Events

## THE INDIA INTERNATIONAL TEA CONVENTION (IITC), KOCHI

The India International Tea Convention (IITC) was held in Kochi, from the 19th to 21st of February 2009. A showcase to the various tea growing and manufacturing regions of India, it is an annual convention jointly organized by the Tea Board of India

***Figure 1:*** *Posters describing the project activities at the Encon Tea stall*

and United Planter's Association of Southern India (UPASI). The Encon project had used this opportunity to display its activities in the exhibition section of the convention. The Encon Tea stall at IITC-2009 enabled the delegates to understand the project objectives and deliverables. Information of the above was disseminated using poster exhibits in the stall. The topics featured were:

- On Energy Conservation in Small Sector Tea Processing units in south India – *initiatives to help tea factories to implement conservation measures*
- Reaching out to the factory – *awareness and exposure programs that are conducted to educate the personnel*
- Findings from the Preliminary Energy Audits in south India – *apprise the visitors of the electrical and thermal energy consumption across the tea clusters audited in south India*
- Typical energy consumption norms – *showcase what are the values of bench marking parameters*
- Experiments on Solar Air Heating system – *visuals and results of the experiments*
- Thermal energy interventions – *replacing cut firewood with briquettes in furnaces*

The posters evinced a lot of interest drawing a large number of visitors to the stall. Key visitors from the Tea Board of Kenya, officials from UPASI and Tea Association of India, Kolkatta and specifically industry personnel - factory representatives from AVT, Parry Agro, Tata Tea, KDHP, Jay Shree Tea and owners of Estate and Bought Tea Leaf factories visited the stall. The expertise of the Encon team was sought on several issues, which included requests for detailed energy audits, suppliers lists for fuels such as good quality briquettes, and efficient factory equipment, details on solar air heating systems and a price list of energy saving equipments. The Encon team was also able to obtain first hand information about the energy use practices in different industries.

The EnCon stall also displayed posters put up by ELPRO Energy Dimensions Pvt. Ltd., that focused on methodologies of energy audits and available options for conservation measures.

***Figure 2:****Chairman, Tea Board with a host of dignitaries at the stall*

The participation of the project in the exhibition highlighted the fact that addressing energy issues was a critical need in the industry. It also reinforced the readiness of the industry to adopt energy conservation measures.


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### 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

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# EnConTea

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

Issue - 4 March 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


We, the team of the EnCon Tea project look back with satisfaction over a year of focused energy conservation activities in the Nilgiris district and are gradually moving outward in the rest of south India. It began with awareness workshops, followed by Preliminary Energy Audits of all tea factories, which in turn led to detailed audits of 13 of these processing units. We expect to complete detailed energy audits of 100 factories this year which would transition to implementation of the recommendations leading to an average energy conservation by about 30%.

I note that while the activities in the last year have shown us the way for electrical energy conservation and we are on course to implementation through the recently launched energy center, ideas for thermal energy intervention have not emerged with the strength and clarity required for implementation. I am extremely grateful to the Chairman of the Tea Board for initiating a dialogue with the Ministry of New and Renewable Energy (MNRE), which I am positive will create cost effective renewable energy options for the tea industry. Solar air pre-heaters, and thermal gasifiers are possible technology options but they would be further investigated in the context of the tea industry before we recommend them. The intiative has been further strengthened by the visit of senior MNRE officials, who visited the tea factories and dialogued with their owners and managers.

The third project steering committee met in February, and reviewed the findings of the Preliminary Energy Audits. The need for strengthening the fuel supply chain was an item of discussion. The need for dedicated briquetting units for the tea industry emerged as a strong need and I have asked the project team to explore the fuel supply linkages for briquetting units. Similarly, it is also important that we explore sustainable firewood supply linkages.

The project had an opportunity to create awareness on energy efficiency in the exhibition at the India International Tea Convention in Kochi from the 19th to 21st February 2009. Energy needs of the sector were much talked about and in turn attracted huge crowds to the EnCon Tea project stall. . We were heartened by the state of preparedness of both the estate and the bought leaf sector from all parts of the country to explore innovative approaches to energy use reform. We have understood the urgent need to address this issue not only in south India but in other tea clusters as well.

I am gladdened that energy issues of the tea sector are beginning to get addressed but a lot more needs to be done. The project team is working tirelessly and I commend their dedication and sincerity of purpose. We look forward to heightened activity in the coming years.

