Government of India
and
United Nations Development Programme
Global Environment Facility

PROJECT DOCUMENT

Energy Conservation in Small Sector Tea Processing Units in South India

September 2007

NEW DELHI

Country: India

UNDAF Outcome(s)/Indicator(s):	Communities are aware of their vulnerabilities, and adequately prepared to manage (and reduce) disaster and environmental related risks.
Expected Outcome(s)/Indicator (s):	Progress towards meeting national commitment under multilateral environmental agreements.
Expected Output(s):	Capacities built and pro-poor initiatives supported at national and local levels to directly address environmental issues.
Implementing partner:	Ministry of Commerce
Responsible parties:	The Tea Board Technology Informatics Design Endeavour (TIDE)

The project objective is to reduce energy consumption from tea processing units in South India, thereby restricting Greenhouse Gases emissions. It also aims at removing barriers and developing replicable strategies for energy efficiency and energy conservation interventions in the tea processing industry in South India through (1) awareness creation among the target sector about energy efficiency/renewable energy technologies and their relation to profitability; (2) elimination of financial barriers that inhibit investment in energy conservation equipment; (3) adoption and procurement of energy efficiency/renewable energy equipment/ practices; and (4) learning, knowledge sharing and replication

The project would establish that during the project period at least 30 factories in south India would have adopted energy efficient equipment and practices that would cumulatively save 55,800 tons of direct CO2.

Programme Period: 2008-2012
Programme Component: Energy & Environment for Sustainable Development
Project Title: Energy Conservation in Small Sector Tea Processing Units in South India
Project ID: PIMS 3163
Project Duration: 4 years
Management Arrangement: National Implementation

Total Budget	2,050,000
Project Planning Grant	25,000
Allocated resources:	
• Government	240,625
• Regular – GEF	950,000
Other:	859,375
Unfunded budget	nil

Agreed by (Implementing partner[1]) **Ministry of Commerce**

RAJ SINGH
DIRECTOR

Agreed by: **Ministry of Finance**
Department of Economic Affairs

RAJ SINGH
Director

Agreed by (UNDP): **Country Director**

12/1/2009

COMPONENT 1:

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COMPONENT 2:

A) PROJECT OVERVIEW:

India is the largest tea producing country in the world. South India, which is the focus of attention of the project, produces 203 million tons of tea annually which is 24% of the national annual production. There are 350 tea factories in South India with 125 of them being in the small sector. The tea industry has been 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 is consumed to produce 1 kg of made tea. This translates into an annual consumption of 435 million units of electricity and 1.3 million tons of firewood. Energy audit data also suggests that it is possible to save 20% each of electrical and thermal energy. Energy efficient interventions in the tea sector have the potential to conserve 87 million units of electricity and 0.26 million tons of firewood annually. Energy conservation is also a thrust area of the 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, has launched a Quality Upgradation Program aimed at the small sector in tea growing areas in South India – the focus of this project.

The project aims to remove barriers to energy conservation and energy efficiency that inhibit the realization of large energy saving potential in the tea sector. This has been conceived largely with the information and financial barriers identified in the preparatory assistance phase as the basis.

The project focuses on four outcomes with associated outputs and activities. Some key activities that are indicative of the project strategy are:

- Understanding the information needs of the tea factories and compilation of information brochures, publicity material etc. through mail campaigns;
- Creation of a web site for the project with appropriate content;
- Dialogue with commercial lending institutions for attractive commercial lending terms for procurement of energy efficient equipment;
- Creation of a risk insurance scheme for availing of energy efficient equipment;
- Factory specific energy audits to define baseline scenarios and identify areas of intervention;
- Demonstration of select energy efficient technologies in tea factories and site visits to these factories;
- Training programme for air heater operators and factory managers;
- Bringing together the communities of equipment suppliers, researchers and academic institutions and factory owners to make energy conservation available and affordable.

The key strategy element would be to blend all these activities to ensure that all project outcomes are delivered in a time bound manner.

COMPONENT 2:

B) ANNUAL WORK PLAN AND BUDGET SHEET (Ist Year)

COUNTRY PROGRAMME OUTPUT: Capacities built and pro-poor initiatives supported at national and local levels to directly address environmental issues.

S. No	Project Outcome	Expected Project outputs	Key activities	Time frame Q1	2	3	4	Responsible partner	Source of funds	Budget Description	Amount
1.	**Outcome 1** Awareness creation among the target sector about energy efficiency/ renewable energy technologies and their relation to profitability.	1.1 Awareness about EE/ RE technologies of relevance to tea units and implications of their adoption	Brochures and newsletters giving, project, product and process information		x	x	x	TIDE. Involvement of Tea Board for their circulation	UNDP-GEF		
			Seminars. Meetings with energy consultants, energy suppliers and other meetings	x	x	x	x	TIDE in associations with Tea Board	UNDP-GEF	71200 International Consultants	17,600
			Project web site	x	x	x	x	Consultant web site content inputs from TIDE	UNDP-GEF	71300 Local Consultants	16,180
		1.2 Institutionalized mechanism for knowledge creation and management	Agreement for knowledge management and its implementation	x	x			TIDE, UPASI	UNDP-GEF	71600 Travel	5,600
			Energy audits, factory specific advice and its documentation	x	x			TIDE	UNDP-GEF	74500 Meetings & Workshop	5,200
			Data collection from technology demonstration sites				x	TIDE	UNDP-GEF	72500 Office supplies	875
			M&Es conducted Data collection from technology demonstration sites. Evolving a formal mechanism for data management. Structured format for data collection	x	x	x	x	TIDE, statutory external M&E	UNDP-GEF	74500 Misc	800
			Evolving a structured mechanism for data management and monitoring CO2 abated.			x	x	TIDE	UNDP-GEF	**Total: Outcome 1.**	**46,255**
2.	**Outcome 2:** Elimination of financial barriers that inhibit investment in energy conservation equipment.	2.1 Institutionalization of commercial lending for investment in RE/EE equipment	Logistic assistance to tea factories for accessing institutional finance including Tea Board subsidy	x	x	x	x	TIDE, Industry association	UNDP-GEF		
			Data collection from financial institutions on lending to tea factories for energy efficiency		x	x	x	TIDE, with inputs from consultant finance	UNDP-GEF	71200 International Consultants	10,000
		2.2 Development and operationalization of the risk	Formulation of the risk insurance scheme and its acceptance		x	x		Consultant finance with inputs from TIDE and UNDP-GEF	UNDP-GEF	71300 Local Consultants	7,500
										71600 Travel	3,375
										74500 Meetings & Workshop	2,250
											1,375

		insurance scheme	Announcement and operationalization of the risk insurance scheme			x	x	TIDE with periodic review by the consultant finance	UNDP-GEF	72500 Office supplies **Total: Outcome 2.**	 **24,500**
3.	**Outcome 3:** Adoption and procurement of energy efficiency/ renewable energy equipment/ practices.	3.1 Nurturing the market driven establishment offering all components of energy service to the target sector	Developing and demonstrating a list of the energy efficient services and equipment promoted by the project			x	x	TIDE, industry associations	UNDP-GEF	71200 International Consultants 71300 Local Consultants 71600 Travel 72000 Service Contract 74500 Meetings & Workshop 74500 Mis	9,750 7,082 3,180 71,930 5,280 325
			Interacting with equipment suppliers			x	x	TIDE, industry association,	UNDP-GEF		
			Award of service contract				x	TIDE, consultants	UNDP-GEF	**Total: Outcome 3.**	**97,547**
4.	**Outcome 4:** Learning, knowledge sharing and replication	4.1 Capacity building of the agencies involved to replicate energy efficiency projects in other areas and sectors	Evolving the end of project scenario		x	x	x	TIDE, Tea Board, TRI, Industry association	UNDP-GEF	71200 International Consultants 71300 Local Consultants 74500 Meetings & Workshop	25,500 5,250 1,250
			Capacity building of local institutions, TIDE	x	x	x	x	TIDE	UNDP-GEF		
			Evolving methodologies for project replication in other areas					TIDE, Tea Board	UNDP-GEF	**Total: Outcome 4.**	**32,000**
		-	Project Management Unit	x	x	x	x		UNDP-GEF	71300 Local Consultants 71600 Travel 72000 Equipment & Furniture Total:	14,750 3,750 3,000 **21,500**
		Total input for the first year									**221,802**

COMPONENT 3:

A) MANAGEMENT ARRANGEMENT

Since the approval of this Medium Sized Project by GEF Secretariat, new Results Management Guide (RMG) procedures of UNDP have become operational and these are listed out in brief and will be applicable.

3.1 Implementation Arrangements – Institutional Mechanisms & Monitoring:

3.1.1 The Implementing Partner:

The project will be nationally implemented by the Ministry of Commerce. The Ministry of Commerce will designate a National Project Director, who will be responsible for overall management, including achievement of planned results, and for the use of UNDP funds through effective process management and well established project review and oversight mechanisms. S/he will be assisted by a Project Manager for the day-to-day management of the project.

The Implementing Partner will also sign a budgeted Annual Work Plan with UNDP on an annual basis, as per UNDP rules and regulations.

3.1.2 Responsible Parties:

The following two organizations will be the Responsible Parties for the project:

a) The Tea Board: The Tea Board is an institution established by the Ministry of Commerce and is their extended arm to implement the Government of India policies relating to the Tea Industry. They were also instrumental in giving direction to MSP document preparation.

On behalf of the Ministry of Commerce, The Tea Board will provide day-to-day guidance and implementation support to TIDE in achievement of the overall project objectives in accordance with the policies of the Government of India.

b) Technology Informatics Design Endeavour (TIDE), Bangalore: TIDE is a not-for-profit society registered under the Societies Registration Act. TIDE has been identified by GEF as the Responsible Party. TIDE was also involved in the preparation of PDF-A phase of this project and are familiar with the issues to be addressed in the project.

TIDE will be responsible for implementation of project activities and would carry them out under the overall guidance of the NPD and the Project Steering Committee. TIDE would set up a Project Management Unit and all project activities will be carried out from the PMU which will be headed by the Project Manager. The PMU will also coordinate the project activities including the preparation of Annual and Quarterly Work Plans, Budget, Financial Reports, etc. and will interface on project management issues. TIDE will also set up a Technical Advisory Committee comprising of eminent persons from all stakeholders to provide the technical inputs and to steer the project.

TIDE will provide infrastructural facilities in the form of office space, water, housekeeping, security, furniture etc. Qualified and skilled TIDE personnel will work on the project.

Most importantly, TIDE will provide able and qualified management capacities to the project. The project will also benefit from inputs from TIDE's advocacy programmes and TIDE's experience in managing several other projects in the field of environmental management and climate change areas.

3.1.3 Project Steering Committee:

A Project Steering Committee (PSC) will be comprising designated representatives from the Ministry of Commerce, Tea Board, Ministry of Environment and Forests, UNDP and TIDE and will be chaired by the NPD. The PSC will carry out the following functions:

- Ensure that the project goals and objectives are achieved in a defined timeframe;
- Review the project progress and suggest implementation strategies periodically;
- Review the project expenditures against activities and outcomes; and
- Approve Annual and Quarterly Work Plans.

The PSC will be the group responsible for making, by consensus, management decisions for the project and holding periodic reviews. In order to ensure UNDP's ultimate accountability, final decision making rests with UNDP in accordance with its applicable regulations, rules, policies and procedures. Project reviews by the PSC will be carried out on a quarterly basis during the running of a project, or as necessary when raised by the Project Manager.

3.1.4 National Project Director:

The NPD will coordinate project implementation on behalf of Ministry of Commerce and ensure its proper implementation.

3.1.5 Project Manager:

A full-time Project Manager will be recruited by the MoC/Tea Board under project funds for the day-to-day management and decision making of the project and will be accountable to the NPD and PSC. S/he will prepare the detailed activity and monitoring plan based on the Annual Work Plan (AWP) and Budget and submit it to the PSC for approval. The Project Manager will ensure that the project produces the results specified in the project document, to the required standards of quality and within the specified constraints of time and cost. The Project Manager will prepare and submit to UNDP the following reports/documents:

Annual and Quarterly Work Plans, Quarterly and Annual Progress Reports (substantive and financial), Issue Log, Risk Log, Quality Log, Lessons Learnt Log, Communications and Monitoring Plan using standard reporting format to be provided by UNDP.

The Project Manager will head the PMU and will work in close collaboration with the MoC and Responsible Parties and other partner organizations and undertake periodic monitoring and review of the project activities. Please see Annex 1 for the Terms of Reference for the Project Manager.

3.1.6 Technical Advisory Committee and Support Teams:

TIDE will establish and institutionalize a Technical Advisory Committee and Support Teams and any other Committees, as and when needed with the approval of the PSC, to steer and monitor the progress of the project.

The Technical Advisory Committee will have the following roles and responsibilities:

1. Advise the project team on technical issues
2. Review of energy audits and data management
3. Advise on technology selection
4. Suggest policy issues of relevance to technology adoption in tea factories

An expert in the field of energy efficiency in tea factories would be the Chairman of the TAC.

Support teams:

The support teams, recruited under the project, assist the Project Manager in day-to-day management of the project.

Finance and Audit Team

The team would consist of an accountant, a part time auditor, local and international consultant. The tasks for the team would be to:

1. Address issues relating to financial barriers identified in the project proposal.
2. Conceptualize and operate the Risk Fund.
3. Assist the PM in interaction with Industry associations and suppliers of equipment in financial matters.
4. Interact with Financial Institutions for financial options for energy conservation. Interface with Tea Board in availing subsidy schemes.
5. Maintain accounting of project expenses as per UNDP guidelines.
6. Purchase and procure in accordance with TIDE purchase procedures.
7. Co-ordinate with external auditor for annual audit.

Information and Awareness Creation Team

This team would consist of local consultants for market development, documentation and supported by an international consultant for addressing the information barrier. Project partner Tea Board would be involved in this activity. The tasks for the team would be:

1. Creation of promotion and publicity material
2. Content management of the web site
3. Preparation of statutory reports as required by the M&E plan
4. Preparation of manuals
5. Addressing information barriers as identified in the project proposal
6. Organizing awareness meets
7. Organizing meetings between tea factories, suppliers, financial institutions and technology experts

8. Carrying out promotional activities for acceptance of energy conservation

The management of the web site will be out sourced to an external agency.

Technical Team

The tasks for the technical team would include the following: Local consultants from partner institution, i.e. UPASI, would be used to

1. Review the energy utilization patterns and ways of improving the efficiency
2. Technology selection and recommendation
3. Energy audits & data management
4. Assessment of data from energy efficiency and CDM considerations

Consultants in solar energy, energy audits and technology selection would assist the technical team. The ToRs for the consultants would be developed at the time of project inception.

In order to accord proper acknowledgement to GEF for providing funding, a GEF logo should appear on all relevant GEF project publications, including among others, project hardware and vehicles purchased with GEF funds. Any citation on publications regarding projects funded by GEF should also accord proper acknowledgment to GEF. The UNDP logo should be prominent – and separated from the GEF logo, if possible.

3.1.7 Project Assurance:

Project Assurance will be the responsibility of UNDP. The Project Assurance role will support the PSC by carrying out objective and independent project oversight and monitoring functions. This role ensures that the appropriate project management milestones are managed and completed.

3.2 Funds Flow Arrangements and Financial Management:

The Ministry of Commerce will enter into an agreement with the Tea Board which, in turn, will enter into an MOU with TIDE for implementing the project. Based on the AWP, quarterly work plan will be prepared by TIDE and funds will be released accordingly. The Tea Board will account for funds received from UNDP on a quarterly basis through the standard Fund Authorization and Certificate of Expenditures (FACE) Report. The funds will be released to the Responsible Party (TIDE) at the signed request and approval of the NPD, also through the standard FACE format. The Project Manager will be responsible for compilation and collation of these Financial Reports. Unspent funds from the approved AWPs will be reviewed in the early part of the last quarter of the calendar year and funds reallocated accordingly. The detailed UNDP financial guidelines will be provided on signature of the project.

0.5% of the total project budget will be allocated for communication and advocacy activities undertaken by UNDP.

Interest Clause: A separate Savings Bank Account will be opened in the name of the project and any interest accrued on the project money during the project cycle will be ploughed back

into the project in consultation with Tea Board and UNDP or refunded to UNDP if there is no scope for ploughing back.

3.3 Audit:

The project shall be subject to audit in accordance with UNDP procedures and as per the annual audit plan drawn up in consultation with DEA. The project shall be informed of the audit requirements by January of the following year. The audit covering annual calendar year expenditure will focus on the following parameters – (a) financial accounting, documenting and reporting; (b) monitoring, valuation and reporting; (c) use and control of non-extendable reporting; (d) UNDP Country Office support. In line with the UN Audit Board requirements for submitting the final audit reports by 30 April, the auditors will carry out field visits during February/March. Detailed instructions on audit will be circulated by UNDP separately and on signature.

Cost recovery for implementation support services by UNDP will be charged as per UNDP rules and regulations. The details of UNDP's support services will be outlined while finalizing the annual workplan and budget for each year.

COMPONENT 4:

A) MONITORING & EVALUATION PLAN AND BUDGET

The PSC, assisted by the Technical Advisory Committee, will monitor the progress of the project. The TAC will give an emphasis on reviewing the activities of the project in a holistic manner.

The key M&E activities and timeframes along with related budget, as per GEF requirements, are given in the table below:

Activity	Time Frame	Budget
Inception – proposed monitoring and evaluation plan	Within two months of approval of the project	$6000
Steering Committee meetings at Coonoor/ Bangalore	Quarterly	$12000
Project Implementation Review	Once in a year (GEF requirement)	-
Review by Project Implementation Team	Once a month based on field reports	$15000
Mid-Term evaluation	To be initiated after 1.5 years of implementation	$20,000
Independent mid term Impact Review	Baseline setting within six months of implementation	$10,000

Desk review and Concurrent monitoring	Done internally based on activity reports sent by project staff	$2500
Periodic Reports	Quarterly reports to UNDP/GEF in the prescribed format	-
Management Audit	As per UNDP guidelines (Annual audit is mandatory for expenditures exceeding US $20, 000)	$10,000
Documentation of Lessons Learnt by professional consultants	Synthesis reports/case study preparation for dissemination and advocacy purposes prepared (consolidation once in six months)	$50,000
Field visits by UNDP	Once in a year or more if required	$25000*
Final Evaluation	During the last 3 months	$20,000

* these would be merged with the project steering committee and other meetings to the extent possible

B) RISK ANALYSIS:

The PSC and Project Manager will establish a system within project management to regularly identify risks and recommend/implement risk management strategies.

C) LOGICAL FRAMEWORK AND OBJECTIVELY VERIFIABLE IMPACT INDICATORS:

A Logical Framework Matrix given below provides performance and impact indicators for project implementation along with their corresponding means of verification which will form the basis on which the risk analysis, project monitoring and evaluation system will be built.

Project Strategy	Objectively verifiable indicators				
Goal	*REDUCING ENERGY CONSUMPTION FROM TEA PROCESSING UNITS IN SOUTH INDIA, THEREBY RESTRICTING GHG EMISSIONS*				
	Indicator (quantified and time-bound)	*Baseline*	*Target*	Sources of verification	Risks and Assumptions
Objective To remove barriers and develop replicability strategies for energy efficiency	30 tea processing units in south India adopt energy efficient equipment and practices within the project period resulting in accumulative saving of 56,925 tons of direct CO_2	Limited awareness about what is an energy efficient technology and its advantages Barriers identified for the first time in	Project to expose every tea industry in south India to energy conservation To demonstrate	Field visit by external evaluators to the project sites and inspection of the data collected	Unforeseen policy interventions make the project irrelevant The industry

and energy conservation interventions in the tea processing industry in South India		the pdf phase No strategy for replicability	replicability by introducing energy usage reform in 30 factories. To directly save 56,925 tons CO_2		responds favourably to project initiatives Tea factories invest in energy efficient equipment
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 2. Content developed and web site of the project launched in the first year	No history of awareness creation on energy usage reform Data from research / student projects / energy audit reports with individual institutions, not made public	An awareness creation vehicle and strategy that can be used by the industry beyond the project period Launch of a project web site and its regular up gradation	Review of the awareness creation material developed by the project including the web site and its assimilation by the target sector	The industry associations are pro active and their members participate in awareness meets / site visits The publicity material and web site content addresses the information needs
Output 1.1 Awareness about energy efficiency / renewable energy technologies of relevance to tea units and implications of their adoption	1. Avenues for demonstration of select energy efficient technology options in tea factories created and site visits to these factories organized in the first year 2. Meetings / seminars / interaction meets with energy consultants, equipment suppliers organized in the first year. Project again reaches out to all tea factories	One seminar held on technology up gradation in tea factories that covered energy efficiency. Tea Board / UPASI initiated a study on energy consumption. Study findings presented in stakeholder meet organized by project.	Demystify energy efficiency / renewable energy technology by demonstration, data collection, analysis and dissemination of information in an organized manner	Field visits to technology demonstration sites, study of equipment performance monitoring reports and published proceedings	Equipment suppliers / academic institutions respond to the project request for information sharing
Output 1.2 Institutionalized mechanism for knowledge creation and management	1. Data on performance of energy efficient technology demonstrated, collected and made available at the project office in the first year 2. Project identifies and supports a local institution like the Tea Research Foundation to be the repository of knowledge created in the second year 3. Structured format for data collection and monitoring with data on CO_2 abated	R & D institutions catering to the needs of the tea industry focus on pre harvest technologies Limited understanding of what constitutes knowledge and its management	Create a sustainable institutionalized mechanism for knowledge creation and management that endures beyond the project period and expands to other knowledge gaps	Review of the methodology of data collection, its storage, use and up gradation. Meeting with local institution like the Tea Research foundation to review their commitments and obligations	Tea factories permit data collection and dissemination with their peers Tea Research Foundation obtains consent for becoming the repository of knowledge under the conditions of the project

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	Current financing mechanisms include Tea Board subsidy and commercial lending based on credibility of the factory. No schemes for availing energy conservation equipment	Leverage the project to create an atmosphere for easy and attractive access to finance energy conservation	Review of data and reports on the extent and ease of investments Meetings with financial institutions, tea factories and equipment suppliers	Financial institutions continue to remain interested in lending to the sector if plagued by unforeseen adverse circumstances

Output 2.1 Institutionalizatio n of commercial lending for investment in energy efficiency / renewable energy equipment	1. Biannual data collection on lending to tea factories for energy efficient equipment by commercial financial institutions from the second year	Financial institutions lending to tea factories on case to case basis. No data on lending for energy usage reform. Baseline data will be collected during the course of the project	Dialogue and motivate financial institutions for developing schemes for energy efficiency that begin with tea but expand to other industries	Review of data and reports on the extent and ease of investments Meetings with financial institutions, tea factories and equipment suppliers	Financial institutions continue to remain interested in lending to the sector if plagued by unforeseen adverse circumstances
Output 2.2 Development and operationalizatio n of the risk insurance scheme	1. Risk insurance scheme evolved and implemented in the second year 2. Measurement of the extent of utilization of the risk insurance scheme in the third year	No precedent for risk insurance in the tea industry and for availing new energy efficient equipment	Conceptualize and operationalize a pioneering risk insurance scheme	Study of the documents of the risk insurance scheme and meetings with beneficiaries	The project team may not be able to enthuse insurance agencies to evolve and participate in risk insurance schemes
Outcome 3 Adoption and procurement of energy efficiency / renewable energy equipment / practices	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	No vision in the current tea establishments on the structure and operations of a market driven energy service provider Decision on investment in new equipment driven by factors like breakdown and not energy conservation	Facilitate the creation of a market driven enterprise and through its intervention motivate 30 tea factories adopt energy efficient equipment and practices	Review of the database containing all information Review of factory specific documentation Field visits	Tea factories, equipment suppliers accept the services of the energy service provider and his business stabilizes during the project period
Output 3.1 Nurturing the market driven establishment offering all components of energy service to the target sector	1. Listing of the energy efficient services and equipment promoted by the project. 2. Definition of the market driven establishment and its business plan 3. Extent of physical and financial support offered to the tea factories, equipment suppliers and the market driven establishment	No dedicated service provider for offering all aspects of energy efficiency. Definition of what is an energy efficient technology required.	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	Review of classification of energy efficient equipment and services Review of the business plan of the market driven establishment and its performance	The energy service provider / market driven establishment continues to service the sector after the project withdraws support to it.

Outcome 4 Learning, knowledge sharing and replication	Tea Board imbibes the project methodology and extends the same to other tea clusters Assessment of how the implementing agency has leveraged the project for its own qualitative and quantitative growth	No energy efficient interventions in other tea growing regions in India Current status of learning and adaptive management of TIDE being documented by an external agency	Document the learning, evaluation and adaptive management processes initiated by the project for a larger audience	Minutes of meetings of Tea Board where the project has been mentioned / discussions with Tea Board officials. Review of the other activities of the implementing	Local conditions in other industry clusters do not inhibit the replication of the project outputs and outcomes

				agency	
Output 4.1 Capacity building of agencies involved to replicate of energy efficiency projects in other areas and sectors	Tea Board initiates visits / interaction meets to project sites from other tea processing clusters Number of projects / publications on energy efficiency that TIDE is implementing from third year onwards	TIDE has introduced energy efficient technology and enterprise models in informal industries. Limited exposure to formal industries	Strengthen the institutional mechanisms in TIDE to conceive and implement energy efficiency / CDM projects	Documentation of field visits / interaction meets and their follow up. Review of how the implementation agencies have leveraged the project for intervention in other sectors	The agencies involved in project implementation are able to build capacity and infrastructure for executing similar projects

The Quarterly and Annual Progress Reports shall be submitted by the Project Manager to the PSC through Project Assurance, using the UNDP standard report format available.

An Issue Log shall be activated in Atlas and updated by the Project Manager to facilitate tracking and resolution of potential problems or requests for change.

A Risk Log shall be activated in Atlas and regularly updated every quarter by reviewing the external environment that may affect the project implementation.

A project Lessons-learned Log shall be activated and regularly updated to ensure on-going learning and adaptation within the organization, and to facilitate the preparation of the Lessons-learned Report at the end of the project.

A detailed Communication and Advocacy Plan will be prepared that describes which activities and outputs will be monitored, reviewed and evaluated, how and by whom. A detailed Communication and Advocacy Plan needs to be drawn out by TIDE and approved by the PSC. The Plan will articulate the types of communication and associated scheduling required during the project, as well as methods of communicating project results to stakeholders shall be activated in Atlas and updated to track key management actions/events.

To complement the above, an annual project review will be conducted during the fourth quarter of year as a basis for assessing the performance of the project. In the last year, this review will be a final assessment. This review will involve all key project stakeholders and the Implementing Partner, and focus on the extent to which progress is being made towards outputs, and that these remain aligned to appropriate outcomes. The review will be structured by a set of common standards, and will be subject to spot external quality assurance assessments. This review should update output targets and results achieved in Atlas.

COMPONENT 5:

A) LEGAL CONTEXT

This project document shall be the instrument envisaged in the Supplemental Provisions to the Project Document attached hereto as Annex 2.

The following types of revisions may be made to this document with the signature of the UNDP Country Director only, provided he or she is assured that the other signatories of the Project Document have no objections to the proposed changes.

