Assessment of Bio-energy Potential for Distributed Power Generation from Crop Residue in Indian State Punjab

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ABSTRACT
In India, renewable energy sources are now developing at fast speed. Especially energy generation using Biomass resources is one of the area in which Researchers & Governments are concentrating. Agricultural residue/waste is the main source of Biomass energy. A large amount of crop residue biomass is generated in India. The amount of residue varies geographically. As the Punjab state is the agricultural rich state of India, so the information collected in this study is about assessment of the Biomass potential in Punjab for power generation using local Biomass Power Plant to meet the demand & supply requirements. A sample study has been presented in this paper. By using the concept of power generation at local (distributed) level, the economic & social status of the society will be raised as this will create the employability to the local people.

Keywords
Distributed Generation, Bio-mass Power Generation, Cluster of Villages, Crop Residue

1. INTRODUCTION
Distributed generation (DG) is generally regarded as small generators, both in terms of power output and physical size, connected to the existing power distribution grid. The difference between distributed generation and power plants operating in the modern transmission system is at least partly semantic. Although both types of generators operate in an interconnected system, power plants on transmission systems are generally located far from the loads they serve and are operated by utilities, whereas distributed generators are typically located on-site close to the loads they serve and could be operated independently by a customer or independent power producer instead of a utility company. Customers are, however, limited in the amount of control they can exert on their own generators. However, the technology offers several benefits to both consumers and producers of electrical power and has resulted in increased research and usage of DG technologies.

1.1 Distributed Generation
Distributed Generation is also known as on-site generation, dispersed generation, embedded generation, decentralized generation, decentralized energy or distributed energy, generates electricity from many small energy sources. It is fairly a new concept in the economics literature about electricity markets, but the idea behind it is not new at all.

Generally, the term Dispersed or Distributed Generation refers to any electric power production technology that is integrated within distribution systems. Distributed generators are connected to the medium or low voltage grid. They are not centrally planned and they are typically smaller than 30 MW. The exact definition of distributed generation (DG) varies somewhat between sources and capacities; however, it is generally and summarily defined as any source of electric power of limited capacity, directly connected to the power system distribution network where it is consumed by the end users.

2. AGRI-RESIDUE POTENTIAL IN PUNJAB
Punjab along with the adjoining state Haryana is referred as the "Grain basin of India". Agriculture is the most important economic doings of the state, The cropping strength in the state is considered as one of the highest within the country. This is due to the significant availability of ground water for irrigation purpose in the state.

There are two major agricultural seasons in the state "Rabi" (winter crop) and "Kharif" (summer crop). The major crops grown during the Rabi season are Wheat, Arhar, Mustard(Sarson), Sunflower, Cotton, Dry chillies & Sesamum while during Kharif season Paddy, Bajra, Jowar, Maize, Moong, Ground nut and Sugarcane are important crops. Apart from these crops, there are various other crops such as barseem, vegetables, potatoes, tomatoes, green manure, etc., which are categorized as 'Insignificant Crops'. Here, it is important to mention that in the present work I have considered only major and minor crops. A crop is considered major if its crop area fraction was 10% or above of the total cultivated area. A crop is considered minor if it was not covered under the major crop and had either crop area fraction of 2.5% or above. Crops that do not qualify either as major or minor was considered 'Insignificant crop'. Data for the insignificant crops is not calculated in the present work due to miniscule contribution by such crops in the total biomass production. The total biological residue generation was expressed in Quintals per season at 10% moisture content and CRR (Crop to Residue Generation Ratio) measured in terms of their weight and averaged. The residues generated from the major crops consists of wheat straw, mustard stalk, cotton stalk, paddy straw and husk, Maize husk and cob, and sugar-cane leaves and trash. [2]

3. TYPES OF AGRI-RESIDUE
Electrical power can be generated from agri-residue by setting up agri-residue based small power plants in rural areas; one such plant can satisfy the power needs of a cluster of villages. The agri-residues like rice straw, rice-husk, soya bean stalks, mustard stalks, mustard husk, wheat straw cotton stalks, cotton kernals, maize stalks, maize cobs, sunflower stalks, grass, sugarcane trash, bagasse can be fruit fully utilized in power generation. The different types of available agri-residue are shown in figure 1.

