RESOURCES

DHAN FOUNDATION

The DHAN Foundation (Development of Humane Action) is a professional organization in Tamil Nadu working for people's development and catering to about 7 lakhs poor families through various thematic poverty alleviation programmes. There are 650 professionals and 750 development personnel who run the foundation through its branches in 11 states and one union territory. The development intervention is conducted in 4 phases - Social intermediation (organizing the unorganized), financial intermediation (access to savings, credit and insurance), Business intermediation (promotion of sustainable business) and civic intermediation (Establishment of Schools, hospitals etc.). The business intermediation necessitated the need to promote an exclusive business unit giving birth to Kalanjium Thozhilagam Limited (KTL) where individuals who run the business are its shareholders. KTL explores local skills and promotes micro enterprises, acting as a vehicle to enhance the income of the poor.

Figure 1 : The prosopis juliflora is a hardy tree that grows easily with scanty rainfall

One of their business units is involved in charcoal making and supply to local industries. Prosopis juliflora is a thorny tree, which grows well even in areas with scanty rainfall and low fertile soil. About 5 lakhs ha of wastelands in Ramnad, Virudhunagar, Sivagangai and Tuticorin districts are populated by this species. KTL which is helping the local women's self help groups in charcoal making would like to diversify and supply cut wood to the tea factories in the Coonoor region. Added costs on cut wood are incurred due to the transportation costs and the need for a larger sized wood. Negotiations between KTL and the tea associations are on to settle for a price that benefits both parties.

KTL has also shown its willingness to invest and operate a briquetting unit dedicated to supply briquettes to the tea industry. Their estimates suggest that the project cost of a briquetting unit to produce 10 TPD of briquettes would be Rs 22.45 lakhs, which includes the cost of the machine (Rs 12.9 lakhs), the puliverizer, working capital and pre operative expenses. As a unit managed by its people, they plan to finance the costs through government subsidy (35% of project costs), and individual investments. Tea factories keen to avail of the KTL supply for fuel should contact them. The details are as given:

Mr. T. Dhanabalan
Kalanjium Thozhilagam Limited
No. 52, T. B. Road, Mehaboobpalaym,
Madurai - 625 016
Ph : 0452 2301112 / 4358001

ABOUT THIS NEWSLETTER

Tea processing requires large amount of thermal and electrical energy. In an effort to reduce energy consumption, and thus energy costs, the Tea Board of India has launched a project 'Energy Conservation in Small Sector Tea Processing Units in South India' aimed at promoting energy efficiency and renewable energy in the industry. A main objective of this project is creating awareness in the tea industry about energy efficiency and renewable energy and their relation to profitability, gathering data and information, and sharing knowledge. The Encon Tea newsletter is brought out to meet the above objective.

Editorial Team

Chief Editor

Mr. R.D. Nazeem, I.A.S.,
Executive Director
Tea Board, Coonoor

Assistant Editors

Mrs. Svati Bhogle, TIDE
Ms. Chitra Narayanswamy, TIDE

Call for Innovators

Have you used or are you aware of an innovative idea to improve the energy efficiency in tea factories? Share it with us and it could be featured in the issue of EnConTea

Contact

TIDE Project Office
Tea Board Zonal Office
Shelwood, Coonoor Club Road
Post Box No. 6
Coonoor - 643101
Phone: 0423 2222090
e-mail: encontea@bsnl.in

TIDE
#19, 9th Cross Road, 6th Main Road
Malleswaram
Bangalore 560003
Phone: 080 23315656
Fax: 080 23344555
e-mail: tide@vsnl.com

EnConTea

A Quarterly Newsletter of the Project -
Energy Conservation in Small Sector Tea Processing Units in South India

GEF TIDE

Issue - 5 June 2009

PROJECT IN BRIEF

The project - Energy Conservation in Small Sector Tea Processing Units in south India, has been initiated by the Tea Board to remove barriers to energy conservation and energy efficiency that inhibit the realization of large energy saving potential in the tea sector. This 4-year project is supported by the United Nations Development Programme - Global Environment Facility. The project's objective is to remove barriers and to develop replicable strategies for energy efficiency and energy conservation interventions in the tea processing industry in south India. The objective would be achieved by:

a. Awareness creation among the target sector about energy efficiency/renewable energy technologies and their relation to profitability
b. Elimination of financial barriers that inhibit investment in energy conservation equipment
c. Adoption and procurement of energy efficiency/renewable energy equipment /practice
d. Learning, knowledge sharing and replication