- Revisions in, or addition of, any of the Annexes of the project document (with the exception of a Standard Legal Text for non-SBA countries which may not be altered and agreement to which is a pre-condition for UNDP assistance);
- Revisions which do not involve significant changes in the immediate objectives, outputs or activities of the Project but are caused by the re-arrangements of inputs already agreed to or by cost increases due to inflation; and
- Mandatory annual revisions, which re-phase the delivery of agreed project inputs or increased experts or other costs due to inflation.

The Implementing Partner and Responsible Parties shall, at all times, ensure compliance with UNDP RMG guidelines to the extent they do not conflict with the extant rules and provisions of Government of India.

COMPONENT 6:

ANNEXES

A) Other agreements

Endorsement letter from Ministry of Environment and Forests.

B) Terms of Reference for key project staff:

TOR of Project Manager

C) Annex to Legal Context

D) Approved MSP proposal

Approved Medium Sized Proposal with its Annexes and GEF's approval letter dated 25 July 2007 which form an integral part of this project document are enclosed.

E) Acronyms

To: Ms. Monique Barbut
CEO, Global Environment Facility

भारत सरकार
पर्यावरण एवं वन मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT & FORESTS

F. No. 4(1)/16/2006 – IC &SD.I
Dated: 19th September 2006

Re: Endorsement Letter for 'Energy Conservation in Small Sector Tea Processing Units in South India'

On behalf of the Government of India, and in my capacity as GEF Operational Focal Point, I hereby re-endorse the project titled 'Energy Conservation in Small Sector Tea Processing Units in South India' to be proposed through the United Nations Development Program (UNDP) to the Global Environment Facility (GEF) for funding under GEF 4.

The Government of India confirms that the project addresses national climate change priorities, and we hereby agree to allocate USD 0.95 million of the GEF climate change funds available to India through the GEF Resource Allocation Framework to this project.

Yours sincerely,

(SUDHIR MITAL)
Joint Secretary
and, GEF Operational Focal Point India
Ministry of Environment and Forests
Government of India

Cc: Mr. Rajeev P Singh, Director, DEA, North Block, New Delhi
Dr. Medhe Olsen, Resident Representative, UNDP Co, 55 Lodhi Estates, New Delhi
Mr. Manoel Alves, Climate Change Manager, UNDP/GEF, New York

Terms of Reference for the Project Manager

Duties and Responsibilities:
Under the overall supervision and guidance of the National Project Director and/or his/her representative and the Project Steering Committee and in consultation with UNDP (Project Assurance Role), the incumbent will be responsible for successful management and delivery of project outputs and achievement of outcomes.

S/he would serve as the Secretariat to the Project Steering Committee (PSC) and perform the following tasks:

1. **Running the project**
   - Provide inputs to PSC for the development and approval of the strategy for the project "Energy Conservation in Small Sector Tea Processing Units in South India" (Tea Project).
   - Develop annual work plan and action plans consistent with the programme strategy approved by the PSC.
   - Provide leadership in results-based management of the project ensuring effective and timely implementation of the activities as per the work plan.
   - Ensure project management in Atlas including maintenance and updating of risk log [risk identification], issue log [implementation issue], activity status, and lesson learnt log in implementation of the Tea Project.
   - Establish effective linkages with other ongoing national/state level initiatives.
   - Ensure formal partnership arrangements with state nodal agencies and other stakeholders as required through conclusion of MOUs. Also, monitor the results of the partnership and manage course correction as required.
   - Participate in the periodic Project Work Plan Review, meetings and discussions related to project implementation, monitoring and follow-up.
   - Ensure compliance of rules and procedures of the Government and UNDP in programme implementation.
   - Serve as secretariat to the PSC.

2. **Monitoring, review and evaluation**
   - Develop a project monitoring strategy with clearly defined roles and responsibilities, resources and reporting arrangements to ensure monitoring and reporting at different levels and convergence of reports from different sources to provide complete information on progress towards outcomes/ outputs.
   - Prepare quarterly progress reports and an annual progress report. Also, organize annual project review as required.
   - Develop and implement systems for collation/ collection and regular updation of strategic information and information summaries, briefs, fact sheets, achievement reports, as required to assess progress and impact.
   - Organize project evaluation, as directed by PSC in accordance with Government/UNDP rules and regulations.
   - Document processes, lesson learnt and results to facilitate demonstrability of results.
   - Ensure that M&E standards are maintained.

- Identify and implement ICT based-solutions for programme monitoring.

3. **Financial Management and audit**
   - Prepare an annual project budget in line with the approved work plan.
   - Ensure timely disbursement of funds to project implementing partners and timely reporting of expenditures from project and consolidated reporting to UNDP.
   - Ensure periodic reviews of outstanding funds and utilization pattern.
   - Arrange annual audits, as required. Also, ensure follow-up action on audit reports.

4. **Strategic partnership and knowledge management**
   - Foster strategic partnerships with counterparts in Government at national and state levels and stakeholders (NGOs, INGOs, academic institutions, national and state level training institutions etc.) at various levels in the tea sector.
   - Facilitate technical assistance/support for project partners in all relevant areas as appropriate.
   - Facilitate knowledge networking in tea industry in the country among all stakeholders.
   - Coordinate inputs and submit these to UNDP for reporting to GEF on specific requests and to meet others.
   - Develop and manage a reporting and exchange of information system as per corporate reporting requirements and the needs of project partners. Particularly, ensure that reporting requirements of GEF and UNDP are fully complied with.
   - Develop and implement a suitable mechanism based on electronic medium for such information exchange.
   - Prepare and implement a Communications and Advocacy Plan.

5. **Personnel**
   - Oversee the recruitment of project personnel and consultants (including drafting ToRs and work specifications based on project deliverable descriptions) in line with relevant procedures.
   - Supervise and monitor staff performance and prepare performance evaluation reports for project staff and consultants.
   - Contribute to capacity building of the field team on different aspects of the project.

6. **Others**
   - Ensure operational completion of the project with appropriate Project Board and project Level reviews and identify follow-on actions and update outcome evaluation plan.
   - Undertake any other tasks assigned by the National Steering Committee [Project Executive Group/ Project Board], National Project Director and UNDP, as necessary.

ANNEX 2

Supplemental Provisions to the Project Document: The Legal Context

General responsibilities of the Government, UNDP and the executing agency

1. All phases and aspects of UNDP assistance to this project shall be governed by and carried out in accordance with the relevant and applicable resolutions and decisions of the competent United Nations organs and in accordance with UNDP policies and procedures for such projects, and subject to the requirements under UNDP Monitoring, Evaluation and Reporting System.
2. The Government shall remain responsible for this UNDP-assisted development project and the realization of its objectives as described in this Project Document.
3. Assistance under this project document being provided for the benefit of the Government and the people of (the particular country or territory), the Government shall bear all risks of operations in respect of this project.
4. The Government shall provide to the project the national counterpart personnel training facilities, land, buildings, equipment and other required services and facilities. It shall designate the Government Co-operating Agency named in the cover page of this document (hereinafter referred to as the "Co-operations Agency"), which shall be directly responsible for the implementation of the Government contribution to the project.
5. The UNDP undertakes to complement and supplement the Government participation and will provide through the Implementing Partner the required expert services, training, equipment and other services within the funds available to the project.
6. Upon commencement of the project the Implementing Partner shall assume the responsibility for project execution and shall have the status of an independent contractor for this purpose. However, that primary responsibility shall be exercised in consultation with UNDP and in agreement with the Co-operating Agency Arrangements to this effect shall be stipulated in the Project Document as well as for the transfer of this responsibility to the Government or to an entity designated by the Government during the execution of the project.
7. Part of the Government's participation may take the form of cash contribution to UNDP. In such cases, the Implementing Partner will provide the related services and facilities and will account annually to the UNDP and to the Government for expenditure incurred.

(a) **Participation of the Government**

8. The Government shall provide to the project the services, equipment and facilities in the quantities and at the time specified in the Project Document. Budgetary provision, either in kind or in cash, for the Government's participation so specified shall be set forth in the Project Budgets.
9. The Co-Operating Agency shall, as appropriate and in consultation with the Implementing Partner, assign a director for the project on a full-time basis. He shall carry out such responsibilities in the project as are assigned to him by the Co-operating Agency.
10. The estimated cost of items included in the Government contribution, as detailed in the Project Budget, shall be based on the best information available at the time of drafting the

project proposal. It is understood that price fluctuations during the period of execution of the project may necessitate an adjustment of said contribution in monetary terms; the latter shall at all times be determined by the value of the services, equipment and facilities required for the proper execution of the project.

11. Within the given number of man-months of personnel services described in the project document, minor adjustments of individual assignments of project personnel provided by the Government, may be made in consultation with the Implementing Partner, if this is found to be in the best interest of the project. UNDP shall be so informed in all instances where such minor adjustments involve financial implications.

12. The Government shall continue to pay the local salaries and appropriate allowances of national counterpart personnel during the period of their absence from the project while on UNDP fellowships.

13. The Government shall defray any customs duties and other charges related to the clearance of project equipment, its transportation, handling, storage and related expenses within the country. It shall be responsible for its installation and maintenance, insurance and replacement, if necessary, after delivery to the project site.

14. The Government shall make available to the project - subject to existing security provisions - any published and unpublished reports, maps, records and other data, which are considered necessary to the implementation of the project.

15. Patent rights, copyrights and other similar rights to any discoveries or work resulting from UNDP assistance in respect of this project shall belong to the UNDP. Unless otherwise agreed by the parties in each case, however, the Government shall have the right to use any such discoveries or work within the country free of royalty and any charge of similar nature.

16. The Government shall assist all project personnel in finding suitable housing accommodation at reasonable rents.

17. The services and facilities specified in the Project Document which are to be provided to the project by the Government by means of a contribution in cash shall be set forth in the project Budget. Payment of this amount shall be made to the UNDP in accordance with the Schedule of Payments by the Government.

18. Payment of the above mentioned contribution to the UNDP on or before the dates specified in the Schedule of Payments by the Government is a prerequisite to the commencement or continuation of project operations.

(b) **Participation of the UNDP and the Implementing Partner**

19. The UNDP shall provide to the project through the Implementing Partner the services, equipment and facilities described in the Project Document. Budgetary provision for the UNDP contribution as specified shall be set forth in the Project Budget.

20. The Implementing Partner shall consult with the Government and UNDP on the candidature of the Project Manager[2] who, under the direction of the Implementing Partner, will be responsible in the country for the Implementing Partner's participation in the project. The Project Manager shall supervise the experts and other agency personnel assigned to the project, and on-the-job training of national counterpart personnel. He shall be responsible

[2] May also be designated Project Co-ordinator or Chief Technical Adviser, as appropriate

for the management and efficient utilization of all UNDP-financed inputs, including equipment provided to the project.

21. The Implementing Partner, in consultation with the Government and UNDP, shall assign international staff and other personnel to the project as specified in the roject Document, select candidates for fellowships and determine standards for the training of national counterpart personnel.

22. Fellowships shall be administered in accordance with the fellowship regulations of the Implementing Partner.

23. The Implementing Partner may, in agreement with the Government and UNDP, execute part or all of the project by subcontract. The selection of subcontractors shall be made, after consultation with the Government and UNDP, in accordance with the Implementing Partner's procedures.

24. All material, equipment and supplies which are purchased from UNDP resources will be used exclusively for the execution of the project, and will remain the property of the UNDP in whose name it will be held by the Implementing Partner. Equipment supplied by the UNDP shall be marked with the insignia of the UNDP and of the Implementing Partner.

25. Arrangements may be made, if necessary, for a temporary transfer of custody of equipment to local authorities during the life of the project, without prejudice to the final transfer.

26. Prior to completion of UNDP assistance to the project, the Government, the UNDP and the Implementing Partner shall consult as to the disposition of all project equipment provided by the UNDP. Title to such equipment shall normally be transferred to the Government, or to an entity nominated by the Government, when it is required for continued operation of the project or for activities following directly therefrom. The UNDP may, however, at its discretion, retain title to part or all of such equipment.

27. At an agreed time after the completion of UNDP assistance to the project, the Government and the UNDP, and if necessary the Implementing Partner, shall review the activities continuing from or consequent upon the project with a view to evaluating its results.

28. UNDP may release information relating to any investment oriented project o potential investors, unless and until the Government has requested the UNDP in writing to restrict the release of information relating to such project.

(c) **Rights, Facilities, Privileges and Immunities**

29. In accordance with the Agreement concluded by the United Nations (UNDP) and the Government concerning the provision of assistance by UNDP, the personnel of UNDP and other United Nations Organization associated with the project shall be accorded rights, facilities, privileges and immunities specified in said Agreement.

30. The Government shall grant UN volunteers, if such services are requested by the Government, the same rights, facilities, privileges and immunities as are granted to the personnel of UNDP.

31. The Implementing Partner's contractors and their personnel (except nationals of the host country employed locally) shall:

    (a) Be immune from legal process in respect of all acts performed by them in their official capacity in the execution of the project;

(b) Be immune from national service obligations;

(c) Be immune together with their spouses and relatives dependent on them from immigration restrictions;

(d) Be accorded the privileges of bringing into the country reasonable amounts of foreign currency for the purposes of the project or for personal use of such personnel, and of withdrawing any such amounts brought into the country, or in accordance with the relevant foreign exchange regulations, such amounts as may be earned therein by such personnel in the execution of the project; and

(e) Be accord together with their spouses and relatives dependent on them the same repatriation facilities in the event of international crisis as diplomatic envoys.

32. All personnel of the Implementing Partner's contractors shall enjoy inviolability for all papers a documents relating to the project.

33. The Government shall either exempt from or bear the cost of any taxes, duties, fees or levies which it may impose on any firm or organization which may be retained by the Implementing Partner and on the personnel of any such firm or organization, except for nationals of the host country employed locally, in respect of:

(a) The salaries or wages earned by such personnel in the execution of the project;

(b) Any equipment of the project or which, after having been brought into the country, may be subsequently withdrawn therefrom;

(c) Any substantial quantities of equipment, materials and supplies obtained locally for the execution of the project, such as, for example, petrol and spare parts for the operation and maintenance of equipment mentioned under (b), above, with the provision that the types and approximate quantities to be exempted and relevant procedures to be followed shall be agreed upon with the Government and, as appropriate, recorded in the Project Document; and

(d) As in the case of concessions currently granted to UNDP and Implementing Partner's personnel, any property brought, including one privately owned automobile per employee, by the firm or organisation or its personnel for their personal use or consumption or which after having been brought into the country, may subsequently be withdrawn therefrom upon departure of such personnel.

34. The Government shall ensure

(a) Prompt clearance of experts and other persons performing services in respect of this project; and

(b) The prompt release from customs of:

(i) Equipment, materials and supplies required in connection with this project; and

(ii) Property belonging to and intended for the personal use or consumption of the personnel of the UNDP, its Executing Agencies, or other persons performing services on their behalf in respect of this project, except for locally recruited personnel.

35. The privileges and immunities referred to in the paragraph above, to which firm or organization and its personnel may be entitled, may be waived by the Implementing Partner where, in its opinion or in the opinion of the UNDP, the immunity would impede the course of justice and can be waived without prejudice to the successful completion of the project or to the interest of the UNDP or the Implementing Partner.

36. The Executing Agency shall provide the Government through the Country Director with the list of the personnel to whom the privileges and immunities enumerated above shall apply.

37. Nothing in this Project Document or Annex shall be construed to limit the rights, facilities, privileges or immunities conferred in any other instrument upon any person, natural or juridical, referred to hereunder.

(d) Suspension or termination of assistance

38.

a) The UNDP may by written notice to the Government and to the Implementing Partner concerned to suspend its assistance to any project if in the judgement of the UNDP any circumstance arises which interferes with or threatens to integration of the successful completion of the project or the accomplishment of its purpose UNDP may, in the same or subsequent written notice, indicate under which it is prepared to resume its assistance to the project. Any such suspension shall continue until such time as such conditions are accepted by the Government and as the UNDP shall give written notice to the Government and the Implementing Partner that is prepared to resume its assistance.

b) If any situation referred to in paragraph 1, above, shall continue for a period of fourteen days after notice thereof and of suspension shall have been given by the UNDP to the Government and the Implementing Partner, then at any time thereafter during the continuance thereof, the UNDP may by written notice to the Government and the Implementing Partner terminate the project.

(a) The provisions of this paragraph shall be without prejudice to any other rights or remedies the UNDP may have in the circumstances, whether under general principles of law or otherwise.

GEF

Global Environment Facility

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Washington, DC 20433 USA
Tel: 202.473-0508
Fax: 202.522.3240/3245
Internet: www.theGEF.org

July 25, 2007

Mr. Yannick Glemarec
Acting GEF Executive Coordinator
United Nations Development Programme
One United Nations Plaza
New York, NY 10017

Dear Mr. Glemarec:

I am pleased to inform you that I am approving the medium-sized project proposal entitled ***India: Energy Conservation in Small Sector Tea Processing Units in South India.***, for $950,000 in financing from the GEF Trust Fund. I understand that this project proposal will be submitted for approval in accordance with the UNDP procedures. I note that a project preparation grant of US$25,000 was previously approved for preparation of this project and that a report on the completion of activities of this grant has been submitted to the GEF Secretariat. Taking into account the project preparation funds, the total GEF grant for the project is US$975,000.

I am also approving the fee of $97,500 representing 10.00% of the project allocation for implementation services.

I am approving this project on the understanding that the project will meet the following milestones:

(i) the grant agreement will be signed no later than September 2007;
(ii) the closing date of the project grant will be no later than December 2011 and a terminal evaluation/project completion report will be submitted to the GEF Secretariat within 6 months of such closing date.

You are requested to ensure that the GEF Secretariat is informed when each of these milestones is met. If any milestone is not achieved, and after consultations with your agency, I may agree to revised milestones or recommend cancellation, termination, or suspension of the project, and I will communicate to the beneficiary country and your agency the basis for such a recommendation.

Please ensure that your grant agreements continue including a closing date and providing for your agency's right of cancellation, suspension or termination upon my recommendation to that effect.

I am attaching a copy of the project tracking sheet for your records.

Sincerely,

Monique Barbut
Chief Executive Officer and Chairperson

Climate Change
OP : 5

PMIS Project ID : 2500
UNDP

GEF Project Tracking System
Medium-Sized Project Clearance/Approval

India: Energy Conservation In Small Sector Tea Processing Units In South India.

[redacted]	GEF Contribution	Total Cost	Recommended Action	Signature	Date
[redacted]	$25,000	$25,000			
Program Manager	Approved 6/15/04		Recommendation	Zhiliang Zhang	
			Recommendation		
Team Leader			Clearance	Richard Hosier	
CEO			Approval	Monique Barbut	
MSP Review	$975,000	$2,075,000			
Program Manager			Recommendation		6/29/07
			Recommendation		
Team Leader			Clearance	Richard Hosier	7/2/07
CEO			Letter to Council	CEO Letter to Council	7/2/07
MSP Approval	$975,000	$2,075,000			
IA Fee	$97,500				
Program Manager			Recommendation	Zhiliang Zhang	7/25/07
			Recommendation		7/25/07
Team Leader			Clearance	Richard Hosier	7/25/07
CEO			Approval	Monique Barbut	

MEDIUM-SIZED PROJECT PROPOSAL
REQUEST FOR GEF FUNDING

GEF

GEFSEC PROJECT ID: 2500
AGENCY'S PROJECT ID: PIMS 3163
COUNTRY: India
PROJECT TITLE: Energy conservation in small sector tea processing units in South India
GEF AGENCY: UNDP
OTHER EXECUTING AGENCY (IES):
DURATION: 4 years
GEF FOCAL AREA: Climate Change
GEF STRATEGIC OBJECTIVE: CC-2 Promote industrial energy efficiency
GEF OPERATIONAL PROGRAM: OP-5
IMPLEMENTING AGENCY FEE: US $ 87,750
CONTRIBUTION TO KEY INDICATORS OF THE BUSINESS PLAN: The total direct CO_2 emission reduction is estimated to be 56,925 tonnes. Further emission reduction through the replication effect would result in indirect CO_2 reduction of 170,775 tonnes.

FINANCING PLAN ($)		
	PPG	Project*
GEF total	25,000	950,000
Co-financing	(provide details in Section b: Co-financing)	
GEF IA/ExA		
Government		240,625
Others		859,375
Co-financing total		1,100,000
Total	25,000	2,050,000
Financing for Associated Activities If Any:		

MILESTONES	DATES
PIF APPROVAL	Nov 2004
PPG APPROVAL	Nov 2004
MSP EFFECTIVENESS	Sept. 2007
MSP START	Dec. 2007
MSP CLOSING	Dec. 2011
TE/PC REPORT*	Dec. 2011

*Terminal Evaluation/Project Completion Report

Approved on behalf of the *UNDP*. This proposal has been prepared in accordance with GEF policies and procedures and meets the standards of the Review Criteria for GEF Medium-sized Projects.

Y. Glemarec

Yannick Glemarec
Executive Coordinator
Date: 29 June 2007

Project Contact Person
Martin Krause
Regional Technical Advisor Climate Change
Tel. and email: +6622882722; martin.krause@undp.org

LIST OF ABBREVIATIONS

ADB	Asian Development Bank
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CGPL	Combustion, Gasification, Propulsion Laboratory (Indian Institute of Science)
CO2	Carbon dioxide
COP-8	Conference of Parties
CTC	Cut Tear Curl
EE	Energy efficiency
FD	Forced Draft
GEF	Global Environmental Facility
GHG	Green House Gases
ID	Induced Draft
IREDA	Indian Renewable Energy Development Agency
KL	Kilo liters
KWh	Kilo Watt Hours
MWH	Mega Watt hours
NILMA	Nilgiris District Tea Producers Marketing Co
NSC	National Steering Committee
PD	Project Director
PMU	Project Management Unit
PSC	Project Steering Committee
PSGCT	PSG College of Technology
TEDA	Tamil Nadu Energy Development Agency
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UPASI	United Planters Association of South India

PART I - PROJECT

1. PROJECT SUMMARY

A) PROJECT RATIONALE, OBJECTIVES, OUTCOMES/OUTPUTS, AND ACTIVITIES

India is the largest tea producing country in the world producing 870 million kgs of tea annually. Most of the tea is grown in the North east states of the India. South India, which is the focus of attention of this project has a total of 89,000 hectares under tea cultivation and produces 203 million kgs of tea annually, which is nearly 24% of the annual production. Over a quarter million plantation workers are employed in tea gardens in South India. Over the past two decades there has been a rapid expansion in the small sector tea industry with a large number of farmers in the Nilgiris district of Tamil Nadu converting to this plantation crop. There are 350 tea factories in south India with 125 of them being in the small sector. All these tea factories rely heavily on biomass to meet their thermal energy requirements for tea drying. Tea processing is energy intensive with energy costs constituting 30% of the total processing cost. There has been no significant intervention to reduce energy consumption by the sector.

There are several problems, challenges and barriers in implementation of energy efficient interventions. The tea industry has gone through a crisis and is recently in a reform mode. Past interventions have not been well accepted by the industry mainly because of inadequate knowledge about the limitations of the technology and conditions for optimum delivery by the technology. This has created an atmosphere that is not very receptive to acceptance of options for energy efficiency. Barriers exist due to limited information and awareness about potential for increased profitability from energy saving, technology options. There are also financial barriers that would come in the way of decision making for adoption of energy efficient packages. The project would like to experiment with a very innovative approach of risk insurance for reducing the risk perception associated with new technology adoption. TIDE proposes to work in association with insurance consultants and insurance companies to develop a scheme that creates a positive environment for acceptance of energy efficient / renewable energy technology. It would also interact with NABARD to explore current crop insurance schemes for tea growing and if they could be extended for tea processing. This experiment, if successful would be replicable in many other similar projects.

The goal of the intervention is: "*Reducing energy consumption from tea processing units in south India, thereby restricting GHG emissions*". The project objective is "*To remove barriers and develop replicability strategies for energy efficiency and energy conservation interventions in the tea processing industry in South India*". The outcomes of the project are:

1. Awareness creation among the target sector about energy efficiency / renewable energy technologies and their relation to profitability
2. Elimination of financial barriers that inhibit investment in energy conservation equipment
3. Adoption and procurement of energy efficiency / renewable energy equipment / practices
4. Learning, knowledge sharing and replication

The project will support at least 30 factories in South India to adopt energy efficient equipment and practices that would accumulatively save 55,800 tons of direct CO_2. In addition 1,125 tons of

direct CO_2 will be saved due 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 reform created by the project would have a replication effect and momentum to sustain beyond the project period. In such a scenario, the indirect CO_2 emission reduction is expected to be 170,775 tonnes over the next ten years.

B) KEY INDICATORS, ASSUMPTIONS, AND RISKS

Key indicators are:

- 30 tea processing units in south India adopt energy efficient equipment and practices within the project period resulting in accumulative saving of 56,925 tons of direct CO_2
- Estimation of extent of new investment in energy efficient technology annually from the second year
- Number of factories that have invested in energy efficient equipment, nature of equipment and analysis of the same
- Tea Board imbibes the project methodology and extends the same to other tea clusters

Key assumptions are:

- Unforeseen policy interventions make the project irrelevant
- The industry responds favourably to project initiatives
- Tea factories invest in energy efficient equipment
- Financial institutions continue to remain interested in lending to the sector if plagued by unforeseen adverse circumstances
- Tea factories, equipment suppliers accept the services of the energy service provider and his business stabilizes during the project period

2 - COUNTRY OWNERSHIP

A) COUNTRY ELIGIBILITY

India ratified United Nations Framework Convention on Climate Change (UNFCCC) on November 1, 1993

B) COUNTRY DRIVENNESS

India is a net importer of energy and energy conservation is a thrust area for the Government of India. The Bureau of Energy Efficiency (BEE), Ministry of Power set up under the Energy Conservation Act 2001 is committed to strengthening the ongoing Indian industry program for energy conservation. The Energy Conservation Act 2001 empowers the Central and State Governments to facilitate and enforce efficient use of energy and its conservation. In its current form the Act "promotes" rather than "regulates" energy conservation. The salient features of the Act are

- It specifies norms for processes and energy consumption standards for equipment / appliances which consume, generate, transmit or supply energy

- It establishes and prescribes energy consumption norms and standards for designated consumers as it may consider necessary.

The major gap in compliance and enforcement of the Energy Conservation Act is the weak penalty for failure to adhere to the stipulated norms. The maximum penalty is Rs 10,000 (US$ 220). The penalty is applicable only after 5 years of the commencement of the Act (2001). Also the offence is outside the jurisdiction of a Civil court and needs to be adjudicated by a state government official. The Act is heavily biased towards regulation of consumption of electrical energy and is silent on the abuse and misuse of firewood for thermal energy needs and other sources of energy.

Energy conservation in the small scale tea processing falls under the guidelines of this Act. BEE has recognized the energy intensive nature of tea processing and has constituted an award for energy efficiency in the tea sector. The Bureau of Energy Efficiency rewards the best practices on energy conservation in 33 energy intensive industry sectors. The tea industry was included for the award only in the year 2005 and no tea processing unit has won the award as yet.

Applications / nominations are sought from the select industry sectors through a public announcement. The objective is to give national recognition to select industrial units who have made serious and systematic attempts at efficient utilization of energy.

3 – Program and Policy Conformity

A) Program Designation and Conformity

The project aims to remove barriers to energy conservation and energy efficiency that inhibit the realization of large energy saving potential in the tea sector. Tea processing is energy intensive requiring both thermal and electrical energy. The programmatic objectives of OP5 that suggest interventions in industrial energy consumption and manufacturing processes and energy for agro processing industries are very pertinent in this project. Capacity building, training and awareness creation are large components of the project activities and establish that the project is in conformity with OP5. The project is in conformity with CC-2 "Promote industrial energy efficiency".

