15 quarterly newsletters were printed and disseminated through participation in annual events of the Tea Board. Circulation doubled from 500 to 1,000 copies because of demand from tea factories from other tea clusters in India. The project website, which was launched in the 3rd quarter of 2009 and became operational, contains information about the project structure, newsletters, power point presentations, video tutorials, energy audit reports, project documents and other useful information like contact details of EC/EE suppliers of equipment.

- About 100 one-on-one meetings were held between tea factory owners and experts on EC/EE interventions which have contributed to the high adoption rates of EC/EE measures in more than the target level of 30 tea factories.

- The project conducted 266 preliminary audits and 95 detailed energy audits (DEAs) during the project period and more than 100 post audits monitoring of implementation reports. To quantify and demonstrate the benefits of implementing energy conservation measures suggested in the energy audits, the project conducted a total of 106 performance studies.[25] The project installed the new equipment or made the required retrofit and operated the intervention for some time at the factory and monitored the saving in energy consumption and associated economic benefits.

[25] Ibid., p. 41.

- The project's target of demonstrating replicability has been achieved as 90 tea factories implemented energy reforms with project support and another 24 factories without project support bring to 214 the total number of factories investing USD 3.0 million into EC/EE measures of which USD 2.7 million was provided by the Tea Board and balance of USD 0.3 million provided by tea factory equity and bank finance. As a result of project interventions, more than 200 factories implemented at least one of the 12 energy audit recommendations . The number of EE interventions implemented is placed at 1,000 measures out of the 3,000 measures recommended by the project.

- Based on the post implementation audit studies of 86 factories and assuming that all were in place from 2008-2011, the project would have cumulatively saved a total of 19.5 million kWh and 0.142 million tonnes of firewood with potential GHG emission reduction of 17,545 and 259,711 tons of direct CO_2 from electrical and thermal energy savings, respectively. This aggregates to 277,255 tons of direct $CO_2$with attendant savings of 5,592 tons of CO_2 in consumption of diesel because of reduced vehicular movement (around 1,125 tons direct $CO_2$from diesel use per 55,800 tons of direct CO_2 from energy savings during the project duration). Average annual emission reduction is 69,314 tons of direct CO_2. Replication beyond the project period is expected to contribute 693,138 tons of indirect CO_2 emission reduction over the next 10 years (see ANNEX K).

- Investments in RE projects such as 300 kW of thermal gasifier and 40 kW of micro hydro were made to showcase the use of renewables for tea processing. The budget provided for developing the risk insurance scheme was used instead to provide incentives in the form of small upfront subsidies to 3 BL factories for installation of Hot water Generators and 3 tea factories for setting up of briquetting plants. Two of these briquetting plants developed during the project were the Sri Ra Ra Biofuels and Jayshree Tea factory. The first unit of Sri Ra Ra Biofuels in Coimbatore was operational since June 2010 and briquettes produced have calorific value (CV) of more than 4,000 kcal/kg. The second unit of Jayshree Tea factory commissioned in December 2012, with a capacity of 3,600 tonnes per year, makes briquettes with a CV of 4,300 kcal/kg.[26] The tea factories pre-dominantly use fuel wood to meet their thermal energy needs. Though a significant part of fuel wood is sourced through plantations, some of the fuel wood supply is from forests which results in deforestation. High moisture content in fuel wood results in higher fuel consumption and lower thermal efficiency.

- At the beginning of the project some of the tea factories have experimented with the use of biomass briquettes. However, poor quality and unreliable supply were the main barriers in them shifting to regular use of biomass briquettes. The project took several steps to promote use of biomass briquettes in tea factories. This included financial and technical support for setting up two briquetting plants, dedicated to the tea industry by Sri Ra Ra Biofuels and Jayshree Tea factory (TE team report on visit to one of the briquetting plant can be found in ANNEX D). These plants are producing good quality briquettes on a continuous basis. As per an estimate by TIDE, the project was able to add a production capacity of about 6000 tons of briquettes annually. This is less than 3% of the total demand of 250,000 tons of briquettes annually in the South Indian tea industry.

[26] Ibid., p. 56.

- The Thaymudi Tea Factory in Valparai have made a total investment in energy efficiency and renewable energy interventions during last 2-3 years is of the order of Rs 30 million which includes their recent construction of a biogas plant of 400 m^3/day capacity at their tea factory in addition to a similar 400 m^3/day biogas plant in their coffee factory. The tea factory plans to feed the biogas plant with tea waste/washings and cattle dung and to use this methane-rich gas for running a 180 kVA generator set for 8-9 hours per day. During the last year, they generated 15% electricity of its requirement through DG sets.

4.3.2 Attainment of Outcomes/ Achievement of objectives

a) The progress for Outcome 1 (awareness creation) has been ***highly satisfactory***. The project is to be commended for creating widespread awareness, through seminars, meetings, newsletter, video films and web-site about energy efficiency and renewable energy. In all, the project conducted around 35 awareness seminars, training programmes, meetings with associations and was able to reach to almost all 266 tea factories in South India. During the project period, 15 newsletters were printed and disseminated during annual events of the Tea Board. The circulation which was initially 500 was increased to 1,000 copies at the end of 2009. The project reached out to about 250 of the 256 factories through awareness creation and personal visits of experts. [27] The project website contains information about the project structure, newsletters, project presentations, project documents and other useful information like contact details of suppliers of equipment.

b) The progress in Outcome 2 (elimination of financial barriers) has been ***satisfactory***. The project facilitated the access to Tea Board subsidy available under QUPDS. However, for most part of the project the disbursement of the subsidy was delayed and remained erratic. Towards the end of the project, Tea Board has suspended accepting fresh applications for availing the subsidy while awaiting fresh funds for the 12th five year plan. The project had aimed at increasing commercial borrowing by tea factories for the implementation of energy conservation measures, however, most of the factories have opted for equity investments and the commercial borrowing has remained low. The project provided incentives in the form of small upfront subsidies to 3 BL factories for installation of Hot water Generator and 3 industries for setting up of briquetting plants. These incentives have been availed and have led to positive demonstration effect. The project could not succeed in its attempt to introduce ESCO concept.

c) The progress on Outcome 3 (adoption of EE/ER equipment) has been ***highly satisfactory***. Against a target of 30 primary beneficiary tea industries, 90 tea factories implemented energy reforms with project support and another 24 factories without project support for a total of 214 factories investing USD 3.0 million As a result of project initiatives, more than 200 factories implemented at least one of the 12 energy audit recommendations. A partial list of energy efficient equipment installed (133) and the investments (INR 17.4 million) made is provided in Table 4.7.

Table 4.7: Major Investments in energy conservation equipment

	No. of Equipment	Investments (million INR)
Thermal Energy		
Hot water generator	17	70.7

[27] R. Ambalavanan, R. Sethumadhavan and Svati Bhogle: Experiences of investments in Energy Efficiency and Renewable Energy in Tea processing units. 8th CII-EXIM BANK Conclave on India Africa Project Partnership, 18 – 20 March 2012, New Delhi.

Wood splitter	58	14.7
Wood shed	30	8.1
ID fan controller	47	4.4
Total	**152**	**97.9**
Electrical Energy		
Energy Efficiency Motors	23	6.0
Flat belt drive	32	3.2
APFC/MD Controller	78	8.2
Total	**133**	**17.4**

Source: Project presentation in 7th PSC

The project has provided an excellent platform for suppliers of energy-efficiency equipment and several of them are now active in the region. Several new products are now available in the market. The presence of Dr. Sethumadhavan, Director (Implementation and Monitoring) as Head of the technical team at Coonoor during 2010 and 2011 and the work done by the TIDE-UPASI technical team under his guidance has been instrumental in achieving this success.

d) Outcome 4 (learning, knowledge sharing) can be termed as ***highly satisfactory***. The project has built capacities of Tea Board and UPASI. The Tea Board decision to fund a new project in North East India has a very large replication potential. TIDE, Tea Board and UPASI need to come up with an action plan for the utilization of equipment and human resources available for energy audit and energy conservation activities in Coonoor.

4.4 Completed tracking tool

The ToR of this TE review requires the calculation of GHG benefits relating to energy efficiency and renewable energy projects. Towards this end, the TE team applied the principles in the GEF guidelines in calculating the CO_2 emission reductions attributed to the implementation of the project. A number of assumptions were made to estimate GHG emission reductions:

- Annual made tea production in South India of 203 million kg or around 24% of total India production of 870 million kg
- Specific energy consumption of 0.478 kWh per kg made tea with 7.62% energy savings
- Specific energy consumption of 1.372 kg FW per kg made tea with 19.34% energy savings
- Grid emissions factor of 0.90 tons CO_2/MWh for the Indian electricity grid[28]
- Biomass emissions factor of 1.83 tons CO_2/tonne FW
- Average biomass calorific value of 3,750 kcal/kg FW – 15.7 MJ/kg FW

[28] The rate promulgated by the CO_2 Baseline Database for the Indian Power Sector published by the GoI, Ministry of Power, Central Electricity Authority, Table S-1 (page 1) is weighted average baseline emission factor (by net generation) = 0.79 for whole India, 0.72 for South India and 0.81 for NEWNE India. The TE team adopted the value in the back of the envelop calculation from UNDP-India.

The project's direct emission reduction is 277,255 tons CO_2/year for the 4 year project duration, or an average annual reduction of 69,314 tons CO_2. For the next 10 years, the lifetime direct GHG emissions avoided is 693,138 tons CO_2. (ANNEX K)

There are no direct post project emissions reductions once the project ends.

Based on a replication factor of 3.0 applied on the annual direct emission reduction of 69,314 tons CO_2/year (4,386 electrical and 64,928 thermal), the indirect bottom-up emissions reduction is 2,079,415 tons CO_2/year. However, indirect top-down emissions reductions based on 40% GEF causality factor, the maximum reduction estimate is lower at 1,732,846 tons CO_2/year vs. the bottom-up reduction of 2,079,415 tons CO_2/year. The CEO endorsement target from the basic text of PIR 2012 is listed at 1,300,000 tons CO_2/year of lifetime indirect GHG emissions avoided.

