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FEASIBILITY STUDY OF TECHNOLOGICAL INTERVENTION TO TURN WASTE TO ENERGY IN TIMBER BASED SMALL SCALE INDUSTRY: A CASE STUDY

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Abstract

The industrial sector today consumes approximately 35% of the total electricity generated in the country. Timber processing industry in Uttarakhand buys power from the State Electricity Board and during the periods of chronic power shortage and frequent energy blackouts, it generates its own power largely through diesel generators. As fossil fuels are limited and have adverse environmental impact, it would be appropriate to convert huge amount of sawdust and wood waste generated by timber processing unit to energy either through saw dust briquetting or through biomass gasification power generation (BGPG). Technical and feasibility reports for BGPG in A-One Trading Corporation, a timber based SSI unit at Haldwani, Uttarakhand, estimated that AOTC has a potential of generating 20 KWh power with 901 Quintals of wood waste per month with a profit of 0.90 Rs/- per unit of electricity generated when compared to the commercial electricity rate of 3.10 Rs./- as purchased from the State Electricity Board. To convert wood waste into electricity for SSI's self-consumption through biomass gasification-power generation technology has favorable conditions of environmental protection and energy conservation.

Introduction

The Small Scale Industry today constitutes a very important segment of the Indian economy as a major contributor to country's Gross Domestic Product (GDP). They are characterized by the wise utilization of labor for commodity production and the advantage lies in consumption of ample laborers who are not qualified to work for the large scale industries and thus reducing unemployment and poverty in the country as well (1).

Though SSIs play a very important role in overall growth of an economy, on the other hand this growth is inversely related to development. Development can be perceived as an improvement in basic needs but, the present growth pattern is giving *food*; adulterated, *water*; polluted with effluents and disease causing agents, *air*; laden with oxides of S, N and C and carcinogens, *land*; with unmanageable amount of solid wastes and *settlements*; with mushrooming clusters of slums. Thus the visible economic growth is developing on the expense of health, hygiene and environment, which furthermore is directly interrelated to climate change.

Industrial sector is one of the major energy consuming sectors in India. While per capita energy consumption is lowest in the country, the energy consumption per unit of GDP is one of the highest compared to other developing countries. In other words, we are using more energy for a given amount of output. Energy conservation has once again become a hot topic in the national discourse, prompting companies to take a fresh look at conservation practices. Many SSIs today pay lip service to sustainability while only a few are making genuine investments to make facilities and operations more efficient (2).

Due to lack of implementation of environmental management facilities and their conservative approaches of development, SSIs exploit the available resources in an unsustainable manner. In most SSI units, the operational mechanisms are not energy efficient and the management as well as workers does not have any strategic knowledge on climate change.

The Study Objectives:

The present study was undertaken (1) To evaluate the level of knowledge on environmental issues and climate change among the management and workers. (2) To enlist the GHG emitting activities and find out the best possible measures to reduce GHG emissions, and (3) To assess the possibility of implementation of most feasible and economic technology to turn wood waste to energy, in timber based SSI unit, A-One Trading Corporation at Haldwani, a fast growing township of Uttarakhand.

A-One Trading Corporation (AOTC), is a large scale timber processing enterprise that is located at Haldwani. This SSI unit broadly has five working sections, viz. timber trading, sawmill operations, wood shredders for manufacture of wood wool, furniture processing unit and management of saw dust and other wood residues. AOTC gives employment to more than one hundred people of which 60% are illiterate and 50% are unskilled. This enterprise also imparts skill training to the laborers and provides residential facilities to its workers and their families.

Timber processing is a high electricity consumption activity. AOTC consumes power of about 5761 unit per month and the cost is up to 3.5 million per year. About 222 tons of wood waste is produced monthly, which

includes 32 tons of saw dust and 190 tons of leftover material, sieving waste and all kinds of bark. Due to the easy availability of the fuel wood in the form of wood residues, the laborer residents use approximately 3 quintal of wood for cooking purpose daily. During winters this amount becomes as high as 5 quintal as the requirement increases for water heating and room heating purposes.

There is an immense need to adopt the wood waste management technology in such a way that waste can be converted to energy to meet fuel requirements of resident workers as well as to fulfill power requirements of industry, besides providing environmental benefits.