### UPCOMING EVENT

Seminar on "Renewable Energy options for the tea industry" scheduled for May 6th, 2009.

Secretary,MNRE and other officials from the ministry to participate.

*(For Internal Circulation Only)*

VIEW POINT

# INTERVIEW WITH MR. MOHAN VERGHESE CHUNKATH (IAS)

## Chairman & MD, TEDA.

**1. What is the role of TEDA in the energy sector in Tamil Nadu? Can you please outline TEDA's schemes to promote sustainable energy use in industries in TamilNadu?**

Tamil Nadu Energy Development Agency (TEDA) is the state nodal agency of Ministry of New and Renewable Energy (MNRE), Government of India (GOI) involved in promotion of various renewable energy schemes (Wind, Solar, Bio Energy, etc.) It facilitates financial assistance from MNRE, GOI and the government of TamilNadu (GoTN) apart from providing technical guidance to Govt./public/private /other agencies. TEDA's schemes in industries can be listed as:

- Promoting captive/grid connected biomass based power projects and co-generation power projects
- Promoting biomass gasifier systems for thermal application and power generation
- Promoting cow dung based /kitchen waste based and other bio mass waste based bio gas plants
- Promoting energy recovery from waste based power projects. (poultry litter, distillery/other industrial effluents, food processing industries etc.,)
- Promoting use of solar water heating/air heating systems and solar cooking/steam generation systems.
- Promoting use of small Aerogenerators (upto 5 kW) for power generation and wind mills for water pumping and solar/wind hybrid power generating systems (upto 10 kW)

**2. Several sugar mills have begun co-generation of power using bagasse. This has come about through one of TEDA's programs. What kind of a role did TEDA play in helping sugar mills tap their unutilized fuel for producing power?**

Sugar mills with cogeneration use the entire bagasse and produce surplus power, which after meeting their own consumption is exported to the grid, fetching revenue. This improves the profitability of sugar mills.

Tamil Nadu is No.1 state in the country in co-generation of power from sugar mills. 3 co-operative and 18 private sugar mills have installed cogeneration plants in the state. TEDA facilitates providing Central Financial Assistance (CFA) through MNRE, GoI and provides technical guidance towards establishing these plants. Tamil Nadu Electricity Board (TNEB) has taken the initiative to set up co-generation power plants for a total capacity of 234 MW in 15 co-operative sugar mills of Tamil Nadu. TNEB has also signed a MoU with Power Finance Corporation for availing loans of Rs.1200 Crores for funding these projects.

TEDA is involved in R&D projects on further energy recovery schemes in cogeneration plants.

**3.Tea Plantations and its factories are similar manufacturing entities. Is co- generation a feasible option for tea factories where biomass gasifiers are used for power generation and the waste heat is tapped for any of the thermal applications in tea processing?**

Drying is the most essential process in beverage and spices industries like tea and cardamom. Hot gases in the temperature range of 120 - 130°C, in the existing designs are required for drying. Gasifier is an ideal solution for the above situation, where hot gas after combustion can be mixed with the right quantity of secondary air, so as to lower its temperature to the desired level for use in the existing dryers. Typically the heat energy required is equivalent to 1 kg of biomass for 1 kg made tea. Bio mass gasifiers could be deployed utilizing the locally available bio mass fuel for power generation as well as for thermal/drying applications (i.e., combined heat and power).

Biomass gasification has key advantages over conventional fuels – it replaces fossil fuels; reduces wood consumption by 50%; gasifiers are available in modules of different capacities (5kWe to MW) and has a multi-fuel capability where forest, plantation, and agro residue in briquetted forms can be used with a maximum moisture content of 15%; and the costs of power generation are low and competitive with grid tariff.

**4.In tea processing, about 80% - 90% of the energy required is the thermal energy to remove moisture from tea leaves. The primary fuel for such processes is cut wood, supplies of which in an ecological sensitive region such as the Nilgiris, cannot be sustained in the long run. Is investment in energy plantations an immediate and sound solution? How can it be done? What are the available policy measures for such an initiative; any limitations that the stakeholder must be aware off.**

Yes, investments in energy plantations will offer sound solution in the long run. The TamilNadu Agriculture University, Coimbatore provides complete guidance/support on energy plantations, including sale of hybrid varieties suitable for cultivation in the respective lands. NABARD provides funding schemes for energy plantations. At present there are no policy measures for such initiatives.