From the same back of envelop calculations (Summary for TT), the total lifetime electrical and thermal energy savings are estimated at 572 and 5,570 TJ, respectively, for a total of 6,143 TJ.

5. Conclusions on the findings

A detailed description of the key aspects of the implementation approach which led to the success of the project has already been described in Section 4.2.1. Similarly findings and results related with GHG emission reductions, financial planning etc. have also been covered in chapter 4. These conclusions are not being repeated in this chapter.

This chapter deals with findings and results which have not been covered in earlier chapters.

5.1 ESCO approach

The original strategy of the project team for implementing energy efficiency measures in tea factories revolved around an Energy Service Company (ESCO) approach. It was planned that the ESCO would conduct energy audits and would subsequently invest in equipment and would take away a significant proportion of the savings in the energy cost (e.g. one proposal was for sharing of energy cost savings in a ratio of 75:25 between the ESCO and the tea factory). The tea factories did not find this approach attractive. Also, the tea factories were reluctant to share 'real' base-line data on production and energy costs, which made it difficult for ESCO to make credible investment proposals. Realizing that the factories were not comfortable with the ESCO approach, the project team decided to augment its own technical competency and started offering implementation assistance with the help of equipment suppliers to tea factories.

5.2 Biomass briquettes

Biomass briquettes made from agriculture residues (rice husk, palm, castor husk, coffee husk, saw dust, groundnut shell, etc.) have a higher calorific value, significantly lower moisture level and higher carbon content. The use of biomass briquettes can help in reducing deforestation as well as improve thermal energy efficiency in tea industry.Overall it can be concluded that the project was able to demonstrate the advantages of briquettes as well as technical and financial viability of good quality briquettes. The fuel wood replacement by briquettes is still very small, and is primarily an issue of demand and supply gap as there is a huge demand for briquettes by other industries (primarily textile). However, it is hoped that the project interventions would result in setting up of more captive briquetting units dedicated to tea factories.

5.3 Solar energy utilization in tea industry

The project document had identified solar air pre-heating systems installed on the roof of tea factories as a major technological option for saving fuel wood in tea factories. The project document had estimated that 33% fuel wood savings are possible by adopting solar air pre-heating along with energy-efficiency measures in the air heaters used in tea industry. However, the experience with the application of solar air pre-heating system has not been positive in the South Indian tea industry. During TE team interaction with the tea factories (which included Havukal, which had experimented with solar air pre-heater application), reasons such as: low solar intensity due to fog , mist and cloud cover; and poor solar air heater design for industrial applications were cited as reasons for the poor performance of the solar air pre-heating systems.

However, it would be wrong to conclude that solar energy has no role in tea industry in South India. The TE team was informed about recent experimentation with solar energy pumps for irrigation of tea plantations; there are also a few examples of use of solar energy based LED lights; solar water heating is gaining popularity in Coonoor and neighbouring areas and might find applications in tea plantations, particularly for meeting hot water requirements of the workers. With the reduction in prices of solar PV technology, large roof areas of tea factories may also offer scope for electricity production in future.

5.4 Biogas utilization in tea industry

The BBTC factory at Thaymudi is constructing a 400 m3 biogas plant for power generation and process heat. It is debatable whether the factory should use biogas for power generation (having low utilization efficiency of 25% in gensets), compared to hot water generation (efficiency of around 85%) or cogeneration of steam and power (overall efficiency exceeding 50%). These experiences indicate the need for a more focussed and careful examination of the potential of generating and utilizing biogas in tea factories.

5.5 Biomass gasification

In a biomass gasifier, solid fuels such as fuel wood, briquettes, rice husk can be converted into a low calorific value producer gas through a thermo-chemical process. The producer gas can be used for direct burning to produce heat; can be utilised in an internal combustion engine to produce electricity; or can also be used for combined heat and electricity generation. The project facilitated installation of a thermal biomass gasifier of 360 kW_{th} capacity at Glenmorgan tea factory for panning of green tea. The TE team did not visit the Glenmorgan tea factory and hence is not in a position to comment on the results of the testing. During the review of documents of the project, the TE team has come across a brief discussion on the experiment in the process document, which indicates that the gasifier faced certain operational problems. During interactions with stakeholders during the TE mission, mismatch in the capacity of the gasifier and end-use application; and problems in sourcing cut fuel wood were mentioned as two problem areas. In the absence of full information on the topic it is difficult to reach to a conclusion on the feasibility and potential of biomass gasifiers in the tea industry.

5.6 Energy Plantations

The tea industry is facing a shortage of biomass fuel. As per estimates made by the project team, growing energy plantations on 5% of the area in tea estates would meet annual fuel wood demand for tea processing for the tea estate. The project facilitated plantation of Beema bamboo, which yields 40-60 tons/acre/year, in 4 tea estates[29]. The biomass production cost is estimated at Rs 650/ton, which is 1/4th of the current fuel wood cost. The concept of energy plantations appears to be an attractive option and could become the source for sustainable energy supply to tea industries.

[29] Process Document, Energy Conservation in Small Sector Tea Processing Units in South India, June 2012, p. 57.

5.7 Hydro Power

Tea estates being located in the hilly regions offers the potential for harnessing hydro power. A hydropower potential survey was conducted in the region and 12 estates were identified to be located nearby a stream, with a combined electricity generation capacity of 3,500 kW[30]. The project tried to facilitate erection of new hydro power generation facility; however, establishment of a small hydro power plant requires a large number of permissions from the state government and was found to be a major barrier in the promotion of hydro power.

5.8 Energy Efficiency Interventions

Preliminary energy audits were conducted in these 266 tea factories and detailed energy audits in 86 tea factories. All the 86 factories have implemented at least one or more of the 12 energy efficiency recommendations (See Table 5.1). Factories that carried out most of the recommendations were observed to have larger % energy cost savings and GHG emission reduction potential; whereas, the 3 factories mentioned earlier that implemented a few had small % energy cost savings. It was also observed that thermal energy interventions provided larger energy savings compared to electrical energy interventions; hence, the need to rethink carefully where to apply biogas fuel – for power generation or for thermal heating applications.

Table 5.1: Energy Efficiency Recommendations and Performance Studies

No.	EE Recommendation / Performance Study	No. of Tea Factories
	ELECTRICAL ENERGY:	**61**
1	Housekeeping, factory maintenance	14
2	Implementation of ENCON schemes	12
3	Energy efficient motors	10
4	Flat belt performance evaluation	8
5	Star connection for lowly-loaded motors	6
6	Transformer study	9
7	Capacitor performance study	2
	THERMAL ENERGY:	**28**
8	IF fan controller for fuel optimization in furnace of the drier	14
9	Dual speed motor	3
10	Withering study (specific to fans)	5
11	Thermal study (hot air generator, drier)	4
12	Thermal study (hot water generator, drier)	2

[30] Process Document, Energy Conservation in Small Sector Tea Processing Units in South India, June 2012, p. 58

6. Lessons Learned

Some of the best practices which resulted in the successful implementation of the project are as follows:

- Offering a large bouquet of technical solutions: Unlike several other similar GEF projects which offer only one or a few technical solutions, the tea project offered 17 energy efficiency and 5 renewable energy solutions. The project pro-actively looked for identifying newer options throughout the implementation period. As explained in Section 4.2.1, this large bouquet of technical solutions meant that the project had at least one solution for any of the tea factories. Thus, project was able to facilitate implementation of measures in all types of tea factories.
- Ensuring availability of a high quality technical support: The project was able to mobilize a high quality technical team led by Prof. Sethumadhavan. The technical team was based at Coonoor for almost 2 years. During this time period it was easily accessible and was highly mobile which ensured uninterrupted availability of the technical services to tea industry.
- Effective relationship management by TIDE: Implementation of all UNDP-GEF projects requires working with a wide variety of stakeholders and multi-disciplinary implementation teams. Relationship management to ensure positive and synergetic involvement of stakeholders becomes an important role of the project management team. TIDE played this role effectively.
- Focus on removing the barrier associated with the lack of access to information and technology: A large number of GEF projects dealing with energy efficiency in small and medium enterprise identify lack of access to finance as one of the most important barrier. The project was also based on this hypothesis. Mid-way through the project, the project team realised that lack of access to information and technology was the major barrier and not access to finance as was understood at the time of project conceptualization. This realization resulted in the modification of the strategy and the project proved that success could be achieved through sustained awareness, technical support and demonstrating proof of concept in a production environment, success can be achieved with minor or no financial incentives.
- Adaptive management: The PMU with support from the PSC and UNDP was able to take note of ground realities and take actions to adapt action plan and budget to meet the project objectives. This aspect is covered in more detail in Section 4.2.
- Strengthening the supply chain of energy efficient equipment suppliers: The strengthened supply chain of energy efficient equipment suppliers, e.g. liaison with key manufacturers as Thermax Ltd. to customize HWG equipment to capacities as required for tea sector, has led to acceptance of the equipment suppliers from being mere “salesmen of equipment” to value-adding energy service providers.

7. Recommendations

The main recommendations of this TE are as follows:

1. *Organized project follow-up in South Indian Tea Industry:*

It is expected that in the post-project period, pro-active market development by equipment suppliers would ensure sustainability of energy efficiency interventions to some degree. A large-scale dissemination of renewable energy technologies is yet to take place. The sustainability of the interventions can be greatly reinforced if an organized way of follow-up and support involving main project implementation partners i.e. Tea Board, TIDE and UPASI can be established. This should involve ensuring sustainability of the fuel test lab cum energy centre which now has been handed to UPASI.

The project has been successful in initiating the process of adoption of energy efficiency and renewable energy options in South Indian tea factories. As per the estimates of the project implementation team of TIDE and Tea Board, out of an overall potential of 3,000 energy efficient activities, 1,000 implementation activities have been carried out during the project period. Thus there are 2000 energy efficient activities that are yet to be carried out.