INSIDE

EDITORIAL

Mr. R.D. Nazeem, I.A.S.,
Executive Director**,** Tea Board
National Project Director of the Project

It is sunshine days for the Tea industry, where growing demand has kept the profits high for the popular brew. All tea factories must make the best use of the good times and utilize the opportunity to invest now in enhancing their productivity and guaranteeing sustained profits. Decision makers of the tea industry can gain long term benefits by investing in energy conservation measures such as energy efficient equipment and processes that utilize renewable fuel sources. Energy efficient equipment is included in the subsidy list of the Tea Board of India.

Energy audits have helped tea factories gauge energy losses. The audits have recommended energy conservation measures and the projected savings; on an average, it is possible to easily save 15-20% of the energy costs. The focus of every factory must now be to implement the audit recommendations. The measures may be taken up in phases, dictated by the factory's specific issues, but it is imperative to act now.

Fuel related issues have remained the subject of discussion in the project since its inception. The most pressing problem has been the erratic supply of cut fuel wood, its thickness, and high moisture content. The need to address the issue was expressed in the seminar session on "Renewable energy options for the tea industry" on 6th May 2009 held to coincide with the visit of the Secretary, Ministry of New and Renewable Energy to Coonoor. The presentations in the seminar emphasized the need for standardization of biomass fuels – in their moisture content and calorific value, and their efficient use either in thermal gasifiers, steam boilers, air heaters etc. The use of good quality biomass fuels would help reduce fuel consumption to 0.6 to 0.7 kg per kg of made tea making south India the most energy efficient tea making region in the world. The Encon project which to date has educated us on the energy related issues, is now changing gears and working towards setting up dedicated briquetting units for the tea industry.

Select members of the Encon team went on tour to the tea factories in the north east to understand their tea processing practices. Some of the manufacturing processes, when adopted here would be beneficial for our factories. Take as example the withering process - a separate building is dedicated for the process, where withering of the tea leaves takes place in enclosed troughs. The enclosures assist in conserving the heat generated using natural gas. Also, each trough is loaded with 1.5 to 2 kg of leaf per sq. foot exposing the entire produce to wither proportionately.

I am happy to inform you that the Energy laboratory at UPASI would be functional soon. I look forward to its playing a pivotal role in the provision of energy services to the tea sector. In addition to hosting the entire spectrum of energy consumption monitoring instruments I would like the facility to demonstrate the best energy efficient equipment and offer trial usage facilities to the tea factories. This is a confidence building measure that should influence factory owners take the first bold step towards energy savings in tea making!

(For Internal Circulation Only)

INTERVIEW WITH MR GOPALAKRISHNAN, Director Glenworth Estate Limited, Coonoor, The Nilgiris District

1. 50% of the tea produced in south India is exported. Has the south Indian tea industry changed its processing techniques to enable the south Indian teas cater to the international market?

The south Indian tea industry has not changed the processing technique but has become more quality conscious in making internationally acceptable quality tea. The Golden Leaf India Tea award programme has increased the awareness of making high quality tea in south India and the visit of various international buyers here has opened up the export market. There is always good demand for quality and in its consistency, which is appreciated by the buyers.

2. What in your opinion should be the bench mark for energy consumption by tea factories? What do you think are main points in achieving this bench mark?

The bench mark for energy consumption of fuel wood in a orthodox factory will be around 0.550 kg of tea per kg of fire wood and in a CTC factory will be around 0.700 Kg of tea per kg of fire wood. This includes the fire wood used for withering.

In the case of electricity consumption the bench mark will be 1.9 kg per unit in the case of orthodox manufacture and 1.7 kg of tea per unit for CTC manufacture. Of course it varies from factory to factory depending upon the heating system used and the horsepower of the machinery used.

The main points in achieving these bench marks are the capacity utilization of the factory as well as the regular maintenance of the machinery.