B) Project Design

Context

India is the largest tea producing country in the world producing 870 million kgs of tea annually. Tea processing is energy intensive and data from energy factories show that energy costs constitute more than 30% of the cost of tea production. Energy audit data indicates that 0.5 KWh of electrical energy and 1.5 kg firewood is consumed to produce 1 kg of made tea and that it is possible to save 20% each of electrical and thermal energy. This translates to 435 million units of electricity and 1.3 million tons of firewood consumed annually. Energy efficient interventions in the sector therefore have the potential to conserve 87 million units of electricity and 0.26 million tons of firewood annually.

The tea industry has been going through a crisis where the small growers and processors are hit the hardest. The tea industry has identified quality in all aspects as the key in overcoming this crisis. The Tea Board under the Ministry of Commerce has launched a Quality Up gradation Programme in July 2000 aimed at the small sector in tea growing areas in South India – also the focus of the present project. The industrial policy of some tea growing state governments has proposed the enlargement of ancillary industries to tea. The project proposes strengthening of ancillary units.

Tea processing requires both thermal and electrical energy. (The process of tea making and the possible interventions for energy conservation are given in the appendix on technology issues). Firewood, a precious forest resource is most often the input for thermal energy (the major component of energy consumption) and most efforts were concentrated on reducing the thermal energy requirement. Many research institutions have developed technology options for energy conservation measures in tea processing but with limited success. In south India attempts were made to introduce biomass gasifiers for meeting both the thermal and electrical energy needs. Solar air pre-heaters were also introduced to preheat the air and thus reduce energy requirement from burning firewood for hot air generation.

The PDF phase has revealed that elements necessary for energy conservation are currently not in place. The sector requires information about options for energy efficiency and expected post installation performance of equipment. Companies are also not aware of tools and methods of measuring the performance of energy saving equipment and were thus unable to link energy conservation measures initiated by them to reduced cost of production.

The tea industry in India is mostly concentrated in the East and North East regions of the country. Most equipment suppliers are located in Calcutta and the South Indian tea processing industry is not their focus. The tea processing industry in south India therefore has very limited interaction with reputed suppliers of equipment and has not been sufficiently exposed to new equipment and practices. The density of tea factories in the Nilgiris district of Tamil Nadu (unlike in the north east India) should make the region ideal for low cost introduction of energy efficiency

Tea estates and factories are family owned and not professionally managed. Family run businesses could survive in the past because of India's trade treaty with undivided USSR. But the collapse of USSR and consequently the trade agreements created a crisis in the South Indian tea industry. The industry needs to modernize and initiate energy conservation measures for its survival but does not have the means and the linkages to do so. A project of this nature than brings in information and new technology is required by the industry for its survival.

Barriers

The PDF phase of the project has identified barriers to the adoption of energy efficient equipment and practices. The PDF phase conducted qualitative group discussions among tea factory owners to assess perceptions about energy usage reform and enable a listing of barriers to adoption of energy conservation equipment and practices. The following barriers have emerged during the discussions:

Information barriers

1. Inadequate information for informed decision making on factory modernization. There is very little quantified information about equipment specific energy consumption
2. Lack of information about options for thermal energy conservation constituting 70 – 80% of the total energy consumption
3. Absence of a mechanism for information flow about emerging technology options and their performance

Technology barriers

1. Poor acceptance of past interventions in renewable energy technology options like solar air preheating and wood gasifiers. This can be attributed to not defining the limits of acceptability of the technology. (e.g. wet wood not suitable for wood gasifiers, solar preheating not recommended in high ranges with insufficient number of sunny hours per day).
2. Fuel efficient air heater expected to have high acceptability is of recent origin (first air heater operating satisfactorily installed only a year ago.
3. Operation and maintenance protocols for optimum use of thermal energy equipment not followed. Need for scientifically designed operator training programmes

Financial barriers

1. The cost of new technology is high. (Rs 600,000 – Rs 1,200,000 i.e. US$ 13,636 – US$ 27,272). There is inadequate data on return on investments from energy saving alone. This creates barriers to financial decision making for acquisition of new technology
2. Banks, although willing to lend to the sector are unable to take decisions about lending in the absence of information about techno economic feasibility of energy saving equipment

Sector specific barriers

1. Crisis in tea industry as a result of non-remunerative prices for tea. Energy efficiency was not a priority. The situation however has improved and the industry is more positive.
2. Current practices in the sector undervalue the use of information based analysis and decision support
3. Lack of the necessary infrastructure for repair, maintenance and trouble shooting
4. Barriers related to the risk perception associated with adoption of energy efficient technology have also been identified. The project therefore proposes to experiment with an innovative risk insurance scheme for reducing the risk perception associated with new and renewable energy. If this experiment is successful, it would be replicable across many GEF projects and show the way for faster adoption of energy efficient technology in other industry sectors as well.

Incremental Cost Reasoning

Baseline situation

Inefficient use of electrical and thermal energy is contributing to high release of CO_2 into the atmosphere. Each small tea factory consumes 300,000 KWh of electricity and 900 –1200 tons of firewood annually releasing 1600 –2100 tons of CO_2 into the atmosphere. South India, the focus

of attention of this project produces 200 million kgs of tea annually consuming 100 million KWh of electricity, 300,000 tons of firewood and releasing 540,000 tons of CO_2. (1 kg of made tea requires 0.5 KWh of electrical energy and 1.5 kg of firewood; the average production capacity of a tea factory is 600,000 kgs of tea annually).

Nilgiris district alone produces 75 million kgs of tea annually and 112000 tons of firewood is transported into the district annually from a distance of about 250 kms. 12 tons of firewood can be loaded onto one truck implying 9330 truck loads are transported annually covering a distance of 500 kms per trip. If the truck consumes 1 liter of diesel for every 4 kms traversed, 1166 KL of diesel is consumed annually just for transporting firewood to the tea factories releasing 3500 tons of CO_2 annually (1 KL diesel equivalent to 3 tons of CO_2).

Energy efficiency is not a priority with tea factories because of inadequate capacity and data for decision making. Some tea factories have invested in energy efficient equipment but data on resulting energy conservation has not been collected. There is no formal mechanism for sharing technical information among other tea factories. In the absence of GEF interventions, information compilation, its dissemination and exploitation would continue to remain unaddressed. Data collection has largely been limited to commercial information that is traditionally not made public.

In spite of India being the largest producer of tea in the world, availability of energy efficient equipment is a recent development. This has been a slow process because of the sluggish response of the industry towards investment in energy reform. However the baseline today is that, as a result of Tea Board initiatives, the industry has started accepting reform in other sectors especially in regard to quality up gradation. The cost of energy is also rapidly increasing, and the time is right for the project to create an environment for bringing energy issues to the fore. There is no other initiative currently visualized for this.

Another baseline situation is that the cost of energy efficient equipment is high. The high cost can perhaps be justified by lower sales. The linkages that the PDF phase has already developed with all stakeholders can be leveraged to reduce prices but this alone would not be enough address the financial barriers.

Project alternatives

The GEF intervention will address all barriers. The intervention will close the technical information gap, create mechanisms for technical data collection and sharing thus introducing information based decision support system to the sector. Data collected during the pdf phase was shared with the industry in the stake holder meeting and this was the first initiative for technical information sharing in the small sector.

The project will address the technology barriers especially about factory specific data generation and will offer energy audits on a cost sharing basis. This would contribute to bringing energy conservation as a priority item to the factory agenda. The project will address information,

technology and financial barriers simultaneously so that resistance to investment in energy efficient equipment would be minimized.

In addition to interacting with financial institutions for providing loans to factories the project also proposes to experiment with a novel risk insurance scheme. The project proposes to associate with progressive insurance providers and energy efficient equipment suppliers to develop a scheme that would insure factory owners against below par performance of select energy efficient equipment. The current projections are that the pay back periods for energy efficient equipment from fuel saving alone would be less than 3 years. Although the life of the equipment is expected to be 10 years, the risk insurance scheme would be time bound and operational for 3 years. The project would bear the premium cost on behalf of factory owners for the first year when the threat of below par performance of equipment is high. The details would be worked out in the first year of project implementation. It is expected that with access to bank loans and risk coverage the adoption of energy efficient equipment would gain rapid impetus.

Energy conservation measures will be introduced in 30 factories during the project period. Estimation of the CO_2 reduction has been done using the GEF methodology. This considers the direct and indirect CO_2 effects using the bottom – up approach. Please refer to the Excel sheet for CO_2 calculations.

Direct CO_2 reduction is expected from saving in thermal and electrical energy after installation of energy efficient equipment and from reduced consumption of diesel because of reduced vehicular movement consequent to reduced consumption of firewood.

A 10% reduction in thermal energy would reduce release of 160 –210 tons of CO_2 by each factory. A 10% reduction in electrical energy would conserve 30,000 KWh of energy and prevent release of 24 tons of CO_2 annually (1000 kWh electricity equivalent to 0.8 tons of CO_2. The 30 factories that would adopt energy efficient practices and save at least 10% each of electrical and thermal energy would therefore prevent release of 4800 tons of CO_2 annually beyond the project period from thermal energy interventions and 720 tons of CO_2 from electrical energy conservation measures. Direct CO_2 reduction through project interventions would be approx. 55,800 tonnes

Direct CO_2 reduction is also expected because reduced firewood consumption would result in reduced number of truckloads carrying firewood to the hills where tea is grown and processed. The project interventions would lead to reduced number of truckloads carrying firewood into the hills. The PDF phase has calculated that 37.5 KL of diesel would be saved preventing release of 112.5 tons of emissions annually beyond the project period. For a 10 year period indirect reduction in CO_2 would be 1125 tons. This would also contribute to environment improvement and safety in the ecologically sensitive Nilgiris district. Detailed estimates of global environmental benefit of the project is given in the appendix on CO_2

The total direct CO_2 emission reduction as a result of project interventions during the project period is estimated to be 56,925 tonnes. Further emission reduction through the replication effect as a consequence of project implementation would result in indirect CO2 reduction of 170,775 tonnes.

One emerging technology option is the improved air heater that burns firewood generating hot flue gases. This recently introduced air heater has higher surface area for heat transfer and requires very little maintenance. Presently each factory spends US$ 1750 on maintenance every year nearly 5% of the cost of the equipment and the new air heater would reduce the maintenance costs in addition to saving fuel costs.

There are also several options for reducing the electrical energy consumption in tea factories. Ensuring that the load factor is around 0.9, use of energy efficient fans and motors and proper selection of FD and ID fans are some of the options for reduction in electrical energy consumption. It is estimated that these and other measures can conserve about 20% electrical energy.

It is therefore clear that while technology for introducing energy efficiency in tea factories is available, it's positioning and exploitation has not yet happened.

Global environmental benefits of project

The project aims to reduce global environmental emissions by introducing technology that would reduce consumption of firewood. During the pdf phase the project has understood that some factories use agro residue briquettes but most factories use firewood. The firewood has been tracked to its origin and it is learnt that the species of firewood used are silver oak, acacia, eucalyptus and tamarind. Acacia, eucalyptus, and tamarind are grown on fallow land and transported from a distance of 250 -350 kms. Discussion with firewood dealers reveals the absence of any sustainable biomass cultivation at the point of origin of biomass. However, some of the larger estates do have their own energy plantation from where biomass is harvested sustainably. In this scenario, it would be realistic to assume that unsustainable biomass is used in more than half of the factories in the project area.

The following assumptions have therefore been made to assess the global environmental benefit of the project:

1. As thermal energy constitutes about 70-80% of the energy used, global environmental benefits have been computed for saving in thermal energy alone.
2. 30 factories would adopt energy efficient equipment and practices to save at least 10% of the thermal energy. (each factory would save between 90 – 120 tons of firewood annually)
3. 20 of the 30 factories that adopt energy efficient equipment and practices are consumers of unsustainable biomass.

The estimated CO_2 emissions saved by adoption of renewable energy and energy efficient technology by 30 factories are 4860 – 6480 tons per annum.

The pdf phase has established that firewood originates in Ramnathpuram, Madurai and Tuticorin districts of Tamil Nadu and is transported into the Nilgiris district a distance of about 250 –350 kms. If each of the 30 target factories saves 100 tons of firewood then 3000 tons of firewood transported in 300 truck loads can be avoided. At 500 kms per return trip and 4 kms per liter of

diesel consumption, the project would save 37.5 KL of diesel annually reducing 112.5 tons of CO_2 emissions (1 KL diesel equivalent to 3 tons of CO_2).

If 20 of the 30 factories that adopt energy efficient equipment and practices were consumers of unsustainable biomass then the following can be possible approaches for estimating global environmental benefits:

Scenario 1: Unsustainable supply of firewood
20 of the 30 factories that would adopt energy conserving equipment and practices and who are currently assumed to use 900 –1200 tons of unsustainable biomass are releasing 32,400 – 43,200 tons of CO_2 annually (900 –1200 tons of firewood x 20 factories x 1.8 biomass to CO_2 conversion factor). 75 million kgs of tea produced by the small sector in south India releases 202,500 – 270,000 tons of CO_2. (75 million kgs tea x 1.5 –2 kgs firewood per kg of tea produced x 1.8 biomass to CO_2 conversion factor).

Scenario 2: Firewood saved will free sustain ably harvested firewood to meet demand elsewhere and replace diesel, kerosene etc. (considering that 30 factories adopt energy efficient options)
Based on current understanding of biomass usage patterns in tea factories, it is assumed that 10 of the target 30 factories are using sustain ably harvested biomass. The 10 factories would free 900 – 1200 tons of sustain ably harvested biomass to replace diesel annually. Assume that 4 tons of biomass is equivalent to 1 KL of diesel (true both for gasifier route or the conventional steam generation route) the project interventions would replace (900 –1200) / 4 = 225 to 300 tons of diesel annually

Scenario 3: Marginal fuel saved becomes coal
Ultimate analysis of firewood used in tea estates shows that on a moisture free basis the firewood contain 50% carbon by weight. Anthracite coal contains more than 90% carbon. Therefore theoretically two tons of wood should convert to about one ton of anthracite assuming that there is negligible carbon loss in the ultimate conversion of wood to anthracite coal. However, even assuming that there are carbon losses in the conversion of wood to coal and that the ratio of conversion of wood to carbon is 3:1, then the 900 –1200 tons of sustain ably harvested biomass conserved annually would increase coal reserves by 300 – 400 tons annually.

Project implementation strategy

The project implementation strategy has been conceived keeping in mind the barriers identified during the PDF phase, the need for confidence building about energy efficient equipment in the background of past attempts and issues of sustainability and replicability. The strategy has evolved considering the transient nature of the project, the presence of competent local institutions, the realization that sustainability of the intervention can be ensured only if local institutions and infrastructure are energized and that infusion of capital and resources is time bound and not unceasing.

This section discusses how the project strategy has evolved from barrier identification, analysis and planning of an intervention strategy comprising activities, outputs and outcomes.

The goal of the project is: "*Reducing energy consumption from tea processing units in south India, thereby restricting GHG emissions.*"

The objective of the project is "*To remove barriers and develop replicability strategies for energy efficiency and energy conservation interventions in the tea processing industry in South India*".

The project strategy comprises 4 outcomes with associated outputs and activities.

Outcome 1: Awareness creation among the target sector about energy efficiency / renewable energy technologies and their relation to profitability

Activities are:

- Networking with various individuals/ organizations associated with energy efficiency for the industry and involving them in achieving the project goal
- Understanding the information needs of the tea factories and compilation of information brochures, publicity material, brochures of equipment suppliers, information on Tea Board schemes and dissemination of this information through mail campaigns
- Creation of a web site for the project with appropriate content.
- The PDF phase has understood that one of the reasons for the information barrier is the absence of information. The project would seek to create information by demonstration of energy efficient equipment and practices on a cost sharing basis in select receptive tea factories and data collection on the performance of the equipment
- The project would organize interaction meets with energy consultants, buyer sellers meets with equipment providers. These meetings would be held in convenient locations so that travel to meetings is not a barrier.
- The project would ensure that its awareness creation efforts would reach out to every factory in south India.

It is expected that as a result of the awareness campaigns, tea factory owners would be able to discern good performance and demand the same. The project team realizes that information creation is dynamic and constantly evolving. It therefore proposes to creation infrastructure for knowledge creation and sharing during the project period. It is expected that this center would be self sustaining beyond the project period. The project has contacted the Tea Research Foundation, a research facility of the Indian Council for Agricultural Research to be the hub of all knowledge creation, management and dissemination and offered to support it during the project period. The TRF currently has several other research and analysis facilities catering to the pre harvest stage.

Outcome 2: Elimination of financial barriers that inhibit investment in energy conservation equipment

The activities for the delivery of this outcome are:

- Dialogue with commercial lending institutions for attractive commercial lending terms for procurement of energy efficient equipment. (Dialogue has commenced with commercial banks and they are willing to offer attractive terms for investment in energy efficiency equipment. Letters of commitment have already been obtained by banks and these are projected as co financing commitments). The industry associations have indicated that they would take the lead in this activity but they need to be equipped with information about equipment performance and cost effective options for energy conservation.

- Another technology cum financial barrier expressed was that energy efficient technology specifically for the tea sector is just entering the market and the climate for investment in this option is perceived to be risky especially in the initial stages of technology adoption. A project activity that would address this problem is the development of a risk insurance scheme in association with progressive insurance companies, equipment suppliers and the agency identified for knowledge creation and management. It is too early to state how this scheme would develop, but the project team believes that the equipment supplier should commit to the exact energy saving possible with new technology and train operators in its operation. Independent evaluators should assess the performance of the equipment during the warranty period and the insurance agency should accept the same. The premium for risk insurance could be borne by the project for the first 30 factories that avail this scheme.

- The Tea Board is currently implementing a subsidy scheme for factory modernization that is scheduled to be in operation until the year 2008 in its current phase. Most of the energy efficient equipment recommended by the project is eligible for 25% subsidy under the scheme. The project would also seek the services of a financial consultant who would additionally recommend to the Tea Board non-financial incentives for adoption of renewable energy and energy conservation practices. The project would then dialogue with Tea Board to adopt the recommended incentives.

Outcome 3: Adoption and procurement of energy efficiency / renewable energy equipment / practices

The sector has a history of poor acceptance of renewable energy interventions. Analysis of past interventions shows that besides inappropriate technology selection, data was also not collected to identify limitations of the technology performance. Operator training was not carried out and infrastructure for maintenance and repair was not created. It was also seen that the technology providers were largely academics institutions seeking to field test the technology developed and not competent to leave behind an infrastructure for adoption and trouble shooting.

However there have been some recent interventions emerging from equipment suppliers. Fuel efficient air heaters have recently been commercialized and believed to save 15- 20% of thermal energy costs. Their costs are currently high but pay back period less than three years. If as a result of project intervention the rate of adoption increases then the equipment costs could come down. The project therefore would associate both with academic institutions and with equipment

suppliers to identify key equipment that should be promoted by the project and enhance infrastructure of existing agencies for the same.

The project has also identified some electrical energy saving equipment like FD and ID fans, which would regulate the air intake by the heaters and result in fuel efficiency. Data collected on moisture content in firewood during the PDF phase shows that storage of wood in covered yards would also reduce wastage of heat for drying wood.

Considering the above the project implementation strategy has planned the following activities to overcome the technology barrier:

- Factory specific energy audits to define baseline scenarios and identify factory specific interventions
- Monitoring the performance of key equipment installed (not defined to be energy efficient) but consuming large quantities of electrical and thermal energy
- Demonstration of select energy efficient technologies in tea factories and site visits to these installations.
- Encourage factories to store wood in covered yards and include drying yards as a component of factory modernization
- Develop and conduct training programs for air heater operators, factory managers etc. that would train them in adopting a package of energy efficient practices
- Bring together equipment suppliers, consultants, academic institutions to initiate modifications in existing equipment for energy conservation and make technology affordable
- Collect data to measure the energy conserved and disseminate the information
- Upgrade existing infrastructure to offer all technology services from installation, monitoring, trouble shooting to repair and maintenance. With this infrastructure developed, it is expected that renewable energy technologies with high potential for energy saving like the solar air pre-heaters would become popular in tea factories at lower altitudes.

Outcome 4: Learning, knowledge sharing and replication

The project is expected to be a pioneering effort at minimizing barriers and creating a positive environment for adoption of energy efficient practices. It is therefore important that the lessons learnt by this project are disseminated and assimilated by tea industry in other parts of the region. The activities that would be carried out to achieve this outcome are:

- Regular process documentation during the project period and beyond and its circulation
- Publication and circulation of a newsletter on project processes
- Exposure visits / Field visits to project site by other tea processing units
- An annual experience sharing workshop featuring all the stake holders
- Video documentation
- Presentations on project achievements in various forums

TABLE 1: Logical Framework and Objectively Verifiable Impact Indicators

Project Strategy	Objectively verifiable indicators				
Goal	*REDUCING ENERGY CONSUMPTION FROM TEA PROCESSING UNITS IN SOUTH INDIA, THEREBY RESTRICTING GHG EMISSIONS*				
	Indicator (quantified and time-bound)	*Baseline*	*Target*	Sources of verification	Risks and Assumptions
Objective To remove barriers and develop [illegible] replicability 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 accumulative saving of 56,925 tons of direct CO_2	Limited awareness about what is an energy efficient technology and its advantages Barriers identified for the first time in the pdf phase No strategy for replicability	Project to expose every tea industry in south India to energy conservation To demonstrate replicability by introducing energy usage reform in 30 factories. To directly save 56,925 tons CO_2	Field visit by external evaluators to the project sites and inspection of the data collected	Unforeseen policy interventions make the project irrelevant The industry responds favourably to project initiatives Tea factories invest in energy efficient equipment
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 2. Content developed and web site of the project launched in the first year	No history of awareness creation on energy usage reform Data from research / student projects / energy audit reports with individual institutions, not made public	An awareness creation vehicle and strategy that can be used by the industry beyond the project period Launch of a project web site and its regular up gradation	Review of the awareness creation material developed by the project including the web site and its assimilation by the target sector	The industry associations are pro active and their members participate in awareness meets / site visits The publicity material and web site content addresses the information needs

Output 1.1 Awareness about energy efficiency / renewable energy technologies of their relevance to tea units and implications of their adoption	1. Avenues for demonstration of select energy efficient technology options in tea factories created and site visits to these factories organized in the first year 2. Meetings / seminars / interaction meets with energy consultants, equipment suppliers organized in the first year. Project again reaches out to all tea factories	One seminar held on technology up gradation in tea factories that covered energy efficiency. Tea Board / UPASI initiated a study on energy consumption. Study findings presented in stakeholder meet organized by project.	Demystify energy efficiency / renewable energy technology by demonstration, data collection, analysis and dissemination of information in an organized manner	Field visits to technology demonstration sites, study of equipment performance monitoring reports and published proceedings	Equipment suppliers / academic institutions respond to the project request for information sharing
Output 1.2 Institutionalized mechanism for knowledge creation and management	1. Data on performance of energy efficient technology demonstrated, collected and made available at the project office in the first year 2. Project identifies and supports a local institution like the Tea Research Foundation to be the repository of knowledge created in the second year 3. Structured format for data collection and monitoring with data on CO_2 abated	R & D institutions catering to the needs of the tea industry focus on pre harvest technologies Limited understanding of what constitutes knowledge and its management	Create a sustainable institutionalized mechanism for knowledge creation and management that endures beyond the project period and expands to other knowledge gaps	Review of the methodology of data collection, its storage, use and up gradation. Meeting with local institution like the Tea Research foundation to review their commitments and obligations	Tea factories permit data collection and dissemination with their peers Tea Research Foundation obtains consent for becoming the repository of knowledge under the conditions of the project
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	Current financing mechanisms include Tea Board subsidy and commercial lending based on credibility of the factory. No schemes for availing energy conservation equipment	Leverage the project to create an atmosphere for easy and attractive access to finance energy conservation	Review of data and reports on the extent and ease of investments Meetings with financial institutions, tea factories and equipment suppliers	Financial institutions continue to remain interested in lending to the sector if plagued by unforeseen adverse circumstances
Output 2.1 Institutionalization of commercial lending for investments in energy efficiency / renewable energy	1. Biannual data collection on lending to tea factories for energy efficient equipment by commercial financial institutions from the second year	Financial institutions lending to tea factories on case to case basis. No data on lending for energy usage reform. Baseline data will be	Dialogue and motivate financial institutions for developing schemes for energy efficiency that begin with tea	Review of data and reports on the extent and ease of investments Meetings with financial institutions,	Financial institutions continue to remain interested in lending to the sector if plagued by unforeseen adverse

equipment		collected during the course of the project	but expand to other industries	tea factories and equipment suppliers	circumstances
Output 2.2.1 Development and operationalization of the risk insurance scheme	1. Risk insurance scheme evolved and implemented in the second year 2. Measurement of the extent of utilization of the risk insurance scheme in the third year	No precedent for risk insurance in the tea industry and for availing new energy efficient equipment	Conceptualize and operationalize a pioneering risk insurance scheme	Study of the documents of the risk insurance scheme and meetings with beneficiaries	The project team may not be able to enthuse insurance agencies to evolve and participate in risk insurance schemes
Outcome 3: Adoption and procurement of energy efficiency/renewable energy equipment/ practices	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	No vision in the current tea establishments on the structure and operations of a market driven energy service provider Decision on investment in new equipment driven by factors like breakdown and not energy conservation	Facilitate the creation of a market driven enterprise and through its intervention motivate 30 tea factories adopt energy efficient equipment and practices	Review of the database containing all information Review of factory specific documentation Field visits	Tea factories, equipment suppliers accept the services of the energy service provider and his business stabilizes during the project period
Output 3.1: Nurturing the market driven establishment(s) offering all components of energy service to the target sector	1. Listing of the energy efficient services and equipment promoted by the project. 2. Definition of the market driven establishment and its business plan 3. Extent of physical and financial support offered to the tea factories, equipment suppliers and the market driven establishment	No dedicated service provider for offering all aspects of energy efficiency. Definition of what is an energy efficient technology required.	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	Review of classification of energy efficient equipment and services Review of the business plan of the market driven establishment and its performance	The energy service provider / market driven establishment continues to service the sector after the project withdraws support to it.
Outcome 4: Learning, knowledge sharing and replication	Tea Board imbibes the project methodology and extends the same to other tea clusters Assessment of how the implementing agency has leveraged the project for its own qualitative and quantitative growth	No energy efficient interventions in other tea growing regions in India Current status of learning and adaptive management of TIDE being documented by an	Document the learning, evaluation and adaptive management processes initiated by the project for a larger audience	Minutes of meetings of Tea Board where the project has been mentioned / discussions with Tea Board officials. Review of the other	Local conditions in other industry clusters do not inhibit the replication of the project outputs and outcomes

		external agency		activities of the implementing agency	
Output 4.1 Capacity building of agencies involved to replicate of energy efficiency projects in other areas and sectors	Tea Board initiates visits / interaction meets to project sites from other tea processing clusters Number of projects / publications on energy efficiency that TIDE is implementing from third year onwards	TIDE has introduced energy efficient technology and enterprise models in informal industries. Limited exposure to formal industries	Strengthen the institutional mechanisms in TIDE to conceive and implement energy efficiency / CDM projects	Documentation of field visits / interaction meets and their follow up. Review of how the implementation agencies have leveraged the project for intervention in other sectors	The agencies involved in project implementation are able to build capacity and infrastructure for executing similar projects

C) SUSTAINABILITY (INCLUDING FINANCIAL SUSTAINABILITY)

The PDF phase has developed the project proposal considering the following aspects of sustainability:

- Technical sustainability
- Financial sustainability
- Social, economic sustainability
- Environmental sustainability
- Institutional sustainability
- Actions towards sustainability outside the project
- Actions towards sustainability beyond the project

A key indicator of **technical sustainability** is that the energy efficient equipment is emerging out of R&D institutions and offered through equipment suppliers. Energy audit recommendations suggest that conventionally available equipment like FD / ID fans, capacitors can be used in an innovative way contributing to energy efficiency. It is feasible to include drying yards to store dry firewood in the Tea Board subsidy scheme and get it into the energy conservation package. The project target of compilation of information which, when implemented and conversion of 30 factories would demonstrate the technical sustainability of project interventions

Financial sustainability can be achieved during the project period. Letters of commitment from the banks and IREDA indicate the presence of a sustainable mechanism for financing energy efficient equipment. The project stipulation that the entire investment for energy efficient equipment should come from equity and loans also contributes to the sustainability of the interventions. The factory modernization scheme of the Tea Board that provides capital subsidy of 25% emphasizes the need and acceptance of energy usage reform by the sector. Operationalization of the risk insurance scheme would reduce financial barriers

The project does not have any specific proposals for ensuring **social sustainability**. Barrier identification in the pdf phase suggests that crisis in the tea industry as a result of non remunerative prices and the current practices that undermine the value of information based analysis are socio economic barriers. But the project team expects that social sustainability would get addressed in the process of implementation of barrier removal strategies. The project is not competent to intervene in the economic downturn of the industry but its interventions would contribute to improved profitability for each factory.