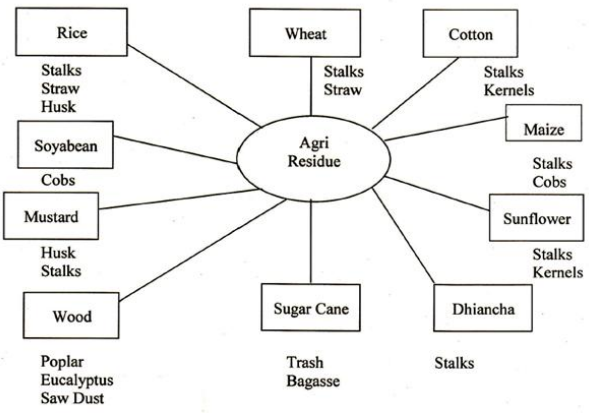

Figure 1

4. INTRODUCTION OF BIOMASS BASED POWER PLANT BY VIATON ENERGY PVT LTD.

In year 2013 the VIATON ENERGY PVT LTD has launched a 10 MW Biomass based power plant in Khokhar Khurd, District Mansa in state Punjab. The plant has started generating power from the year 2014.

The plant has done remarkable work and adopted couple of schemes to support energy conservation. The plant consists of nominal capacity Fluidized Bed Boiler with super heater outlet parameter. This boiler produces steam by burning the various Bio-mass fuels available and the steam thus produced runs a 10 MW Turbo Alternator of both extractions cum condensing type, which produces Power at 11 KV. The Turbo-generator is a multistage, impulse type, extraction condensing, having single reduction parallel shaft gearbox. The alternator is operating on 11 KV, A.C, 3-phase, 50 Hz and having a power factor of 0.8 (lagging).

The 11 KV power generated is stepped up to 66 KV with the help of step up transformer as per PSPCL guidelines and with the help of required synchronization / other equipments and fed to the Grid of M/s Punjab State Power Corporation Limited at Mansa grid substation which is approx. 10 Km from the Power Plant location.

Various types of agri-residue are used in the plant which is given below:

1. Cotton Stalks
2. Mustard Husk
3. Maize Stalks & Cob
4. Peddy Straw
5. Rice Husk
6. Sugarcane Tops & Leaves

5. AGRI-RESIDUE BASED ELECTRIC POWER POTENTIAL AND CLUSTER OF VILLAGES

The State of Punjab, known all over the world as rich agricultural state, contributes heavily to national grain stalks. The agriculture can also show way for power generations. Agri- residue, waste material left after separating grains from crop, can be used to generate electricity. In this study, an effort has been made to explore the feasible electric power potential of available agri- residue in a cluster of villages in district Sangrur, Tehsil Lehra of Punjab State. An agricultural survey was carried out to cover both Rabi and Kharif seasons (2013-2014).

5.1 Profile of Cluster

- **Cluster of villages**: Raidharana, Jhaloor, Bhutal Kalan, Kartarpura alias Changaliwala, Gaga,Ramgarh Sandhuan, Khandebad, Lehal Kalan A, Lehal Kalan B, Lehal Khurd

Table 1: Profile of Cluster

District & Tehsil	Sangrur, Lehra
Number of Villages	10
Nearest Towns	Lehragaga, Sunam
Nearest Railway Station	Lehragaga, 05Km away
Nearest Airport	Chandigarh,180Km away
Main Crops	Rabi-Wheat,Barseem, Sarson Khariff-Paddy, Cotton, Maize.Sugarcane

5.2 Assessment of Agri-Residue in the Cluster of Villages

Data pertaining to different locally available crops was collected from local circle Patwaris (official of land and revenue department) of said clusters. By using grain production per acre and residue to production ratio (R.P.R) total agri-residue per village and then total agri-residue of whole cluster was calculated. Table 2 shows the different types of local crops, there agri-residue components, residue production ratio, grain production and agri-residue production.

