Project Information Document

1. Project Title: Eco-friendly Utilization of hazardous Pine Needles for social benefits

2. Objectives:

Pine Needles cause major threat to Environment, Forest Biodiversity and Local Economy in entire Himalayan Region due to their non-bio-degradable and highly-inflammable nature. In our project, we propose to address the challenge of utilizing pine needles for social benefit by making pellets which can be used as fuel for domestic/industrial purposes.

We propose to set up a demonstration unit for pelletization in the first phase of the project through which we aim to create exposure among Government/Non-government organizations of the Himalayan region about the technology and its benefits.

3. Work Plan:

We aim to introduce the pilot project at our base location, Kamand, with the help of equipments provided by Namdhari Industrial Works, Khanna, Punjab [1]. As of now, organizations across the Himalayan ranges are making briquettes that are later used as fuel for cooking purposes. Our evaluation of their processes suggests that the efficiency of the technology is as low as 30% with a scope of further improvement. In our search for better solution, we have successfully identified one efficient technology that uses hammer mill and pellet mill in its process and increases the overall efficiency to 85%.

In this project, we wish to pilot our identified solution in Kamand in order to demonstrate its effectiveness. We believe that successful demonstration of the effectiveness of this technology will encourage/motivate fellow organizations to adopt it in their respective regions.

4. Project Duration: Two years

5. Project Area (Block and villages to be covered)

Owing to our remote location, IIT Mandi campus in Kamand itself is an ideal location for commencing the pilot project. The raw material needed, that is, pine is easily available in this region and collaborating with Forest department and involving local rural population are added advantages.

We shall invite government/non-government organizations from all across Himalayan region to study our demonstration unit and understand its sustainability aspects.
6. TECHNICAL DETAILS

1. Description of the problem and its priority as perceived by the people including socio-economic status of the area.

In the entire subtropical pine forest cover across the Himalayan ranges, pine needles are identified as major cause for forest fires, causing immense threat to Environment, Forest Biodiversity and Local Economy. The needles that fall from the month of April to June cover ground in thick net format and prohibit air to pass across, thereby, hindering the growth of grass on the ground. This phenomenon leaves no option for local masses other than setting the needles on fire; else it becomes almost impossible for them to feed their cattle. The needles, being highly inflammable in nature, not only pollute the environment by burning themselves, but also take entire biodiversity into their gulp.

*Only the hill districts

Indian Himalayan Region [2]

The following forest fire data shared by Forest Department, Uttrakhand [3] clearly clarifies the picture:
In past few decades, the forest departments of Hilly states such as Himachal Pradesh and Uttrakhand have tried various ways to collect and utilize pine needles for social good. Though the efforts have not yielded significant results as of now, they have surely highlighted gravity of the situation and have motivated numerous organizations (For-profit/Not-for-profit) to solve the problem. In the meantime, forest departments have taken a safer route of burning pine needles in controlled manner far away from their origin. They spend crores of rupees every year to address first half of the challenge- to prevent forest fires, while the other half- to make something constructive from pine needles- remains unsolved. For instance, Himachal Government has allocated a budget of Rs 422 Crores in 2013-14 to protect its forest from fires by cleaning/maintaining its 1000 Kms long fire line [4]. The Government is also looking for alternative ways to address the challenge.

Socio-Economic Status:

In the Himalayan states, people mostly depend on Agriculture and Animal Husbandry for their livelihood. In Himachal Pradesh alone, about 69% of the main workers are engaged in these sectors [5]. Therefore, it becomes really important for them to ensure proper health of their cattle and provide them with sufficient diet. As already described, pine needles hinder the growth of grass on ground by prohibiting air to pass thorough. This frustrates people and forces them to set the needles on fire. Hence the problem comes into the picture.
2. Suggested solution(s) and alternatives with anticipated physical and financial benefits. Please also state solutions attempted by your institution and others to solve the problems.