Environmental sustainability is important especially as the project is located in the environmentally fragile hills of Nilgiris and Western ghats. The project would have a positive impact on air quality and deforestation. Project interventions would lead to a reduction in release of direct CO_2 of 56,925 tons. Project interventions are also expected to save about 3000 tons of firewood annually half of which is assessed to be unsustainable firewood.

Considering the transient nature of the project **institutional sustainability** has been built into the project proposal. The institutional mechanism developed in the PDF phase where the Tea Board

would be the executing agency of the project indicates the ownership of the project by the Tea Board, Ministry of Commerce. The project is therefore not a stand alone project but is compatible with the Tea Board scheme for factory modernization. The project strategy of not creating new institutions but strengthening existing ones, working in close collaboration with industry associations like NILMA, Bought leaf manufacturers association, research institutions, and financial institutions also contributes to institutional sustainability.

Actions towards sustainability outside project

There is consensus that reduction of energy cost is an area of concern in the tea industry. The Tea Board has initiated several schemes for factory modernization and quality upgrade. These schemes would uplift the sector and create an atmosphere for acceptance of new initiatives. An infrastructure development report submitted under the Industrial Infrastructure Up gradation Scheme for Nilgiris Tea Cluster to the Ministry of Commerce and Industry, Government of India is currently under review. This proposes wind energy systems for captive power generation, pilot projects for increasing the quantity of sustainable biomass used by the sector and agro residue based briquette facilities.

Actions towards sustainability beyond project period

The project activities would continue beyond the project period but by a local organization identified and initiated into the same during the project period. An industry association linked organization is expected to emerge from the Infrastructure Up gradation Scheme that could also deliver energy services. The Hill Area Development Board of the Government also focuses on environment management of the region and their involvement in the project beyond the project period can also be pursued.

D) REPLICABILITY

The project has a strong focus on replicability. Project outcome 4 will be exploited for the preparation of a replication strategy. The awareness programs, the information brochures and the information flow planned have been designed keeping the high potential of replicability of the project in other parts of the country, especially the North East.

The project would document the best practices in the adoption of energy efficiency by the tea processing sector and disseminate the same widely. The current project aims to introduce energy efficient equipment and practices in 30 tea factories in south India. There are 350 factories in south India and 1500 factories in the country establishing the potential for replication. The project interventions would penetrate the target market and the institutional mechanism would ensure that the project reaches out to newer areas. The Tea Board would facilitate exchange programs and interaction meets to expose the project interventions to the tea factories in North East India.

The project would initiate an operator training program for south India. In course of time it would facilitate the transition of some of the trainees into trainers through the training of trainers program. The project team would spend time in north east India to understand the energy use patterns there and modify operator training programs to suit other parts of the country. Exchange

visits would also be planned for technology providers and equipment suppliers to assess if the technology issues in other regions are at variance with south India tea factories.

The project proposes to bring in financial packages and an innovative approach to managing risk associated with new technologies. The project would create extensive documentation about the experiences and facilitate interaction between the financial institutions in South and North East India. The knowledge gained by the project team, the Tea Board and the Tea factories in south India would enable the development of a replication strategy for North East India. The project has proposed regional experience sharing workshops that would enable the development of a replication strategy for other regions.

The Tea Board would facilitate the development of the replication strategy and would also implement the same in north east India in consultation with stakeholders in other regions. While the strategy for replication would be developed only in the later part of the project, some of the key components of the replication strategy have already been identified and the Tea Board would assist the project team in acquiring information about North East India. Some components of the replication strategy as understood today are:

- Scale of operation of tea factories and need for modification of equipment design
- Type of fuel used and fuel consumption data
- Revision to the operator training programs
- Annual sunshine data at different locations
- Humidity data and need for thermal energy input for withering

- Presence of tea industry associations and their interest levels
- Profitability of the industry and the willingness of the tea factories to invest in energy efficient equipment
- Credibility of the industry among financial institutions and willingness of the commercial banks to lend to the sector
- Local issues like logistics for movement of equipment, availability of tea clusters etc.

The project would also explore replicability potential for Sri Lanka and recommend inputs required for development of replication strategy for Sri Lanka.

E) STAKEHOLDER INVOLVEMENT

Stakeholder involvement in project development

Stakeholders have been involved with the project from the time of project conceptualization. The project document has been developed in active association and collaboration with the various stakeholders. The presence of all stakeholders in the stakeholder meeting and the nature of deliberations are indicative of the keen interest of all stakeholders. A report on the stakeholder meeting is appended in the annexure on stakeholders. The Tea Board has taken the lead in organizing the stakeholder meeting. Industry associations, equipment suppliers, government owned tea factories committed support to the project by behalf of the tea industry. The research institutions have unreservedly shared all information and data available with them with all

stakeholders. The financial institutions reiterated their support for the project and actively canvassed for the status as sole bankers for the project. IREDA offered attractive financial packages for adopting renewable energy technology including free energy audits and detailed project report preparations if loans were availed from IREDA.

TEDA, the state nodal agency was represented by its Chairman and Managing Director and offered support to the project. Senior officials of the Ministry of Environment and Forests Government of India made field visits to the tea factories and had discussions with the Tea Board. They gave valuable advice that has added value to the project document.

Roles and responsibilities of stakeholders during project implementation

The project would be executed by the Tea Board, which would take overall responsibility for the execution of the project in accordance with UNDP guidelines. The project team would seek guidance from the National Steering Committee. They would be involved in the project monitoring and evaluation.

The Tea Board and TEDA would be associated in information dissemination linked activities and promoting the project at various forums. The various industry associations / equipment suppliers would be involved in organizing interaction meets / buyer seller meets. The Tea Research Foundation is proposed to be the hub of all knowledge created by the project. Facilitation and support services would be provided by the project.

TEDA would work towards the development of a technology up gradation fund currently available in the textile sector in the state of Tamil Nadu for the tea sector. TEDA would work towards enabling investments in windmills for power generation by the industry and also work towards obtaining an interest subsidy on capital equipment for the same. It would also help the industry in accessing IREDA funds and work towards providing subsidies for gasifiers for electrical application.

The institutional arrangements in the bought tea leaf sector will ensure involvement of the marginal groups. All benefits in tea processing are shared with the small growers and the labour engaged in tea plucking. The project would thus benefit the 65,000 small growers and 200,000 people employed in tea operations.

F) MONITORING AND EVALUATION

The principle components of the Monitoring and Evaluation Plan will include: (1) a project inception phase, (2) establishing monitoring responsibilities and events, (3) project reporting and (4) independent evaluations.

A Project Inception Workshop will be conducted with the full project team, relevant government counterparts, co-financing partners and UNDP representatives. The fundamental objective of this Inception Workshop will be to assist the project team to understand and take ownership of the project's goals and objectives, to finalize coordination arrangements with existing initiatives as well as to finalize the preparation of the project's first Annual Work Plan (AWP) on the basis of

the project's logic framework (logframe) matrix. This will include reviewing the logframe (indicators, means of verification, assumptions), imparting additional detail as needed, and on the basis of this exercise, finalizing the AWP with precise and measurable performance indicators, and in a manner consistent with the expected outcomes for the project. Targets and indicators for subsequent years would be defined annually as part of the internal evaluation and planning processes undertaken by the project team.

A Project Inception Report will be prepared immediately following the Inception Workshop. It will include a detailed Annual Work Plan (AWP) divided in quarterly time-frames detailing the activities and progress indicators that will guide implementation during the first year of the project. It will also include the project's Monitoring and Evaluation Plan.

Day to day monitoring of implementation progress will be the responsibility of the Project Manager, based on the project's Annual Work plan and its indicators. The Project Management Unit (PMU) will inform the UNDP CO of any delays or difficulties faced during implementation so that the appropriate support or corrective measures can be adopted in a timely and remedial fashion. Quarterly Progress Reports outlining main updates in project progress will be provided quarterly to the local UNDP Country Office (and forwarded to the UNDP-GEF RCU) by the Project Manager.

Periodic monitoring of implementation progress will be undertaken by monthly by a team comprising TEA Board and TIDE. This will allow parties to take stock and to troubleshoot any problems pertaining to the project in a timely fashion to ensure smooth implementation of project activities. The continuous monitoring and evaluation of the project sites, even after completion of the project period, will bring sustainability of the project with desired benefits in the long run.

The Annual Project Report (APR) - Project Implementation Review (PIR) is a self-assessment report by the PMC to the CO, providing inputs to the CO reporting process, as well as forming a key input to the UNDP/GEF M&E Unit, which analyzes the APR-PIRs by focal area, theme and region for common issues/results and lessons. The APR-PIR provides a more in-depth summary of work-in-progress, measuring performance against both implementation and impact indicators.

During the last three months of the project the project team will prepare a Project Terminal Report. This comprehensive report will summarize all activities, achievements and outputs, objectives met of the Project, as well as lessons learnt and structures and systems implemented. It will also lay out recommendations for any further steps that need to be taken to ensure sustainability and replicability of the Project's activities.

Thematic and Technical Reports will be prepared, as and when called for by UNDP/GEF or PSC. These are detailed documents covering specific areas of analysis or scientific specializations within the overall project. As part of the Inception Report, the project team will prepare a draft Reports List, detailing the technical reports that are expected to be prepared on key areas of activity during the course of the Project, and tentative due dates. Where necessary this Reports List will be revised and updated, and included in subsequent APR-PIRs. Technical Reports may also be prepared by external consultants. In addition, Project Publications will form a key method of crystallizing and disseminating the results and achievements of the Project.

These publications are informational texts on the activities and achievements of the Project, in the form of journal articles, multimedia publications, etc. These publications can be based on the Thematic and Technical Reports or may be summaries or compilations of a series of reports. The results from the project will be disseminated through a number of existing information sharing networks and forums. The project will participate, as relevant and appropriate, in UNDP and GEF sponsored knowledge networks, organized for staff working on activities that share common characteristics. The project will identify, analyze, and share lessons learned that might be beneficial in the design and implementation of similar future projects. Identify and analyzing lessons learned is an on- going process and communicating such lessons is a requirement to be delivered not less frequently than once every 12 months. UNDP/GEF shall provide a format and assist the project team in categorizing, documenting and reporting on lessons learned. To this end a percentage of project resources will need to be allocated for these activities.

The project will be subjected to at least two independent external evaluations as follows:

An independent Mid-Term Evaluation will be undertaken 18 months after project initiation. The Mid-Term Evaluation will determine progress being made towards the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation, will highlight issues requiring decisions and actions and will present initial lessons learned about project design, implementation and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the final half of the project's term. The organization, terms of reference and timing of the mid-term evaluation will be decided after consultation between the parties/ The Terms of Reference for this Mid-term evaluation will be prepared by the UNDP CO, based on guidance from the UNDP-GEF RCU.

An independent Final Evaluation will take place three months prior to the project's termination date and will focus on the same issues as the mid-term evaluation and, in addition, will also look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental goals. The Final Evaluation should also provide recommendations for follow-up activities. The Terms of Reference for this Mid-term evaluation will be prepared by the UNDP CO, based on guidance from the UNDP-GEF RCU.

TIDE will provide the UNDP Resident Representative with certified periodic financial statements, and with an annual audit of the financial statements relating to the status of UNDP (including GEF) funds according to the established procedures set out in the Programming and Finance manuals. The Audit will be conducted by the legally recognized auditor of the Government, or by a commercial auditor engaged by the Government .

The knowledge management center proposed at the Tea Research Foundation would ensure information flow for measuring the indicators ranging from technology, socio-economic and environmental factors (GHG emissions reduction).

A few data examples are provided below:

- Energy audits carried out in tea factories
- Demonstration units installed and data collected

- Publicity material developed and distributed
- Web site launched and regularly updated
- Interaction meets, buyer seller meets held
- Number of factories invested in energy efficient equipment and its performance
- Investment for availing energy efficient equipment

Table 1: Key Milestones in Monitoring and Evaluation:

Activity	Time Frame
Inception – proposed monitoring and evaluation plan	Within two months of approval of the project
Steering Committee meeting – Progress reporting	Once in a year
Project Implementation Review	Once in a year (GEF requirement)
Review by Project Implementation Team	Once a month based on field reports
Mid-Term evaluation	To be initiated after 1.5 years of implementation
Independent mid term Impact Review	Baseline setting within six months of implementation
Concurrent monitoring	Done internally based on activity reports sent by project staff
Periodic Reports	Quarterly reports to UNDP/GEF in the prescribed format
Management Audit	As per UNDP guidelines (Annual audit is mandatory for expenditures exceeding US $20, 000)
Documentation of Lessons Learnt by professional consultants	Synthesis reports/case study preparation for dissemination and advocacy purposes prepared (consolidation once in six months)
Field visits by UNDP	Once in a year or more if required
Final Evaluation	During the last 3 months

4. FINANCING

FINANCING PLAN, COST EFFECTIVENESS, CO-FINANCING, CO-FINANCIERS

a) PROJECT COSTS

Project Components/Outcomes	Co-financing ($)	GEF ($)	Total ($)
1. Awareness creation	50,000	233,800	283,800
2. Financial barriers	65,000	99,500	164,500
3. Adoption of EE/RE equipment/ practices	890,000	396,200	1,286,200
4.Learning, Knowledge, Replication	20,000	125,500	145,500
5. Project management budget/cost*	75,000	95,000	170,000
Total project costs	1,100,000	950,000	2,050,000

* This item is an aggregate cost of project management; breakdown of this aggregate amount should be presented in the table b) below.

b) PROJECT MANAGEMENT BUDGET/COST[1]

Component	*Estimated staffweeks*	*GEF ($)*	*Other sources ($)*	*Project total ($)*
Personnel*		-	-	-
Local consultants*	208	59,000	46,000	105,000
International consultants*		-	-	-
Office facilities, equipment, vehicles and communications		20,000	30,000	50,000
Travel		15,000	15,000	30,000
Miscellaneous		1,000	10,000	11,000
Total	208	95,000	75,000	170,000

** Local and international consultants in this table are those who are hired for functions related to the management of project. For those consultants who are hired to do a special task, they would be referred to as consultants providing technical assistance. For these consultants, please provide details of their services in c) below:*

c) CONSULTANTS WORKING FOR TECHNICAL ASSISTANCE COMPONENTS[2]

Component	*Estimated staffweeks*	*GEF($)*	*Other sources ($)*	*Project total ($)*
Personnel				
Local consultants	428	152,990	165,000	317,990
International consultants	96	292,840	0	292,840
Total	524	445,830	165,000	610,830

[1] Please find detailed explanations of cost calculations in the budget notes.

[2] Please find detailed explanations of cost calculations in the budget notes.

d) CO-FINANCING SOURCES[3] (expand the table line items as necessary)

CO-FINANCING SOURCES					
Name of co-financier (source)	Classification	Type	Amount ($)	Status	
				Confirmed	unconfirmed
Individual Tea Factory Promoters	Beneficiary	Equity	199,375	199,375	
Tea Board	Government	Grant	240,625	240,625	
Union Bank of India, Coonoor; Central Bank of India, Coonoor; IREDA, New Delhi	Commercial Financial Institutions	Commercial Credit	660,000	660,000	
Sub-Total			**1,100,000**	**1,100,000**	

Budget Notes

Project Management Budget

a) **Local Consultants**
4 person years (= 208 staff weeks) are needed to manage the project over 4 years of which 3 person years are calculated at the rate of a senior professional contracted long term (USD 30,000 per person year) and 1 person years at the rate of an assistant (USD 15,000 per person year). Here is the equation: 3x30,000 + 1x15,000 = 105,000.

b) **Office facilities, equipment, vehicles and communications**
Total costs over the 4 year period are approx. USD 50,000 of which GEF would pay USD 20,000 which is 40% and the Tea Board would co-finance 60% of the costs. The breakdown of the GEF contribution of USD 20,000 is calculated as follows: 2 laptops @ 2,000 each = 4,000; 1 printer @ 2,000; 2 cellphones @ 500 each = 1,000; Accessories, repairs and maintenance (including cartridges) @ 5,000; Communication costs such as internet connection, telephone bills @ 8,000 over 4 years.

c) **Travel**
Extensive travel for face to face interactions with local stakeholders (financial institutions, tea factories, government representatives) is considered essential for project success. A total budget of USD 30,000 (including co-financing) is contemplated for this project.

d) **Miscellaneous**
Approximately 6% of the project management budget is reserved for miscellaneous expenses that may be encountered during the project lifetime

[3] Refer to the paper on Cofinancing, GEF/C.20/6/Rev. 1

Technical Assistance Consultancy Budget

a) **Local Consultants**
428 staff weeks are estimated for local consultants providing technical inputs. Most of these will be short term consultancies at a rate of USD 150/day resulting in a staff week cost of USD 750. Here is the equation: 750x428=321,000.

b) **International Consultants**
96 staff weeks are estimated for international consultants providing technical inputs. Most of these will be short term consultancies at a rate of USD 600/day resulting in a staff week cost of USD 3,000. Here is the equation: 3,000x96=288,000.

Service Contract under Outcome 3
In addition to interacting with financial institutions for providing loans to factories the project also proposes a risk insurance scheme. Progressive insurance providers and energy efficient equipment suppliers will develop a scheme that would insure factory owners against below par performance of select energy efficient equipment. The current projections are that the pay back periods for energy efficient equipment from fuel saving alone would be less than 3 years. Although the life of the equipment is expected to be 10 years, the risk insurance scheme would be time bound. The project would bear the premium cost on behalf of factory owners for at least the first year when the threat of below par performance of equipment is high. It is expected that with access to bank loans and risk coverage the adoption of energy efficient equipment would gain rapid impetus. If successful the scheme will be extended beyond the currently defined project area to demonstrate replicability. A maximum amount of USD 290,930 will be available under this scheme.

Description of major consultancies

Consultancy	Description	Estimated Cost (GEF)
Project Management	A project manager (3/4) and 1 assistant (1/4) will be contracted to manage the project, which includes: leading and guiding the project team, contracting and supervising all technical consultancies, administrative and financial management, and liaison with UNDP office and so on. Combined, 4 person years (3 for the project manager, 1 for the assistant) are allocated for the 4 year project. The project manager and will also have technical advisory functions which are budgeted to the technical budget.	$59,000
Awareness creation experts	A local and an international consultant will be contracted for approx. 86 weeks (49 weeks for the national and 37 weeks for the international consultant) over the 4 year period. These consultants would support the project team with regard to: Developing project brochures, including brochures for equipment manufacturers, developing a web site of the project, organizing meetings/ seminars/ and site visits to factories and other tasks as relevant to this component.	$184,000
Financing experts	A local and an international consultant will be contracted for approx. 34 weeks (20 weeks for the national and 14 weeks for the international consultant) over the 4 year period. These consultants would support the project team with regard to: Design a risk insurance scheme and then implement and measure its utilization; tracking and calculating new investments in energy efficient technology; data collection on lending to tea factories for energy efficient equipment by commercial financial institutions, and other tasks as relevant to this component.	$71,500
Energy audit and technology experts	A local and an international consultant will be contracted for approx. 49 weeks (36 weeks for the national and 13 weeks for the international consultant) over the 4 year period. These consultants would support the project team with regard to: Factory specific energy audits to define baseline scenarios and identify factory specific interventions; Monitoring the performance of key equipment installed; demonstration of select energy efficient technologies in tea factories and site visits to these installations; develop and conduct training programs for air heater operators, factory managers etc; bring together equipment suppliers, consultants, academic institutions to initiate modifications in existing equipment for energy conservation; collect data to measure the energy conserved and disseminate the information and other tasks as relevant to this component.	$67,330
M&E and Learning experts	Approx. six local and international consultants will be contracted for 52 weeks (28 weeks for national and 34 weeks for international consultants) over the 4 year period. These consultants would support the project team with regard to: conducting the mid-term and final evaluation (2 consultants each, one national and one international); exposure visits to project sites; an annual experience sharing workshop featuring all stake holders; video documentation; presentations on project achievements in various forums and other tasks as relevant to this component.	$123,000

Total Budget and Work Plan

Award ID:	00047624
Award Title:	PIMS 3163 India Energy Conservation in Small Sector Tea Processing Units in South India
Business Unit:	IND10
Project ID:	00057404
Project Title:	PIMS 3163 India Energy Conservation in Small Sector Tea Processing Units in South India
Implementing Partner (Executing Agency)	The Tea Board (under the Ministry of Commerce)

GEF Outcome/Atlas Activity	Responsible Party/ Implementing Agent	Fund ID	Donor Name	Atlas Budgetary Account Code	ATLAS Budget Description	Amount Year 1 (USD)	Amount Year 2 (USD)	Amount Year 3 (USD)	Amount Year 4 (USD)	Total (USD)
OUTCOME 1: Awareness creation	UNDP	62000	GEF	71200	International Consultants	17,600	35,000	37,900	19,840	110,340
				71300	Local Consultants	16,180	21,000	21,580	14,900	73,660
				71600	Travel	5,600	5,600	5,600	5,600	22,400
				74500	Meetings & Workshop	5,200	5,200	5,200	5,200	20,800
				72500	Office Supplies	875	875	875	875	3,500
				74500	Misc	800	800	700	800	3,100
					Total Outcome 1	**46,255**	**68,475**	**71,855**	**47,215**	**233,800**
OUTCOME 2: Financial barriers	UNDP	62000	GEF	71200	International Consultants	10,000	10,750	10,000	10,750	41,500
				71300	Local Consultants	7,500	7,500	7,500	7,500	30,000
				71600	Travel	3,375	3,375	3,375	3,375	13,500
				74500	Meetings & Workshop	2,250	2,250	2,250	2,250	9,000
				72500	Office Supplies	1,375	1,375	1,375	1,375	5,500
					Total Outcome 2	**24,500**	**25,250**	**24,500**	**25,250**	**99,500**
OUTCOME 3: Adoption of EE/RE equipment / practices	UNDP	62000	GEF	71200	International Consultants	9,750	9,750	9,750	9,750	39,000
				71300	Local Consultants	7,082	7,081	7,086	7,081	28,330
				71600	Travel	3,180	4,115	4,115	4,110	15,520
				72000	Service Contract	71,930	74,000	72,000	73,000	290,930
				74500	Meetings & Workshop	5,280	5,280	5,280	5,280	21,120
				74500	Misc	325	325	325	325	1,300
					Total Outcome 3	**97,547**	**100,551**	**98,556**	**99,546**	**396,200**

OUTCOME 4: Monitoring, Evaluation, Learning	UNDP	62000	GEF	71200	International Consultants	25,500	25,500	25,500	25,500	102,000
				71300	Local Consultants	5,250	5,250	5,250	5,250	21,000
				74500	Meetings & Workshop	1,250	0	1,250	0	2,500
					Total Outcome 4	**32,000**	**30,750**	**32,000**	**30,750**	**125,500**
PROJECT MANAGEMENT UNIT	PMU	62000	GEF	71200	International Consultants	0	0	0	0	0
				71300	Local Consultants	14,750	14,750	14,750	14,750	59,000
				71600	Travel	3,750	3,750	3,750	3,750	15,000
				72400	Communication	0	4,000	4,000	0	8,000
				72000	Equipment & Furniture	3,000	0	6,000	3,000	12,000
				74500	Misc	0	500	0	500	1,000
					Total Managemeot	**21,500**	**23,000**	**28,500**	**22,000**	**95,000**
					PROJECT TOTAL	221,802	248,026	255,411	224,761	950,000

* In financing section table a) and b), a cost for this component is shown under "Project Management Costs".

Summary of Funds: [4]

GEF	In cash	221,802	248,026	255,411	224,761	950,000
Individual Tea Factory Promoters	Equity	39,875	59,812	59,813	39,875	199,375
Tea Board	Grant	72,000	48,312	48,313	72,000	240,625
Union Bank of India, Coonoor; Central Bank of India, Coonoor; IREDA, New Delhi	Commercial Credit	231,000	99,000	99,000	231,000	660,000
TOTAL		564,677	455,150	462,537	567,636	2,050,000

[4] Summary table should include all financing of all kinds: GEF financing, cofinancing, cash, in-kind, etc. etc

Cost Effectiveness

The project is cost effective considering that given the magnitude of the problem, the extent of firewood and electricity consumption, the need to transport fuel over long distances, the amount of CO_2 released and the potential for reduction in CO_2. The extent of co financing (US$ 1,100,000) and the fact that a large component of the co financing is coming from commercial lending institutions contributes to the cost effectiveness of the project. The table below gives estimates for cost of CO_2 reduction in the project.

Narration	Accumulative tons of direct + indirect CO_2	Co-financing*	Co financing /accumulative tons of CO_2 (US$)
Equipment installed during the project period	56,925	1,100,000	19.32
Equipment installed annually beyond the project period	17077	240,160 (only tea board subsidy and commercial banks lending)	14.06
*assuming zero cost of escalation of equipment			

From the investor point of view, the project interventions are cost effective and more sustainable if other competing options of introduction of energy efficiency are considered primarily because they form a part of a package and there has been no past effort at doing so. The pdf phase had been exposed to two other energy efficiency intervention options. The first option was the capital subsidy scheme of the Tea Board. This scheme offers a 25% capital subsidy and extends to factory modernization schemes of all tea factories. This scheme would be relevant where the cost of technology intervention is high and appropriate for equipment such as air heaters. However, it does not have any mechanism to assist borrowing commercially for the balance requirement. It also does not offer any support for decision making about investment in competing technology options. It is necessary that the information barrier be addressed first in order to profit from capital subsidy schemes and capital subsidy schemes do not include this requirement.

The experience of the industry with technology demonstration as a stand alone option has been negative. There are several instances where the industry has rejected technology demonstration especially for solar air heaters, biomass gasifiers because complementing systems for trouble shooting, monitoring, maintenance and repair were not in place. Technology demonstration options are hindered by the absence of a one time investment in infrastructure development for technology replication and the investment in demo units can also not be translated into profits.

