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Implementation of Biomass Power Plants Regarding Future Virtual Power Plants

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Abstract—*Energy is one of the most fundamental parts of our universe. About 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs. Biomass power generation in India is more than 5000 million units of electricity. India has over 5,464 MW biomass based power plants comprising 4,545 MW grid connected and 918 MW off-grid power plants. The power output of a biomass plant is* ***flexible****. If we interconnect biomass plant within the framework of a* ***virtual power plant****, the flexibility of their plant can be sold on* ***balancing energy markets*** *as ancillary reserve. Furthermore, if prices on the energy exchange are high there can be increase in* ***power production*** *and at the time of low market prices production can be decreased. This paper is about the possibilities of the implementation of biomass power plants in India, with the help of the concept of Virtual Power Plant (VPP), and aggregation of distributed energy resources that communicate with decentralized EMS. The technical aspect of operation will be reviewed and application of Distributed Generator in the power market will be explained. A future VPP with various DG technologies in all voltage level distribution networks is discussed in this paper.*

Keywords*: Distributed Generator; Virtual Power Plant; Biomass; decentralized EMS.*

1. INTRODUCTION

Due to several supportive regulations in the worldwide, the use of biomass in the power system will be highly increased in the coming time. This event needs the changes in the management in control strategies of the system.

There are different developments plants for renewable energy, in order to limit the pollution from the energy domain. Rising fossil fuels costs and concerns about the environmental impact of fossil fuels have generated major interest in the renewable energy resources. The renewable sources want to satisfy the electrical energy needs of society. The strong growth in renewable generation is expected to continue, and as its role increases it will bring new challenges.

A classification of distribution generation units (DGU) is made in Table 1. In some literature, the DGUs are called Micro-plants respectively Pico-plants. From the utility point of view, DGUs are located near customers to reduce the load in the transmission and distribution systems with two major effects: loss and network cost reduction. [1]

Table I: Classification of DGU

No.	Classification of DGU	
	Type of DGU	**Power rating range**
1	Micro DGUs	1 W < 5 kW
2	Small DGUs	5 kW < 5 MW
3	Medium DGUs	5 MW < 50 MW
4	Large DGUs	50MW < 300MW

Apart from technical advantage of VPP, planning and observing the operation distributed energy sources, it is very beneficial from the view of power market transactions. Participation of VPP in the power market can be effectively confronting DG with the power market. This makes possible effective use of the capacities of DGs and their capabilities for providing both energy and ancillary services in the competitive environment.

Some discussions provided about the business models of VPP in regard to the investing cost. In the presence of VPP in the power market as a participant is not advanced. In order to provide the electrical and thermal loads, VPP minimizes the total variable cost which are included the fuel cost of DG units and the revenue of the electrical power exchanged with the grid in. The authors of developed their model by proposing the coordinated optimization of VPP and Distribution System Operator (DSO) to maintain the security of distribution.

In India, at this time, the renewable energy sources are in the state of development and implementation. The influence of DGU on the grid is relatively low. The country is installed with small and medium DGU based biomass plants [2].

2. METHODS OF ANALYSIS

2.1 Biomass potential in India

The biomass power plants in India are mainly based on agricultural and city waste. Power plants based gasifier are providing a great solution for the energy out of the

decentralized network and are lighting homes in various states of India. As to power grid based thermal power plants 15.8 MW biomass are suitable for Indian conditions, stand nothing compared to power plants are being created in Europe that are at least 20 times larger[5].

As India has an abundant amount of biomass, there is a high potential for biomass energy in India.

2.2 Manufacturing base

Manufacturing capacity exists in the country for the team / necessary for creating biomass projects machinery. Except for some critical control equipment, most teams can come from indigenous sources.

Boilers

A high number of manufacturers have created capacities for manufacturing spreader stoker fired, traveling grate / grill boilers dumping; atmospheric pressure boilers and circulating fluidized bed boilers fluidized bed. Due to the recent increased interest in cogeneration of surplus power, leading manufacturers are improving their capabilities to further high efficiency boilers.

Steam Turbines

Almost all combinations - condensation, simple extraction / condensing double extraction back pressure, etc. They are now being manufactured in the country with full after sales services. The efficiency of the turbines now being offered are comparable to the best in the world.