2. *Replication opportunities within the tea industry as well as in other plantation industries:*

The successful project design and implementation has opened many possibilities for replication. UNDP-India, Tea Board and TIDE, are preparing a proposal to support adoption of energy efficiency measures in the tea industry in North India, which is much larger tea growing region than South India. The success of the project has encouraged the Tea Board to look into the possibility of develop similar intervention programmes for water and overall resource efficiency in the South Indian tea industry. Coffee, rubber and cashew are other major commercial crops in South India; there is also a potential to develop similar intervention projects in these plantation industries.

3. *Developing further the concept of zero carbon tea:*

The project tried to develop a concept of ‘Zero Carbon Tea’ that would provide global consumers with an environmentally benign tea drink as well as branding (factory, company or country level). It would require a second level of interventions in the form of a) renewable energy sources such as micro hydro, wind and solar tapped for electrical & thermal energy requirements of tea processing b) new energy conservation interventions in tea processing and transportation. This is a very promising concept and efforts should be made to further develop this concept.

8. ANNEXES

8.1 ANNEX A - Mission Terms of Reference (ToR) for Project Final Evaluation

Post Title: *International Consultant for TERMINAL Evaluation (TE)*

Project name: *Project 3163 Energy Conservation in Small Sector Tea Processing Units in South India*

Duration: *25 working days*

Duty Station: *Home Based consultancy with travel to sites*

1. BACKGROUND

In the thematic area of "Energy and Environment", UNDP works in close alignment with the National Action Plan for Climate Change (NAPCC) on energy efficiency and renewable energy. On these sub-themes, UNDP works with various stakeholders including national and state governments, local governments, community institutions, NGOs, technical support agencies etc. On energy efficiency, the context of this assignment, UNDP works on specific sectors/technologies with major energy consuming industries and on major uses such as electricity and transportation.

One such project under the Climate Change portfolio of the E&E unit is on ***Energy Conservation in Small Sector Tea Processing Units in South India***[31]***.*** It was conceptualized for the tea industry in southern states of Tamil Nadu, Karnataka & Kerala.

India is the largest tea producing country in the world. South India is the focus of attention of the project and produces 203 million tonne of tea annually which is 24% of the national annual production. There are 350 tea factories in South India with 125 of those belong to the small sector. The tea industry is going through a crisis where the small growers and processors are hit the hardest.

Tea processing is energy intensive with energy costs contributing to 30% of the total processing cost. All tea factories rely heavily on biomass to meet their thermal energy requirements. Energy audit data indicates that 0.5 kWh of electrical energy and 1.5 kg of firewood are consumed to produce 1 kg of made tea. This translates into an annual consumption of 435 million units of electricity and 1.3 million tonne of firewood. Energy audit data also suggests that it is possible to save 20% each of electrical and thermal energy. Energy efficiency interventions in the tea sector have the potential to conserve 87 million units of electricity and 0.26 million tonne of firewood annually. Energy conservation is highly prioritised by Government of India as India is an importer of energy. In addition to achieving energy efficiency, the tea industry has also identified quality in all aspects as the key in overcoming the crisis. To supplement the endeavours of the tea industry, the Tea Board, under the Ministry of Commerce and Industry (MoCI), has launched a Quality Up-gradation Program aimed at the small sector in tea growing areas in South India which is the focus of this project.

The project aims to introduce energy conservation measures in the firewood intensive tea sector in the region by addressing awareness, technology, and financial barriers that stand in the way of greater adoption of energy conservation technologies and practices. Its primary objective is to reduce energy consumption and thereby reduction in GHG emissions in tea processing units. Reduced energy consumption would also lead to achieve market competitiveness of tea processing units. It will pave the way to develop replicable strategies for energy efficiency and energy conservation interventions in the tea processing industry.This is a medium sized project with project implementation duration of four years, and funded by the Global Environment Facility (GEF). In

[31] For more details about the project, please visit http://www.encontea.org/ or http://www.undp.org.in/sites/default/files/7-Energy-Conservation-in-Small-Sector-Tea-Processing-Units-in-South-India.pdf.

accordance with UNDP/GEF monitoring and evaluation (M&E) policies and procedures, all regular projects supported by the GEF should undergo a mid-term review (MTR) and terminal evaluation (TE). GEF's policy with respect to evaluations has been updated in 2010[32].

This ToR details the activity of TE, which is intended to assess the relevance, performance and success of the project. It will analyze the project impact and sustainability of results, including the contribution to capacity development, development dividends[33] and the achievement of global environmental benefits. It will also identify/document lessons learnt and provide recommendations that might improve design and implementation of other UNDP/GEF projects. ***The evaluation team will comprise of an international and a local consultant.***

2. SCOPE OF WORK, RESPONSIBILITIES AND DESCRIPTION OF THE PROPOSED ANALYTICAL WORK

The international consultant will be the team leader and shall coordinate the consultancy to ensure quality of the report and timely submission. The local consultant will provide supportive roles both in terms of professional back up, translation etc.

TE review team shall comment on the following specific issues in addition to project review criteria listed in Annex 1.

1. Policy impact of the project on the decisions of Tea Board and/or Ministry of Commerce and Industries (MoCI), including change in decision making at the MoCI if any happened or envisaged to happen.
2. Whether the performance measurement indicators and targets used in the project monitoring system were accomplished and able to achieve desired project outcomes within July 2012?
3. Did the project made satisfactory accomplishment in achieving project outputs vis-à-vis the targets and related delivery of inputs and activities?
4. How effective is the project in terms of
    - Supporting and facilitating tea industries in moving towards low carbon pathways?
    - Strengthening local capacities in the design and implementation of energy efficiency interventions in tea industries
    - Will the project be sustainable on its conclusion and stimulate replications and its potential?
5. Appropriateness of the institutional arrangement and whether there was adequate commitment to the project.
6. Is technical assistance and support received from project partners and stakeholders appropriate, adequate and timely?
7. What was the impact of (a) Tea Board subsidy, (b) effectiveness of energy audits and implementation of recommendations, (c) effectiveness of risk mitigation measures, (d) implementation of alternate technologies & fuels, and (e) perceptions of the tea industry in use of renewable energy options?
8. What was the additional co-financing amount that was leveraged by the project and mobilized private sector investments?

[32] Refer to http://www.thegef.org/gef/node/4184 for more information.

[33] "Development dividends" 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.

9. How effective was the adaptive management practiced under the project and lessons learnt?
10. Details of co-funding provided (GoI subsidies, Tea Board activities and others) and its impact on the activities. A “Financial Planning Co-financing” format in Table A1 of Annex I for reporting.
11. How does the APR/PIR process helped in monitoring and evaluating the project implementation and achievement of results?
12. 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?
13. Assess the use of electronic information and communication technologies in the implementation and management of the project such as impact of the quarterly project newsletter and Encon website.
14. Source the required information and complete the tracking tool as required by the TE for climate change mitigation projects.
15. Utilization of resources (including human and financial) towards producing the outputs and adjustments made to the project strategies and scope.
16. 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 terminal review stage.
17. Spin offs created by the project, if any, as a result of the project, the linkages brought with other partners/Ministries (especially the Ministry of New & Renewable Energy) and their impacts on the overall outcomes.
18. In summary, the TE team must include the following points in their final report.
    - Conclusions on the findings, observations and results of TE
    - Lessons learnt and best practices that can be developed from these conclusions

3. MANAGEMENT ARRANGEMENTS

Throughout the period of evaluation, the evaluation team will liaise closely with the UNDP Country Director/Assistant Country Director/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 fulfil its task, the team, however, is not authorized to make any commitments to any part on behalf of UNDP/GEF or the Government.

Logistics

The team will conduct a mission visit to New Delhi, Coonoor & Valparia (via Coimbatore), to meet with relevant project stakeholders. This visit will also include meetings with the officials of UNDP, the Implementing Agency (Tea Board) at Coonoor, Technology Informatics Development Endeavour (TIDE), stakeholders of the tea industry related to the project and financial institutions.

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

4. REVIEW METHODOLOGY

The international consultant will be the team leader and coordinate the consultancy to ensure quality of the report and timely submission. The local consultant will provide supportive roles both in terms of professional back up, translation etc. The TE Team is expected to become well versed as to the project objectives, historical developments, institutional and management mechanisms, activities and status of accomplishments. Information will be gathered through document review, group and individual interviews and site visits. Validation of preliminary findings/reports with stakeholders will happen through circulation of initial reports for comments or other types of feedback mechanisms.

The evaluation team will conduct meeting with the project team including National Project Director (NPD), National Project Manager, Lead Consultants and, experts to be followed by an "exit" interview to discuss the findings of the assessment prior to the submission of the draft final report.

Prior to engagement and visiting the Project Management Office, the TE Team shall receive all the relevant and available documents including at least:

- Project Document
- Inception Workshop Report
- Annual Work and Financial Plans
- Annual Project Report/Project Implementation Review (API/PIR) for 2010, and 2011;
- Quarterly Reports
- Minutes of National Steering Committee/Project Steering Committee meetings
- Back-to-Office Reports of UNDP staff and PMC staff (if any)
- Study reports/Conference proceedings/government guidelines, etc.

To provide more details, as may be needed, the following will be made available for access by the TE Team:

- Terms of Reference for past consultants' assignments and summary of the results
- Past audit reports

The TE Team should at least interview the following people, but not limited to:

- National Project Director
- National Project Manager (NPM)
- Project Administrative Officer
- Project Financial Officer
- Project Management Unit/Board Members
- Relevant project stakeholders, and personnel, but not limited to:
    - Tea Board
    - Ministry of Commerce and Industry (MoCI)
    - Ministry for Environment and Forests
- Lead Project Consultant(s), where applicable
- Research institutions and Experts in the country, where applicable
- Relevant personnel at UNDP Country Office in India and Program Officer in-charge of the Project

The consultants should provide details on the (a) documents reviewed and brief summary of them in an annexure, (b) interviews and brief summary where relevant, (c) field visits and brief summary in annexure or where relevant, (d) questionnaires, if any, (e) participatory techniques and other approaches for gathering and analysis of data; and (f) participation of stakeholders and/or partners.