Perhaps one reason for the limited ability of technology providers and equipment suppliers to penetrate the sector was the absence of support systems and allocations for barrier removal strategies.

5 - INSTITUTIONAL COORDINATION AND SUPPORT

a) CORE COMMITMENTS AND LINKAGES

Energy conservation, arresting deforestation and reduced consumption of fossil fuels are the priority area of GEF. The tea factories are situated in the environmentally fragile areas of the Nilgiris hills. Deforestation because of firewood burning in tea factories is contributing to deterioration in air quality in the hills and reduced habitat for the flora and fauna of the region especially the medicinal plants native to the hills.

The crisis in the tea industry as a result of break down in the trade agreement between India and the erstwhile USSR has affected not only the tea factories but also a large number of daily wage workers employed for tea plucking. The Tea Board has identified modernization of the tea factories one of the options for reform, which would translate into better incomes for the workers in the tea estates.

The project has direct linkage and would address issues of interest to the Tea Board, under the Ministry of Commerce and the Ministry of Environment and Forests

b) CONSULTATION, COORDINATION AND COLLABORATION AMONG IMPLEMENTING AGENCIES, EXECUTING AGENCIES AND THE GEF SECRETARIAT, IF APROPRIATE

IREDA, a key financial institution partner of the project currently operates lines of credits received from ADB and the World Bank and finances energy efficient equipments. In the absence of any particular focus, IREDA schemes are not likely to attract the small and medium enterprise sectors. IREDA however has expressed interest to work in the proposed project and partnered in the stakeholder meeting conducted in the PDF phase to widen their lending portfolio. The proposed project would complement their efforts in significantly addressing the barriers for technological up-gradation of the tea processing sector that would further develop markets for energy efficient devices.

It would draw synergies with other projects of UNEP and bilateral for establishing financing linkages and mainstreaming. Coordinated efforts would be made to document and disseminate lessons for effecting knowledge sharing in this area.

c) PROJECT IMPLEMENTATION ARRANGEMENT

The Executing Agency for the project would be the Tea Board under the Ministry of Commerce. The Executive Director, Tea Board, Coonoor would be the National Project Director. TIDE would be the local implementing agency. It would carry out all activities for execution of the project under the guidance of the Tea Board. The National Steering Committee (NSC) would comprise of representatives from Tea Board, other Government departments and TIDE. It would meet as often as necessary but at least once a year to review the progress of the project. The main functions of the NSC would be:

- Provide guidelines to implementing partner for policy decisions

- Review progress of project activities
- Ensure that the project goals and objectives are achieved in a defined time frame
- Provide coordination and support for involving various government departments if required

The project would constitute a Project Steering Committee (PSC) with the Executive Director Tea Board as the Chairperson. The local stakeholders would be members of the PSC. TIDE would set up a Project Management Unit (PMU) in the Nilgiris and all project activities would be carried out from the Project Management Unit. The Project Steering Committee will review the quarterly action plans, budgets and achievements. UNDP will release project finances directly to TIDE. The project would follow the accounting procedures of TIDE for auditing the expenses of the project.

A separate project account would be opened by TIDE, which would be audited as per UNDP guidelines.

6. REQUIRED ATTACHMENTS

a) Report on the Use of Project Preparation Grant

PDF/PPG STATUS REPORT

GEFSEC PROJECT ID: 2500
UNDP PROJECT ID: PIMS 3163
COUNTRY: India
PROJECT TITLE: Energy Conservation in small sector tea processing units in south India
OTHER PROJECT EXECUTING AGENCY(IES): The Tea Board (under the Ministry of Commerce)
GEF FOCAL AREA: Climate Change
GEF OPERATIONAL PROGRAM: OP 5
STARTING DATE: October 2005
ESTIMATED DATE OF OPERATIONAL CLOSURE: MARCH 2007
ESTIMATED DATE OF FINANCIAL CLOSURE: DECEMBER 2007

Report submitted by:

Name	Title	Date
Monali Ranade	UNDP Environment Focal Point	28 March 2007

PART I - PREPARATORY ASSISTANCE ACHIEVEMENTS

A- SUMMARY OF ACTUAL ACHIEVEMENTS OF PREPARATORY PHASE (OUTPUTS AND OUTCOMES), AND EXPLANATION OF ANY DEVIATIONS FROM EXPECTED OUTCOMES

The major activities carried out to deliver the project outcomes were:

- Assessment of stakeholders and current state of fuel combustion systems in the small tea factories
  Achievements include several in depth meetings with stake holders and listing the barriers to the adoption of energy efficient interventions. The documents generated were
  1. Summary of interactions with stakeholders in the PDF-A phase of the project
  2. A report on the group discussion on assessment of perceptions about energy efficiency and modernization of energy utilization systems
     Data was also collected from select factories about the fuel consumption patterns and the origin of the fuel

- Assessment of technology packages for energy efficiency
  Under this activity the project team compiled all past records of energy audit commissioned by the Tea Board and available with Anna University. The actual technology package and equipment that required revisiting was identified during this activity. Data was also collected the number of hours of sunshine for the calendar year and reports were generated on:
  1. The potential for solar energy intervention and the techno-economics of the same
  2. Sourcing, assessment and monitoring of various technological options that are currently available and other potential options for adoption by the small sector tea industries.
  3. Performance of different air heaters

- Assessment of financing mechanisms to support adoption of the technology packages
  This activity resulted in obtaining co-financing commitments for the project. The project team understood the Tea Board schemes for factory modernization, the IREDA schemes for energy efficiency, the potential for promotion of the project through Bureau of Energy Efficiency. It obtained co-financing commitments from Tea Board, Industry Associations and four nationalized banks.

- Strategies to promote identified technology packages among the small tea factories
  This was developed by TIDE with extensive inputs from all stake holders. Most of the outputs of this activity have been reflected in the MSP

- Technical clearance of the detailed medium sized proposal
  The project team developed the detailed, MSP, responded to all queries and was successful in obtaining the technical clearance for the submission

Table 1: Completion status of Project Activities

Approved			Actuals			
Proposed Activities at Approval	GEF Financing	Co-financing	Status of activities	GEF financing committed	Co-financing committed	Uncommitted GEF funds
Assessment of Stakeholders and current state of fuel combustion systems in the small tea factories	US$11,000	NIL	Completed	US$11,000	NIL	NIL
Assessment of technology packages for energy efficiency	US$8,000	NIL	Completed	US$8,000	NIL	NIL
Assessment of financing mechanisms to support adoption of the technology packages	US$4,000	NIL	Completed	US$4,000	NIL	NIL
Strategies to promote the identified technology packages among the small tea factories	US$2,000	NIL	Completed	US$2,000	NIL	NIL
TOTAL	USD 25,000			USD 25,000		

B – Record of Stakeholder Involvement in project preparation

The project was developed in consensus with all stakeholders. Several formal and informal meetings were held with all stakeholders.

Involvement of Tea Board

The Executive Director of the Tea Board was instrumental in giving direction to MSP document. He was constantly guiding the project development team at TIDE to ensure that the activities that would be taken up by the project were not the mandate of the Tea Board. He was able to articulate the energy efficiency needs of the industry that were not met through Tea Board schemes. The Tea Board also informally assisted the project in reaching

out to financial institutions and obtains co-financing commitments. The stake holder meeting of the project was also projected as an activity of the Tea Board.

Involvement of industry associations
Interaction with industry associations was instrumental in identifying the project barriers and risks. Their active participation in a group discussion on "Assessment of perceptions about energy efficiency and modernization of energy efficient systems" highlighted the urgent need for fuel usage reform by the tea factories.

Involvement of financial institutions
The financial institutions were very keen to be associated with the project. Their attendance in the stake holder meeting and commitment to funding energy efficient interventions was a high point in the PDF phase. Letters of co-financing were given to the project after understanding the techno-economics of project interventions

Involvement of Tamil Nadu Energy Development Agency
The Chairman of the Tamil Nadu Energy Development Agency sought to take the project to another higher level of involvement. He addressed the industry association representatives and assured them of co-operation in setting up their own wind farms to reduce their expense on energy. He assured the project team of all support and encouragement on behalf of the government of Tamil Nadu

Involvement of R & D agencies
Interaction with R & D agencies especially the Anna University and the Planters Energy Network was very useful in collecting data about past interventions attempted in energy efficiency and available energy audit data.

Involvement of Tea Research Institute
The Tea Research Institute, an institute of the Indian Council of Agricultural Research accepted the project request to be the knowledge management hub of the project. They have also sought permissions from their parent body for the same

Involvement of the equipment suppliers
The equipment suppliers are keen to be associated with the project and have offered several innovative schemes for supply of equipment. They have also attended all project meetings and made available all data about their equipment to the project

Stakeholder meetings
The stakeholder meeting for the project was organised by the Tea Board on behalf of the project. This ensured that there was more than adequate representation of all stake holders in the meeting. A document giving a summary of presentations at the stakeholder meeting was produced and circulated among all stakeholders. There were requests for this document from tea factories who had not participated in the stakeholder meeting. The Tea Board also invited participants from other concurrent meetings to participate in the stakeholder meeting. The stakeholder meeting therefore had representation from all tea growing nations.

PART II - PREPARATORY ASSISTANCE FINANCIAL DELIVERY

TABLE 2 – PDF/PPG INPUT BUDGET – APPROVALS AND COMMITMENTS

Input Description*	Approved			Committed		
	Staff weeks	GEF financing	Co-finance	Staff weeks	GEF financing	Co-finance
Personnel						
Local consultants	32	15000			14056	
International consultants						
Training						
Office Equipment						
Travel		7000			6780	
Miscellaneous		3000			4164	
Total	32	25000			25000	

Additional information as relevant:

- Indicate PDF/PPG delivery rate (funds disbursed at time of operational closure as percentage of total GEF allocation) = 100%
- Indicate whether it is expected that there will be unspent PDF/PPG funds at the time if financial closure = No
- Provide justification for major deviations of actual disbursement from what was planned = No major deviations

TABLE 3: ACTUAL PDF/PPG CO-FINANCING

Co-financing Sources for Preparatory Assistance				
Name of Co-financier (source)	Classification	Type	Amount	
			Expected ($)	Actual ($)
	(select)	(select)		
	(select)	(select)		
	(select)	(select)		
	(select)	(select)		
	(select)	(select)		
	(select)	(select)		
	(select)	(select)		
Total co-financing				

Additional information as relevant:

- Provide explanation for major deviations from what was planned

Country Endorsement Letter (RAF endorsement letter if BD or CC project)

c) Confirmed letters of commitments from co-financiers (with English translations)

d) Agency Notification on Major Amendment and provide details of the amendment, if applicable.

N/A

PART III - RESPONSE TO PROJECT REVIEWS

a) Convention Secretariat comments and IA/ExA response
b) STAP expert review and IA/ExA response (if requested)
c) GEF Secretariat and other Agencies' comments and IA/ExA response

India Tea Sector project
UNDP response to GEFSEC comments from 30 May 2007

GEFSEC Comments:
1. "Travel" cost for the project management need to be more specifically justified, or GEF allocation ($15k) needs to be eliminated.

UNDP Response:
The PMU would be located in Coonoor close to the tea factories but it is to be noted that the project covers the whole of South India. Some of the activities that require extensive travel to the tea factories are energy audits, operator training, data collection and trouble shooting. Travel cost of USD 30,000 is spread over 4 years and across all tea factories in South India. Bus connectivity is very poor in the region and the terrain is difficult. All travel would have to be done by car / taxi. The daily travel cost is estimated to be between USD 35 – 40 per day and about 200 person days of travel per year would be required.

GEFSEC Comments:
2. Local consultants cost for Project Management ($224/w) seems a bit low, and Local Consultants cost for TA (1,503/w) seems a bit high, are those realistic? Please justify.

UNDP Response:
Some adjustments have been made as follows. 4 person years (= 208 staff weeks) are needed to manage the project over 4 years of which 3 person years are calculated at the rate of a senior professional contracted long term (USD 30,000 per person year) and 1 person years at the rate of an assistant (USD 15,000 per person year). Here is the equation: 3x30,000 + 1x15,000 = 105,000. These rates are consistent with UN local salary scale of the India Country Office. Local technical consultants will be contracted at an average rate of USD 150/day for a total of 528 staff weeks. Again, rates are consistent with UN local salary scale of the India Country Office.

GEFSEC Comments:

3. The total cost of TA consultants to be funded by GEF seems high (65% of GEF financing). Please justify or reduce.

UNDP Response:
The cost of TA consultants has been reduced to 448k which is now less than 48% of the GEF financing. These are incremental costs to remove all market barriers. Baseline activities and most of the investment costs for tea factory upgrading is not funded by GEF but by co-financing partners. GEF is absorbing most of the TA costs associated with this project.

GEFSEC Comments:
4. On Total Budget and Work Plan (page 31), the total Travel cost for outcome 1-4 ($49,920 = 5.3% of GEF financing) and the total Meeting &Workshop cost for outcome 1-4 ($51,500 =5.4% of GEF financing) need to be fully justified.

UNDP Response:

The reason why extensive travel is envisaged is because the various competencies required by the project are not located in one place. The PMU would be located at Coonoor, close to the tea estates. However Coonoor is a small estate town known only for the tea factories and for tourism and several activities may have to be carried out from distant locations where the competencies exist. These would then have to be integrated into the project activities by the PMU. For example all activities for elimination of financial barriers and for evolving the risk management strategies would have to be done from Bangalore where the TIDE office is located and where TIDE has good contacts with financial institutions. Similarly monitoring and evaluation is also envisaged from Bangalore

The technical competence for energy efficient interventions is available at Chennai and Madurai and again extensive travel is envisaged for the same. The equipment suppliers are largely located in Calcutta and have small offices in Coimbatore. It has been our experience that meaningful interaction with equipment suppliers is best carried out in Calcutta where all commercial decisions are taken. The Head Office of the Tea Board is also located in Calcutta and Coonoor only has a regional office where major decisions may not necessarily be taken. Also the MOEF, UNDP and the Ministry of Commerce are located in New Delhi and networking with Government institutions and would require travel between the PMU to these distant places.

The travel cost includes the cost of boarding / lodging and travel by car / air travel. The project envisages about 100 days per year of consultant's travel time considering the variety of consulting competencies required by the project.

The travel cost for meetings and workshops is largely envisaged for the replication component of the project. Tea making is largely in the north east part of the country which is very far from the project site in south India. Meetings and workshops are a means of facilitating extensive experience sharing between the tea factories in south India and the north east in addition to the meetings and workshops envisaged for eliminating barriers. At least 20 meetings and workshops are planned each with a budget of USD 2500.

GEFSEC Comments:
5. On Co-financing confirmation, some of commitment letters does not seem to specify the amount of commitments. Please specify how the total amount of commitment (1,100k) was calculated.

UNDP Response:
The district tea producers have committed USD 199,375 as per letter and co-financing table. Loan amounts required for upgrading 30 tea factories are in the range of USD 660,000 – 700,000. Loans will be provided by 3 Banks (Central (Indian, Union Bank) as per attached letters. The Tea Board makes available USD 240,625 for investment related subsidies, as per attached letter. As shown in the co-financing table 199,375 + 660,000 + 240,625 = 1,100,000.

UNDP Response to Review Sheet

Concerns	Response	Reference
Please elaborate on how the Energy Conservation Act "regulate" energy use and promotes EE of the tea processing sector, and what are the "gaps" in compliance and enforcement of the Energy Conservation Act. Please also explain how the "award" by BEE works.	The EC Act has more of a promotional role than regulatory and is meant to create a set of incentives for improving efficient use of electricity in various energy intensive sectors through the establishment of standards, benchmarks and awards for best practices.	Section B.2 Pages 4-5
The barriers to the adoption of EE technologies and practices are well documented. However, project activities under each of the four components are not well defined. The project documents needs to have a section clearly describing project strategies and activities of each of the above components. The current description on pp.10-12 lacks clarity, coherence, and details.	The activities elaborated under this section have been clearly linked with the strategies and outcomes to bring greater clarity in this section	Section C.2 Pages 11-14
A detailed financing and co-financing plan is provided. However, it is difficult to reconcile or link the three tables. For example, the largest budget item for GEF is manpower and consultancy (400k), while the second table indicates that $416k of the GEF grant is earmarked for procurement and adoption of EE equipment and	The total budget of $ 2050k is now being broken down as per new GEF requirements. This should bring the requested clarity.	Section D Pages 26-29

practices. Please clarify and make sure that the two tables are "linked" with each other.

Additional Annexes

Annexure 1: Sector issues

Annexure 2: Stakeholder participation

a) Involvement of stakeholders prior to stakeholder meeting
b) Proceedings of the Stakeholder meeting

Annexure 3: Executive summary on pdf processes

a) Fuel tracking and consumption patterns in tea processing units
b) A report on the group discussions carried out with owners of tea processing units to assess perceptions about energy efficiency
c) Report on technology interventions in tea processing
d) Assessment of potential for biomass conservation in small scale tea factories through the adoption of solar air heating technology
e) Report on performance of conventional air heater

Annexure 4: Technology issues

a) Letter from Anna University used as basis for return on investment estimation
b) Note from Pandiyan Engineering
c) Note from Tea Kraft
d) Weather data from Met station at TRI, UPASI, Coonoor

Annexure 5: GHG emission reduction issues

Annexure 6: Financial viability

Annexure 1 Sector issues:

India is the largest tea producing country in the world producing 870 million kgs of tea annually. South India, with a total of 89,000 hectares under tea cultivation produces 203 million kgs of tea annually, which is nearly 24% of the annual production. Over a quarter million plantation workers are employed in tea gardens in South India. About 100 million kgs of tea that constitutes more than half of the total tea exports from the country is exported from this region. Over the past two decades there has been a rapid expansion in the small sector tea industry with a large number of farmers in the Nilgiris district of Tamil Nadu converting to this plantation crop. There are 350 tea factories in south India with 125 of them being in the small sector. Tea processing is energy intensive and there has been no significant intervention to reduce energy consumption by the sector.

The process of making CTC tea is briefly as follows:

- Green tea leaves harvested from the tea gardens are brought to the factory by trucks / trailers. They are evenly spread on troughs in 2 to 3 lofts at different elevations and allowed to wither. Green tea leaves contain about 80% moisture and 15-20% of it is removed during withering. It is brittle and if it were not withered it would be mashed into a pulp during further operation. Withering also makes the leaves flaccid.

- Conveyors carry the withered leaves to the rolling units where the leaf cells are ruptured, releasing enzymes and a twist or a curl given to the leaves to initiate fermentation

- The tea leaves are fed into a crushing tearing and curling machine. Here the leaf breakage is more severe, exposing more surface area to the atmosphere. Quicker and more intensive fermentation is achieved. They are then lead into fermenting rooms / drums rotated at slow speed and allowed to ferment in an artificially created humid atmosphere. During fermentation tea leaves change color, the organic acids and other undesirable materials get oxidized and yield the type of liquor having the desired color, taste and flavor. The moisture content in the leaves at this stage is 60-65%

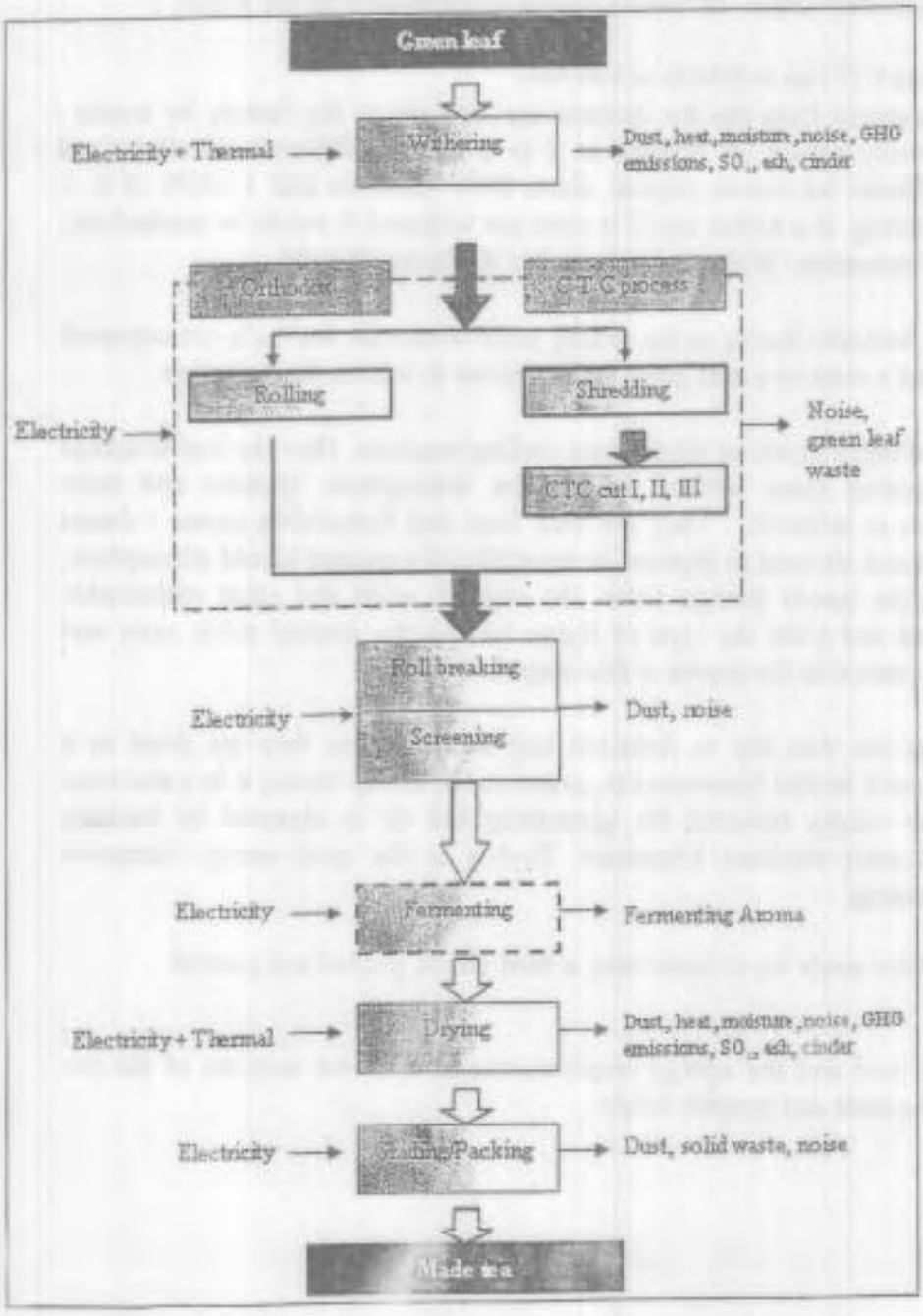
- The fermented leaves are then fed to fluidized bed dryers where they are dried in a current of hot air to arrest further fermentation, preserve the tea by drying it to a moisture level of 3-3.5%. The energy required for generating hot air is obtained by burning firewood and occasionally biomass briquettes. Drying is the most energy intensive operation in tea processing.

The dried tea (also called made tea or black tea) is then sifted, graded and packed.

The main equipment used and the energy requirements in different sections of the tea factory are given in the table and graphic below

Section	Main equipment	Form of energy
Withering	Motors, blowers, fans	Electrical energy
Rolling and cutting unit	Rolling machines, motors	Electrical energy
CTC units	Motors, CTC machines comprising rotor vanes, roller pairs etc,	Electrical energy
Fermentation unit	Motors, humidifier, fans	Electrical energy
Drying unit	Air heaters, dryers	Thermal and electrical energy

Pictorial presentation of processes in tea making



Data from energy audits and information collected during the pdf phase suggest that thermal energy constitutes 75-80% of the total energy consumed by a tea factory. The electrical energy consumption in a typical factory is about 0.5 KWhs / kg of made tea and the thermal energy consumption is in the range of 5000 –6000 kcals /kg of made tea. When firewood (20% moisture) is the thermal energy source the firewood consumption is 1.5 – 2 kgs / kg of made tea. A typical small sector tea factory producing 600,000 kgs of made tea annually would therefore consume 300,000 KWH of electricity and 900 – 1200 tons of firewood annually.

Some technology options for reducing the thermal energy consumption by a tea factory are given in the table below:

Technology intervention	Impact	Current status
Solar air pre heaters	Can pre-heat the air entering the air heater thus reducing consumption of firewood / biomass briquettes	Demonstration units installed in 2 factories at low altitudes performing well and saving 18 - 37% firewood. Technology not very well received in factories in higher altitudes Expected to be well accepted in factories at lower altitudes Investment in the range of Rs 500,000 – 600,000 (US$ 11,650 –14,000) and pay back period 2-3 years
Fuel efficient air heater	Features include heat transfer tubes of higher diameters, thus providing larger heat transfer areas, FD / ID fans for regulating air fuel ratios. Can reduce firewood consumption Maintenance requirements also significantly reduced	Installed in one factory and reportedly saving 20% firewood. Expected to be well accepted in factories at all altitudes. Investment around Rs 1,000,000 (US$ 23,000). Payback period 2.5-3 years
Firewood drying yard	Can facilitate firewood drying at minimal cost and zero energy thus reducing energy consumed for drying firewood in air heaters Expected to reduce	There is consensus among tea factory owners about the usefulness of a drying yard, but decision making difficult in the absence of data about the efficacy, investment and pay back period. Accurate data could not be generated during the pdf phase as this would

	firewood consumption by 5%	require monitoring of moisture content in wood samples for one calendar year at least.
Protocol for equipment maintenance and operator training	Can reduce firewood consumption by reducing excess air factor and obtaining higher temperature Life of the heat exchanger tubes can be extended and their heat transfer efficiency improved	No information on generation temperatures, excess air factors, flue gas analysis data Data generated during the pdf phase indicated average excess air of 300%. Establishes a case for operator training High expenditure on maintenance of air heaters and poor performance of the same

Annexure 2

a) Involvement of stakeholders prior to stakeholder meeting

Stakeholders have been involved in project implementation from the time of project conceptualization. The following activities have been carried out with stake holder involvement prior to the pdf phase

- Dialogue with tea factory owners to enable the probable project implementation team to understand issues relating to energy efficiency, acceptance of renewable energy technologies, past interventions
- Discussion with various teams that have carried out energy audits in tea factories to understand technology interventions and likely impact of technology interventions
- Interaction with technology providers to assess status of new energy and GHG emission reduction technology and factors influencing acceptance of the same by the sector

The MSP has been developed in partnership with stakeholders. During the pdf phase stakeholders have guided the project implementation team in formulating a project implementation strategy and participated in data generation and analysis. The stake holder contributions to the project development activities in the pdf phase reflect the participation of the stake holders in project development:

The Executive Director of Tea Board Coonoor has guided the project team in the preparation of the project document. He has also introduced the project to the various financial institutions and other key stakeholders like NILMA (Nilgiris District Tea Producers Marketing Cooperative), Tea Research Institute, UPASI (United Planters Association of South India) etc. The Executive Director is a member of the project Steering Committee and has initiated the stakeholder meeting in Coonoor. The receptive environment for the project is mainly because of nearly half a decade of effort of the Tea Board.

The Tea Research Institute Vaalparai has been very supportive of the project even prior to the pdf phase and has enabled the implementation team to understand the focus of tea research. The project team understood that energy in tea processing is an area of major concern and research efforts in the area need to be strengthened.