3. Would you be aware of the best energy consumption values for orthodox and CTC tea making internationally? Is the south Indian tea industry within reach of attaining these internationally competitive values?

We do not have any data on the energy consumption in the tea factories of other countries. Since India is the leader in tea production the Indian energy consumption on tea production could be considered as an international standard.

4. Renewable energy becomes the focus of attention only when the oil prices start to rise. In the context of the tea sector what are your suggestions for creating a sustained interest in renewable energy for tea making?

Suggestions for creating a sustained interest in renewable energy are:-

i) Sufficient land should be provided to the plantations to grow fuel wood trees to meet the fuel requirement of the tea garden

ii) Tree cutting rule has to be relaxed so that tea plantations can use their own fire wood

iii) Subsidies should be available to tea plantations owners to grow fuel wood in large tracts of waste lands available in the plains

iv) Selection of fast growing and high calorie wood producing fuel wood tree has to be identified and it should be cultivated

v) Production of biomass briquettes in a very large scale should be encouraged

5. Do you think the present energy policy is a barrier to energy reform in the sector? What recommendations or suggestions can you make at the policy level that would assist the sector to make a transition to energy efficiency?

The Energy policy is not a barrier to the energy reforms in the tea sector but more forward thinking in the energy policy will help the industry.

Almost all the plantations have adequate water resources and they should be allowed to utilize these resources to generate energy.

Government should come forward with the idea of micro hydel project and generate electricity where ever possible.

6. Energy consumption is always spoken off in the context of tea factories. Are you aware of any data that has been compiled on energy consumption in the farm prior to the leaf coming to the factory? Is there scope for intervention on the plantations?

Energy consumed on the farm, prior to the leaf taken to the factory is from the use of fossil fuels when transporting the produce and fuel to operate the sprayers on the plantations. Tabulated data of fuel consumed on the plantation does not exist, but the fuel used is constantly monitored.

Introduction of solar operated sprayers will help the farm to reduce costs on spraying. In the case of transport of the leaf, organizing the movement of vehicles properly and constantly monitoring the vehicle movement could bring down the energy consumption. Introduction of leaf movement through overhead cable system, wherever possible, will considerably reduce the energy usage.

ducts remained. Maintenance issues and design improvement was discussed with the MNRE officials and Dr. Palaniappan said that there was a solution to the same in the newer version of the technology. The factory reported that it was operating in the dual fuel mode (solar and coal) because of problems with dry wood supply.

The next stop of the field trip was the Kaikatty tea factory, an INDCO factory about 12 kms from Coonoor. An emerging model factory in the practice of energy efficient alternatives, the project officer Dr Swaminathan is instrumental in initiating energy conservation practices and equipment. Dr. Swaminathan reported that even with limited interventions, his factory was reporting a consumption of 0.5 kWh electrical energy / kg of made tea in contrast to the industry average of 0.7 kWh / kg of made tea. He was currently exploring a process intervention whereby heat could be extracted from chimney exhaust gases and used for withering.

Figure 3: *MNRE secretary in conversation with Dr. Palaniappan and Mr Lakshmanan discussing the pluses of solar roof tops at the Golden Hills Tea factory*

In the past, the factory had fully substituted fuel wood with briquettes. However they shifted back to wood because of the poor quality of briquettes supplied resulting in erosion of user confidence and deterioration of grates and air heater components. There was consensus for the need for an Indian standard for biomass briquettes. Another topic of discussion was the state of willingness of the tea industry to invest in briquetting units and manufacture their own fuel as per their requirements. This idea needed further development.

Dr. Swaminathan said that he was not in favour of solar air heaters because of the monkey menace. He suspected that monkeys in the vicinity would damage the glass panels. Dr. Ashvini Kumar said that protection from monkeys could be factored into the design of the solar panels.

The team also visited the Deveshola Tea Factory, an estate factory, situated at a height of 2100 meters surrounded by a scenic spread of tea plantations. Mr Balaji, who has explored several energy efficient interventions, including the gasifier in the past, explained the daily tea making schedules, especially for orthodox factories, and how it impacted the renewable energy options. He explained that orthodox tea is made in the early hours of the morning to retain the aroma of the tea. He believed that under the circumstances, solar air heaters may not be recommended because of the mismatch between the peak solar radiation time and the time period when thermal energy is required for tea drying.