Centre for innovative technologies for Himalayan Region (CITHR) in Indian Institute of Technology Mandi has decided to address the challenge in its entirety i.e. to remove pine needles from the forests and to make something constructive out of them. In our quest for finding a suitable solution for pelletization, we came across three suppliers in the USA (1) and India (2). An in-depth analysis, including pricing, of their units is follows:

<table>
<thead>
<tr>
<th>S No</th>
<th>Company Name</th>
<th>Country</th>
<th>Product Model No</th>
<th>Capacity (Kg/Hr)</th>
<th>Power Required (HP)</th>
<th>Price (Rs)</th>
<th>Other Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alaska Pellet Mill</td>
<td>USA (Manufactured in China)</td>
<td>ATHMA20E</td>
<td>400</td>
<td>35</td>
<td>630,000</td>
<td>Price includes Customs Duties, Fees, Taxes, Inland Shipping and Installation cost</td>
</tr>
<tr>
<td>2</td>
<td>BK Engineers</td>
<td>Khanna, Punjab, India</td>
<td>BK 300</td>
<td>400</td>
<td>100</td>
<td>1,015,000</td>
<td>VAT 6.05% + Transportation</td>
</tr>
<tr>
<td>3</td>
<td>Namdhari Industrial Works</td>
<td>Khanna, Punjab, India</td>
<td></td>
<td>400</td>
<td>61</td>
<td>713,000</td>
<td>VAT 6.05% + Transportation</td>
</tr>
</tbody>
</table>

The quotations received from these suppliers are attached in Appendix A.

<table>
<thead>
<tr>
<th>Supplier/Features</th>
<th>Alaska Pellet Mill</th>
<th>BK Engineers</th>
<th>Namdhari Industrial Works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experience in Pine Needles Pelletization</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Maintenance Services</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

After analyzing above mentioned information, we propose to purchase our pilot plant from Namdhari Industrial Works as the firm is experienced in installing similar units for the processing of pine needles. Moreover, its prices are not much different from those of Alaska Pellet Mill, and it will be better equipped to provide us maintenance services due to its close geographical location.

**Physical/Health Benefits:** The most significant benefit comes in terms of reduced environmental pollution and conserved forest biodiversity. Also, households would be able to use alternate fuel (pellets) that shall help them in reducing kitchen smoke while cooking, thereby improving family health scenario particularly of women and children.
Though pellets cause more pollution as compare to wood (700 gCO$_2$/mJ vs 305 gCO$_2$/mJ), their required quantity for cooking is lesser than wood (3 KG/family/day vs 10 KG/family/day). Therefore, pellets end up causing less pollution as compare to wood on daily basis [6].

**Financial Benefits**

**Raw Material Collection:** In all three solutions, the requirement to collect pine needles from forests shall help to create jobs at local level. It is estimated that the fall of the needles is about 3-5 ton per hectare per season. A healthy person can collect around 100-150 KG of pine needles in a day, thereby earning around Rs 200-250 on daily basis depending upon the market price of pine needles. Moreover the removal of pine needles from forests shall facilitate more grass production for people’s benefit. At present, in Himachal, the forest department is getting it collected by paying some minimal amount to people, therefore, the set up for collection is already there through Forest Department of the State.

**Benefits from Product:**

The cost of pellets would be Rs 5/KG while wood costs around Rs 4.5/KG. Since households would require 3KG of pellets per day as compare to 10 KG of wood, they will be saving Rs 30 on daily basis.

**Employment:** We shall hire 2 people to work on the proposed unit.

3. **Objectives of the project (Please make these brief and preferably quantifiable. Referees are asked to comment on these and they will form part of the sanction, if project is approved)**

Our objective is to come up with a demonstration unit for making pellets from pine needles in IIT Mandi campus. The unit shall help us to convey its socio-economic benefits to various Govt/Non-Govt organizations.

Other benefits of the pelletization unit include:

**Removal of pine needles from the forests:** 141 MT/ Year, Reduced forest fires; Conserved Biodiversity; Reduced Environment Pollution.

**Annual Production:** 120 MT/Year

**Employment Generation:** Successful demonstration of pelletization can impact the region by creating small scale units at many locations and hence generating self-employment to some entrepreneurs as well as employment to others in the plant.

4. **Report of preliminary investigation conducted**

All the suppliers were asked to submit quotations along with detailed process flow of their machines.
5. Implementation strategy covering aspects such as:

(a) Information about local economy, relevant artisanal skills, market availability and link up, etc.