The various industry associations like UPASI, NILMA bought tea leaf manufacturers association have participated in meetings and group discussions on technology and commercial aspects of energy efficiency interventions. The co financing plan for the project involving financial institutions has emerged as a result of meetings / discussions with industry associations.

Research institutions like PSG Institute of Technology, Planters Energy Network, have participated in technology assessment, data collection and analysis. The School of Energy Studies, Anna University, Chennai has shared its data of energy consumption in tea factories and advised the project team on factors likely to influence acceptance of energy efficient technology.

- Equipment suppliers to tea factories like Tea Kraft and Pandian Engineering have interacted with the project team, accompanied the project team to tea factories to explain the new energy efficient equipment installed by them and have shared data about its performance and energy saving potential

- Several tea factories have permitted data collection in their factories and freely shared information available with them. Discussions with tea factory owners on processes and practices in the tea factories have built capacity of the project implementation team to develop the project document.

- Commercial financial institutions especially the Central Bank of India and the Union Bank of India have associated with the project to understand the project deliverables and given their letters of commitment for co-financing the project. Their quick response is indicative of their willingness to be associated with the project. IREDA has also understood the project proposal and given a letter stating its willingness to lend to energy efficient interventions within the framework of IREDA norms. IREDA has also come forward to co sponsor the stake holder meeting.

- Government institutions like the Ministry of Environment and Forests and Tamil Nadu Energy Development Agency have regularly advised and encouraged the project team during the pdf phase.

- The participation in stake holder meeting is a reflection of the interest of various stake holders in the project

Annexure 2
b) Report of the Stakeholder meeting of the project

Introduction: The stakeholder meeting for the proposed project on "Energy efficiency in small sector tea processing units in south India" was conducted in Coonoor, Nilgiris district, Tamil Nadu, a region with a large presence of the tea industry. The Tea Board office in South India is also located here. The stakeholder meeting was conducted as part of the PDF-A activities for project development to introduce the project to the stakeholders and seek their involvement and suggestions to the activities proposed. All stakeholders participated in the stakeholder meeting conducted on April 4, 2005. The meeting was organized in partnership with Ministry of Environment and Forests (Government of India) and UNDP-GEF. Indian Renewable Energy Development Agency (IREDA) was the co-sponsor of the meeting. Dr. Rajagopalan, Chairman, TIDE moderated the meeting. The list of participants in the stakeholder meeting is given at the end of this report.

The meeting began with a minute's silence in memory of Pope John Paul II.

Delivering the opening comments, Mr. Vikram Kapur, IAS, Executive Director, Tea Board, Coonoor, welcomed the participants. He explained the purpose of this meeting and invited stakeholders such as research institutions, technology developers, governmental departments, industry associations, tea factory owners, financial institutions, and representatives of the UNDP-GEF to come up with suggestions for project implementation and react to the presentations in the meeting. He said that tea processing was an energy intensive activity with energy comprising about 30% of the processing costs. The adoption of energy efficient technologies would lead to reduction in energy use by about 10%-15% and contribute to higher profitability and enhanced export competitiveness of the tea presentations in the meeting. He said that tea processing was an energy intensive activity with energy comprising about 30% of the processing costs. The adoption of energy efficient technologies would lead to reduction in energy use by about 10%-15% and contribute to higher profitability and enhanced export competitiveness of the tea sector. The Tea Board welcomed the project that was beneficial to both the industry and the environment. He said that this project would be the contribution of the tea sector towards reducing GHG emissions.

Explaining the past efforts of the Tea Board in energy conservation, Mr. Kapur mentioned an earlier attempt where the Tea Board had collaborated with Anna University and UPASI-KVK to assess energy usage and conservation in a cooperative tea factory in the Nilgiris. This initiative had demonstrated that energy savings were possible and the results were disseminated to the industry. However, due to inadequate follow-up, an institutional mechanism for energy conservation in the sector could not be developed. The proposed project would be an exhaustive and sustained effort and the project would intervene with benchmark surveys for energy efficiency and energy conservation in the tea sector, identify best practices, identify technology providers, assess barriers and develop technology package including co-financing with banks, TEDA and IREDA. The project would also lead to an institutional mechanism for equipment servicing and

interacting with the tea industry to promote energy conservation. The experiences in this project would be useful for replication. The main output of this project would be an institutional mechanism for sustained technology adoption by the tea sector. He reaffirmed involvement of the Tea Board in the project.

Ms. Neera Burra, Assistant Resident Representative UNDP, welcomed the participants on behalf of UNDP. She said that the UNDP was pleased to partner with MoEF, Tea Board and other agencies in this project. Noting that the sector provided a high potential for energy conservation, she felt that the successful implementation of this project could serve as a model on both the financial and technical fronts. She noted that TIDE was a key partner of the project and the commitment to the project from banks and industry was very encouraging.

Ms. Usha Rao, Programme Analyst, UNDP mentioned that stakeholder meetings are an integral component of the project development process. She said that the project was relevant to UNDP as it covered aspects of energy security, environmental sustainability – GHG emissions and climate change and economic viability. Promoting clean energy technologies for sustainable development and increasing access to investment financing for sustainable energy were the focal areas of UNDP. She also presented the GEF programme, its strategic priorities in climate change, the GEF project cycle, the extent of global funding, GEF grants, funding to India, GEF's interventions in EE, GEF investment in EE programmes and other ongoing projects of GEF in India.

Ms. Svati Bhogle, Secretary, TIDE made a presentation on the project. She said that the objective of the presentation was to present the proposed strategy for project implementation and to seek and incorporate the priorities of the various stakeholders in the project document. She presented data on energy consumption by the sector and projected a case for EE interventions. She also presented a list of barriers to energy usage reform and proposed a strategy for project implementation in association with the stakeholders. The project goal, objective, outcome, the risks and assumptions and the estimated budget were also presented.

Mr. K. Allaudin, IAS, Chairman and Managing Director, TEDA, confirmed the support of TEDA to the project. Complementing UNDP, MoEF, Tea Board and TIDE for organizing this meeting, he noted that this project was distinct in that it focused on small industries as compared to the normally observed programs that concentrate on HT industries. The profitability and growth of small industries is highly influenced by energy costs and this project could lead to improved performance of the tea industry. He noted the presence of various stakeholders such as Anna University, Planters Energy Network (Technology developers) and complemented TIDE for ensuring the participation of all stakeholders. He said that the tea sector required a program such as the technology up gradation fund (TUF) currently available for the benefit of the textile sector. The wheeling and banking system of the state government has enabled the textile industry to invest in windmills and he called upon the tea industry to similarly participate and obtain benefits. He suggested that the Ministry of Commerce, Government of India could initiate a similar program for the tea sector to enable technology up gradation.

He noted that, due to shortage in energy supply in the country, energy efficiency and energy conservation would be relevant in the short-term and increased use of renewable energy in the long run. He called upon the tea industry to adopt technologies such as wood gasifiers for electrical and thermal applications. Use of gasifiers for thermal applications would lead to reduction in wood consumption. The adoption of an improved technology such as solar air heating systems was hitherto low due to recession in the industry and consequent lack of financial resources. He also noted that wind energy is a suitable renewable energy technology that can be adopted by the industry.

He said that Tamil Nadu has been a frontrunner in promoting energy efficiency since 1990 there has been a focus on promoting energy efficiency and conservation in HT industries in the state. However, the focus on small-scale industries has been low and the coordination among ministry of power, ministry of environment and forests, ministry of non-conventional energy sources needs to improve while also focusing on LT industries. Mr. Allaudin suggested that TEDA could take a wider role in the project by providing assistance in accessing IREDA funds and providing subsidies for the use of gasifiers for electrical applications. TEDA could also assist the project implementers in technology selection. While being technology-neutral, TEDA would support project activities by promoting energy conservation in the tea sector.

Mr. Ramamoorthy of UPASI-KVK made a presentation on the perspectives of Tea Research Institute. He began by narrating the experiences of TRI in solar energy and presented data on solar energy in tea processing. He said that the disadvantages of high installation cost, problems associated with maintenance of large panel areas and shorter sunshine hours in the monsoon could be overcome by the integrated energy system for tea manufacture. He also discussed the scope for energy conservation by adopting the NRC process. He presented data on saving in power consumption in RC and NRC tea.

Dr. Sethumadhavan of Anna University made a presentation on the perspectives of technology generating institutions while focusing on energy audits and scope for energy efficiency in tea factories. His presentation was in three parts, the energy scenario in bought leaf factories, detailing the scope for energy conservation and the way forward. Presenting the data from the factories surveyed he said that the average electrical energy consumption is 0.6 kWh /kg of made tea and 1.47 kg firewood / kg of MT. He estimated that 1 million tons of made tea would consume 1500 tons of firewood, 700,000 kWh of electricity and release 4730 tons of CO_2. The total cost of energy for the same would be US$ 121,000. He recommended several measures for electrical energy conservation like shifting from LT to HT, optimum power factor, installation of energy efficient motors, use of two speed motors for withering which would reduce electrical energy consumption by 20%. He also said that efficient combustion, effective heat transfer and efficient drying could result in up to 35% saving in firewood usage.

Mr. VT Valavan presented the experiences of IREDA in financing EE projects. He said that IREDA had approved 1772 projects and sanctioned loans of US$ 1556 million. Presenting the larger picture on EE in other industry sectors he said that investment in EE

is highly cost effective across all industry sectors as 1 unit saved at consumption point avoids 2.5 to 3 times of fresh capacity generation. He also said that EE interventions are highly cost effective and avoid coal, oil based additions. Also adding capacity takes time whereas EE interventions are faster.

Mr Valavan also presented the financing schemes of IREDA, IREDA's financing norms. IREDA's scheme whereby energy audits and DPRs are funded by IREDA if loan would be availed from them is of particular relevance to the sector. He also elaborated on how IREDA could be approached for availing financial assistance for EE projects.

Mr. NK Krishnamoorthy of Nilgiri District Tea Producers' Marketing Co. (P) Ltd. (NILMA), Coonoor explained that the tea industry is incurring a high cost on electrical and thermal energy because of financial constraints to invest in energy efficient equipment. The industry was facing scarcity of fuelwood (for thermal applications) and higher cost of electrical energy (for electrical applications). The small tea factories had attempted to use lyco, coal, furnace oil etc but due to higher cost of the fuels, they have settled for firewood but fuelwood was also becoming costlier due to higher demand by the textile sector. Mr. Krishnamoorthy sought information on the possibility of establishing energy plantations in other districts of Tamilnadu and whether agro-residue briquettes were available on a large-scale. He also sought information on the storage conditions of briquettes and the benefits from energy efficient heaters and heat exchangers. He sought financial assistance to the industry towards adopting energy efficient technologies. He said that this project was timely and the tea industry would extend its cooperation to the project.

Mr. Joy Mathew of Central Bank of India made a presentation and informed that the bank worked with a number of industries such as textile factories and that the bank had considerable exposure to Nilgiris district. He said that to facilitate lending the technical feasibility of the technologies had to be established. Subsequent to that stage, the banks could provide loans with 25% margin with repayment period of up to 7 years. He stated that the bank would assess debt service capacity ratio, debt-equity ratio, cash flows and repaying capability of the business before offering credit. He suggested that the project initially work with financially stronger units and the bank would be able to provide funds at reduced interest rates. Collateral security was required to obtain credit but the unit's capacity to withstand shocks would also be considered while evaluating applications.

Mr. Vineet Bagaria of Tea Kraft, Coimbatore made a presentation on the vertical tube hot air generator the BLAZE. He presented the technical features, the safety systems of the BLAZE air heater and projected a pay back period of 3 years. He expressed his willingness to be associated with the project.

Subsequent to the presentations, an animated discussion was held among the stakeholders

Mr. Jayantilal of Sampath Tea Industries and Secretary, Bought Leaf Factories Associated stated that fuelwood is currently being transported from long distances and energy (diesel, a fossil fuel) is being used for this purpose. Permitting use of locally

available fuelwood by the forest department could reduce diesel consumption and reduced traffic in the hills. He sought the assistance of governmental agencies for this purpose.

Mr. Sunil Goyal of Akshaya Tea Industries sought clarification about infrastructure assistance to a cluster of tea factories for wind energy installation. Mr. Goyal also mentioned that the cluster had submitted a proposal to Ministry of Commerce to create infrastructure. Mr. Allaudin clarified that in Tamilnadu, wheeling and banking of power was allowed based on payment of certain charges. Under the TUF scheme for textile industries, windmills were put up with interest subsidy from MNES. In addition, the investing industries benefited from accelerated depreciation in the first year. Mr. Allaudin explained that wheeling and banking facility was being provided only to HT industrial units and units desirous of benefiting from this should convert to HT.

Mr. Vikram Kapur sought information regarding availability of subsidy from TEDA/IREDA for creation of infrastructure for wind energy. Mr. Allaudin clarified that no subsidy is being provided to set up windmills but under the TUF scheme, interest subsidy was being provided to investors from the textile sector. Mr. Allaudin suggested that a similar scheme be developed for the tea sector to provide interest subsidy to investors in windmills. Mr. Joy Mathew clarified that if the cluster of industries is financially robust, banks can lend at lower rate of interest for infrastructure development.

Ms. Usha Rao sought a clarification from Mr. Joy Mathew whether collateral was essential to obtain credit or whether credit guarantee would be adequate for banks. Mr. Mathew clarified that upon availability of guarantee, collateral would not be insisted upon. Mr. Jabarathinam of Indian Bank intervened to explain that banks could innovate to provide credit if specific requirements were defined and met. He clarified that the cost of funds from commercial banks was lower than that of funds from NABARD (National Bank for Agriculture and Rural Development) and schemes of commercial banks could be made flexible. Ms. Usha Rao also sought to know if the project could source funds under KVIC schemes whereupon Dr. Rajagopalan clarified that it would not be recommended. Dr. Rajagopalan said that if insurance could be arranged to ensure technology performance, banks would be comfortable to lend to the industry.

Mr. RK Ojha of Tamilnadu Tea Corporation mentioned that his factory had installed a solar air heating system about a decade ago. He felt the need for a system of assured after-sales service. He felt that such as system would encourage large-scale adoption of such improved technologies. He explained that the use of firewood grown in Nilgiris district was not banned but the species available; acacia and eucalyptus were not suitable for use as fuel in tea factories. The existing tubes in heat exchangers would be difficult to maintain if eucalyptus was used as fuel. Species such as *acacia* and *prosopis* that were grown at lower altitudes were suitable and it should be examined whether these species can be cultivated in Nilgiris district. He said that Tamil Nadu tea corporation had done an analysis of calorific value of various wood species and found that *prosopis* is highly suitable as a fuel. He observed that although the production of NRC tea is a clean process, RC tea fetched a better price due to less proportion of secondaries as compared

to NRC tea. He explained that if RC tea was manufactured and production was continuous, then the BLAZE vertical tube heat exchanger would be useful. Mr. Ojha also stated that it was difficult to purchase and store large quantities of energy (fuel) briquettes due to the higher cost. Also, formation of clinkers in the furnace was a problem requiring regular maintenance.

There was a discussion about the energy consumed by withering units. It was observed that withering units take up about 30% of energy. FRP fans and dual speed fans were said to reduce energy consumption by about 30%. Dr. Sethumadhavan clarified that dual speed fans would be useful in reducing energy consumption but FRP fans may not lead to reduction in energy use. He suggested that the loading of the energy-consuming technologies would influence their efficiencies and the performance could differ from the energy labels on the device.

Dr. Rajagopalan summarized the proceedings and noted a general consensus that the proposed project would be beneficial to the tea industry. A number of technologies were available and the reliability of technology packages in specific scenarios needed to be assessed. As the tea industry was slowly recovering after a recession, innovative financing schemes need to be developed to assist the industry to adopt energy efficient technologies. He called upon bankers to enable financing in a manner similar to venture financing. He concluded by observing that human infrastructure and co-financing are crucial to the success of the intervention. He thanked all the stakeholders for their presence and participation in the meeting.

List of participants in the stakeholder meeting

Sl. No.	Name	Organization / Factory Name	Address
1	Allaudin K	Tamilnadu Energy Development Agency	# 68, College Road, Chennai
2	Amarakoon A.M.T	Tea Research Institute of Srilanka	Talawakelle, Srilanka
3	Anand B.L	Kannavarai Tea	
4	Ashwini Kumar BJ	TIDE	Malleswaram, Bangalore
5	Ayub Khan M.D	Mahim Tea Company	Bangladesh
6	Balasundaram M	Nilgiri Monarch Tea Limited	Westbrooke, Farm Tea Post, Kotagiri
7	Benjamin Bhio V	High Field Tea Estate	Manager
8	Dr. A.V.K Iyengar	Plantation Management Academy	# 83, Upasi Glen View Campus, Coonoor
9	Dr. Ramu S	UPASI	Coonoor
10	Gurumurthy M	Nilgiri Glenburn Tea Limited	Kotagiri
11	Hiromi Nishanthi	Tea Research Institute of Srilanka	Talawakelle, Srilanka
12	Hudson J.B	UPASI	Coonoor
13	Jabarathnam T.A	Indian Bank	Coonoor
14	Jayanth S	Sampath Tea Industries	Figure of Road, Coonoor
15	Joy Mathew P	Central Bank of India	Regional Office, Variety Hall Road, Coimbatore
16	Kannan Rajesh	Hittakkal Estate	Hittakkal Post, Kotagiri
17	Kannappa S	Snowdon Tea Factory	
18	Kothandaram	TeaKrafts	# 24, Vidyanagar, Coimbatore - 14
19	Krishanan P	Indcoserve	Sales Officer
20	Krishna Murthy N.K	Nankep Tea	Holmwood, Coonoor
21	Luis Agvier	Royal Agricultural College	Stroud Road, Cirencester, England
22	Magesh Kumar	Agriflora	Peshotea Hall, Darlington Bridge, Coonoor
23	Mohammed Hussain	Tea Research & Development Projects	Govt. of NWFP, Pakistan, ATI Complex, Jamrud Road, Peshawar
24	Mohammed Ilyas	Agriculture Research	Govt. of NWFP, Pakistan, Agriculture Research Station, Mirgona,
25	Mohammed Mohsin	N.T Company Limited	Manager, Dhaka
26	Mohankumar C.V	TeaKrafts	# 18, Sidco Industrial Estate, Coimbatore - 21

27	Mohankumar M	Garswood Tea	Getticombai, Kotagire
28	Moses Nayagan D	Katary Estate, Neelamalai Agro Industries	Katary Estate & Post, Nilgiris
29	Murali Subramaniam	TIDE	Malleswaram, Bangalore
30	Neera Burra	UNDP	New Delhi
31	Olaf Lundstol	GEF, Regional Office	Malaysia
32	Prof. Luis	International Business School	Royal Agricultural College, London
33	Ojha RK	Tan Tea Coonoor	General Manager, Tamil Nadu Tea Corporation, Coonoor
34	Rahul J Choradia	Golden Dew Tea Factory	Rathanbagh, Figure of 8 Road, Coonoor
35	Rajeev K	TIDE	Malleswaram, Bangalore
36	Rajendra S	TIDE	Malleswaram, Bangalore
37	Ramamoorthy G	UPASI	Coonoor
38	Ramarathnam V	Agri Finance Corporation	Chennai
39	Ramu A	Shanthi Tea Industries	Aravenu P.O Kotagiri
40	Rudramurthy R	PSG College of Technology	Coimbatore
41	Rajagopalan S	TIDE	Malleswaram, Bangalore
42	Saleemdeen A	Orange Valley Tea Factory	Kappatty
43	Sampath Kumar K	Venus Tea Factory	Kethorai, Soghthorai Post, Nilgiris
44	Sasikumar T.B	UPASI	Glenview, Coonoor
45	Satish M.G	UPASI	Glenview, Coonoor
46	Sekhar A.K	Chamaraj Group	Engineer, Chamraj Estate
47	Sethumadhavan R	Anna University	Professor, Chennai
48	Sirajuddin Ahmed	N.T Company Limited	Deputy General Manager, Dhaka
49	Lokras SS	TIDE	Malleswaram, Bangalore
50	Subramanyam K.K	Tea Krafts	# 18, Sidco Industrial Estate, Coimbatore - 21
51	Sugumaran S	Doddacanti Tea Factory	
52	Sultan Mohideen M	Central Bank of India	Mount Road, Coonoor
53	Sunil Goyal	Akshaya Tea Industries	89-A, Gray's Hill, Bedford, Coonoor
54	Suresh B	UPASI	Coonoor
55	Suresh Babu H	UPASI-Valparai	Sr. Engineer, UPASI-TRF, Valparai
56	Suresh Kumar S	Agri Business Development Manager, Indian Bank	Circle Office, Coimbatore
57	Suresh T.R	Business Manager, Indian	Coonoor

		Bank	
58	Sureshbabu J	Mavukarai (n) Estate Tea Factory	Aravenu P.O Kotagiri
59	Svati Bhogle	TIDE	Malleswaram, Bangalore
60	Swaminathan P	High Field Tea Estate	General Manager, (Technical)
61	Thangaraj S	Union Bank of India	# 14 B, Mount Road, Coonoor
62	Thiagaraj H	Sreeram Tea	Aravenu P.O Kotagiri
63	Usha Rao	UNDP-GEF	New Delhi
64	Vaithyanathan S	State Bank of India	K.N.M Compound, Coonoor
65	Velavan R	PSG College of Technology	Peelamedu, Coimbatore
66	Vikram Kapur	Tea Board	Coonoor
67	Vineet Bagaria	TeaKrafts	# 18, Sidco Industrial Estate, Coimbatore - 21

Annexure 3

EXECUTIVE SUMMARY ON PDF PROCESSES

a) EXECUTIVE SUMMARY OF A REPORT ON FUEL TRACKING AND FUEL CONSUMPTION IN TEA PROCESSING UNITS

Most tea factories use firewood as fuel for meeting the thermal energy needs for tea drying. Very few factories use briquettes

1. Tea factories are open to using biomass briquettes if they confirm to their specifications and if the price is right. Tea factories prefer briquettes with low ash content (less than 5%), low moisture content (around 10%) and high calorific value (about 4500 kcals / kg). The acceptable price range would be Rs 2200 –Rs 2400 (US$ 51 –56) / ton which is about 1.5 times the price of firewood.

2. The moisture content in wood is very high at the time of purchase. The pdf phase was unable to accurately and completely collect data on moisture content in firewood as it has not been able to capture seasonal variations. In the monsoon months the moisture content in firewood is as high as 45%. In summer months when the wood is relatively dry, the agents supplying wood to tea factories spray water on the wood before selling it. The average moisture content of wood that is fed to the air heater is 20-25%.

3. Tea factories normally maintain at least one month's stock of firewood. However wood is not stored in covered yards. In the hills when the mornings are misty, the wood that would otherwise have dried during storage becomes wet again.

4. Tea factories on an average consume about 1.5 kgs of firewood per kg of made tea for drying alone. In the wet months firewood is also used for withering and firewood consumption in the wet months is 2.2 –2.5 kgs / kg of made tea.

5. On an average tea factories purchase 1200 to 1400 tons per annum. The fuel purchased in the quarters April –June and Oct - Dec is 1.8 to 2 times higher than in the quarters Jan – March and July –Sept.

6. There are at least 12 –15 agents supplying firewood to the small sector tea processing units in Nilgiris district. Firewood is transported in Ashok Leyland trucks (6ms x 2.5ms). About 10-12 tons of firewood is loaded into a truckload. The kilometers per liter data is as follows:

   4-5 kms / liter when moving on straight roads
   2 kms / liter when moving on ghat road (road in the hills)

7. Most of the firewood is transported from long distances. Small quantities are brought from Sirumugai about 42 kms away. The distance between the point of generation and consumption of firewood is given in the table below:

Source of firewood	Distance from point of consumption (kms)
Madurai	280
Trichi	282
Ramnathpuram	300
Pudukottai	
Sirumugai	42

8. The species of wood that is used and their price is given in the table below:

Species	Cost Rs / kg	Cost US$ / kg
Veli (p. Juliflora)	1650	38
Karuveli (juliflora)	1450	34
Blue gum (eucalyptus)	1650	38
Wattle (acacia)	1750	41
Tamarind	1750	41
Silver oak	750	17
Neem	1400	33
Tea stumps	-	

10. The project team accompanied the firewood supply agent to the district of Madurai. It was clear that there were several thousand hectares of fallow lands from where the firewood was cut. It was clear that firewood was cut from what could have been a social forestry program several years ago. The local agents and the firewood depots in the district were contacted to explore if there were any reforestation programs. No information was forthcoming and no reforestation programs visible.

11 The project team experienced severe difficulties in collecting this data. It is believed that the data collected is very sensitive as firewood trade is controlled by a select few. The project team therefore decided to stop this component of the project at this stage because adequate information was collected for the MSP project document. Further data collection planned like counting the number of trucks going up the hill would have adversely affected the tea factories.

b) A report on the group discussions carried out with owners of tea processing units to assess perceptions about energy efficiency

Introduction: Technology Informatics Design Endeavour (TIDE) is involved in a series of consultations to plan interventions leading to energy conservation in small tea sector in South India. As part of the consultations, TIDE conducted a focus group discussion to assess perceptions of the entrepreneurs from the target sector and other stakeholders about potential for energy efficiency and possibilities of modernization of energy utilization systems. The focus group discussion was held on 21st March 2005 at Hotel Velan, Coonoor for duration of about two hours.

Moderator: Dr. P Balachandra, Department of Management Studies, Indian Institute of Science, Bangalore

Participants:

1. NK Krishnamurthy, Managing Director, NILMA, Coonoor
2. P. Ravindran, RK Hillmart Tea (P) Ltd, Kotagiri
3. M Mohan Kumar, Garswood Tea Products Co., Kotagiri
4. Rahul J Chordii, Sampath Tea Industries (P) Ltd, Coonoor
5. Sidharth J Chordii, Golden Dew Tea Factory, Coonoor
6. P Swaminathan, Highfield Tea Factory, Coonoor
7. B Rajkumar, Darmonate Industry, Aravenu
8. Sunil Goyal, Akshaya Tea industries, Kotagiri
9. L Anand, Kannavarai Tea, Kotagiri
10. MA Hiromi Nishanthi, Tea Research Institute of Sri Lanka
11. AMT Amarakoon, Tea Research Institute of Sri Lanka
12. D Suresh, UPASI-KVK-QUP, Coonoor
13. MG Sathish, UPASI-KVK-QUP, Coonoor
14. TB Sasikumar, UPASI-KVK-TRF, Coonoor
15. HS Chanakya, Centre for Sustainable Technologies, Indian Institute of Science, Bangalore
16. BJ Ashwini Kumar, TIDE, Bangalore

Mr. Ashwini Kumar provided a brief introduction to TIDE and its activities. He stated that TIDE has been promoting energy efficiency in various industrial sectors in South India and more than 1 lakh tons of biomass has been conserved by TIDE's interventions. He requested cooperation from the owners of tea factories and stakeholders such as NILMA and UPASI.

Mr. Krishnamurthy briefly highlighted the relevance of energy efficiency in the tea sector and mentioned that in a scenario of increasing fuel costs, energy efficiency would lead to enhanced competitiveness of the tea industry. Mr. Krishnamurthy assured the support of NILMA to TIDE's intervention in the tea industry while terming it as timely. Mr. Krishnamurthy explained the objectives of the focus group discussion and sought inputs from all the participants.