To achieve the aforesaid objectives, this study was executed in three steps: First step included questionnaire and interactive discussion with management, laborers and female residents to evaluate their perception towards environmental issues and climate change. In the second step, base line data on consumption of timber, generation of wood waste & saw dust, power consumption and fuel wood burning by residents was collected and evaluated. Third step included the visit of experts from Uttarakhand Renewable Energy Development Agency (UREDA), The Energy and Resources Institute (TERI), New Delhi and Hi Tech Solar, Almora to explore the possibility of generation of energy from wood waste.

Assessment /Analysis/ Key outcomes

I: The education and awareness level in relation to climate change was analyzed by interactive discussion with female residents, male laborers and management separately. The perception of climate change issues by them can be summarized as (Table 1.1):

Table 1.1: Perception of female residents and male laborers about climate change issues.

	Understanding of climate change	Reasons of climate change	Impact of climate change
WOMEN (20% literacy)	<ul style="list-style-type: none"> Summers are getting hotter (50%) Monsoons have become unreliable (50%) 	<ul style="list-style-type: none"> Temperature rise is due to nature (40%) They are uneducated so how they can know this (30%) 	<ul style="list-style-type: none"> Feeling of restlessness and dizziness in hot noons (100%) Diarrhea, dysentery and boils are common in hot whether(40%) Feel eye irritation and suffocation while burning fuel wood in open chullhas (100%)
MEN (60% literacy)	<ul style="list-style-type: none"> Summers have become more hotter than those 10-15 years back (100%) Energy can be harnessed from renewable sources (40%) 	<ul style="list-style-type: none"> Pollution in their surroundings is due to poverty (30%) 	<ul style="list-style-type: none"> Feel restless and uneasy while working in mid day hot summer (50%)

Female residents: When a group of female residents, with only 20% literacy, was asked about climate change 50% responded that summers are getting hotter and monsoon have become very unreliable for agriculture. 20% said that during last winters negligible rainfall was observed. When they were asked about the reason behind temperature rise 40% said that this is all due to nature, which man can not understand, while 30% said that they don't know this because they are uneducated. All of them said that because of scorching heat they feel restless and sometimes dizziness also occurs and they feel like fainting after cooking food in hot summer noons. 40% said that diarrhea, dysentery, and boils appear frequently in their children in summers. 40% knew that biodegradable kitchen waste and cow dung can be converted to gobar gas and manure. All of them did not know the hazards of non-biodegradable wastes like plastic, polythene, metal cans etc. Female laborers use wood waste and cuttings for cooking requirement in traditional open mud chullhas, because of its free of cost availability in the premises. 20% of them are asthmatic and all of them feel eye irritation and suffocation while cooking. Almost all women residents were unaware about their role in environmental pollution and climate change as well as the harmful effects of fuel wood burning.

Male workers: On the other hand, male laborers, with 60% literacy, were found more familiar about environmental issues. All of them said that summers have become more hotter than those during 10-15 years back and 50% said that they feel restless and uneasy while working hard during mid day hot summer. 40% of them knew that energy can be harnessed from renewable sources like wind, biomass and sun, but nobody knew the hazards associated with burning wood for their fuel requirements in open mud chullhas. They said that they have to earn money to feed their big families so they can't think to spend on luxuries like gas stoves and LPG cylinders. But, unfortunately on the other hand, alcoholism, smoking and gambling are the major money eating ill habits that are mushrooming among laborers.

Management of the AOTC was found to be progressive with excellent understanding of the complete set of environmental issues and climate change scenario. They knew that fossil fuel burning emits green house gases, which are responsible for global warming. Management was also interested to adopt the economically promising, renewable energy generating and waste management technologies to make the SSI unit more sustainable with a good global hand impression and a small foot prints.

These observations clearly point out that lack of education and poverty are the two main culprits which cannot let the laborers adopt eco-friendly way of living and cooking unless they are provided with the full support and facilities from the management. To manage the garbage, that includes: biodegradable kitchen waste of 100 laborers and their non-biodegradable waste is also a big challenge. The laborers are not aware about sustainable way of using available resources and they don't know about the habits which are unhealthy for them and environment as well. So, this is only the responsibility of management to provide (i) certain strict environment friendly rules and regulations to comply with, (ii) alternatives to fuel wood and traditional chullhas, (iii) good

sanitary conditions to maintain health and hygiene among laborers, and (iv) facility of decomposition of biodegradable waste through biogas plant or vermi-composting and (v) recycling of non-biodegradable waste.