He further cited his unhappy experiences with the biomass gasifiers for tea drying. Going into the past correspondence that he presented and based on an analysis, it was understood that the past experiences were largely due to mismatch between the capacity of the gasifier and the thermal energy need for tea drying, the quality of the fuel, (wet wood, adulterated briquettes etc). He further stated that a resurgent gasifier option may be technically viable if the capacity matches the need and if prepared fuel supply linkage is developed. He however thought that the gasifier option may not be viable considering the high cost of prepared fuel. A probable option worth exploring was to seek an ESCO that would be prepared to own and operate a gasifier and charge a standard rate for supply of hot air. The discussions suggested that there was perhaps a need to intervene in the biomass supply chain for tea industries. Dry storage of wood was another option that needed to be evolved and supported.

Mr Balaji further expressed his frustration with the current energy situation and informed of his probable decision to shift to coal.

Figure 4: *Use of Aero generators driven by wind in Deveshola Tea factroy*

The major learnings from the field trips were:

1. Need to develop specifications indicating high acceptability of solar air heaters criteria being, roof area, roof orientation, tea production capacity and time when tea drying and withering is traditionally carried out
2. Need to review the state of the technology for solar air heating, understand the performance of the most recent solar air heating technology under optimum conditions and define limits for acceptance of solar air heating as a cost effective option.
3. Need to develop monkey proof designs of solar panels
4. Need for more clarity on techno economics of the gasifier option for tea drying and withering and in the context of other competing technologies.
5. Exploration of the willingness of energy service companies to invest in biomass gasifiers and other energy efficient thermal equipment and then charge for hot air based on cfm and temperature.
6. Need for making standardized, high calorific value, low moisture content fuel available to the tea industry.

Events

2. Arrange for demonstration projects funded by MNRE using solar in conjunction with boilers for air heating purposes.

Hydropower: In order to set up hydro power plants in tea plantations, factory owners are eager to learn more on Tamil Nadu's power generation policies through TEDA, MNRE's nodal agency.

Possible steps to take it forward:

1. The Encon project team would conduct a survey on hydro power generation potential in tea estates in south India.
2. TEDA offices will communicate with the tea industry on procedures for implementation and operation of hydro power plants in Tamil Nadu.

Briquettes: Given the foreseen scarcity of fuel wood supply and its high moisture content, there is consensus among stakeholders that good quality briquettes at an affordable price are an urgent requirement for the industry. MNRE is perceived as an useful liaison to help build linkages with briquette manufacturers and loose fuel supply agents.

Possible steps to take it forward:

1. The Encon project team would collect information available with MNRE on briquettes and disseminate the same to tea factories.
2. Facilitate to establish a briquetting unit with a capacity of 100 tons/day at Mettupalyam for the Coonoor region.

Policy Measures:

1. Disseminate current MNRE schemes and establish policies specific for the tea industry for solar and gasifier installations.
2. Tea factories requested simplified procedures in availing subsidies and loans from MNRE.
3. Current total investment in equipment and machinery in the bought leaf factories is Rs 1 crore. It was imperative that MNRE keep costs in perspective and recommend low cost RE technology that is affordable.

VISIT BY MNRE OFFICIALS TO COONOOR TEA FACTORIES – 5th May 2009

The officials of the MNRE, Mr Deepak Gupta, IAS, Secretary, MNRE, Dr Khare and Dr Ashvini Kumar undertook a familiarization visit to select tea factories in the Nilgiris to understand tea making first hand and the probable renewable energy interventions in the tea sector. This was an opportune exercise coming as a precursor to the seminar on renewable energy in the tea sector the next day. It helped them understand electrical and thermal energy issues, especially about issues concerning wood as fuel faced by tea factories.