Dr. Balachandra made a brief presentation on the core concept of Energy efficiency. The presentation dealt with issues such as indicators of energy efficiency, factors influencing

energy efficiency (technological, economic, human resource, organizational/behavioral, regulatory/policy), barriers and drivers to energy efficiency, and measures to remove barriers. This presentation was made to bring all the participants to a common platform and trigger ideas and inputs from participants. During the course of the presentation, some of the participants also asked for clarifications that were provided by the presenter.

Subsequent to the presentation, Dr. Balachandra sought opinion, perceptions and suggestions from participants in relation to energy efficiency from the perspective of the tea sector. A series of pointers were displayed on the screen to enable participants to discuss in a focused manner.

The focus group discussion had the following objectives:

1. The perceptions of the owners and operators of the small tea factories vis-à-vis energy efficiency of fuel use for thermal applications
2. The expectations of the owners/operators about interventions relating to energy efficiency
3. The perceptions of owners of small tea factories regarding modernization of energy systems so as to improve efficiency of fuel use for thermal applications
The barriers to adopt energy efficient packages and to modernize energy systems in the factories

Summary of discussion:

1. Energy efficiency is highly relevant to the tea industry considering that about 50% of the processing costs relate to energy. The industry is finding it difficult to procure fuelwood due to reduced availability and higher costs of wood. Equally important is the high cost associated with consumption of electricity. It is felt that electrical energy efficiency can enable the factories to avoid entering the HT bracket and maintain costs at lower levels. Deforestation can have long term impact due to changing rainfall patterns and microclimate thereby influencing productivity of tea.
2. There have been instances where a few working days have been lost due to non-availability of wood. However, this occurrence has been minimal and the higher cost of wood and its impact on profitability is the primary concern
3. There has been an 80% increase in the price of wood during the past five years. The rapid growth of the textile sector in Tamilnadu and the emergence of biomass power plants have led to higher demand for scarce fuelwood and thereby, the price of wood had increased rapidly. Also, with wood prices being higher in lean season, the profitability of the factories is threatened.
4. The use of alternate fuels could counteract the fluctuations in price of wood. Alternate fuels such as briquettes are perceived to be costlier than wood but only a few factories have tried to use briquettes during periods of high wood prices. The industry is interested in using briquettes if supply is consistent at reasonable prices. Training programs are required to train operators in use of briquettes in the existing air heaters.
5. The industry is interested in adopting energy efficient technologies. However, lack of availability of relevant information is the primary barrier, as the small scale tea sector is

unaware of technologies that can reduce energy consumption levels, which can bring about energy conservation.

6. The industry is willing to adopt energy conservation technologies if the benefits from the technologies are demonstrated in actual usage conditions. In the past, a few interventions were attempted to promote energy efficient technologies but information about the benefits of the technologies was not disseminated among the tea factories. Confidence of the industry in energy efficient technologies would develop if this information is shared and doubts are addressed.
7. Most of the small tea factories are currently not energy efficient considering that some of the industries' share of energy costs in total processing costs is higher than some of the other comparable industries. However, other than this indicator, the factories are not aware of the level of energy efficiency as they have not undertaken energy audits in their units
8. The industries are interested in being energy efficient but are unaware about the means to become energy efficient. Energy audits can highlight the weak areas, points of improvements, and potential benefits but information about energy audits and the processes need to be clear to factory owners to make the decision to implement energy audits.
9. Subsequent to energy audits, a roadmap for improvements in the factories is essential along with a manual for maintenance of energy efficient technologies. This should be reinforced by conducting programmes for operator trainings in use and maintenance of the energy efficient devices.
10. An information-cum-service centre would be useful in promoting the use of energy efficient technologies in the tea sector. Considering that such a body exists for the textile sector (South India Textile Research Association – SITRA, Coimbatore), it would be beneficial to the sector if such an institution exists for the tea sector to specifically address energy efficiency issues and interact with stakeholders such as equipment suppliers.
11. Currently some factories use up to 3 kgs of fuelwood per kilogram of made tea while some factories use 0.75 kgs. This improvement is perceived to be possible due to better operating procedures. If standard procedures and best practices are documented and shared with all the factories, it would enable all factories to become energy efficient.
12. The assessment of tea processing devices (such as air heater) at the manufacturer level and their performance at actual locations would help in identifying better technologies and simplify the decision making process for factory owners. This assessment would be have be done in a transparent manner and involve all stakeholders. Technology packages for different locations in Nilgiris district need to be identified and recommended.
13. External interventions to improve energy efficiency are essential, as the factory owners need to be guided along the path of efficiency improvement. The primary expectation from external intervention is professional help in identifying means to improve energy efficiency and to assist in the transformation by developing linkages with various stakeholders.
14. Soft loans/efficiency incentives would accelerate technology adoption towards making these units energy efficient. Innovative financing schemes that relate repayment to benefits obtained would encourage adoption and use of improved technologies. Subsidies too would encourage adoption.

15. Both Electrical energy and Thermal energy contribute to costs and interventions need to focus from both perspectives.
16. Emerging as an energy efficient unit is a clear step towards modernization. All energy efficient technologies should be recognized as contributing to factory modernization and industrial development.
17. The expectations from improved technologies include: uniform temperature, quality retention/improvement, reasonable payback period (3-4 years) and compatibility with existing infrastructure.
18. The main barrier to energy efficiency improvement is the information barrier followed by economic barriers. The barriers could be overcome by external interventions, information dissemination programs and subsidies, and incentives from governmental agencies.

Moderator comments

The initiative of TIDE in bringing the owners of small tea factories and other stakeholders together for a focused discussion on assessing the importance of energy efficiency in the tea sector is timely. Considering that the cost of energy (for both firewood and electricity) accounts for about 50% of the total operating cost, any initiative on energy efficiency front is bound to reduce the cost of production significantly thereby contributing to increase in profitability. Even the owners of these small tea factories are aware of this fact and could perceive the possible benefits of energy efficiency improvements. However, it is surprising to observe that hardly there is any initiative related to adoption of energy efficient technologies and for that matter there are no efforts even to know the energy consumption pattern in detail. The major reasons given by the entrepreneurs are – lack of knowledge/information on technologies, possible benefits, cost implications and pay-back periods. Even the initiative related to power factor correction to reduce electricity consumption is due to government regulation. It appears that effective external intervention is the need of the hour to initiate measures related to energy efficiency. External interventions are required for capacity building, providing appropriate technologies, and for subsequent implementation and monitoring. Even the entrepreneurs are forthcoming in accepting such interventions. The initiatives related to energy efficiency need to cover both electrical and thermal energy applications. As a first step, the activities can begin with a detailed assessment of energy consumption patterns through energy audits

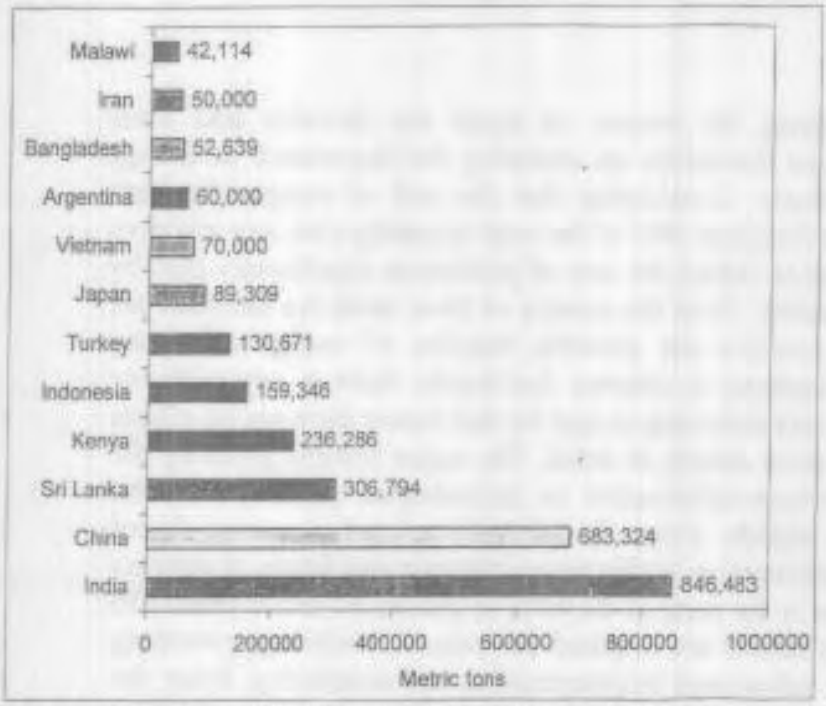
Overall the discussions were thought provoking and all the stakeholders were forthcoming in expressing their opinions and providing suggestions

c) Report on technology interventions in tea processing

Sourcing, assessment and monitoring of various technological options that are currently available and other potential options for adoption by small sector tea factories – An executive summary

1. Introduction

Tea is mainly produced in the tropical countries of Asia, South America and Southern Africa. The outlook of the global tea production is shown in Figure 1.



Source: Kenya Tea Development Agency Limited, Kenya

1.1 Industry Indicators

Table 1: Tea sector indicators

Indicators	Details
Production	829,000 tonnes of made tea of which about 15% is Orthodox tea
Production Growth	Over 250% since independence
Cultivation area increase	About 40% since independence
Area under cultivation	Around 509,000 hectors
Exports	Rs. 18,470 million

Market share	65% in rural and 73% in urban areas
Major companies	Over 300
No. of estates	12,000 larger and 37000 small estates
Employment	1.1 million (direct) & 10 million (indirect)

1.2 Tea Production Regions

Assam North : North-East : Assam Valley and Cachar District.
West Bengal : East : Darjeeling (Hills), Terai (Foot-Hills), Dooars (Plains).
Tripura : North-East : Plains
Karnataka : Central-South : Hilly Terrain
Tamil Nadu : South : Nilgiri (Hills), mid-elevation.
Kerala : Sourth : Munnar (Plateau), Travancore (Plains).

Tea plantations exist from 300 fet above sea levels to heights of over 7,000 feet above sea level. Two processes are available for black tea production - Orthodox and CTC (Cut, Tear, Curl) methods. A comparison of the two is given in Table 2

Table 2 Comparison of Orthodox and CTC process

		ORTHODOX	CTC
Finished product	Appearance	Flakes / Leafy	Graduals / powder
	Quality characteristic	Rich in aroma and less colour	Rich in colour and less aroma
Withering	Moisture content of withered leaf	55%	70 %
	Period of withering	20 hours	12 hours
Rolling/CTC	Additives	No	R.C powder
	Change in moisture content during process	Nil	Reduced to 55% from 70%
	Mechanical operation	high	Very high
General	Application	Man power intensive	For large scale production

D) Energy Utilisation

The theoretical energy requirement to remove the moisture from one kg of made tea is about 1.9 kWh, whereas the actual energy consumption varies from 5.27 – 8.1 kWh. This depends on various process parameters and regional climate factors. The specific energy consumption details are given in Table 3.

Box 1 Specific Energy Consumption

Specific energy consumption is estimated in terms of kWh per kg of tea produced. In tea industry, the specific energy consumption is calculated for both thermal and electrical energy as per equation (1) and (2).

$$\text{Specific thermal energy consumption} = \frac{\text{Total thermal energy consumption (kWh)}}{\text{Total amount of Made Tea produced (kg)}} \quad \ldots\ldots(1)$$

$$\text{Specific electricity consumption} = \frac{\text{Total electric energy consumption (kWh)}}{\text{Total amount of Made Tea produced (kg)}} \quad \ldots\ldots(2)$$

The specific energy consumption could be used to verify compatibility and comparison with benchmarks, if available. It helps to ensure quick assessment of the improvements and weaknesses on the process. It also allows determination of achievable quantifiable goals, which can be a measure for the success or failure of an energy saving project. For monitoring individual process, specific energy consumption of each process can be calculated to identify the energy wastage in a process and it helps in identifying energy intensive operations.

Conventionally, the total specific energy consumption is estimated by adding the specific thermal consumption and the specific electrical energy consumption. In such calculations, the efficiency of the electrical energy is not taken in to account. The total specific primary energy consumption could be the best way to compare the various production processes and to compare alternate energy sources.

Table 3 Specific Energy Consumption Details

Factory (Tea processing)	Average production (tonnes of made tea per year)	Specific Energy Consumption	
		Electricity (kWh per kg of made tea)	Thermal (kWh per kg of made tea)
Factory 1	402.5 (CTC)	0.472	6.50
Factory 2	394.5 (CTC)	0.580	7.08
Factory 3	486.4 (Orthodox)	0.529	5.65
Factory 4	1453.8 (Orthodox)	0.540	7.06
Factory 5	625.5 (CTC) 712.5 (Orthodox)	0.365	8.14
Factory 6		0.472	7.48

3.1 Thermal Energy Utilization

Thermal energy is consumed in drying and withering process. The heat is produced by burning coal, firewood and fuel oil in heaters. Firewood is widely used in Southern India whereas coal is used in northern India.

3.1.1 Withering

For withering, air is used at 25-32°C. In this process the moisture content of the green leaves gets reduced from 80% to 55%. In orthodox tea production, usually the exhaust hot air from the dryer at about 70°C is mixed with the ambient air of about 20°C to get the required air for withering. This method is energy efficient but it depends on the production schedule

3.1.2 Drying

The specific thermal energy consumption for drying is about is about 75-85% of the thermal energy requirement and about 50-75% of total energy depending of the type of tea produced. The energy consumption for the drying process depends on the efficiency of the heater cum dryer. The efficiency of the heater is influenced by the type of fuel and its moisture content, heater insulation, combustion air supply. The dryer efficiency varies with type of dryers like ECP, FBD and Tempest

Box 2 Technology Development in Tea Dryers

The earliest types of dryers were **static tray dryers**. Fermented tea is put on a bed of flat trays (each 2 inches wide and 6 feet in length and hinged longitudinally). Using a chain mechanism, the trays are turned upside down. Tea leaves fall down to the next set of trays and the process continues for about 10 – 12 tray sets. Hot air is blown upwards, and tea dries in about 30 minutes. The output of static tray dryers is low and they require high heat input to compensate for losses. These dryers are still being used in the coconut oil industry for drying and roasting shredded copra.

Later, multi-pass moving belt dryers called **endless chain pressure dryers** (ECP) were introduced. The basic operation is to feed fermented tea into the top moving tray and at the end, tea will fall down to the moving tray below it. This process continues for about 6 passes (20 minutes) and hot air is blown upwards. The capacity is about 200 kg/h. Efficiency is relatively high. This system is good for leafy grades but for powdered grades, output becomes low.

The **fluidized bed dryer** (FBD) is more efficient. It operates on the principle that if a sufficient volume of air is passed through a uniform mass of particles, it acts as a liquid. Tea is fed from the top and hot air is blown from the bottom, so that the tea particles are fluidized. In this process, moisture is removed quickly since each particle is surrounded by flowing hot air. A weir at the end controls the bed depth and outlet flow of tea.

The limitation of FBDs is that the moisture of the leaves should be less than 45%, otherwise it becomes difficult to fluidize. This problem was partially overcome with **vibratory fluidized bed dryers** (VFBD). For the powdered grade CTC process, a **combined ECP/FBD dryer (Tempest)** was introduced which has the features of both the ECP and FBD. This combined dryer has both moving trays at the first stage of drying, bringing the moisture content of leaf down for fluidizing, and the second stage is fluidized drying. The capacity and efficiency of Tempest dryers is the highest at present.

Dryer efficiency can be further improved by the exchange of R & D experience and introduction of better technology rather than considering this sector as a traditional processing industry.

In drying process, the fermented tea with moisture content of about 55% is dried to a moisture content of 3%. For this process, the hot air is generated in heater and used in the dryer. Most of the heater cum dryers has an overall efficiency of about 20-40%. Most of the heat is lost in heater and in the flue gas. The energy flow for withering and drying process is shown ion Figure 4.

Figure 4 Energy flow for withering and drying process

The energy flow for drying process is shown in Figure 5

Figure 5 Energy flow for drying process

Figure 6: Energy flow of diesel fired direct heater

3.2 Electrical Energy Utilization

Electricity is used mainly for machines and a small fraction for lighting. In case of Orthodox tea production, withering and rolling process consume more energy while in CTC tea production; the CTC process consumes large electrical energy. In orthodox process, withering takes most of the electrical energy followed by rolling. In CTC process, CTC machines take most of by grading operation. The reason for high electrical

energy consumption is that most factories use duel processing or CTC only. Both these arrangements require energy consuming CTC machinery and pre-rolling / post-rolling machinery like rotor vanes, pulverizes, drum fermenters etc.

3.3.1 Withering

The energy requirement for the withering process is mainly electrical energy to run the trough fans. Withering consumes about 15 - 55% of the total electrical energy. Orthodox tea processing consumes comparably higher energy for withering, the highest for all unit operations. This is because of hard withering in comparison to light withering in CTC tea production. Withering air flow can be reduced after initial withering is done. In case of reducing the air low rate during withering by adjusting the throttle valve, the motors are not designed to reduce the energy consumption according to the air flow rate. Only 10% of reduction is achieved, even the flow is reduced to 50%. Also, in most cases the equipment are oversized, minimal or no control over the speed of motors or air flow, and no monitoring of process conditions have often led to higher energy consumption. This is a large scope for the reduction in electrical energy consumption in withering

4. Energy Efficient Technology (EET) Options for Tea Industry

4.1 Housekeeping Measures

Reduce heat losses by insulation, avoiding leaks and using proper sized equipment eg (motors)

- Preventive maintenance system adoption
- Control of air flow in withering and drying process
- Improve heat transfer efficiency by cleaning tubes and ducts
- Usage of dried fire wood in comparison to moist firewood
- Operational improvements like excess air control
- Improve capacity utilization
- Improve load factor
- Proper production, planning and control

4.2 Use of Energy Efficient equipment

Using energy efficient equipment, like fluidized bed dryers, combined dryers, dual speed trough fans, direct-fired heaters

- Use of cleaner and energy efficient fuels
- Recovery of heat from flue gases and recirculation from dryer exhaust

4.3 Use of alternate energy sources

- Solar energy for withering or air pre-heating
- Generation of electricity using mini-hydro plants
- Biomass gasification

4.4 Energy Efficient Options for Energy Utilization

4.4.1. Electrical Energy

- Keep the power factor as high as possible preferably around 0.9
- The load factor should be more than 0.6

- For part-load operation, use delta-star connection
- For part-load operation, use variable speed drives
- Fans should be operated at its maximum operating efficiency obtained from the characteristic curves
- Use energy efficient fans
- Use energy efficient motors
- Use energy efficient lighting systems
- Proper operation and proper maintenance of electrical systems and equipments
- Proper selection of FD and ID fans

4.4.2 Thermal Energy

- Proper storage and handling of fuels
- Proper preparation of fuel like sizing etc
- Proper selection of burners/grates
- Proper combustion and control of excess air
- Waste heat recovery equipment installation
- Adequate thermal insulation

Variable speed motors are a more suitable option. This will consume less energy and regulate the air flow rate according to the withering condition and demand. It is possible to reduce at least 15 % of the energy costs for withering can be reduced by installing two speed axial flow fans, which will facilitate higher air flow at the beginning and lower airflow at a later stage. Studies and observation have shown that, the trough fans are mostly oversized and there is no control over the speed of motors or air flow. There is inadequate monitoring of process conditions and these often have lead to higher electrical energy consumption. Observations in most of the tea factories show that the trough fans generate about 5,000 cubic feet per minute (CFM) of air per kW of motor, whereas a modern motor-fan generate about 13,000 CFM of air per kW of motor. The high energy consumption is due to the improper design of fan and inefficient motors and so there is a considerable potential to conserve electrical energy

4.4.3 Improvements in electrical energy utilization

Withering

Studies and observation have shown that, the trough fans are mostly oversized and there is no control over the speed of motors or air flow. There is inadequate monitoring of process conditions and these often have lead to higher electrical energy consumption. Observations in most of the tea factories show that the trough fans generate about 5,000 cubic feet per minute (CFM) of air per kW of motor, whereas a modern motor-fan generate about 13,000 CFM of air per kW of motor. The high energy consumption is due to the improper design of fan and inefficient motors and so there is a considerable potential to conserve electrical energy. Variable speed motors are a more suitable option. This will consume less energy and regulate the air flow rate according to the withering condition and demand. It is possible to reduce at least 15 % of the energy costs for withering can be reduced by installing two speed axial flow fans, which will facilitate higher air flow at the beginning and lower airflow at a later stage

Box 3 Reducing Electrical Energy In Withering

THE WITHERING PROCESS CONSUMES ABOUT 32-45 % OF THE TOTAL ELECTRICAL ENERGY USED IN PROCESSING OF TEA. INADEQUATE PHYSICAL WITHER LEADS TO EXCESSIVE LOAD ON DRYER (HIGH THERMAL ENERGY). THE USUAL AMOUNT OF AIR REQUIRED IS AROUND 15-20 CUBIC FEET PER MINUTE / KG OF GREEN LEAF.

THE NEW SYSTEM CONSISTS OF ENERGY EFFICIENT AERO-FOIL AXIAL FAN WITH ADJUSTABLE PITCH AND WITH DUAL SPEED MOTOR WITH THE CONTROL. THE AIR FLOW IS AUTOMATICALLY REDUCED AFTER A PRESET TIME AND HENCE THE MOTOR POWER.

TEST RESULTS:

	FACTORY A		FACTORY B	
TYPE	ORTHODOX		ORTHODOX	
ANNUAL PRODUCTION (KG OF MADE TEA)	1,050,000		1,050,000	
UTILIZED TOUGHS AND SIZE	16 -(60 FT X 5 FT)		8 – (60 FT X 15 FT)	
AVERAGE LOADING (KG OF GREEN LEAF)	750-800		1800	
COST OF POWER PER KWH	RS. 4.50			
	BEFORE	AFTER	BEFORE	AFTER
ENERGY IN WITHERING (KWH/KG OF TEA)	0.36	0.26	0.31	0.20
SAVING PER ANNUM (RS.)	4,72,500		5,19,750	
COST OF SYSTEM INSTALLATION (RS.)	1 MILLION		1 MILLION	
SIMPLE PAYBACK PERIOD	2 YEARS AND 2 MONTHS		1 YEAR AND 11 MONTHS	

4.4.3.2 Energy Efficient Motors

The energy efficient motors have additional windings when compared to the conventional motors. An energy efficient motor produces a given amount of work with less energy than a standard motor. Though the initial cost of energy efficient motor is higher than the conventional motor, its running cost and the power consumption are much less when compared to those of the conventional motor. The energy and financial benefits are given in Table 4.

Table 4 Techno-economic benefits of Energy Efficient motors

Category	Before installation	After installation
Energy consumption		
Electrical energy consumption (kWh/year)		
(i) For 15 HP motors (5 nos)	89,686	78,216
(ii) For 20 HP motors (1 no)	23,886	21,121

ELECTRICAL ENERGY SAVING PER YEAR (i) *For 15 HP motor* (ii) *For 20 HP motor*	 Rs. 45,880 Rs. 84,484
Total saving	Rs. 0.13 MILLION
Total investment (six motors)	Rs 0.12 million
Pay-back period	1 year

4.4.3 Improvements in thermal energy utilization

Energy Efficient Dryer

The efficiency achieved in a Endless Chain Pressure (ECP) dryer is about 35 % whereas it is about 50% in fluidized bed dryer (FBD). However, many orthodox tea producers still use ECP dryers, because it can be used to dry both CTC and Orthodox tea. Lately, by incorporating the features of both ECP & FBD dryers, the combined FBD dryer has been introduced in India. This dryer of which has a higher output and better energy efficiency

Box 5 Performance Comparison of ECP, FBD, and Combined FBD dryer

	ECP- 6ft	FBD –24 x4	Combined FBD
Rated Out Put (Kg/ hr)			
Electrical Power (kW)	18	61	24
Out Put at 70 % Wither (kg/hr)	180	300	300
Water Evaporation rate (kg/hr)	380	700	700
Coal Consumption (kg /kg tea)	0.9	0.7	0.65
Equivalent Thermal Energy (kWh/kg)	5.76	4.48	4.16
Electricity Consumption (kWh/kg)	0.061	0.123	0.156
Specific Energy Consumption(kWh/kg)	5.82	4.60	4.32
Wither factor %	Any	70 -73	Any
Heater Unit	Any type	Gas/ Oil	Any type
Drying time	Controlled	Variable	Controlled
Fly off (% of Made Tea)	3 %	16%	< 2%

The techno-economic benefits of combined FBD are given in Table 5.

Table 5 Techno-economic benefits of combined FBD

Category	Before installation	After installation
Energy consumption		
Electrical energy consumption (kWh/year)	138,528	52,416
Coal (tons/year)	786	674
Energy saving		
Electrical energy saving per year	Rs. 0.35 million	
Saving in fuel consumption per year	Rs. 0.23 million	
Total saving	Rs. 0.58 million	
Total investment	Rs. 1.8 million	
Pay-back period	3 years 2 months	

4.4.3.2 Direct Fired Heater

Most tea industries use indirect heaters which are essentially tubular heat exchangers using coal or firewood. Recently, the tea industry started using direct-fired heater where flue gas is directly sent to the dryer. This system is ideal for Fluid Bed Dryer as well as conventional dryers. However, this is possible only if a clean fuel such as low sulfur LPG or oil is available. The techno-economic benefits are given in Table 6

Table 6 Techno-economic benefits of direct fired heater

Category	Before installation
Energy consumption	
Fuel oil (litre/year)	1,217,000
Annual Fuel saving	Rs. 1.4 million
Total investment	Rs. 0.5 million
Pay-back period	5 months

4.4.3.3 Fuel (Firewood) Efficient Air Heaters

Inefficient heat transfer in heat exchangers/ dryers results in high consumption of fuel. In tea industry the major use of thermal energy is in the drying process. Efficiency of good

firewood fired air heaters could be about 65 % while heaters are operating at about 35% efficiency at present. This is because of outdated heaters, inadequate thermal insulation, air leakages, clogged air tubes etc. It is also due to incomplete combustion caused by wet and un-chopped firewood, and manual feeding of firewood.

4.5 Case examples of application of EETs for different tea units The operating efficiencies of firewood furnaces and losses are given in Table 7. It was observed that the major losses are due to flue gas losses. The amount of excess air used high and it ranges from 125 –238%.

Table 7: Efficiency details of firewood fired furnaces in different tea units

Parameters		Unit-1	Unit-2	Unit-3	Unit-4
Furnace Make		Parucca	Parucca	Pandian	Pandian
No. of Pass		5	4	5	5
Fuel		Firewood	Firewood	Firewood & Briquette fuel	Firewood
Furnace Efficiency (%)		38.73	37.07	44.84	34.91
Excess air (%)	Actual	125	219	211	238
	Ideal	50	50	50	50
Flue gas temperature (°C)	Actual	128	140	139	131
	Ideal	120	120	120	120
CO2 (%)	Actual	8.5	6	9	8
	Ideal	12-18	12-18	12-18	12-18
Flue gas loss (%)		10.27	16.21	16.32	16.47

The techno-economics of different technologies are given in Table 8.