5. REVIEW TEAM

The TE Team will be composed of one International Lead Consultant and one National Consultant. With the aim of having an objective and independent project review, the TE Team is expected to conduct the project review according to international criteria and professional norms and standards as adopted by the UN Evaluation Group. The individual experts in the Team needs to have good technical knowledge of the EE and climate change projects and national context of EE project and program implementation in India, must be independent with no conflict of interest (i.e. not involved in the development or management of the project), possess good evaluation experience, and writing skills to carry out the assignment.

The allocation of tasks in the execution of this TOR shall be decided mutually between the International and National consultants.

At the minimum, the International Consultant of the TE Team shall have the following professional background and responsibilities:

International Lead Consultant

Profile

- Post-Graduate in Engineering, Management or Business
- Minimum of ten years accumulated and recognized experience in energy efficiency and climate change projects
- At least 3 years technical experience in energy efficiency and process engineering or operations. Experience in specific to small and medium enterprises (SME) in tea industry is advantageous.
- Minimum of five years of project evaluation and/or implementation experience in the result-based management framework, adaptive management and UNDP or GEF Monitoring and Evaluation Policy
- Demonstrated ability to assess complex situations, succinctly, distils critical issues, and draw forward-looking conclusions and recommendations.
- Ability and experience to lead multi-disciplinary and national teams, and deliver quality reports within the given time.
- Familiar with developing countries context or regional situations relevant to that of India.
- Experience with multilateral and bilateral supported EE/RE and climate change projects.
- Comprehensive knowledge of international EE/RE industry best practices.
- Very good report writing skills in English

Responsibilities

- Documentation of the review
- Leading the TE Team in planning, conducting and reporting on the review
- Deciding on division of labor within the Team and ensuring timeliness of reports
- Use of best practice review and evaluation methodologies in conducting the evaluation
- Leading presentation of the draft review findings and recommendations in-country
- Conducting the debriefing for the UNDP Country Office in New Delhi and Project Management Office
- Leading the drafting and finalization of the TE Report
- Validate and complete appropriate sections in tracking tool for terminal results of climate change mitigation projects

The members of the Team must be independent from both the policy-making process and the delivery and management of the UNDP/GEF assistance. Therefore, candidates who had any direct

involvement with the design and implementation of the project "Energy Conservation in Small Sector Tea Processing Units in South India" will not be considered.

6. TE SCHEDULE AND DELIVERABLES

The TE field visit to meet with the project stakeholders will commence on 02nd July 2012. A review report will be produced not later than 24th July 2012. The report shall highlight important observations, analysis of information and key conclusions including its recommendations as mentioned earlier. Based on the scope of the TE described above, the review report will include, among others:

- Findings on the project implementation achievements, challenges, difficulties, and adaptive management practiced to date;
- Assessments of achievements towards the attainment of outcomes;
- Recommendations for modifications and the future course of action if a similar project is initiated in future elsewhere;
- Lessons learnt from the project structure, and experience of the implementation;
- Qualitative assessments of the study reports generated and other project relevant documents reviewed for the evaluation.

The report will be initially shared with the National Project Director (NPD) and National Project Manager (NPM) to solicit comments or clarifications and will be presented to the UNDP Country Office (CO) in New Delhi for further deliberations. Consequently, the final TE Report (in three copies) will be made and submitted to the UNDP CO with a copy furnished to the Executing Partner of the project.

There will be two main deliverables:

- Based on agreed TE work plan, the consultant should provide TE report, including an executive summary, fulfilling the review requirements set out in this Terms of Reference (TOR). The final report is to be cleared and accepted by UNDP CO in New Delhi before final payment. The final report (including executive summary, and annexes) should not exceed 50 pages.

  The review 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. Conclusions on the findings, observations and results of TE
  7. Lessons learned
  8. Recommendations
  9. Annexes

More guidance on the GEF project review criteria and explanation of terminology provided in the Annex 1.

- A power-point presentation of the findings of the review. Depending upon the complexity of the review findings, UNDP CO in New Delhi may consider organizing a half-day stakeholders meeting at which to make a presentation to the partners and stakeholders.
- Soft copies of all documentations procured as part of the study (if only hard copies are available, hard copies or scanned soft copies can be given) on a CD or through appropriate e-mail to UNDP.

7. 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.

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

8.2 ANNEX B - Terminal Evaluation Mission Programme

Monday , 6th August 2012			Accompanied by
1	10 00 h	Briefing by Dr. S. N. Srinivas & Ms. Chitra Narayanswamy at Hotel Lemon Tree at Chennai: Opening discussion, brief presentation about the project objective, goals, activities, results and methods adopted. Also handing over of relevant project documents to the evaluation team.	
2	12 30 h	Opening Meeting with Ms. Svati Bhogle, TIDE, and Dr. Sethumadavan, Anna University at Anna University Guest House, Chennai	
3	15 00 h	Meeting with Mr. R. Muralikrishna, Concept 4 E at Anna University Guest House, Chennai: Mr. Muralikrishna is a supplier of LED lights to the tea sector	
4	16 00 - 20 00 h	Travel: Chennai to Coimbatore	
Tuesday , 7th August 2012			
1	10 00 - 11 00 h	Travel by road to Valparai • Visit to briquetting unit of Jayshree briquetting plant (enroute to Valparai) Meeting with Mr. Ravindranathan, Jayshree Biomass Briquette Factory	Mr.S.Mani-gandan (UPASI)
2	15 00 - 18 30 h	• Visit to Thaymudi tea factory, meeting with officials of BBTC. Mr. Leonit Shaji (BBTC) and Mr. V. Suresh Menon (General Manager, BBTC)	
3	Night halt at BBTC guest house (Valparai)		
Wednesday , 8th August 2012			
1	08 00 -12 00 h	Travel from Valparai to Coimbatore by Road.	
2	14 00 -17 00 h	Meeting with equipment suppliers/manufacturers at Hotel Annapoorna, Coimbatore - Hot water generator (Mr. M. Udaya Kumar & Mr. V. Suresh Kannan,Thermo Solutions(India) Pvt. Ltd) - Flat belt drives (Mr. K. Sivakumar & Mr. A. Shanmugam, ELGI ULTRA Industries Ltd - Dual speed motors, ID/FD fan controllers, SCADA system for collecting plant operation data (Mr. P. R. Senthil Kumar, Instrument Automation)	Mr.S.Mani-gandan (UPASI)
3	17 30 - 20 00 h	Travel from Coimbatore to Coonoor by road.	
Thursday , 9th August 2012			
1	09 15 - 10 30 h	Meeting with Mr. R. Ambalavanan, Executive Director, Tea Board & NPD UNDP-GEF Tea Project at Tea Board office, Coonoor	
2	10 45 - 11 15 h	Meeting with Mr. Ullas Menon, Secretary General, UPASI & PSC member at UPASI office, Coonoor	
3	11 15 - 12 45 h	Visit to the TIDE project office; UPASI energy lab; Meeting with Mr. Manigandan, Dr. G. Rudramoorthy, Scientist and Technical Advisor & PSC member	
4	14 00 - 17 00 h	Visit to Havukal tea factory and meeting with Mr. Surendra Mohan, Plant Manager	
		Friday , 10th August 2012	
1	09 30 -15 00	Work by the TE team on the findings &	

		recommendations for presentation	
2	15 30 – 16 00	Telecom with ACD & Head, EEU at UNDP, New Delhi Mr. Srinivasan Iyer	
Saturday , 11th August 2012			
1	13 00 - 15 00 h	Presentation of the initial findings & recommendations to UNDP, Tea Board, TIDE and members of the Technical Advisory Committee (TAC)	

8.3 ANNEX C - List of persons interviewed

1. Mr. R. Ambalavanan, Executive Director, Tea Board & NPD UNDP-GEF Tea Project
2. Mr. Srinivasan Iyer, ACD & Head, EEU,UNDP, New Delhi
3. Dr. S. N. Srinivas, Programme Officer, Energy & Environment Unit, UNDP
4. Ms. Chitra Narayanswamy, Programme Associate, Energy & Environment Unit, UNDP
5. Ms. Svati Bhogle, Project Manager, TIDE
6. Dr. R. S. Madhavan, Ex-Director I&M, EnConTea Project & Professor, Institute for Energy Studies, Anna University
7. Dr. G. Rudramoorthy, Scientist and Technical Advisor, UPASI
8. Mr. Ullas Menon, Secretary General, UPASI
9. Mr. S. Manigandan, UPASI energy lab
10. Mr. Muralikrishnan R, CEO, Concept 4E
11. Mr. P. R. Senthil Kumar, Instrument Automation
12. Mr. Leonit Shaji, Plant Manager, BBTC Thaymudi tea factory
13. Mr. V. Suresh Menon, General Manager, The Bombay Burmah Trading Corporation Ltd.
14. Mr. Udayakumar, Director, Thermo Solutions
15. Mr. V. Suresh Kannan, Director, Thermo Solutions
16. Mr. A. Shanmugam, Jr. Officer-Marketing, Elgi Ultra Industries Ltd.
17. Mr. K. Sivakumar, AGM-Marketing, Elgi Ultra Industries Ltd.
18. Mr. Surendra Mohan, Plant Manager, Havukal tea factory
19. Mr. Ravindranathan, Jayshree Briquette Factory

Persons met during the presentation of findings:

1. Mr. Boriah, Director Technical, Tea Board of India

8.4 ANNEX D - Summary of observations from discussion with project team and field trips

8.4.1 UNDP-India Program Officer

A kick-off meeting and briefing for the TE team was presided by the Programme Officer Dr. S.N. Srinivas, and Programme Associate Ms. Chitra Narayanswamy of Energy & Climate Change, Energy and Environmental Unit of UNDP-India.

Project development phase was long and extended to 3 years. One of the important landmark during the project development phase was Ministry of Commerce and Industry and the Tea Board agreeing to take up the role of implementing partner.

During the project implementation, the project was struggling for gaining confidence of the tea industry on technical issues. The turning point in the project came with the joining of Prof. Sethumadhavan and the establishment of a technical team at Coonoor during the 2nd year. The project developed credibility around the technical strength and dedication of the project team.

The project has been a good example of adaptive management. During the project implementation, the list of technology interventions were revised; the concept of risk guarantee fund did not work and so was abandoned; technical support was found critical so was enhanced and new activities on briquettes, test labs and subsidy for HWG were added.