II. The timber processing industry in Uttarakhand suffers from chronic power shortage and frequent periods of energy blackouts, hence mostly sawmill industry is dependent upon diesel generators for their electricity requirements. High diesel costs result in high wood processing cost for mill operation. The large amount of sawdust and wood waste that is generated by the AOTC is sold for different purposes viz. as bedding for animals, as a fuel to local fuel wood buyers, as a fuel to boiler plants, as a fuel to furnaces, etc. Yet most of the wood waste generated remains dumped in the premises. Over a period of time the wood waste decomposes and emits methane, a green house gas that is about 21 times more harmful to the environment than carbon dioxide.

Ground data was collected and statistically analyzed to estimate per month average consumption of electricity as well as generation of saw dust and wood waste (Table 1.2) for last three years.

Table 1.2: Average consumption of electricity and generation of saw dust & wood waste for last 3 years by AOTC

Financial year	Average timber consumption cum/month	Average electricity consumption unit (KVAH)/month	Average sawdust generation Qtl/month	Average wood waste generation Qtl/month
2010-2011	180.3	5526	94.5	901.3
2009-2010	240.8	4618	150.8	1814.7
2008-2009	287.2	7140	733.0	2972.9
Avg of 3 years 2008-2011	236.1	5761	326.1	1896.3

The data of last 3 years reveals that processing of 236Cum of timber per month consumes 5761 unit electricity with a generation of 326 quintal of saw dust (14.7% of total waste) and 1896 quintal of wood waste (85.3% of total waste). Due to complicated sorts of timber wastes some of the wastes are used and sold, while others are disposed which causes some severe problems of storage and pollution. On the other hand timber processing is a high electricity consumption activity, and AOTC consumes 25 KW (100 BHP) power and the average electricity consumption is 5761 unit (KVAH) per month. So, adoption of such technology which can properly manage the huge amount of saw dust and wood waste generated by AOTC and convert it to energy like saw dust briquetting technology and biomass gasification power generation technology have favorable conditions of environmental protection and energy conservation for timber processing SSIs.

III. The visit of experts from Uttarakhand Renewable Energy Development Agency (UREDA), Hi Tech Solar, Almora and The Energy Resource Institute (TERI) was planned for technical and feasibility study of the site for renewable energy generation technology.

The experts from Hi Tech Solar, Almora, suggested that sawdust briquettes can be an environment friendly alternative to burning fuel wood by resident laborers. They advised for sawdust briquetting plant to manage the huge amount (1069 kg/day) of sawdust generated by the SSI unit. The proposed plant consists of briquetting press, grinder, dryer, material handling and storage equipments. The process consists of grinding, crushing, drying and binderless briquetting of saw dust, whereby the material gets converted from loose form into higher compact briquettes.

The briquettes have the following advantages.

- Have a high calorific value
- Burn evenly and steadily giving longer lasting fire
- Have low ash content which means no pollution of the environment
- Clean and easy to store
- Saving of cost in disposal or in storage of waste material

Another company “Bioflame”, states that smoke from burning these briquettes contain 69% fewer particles, 88% less carbon monoxide and the smoke is 50% less opaque than burning regular firewood (3). They also claim that the amount of carbon monoxide they do put out makes them Kyoto neutral. As for the type of heat these briquettes give out, given equal weights in briquettes and firewood the briquettes would end up giving substantially more heat (3). The one and only major disadvantage associated with briquetting is that the pellets and briquettes expand back into sawdust at the first hint of moisture. This fragility of briquettes makes their handling, loading and transport to the destination very difficult. The proposed briquetting plant involves capital investment of 10 Lakhs and has no certain economic benefits, so this is not suitable for AOTC, as the timber processing industry does not have any major boiler or furnace requirement.

Countries like Austria, China, Finland and Sweden produce a significant fraction of their electricity needs from wood or wood wastes(4). In India so many successful wood waste based power plants are already operating, with significantly high economic returns. When the specifications of Biomass Gasification Power Generation technology and its potential for AOTC were asked from UREDA experts, they suggested this technology to be practically viable and economically feasible for timber processing units. The ‘Biomass Gasification – Electricity Generation’ system is a technology which converts any kind of biomass energy with low heat value (such as waste from agriculture and forest and organic waste) into combustible gas and then feeds this gas to a generator for electricity generation(5). Biomass gasifier can not only work with internal combustion engine for electric power generation, but can also produce biomass gas that is used for household fuel to cooking or heating.