**5.Please comment on the viability of hydropower generation, for plantations where water bodies such as streams or rivulets exist. What are the schemes offered by TEDA for tapping it for commercial needs?**

Hydro power generation utilising the water bodies such as streams or rivulets is very much viable provided perennial flow is there for atleast eight or nine months in a year. Water turbines cum generators are available in various ranges according to the need. TEDA facilitates providing subsidy through MNRE, GoI for setting up of micro hydel projects up to 100 kW. In Tamilnadu, the small/mini hydro projects are looked after by the State Electricity Board i.e., TNEB.



PROGRESS REPORT

# AN AUSTRIAN THERMAL ENERGY AUDIT TEAM VISITS COONOOR TEA FACTORIES

Tea Factories depend on both electrical and thermal energy to process tea, and most tea factories in south India utilize firewood to meet their thermal energy requirements. Key factors influence the quantity of firewood consumed in tea drying - the quality of firewood and its moisture content for the set operating temperatures. An Austrian team of thermal energy auditors conducted pilot thermal energy audits in 3 of the tea factories in Coonoor. They shared their experiences and suggested new energy saving measures to the Encon project team and other involved stakeholders. The team of Bettina Slawitsch and Christoph Brunner belong to a Research & Development company - Joanneum Research. The company has developed a thermal energy auditing software called EISTEIN an acronym for *Expert System For An Intelligent Supply Of Thermal Energy In Industry.* EINSTEIN helps to record and access preliminary thermal energy audits for various industries. Their visit educated the field team in conducting preliminary thermal energy audits and the usefulness of the EINSTEIN software.

A few of ideas shared by them, based on their study, was to focus on system optimization in addition to optimization of the machinery. The process of system optimization focuses on heat transfer mechanisms to shift excess heat from processing parts that need to be cooled to the parts that require heat, and to recapture and reuse heat from the excess hot air being wasted. This would, in effect, reduce the amount of energy needed to generate heat, and thus reduce firewood consumption. In addition to reducing the energy needs,

***Figure 1:*** *The Austrain team of Bettina and Christoph conducting the energy audit.*

emphasis was laid on shifting from the use of firewood to sustainable fuels with higher calorific value fuels such as briquettes and renewable sources of energy. The efficiency of the alternatives would depend on the temperatures that need to be generated. For example, solar energy is most efficient for generating temperatures between the range of 20°C to 80°C; in order to generate higher temperatures alternatives such as CHP or Cogeneration, Direct combustion (Briquettes) and Steam combustion could be utilised. Both the EINSTEIN software as well as the alternatives suggested by the team hold a significant potential in reducing use of firewood in the tea industry. The next step is to explore the feasibility and viability of these alternate options.

# ENERGY LAB AT UPASI-KVK

An energy lab has been established at the UPASI-KVK premises in Coonoor and would soon become operational. It is a centre dedicated to assessing energy consumption patterns both for electrical equipment and fuels used for thermal processes – firewood and briquettes used by tea factories. The 4 parameters that ascertain the quantity of heat supplied by the fuel are its calorific value, moisture content, ash content and fixed carbon. The center is being equipped with the standard testing equipments such as, hot air oven, muffle furnace, bomb calorimeter with oxygen cylinder, a laboratory scale weighing machine and uses scientific methods to quantify these

***Figure 2:*** *Energy data collection for the EINSTEIN audit work.*

parameters. A database will be maintained to provide data on various types of wood and briquettes presently

ARTICLE

Preliminary Energy Audits conducted in 257 factories of south India indicate wood consumption to be 340,275 MTs of wood in the period 2007-08 where the specific wood consumption averages 1.4 to 1.70 kg per kg of made tea. In ecologically sensitive regions such as the Nilgiris, tea plantations are restricted from cutting their trees. Tea estates find it very stressful to source firewood and there is need for intervention to ease the stress. One option could be for tea factories to buy or lease land for energy plantations in the plains and associate with local institutions, panchayat raj institutions for sustainable cultivation and harvesting. For e.g., in the case of Prosopis, one hectare of the species under rain-fed conditions can provide on an average 10 tons per annum. Its gestation period is 3 years. Harvesting the plant on a rotational basis, a standing plantation of about 34 thousand hectares would suffice to supply fuelwood to the tea factories of south India.