Figure 1: *MNRE secretary, Mr Deepak Gupta at the Glendale tea factory*

The first stop was at Glendale Tea Factory, an estate factory about 6 kms from Coonoor. The visit started of with an introduction to every stage of tea making. The officials studied the issues relating to fuel stress, wood availability, cost, storage, transportation, moisture content, quality issues in the use of the briquettes, etc. The Glendale factory uses solar preheating of air for withering and tea drying. The performance of the solar air heating system is being monitored for the past two months and the factory reports 10 -15% saving in fuel cost during the period February to April 2009. Dr. Palaniappan of the Planters Energy Network who was the technology provider informed the visitors that the solar air heating technology in Glendale was now almost outdated and technology has since advanced. He further informed that Glendale was not ideally suited for solar considering the roof direction and the limited sunshine because of interference of the shadow from the hill behind. The use of solar air pre-heaters as an option for reducing the fuel consumption was discussed.

Figure 2: *Dependence on fuel wood for all thermal processes (withering and drying)*

The second stop was at the Golden Hills Tea Factory, a short drive from the Glendale factory about 3 kms away which had also implemented solar air preheaters but a version that was more advanced than that installed at Glendale. A small sized factory, they processed leaves from bought tea leaf owners. However the orientation, the roof area and scale of operation made the factory an ideal location for solar air preheating. Dr. Palaniappan reported that the Golden Hills Tea Factory offered considerably higher fuel saving (upto 40%) but there was scope for further fuel conservation because the version 3 of the solar air heating technology was now developed and ready for implementation. Mr. Lakshmanan, of the Golden Hills Tea Factory stated that he was happy with the solar technology and found it effective. However the issue of dust entering the

ARTICLE

QUALITY OF MADE TEA THROUGH EFFICIENT DRYING

by Sanjay Misri

In 1824 tea plants were discovered in the hills along the frontier between Burma and the Indian state of Assam. The British introduced tea culture in India in 1836 and in Sri Lanka (then Ceylon) in 1867. Initial tea plantations used seeds from China, of which later harvests were using seeds from the Assam plant species. Incidentally, India is the world's largest producer and consumer of black tea. It produces over 900 million kgs of tea per annum, which accounts for over 25% of world production.

Tea is the most popular non-alcoholic beverage in the world long appreciated for its unique ability to refresh, relax and revive. Today, more tea is drunk around the world than coffee and carbonated soft drinks combined and its consumption is on the rise year on year.

Tea drying is an important part of tea manufacturing that requires sizable energy. The main objectives of drying are:

1. To arrest enzyme reaction as well as oxidation,

2. To remove moisture from the leaf particles and to produce a stable product with good keeping quality.

Technology of tea drying

On an average 100 kg of fresh leaf produces 22.5 kg of dried tea containing residual 3% moisture. The difference of 77.5 kg is the moisture that evaporates during the process. About 20-25 kg of the moisture evaporates during withering and remainder 20-50 kg gets evaporated during drying. In the entire drying process, moisture in a tea leaf particle is reduced from around 70% to 3%.

Post withering, the tea leaves are further processed and then dried in hot air. The drying equipment consists of the dryer and the air heating system. The hot air fan connected to the dryer is used to introduce clean hot air from the heating unit to the bottom of the dryer. In the dryer the fermented leaf falls over a series of moving perforated trays (in conventional dryer) or a perforated vibrating plate (in FBD dryer) where the hot incoming air-dries the leaf and the moisture is reduced from around 70% to 3%.

Factors that influence drying are:

1. Temperature of inlet and exhaust air
2. Volume of air
3. Quantity of leaf fed (i.e. thickness of spread)
4. Period of drying (through put time)

Temperature of inlet air:

Drying of tea involves both physical and chemical aspects. Temperature, at which tea is dried, therefore, has to be selected judiciously. Too high temperature at the initial stage may cause case hardening and blistering or scorching. Even if these effects are taken care of, a faster rate of evaporation may impart the teas an undesirable harshness. On the other hand, too low a drying temperature slows down the rate of drying and high temperature oxidation is allowed to proceed for a longer period resulting in a 'dull' and 'soft' product. This affect is known as stewing. Hence it is necessary to maintain an accurate, and consistent firing temperature in a dryer to produce high quality tea.

