Standard Operating Procedure (SOP)
Gasifire electricity from pine needle

NMHS Project: Harnessing the destructive energy in pine needles – demonstration units of electricity and charcoal generation from pine needles and study their socio-economic environmental impact on community in selected villages and economic viability for scaling in the Himalayan ecosystem

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SOP Brief/Introduction -The SOP given below describes the starting and shutting down process of the pine needle based power generation system. This project aims to understand the impact of electricity generation using the destructive energy of pine needles in the mountains districts of Uttarakhand. This prevents the forest fires, restores biodiversity thus improving the lives of local people, give them employment, and produces electricity that is used by the local community after being suppplied to the grid. This study will help to understand and articulate this impact which can be used to further replicate and scale up the same intitiative in the diferent regions of Uttarkhand and other mountain states.

Step 1: Collection of Pine Needles

The villagers are involved in collection of pine needles and stacking them in heaps at the assigned location. The heap is usually stacked nearest to the Plant. The time and efforts get reduced considerably and the heap stays safe and intact.

Step 2: Drying and Cutting of Pine Needles

Top layer, which is usually reasonably dry during sunny days pine needles are placed in front of the engine radiator to crisp dry these and then fed into a cutting machine to cut these into 10mm to 40 mm size. Usually, recently collected pine needles have very high moisture content which can go upto 32%, it is advised to use older pine needles which has been exposed to one monsoon, where intermittent sun drier those adequately even in the rainy season. Operators are also advised to manage the supply in such a way that they shift the naturally dried pine needles inside the shed during the day, so that they are available for power plant operations the next day. Operators should ensure that the pine needles to be fed in the system should have moisture level well below 20%. An easy way to measure this is to crush a handful of pine needles in your fist, and if they start breaking, they are adequately dried. Moisture levels higher than the recommended levels will lead to excessive tar formation, reducing the efficiency of the system and eventually seizing of the engine. Pistons.

Step 3: Ignition process

Appropriately dried and sized pine needles are placed manually in the combustion chamber of the gasifier, lid secured with the hatch and primary air blower is turned on along with the ignition point. Flame from the ignition point is directed at the pine needles placed in the chamber and cut pine needles are ignited, thereafter in about 10 to 15 minutes, the gas formation starts which is then passed through cooling and filtration process before being directed into the engine.

Step 4: Gas Test

Ultra clean gas before being directed into the engine needs to be tested for its quality by igniting it just before the entry into the engine. For this purpose, two valves are provided, one for letting the gas out for combusting, and another for letting the gas go in the engine. For combustion testing, the testing valve should be open and engine valve should be closed. A clean blue flame indicates that the gas quality is good to fire the engine. If the gas quality is not good, it is advised to continue combusting till the gas starts burning with a clear blue flame.

Step 5: Checking of engine and accessories

During this process of gas production, engine should be checked for radiator water level, engine oil, and nuts & bolts and corrective action taken in case of any issues before starting the engine.

Step 6: Starting the Engine

Once satisfactory gas quality is reached, gas is directed in the engine by turning off the test valve and opening the engine valve, and the engine is started by turning the ignition switch .

Step 7: Turning on the Synchronization Panel

A few minutes after starting the engine, Synchronization Panel is turned on. The panel starts sensing the frequency and voltage of both the generator and the grid. It usually takes five minutes or so for it to get completed. However, if Grid voltage is lower or higher or imbalanced in different phases, the match between grid and generator voltages and frequencies does not happen and the operator has to wait for the grid voltage to be proper. These issues are detected using the alarm mechanism installed. In case of persistent voltage mismatch, operators are advised to talk to the sub-station personnel to address these grid supply issues. After synchronization, electricity starts flowing in the grid.

Step 8: Turning on the Auxiliary Load

Post synchronization, the auxiliary load is turned on and the vibrator, cooling pump, scrubber pump, cooling fan, and the grate gear are start working.

Step 9: Turning off the blower and starting the conveyor system

Once these auxiliary devices start working, lid of the Combustion chamber is opened and blower is turned off. The conveyor system is also turned on so the continuous supply of cut pine needles is started for continuous feed supply and functioning of the gasifier. As pine needles were used in the beginning, now they are being used as fuel in an ongoing way. The conveyor system is used to feed pine needles into the combustion chamber. The sensor turns on and senses the pine needle level and starts/stops the movement of conveyor and hence feeding if biomass, depending on the pine needle level in the combustion chamber.

Step 10: Production and removal of biochar as a byproduct

Gasification process of oxidation followed by reduction leaves 10% (and above) quantity of biochar in the system. The grate which is a circular disc placed in the combustion chamber moves and stops every fifteen seconds. It is rotated using a gear box and pushes this biochar down into the ash chamber. Biochar gradually slips into the ash drum through open valve due to vibrations in the system created by the vibrator installed for this purpose. It must be noted that ash remover tank shall be emptied every half an hour. The emptying must be preceded by closing the valve between ash chamber and ash drum before opening the door of the ash drum. This valve between ash chamber and ash drum will be opened only after securing the ash drum lid. This is to stop the ambient air from flowing into the system and combusting the producer gases present in the system. It should be noted that if biochar is not removed at stated intervals, the biochar dust starts going in the gas lines choking them and ultimately shutting down the engine.

Step 11: Cleaning the gas and Tar Removal

The impure hot producer gases are passed through a cyclone to remove dust, scrubbed to remove more dust and some quantity of tar, then cooled by passing through a heat exchanger device, and traces of tar are removed and passing it through saw dust filters and a fine cloth filter. Liquid tar is collected from all these devices with a set of tubes and channeled into a box, where tar separated from all other points is also channeled.

Step 12: Shutting down process

During the shutdown, synchronization is disabled first so the power stop flowing into the grid and engine is basically running idle, then the combustion chamber lid is closed, and conveyor is turned off. Testing valve is opened and engine valve is closed. The engine is turned off followed by turning off the auxiliary load.

Step 13: Cleaning of the components

After shutdown of the power plant, dust accumulated in the cyclone should be cleaned by opening the lower lid, and the lid should be secured once the dust falls down. The fin plates of the scrubber should also be cleaned and secured in their place after this before closing the day.