Table 2

Sr.No.	Crop	AgriResidue Component	Residue Production Ratio (RPR)*	Grain Production (Quintal /acre)*	Agri-Residue production (Quintal/acre)
1.	Cotton	Stalks	4.2	12	50.4
2.	Paddy	Straw	1.86	32	59.52
3.	Paddy	Husk	-	-	9
4.	Wheat	Straw	1.75	29	50.75
5.	Maize	Stalks Co	2.27	18	40.86
6.	Sugarcan e	Tops Lea	0.3	400	75**
7.	Sarson	Straw	2.7	20	54
8.	Barseem	-	-	-	-

* Local Survey & Rich Experience of Farmers

** Approximated to 75 due to high moisture content

Paddy, wheat, maize and cotton are the major agri-residue contributors. Total agri- residue in cluster was calculated to be

120154.8 tonnes for the year 2012 (Rabi and Kharif). Table-3 total agri-residue production crop and village wise is presented. Paddy, wheat, maize and cotton are the major agri-residue contributors. Total agri- residue in cluster was calculated to be 1201548 tonnes for the year 2013 (Rabi and Kharif).

Table 3

Sr. No	Crop	Agri-residue Component	TOTAL AGRI-RESIDUE- CROP WISE (QUINTALS) (FROM CLUSTER OF 10 VILLAGES)
1.	Cotton	Stalks	**13154.40**
2.	Paddy	Straw	**959105.30**
3.	Paddy	Husk	**145026.00**
4.	Wheat	Straw	**40834.00**
5.	Maize	Stalk & Cobs	**8826.30**
6.	Sugar cane	Top & leaves	**23100.00**
7.	Sarson	Straw	**11502.00**
TOTAL			**1201548.00**

5.3 Calculations For Agri-Residue Basesd Power Plants

Calculation work is carried out for 10 MW capacity agri-residue based (Steam- Boiler System) power plant by taking annual load factor of 0.88. Fuel requirement per year for 7.5 MW steam boiler plant was calculated to be 83950±10% MT*. Total agri-residue production per year in said cluster is 1,20,1548 MT**. By using approximately 78% of this agri-residue, fuel demand of 10 MW steam - boiler plant can be satisfied. Fuel used for this system is mainly Cotton sticks, paddy straw & rice husk. The cluster of 10 villages gives cotton stalks equal to 1315.44 MT, paddy straw equal to 95910.53 MT & rice husk equal to 1450.26 MT. Total agri-residue fuel came out to be 98676.23 MT** (only cotton stalks, paddy straw & rice husk). By using approximately 94% of total agri-residue of cotton stalks, paddy straw & rice husk per year in said cluster fuel demand of 10 MW Biomass plant can be satisfied. Hence agri-residue of cluster of 10 villages can sufficiently meet the fuel requirements of 10 MW plant.

6. RESULTS AND DISCUSSIONS

The Study was initiated with the aim of investigating the agri-residue based electric power potential in clusters of villages, exploring the possibility of utilizing Biomass for Electrical power generation in Punjab state.

For investigating the agri-residue based electric power potential in cluster of villages total agri-residue (Rabi & Kharif) in year 2013-14 was estimated which came to be 1,20,1548 MT covering all major local crops. Calculation work was carried out for 10 MW power plant. Requirement of fuel for 10 MW power plant came out to be 83950±10% MT. By using 78% of the total village cluster agri-residue, the fuel demand of 10 MW (Boiler System) can be satisfied for Power generation from 10 MW plant is sufficient to meet the requirement of more than 20 villages approximately. The benefits from agri- residue based power plants are multiple in terms of development, employment generation and environmental aspects.

7. CONCLUSION & FUTURE SCOPE OF THE IDEA

For small power plants, biomass offers the most attractive alternative energy system than steam power plants. A cluster of 10 villages can fulfill the fuel requirements of 10 MW agri-residue based electric power plant, which can serve the power needs of more than 20 villages approximately. The annual financial benefit to the village Cluster from the sale of agri-residue is approximately 1.7 times than the amount of annual electrical energy consumed by the village cluster. Employability will be created for the youth of the rural & remote areas of the state. It helps & encourages Distributed Power Generation in de-centralized energy market of today.

So, we can see that the implementation of this idea may uplift the social-economic stranded of the public of the state alongwith the benefit of rural electrification of the state.

8. REFERENCES

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