One of the major achievements of the project was that instead of the original target of 30 units, the interventions were implemented in more than 200 units. The CO_2 emission reduction target was exceeded and interaction with suppliers resulted in specific products being made available to the tea industry.

As a consequence, a total 3,000 interventions were identified of which 1,000 interventions were actually implemented during the four-year duration, and a balance of 2,000 interventions are in the pipeline for future implementation by the tea industry with or without assistance from the government and UNDP.

The project exit strategy in terms of local institution is built around UPASI energy lab. The TE team should look into the sustainability of lab.

The spin-offs of the project are:

- New project being planned with Tea Board funding routed through UNDP in Assam
- Development of concept of “Zero Carbon” tea
- Institutions of awards by Tea Board for energy conservation
- Tea Board being made a nodal agency of the implementation of MNRE programmes.

8.4.2 UNDP-India Assistant Country Director & Head

On the morning of Saturday before the afternoon presentation of the initial findings of the TE team to the UNDP and Tea Board, a conference call was arranged with the UNDP Assistant Country Director & Head Mr. Srinivasan Iyer. The TE team presented verbally the main findings, conclusions and recommendations of the terminal review, including the team’s initial rating.

Mr. Iyer was in general agreement with the evaluation results and the team further made greater appreciation of the work done with respect to stakeholder participation, which he believes is more than satisfactory. He also emphasized that the regional UNDP is keenly watching this project as it has blazed a trail in terms of cooperation among the stakeholders from private sector, government and international institutions, adaptability at the early stage to ensure that it is facing the right direction by putting more emphasis on technical barriers than financial barriers, establishing the fuel testing laboratory to ensure quality biomass fuels are available and valued correctly according to its energy content, and raising the competence of the audit teams with the help of academic experts rather than on ESCO external service providers.

The confidence and expertise of the TIDE and UPASI audit teams were raised so much so that the tea industry and its factory staff cooperated well during the conduct of the energy and process audits as well as implemented EC/EE/RE interventions using their own capital while awaiting possible subsidy from the Tea Board Up-gradation and Product Diversification Scheme (QUPDS) after having reduced the risks associated with energy cost savings thru detailed energy audits.

8.4.3 LED from Concept 4

Mr. Muralikrishna of Concept 4 represents a company that is supplying LED lighting systems to Tea industry. The company came in contact with Tea factories in September 2010 through the UNDP-GEF project. Since then in last one year, they have made a sale of LED lights worth INR 2 million (USD 40,000) amounting to installed capacity of around 7 kW to the tea industry.

One of their first customers was Tea Board, who has up till now replaced almost 85% of the lights in their Coonoor office with LEDs. The company is selling products, both for indoor lighting as well as outdoor lighting (street lights). The typical price of a LED street light of 40 W (which can replace a conventional 250 W street light) is INR 25,000 with a pay-back period of around 2 years.

8.4.4 Briquetting Factory

Along the way to the Thaymudi tea factory in Valparai, the TE team accompanied by Mr. interviewed Mr. Ravindranathan of Jayshree Biomass Briquette Factory. The factory is located at Alangandi and has the capacity to produce around 20 tonnes/ day (12 hours operation/day) or around 6,000 tonnes briquettes/ year. Almost 90% of the production is used in two tea factories of the Jayshree group while remaining excess production is sold to other tea factories.

The production process consists of three main operations: drying of sawdust; mixing and briquetting; packing and storing. The sawdust received can have moisture content of up to 40%; the sawdust is dried in a dryer to 7-8% moisture content. The typical briquetting mix consists of: Sawdust (60%) + Coffee husk (20%) + Tamarind husk (3-10%) + ground nut shell (10%). The gross calorific value (GCV) of the briquettes range from 4,000 to 4,300 kcal/kg. The purchase price of biomass raw-materials is given in the Table 8.1 while the price of the briquettes is INR 5,000/ tonne + INR 600/tonne (transportation within 70 km):

Table 8.1: Price of Biomass Raw Materials

Biomass Raw-material	INR/tonne
Saw dust (40% moisture)	1,700 -1,800
Ground nut shell	2,000
Tamarind	1,400

Coffee husk	2,000
Fuel for drier (Firewood)	4,000
Fuel for drier (Coconut leaves)	INR 1.40/leaf

The main elements of economics of the plant are given Table 8.2 below:

Table 8.2: Some of the Economic Parameters of a Briquetting Plant

Total investment	INR 15 million (civil + machines+ office+ electricity connection + weigh bridge + water tank + initial inventory)
Electricity	Connected load of the factory: 110 hp 600 kWh/day @ INR 5.5 /kWh
Workers	▪ 18 workers x 2 shifts/day x INR 225/worker/day ▪ 1 supervisor x INR 9,000/month ▪ 4 mechanics x INR 12,000/month ▪ 1 in-charge x INR 19,000/month
Maintenance	▪ The die holder is sent for rebuilding after every 60 hrs of operation (5 days of operation) ▪ 60 L oil change after every 2 months @ INR 200/L

Support provided by the UNDP-GEF project consisted of

- Knowledge support for setting up the unit
- INR 0.5 million as financial support (grant)
- Laboratory support for the testing of biomass feedstock and finished briquettes.

8.4.5 Thaymudi Tea Factory in Valparai

Upon reaching the high mountain animal sanctuary of Valparai, the TE team interviewed Mr. Leonit Shaji and Mr. V. Suresh Menon of BBTC. The factory is owned by The Bombay Burmah Trading Corporation (BBTC) Ltd. As per the factory management, the total investment in energy efficiency and renewable energy options during last 2-3 years is of the order of INR 30 million.

The energy-efficiency measures include:

- ID/FD fan controller
- Section-wise electric meters
- APFC panels
- Security lights – LEDs
- Hot water generator
- Energy efficiency motors
- Flat belt drives in place of v-belt drive

The renewable energy options include:

- BBTC owns 12 wind mills (12 x 225 kW = 2.7 MW) since mid-1990's
- The factory has recently started construction of a biogas plant of 400 m^3/day capacity. The idea for the biogas came after visiting TEDA renewable energy exhibition at Chennai on invitation of TIDE. BBTC has already installed a 400 m^3 plant in their Coffee factory. The feed for the biogas plant is likely to be tea

waste/washing and cattle dung. The factory plan to use biogas for running a 180 kVA generator set for 8-9 hrs/day. During last year they generated 15% electricity through DG sets.

The factory also houses one of the fuel test labs established under the project. The management was highly appreciative of the UNDP-GEF project as it has given a firm action plan to the desire of the management for resource efficiency and environment protection. The lab has helped in monitoring the quality of fuel purchased by the factory as well as near-by tea factories. One of the specific contribution of the UNDP-GEF project is its work with equipment suppliers to facilitate development/ introduction of right-sized/appropriate products for tea industry e.g. small-sized Hot Water Generators.

8.4.6 Hot Water Generators of Thermo Solutions

Upon its return to Coimbatore from the high mountains of Valparai, the TE team interviewed in sequence three (3) equipment suppliers, the first of which were Mr. M. Udaya Kumar and Mr. V. Suresh Kannan of Thermo Solutions (India) Pvt Ltd).

Thermo Solutions (India) Pvt Ltd manufactures a variety of products which includes thermic fluid heaters, hot water generators and steam generators. For the tea industry, Thermo Solutions provides Hot Water Generators (0.5 to 2.5 million kcal/hr) capacity. The company has supplied two Hot Water Generators to Woodbridge Tea Industry (tea estate) and Selvaganapathy (bought leaf factory). The price of Hot Water Generators ranges from approximately INR 3.5 million (0.8 million kcal/hr) to INR 6.5 million (2 million kcal/hr). As per their estimation, the potential fuel savings by replacing conventional hot air dryers with hot water generators is about 50%. Such savings are possible because of faster and more efficient heat transfer between flue gas-water fluids and lower pressure drop and material losses in piped hot water than in ducted hot air.

They are hoping to get 4 new orders for hot water generators from tea industry during this financial year. They were introduced to Tea Industry through the Executive Director, Tea Board and TIDE. They appreciated the work of the project in increasing awareness amongst tea factories about energy efficiency as well as providing independent technical support for selection of equipment. The company now sees the tea industry as one of its main market in coming years contributing to around 30-40% of their total annual sales.

8.4.7 Dual speed motors and ID/FD fan controllers of ELGI

The next persons to be interviewed by the TE team in their hotel at Coimbatore were Mr. K. Sivakumar and Mr. A. Shanmugam of ELGI ULTRA Industries Ltd.

ELGI ULTRA Industries supplies flat belt drives to tea industry. The company already had a few clients (around 5) in tea industry before the inception of the project. The project activities have helped in expanding its market. Now, 60-70 tea factories are using flat belt drives. The project has helped in quantifying the electricity savings through independent energy audits. The company estimates that their annual sale to tea industry was around INR 20 million/year, which is 5% of their total sales.

8.4.8 SCADA system for collecting plant operation data of Instrument Automation

The last person to be interviewed by the TE team was Mr. P.R. Senthil Kumar of Instrument Automation). The company is primarily an instrumentation company. It has developed two products for the tea industry (dual

speed ID fan and SCADA system). The company was already providing instrumentation and technical support to tea industry before the project.

The company supplies dual speed (3 hp/ 5 hp) motors for ID fan of hot air generator. The company has so far supplied these motors to 6 industrial cooperative tea factories and is planning to supply to 10 more such factories.

The company has recently installed a SCADA system for on-line monitoring of tea production process. The system can potentially be also used for energy management in the tea industry. The system cost for a tea factory is around INR 0.3 to 0.4 million.

8.4.9 Executive Director, Tea Board & National Project Director

According to Mr. R. Ambalavanan, the UNDP-GEF project has been a very successful project. It also has been a great learning for Tea Board on two counts: (1) It has focussed attention on the issue of energy which is an important input in tea production; and (2) The approach used by the project could be replicated to launch initiatives on water or overall resource efficiency in tea industry. Working in the time-bound project mode has helped in achieving the results.