Raw Material Availability

As Himachal Pradesh falls completely inside Himalayan region, pine needles are widely available in the entire state. Following data is provided by Forest Survey of India (FSI) in its 2011’s report [7]:

- Total Geographical Area: 55673 sq Km
- Total Forest Cover: 14679 sq Km
- Subtropical Pine Cover: 22.35% = 3281 sq Km (Pine needles come from this category)
  Expected pine needles outcome per hectare per year: 4 Ton/Hectare
  Expected pine needle outcome from Himachal Pradesh per year: 3281*100*4/1000= 1312.4 MT

District-wise forest cover in Km\(^2\) is given in the table.

<table>
<thead>
<tr>
<th>District</th>
<th>Geographical Area</th>
<th>2011 Assessment</th>
<th>Total</th>
<th>Percent of GA</th>
<th>Change</th>
<th>Scrub</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Dense Forest</td>
<td>Mod. Dense Forest</td>
<td>Open Forest</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilaspur</td>
<td>1,167</td>
<td>24</td>
<td>171</td>
<td>167</td>
<td>362</td>
<td>31.02</td>
</tr>
<tr>
<td>Chamba</td>
<td>6,522</td>
<td>853</td>
<td>773</td>
<td>811</td>
<td>2,437</td>
<td>37.37</td>
</tr>
<tr>
<td>Hamirpur</td>
<td>1,118</td>
<td>39</td>
<td>91</td>
<td>114</td>
<td>244</td>
<td>21.82</td>
</tr>
<tr>
<td>Kangra</td>
<td>5,739</td>
<td>310</td>
<td>1,221</td>
<td>533</td>
<td>2,064</td>
<td>35.96</td>
</tr>
<tr>
<td>Kinnaur</td>
<td>6,401</td>
<td>82</td>
<td>262</td>
<td>256</td>
<td>600</td>
<td>9.37</td>
</tr>
<tr>
<td>Kullu</td>
<td>5,503</td>
<td>586</td>
<td>785</td>
<td>588</td>
<td>1,959</td>
<td>35.60</td>
</tr>
<tr>
<td>Lahaul &amp; Spiti</td>
<td>13,841</td>
<td>15</td>
<td>32</td>
<td>147</td>
<td>194</td>
<td>1.40</td>
</tr>
<tr>
<td>Mandi</td>
<td>3,950</td>
<td>373</td>
<td>735</td>
<td>567</td>
<td>1,675</td>
<td>42.41</td>
</tr>
<tr>
<td>Shimla</td>
<td>5,131</td>
<td>739</td>
<td>1,037</td>
<td>610</td>
<td>2,386</td>
<td>46.50</td>
</tr>
<tr>
<td>Sirmaur</td>
<td>2,825</td>
<td>130</td>
<td>568</td>
<td>687</td>
<td>1,385</td>
<td>49.03</td>
</tr>
<tr>
<td>Solan</td>
<td>1,936</td>
<td>55</td>
<td>404</td>
<td>391</td>
<td>850</td>
<td>43.90</td>
</tr>
<tr>
<td>Una</td>
<td>1,540</td>
<td>18</td>
<td>302</td>
<td>203</td>
<td>523</td>
<td>33.96</td>
</tr>
<tr>
<td>Grand Total</td>
<td>55,673</td>
<td>3,224</td>
<td>6,381</td>
<td>5,074</td>
<td>14,679</td>
<td>26.37</td>
</tr>
</tbody>
</table>
Product Applications and Market Availability

Pelletization:

The pellets are mostly used in domestic fuel requirements such as cooking and heating. They may also be used in Industry as a fuel in boilers etc.

In Himalayan region, more than 70% people depend on wood for their cooking requirements. Following chart shows the number of households dependent on wood for their cooking requirements [8]:

Therefore, total market size for pellets is more than 8.6 Lakhs households in Himachal Pradesh only.

Demand Projections

As per the projections mentioned above, we have more than 8.6 Lakhs households in Himachal Pradesh who depend on wood for their cooking requirements. Considering 3 Kg per day requirement of pellets per households, we can expect to have a demand of 2500 MT pellets in Himachal Pradesh.

