A rural energy system based on energy forest and wood gasifier

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A decentralized electricity generation system using a 5 kW wood gasifier has been installed for electrification in a non-electrified village. All the 43 houses in the village are provided with two lighting points each in addition to eight street lights. An energy forest has been raised and an annual productivity of 6.4 tonnes per hectare has been recorded compared to an annual wood fuel requirement of 5.1 tonnes for the gasifier. A diesel substitution level of 73% has been achieved in the field. The use of electricity for lighting has saved 0.803 tonne of kerosene per year in the village. Economic analysis has been carried out for the wood-gas-based system. The study has demonstrated the technical feasibility of a decentralized electricity generation system based on renewable source of energy which has been accepted by the village community.

In remote rural settlements the basic energy needs, apart from energy for cooking, are electricity for lighting and shaft power for pumping water (drinking and irrigation) and flour milling. Such settlements are located away from the power grids and the loads would be low. Thus, in view of the long distance over which the electricity has to be transmitted to remote villages and the low loads involved, the approach of the centralized generation and grid transmission is inefficient and involves relatively higher transmission and distribution losses compared to supplies of large loads to nearby load centres[1]. The cost of transmission lines is also high (Rs 20,000/km of 11 kV lines). Thus, one of the options for meeting the energy needs of home electrification, pumping, flour milling, etc. in rural settlements could be to shift to decentralized electricity generation systems based on renewable sources of energy. There are several options like wood-gas, biogas and solar energy systems. In this paper, a wood-gas-based system is considered for village electrification. A small wood gasifier of 5 kW capacity has been developed at ASTRA, Indian Institute of Science[2]. A field experiment was undertaken with the following objectives: (i) To experiment with a decentralized electricity generation system using a small wood gasifier (of 5 kW) for electrification of a non-electrified village. (ii) To grow an energy forest to supply wood in a sustainable way and to make the energy system self-reliant. (iii) To study the performance of the wood gasifier and its technical feasibility and economic viability. (iv) To develop and implement a local management system involving the village community for the operation and maintenance.

Hosahalli, a backward and non-electrified village in Tumkur district (100 km from Bangalore) with a population of 267, was selected. Group meetings were held with the village community and they agreed to the project proposal. They provided land for growing an energy forest and for the generator room. Using the project funds (i) an energy forest was raised, (ii) a generator room was built, (iii) wiring of all the households was carried out and (iv) two village youths were trained to operate the system. The woodgasifier–diesel engine–genset system has been in operation since May 1988.

Connected load

The village community agreed for two lighting points for each house and lighting for 4 to 5 h per day. Load in kW = 43 houses × (1 × 40 W flourescent tube + 1 × 15 W bulb) + 8 street lights × 40 W flourescent tube = 2.685 kW or 10.74 kWh/day considering 4 h of lighting. Considering a load of 2.685 kW a 3.7 kW diesel engine genset was installed.

Energy forest for sustainable supply of wood fuel

The basic concept was not to deplete the existing stock of local biomass or to import biomass. Given a load of 10.74 kWh/day and 1.3 kg of wood/kWh, the wood requirement is 14 kg/day and 5.1 t/year. Energy forest was planted on a plot of 2 ha of wasteland to supply wood in a sustainable way. The species composition and density are as follows:

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