Tea Board has played the role of sheet anchor and was critical in providing access to tea industry. Continuous monitoring of the project at the highest level in Tea Board has ensured timely execution of the project. The project has provided an opportunity to tea industries to share best practices in the field of energy efficiency and renewable energy in tea industry.

Tea Board sees a large potential for renewable energy in the tea industry and would be happy if a follow-up project with a focus on renewable energy is planned. On the issue of delay in subsidy under QUPDS scheme, he informed that during last two years, Tea Board has taken steps to simplify and fast track the process of delivery of subsidy. He also informed that to promote innovation and best practices, Tea Board has also constituted awards for tea industries.

8.4.10 Secretary General, UPASI & Member, PSC

Mr Ullas Menon has opined that the project has been a success and had a positive impact on the tea industry. He was also appreciative of the effort of KVK scientists at UPASI who worked with the UNDP-GEF project team for the success of the project. He was confident that UPASI would be in a position to continue the work on energy conservation through its existing manpower, but if there are any new staff requirements, suitable funding sources needs to identified. In his opinion, retaining technical manpower in Bought Leaf factories is an issue, which requires setting up of suitable training facilities for training workers on a continuous basis.

8.4.11 TIDE Project Office and UPASI Energy Laboratory

A meeting was also held with Mr. Manigandan and Dr. G. Rudramoorthy, Scientist and Technical Advisor & PSC member of the project. Dr. Rudramoorthy has a very long experience of working on tea processing technologies. He informed that his team has carried out an independent evaluation of energy conservation measures implemented. In his opinion, ID fan regulator for hot air generators, is a low cost, high impact technology. Hot Water Generator is more viable for large tea factories producing more than 2 million tons of made tea.

Regarding the sustainability of the fuel test lab and energy centre which now has been handed to UPASI, he informed that he would be giving around 10% of his time, while Mr Manigandan would be devoting 100% of his time. The energy centre in all has 30 instruments and equipment needed for conducting energy audits and fuel testing for calorific value, ash content and moisture content (worth INR 750,000). He was quite confident that the existing funds of INR 110,000 (collected as fuel test charges in the past) and new funds collected from fuel testing, would be sufficient for meeting the expenses related with consumables, maintenance and calibration of the instruments. However, the fuel test charges will not be sufficient for meeting the salary of an additional person like Mr Manigandan and would require provision of an additional amount of INR 250,000 – 300,000/year. The test lab cum energy centre would have to look at new ways of generating revenue which can potentially come from: (1) Equipment testing fee collected from testing of performance of any new energy efficient equipment to be sold to tea industries (Dr Rudramoorthy was of the opinion that the Tea Board/ UPASI should make it mandatory for any new equipment to get the performance certified by the energy lab); (2) Paid energy audit service; and (3) Charging an annual rent for exhibition of posters and other information in the energy centre. The issue of sustainability of the test lab cum energy centre is an important issue which needs urgent attention of TIDE, Tea Board and UPASI.

8.4.12 Havukal Bought Leaf Tea Factory in Coonoor

Finally, the TE team visited the Havukal tea factory and met with Mr. Surendra Mohan, Plant Manager. Havukal gets around 20% of the supply of tea leaves from its own fields, and remaining 80% from farmers but exports almost 90% of its produce. Mr Surendra Mohan was very appreciative of the efforts of the UNDP-GEF project.

In his opinion, this is one of the best projects of Tea Board in last 40 years. Havukal had one of the lowest energy consumption among South Indian tea factories when the energy audit was carried out. Despite already being energy efficient, the factory has gone ahead and has implemented measures worth around INR 10 million due to project initiatives. This also includes a Hot Water Generator system.

Havukal also has 2 wind mills, has experimented with solar air heaters in the past and now has plans to experiment with solar water pumps (being demonstrated through UNDP-GEF project). Perhaps its being successful in exporting over 90% of its produce is an indication of its competitiveness arising from its low energy consumption.

8.5 ANNEX E - List of documents reviewed

Internal:

1. *Project Implementation Review Report (2009, 20010, 2010, 2012 APR/PIR as of 30 June of each year)*
2. *Government of India and UNDP/GEF Project Document – Energy Conservation in Small Sector Tea Processing Units in South India, New Delhi September 2007;*
3. *Project Implementation Review Report for the project period. Minutes of National Steering Committee/Project Steering Committee meetings;*
4. *Back-to-Office Reports of UNDP staff*
5. *Terminology in the GEF Guidelines to Terminal Evaluation and the Project Review Criteria – part II, Annex 1 of this TOR.*
6. *Annual work plans for the project period (2008, 2009, 2010, 2011, 2012)*
7. *EnConTea Newsletter Issues 1-15*
8. *Combined Delivery Report by Activity with Encumbrance for the project period Quarterly Progress Reports for the project period Process document on Energy Conservation in small sector tea processing units in South India*
9. *Energy Conservation in Tea Manufacture, by Tea Board & UPASI- Krishi Vigyan Kendra*
10. *Impact Analysis in CTC/Orthodox tea factories, Anna University*
11. *Consolidation of detailed energy audit reports, Anna University*
12. *Video films*
13. *Proceedings of the project inception workshop*

8.6 ANNEX F - Assessment of Progress and Ratings (as of 30 June 2012)

Strategy	Objective, Outcome, Output, Activity & Sub-Activities	Observations & remarks of the TE Team
Objective	To remove barriers and develop replicable strategies for energy efficiency and energy conservation interventions in the tea processing industry in South India	Overall, the project is ***highly satisfactory*** with respect to meeting the main project objective of removing barriers and developing replicable strategies for energy efficiency and energy conservation interventions, including renewable energy solutions, in the tea processing industry in South India.
	30 tea processing units in South India adopt energy efficient equipment and practices within the project period resulting in cumulative savings of 56,925 tons of direct CO_2	1. The project has reached almost all 266 tea factories in South India. 2. Project has conducted 266 preliminary audits and 95 detailed audits and more than 100 post audits monitoring of implementation. 3. A total of 106 performance studies were made to quantify and demonstrate benefits of implementing EC/EE measures. 4. Based on post implementation audits on 86 tea factories, the project has accumulative energy savings equivalent to 282,845 tons of direct CO_2. (See Table 4.3b)
Outcome 1	Awareness creation among the target sector about energy efficiency / renewable energy technologies and their relation to profitability	Outcome 1 has been ***highly satisfactory*** for creating widespread awareness through seminars, meetings, newsletter, video films and web-site about energy efficiency and renewable energy. This awareness creation, however, was not successfully institutionalized at the Tea Board at post-project period. Plans were made, however, to keep the knowledge and expertise resident at the UPASI Laboratory with some assistance from TIDE staff to be funded from UPASI laboratory fees due from fuel testing and energy audit services.
	1. Project brochure, publicity material created by the project, brochures of equipment manufacturers, information on Tea Board schemes mailed to each tea factory in South India in the first year	The project conducted around 35 awareness seminars, training programmes, 15 meetings on information barriers were held which was able to reach almost all 266 factories in South India. A total of 15 quarterly newsletters were printed and disseminated during annual events of the Tea Board. The circulation which was initially 500 was increased to 1,000 copies at the end of 2009.
	2. Content developed and website of the project launched in the first year	Project website (www.encontea.org) was launched in the 3rd quarter of 2009 and updated regularly with relevant information.
Output 1.1	Awareness about energy efficiency / renewable energy technologies and relevance to tea units and implications of their adoption.	About 100 one-to-one meetings were held between owners and experts on EC/EE interventions which have contributed to the high adoption rates of EC/EE measures in more than the target level of 30 factories.
Output 1.2	Institutionalized mechanisms for knowledge creation and management.	The project has succeeded in setting up of an awareness creation vehicle and strategy to provide institutionalized mechanisms for knowledge creation and management that can be used by the tea industry beyond the project period and launch a project website that is regularly updated.
Outcome 2	Elimination of financial barriers that inhibit	Outcome 2 is ***highly satisfactory*** since the project successfully facilitated the access to Tea Board subsidy

	investment in energy conservation equipment	available under QUPDS; however, for most part of the project, the disbursement of the subsidy was delayed and remained erratic while the risk insurance scheme were not developed nor operationalized. Instead, the project team used detailed energy audits as well as post-implementation audits to verify energy savings, enhance confidence and reduce technical risks that resulted in the tea factory management and shareholders investing with their own funds and/or secure Tea Board subsidy and bank debt financing.
	1. Estimation of extent of new investment in energy efficient technology annually from the second year	By fully understanding their needs and investigating energy conservation opportunities arising from detailed energy audits which the project provided, there was a steady stream of financeable projects from the 2nd year onwards as technical risks were ably mitigated by the detailed energy audits and further confirmed by post-audits to verify their effectiveness leading further to increased confidence in such projects.
Output 2.1	Institutionalization of commercial lending for investments in energy efficiency / renewable energy equipment	The target of leveraging the capital of the tea factories with funds from the Tea Board subsidy and commercial lending and operationalizing a risk insurance scheme may not have been achieved fully as envisioned during the project preparation phase. Towards the end of the project, the Tea Board has suspended accepting fresh applications for availing the 25% subsidy (factory provides 75% of project cost) while awaiting fresh funds from the 12th five year plan. The project had aimed at increasing commercial borrowing by tea factories; however, most tea factories have opted for equity investments and the commercial borrowing has remained low. The 25% subsidy granted by the Tea Board through the project also created a new thrust in the area of Hot Wager Generator (HWG), briquetting unit and thermal gasifier.
Output 2.2	Development and operationalization of the risk insurance scheme	The budget provided for developing the risk insurance scheme which was not operationalized was used instead to provide incentives in the form of small upfront subsidies to 3 BL factories for installation of Hot water Generators and 3 factories for setting up of briquetting plants and conducting additional energy audits in order to reduce technical risks rather than financial risks.
Outcome 3	Adoption and procurement of energy efficient / renewable energy equipment / practices	Outcome 3 has been ***highly satisfactory*** since the project was able to organize buyer-supplier meetings and created a directory/catalogue of equipment suppliers that lead to a new market for suppliers in the tea sector. Suppliers established then augmented their capacity for sales and after-sales service to the sector. The development of market-driven enterprise models such as the ESCO model was initiated by the project but efforts to implement ESCO model was not successful. Instead, the project made use of the expertise and facilities of both the TIDE and UPASI to conduct the preliminary and detailed energy audits that were initially assigned to the ESCO service provider.
	1. Measurement of the impact of the various market-driven initiatives taken by the project from the second year	1. The project has provided an excellent platform for suppliers of energy-efficiency equipment and several of them are now active in the region. Several new products are now available in the market such as LED from Concept 4, Hot Water Generators of Thermo Solutions, Dual speed motors and ID/FD fan controllers of ELGI, SCADA system for collecting plant operation data of Instrument Automation 2. The presence of Dr. Sethumadhavan, Director (Implementation and Monitoring) as Head of the technical team at Coonoor (during 2010 and 2011) and the work done by the technical team under his guidance have been