Over decades the heating equipment used in tea drying application have undergone changes which have been primarily guided or driven by some of the following key factors:

1. Type of dryer and tea to be manufactured
2. High reliability and ease of drying
3. Energy cost per kg of made tea
4. Quality of tea manufactured

Thermax Ltd a leading manufacturer of energy equipments and systems has been very closely associated with the tea industry across globe. Over the decades it has been instrumental in developing highly efficient heating equipment for tea drying applications which have evolved in phases and may be classified as under:

- ❑ 1st Generation Heating System: Conventional Cast Iron tube Air Heater
- ❑ 2nd Generation Heating System: Conventional Ceramic tube Air Heater
- ❑ 3rd Generation Heating System: Steam Boiler and Radiator based Heating
- ❑ 4th Generation Heating System: Thermic Fluid and Radiator based Heating
- ❑ 5th Generation Heating System: Hot Water and Radiator based Heating

The 5th Generation Heating System is the most recent development offering a highly reliable, efficient and cost effective system with an unit efficiency that ranges as high as 75% to 80% in the case of tea drying. The system was specifically developed by Thermax Ltd. for the tea industry in year 2000 -2001 with the listed features: state of the art solid fuel fired, horizontal, 3 pass, integral furnace design, shell type smoke tube, high efficiency water heater coupled with a waste heat recovery system (Air Pre Heater) and hooked through a piping system to a radiator. Presently Thermax Ltd., has about 200 installations of steam based heating system (4th Generation) and over 100 installations of hot water based system (5th Generation) in the tea industry across the globe, with smooth operations.

Figure 1: *Thermax Wood fired Integral furnace HWG: 5th generation heating system*

ARTICLE

Figure 2: *Efficient combustion in progress in an integral furnace HWG*

Some of the major benefits of 5th generation hot water heating system are:

a) In built automation and control system all through, provides steady hot air temperature to the tea dryer irrespective of variations in ambient temperature or rate of firing

b) No chances of any smoke taint

c) High unit efficiency at 75%, which results in minimum firing cost per kg of made tea

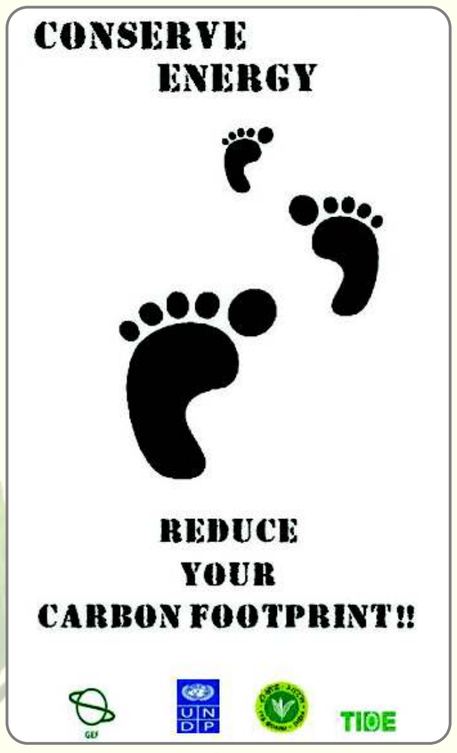
d) Single unit can be coupled to multiple dryers including withering hence manpower cost is reduced

e) Unlike an air heater the system need not be located behind the drier and has no refractory

Most of the tea dryers in India still operate using 1st generation heating system i.e. air heater. Generally, the fuel used is firewood or coal. Besides having lower efficiency, which leads to high fuel consumption other recurring issues encountered using air heater, are tube failure or leak, refractory arch falling, and temperature variations. It results in over and under fired tea having a huge impact on quality of made tea and market price realization for the manufacturer.

Countries like Sri Lanka and Kenya which mostly export their tea are more quality focused and hence as an obvious choice use either Hot Water (5th Generation) or Steam (4th Generation) based heating system. In India, several of the leading tea companies have opted for Hot Water/Steam based heating system since quality and system efficiency is guaranteed. Purchase of these systems has been supported by the Tea Board of India, through its special subsidy scheme under the Xth and XIth quality up gradation plan.

Mr.Sanjay Misri is Head - Marketing & Product Management, Cooling & Heating Division, Thermax Ltd and is based in Pune.