Table 8 Techno-economics of various EETs for Tea sector

Parameters		Unit-1	Unit-2	Unit-3	Unit-4
Firewood Cost per tonne (Rs.)		1500			
Coal Cost per tonne (Rs.)		3000			
Leco per tonne (Rs.)		5000			
Control of Excess Air	*Fuel saving (%)*	*1.1*	5.96	3.1	4.3
	Cost saving (Rs. in lakhs)	0.098	1.21	0.45	0.60
	Investment (Rs. in lakhs)	Marginal	Marginal	Marginal	Marginal
	Pay back period	Immediate	Immediate	Immediate	Immediate
Fuel Savings due to Forced Draught (FD) fan installation	Fuel saving (%)	20	20	FD fan is already installed	20
	Cost saving (Rs. in lakhs)	1.83	4.05		2.79
	Investment (Rs. in lakhs)	0.10	0.10		0.12
	Pay back period	One month	One month		One month
Fuel Savings due to Firewood	Fuel saving (%)	2.5	2.4	6.3	4.85
	Cost saving (Rs. in lakhs)	0.23	0.49	0.807	0.67

Storage in closed space	Investment (Rs. in lakhs)	0.912	0.912	1.139	1.13
	Pay back period	4 years	1.9 years	1.4 years	1.7 years
Use of coal instead of Firewood	Cost saving (Rs. in lakhs)	0.73	2.84	2.31	3.07
	Investment (Rs. in lakhs)	1.00	1.00	1.00	1.00
	Pay back period	15 months	5 months	5 months	4 months
Use of LECO instead of Firewood	Cost saving (Rs. in lakhs)	2.74	6.75	2.57	4.18
	Investment (Rs. in lakhs)	1.00	1.00	1.00	1.00
	Pay back period	5 months	2 months	5 months	3 months
Design Modification in Air Heater	Fuel saving (%)	20	20	20	20
	Cost saving (Rs. in lakhs)	1.824	4.05	2.571	2.796
	Investment (Rs. in lakhs)	12.00	12.00	12.00	12.00
	Pay back period	6.6 years	3.0 years	4.7 years	4.3 years
Fuel Savings due to Firewood Storage in closed space	Fuel saving (%)	2.5	2.4	6.3	4.85
	Cost saving (Rs. in lakhs)	0.23	0.49	0.807	0.67
	Investment (Rs. in lakhs)	0.912	0.912	1.139	1.13
	Pay back period	4 years	1.9 years	1.4 years	1.7 years
Use of coal instead of Firewood	Cost saving (Rs. in lakhs)	0.73	2.84	2.31	3.07
	Investment (Rs. in lakhs)	1.00	1.00	1.00	1.00
	Pay back period	15 months	5 months	5 months	4 months
Use of LECO instead of Firewood	Cost saving (Rs. in lakhs)	2.74	6.75	2.57	4.18
	Investment (Rs. in lakhs)	1.00	1.00	1.00	1.00
	Pay back period	5 months	2 months	5 months	3 months
Design Modification in Air Heater	Fuel saving (%)	20	20	20	20
	Cost saving (Rs. in lakhs)	1.824	4.05	2.571	2.796
	Investment (Rs. in lakhs)	12.00	12.00	12.00	12.00
	Pay back period	6.6 years	3.0 years	4.7 years	4.3 years

d) Assessment of potential for biomass conservation in small scale tea factories through the adoption of solar air heating technology

INTRODUCTION:

75 million kg of tea is manufactured in the Nilgiris district of Tamil Nadu in 170 numbers of small tea factories, having grid power of low tension equal or less than 150 kW, processing an average 0.5 million kg of CTC tea per annum (Dr. Ramu- KVK UPASI Personal communication 2005).

Fire wood transported from distant parts of Tamilnadu and locally available biomass are used as source of fuel as thermal energy is needed for the withering and drying of green tea leaves from 75 ± 5% moisture content (m.c) wet basis (w.b) to 2.5 ± 0.5% m.c.w.b.(De Silva 1993). Withering is the process in which harvested green leaves are spread with a bed thickness of around 0.25 m over wire mesh in a specially made wooden trough and aerated by a cross flow of ambient air during favorable weather condition or heated air not exceeding 32^0C maintained by axial electric fan with a flow rate of $0.175 \pm 0.075 m^3/s$ per m^2.

A bank of hot air (temperature range of 100 to 120°C) produced in solid fuel fed heater/furnace (using cast iron tubes as heat-exchanger) coupled to a drier is used for tea drying. Hot air is blown at the rate of 40-120 m^3/kg for moisture removal (Desilva 1993) is used for tea drying.

150 million kg of firewood worth Rs.3 billion (US$ 7 million), releasing 0.27 million ton of carbon emission is used in small scale tea factories. As thermal energy accounts from 20 to 27 % of the tea production cost (Dr Ramu- KVK UPASI Personal communication 2005), there is a need to investigate methods to reduce it as well as to reduce the carbon emission reduction.

The report shows that a reduction of 30% fuel and carbon emission reduction of around 810,000 ton per annum may be possible through solar heating with energy efficient furnace.

PEN TEA SOLAR HEATER – 'PENTEASOL' A CASE STUDY:

Efficient utilization of biomass coupled with solar pre-heating may pave way for achieving a substantial reduction in biomass consumption. Solar air pre heating are discussed.

Planters Energy Network '**PEN**', a NGO organization started in Maduari Kamaraj University in 1989, had introduced solar preheating units in 9 tea factories (Anx.II) most of them in Nilgris, by converting the large metal roof of the tea factories as absorber.

One such installed unit of collector area 212 m^2 including its fabrication and fuel saving performance is discussed (Palaniappan et al 1998). The factory is located at a latitude 11°N, longitude 77°E and altitude 1950 MASL near Coonoor in Nilgiris district. The factory produces around 0.3 million kg of orthodox tea per annum. During 1990 the factory produced 0.275 million kg of tea using 239,000 kg of coal. The factory has two banks of heater and drier, the first bank a small Sirroco make air heater (fed by coal or fuel wood) coupled with a conventional tray type drier of output 120 kg dmt/h (dmt = drier mouth tea) and the second a large Sirroco make air heater (fed by coal or fuel wood) coupled with a fluid bed drier of output 200 kg dmt/h.

The precipitation at the site is 100 to 150 mm and 110 ± 10 wet days per year. The main factory has two inverted v shaped corrugated galvanized iron roof of 28.75 m length along the apex which lies along east and west direction. A wooden false ceiling is fixed below the two inverted V shaped roof.

The solar air heater is used to pre-heat the air, which is further heated by the conventional furnace before blown into the drier. The flat plate collector is formed by converting the one side of the south facing galvanized iron roof of 20° tilt angle, length 28.75 m and breadth 7.37 m. The total 212 m^2 area of the collector is segregated into 4 equal units each of area 53 m^2 by using double metal sheet partition.

The roof after scratching is painted with commercial heat resistant dull black paint. Tempered glass of 4 mm thickness is used to form collector transparent cover using aluminum sections and frames for support. A vertical space of 150-165 mm is formed between the cover and roof in order to provide a mass flow rate of 0.0024 - 0.0026 kg/s per m^2 (Beckmann et al 1977). All the sides of the collector are enclosed by double metal sheet with 40 mm thick mineral wool insulation. Lower side of the roof is insulated by 50 mm thick mineral wool slab and 25 mm thick polystyrene sheet.

Four separate curved metal ducts connect the attic formed by wooden false ceiling and solar inlet. The temperature in the attic is higher than the ambient during sunny days. The hot air outlets of 4 collectors are connected to a 7.5 kW centrifugal blower through metal duct insulated with 50 mm thick mineral wool slab. The blower outlet is connected to the ambient air inlets of the two conventional heaters through a duct network. Using two dampers it is possible to provide solar heated air to one of the heaters since the factory uses any one of the heater-drier banks at a time. Provision is also made to use the hot air directly for withering of tea leaves during the non-operating period of the drier. Thus the solar inlet air is preheated in the attic taking advantage of solar insolation falling on the bare plate collector.

RESULTS AND DISCUSSION

The solar air heater, after its installation in April 1992, has been in continuous operation. On sunny days the solar air heater is used from around 9 in the morning. When the drier is not operating during sunshine period, the solar heated air is used for withering. The quality and output of drier is not affected by the introduction of solar preheated air.

During the first year of operation covering April 1992 to March 1993, the solar heating was used on 283 days or 1545 hours (h) (1063 h for drying and 482 h for withering). The solar heating during the period April 1992 to December 1994 (2.75y) in combination with the conventional heaters to produce 0.98 million kg dmt have conserved 199 tons of coal.

The annual average specific fuel consumption, the average kg of coal required to process 1 kg dmt, comparing the period before the solar heating introduced, has reduced from 0.93 to 0.65. The percentage of fuel savings is 29%. Other factories having solar heating have shown a fuel savings ranging from 18 to 37 % depending upon the temperature of hot air used and duration of tea drying. Higher savings were obtained for the factories, which run its drying during day shift only as well as processing the tea at lower temperatures.

IMPROVED PEN SOLAR AIR HEATERS:

New innovations recommended are:

- The mechanical power of the suction blower reduced by half by using aerodynamically designed systems. The collectors were made air/water leak proof by using best sealing arrangements.
- Instead of using the roof as the absorber, use roof as a base and form the collector over the same with special black paint coated aluminum absorber.
- Use selective paint coated copper sheet as absorber instead of black painted aluminum with airflow below the copper sheet. This under-blown system will enhance the efficiency of solar heating but at a substantial increase in cost.

While south facing orientation for the collector is ideal, variations up to 30 degrees as well as north slope can be considered. The recommended features of the solar collector

- Collector formed as full multiples (4 or 5 X 56 m^2), area determined by the volume of air needed in the drier.
- Three layers 75 mm thick mineral/rock wool or glass wool insulation, a corrugated metal cover with special black paint and a toughened 4 mm thick glass—aluminum extrusions and MS clamps used to create layers. Air passage duct formed using aluminum sheets.
- Hot air from each 56 m^2 collector collected using double layered GI sheet insulated box (65 /75 mm insulation).
- A suction blower of power around 3/5 HP depending upon the volume of hot air used to suck the hot air and deliver it to the point of application/ cold air entry points of the tea factory.
- Tempered glasses of high quality used in the collector.
- Periodical cleaning of glasses using water especially in dusty periods and repainting the collector once in 4-5 years.

ESTIMATION OF BIOMASS REDUCTION

Assumptions:

1. All factories have suitable roof for installing solar collector
2. Tea processing - drying in day shift alone and 300 d/y or 300 X 8 h = 2400 h
3. Solar radiation is available at the site – 1500 h /y
4 The temperature of hot air in the drier is 120 degree C
5 CTC tea processing and annual production of 75,000,000 kg tea

The fuel consumption reduction FR = {(Ts – Ta)/(Td - Ta)} x hs/ht

Where Ts = average solar hot air temperature
Ta = average ambient temperature
Td = average drier hot air temperature;
hs = hours of solar used and
ht = total hours of drier used.

FR = (75-25)/(120 – 25) x 1500/2400 = 33%

It is possible to save up to 33 % of fuel consumption by combining solar heating and efficient burning furnaces.

PROJECT PAY BACK PERIOD CALCULATION

Assumption: No tax depreciation benefits

Investment including other preparatory works
for 280 sq.m collector = Rs.1,450,000 (US$ 33721)

Parasitic cost in the running of blower
1500 X 3.6 kW X Rs.5 = Rs. 27,000/y (US$ 628)

Fuel savings per annum
250 X 2 kg X Rs.2 X 0.30 X 1500 h = Rs.450,000 (US$ 10465)
Sunny hours
Annually and tea production 250/kg h
Fuel consumed
Cost of fuel

Assuming a simple interest of 10 % and 5 % increase per year in the cost of fuel and Electricity – it is possible to get a pay back of around 4 years.

Under the Tea Board subsidy scheme where 25% of the cost of the equipment is provided by the Tea Board, each factory owner would invest Rs 1.087,500 (US$ 25290) and the pay back period would 3 year

e) Report on performance of conventional air heater

1. Thermal energy constitutes about 80% of the energy consumed in tea processing. The air heater is the only device where firewood is burnt and this energy is generated. Its performance is of critical importance in the project. The present document is a brief report on the performance of air heaters in tea factories.

2. Data is currently being collected in tea factories to verify that firewood consumption in tea factories is 1.5 kgs / kg of made tea. All factory owners have confirmed this number. TIDE team has collected data from two factories and the same is shown in the table below:

Factory	Annual tea production (kgs)	Fuel consumption (kgs)	Specific fuel consumption kg fuel / kg of made tea
Vigneshwara Tea Factory	971070	1386100	1.43
Highfields tea factory	383637	635960	1.68

Data was also collected to find out the fuel burning rate and flue gas analysis from three factories. Sample data from some tea factories is reproduced here. It can be seen that operations at Vigneshwara tea factory are more efficient than in other factories. This is also reflected in the specific fuel consumption data given above. All other parameters like make of furnace being the same, the better performance of Vigneshwara Tea Factory can be attributed to better operation of air heater

Yard storage temperature: 21.6 deg C
Temperature in the factory near the air heater: 31 deg. C

Time	O_2%	CO ppm	Eff %	CO_2 %	Flue gas temp	Ambient temp	P index %	Excess air %	Remarks
Vigneshwara Tea Factory									
13.00	13	272	77.9	7.7	140	27	.35	164.5	
	14.6	1817	70.5	6.1	164	27.6	2.97	231.7	
	15.5	1206	74	5.3	126	27.9	2.27	287	
15.15	14.2	197	77.2	6.5	131	28.6	0.30	211	
	13.1	569	75.4	7.6	162	29	0.74	168	
	15.4	1007	75	5.4	124	29.3	1.86	280	
High field Tea Factory									
11.30	16.4	2142	70.4	4.4	124	29.5	4.84	364.4	
	16.8	2187	68.7	4.0	123	29.4	5.46	409.7	
	18.2	1491	69.8	2.6	87	29.4	5.73	674	
13.30	16.4	2046	71.7	4.4	121	33.1	4.65	364.4	
	17.3	1832	67.4	3.5	123	33	5.23	480.5	
	18.3	1507	67.3	2.5	97	33	6.0	703.8	
Gas wood tea factory									
12.00	16.4	858	69	4.4	143	29	1.95	364.4	
	16.4	997	70.6	4.4	132	29.3	2.26	364.4	
	17.4	1022	68.4	3.4	118	29.6	3.0	497.1	
12.30	16.3	774	69	4.5	146	29.1	1.72	354.2	
	16.1	731	72	4.7	133	29.3	1.55	335.4	
	17	812	70.3	3.8	121	29.5	2.13	435.8	

This data was used to theoretical calculate losses at different moisture percentages. The fuel used was assumed to be eucalyptus. The percentage of excess air was in the same range suggesting compatibility between theory and data.

Assumptions
Composition of eucalyptus is
Carbon 49%
Hydrogen 5.9%
Oxygen 44.8%
Nitrogen 0.3%

The total losses because of un burnt carbon, loss of heat to vapourize the moisture present in the wood etc. is in the range of 1140 –1080 kcals / kg of wood for a wood moisture content ranging between 20 –30%. Data on moisture content shows that the moisture content in the wood at this time of the year is around 30%. It has been measured to be 45% in the monsoon months or at the time of purchase.

5. This data suggests two low cost options for conservation of fuel – operator training and construction of storage yards for storing the firewood (preventing exposure of wood to rain, mist etc.)

Annexure 4
Technology issues

a) Letter from Anna University used as basis for return on investment estimations

Dr. R. Sethumadhavan,
Co-ordinator

To
TIDE
No 19, 9th Cross, Malleswaram,
Bangalore 560 003

Dear Ma'am,

This has reference to your communication of 23rd February 2005.

It is heartening to note that you are trying to do your bit of useful effort in the up gradation of energy utility pattern in tea industries. I am willing to provide any technical information that you may need in this regard.

Incidentally we have carried out detailed energy audits in a couple of tea industries not only in Tamil Nadu but also in Karnataka. We could identify excellent energy conservation potential in these industries both in thermal energy and electrical energy sectors. Having carried out more than 100 energy audits I am quite confident in stating that there is a scope in saving energy to an extent of not less than 20-25% in both thermal and electrical.

On an average a saving not less than Rs 5 –10 lakhs / yr can be achieved with an equal amount of investment in small medium and big tea factories.

As such majority of the tea factories have no high end technocrats and their exposure to energy auditing / conservation / management is quite limited. Hence it will be a worthwhile exercise to create awareness among the tea industries on their energy consumption and induce them to implement energy saving practices and devices.

As indicated earlier you can look forward to me for any technical help in the area

With regards
R. Sethumadhavan
Coordinator IES

Annexure 4
b) Note from Pandiyan Engineering

From: Pandian Group <oty_pandind@sancharnet.in>
To: <tide@vsnl.com>
Subject:
Date: Wednesday, March 02, 2005 5:15 PM

PSP:RNR:PEI:GENL:2004-05 MARCH 02, 2005

Mr. Murali Subramaniam,
Technology Informatics,
19, 9th Street, 6th Main,
Malleswaram,
BANGALORE 560 003.

Dear Sir,

This has reference to the discussions you have had with me during your visit to Coonoor regarding the use of Heat and Electricity in Tea Manufacturing.
We would like to introduce ourselves as a leading Tea Machinery manufacturer. We have been in the field for the past 40 years and the Company has run by qualified Engineers. We have developed and designed many systems for heating and drying of tea. We have over 200 installations in India and abroad and have considerable experience in the fields of drying Tea, Herbs, Tapioca, Coconut, Salt and Marigold.

The following are the efficiencies of the existing Heaters and Driers.

DRIER:
Fluidized Bed Driers are especially in Tea manufacturing fairly efficient and give good quality of tea. These systems have been tested and have been found to be about 70% efficiency. These Driers are extremely energy efficient, but still work could be done on the following:

1. To improve the efficiency of the Fans.
2. Having continuous monitoring system but this will ensure the efficiency and the quality of tea.

HEATER:
Regarding heaters, the following problems have been faced by the operators in and around Nilgiris.

1. Consistent supply of fuel of consistent quality and prices. i.e. relating to quality is not available.
Right now people are using solid fuel heater with firewood as a fuel. Firewood availability is under pressure, it cannot be used for a long time as a solid fuel for Tea Industry.

This has been discussed with you and possible use of Bio fuel on good prices, consistent and quality. The current level of the efficiency of solid fuel heaters is 65%. Some heaters are working at an efficiency of 80% when mechanical stoking is used. We have to develop a good BIO-FUEL with mechanical stoking.

We are keen to work with your organisation and share knowledge in this sector and develop an alternative solution for Tea Industry.

Thanking you,

Yours faithfully,
THE PANDIAN ENGINEERING INDUSTRIES
G. PREM SAGAR PANDIARAJ
MANAGING PARTNER

c) **Note from Tea Kraft**

From: Teakrafts <tk@tiglobal.com>
To: <tide@vsnl.com>; <msub_blore@hotmail.com>
Subject: BLAZE HEATER
Date: Wednesday, February 16, 2005 6:23 PM

Kind Attention: Mr.M.S.Subramaniam

Introduction:
The Blaze vertical steel tube heat exchanger was developed the technical assistance from M/s.PSG Technology in the year 2001-02. The purpose of designing the Blaze was to enhance the efficiency for tea factories thereby saving fuel. The existing heat exchangers are cast iron horizontal tube type having low efficiency and high maintenance costs.

Improvement in efficiency:
The Blaze achieves an efficiency of 70% +/- 2% (combustion and heat transfer). The old system efficiency was 50% +/- 5% on the 5 pass CI heaters.

Established track record:
The Blaze was used for commercial production for the 1st time in the year 2002-03. Thereafter, 20 heaters have been installed in various places in India. In South India, the Blaze is fired with wood and we have recorded from collected field data a 20% saving in fire wood consumption.

Payback:

Installed Cost of Blaze 125 Heater	: Rs 12,50,000
Less: Tea Board subsidy 25%	: Rs. 3,12,500
	: Rs. 9,37,500

Annual fuel savings between Blaze Heater and CI Heaters: Rs. 2,40,000 *

Average annual savings on maintenance	: Rs. 75,000
Total saving	:Rs.3,15,000

Therefore, pay back period is less than 3 years (2.98)

* (150 kgs per hour fire wood consumption x Rs.2.00 per kg cost of fire wood x 250 working days x 16 hours per day x 20% increased efficiency)

Other advantages include:
Lower space requirement
Easier cleaner of tubes
Steady operating temperatures

With best regards
Vineet Bagaria

d) **Weather data giving details of sunny days at Coonoor**

Source: Met station at TRI, UPASI Coonoor

MET data 2002

Month	Mean sunshine period hrs /day	Sunny days	Total sunny hours
January	7	30	210
February	7.6	22	167.2
March	9.4	31	291.4
April	9.5	30	285
May	6.9	30	207
June	5.8	29	168.2
July	5.3	30	159
August	3.9	22	85.8
September	7.0	30	210
October	3.7	26	96.2
November	5.0	24	120
December	7.7	30	231
Total sunny hours			1853.6

Annexure 5
Cost effectiveness based on Sample Energy Audit Summary

	Description of some Electrical Energy Saving Recommendations	Savings (US$ pa)	Investment (US$)	Simple Payback (months)
1	Shaft Mounted ID Fan as opposed to Belt Driven Fan	160	46	3.4
2	Permanent Star Connection for Lightly Loaded Motors	206	46	2.7
3	Change Cast Iron Blades with FRP blades in Withering Section	183	413	27.0
4	Common Chain for fermentor drums	504	573	13.6
5	Servo Stabilizer and Voltage Optimization (Power Distribution Board)	115	229	24.0
6	Automatic Star Delta Star starters in Lightly Loaded Motors	3,781	688	2.2
7	High Freq. Electronic Ballast to replace conventional copper chokes	298	756	30.5
8	Replacement of Faulty Capacitors	8,594	917	1.3
9	Replacement of V-Belt with Synthetic Flat Belt Drive (as required)	1,444	2,063	17.1
	Total	15,285	5,729	4.5

	Description of some Thermal Energy Saving Recommendations (based on interactions with PSG College and Anna University)	Savings (US$ pa)	Investment (US$)	Simple Payback (months)
1	Drying Yard to store Biomass	1,990	4,583	27.6
2	Recovery of flue gas to pre-heat combustion air	1,329	1,833	16.6
	Reduction of excess air in Hot Air Generator or	4,583	0	0.0
	Or			
	Change to more efficient air heater	7,723	27,500	32.0
Energy Audit Performed by Dr. Sethumadhavan, Institute of Energy Studies, Anna University, Chennai				
Performed at Salisbury Industrial Co-operative Tea Factory, Gudalur in April 2001				
It is to be noted that all recommendations are case specific based on the output of detailed energy audit				

E) TOTAL PROJECT BUDGET AND WORK PLAN:

Award ID:	00047624
Award Title:	PIMS 3163 India Energy Conservation in Small Sector Tea Processing Units in South India
Business Unit:	IND10
Project ID:	00057404
Project Title:	PIMS 3163 India Energy Conservation in Small Sector Tea Processing Units in South India
Implementing Partner	Ministry of Commerce

GEF Outcome/Atlas Activity	Responsible Party/	Fund ID	Donor Name	Atlas Budgetary Account Code	ATLAS Budget Description	Amount Year 1 (USD)	Amount Year 2 (USD)	Amount Year 3 (USD)	Amount Year 4 (USD)	Total (USD)
OUTCOME 1: Awareness creation	**UNDP**	**62000**	**GEF**	71200	International Consultants	17,600	35,000	37,900	19,840	110,340
				71300	Local Consultants	16,180	21,000	21,580	14,900	73,660
				71600	Travel	5,600	5,600	5,600	5,600	22,400
				74500	Meetings & Workshop	5,200	5,200	5,200	5,200	20,800
				72500	Office Supplies	875	875	875	875	3,500
				74500	Misc	800	800	700	800	3,100
					Total Outcome 1	**46,255**	**68,475**	**71,855**	**47,215**	**233,800**
OUTCOME 2: Financial barriers	**UNDP**	**62000**	**GEF**	71200	International Consultants	10,000	10,750	10,000	10,750	41,500
				71300	Local Consultants	7,500	7,500	7,500	7,500	30,000
				71600	Travel	3,375	3,375	3,375	3,375	13,500
				74500	Meetings & Workshop	2,250	2,250	2,250	2,250	9,000
				72500	Office Supplies	1,375	1,375	1,375	1,375	5,500
					Total Outcome 2	**24,500**	**25,250**	**24,500**	**25,250**	**99,500**
OUTCOME 3: Adoption of EE/RE equipment / practices	**UNDP**	**62000**	**GEF**	71200	International Consultants	9,750	9,750	9,750	9,750	39,000
				71300	Local Consultants	7,082	7,081	7,086	7,081	28,330
				71600	Travel	3,180	4,115	4,115	4,110	15,520
				72000	Service Contract	71,930	74,000	72,000	73,000	290,930
				74500	Meetings & Workshop	5,280	5,280	5,280	5,280	21,120
				74500	Misc	325	325	325	325	1,300
					Total Outcome 3	**97,547**	**100,551**	**98,556**	**99,546**	**396,200**
OUTCOME 4: Monitoring, Evaluation, Learning	**UNDP**	**62000**	**GEF**	71200	International Consultants	25,500	25,500	25,500	25,500	102,000
				71300	Local Consultants	5,250	5,250	5,250	5,250	21,000
				74500	Meetings & Workshop	1,250	0	1,250	0	2,500
					Total Outcome 4	**32,000**	**30,750**	**32,000**	**30,750**	**125,500**
PROJECT MANAGEMENT UNIT	**PMU**	**62000**	**GEF**	71200	International Consultants	0	0	0	0	0
				71300	Local Consultants	14,750	14,750	14,750	14,750	59,000
				71600	Travel	3,750	3,750	3,750	3,750	15,000
				72400	Communication	0	4,000	4,000	0	8,000
				72000	Equipment & Furniture	3,000	0	6,000	3,000	12,000
				74500	Misc	0	500	0	500	1,000
					Total Management	21,500	23,000	28,500	22,000	95,000
					PROJECT TOTAL	221,802	248,026	255,411	224,761	950,000

Summary of Funds: [3]

GEF	In cash	221,802	248,026	255,411	224,761	950,000
Individual Tea Factory Promoters	Equity	39,875	59,812	59,813	39,875	199,375
Tea Board	Grant	72,000	48,312	48,313	72,000	240,625
Union Bank of India, Coonoor; Central Bank of India, Coonoor; IREDA, New Delhi	Commercial Credit	231,000	99,000	99,000	231,000	660,000
TOTAL		564,677	455,150	462,537	567,636	2,050,000

[3] Summary table should include all financing of all kinds: GEF financing, cofinancing, cash, in-kind, etc. etc

F) ACRONYMS

AWP	Annual Work Plan
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CGPL	Combustion, Gasification, Propulsion Laboratory (Indian Institute of Science)
CO2	Carbon di oxide
COP-8	Conference of Parties
CTC	Cut Tear Curl
FD	Forced Draft
GEF	Global Environmental Facility
GHG	Green House Gases
ID	Induced Draft
IREDA	Indian Renewable Energy Development Agency
KL	Kilo liters
KWH	Kilo Watt Hours
MWH	Mega Watt hours
NILMA	Nilgiris District Tea Producers Marketing Co
MOC	Ministry of Commerce
MOU	Memorandum of Understanding
NSC	National Steering Committee
PD	Project Director
PMB	Project Management Board
PMU	Project Management Unit
PSC	Project Steering Committee
PSGCT	PSG College of Technology
QPR	Quarterly Progress Report
RMG	Results Management Guide
TEDA	Tamil Nadu Energy Development Agency
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UPASI	United Planters Association of South India