		instrumental in achieving this success since it filled-up the technical vacuum left when the ESCO provider's services were terminated.
	2. Number of factories that have invested in energy efficient equipment, nature of equipment and analysis of the same	To demonstrate replicability, 90 tea factories implemented energy measures with project support and 24 factories without project support for a total of 214 factories investing USD 3.0 million into EC/EE projects of which USD 2.7 million came from the Tea Board and balance of USD 0.3 million provided by tea factory equity and bank debt finance.
Output 3.1	Nurturing the market driven establishment offering all components of energy service to the target sector	Facilitating the creation of a "market driven enterprise" such as the ESCO model was not achieved, but in its stead, the technical staff of the UPASI fuel testing laboratory and that of the responsible party TIDE have ably continued the work of the replaced ELPRO Energy Dimension (ESCO).
Outcome 4	Learning, knowledge sharing and replication	Outcome 4 is also ***highly satisfactory***. The project experiences and knowledge collected, created and organized were documented in the form of newsletters, visual material such as CDs and other knowledge products such as 100 energy audit reports and 100 technical reports documenting post-implementation performance.
	1. Tea Board imbibes the project methodology and extends the same to other tea clusters	After several one to one meetings and meetings in tea clusters, the sector completely imbibes issues on energy conservation. The project accepts a limited request from the sector to look at water conservation issues in the same manner as it has considered energy conservation.
	2. Assessment of how the implementing agency has leveraged the project for its own qualitative and quantitative growth	The subsidy provided by the project of Rs. 2.5 million was able to attract from the tea industry more than Rs 16 million for these interventions and more investments are expected.
Output 4.1	Capacity building of agencies involved to replicated of energy efficiency projects in other areas and sectors	The project has adequately built-up the capacities of Tea Board and UPASI. The Tea Board decision to fund a new project in North East India has a very large replication potential. TIDE, Tea Board and UPASI need to come up with an action plan for the utilization of equipment and human resources available for energy audit and energy conservation activities in Coonoor.

8.7 ANNEX G - Project Planning Matrix (Log Frame from ProDoc and PIRs)

8.8 ANNEX H - Year-wise Implementation Progress (from PIRs as of June 30 each year)

8.9 ANNEX I – Tea Industry Energy Savings Potential (SI Units)

Table 8.3: Indian Tea Industry Energy Savings Potential (SI units)

TOTAL INDIA				
Source of Data	ProDoc (a)	3 Factories (b)	86 Factories (c)	Units
Total India Production	870	870	870	million kgs of tea
Specific Energy Consumption:				
Electrical Energy	0.5	0.78	0.478	kWh per kg made tea
Thermal Energy	1.5	1.83	1.372	kg of firewood
Total Energy Consumption:				
India Electrical Energy	435	679	416	million kWh
India Thermal Energy	1,305	1,592	1,194	million kg
	1.305	*1.592*	*1.194*	*million tonnes*
Energy Savings, %:				
Electrical Energy Savings	20%	8.2%	7.62%	
Thermal Energy Savings	20%	6.2%	19.34%	
Potential Energy Savings:				
India Electrical Energy	87	56	32	million kWh
India Thermal Energy	261	99	231	million kg
	0.261	*0.099*	*0.231*	*million tonnes*
Potential Energy Savings: (MJ)				MJ = mega joules
India Electrical Energy	1,021	653	372	million MJ = TJ = tera joules
India Thermal Energy	4,098	1,550	3,624	million MJ = TJ = tera joules
Total India Energy Savings	5,119	2,203	3,996	million MJ = TJ = tera joules
Electrical energy conversion	3600 11,740	kJ/kWh @ 100% efficiency kJ/kWh	30.66% 11.7398	efficiency of generation (d) plant heat rate, MJ/kWh
Biomass energy conversion	3,750 15,701	kcal/kg @22% moisture kJ/kg	4.1868 15.7005	kJ/kcal @ 100% fuel CV, MJ/kg

SOURCES:
a - ProDoc, Medium-Sized Project Proposal, Request for GEF Funding, Project Summary, p. 3
b - Average of energy audit of 3 factories (Snowdon, Kaikatty, Thaymudi) factfiles.pdf
c - Weighted average of energy audit of 86 factories:
d - http://www.cea.nic.in/reports/yearly/thermal_perfm_review_rep/0607/SECTION-13.pdf

Audited Factories	**CTC**	**ORTHODOX**	**TOTAL**	**Source**
Performance data received	23	7	**30**	From energy audit of 86 Tea factories (See ANNEX J)
Performance data projected	40	16	**56**	
Total Audited	**63**	**23**	**86**	
Tea Production, million kgs	1,072	266	**1,338**	
Specific Energy Consumption:				
Electrical Energy, kWh / kg tea	0.472	0.502	**0.478**	
Thermal Energy, kg FW / kg tea	1.255	1.841	**1.372**	
Specific Energy Consumption:				
Electrical Energy, MJ/kg tea	5.541	5.890	**5.610**	
Thermal Energy, MJ/kg tea	19.702	28.912	**21.535**	
Energy Savings:				
Electrical Energy	8.35%	4.88%	7.62%	
Thermal Energy	21.06%	14.60%	19.34%	

Table 8.4: South India Tea Industry Energy Savings Potential (SI Units)

SOUTH INDIA				
Source of Data	ProDoc (a)	3 Factories (b)	86 Factories (c)	
South India	203	203	203	million kgs of tea
Share of South India	24%	24%	24%	of national production
Specific Energy Consumption:				
Electrical Energy	0.5	0.78	0.478	kWh per kg made tea
Thermal Energy	1.5	1.83	1.372	kg of firewood
Total Energy Consumption:				
South India Electrical Energy	102	158	97	million kWh
South India Thermal Energy	305	371	279	million kg
	0.305	*0.371*	*0.279*	*million tonnes*
Energy Savings, %:				
Electrical Energy Savings	20%	8.2%	7.62%	
Thermal Energy Savings	20%	6.2%	19.34%	
Potential Energy Savings:				
South India Electrical Energy	20	13	7	million kWh
South India Thermal Energy	61	23	54	million kg
	0.061	*0.023*	*0.054*	*million tonnes*
Potential Energy Savings: (TJ)				MJ = mega joules
South India Electrical Energy	238	152	87	million MJ = TJ = tera joules
South India Thermal Energy	956	362	846	million MJ = TJ = tera joules
Total South India Energy	1,194	514	933	million MJ = TJ = tera joules
Electrical energy conversion	3600 11,740	kJ/kWh @ 100% efficiency kJ/kWh	30.66% 11.7398	efficiency of generation (d) plant heat rate, MJ/kWh
Biomass energy conversion	3,750 15,701	kcal/kg @22% moisture kJ/kg	4.1868 15.7005	kJ/kcal @ 100% fuel CV, MJ/kg

8.10 ANNEX J – Summary Data from Energy Audit of 86 Tea Factories

	CTC TEA							
No	**ELECTRICAL Parameter**	**Unit**	**2008**	**2009**	**2010**	**2011**	**2008-2011 Total**	**weighted ave 2012**
1	No of Factories	-	63	63	63	63	63	63
2	Total Tea Produced	kg / y	110,942,680	112,209,614	104,155,427	101,303,370	428,611,091	107,152,773
3	SEC - Unaudited Fac.	kWh / kg TT	50,035,149	51,504,213	49,890,450	50,854,292	0.472	50,571,026
4	SEC - Audited Factories	kWh / kg TT	46,152,155	47,015,828	45,932,543	46,295,640	0.433	46,349,042
5	SEC - Difference	kWh / kg TT	0.035	0.040	0.038	0.045	0.039	0.039
6	Electrical energy Savings	kWh / y	3,882,994	4,488,385	3,957,906	4,558,652	16,887,936	4,221,984
7	CO2 Mitigation Factor	kg CO2 / kWh	0.9	0.9	0.9	0.9		0.90
8	Total CO2 Mitigated	tons / y	3,495	4,040	3,562	4,103	15,199	3,800
No	**THERMAL** Parameter	**Unit**	**2008**	**2009**	**2010**	**2011**	**2008-2011 Total**	**2012**
1	No of Factories	-	63					
2	Total Tea Produced	kg / y	110,942,680	112,209,614	104,155,427	101,303,370	428,611,091	107,152,773
3	SFC - Unaudited Fac.	kg wood / kg TT	136,237,611	140,598,646	131,860,771	129,161,797	1.255	134,464,706
4	SFC - Audited Factories	kg wood / kg TT	107,836,285	106,823,553	100,509,987	109,407,640	0.991	106,144,366
5	SFC - Difference	kg wood / kg TT	0.256	0.301	0.301	0.195	0.264	0.264
6	Firewood Savings	kg wood / y	28,401,326	33,775,094	31,350,784	19,754,157	113,281,361	28,320,340
7	CO2 Mitigation Factor	kg CO2/kg wood	1.83	1.83	1.83	1.83		1.83
8	Total CO2 Mitigated	tons / y	51,974	61,808	57,372	36,150	207,305	51,826
	TOTAL CTC + ORTHODOX		73,855	76,761	76,209	50,430	277,255	69,314