A briquette is made up of low particle size biomass material. This unadulterated biomass is dried and then compressed in the shape of a block or a pellet of the required size. Sizes of the finished product vary from 30mm to 100mm in diameter. Biomass briquettes are popular in regions with abundant availability of agro residues and are made from agro wastes such as sawdust, coffee husk and groundnut husks to name a few. Simple mechanical action using compressors help to pack the powdered wastes to the shape and size required. The moisture content of briquettes are very low at 4%, as compared to freshly cut wood that could be as high as 65%. Unlike using biomass in its raw form, since briquettes are in a compact form, it facilitates easy transportation and can be easily loaded in the burning grates of boilers, furnaces and also thermal gasifiers. The supply chain of raw materials can be well maintained by operating briquette-manufacturing units in or proximal to the agro industry such as coffee plantations and groundnut fields.

***Figure 5:*** *Biomass briquettes burnt in a furnace*

**E. WIND ENERGY:**

The components of a windmill consist of 3 blades

source: NREL/ Picture Information Exchange # 08616

***Figure 6:*** *A wind farm, where each of the wind turbine converts wind energy to electricity*



VIEW POINT

**6. Producing power on a higher scale improves the economics and makes power cheap. Can a hydro power producing tea plantation act as an independent power producer and supply the surplus to a cluster of other tea factories?**

Tamil Nadu Electricity Regulatory Commission (TNERC) is in the process of fixing tariff for hydro power. If the required water head is available, power can be generated in a tea estate and used for captive purpose. If it is to be grid connected or to be supplied to other nearby tea industries, permission has to be obtained from TNEB. For further details, TNEB may be contacted in this regard.

**7. What would be the emerging renewable energy technologies for the electrical and thermal needs for tea processing?**

There are several technologies that can be implemented specific to the required application. For heating/drying at low-medium temperatures, solar thermal systems, use of biomass, thermal gasifiers and biogas combustion. Solar thermal can be used for pre-heating of air in moisture removal stages of tea leaf processing. Where shaft power is required, small wind turbines and micro/pico hydro turbines could be operated.

Technologies like Combined Heat and Power systems (cogeneration), waste heat utilization etc. help in achieving pollution control and energy efficiency. Use of nonconventional energy through solar dryers, biomass gasifiers, wind generator etc. will prove to be a boon to energy intensive industry like tea processing in future.

**8. Does TEDA have energy conservation awareness programs specific for the industry?**

TEDA is in the process of conducting industry oriented energy conservation/Renewable Energy awareness programs.

**9. Would you like to talk about other energy aspects that would benefit the tea sector?**

Significant fossil fuel replacement can be achieved in tea industries towards leaf drying applications. Energy conservation/efficiency improvements combined with renewable energy technologies based thermal and electrical energy usage in tea sector would not only result in direct savings of cost but also contribute to energy security.

Mr Chunkath, Chairman & MD at his TEDA office in Chennai

## ANNOUNCEMENTS

- TIDE has proposed and is currently working on building linkages for supply of dry and sized wood between NGO groups in Madurai and the tea factories. Interested parties who can supply or need to procure fuel wood should contact N Radhakrishnan at the TIDE Project Office, Coonoor
- TIDE is also exploring linkages for the supply of saw dust and other agro wastes such as coffee and groundnut husks, which are suitable raw materials for producing briquettes. The technical know-how in setting up individual briquette manufacturing units for self-consumption or sale of products, can be made available to interested persons. For details contact N Radhakrishnan at the TIDE Project Office, Coonoor
- The Energy lab for testing fuels has been set up at UPASI-KVK in Valparai. The institution can provide information on the current testing facilities that are available

## 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.

ARTICLE

# RENEWABLE ENERGY SOURCES – What works for the TEA INDUSTRY.

By Chitra Narayanswamy & Svati Bhogle

Renewable Energy (RE) sources are replenishable energy forms that can be effectively tapped for thermal and electrical power. Solar, wind, hydro, biogas, biofuels, use of biomass and agro residues are common renewable energy forms. Renewable energy is by definition sustainable although in the case of biomass (firewood) if the rate of harvest of firewood is higher than the rate of regeneration, then a percentage of biomass could be considered non renewable. Renewable energy technologies are suited for wide ranging applications both in the industry and for domestic energy needs . Examples of RE products are solar water heaters and solar home lighting systems in homes, wind turbines and small hydro systems to generate electricity, biofuels for public transportation and biogas plants to produce energy from animal dung and organic wastes for use as cooking fuel in rural homes.