Other Equipment

In addition to the top teams, there is a well established capability and manufacturing capacity related to the use of biomass for energy including harvesters, balers, briquetting equipment, handling and shooting equipment, systems of pollution control equipment, etc. . Many multinational companies have established manufacturing facilities in the country for these teams.

2.3 Technology

Combustion

Thermo-chemical processes for the conversion of biomass to useful products consists combustion, gasification or pyrolysis. The route is most commonly used combustion. The advantage is that the technology used is similar to that of a coal-based thermal power station, except for the boiler. The cycle used is the conventional classification cycle biomass is burned in the high pressure boiler to generate steam and operation of a turbine with generated steam. The net efficiency power cycles that can be achieved are about 23-25%. The turbine exhausts steam or can be fully condensed to produce energy, or used in part or in whole for other activity useful heating. The latter mode is called cogeneration. In India, the route of cogeneration finds application mainly in industries.

Fig. 1: 10 MW Biomass Power Project

Cogeneration in Sugar Mills

Sugar industry has been practicing cogeneration by using cane waste as a fuel since long. With the up gradation in the technology for production and utilization of steam at high temperature and pressure, sugar industry can generate electricity and steam for their own needs. It can also produce significant surplus electricity for sale to the grid using same quantity of cane waste. For example, if steam generation temperature/pressure is raised from 400°C/34 bar to 485°C/68 bar, more than 80 KWh of additional electricity can be generated for each ton of cane crushed. The sale of surplus power produced through optimum cogeneration would help a sugar mill to improve its activity, apart from adding to the power generation capacity of the country.

2.4 Distribution

Electricity generated through the biomass power plant is dispatched using local management system which is connected to central management system as a virtual power plant.

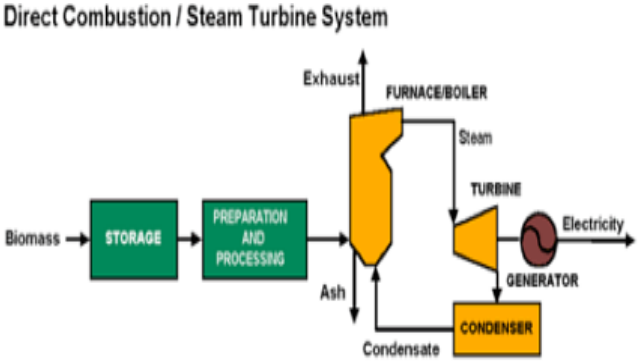

Fig. 2: Direct combustion/ Steam Turbine System

The dispatched electricity is given to the grid which is coming from the major power plant through smart grid process, as a result the load on major power plant is reduced as the power supplied by VPP helps in sharing the load.

The loading of the grid, determine at the specific consumption section, in relation with the loading. It is obtained a reduction of the loading of the grid approximately 10% at peak hours. This value shows that the loading of the lines will not determine an interruption of the power supply. Of course the loading values exceed then the consumption increases and the installed power of the VPP is the same. The voltage boundaries of the LV costumers will not be affected.

3. VIRTUAL POWER PLANT COMPONENTS

A remarkable development process is going on the electric small and micro-plants field that has a range between 5-500 kW. These units are, in general, CHPs, photovoltaic system and biomass plants. Biomass plants have a good potential in the big cities as well as in small cities.

Future VPP should be included the wide varieties of DG technologies in both low voltage and medium voltage distribution network. In this respect, DG can be classified as into two categories-

a. Domestic distributed generator (DDG), it is a small DG unit which serves individual consumer for residential, commercial or industrial parts.
b. Public distributed generator (PDG), it is a DG unit which does not belong to an individual and its primary aim is to inject this power production to the grid.

Generally, DDG and PDG can be equipped with energy storage. DDG is referred to a generator with a load and probably an energy storage which is usually connected to a low voltage distribution network. On the other hand, PDG is referred to a generator and probably an energy storage which can only be connected to the medium voltage distribution network.