	CTC TEA						**CTC**
No	**ELECTRICAL Parameter**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total 2008-2017**
1	No of Factories	63	63	63	63	63	63
2	Total Tea Produced	107,152,773	107,152,773	107,152,773	107,152,773	107,152,773	1,071,527,728
3	SEC - Unaudited Fac.	50,571,026	50,571,026	50,571,026	50,571,026	50,571,026	505,710,257
4	SEC - Audited Factories	46,349,042	46,349,042	46,349,042	46,349,042	46,349,042	463,490,416
5	SEC - Difference	0.039	0.039	0.039	0.039	0.039	0.039
6	Electrical energy Savings	4,221,984	4,221,984	4,221,984	4,221,984	4,221,984	42,219,841
7	CO2 Mitigation Factor	0.90	0.90	0.90	0.90	0.90	0.9
8	Total CO2 Mitigated	3,800	3,800	3,800	3,800	3,800	37,998
No	**THERMAL** Parameter	**2013**	**2014**	**2015**	**2016**	**2017**	**Total 2008-2017**
1	No of Factories						63
2	Total Tea Produced	107,152,773	107,152,773	107,152,773	107,152,773	107,152,773	1,071,527,728
3	SFC - Unaudited Fac.	134,464,706	134,464,706	134,464,706	134,464,706	134,464,706	1,344,647,062
4	SFC - Audited Factories	106,144,366	106,144,366	106,144,366	106,144,366	106,144,366	1,061,443,660
5	SFC - Difference	0.264	0.264	0.264	0.264	0.264	0.264
6	Firewood Savings	28,320,340	28,320,340	28,320,340	28,320,340	28,320,340	283,203,401
7	CO2 Mitigation Factor	1.83	1.83	1.83	1.83	1.83	1.83
8	Total CO2 Mitigated	51,826	51,826	51,826	51,826	51,826	518,262
	TOTAL CTC + ORTHODOX	69,314	69,314	69,314	69,314	69,314	693,138

	ORTHODOX TEA							
No	**ELECTRICAL Parameter**	**Unit**	**2008**	**2009**	**2010**	**2011**	**2008-2011 Total**	**weighted ave 2012**
1	No of Factories	-	23	23	23	23	23	23
2	Total Tea Produced	kg / y	26,036,966	26,608,002	28,023,039	25,826,008	106,494,015	26,623,504
3	SEC - Unaudited Fac.	kWh / kg TT	12,862,261	13,596,689	14,235,704	12,732,222	0.502	13,356,719
4	SEC - Audited Factories	kWh / kg TT	12,445,670	12,346,113	13,787,335	12,241,528	0.477	12,705,161
5	SEC - Difference	kWh / kg TT	0.016	0.047	0.016	0.019	0.024	0.024
6	Electrical energy Savings	kWh / y	416,591	1,250,576	448,369	490,694	2,606,230	651,558
7	CO2 Mitigation Factor	kg CO2 / kWh	0.9	0.9	0.9	0.9		0.90
8	Total CO2 Mitigated	tons / y	375	1,126	404	442	2,346	586
No	**THERMAL Parameter**	**Unit**	**2008**	**2009**	**2010**	**2011**	**2008-2011 Total**	**2012**
1	No of Factories	-	23					
2	Total Tea Produced	kg / y	26,036,966	26,608,002	28,023,039	25,826,008	106,494,015	26,623,504
3	SFC - Unaudited Fac.	kg wood / kg TT	49,027,607	47,442,068	52,991,567	46,641,770	1.841	49,025,753
4	SFC - Audited Factories	kg wood / kg TT	39,185,634	42,093,859	44,864,885	41,321,613	1.573	41,866,498
5	SFC - Difference	kg wood / kg TT	0.378	0.201	0.290	0.206	0.269	0.269
6	Firewood Savings	kg wood / y	9,841,973	5,348,208	8,126,681	5,320,158	28,637,021	7,159,255
7	CO2 Mitigation Factor	kg CO2/kg wood	1.83	1.83	1.83	1.83		1.83
8	Total CO2 Mitigated	tons / y	18,011	9,787	14,872	9,736	52,406	13,101

	ORTHODOX TEA						**ORTHODOX**
No	**ELECTRICAL Parameter**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total 2008-2017**
1	No of Factories	23	23	23	23	23	23
2	Total Tea Produced	26,623,504	26,623,504	26,623,504	26,623,504	26,623,504	266,235,038
3	SEC - Unaudited Fac.	13,356,719	13,356,719	13,356,719	13,356,719	13,356,719	133,567,190
4	SEC - Audited Factories	12,705,161	12,705,161	12,705,161	12,705,161	12,705,161	127,051,614
5	SEC - Difference	0.024	0.024	0.024	0.024	0.024	0.024
6	Electrical energy Savings	651,558	651,558	651,558	651,558	651,558	6,515,576
7	CO2 Mitigation Factor	0.90	0.90	0.90	0.90	0.90	0.9
8	Total CO2 Mitigated	586	586	586	586	586	5,864
No	**THERMAL Parameter**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total 2008-2017**
1	No of Factories						23
2	Total Tea Produced	26,623,504	26,623,504	26,623,504	26,623,504	26,623,504	266,235,038
3	SFC - Unaudited Fac.	49,025,753	49,025,753	49,025,753	49,025,753	49,025,753	490,257,529
4	SFC - Audited Factories	41,866,498	41,866,498	41,866,498	41,866,498	41,866,498	418,664,978
5	SFC - Difference	0.269	0.269	0.269	0.269	0.269	0.269
6	Firewood Savings	7,159,255	7,159,255	7,159,255	7,159,255	7,159,255	71,592,551
7	CO2 Mitigation Factor	1.83	1.83	1.83	1.83	1.83	1.83
8	Total CO2 Mitigated	13,101	13,101	13,101	13,101	13,101	131,014

ORTHODOX	TOTAL		CTC	ORTHODOX	TOTAL	
Total 2008-2017	**Total 2008-2017**	**ELECTRICAL Parameter**				
23	86	No of Factories				
266,235,038	1,337,762,765	Total Tea Produced				
133,567,190	639,277,447	Total kWh - Unaudited Fac.	0.472	0.502	0.478	kWh / kg TT
127,051,614	590,542,030	Total kWh - Audited Fac.	0.433	0.477	0.441	kWh / kg TT
0.024	0.036	SEC - Difference	0.039	0.024	0.036	kWh / kg TT
6,515,576	48,735,416	Electrical energy Savings , kWh/y	8.35%	4.88%	7.62%	Percent Savings
0.9	0.9	CO2 Mitigation Factor				
5,864	43,862	Total CO2 Mitigated , tons/y				
Total 2008-2017	**Total 2008-2017**	**THERMAL Parameter**				
23	86	No of Factories				
266,235,038	1,337,762,765	Total Tea Produced				
490,257,529	1,834,904,591	Total kg firewood - Unaudited Fac.	1.255	1.841	1.372	kg wood / kg TT
418,664,978	1,480,108,638	Total kg firewood - Audited Fac.	0.991	1.573	1.106	kg wood / kg TT
0.269	0.265	SFC - Difference	0.264	0.269	0.265	kg wood / kg TT
71,592,551	354,795,953	Firewood Savings, kg wood/yr	21.06%	14.60%	19.34%	Percent Savings
1.83	1.83	CO2 Mitigation Factor				
131,014	649,277	Total CO2 Mitigated , tons/yr				
	693,138					

8.11 ANNEX K – Summary Tracking Tool (Based on 86 Energy Audits)

	As per IPCC 2006 guidelines				
	NCV	15.6	TJ/kg		
	Emission factor for Wood/Wood Waste	112000	kg CO_2/TJ		
		1.75	kg CO_2/kg FW		
		CTC	ORTHODOX	TOTAL	
Part 1	Cumulative emission reductions achieved during project period	222,504	54,751	277,255	tCO_2
	Assumed economic lifetime of EE interventions	10	10	10	years
Part 2	**Lifetime direct GHG emissions avoided**	556,260	136,878	693,138	tCO_2
Part 3	Lifetime direct post-project GHG emissions avoided	0	0		As there are no financing instruments (RIF or revolving fund or LFG)
Part 4	Lifetime indirect GHG emissions avoided				
	Replication factor	3	3	3	
	Lifetime indirect GHG emissions avoided	1,668,780	410,635	2,079,415	tCO_2 (bottom-up)
	Causality factor	40%	40%	40%	
	Lifetime indirect GHG emissions avoided	**222,504**	**54,751**	**277,255**	tCO_2 (top-down)

	Total tea production, million kg (2008-2011)		
	Total number of factories	**86**	**nos**
Part 1	Cumulative emission reductions achieved by end of project period	277,255	tCO_2
	Assumed economic lifetime of EE interventions	10	years
Part 2	**Lifetime direct GHG emissions avoided**	693,138	tCO_2
Part 3	Lifetime direct post-project GHG emissions avoided	0	As there are no financing instruments (RIF or revolving fund or LFG)
Part 4	Lifetime indirect GHG emissions avoided		
	Replication factor	3	
	Lifetime indirect GHG emissions avoided	2,079,415	tCO_2 (bottom-up)
	Causality factor	40%	
	Lifetime indirect GHG emissions avoided	**1,732,846**	tCO_2 (top-down)
		1,300,000	From Basic text in PIR 2012

Total electrical energy savings	48,735,416	kWh	572,143,417,698	kJ	
Total weight of fuel wood savings	354,795,953	kg of wood	572,143,418	MJ	
NCV of fuel wood	15.7	MJ/kg	572		
Total thermal energy savings	5,570	TJ			
	5,570,473,855	MJ	Total	6,142,617,273	MJ
				6,143	TJ
Efficiency of power plants in India	31.5%				
Power plant heat rate	11,429	kJ/kWh			
All India Station heat rate*					
Year	No of Stations analysed	Capacity	Weighted average design SHR (kJ/kWh)	Weighted average operating SHR (kJ/kWh)	
2005-06	57	35,480	10,040	11,501	
2006-07	56	38,611	10,040	11,978	
*Source: http://www.cea.nic.in/reports/yearly/thermal_perfm_review_rep/0607/SECTION-13.pdf			30.7%	11,740	