The wood waste gasification- power generation technology has following advantages:

- Environmentally sound technology
- Easy to operate and maintain
- Provides energy security
- Generates local employment
- Replace the fossil fuels.
- Produce energy from the waste
- Being renewable energy product, gasifiers are eligible for Carbon Credits under CDM mechanism

The experts from UREDA and TERI estimated that AOTC has the potential of generating 20KW of power on the basis of 29.6 quintal of average wood waste it generates per day during the financial year 2008-2009. The power plant will use wood waste and sawdust to produce clean electricity, which will be supplied to the industry resident laborers.

Based on the current price of wood waste (225 Rs per quintal) in India, the electricity production cost in the proposed project is around 333 Rs./KWh from average 29.6 Qtl waste wood per day. From 1 kg of wood waste, 1 unit (KVAH) electricity can be generated. According to this statistics per day 2963 unit (KVAH) and per month 90130 unit (KVAH) electricity can be produced. Per unit of 20 KWh electricity will cost 2.20 Rs/-. The electricity produced can be consumed directly by the saw mill and other units of AOTC. This SSI unit consumes 5761 unit electricity per month, so the excess amount i.e., 84369 unit electricity produced can be sold to the national grid on a long term power purchase agreement basis. In Uttarakhand commercial electricity costs 3.10 Rs/- per unit, so for per unit consumption the industry will save 0.90 Rs/- and if 84369 unit electricity will be sold to national grid on the current benefit of 0.90 Rs/- per month profit will be 75932.10 Rs/-. The economic return from proposed project will reach about 973404 Rs/- per year, and the capital investment of 16 Lakh (as estimated by TERI) will be paid back with in 2 years.

Consequentially, with the advantage of no CO₂ release, comparing with fuel wood combustion, a great deal of flue gas, such as NO_x and SO₂ can be alleviated. In the long term, the environmental benefit from the application of biomass gasification electricity generation technology will be much more obvious.

In this regard CDM Projects India is an initiative by 'INDSCAN' to disseminate information on the clean development projects happening across the nation. The Clean Development Mechanism (CDM) is an arrangement under the Kyoto Protocol allowing industrialized countries with a green house gas reduction commitment (called Annex B countries) to invest in the projects that reduce emissions in developing countries as an alternative to more expansive emission reductions in their own countries. Biomass energy is one of the sector in which CDM can be adopted. After registration and implementation of the CDM project, the CDM Executive Board (EB)

issues credits, called Certified Emission Reductions (CERs, commonly known as carbon credits, where each unit is equivalent to the reduction of one metric tonne of CO₂ e, e.g. CO₂ or its equivalent), to the project participants based on the monitored difference between the baseline and the actual emissions. The projects already undertaken and successfully completed under CDM can be replicated by other industrial units(List of some CDM projects having potential of replication: APPENDIX TABLE 1).

The Government of India provides incentives for setting up of power generation projects based on biomass in the form of capital subsidy and fiscal incentives such as accelerated depreciation, relief from taxes and duties, term loans from Indian Renewable Energy Development Agency (IREDA). Apart this, policies have been introduced in potential states for wheeling, banking and buy-back of electricity generated from commercial biomass power generation projects. In Uttarakhand, operation and execution of various schemes based on unconventional energy resources is handled by Uttarakhand Renewable Energy Development Agency (UREDA) through local panchayats, volunteer organizations and district administration. The work related to establishment of projects based on renewable energy resources is implemented by UREDA through technically proficient specialists and as and when required, help from AHEC, IIT Roorkee and other technical universities is taken, UREDA mainly implements the various schemes of Ministry of Non conventional Energy Resources, Govt. of India under administrative control of Department of Energy, Uttarakhand. AOTC has already generated project proposal for technical and feasibility studies of this project to UREDA, Uttarakhand.