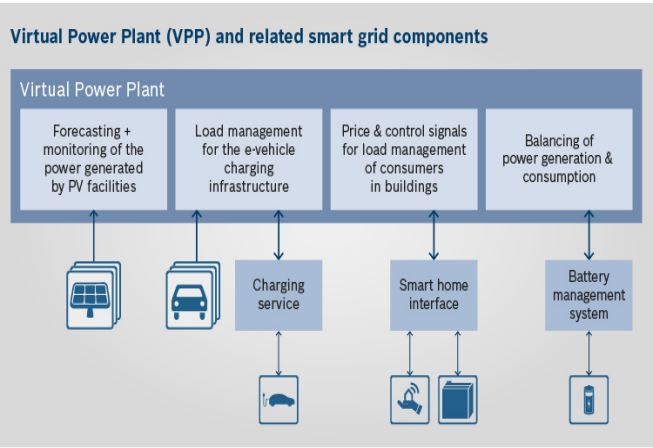

Fig. 3: Virtual power plant components

The distinction of DDG's and PDG's are as follows:

1. The aim of the owners of DDG's is to provide economically their electrical and probably heating needs as well as to promote probably their services and reliability. They are uninformed of the power business rules.
2. Generally, the capacities of DDG's generation are small in comparison with PDG's. So, DDG"s never being able to participate in power market independently as an individual participant, but a PDG may test its chance in the power market[3].

In accordance with the penetration of DDG's in the system, it can be decomposed into very small sub-system called micro-grid. Using the VPP concept, each micro grid and PDG can then be presented as a large aggregated controllable group, available for use in the system management task. PDG's and DDG's can be subdivided into two categories i.e. dispatch-able PDG's (DPDG's) and stochastic PDG's (SPDG's) for the former and also dispatch-able DDG's

4. EVALUATION OF RESULT

Through this paper we have studied about potential of the biomass power plant in India and how we can combine them to form a VPP. We have also studies the distributed generator and the distributed generator units which are used in the distribution of the generated power through the biomass power plant. New technology trends in the field of biomass have also been discussed. The virtual power plant concept using the biomass power plant is a very useful source of generation in future as biomass is the only source of renewable source of energy which is constant throughout the year. As a result we can give a constant supply into the grid by local management systems. We have also studied the present and future capacities of different areas of India to produce biomass energy and that can be combined as a virtual power plant and represented it into a table given below.

Table 2: Current Biomass Potential estimation in India

Biomass Type	Potential (MWe)	Percentage
Agro potential	18728	54
Livestock	9332	27
Fruits	660	2
Vegetables	1220	3
Industrial Wastes	1470	4
Subtotal	**31410**	**90**

Table 3: Urban Wastes

MSW	3190	9
MLW	361	1
Subtotal	**3551**	**10**
Grand total	**34961**	**100**

Rajasthan, Punjab, Maharashtra and Haryana are states with high biomass potential. Together, they comprise close to 50% of the total estimated potential for biomass in India.

Future Potential of Power Generation from Biomass in India

Biomass Type	Realistic		Beyond
	10-13	14-20	2020
Agro potential	19295	20687	21743
Live stock	9332	9767	10470
Fruits	738	963	1165

The most important factor to the success of a virtual power plant is its use in the open power market. These factors are based, along with other things, on the work properties of the energy management system.

The goal of EMS is to reach a maximum utilization ratio and minimal greenhouse gas emissions from the system, in a stable electric network. In order to obtain an optimized utilization ratio the prerequisites should be:

1. Consumer gear lines
2. Reliability in current cooling and Heat
3. Line production of the producers, its means availability of primary energies.

Biomass combined virtual power plants do not require new weather simulation models like solar and wind energy power plant as a result it is less complicated. The cost of installing a biomass power plant is less then solar and wind power plants as result the price per unit energy is lower if we combine small power plants into virtual power plants.[4]

The virtual power plants have created an effective link with renewable sources of energy and combined with biomass power plants, there exists a large environment potential to reduce production emissions per unit energy.

5. CONCLUSION

Using the coordinated virtual power plants we can solve the loading problems and maintain the voltage limits of the distribution system using local energy source. The implementation of the VPP's, using biomass sources, has an advantage that there is a reduction in the major investments for the grid and it also maintains the cleanliness of environment. It can be easily concluded that there is a high potential of biomass power in India but the power generation through the biomass power plants has not been up to the level to which it should have been. Installing biomass power plants can also help in waste reduction of urban and rural areas. As a result combining the biomass power plants to form a virtual power plant can help us easily solve some of the generation and distribution problems arising in our country.

6. ACKNOWLEDGEMENT

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