Tea processing is energy intensive: 93% of the energy consumption in tea processing is thermal energy and 7% is electrical power. Typically, 0.5 – 0.7 kWh of electric power and 1.5 – 1.7 kg of firewood for thermal processes is used for 1 kg of made tea. Preliminary energy audit data suggests energy costs to be Rs 6.26 per kg of made tea, which is 36 to 42% of the total processing costs. If the tea industry has to reduce its fuel cost and shift to sustainable energy use it must make the transition to renewable energy and energy efficiency. Some renewable energy interventions may be expensive today and there is need to find technology and financing options to make renewable energy an attractive option for the sector. A huge potential exists in reducing energy consumption – upgrading to energy efficient equipment to reduce electrical energy consumption and introducing renewable energy options to reduce fuel consumption. Renewable energy sources and their applicability in the context of the tea industry are explored in the current article.

## A. SOLAR ENERGY:

India is endowed with solar energy, where the incident solar radiation translates to 4 to 7 kWh/sq. meter of power depending on the location. Solar energy can be trapped in 3 main ways – passive energy incident on the earth; solar thermal which is heat energy absorbed by black collector plates called absorber plates and used to heat water and air for domestic and commercial needs; and solar PV (Photovoltaics) is when sunlight incident on arrays of solar cells is converted to electricity.

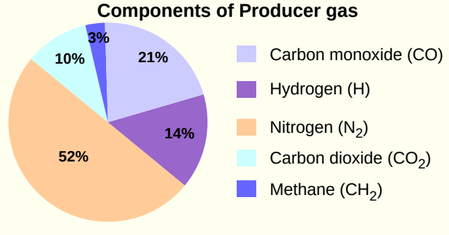
Solar water heaters seen on rooftops of homes and larger units used in the industry is an efficient use of solar thermal energy. A typical solar thermal system has a black painted absorber plate with one or two glass covers, where the sides and back are optimally insulated. Inlet and outlet conduits help the air or water to pass over the absorber plate once or 2 times, heating it up as it flows. The flow maybe controlled using low power blowers or pumps as required. By replacing electric geysers, solar water heaters save upto 50% of the power costs for domestic users. Specific to the tea industry, solar air pre-heaters are an option, where it is possible to pre heat the air upto a temperature of 50-60 °C. It could be used as a preheating device, thereby reducing fuel required in the tea drying processes.

***Figure1:*** *Solar air heaters made up of black absorber sheets at the Glendale tea factory*

Electricity generated from solar PV has wide ranging applications, from low power lighting and appliances of domestic needs to supplying power to the grid from electricity produced in solar power plants. A typical home lighting system consists of a solar panel (solar cells arranged in rows of finite dimension), charge controller (to prevent overcharging of battery), a battery of known voltage that stores the electricity produced, and lighting bulbs or LEDs. Solar lighting systems and solar water heaters can be used in the tea estate factories and residences. Street lighting in the factories and estates can also use solar street lighting systems.

## B. GASIFIERS:

The gasification process involves burning of biomass fuel such as dry, cut wood, coconut shells, briquettes etc., in a limited supply of air (i.e., reduced oxygen) to generate a combination of combustible gases referred to as producer gas.




A gasifier typically consists of a hopper with a lid through which the fuel is fed. The biomass drops down into a reactor, where with increasing heat it dries up and volatile elements are pyrolized. Char residues drop down into a cylindrical throat section with a removable grate. Low powered (1 hp) blowers supply gasification air through nozzles in the throat. The producer gas fills up in the bottom of the gasifier bed and is channeled into pipes from a side opening. A flaring pipe proximal to the opening is used to test for its presence. The generated gas is at a high temperature of 300 – 500 °C and also contains moisture and tar. In order to increase its energy density, the gas goes through a cooling and cleaning process, prior to its use. Gasifiers can be used to run 1.Shaft power systems, 2. Direct heating systems and 3. Gas/Steam

