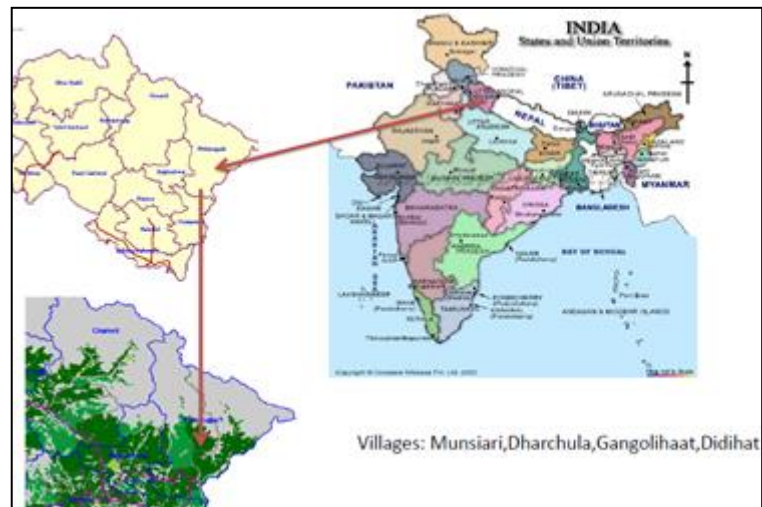


# ELECTRICITY GENERATION USING PINE NEEDLES IN UTTARAKHAND



## Electricity Generation using Pine Needles in Uttarakhand

This case study is focussed on utilization of locally available biomass resource such as **Pine Needles** for decentralized power generation using biomass gasification route. The Himalayan Subtropical Pine Forests are the largest in the Indo-Pacific region about 76.2 lakh hectare of land. In India, these pine forests are widely



found in the state of Uttarakhand. According to the Uttarakhand Renewable Energy Development Agency (UREDA), the total area of Pine forest in the state is about 3.43 lakh hectare. These pine forests produce about 20.58 lakhs tonnes of dry biomass every year in the state. In the summer season, forest fires are common in these areas as pine needles, which keep falling off the trees from the middle of March till the onset of the rains in July, are highly inflammable.

Avani Bio Energy, an NGO based out of Uttarakhand, is voluntarily working for the sustainable energy generation. The organization thought of helping the villagers to get rid of the problem of unreliable power supply using the locally available pine needles for power generation using biomass gasification technology for its conversion into electrical energy. The motivation for implementing such initiative, apart from



overcoming problems being faced by poor villagers was also to minimize the menace of fire hazard in hot dry summer season in hills of Uttarakhand.



In 2009, they set up its first small scale gasifier of 9 kW capacity in its campus at Pittorgarh. About 1.5 kW is consumed for running the system and rest 7.5 kW of energy is used for



productive applications such as welding, calendaring etc. Over the years, this gasifier has continued to generate electricity for the centre. With this success, in 2012, to scale this innovation and bring it to the surrounding communities, Avani Bio Energy got established as an independent power company. In 2014, Avani set up another plant of 120 kW in 2014 at Chachreda village in Pithoragarh. The electricity generated through the biomass gasification plant sell to the state grid through a 20 year Power Purchase Agreement between Avani and Uttarakhand Power Corporation Limited (UPCL).

### *Collection of pine needles*

A 100 kW gasifier running for 24 hours requires 4,500 kg of pine needles. Thus, about 1350 tonnes of pine needles are required per year. Avani Bio Energy has received exclusive rights from Van panchayat (Village forest administrative body) to collect pine needles. Since the pine needles are lighter in weight and can't be gasified as received from the forests, the organization also set a densification unit and pine needles are densified to 5 kg before using in gasifier.

In Uttarakhand, biomass collection is mostly done by women and thus for gasifier also, mostly women are employed for the collection of pine needles. Since the pine forests shed their needles in summer season, the pine collection activities are done during the month of April to June and stored for the complete year. The women are willing to collect more bulk of pine needles as it is an extra source of income to them as they are doing it part time along with their normal household and agricultural works. They are paid Rs 1 per kg of received pine needles. The gasifier plant employs 6 permanent workers together with women pine needles collectors from the villages and men hired as labour for pine needle collection. The permanent workers are paid at a rate of Rs 4000 per month. The collection of pine needles has provided employment to more than 100 people from the villages.

### Other benefits from the plant

Apart from electricity generation, the high energy content residue of biomass gasification process is briquetted into cooking charcoal using a locally available binder. The availability of charcoal at door step has reduced the fuel gathering time of the villagers by 70% and provides a smoke-free environment to the villagers. Residue from a 120-kW gasifier system will be sufficient to meet the cooking fuel needs of 100 households. People who are employed to collect pine needles are remunerated both in cash and



cooking charcoal, thereby generating income for local people and saving the forests from being cut down. Avani has also developed an efficient, inexpensive charcoal cook stove made entirely from locally available materials. Local people are trained to manufacture and repair the stoves, thus generating more livelihoods.

### Plant Economics

The overall economics of the plant is given in following table.

| Parameters                         | Unit     | Value       |
|------------------------------------|----------|-------------|
| Biomass input to gasifier          | kg/hr    | 180         |
| Plant load factor                  |          | 0.7         |
| Total biomass required             | kg/year  | 6,16,800    |
| Duration of plant operation        | hr/day   | 8           |
| Operational days in a year         | days     | 300         |
| Electricity produced               | kWh/year | 10,800      |
| <b>Income</b>                      |          |             |
| Unit price of electricity          | Rs/unit  | 4.89        |
| Income through sale of electricity | Rs/day   | 5,28,120    |
| <b>Cost</b>                        |          |             |
| Capital cost of the plant          | Rs       | 1,00,00,000 |
| Cost of the biomass                | Rs/year  | 6,16,800    |
| Cost of Manpower                   | Rs/year  | 2,88,000    |
| Cost of maintenance                | Rs/year  | 7,00,000    |

### **Major challenges faced and way forward**

Addressing both collection and transportation challenges is key to the implementation of projects. Collection of pine needles involves carrying heavy loads over distances usually over steep slopes. Secondly, the moisture content of the pine needles causes lower efficiency and high maintenance for the gasification system. Avani team is working towards better collection transportation and application of pine needles so that the resource can be best used for power generation.

After having good learnings through successful implementation of 120 kW pilot plant, Avani plans to set up more village-level pine needle based gasifier system of approximately 120 kW capacity that would create sustainable electricity, cooking fuel and employment opportunities in hilly regions of the Uttarakhand state.