ANNOUNCEMENTS

Solar air preheating feasibility survey of tea factories in Coonoor

The Encontea project has launched a survey to assess the feasibility of **solar air preheating** in tea factories. The survey is part of an ongoing collaboration between the tea factories, the project and the Ministry of New and Renewable Energy (MNRE) to assess and demonstrate renewable energy technologies of relevance to the tea sector.

The survey seeks inputs on the production of tea, dryers and fuel currently used, the details of the factory roof and the requirement of hot air for drying. The collected information would be used to determine the factories best suited for solar air heating systems. The project plans to take it further and request MNRE to support the installation of demonstration units for solar air heating.

The Encon project staff is currently visiting factories to collect the information. We request factory personnel to contact Mr. Radhakrishnan (@ 09486244107) to enlist their factory for the feasibility survey.

EVENTS

SEMINAR ON RENEWABLE ENERGY OPTIONS IN THE TEA SECTOR - Coonoor, May 6th 2009

Officials of the Ministry of New and Renewable Energy (MNRE) and representatives/owners of tea factories in Coonoor met on 6th of May at UPASI-KVK to discuss possible renewable energy interventions in the tea sector. The seminar was a culmination of the year long field activities through the EnCon project; an UNDP-GEF funded initiative to review energy issues in the tea sector and bring about possible technological, fiscal and policy measures that would initiate energy conservation. The meeting was of interest to the stakeholders, considering the past history of rejection of renewable energy interventions in the sector and to evolve new thinking on introducing renewables to tea factories in south India.

Figure 1: *Secretary, MNRE Mr Deepak Gupta (in center) along with officials from TEDA and Tea Board at the seminar*

Thermal Gasifiers: Over the years, use of gasifiers, the strengths and limitations of the gasification technology in the tea sector has been well understood. Stakeholders realize that a gasifier cannot be used in conjunction with existing air heaters; an heat exchanger design that integrates the thermal gasifier would have to be evolved for optimal utilization. Factory owners would prefer to explore gasifier technology as demonstration units, not willing to invest in it for the present.

Possible steps to take it forward are:

1. A thermal gasifier would be installed as a first step, coupled to a new designed heat exchanger. This gasifier/heat exchanger combination will have easy switch back options to conventional air heating as and when required.
2. Demonstration units would have gasifiers of 2 different capacities and at 2 different locations – a government factory and a bought leaf or estate factory. Taking into consideration the past issues with gasifiers, Encon project will identify sites in consultation with industry associations and seek the help of MNRE on financing the demo units.
3. MNRE officials and the EnCon team will discuss potential suppliers of the thermal gasifier and their terms of supply. A consultant could help to develop the heat exchanger design.

Boilers: Steam boilers could be a possible option to generate hot air. Tea factory representatives are keen to learn on the performance of low pressure boilers. Representatives of Thermax Pvt. Ltd. present at the seminar, showcased the evolution of boilers and their own products built specific for the tea industry. There was much interest in these fuel efficient devices but the deterrent was in the capital costs of the technology.

Possible steps to carry it forward are:

1. EnCon project team with UPASI and Tea Board would establish contact with tea factories in Sri Lanka to learn more on use of boilers for hot air generation.
2. Arrange for demonstration and know-how events on boilers by companies such as Thermax Pvt. Ltd.
3. Clarify with the help of MNRE officials if non-pressurized boilers also came under the purview of licensing and inspections.

Figure 2: *View of the audience - tea sector representatives from all over south India in attendance at the seminar*

Heat from exhaust gases: Factory owners want suitable options to use waste heat from the exhaust gases. This heat could be tapped and used for withering of the tea leaves.

Possible steps to take it forward are:

1. The EnCon project team would initiate steps to monitor temperatures and air flow rates of exhaust gases in select factories that would help to assess methods to rechannel the waste heat.
2. The EnCon project team would collect data on existing energy consumption patterns for air heating/tea drying from the same factories- flue gas and hot air temperatures, in addition to flow rates, the shell and tube specifications in existing air heaters.

Solar Energy: Tea sector individuals believe that a combination of solar collectors for air preheating in conjunction with steam boilers such as the Thermax water heating technology would be energy efficient but an expensive option.

Possible steps to take it forward:

1. Ongoing monitoring of solar air pre heating installations, and correlate to cost and energy saving.