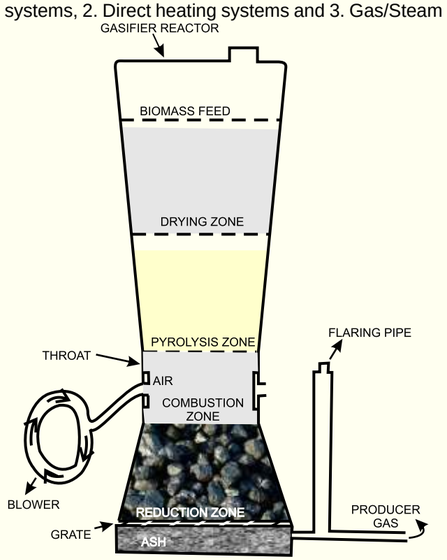



***Figure 3:*** *Schematic of a thermal gasifier showing different device parts and processing zones*

turbines.

The producer gas can drive spark ignition, compression ignition engines and is useful to operate heavy vehicles such as farm tractors and trucks. The advantage of using the gas to direct combustion of biomass in thermal applications is that a controlled and high temperature flame is obtained. It is found very useful in drying applications of agro produce, cooking and water heating. The producer gas can be used to run gas turbines or produce steam to drive steam turbines for power generation. Small generation gasifier based power units of kW to a few MW have found their use in industries and rural areas that are off-grid.

The Encon Tea project is evaluating the necessary and sufficient conditions under which gasifiers would be technically feasible and economically attractive to the tea industry. Technically the only barrier seems to be the need for cut, dry wood with a moisture content of 15 – 20%. The present pattern of open yard firewood storage would not be acceptable. There would be need to develop vendors for cut dry wood as well. However the economic barriers to acceptance of gasifiers are being evaluated. The project would produce a report on the same that explains the conditions under which gasifiers would be acceptable.

## C. HYDRO POWER:

The kinetic energy of falling water is tapped to run flour grinding mills or hydro turbines that generate electric power. Water sources could be from runoff rivers, streams, storage dams and flowing from irrigation canals. In a hydro power setup, water from its source is diverted through an opening called the intake into a channel. The water is led from it through a forebay tank and a desilting tank into a closed pipe called the penstock, which carries it all the way to the turbine situated at the lower level. The pressure in the water

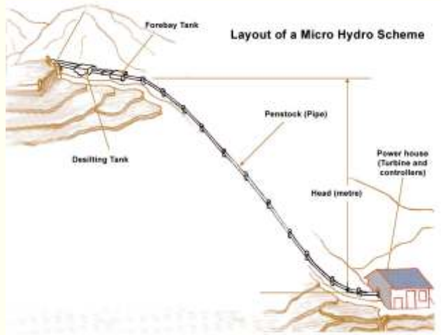



***Figure 4:*** *Components that make up a micro-hydro setup is explained in the above diagram.*

drives the turbine, which in turn transmits the energy to an electricity generator called the alternator.

Generation of hydro power on a small scale ranges between few kW to 25 MW and ascendingly falls under the categories of pico, micro, mini and small hydro. The suitability of a site is determined by key factors - power requirements of the factory or community, the vertical drop referred to as the head through which the water falls, water flow in the stream called the flow rate during various times of the year, the length of the conduit to conduct water to the hydro turbine, and distance of the power plant from the end-users. It is a technology that once installed is robust and with a conversion efficiency of 60% holds a cost effective way of producing power.

Surveys have shown that tea plantations in most cases have water streams that could be utilized for generation of small scale hydro power. Under a MNRE UNDP hilly hydro project, two small hydro power plants have been setup in tea estates of the Darjeeling districts and another 42 potential sites have been identified in the same region. The Encon Tea project has carried out its own survey of potential hydro sites in tea estates in south India and is estimating the power generation potential. It would then explore options for power generation from hydro for tea factories.

## D. ENERGY PLANTATIONS AND BIOMASS BRIQUETTES:

Sustainably harvested energy plantations are a renewable source of biomass. Nearly 85% of the energy needs of rural communities come from biomass. Biomass can also be grown on cultivable wastelands, which in turn helps stabilize the soil and water regime of the land. Appropriate tree species specific to the agro climate have to be chosen, in addition to assessing the soil characteristics of the land. Species of Acacia, Prosopis and Zizyphus are widely grown in wastelands. They require low water and fertilizer inputs and are disease resistant. Their timbre serves multipurpose fuel needs and has high regeneration ability. Prosopis, and Acacia, are the primary wood types used by the tea sector for its thermal processes.

ARTICLE