Policy Implications/ Recommendations

1. As the results of study indicate that laborers and residents are poor and uneducated enough to understand the loop of environmental issues and climate change, hence they can not be blamed for pollution and damage which they are creating to the environment. Under such circumstances, it becomes the responsibility of the management to formulate strict rules and regulations to maintain the surroundings pollution free and adopt such measures like, smoke less chullhas, kitchen waste based biogas plants, vermi-composting of biodegradable waste, alternatives to burn wood waste for fuel requirement, etc., so that GHG emissions can be minimized. These measures must become mandatory for the SSIs having residential facilities for laborers.
2. During the current situation of energy crises, when our fossil fuel reserves are depleting at an alarming rate, it is very important to utilize all the possible energy resources very wisely. Utilization of wood waste biomass for gasification and power generation has a great potential to meet energy demands and raise economic benefits with associated environmental credits. These techniques must become an integral part of such SSI units which are based on biomass for consumer goods production. Government policies must also be there for collaboration of small biomass waste generating units in a particular region and to provide a platform for utilizing their collective waste to generate a substantial amount of power, which otherwise small units can not

pursue independently because of their low investing potential and sometimes insufficient amount of waste that can be converted to energy.

3. Political leadership and investment in public education has a critical role to play in paving the way for decentralized energy solutions to be accepted by local communities. Often the conservative approach of the management becomes a great hurdle for adoption of technologies turning waste to energy. Their adoption must be awarded and encouraged with an attractive amount of subsidy and carbon credits for the SSI.
4. Energy is one of the biggest constraints to development in rural India. Any investment to deal with this bottleneck deserves whole hearted support. If the Government of India is indeed serious about non conventional energy generation, it should support every *Panchayat* in the country to have a technical cell (1–2 persons) entrusted with the task of managing the energy needs of the *Gram Panchayat*– assessing the needs, the resource/ supply base, managing the infrastructure, ensuring payments etc.

Conclusion

The major challenges towards adopting any new renewable energy based technology are lack of education, poverty, conservative approaches of development, very high initial investments, and high economic risks. The poor laborers can't understand the severity, sincerity and urgency of climate change problem and its solution. Management doesn't want to invest in any technology unless and until it is economically very promising. The technologies to turn waste to energy like wood waste gasification- power generation are not advertised well, hence there is a need to popularize them, so that investors can become attracted towards such technologies. Wood waste gasification power generation technology has a potential of generating 20 KWh power with 29.6 Qtl. of wood waste, with a cost of 2.20 Rs/- per unit of power generation of 20 KWh. As the timber processing industries treat wood waste as the least valuable by product and sale them in minimum charges to get rid of their waste generation. If it can be treated by them as a resource to fulfill their high power consumption requirement with an added advantage of supply of surplus power generation to the national power grid, this technology has very high economical benefits too. AOTC has a potential to produce 90130 unit (KVAH) of electricity with 20 KWh power per month with its 901 quintal per month of average wood waste generated in the year 2010-2011, and has economic profit of 81000 Rs/- per month in contrast to the commercial electricity rate of 3.10 Rs./- per unit (KVAH) in Uttarakhand. If same proposed project can be replicated in similar SSI units of Haldwani, this technology may have a potential to fulfill the commercial as well as residential requirement of whole of the city. So, to convert the wood waste into electricity for the factory's self-consumption through biomass gasification-power generation technology has favorable conditions of environmental protection and energy conservation.

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APPENDIX

Table 1: List of some CDM* projects in India having potential of replication

S. No.	Name of the Project	Location	Raw Material	CO2 abatement in t CO2 equivalent
1.	Biomass gasification based electricity generation	Obeetee Private Limited (OPL) at Sant Ravidas Nagar, U.P.	Rice Husk	-
2.	8.25 MW Biogas and biomass based cogeneration project	CDBL, Banur Distt, Patiala, Punjab	Biodegradable biomass	177,595
3.	Biomass based cogeneration plant	Ruchira Paper Mills Ltd., Sirmour, H.P.	Rice husk	127380
4.	Small Scale biomass fired boiler based energy generation project	Indian Glycols Ltd., U.S.Nagar, U.K.	Bagasse	148158
5.	1.25 MW Biomass based cogeneration at a solvent extraction plant	Akbarpur, Ambedkar Nagar, U.P.	Rice husk	33960
6.	Bundle of 100 village 5.15 MW biomass gasifier based power plants	Araria, Bihar	Woody biomass and briquetted agro residues	70681
7.	SSML-Chilwaria 12 MW biomass cogeneration Project	Simbhaoli Sugar Mills Ltd., Bahraich, U.P.	Bagasse	378410

*clean development mechanism