(b) S&T component of the project

Pelletization is a way to convert loose biomass residues, such as pine needles, sawdust, straw or rice husk into high density solid blocks that can be used as a fuel. Such pellets replace fossil fuels or wood for cooking and industrial processes. They are cleaner and easier to handle, and cut greenhouse gas emissions.

How Pelletization works [9]

There are two approaches to pelletization:

1. High pressure technique

High pressure technique uses a power-driven press to raise the pressure of dry, powdered biomass to about 1500 bar (150 MPa). This compression heats the biomass to a temperature of about 120°C, which melts the lignin in the woody material. The press forces the hot material through a die at a controlled rate. As the pressure decreases, the lignin cools and re-solidifies, binding the biomass powder into uniform, solid pellets.
There are three main types of pelletization machines (see diagrams):

I. The piston press, which uses an oscillating piston to compress the biomass, and produces cylindrical pellets, 50 to 100 mm in diameter;

II. The screw press, which uses a tapered screw, and produces longer, hollow pellets;

III. The pellet mill, which compresses the biomass between rollers and makes smaller cylindrical pellets (similar to animal feed pellets) 6 to 12 mm in diameter.

The dies and moving components in the machines need to be made from hardened steel, because they are abraded by the biomass at the high pressures used. Even so, they wear out and need to be replaced. Lower pressures can be used if
the die is heated, but this requires additional energy for heating.

2. Low pressure technique

Low pressure technique can be used for materials with a low amount of lignin, such as paper and charcoal dust. In this process, the powdered biomass is mixed into a paste with a binder such as starch or clay, and water. A press is used to push the paste into a mould or through an extruder, or it can simply be shaped by hand. The pellets thus produced are left to dry, so that the binder sets and holds the biomass powder together. Low pressure pellets machines are often hand operated, using a lever that drives a piston to compress the paste.

The technical parameters of Pine Needles are as follows [10]:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Ash content (%)</th>
<th>Volatile Matter (%)</th>
<th>Fixed Carbon (%)</th>
<th>Calorific Value (kCal/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pine Needles</td>
<td>5.4</td>
<td>67.07</td>
<td>15.55</td>
<td>4811</td>
</tr>
</tbody>
</table>

Process (As narrated by Namdhari Industrial Works):

The pelletization unit consists of a chipper followed by a hammer mill followed by a pellet mill. The conversion ratio of the entire system is around 85%. Total power requirement is 45kW in order to run 61 HP load. The attached picture displays the pellet mill.

We plan to operate the unit for a period of 1 hour on daily basis. As per the technical specifications, we expect to generate 400 Kg of pellets in an hour.

(c) Linkages with S&T institutions/resource persons/R&D agencies for technical back up
We aim to collaborate with Forest Departments of Himachal Pradesh for their assistance in collecting dry pine needles from forests.

(d) Details of the project implementation site including details of relevant GIS data employed (please indicate source)

IIT Mandi, Kamand, Himachal Pradesh

GIS Data: Not Available

6. Work Plan:

(a) Phase wise plan of action including consultation with the target group, resource persons etc. including post project activities.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 to 6</td>
</tr>
<tr>
<td>Procurement, installation and commissioning of pelletizer in Kamand</td>
<td></td>
</tr>
<tr>
<td>Pellets Testings and Community feedback</td>
<td></td>
</tr>
<tr>
<td>Monitoring and Evaluation</td>
<td></td>
</tr>
</tbody>
</table>

8. Comment on the likely impact on adjoining areas/society.

We expect following benefits for the society after launching the project:

- Environment, Forest Biodiversity and Local Economy: With removal of pine needles from the forests, we would be able to prevent the occurrences of fires, thereby reducing pollution, saving biodiversity and helping local economy by facilitating more production of grass. Moreover, the use of pellets for domestic cooking shall help us to reduce wood usage in Himalayan region.

- Increase in household income: As we would require dry pine needles for our operations, local households can help us in collecting and transporting the same to our unit from the forests. The expected cost of pine needles is around Rs 2/KG, which can fetch around Rs 200 per day per individual. Moreover, people who own vehicles will have a chance to earn more by transporting the needles.

- Increase in Employment Opportunities: Our unit is expected to employ 2 People for next two years. Launching more such units across the Himalayas shall help to create more and more employment opportunities in future.