Factors Influencing Grid Interactive Biomass Power Industry

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Abstract— *Presently, in India only 13% of the total installed generating capacity of electricity is from renewable energy sources while 70 % of electrical power is generated using fossil fuels. Contribution of biomass to the total installed generating capacity of the electricity is mere 2%. As on today, only 23% of the total biomass power potential in India is utilized for power generation. The scope for the biomass power industry enhances with the recent ambitious target of biomass power of 10000 MW by 2022. The present research work aims at identifying the factors and to analyze its influence on biomass power entrepreneurship in India. The factors are identified based on the interviews with the biomass power experts and industry representatives. Presently in India, the primary drivers for installing biomass power are returns to the investments, to provide clean and reliable power to the industries and to save on the electricity bill due to high power tariff for industries. The major barriers influencing biomass power industry is the supply and frequent price fluctuations of the fuel stock (biomass input) which leads to reduced gap between the tariff and the cost of fuel over the period of time. A macro level analysis based on the secondary data collated for 28 states in India reveals that the installed capacities of biomass power presently responds strongly to the level of industrialization and power tariff for industries rather than the state level feed in tariff identified for biomass power. Even the states with high biomass potential and high feed in tariff are not able to utilize the existing biomass potential. Region wise installed generating capacity of electricity (utilities) also has strong influence on promotion of grid interactive biomass power. The paper suggests that such states should encourage biomass power entrepreneurship to supply power to the existing industries in addition to the high feed in tariff rates for the biomass power. Frequent revisions in tariff are recommended for sustenance of biomass power plants along with attempts to develop plan for organized supply of biomass fuel stock for power generation at state level.*

Keywords— Grid interactive biomass power; biomass tariff; power tariff for industries; biomass fuel stock supply; Net state domestic product.

I. INTRODUCTION

In India, 70 % of the installed generating capacity of electricity (Utilities) is through thermal power plants while about 30 % of power generation is contributed by various sources like hydro, nuclear and renewable energy. Renewable energy contributes about 13 % of the total power generation in India. Out of the total installed generation capacity of renewable power, Wind power accounted for about 66.69%, followed by Biomass power (12.66%) and Small hydro power (12%) (Ministry of Statistics and Programme Implementation, 2015).

Biomass power generation is becoming an emerging industry in India over the last decade (Singh & Setiawan, 2013). It attracts an annual investment of over INR 8850 million and produces about 5000 million units of electricity with 10 million man-days jobs in rural areas (Ministry of New and Renewable Energy, as on December 2015), (Kumar, Kumar, Baredar, & Shukla, 2015). The total potential for biomass power generation in the country as on 31.03.14 is estimated as 17,538 MW (11.88% of total renewable power potential) and 5000 MW (3.39% of total renewable power potential) from bagasse-based cogeneration in sugar mills. However, the installed capacity of grid interactive biomass power in India as on March 2014 was 4013.55 MW which is only 18% of the total biomass potential. There still holds the possibilities to tap the 80% of the unused biomass potential to feed electricity to the industries. A review of infraline energy database indicates that majority (about 90%) of the biomass power plants are owned by the private sector.

Provided the scenario of huge untapped biomass potential and dominance of private sector in the emerging biomass power industry, the paper tries to understand the factors influencing the biomass power generation industry through the lens of the entrepreneurs. In the later section, the paper attempts a macro level analysis of the influencing factors using the data secondary data collated for 28 states in India to relationship of the influencing factors in present context with the biomass power capacities.

II. SCOPE FOR BIOMASS POWER GENERATION

Electricity is an important input for sustained production processes in industries and agriculture as well as to maintain a basic quality of life. With increasing urbanization, industrialization and improving quality of life, the consumption of electricity is also increasing. The estimated electricity consumption increased from 4,11,887 GWh during 2005-06 to 882,592 GWh during 2013-14, showing a CAGR of 8.84% and the increase in electricity consumption is 7.07% from 2012-13 (824,301GWh) to 2013-14 (882,592 GWh) (Ministry of Statistics and Programme Implementation, 2015). Of the total consumption of electricity in 2013-14, industry sector accounted for the largest share (43.83%), followed by domestic (22.46%), agriculture (18.03%) and commercial sectors (8.72%) (Ministry of Statistics and Programme Implementation, 2015). Figure 1 provides the power supply position (peak demand and peak met) in India for the period 1996 to 2015. The supply of electricity increased in India with the growing demand. The shortage of electricity supply was by about 13815 in the year 2011-12 (for the peak demand and peak met scenario) and thereafter the shortage reduced to about 7000 MW in the year 2014-15.Still a huge demand supply gap exists for power in India. One of the sustained means of supply of electricity is through renewable energy resources. One among the renewable power generation resource is biomass. The Government of India has planned capacity addition target to take the total renewable capacity to almost 55 GW by the end of 2017 which includes 2.9 GW from biomass power (www.makeinindia.com, as on October 2015). The peak demand of power requirement and supply status is shown in Figure 1.

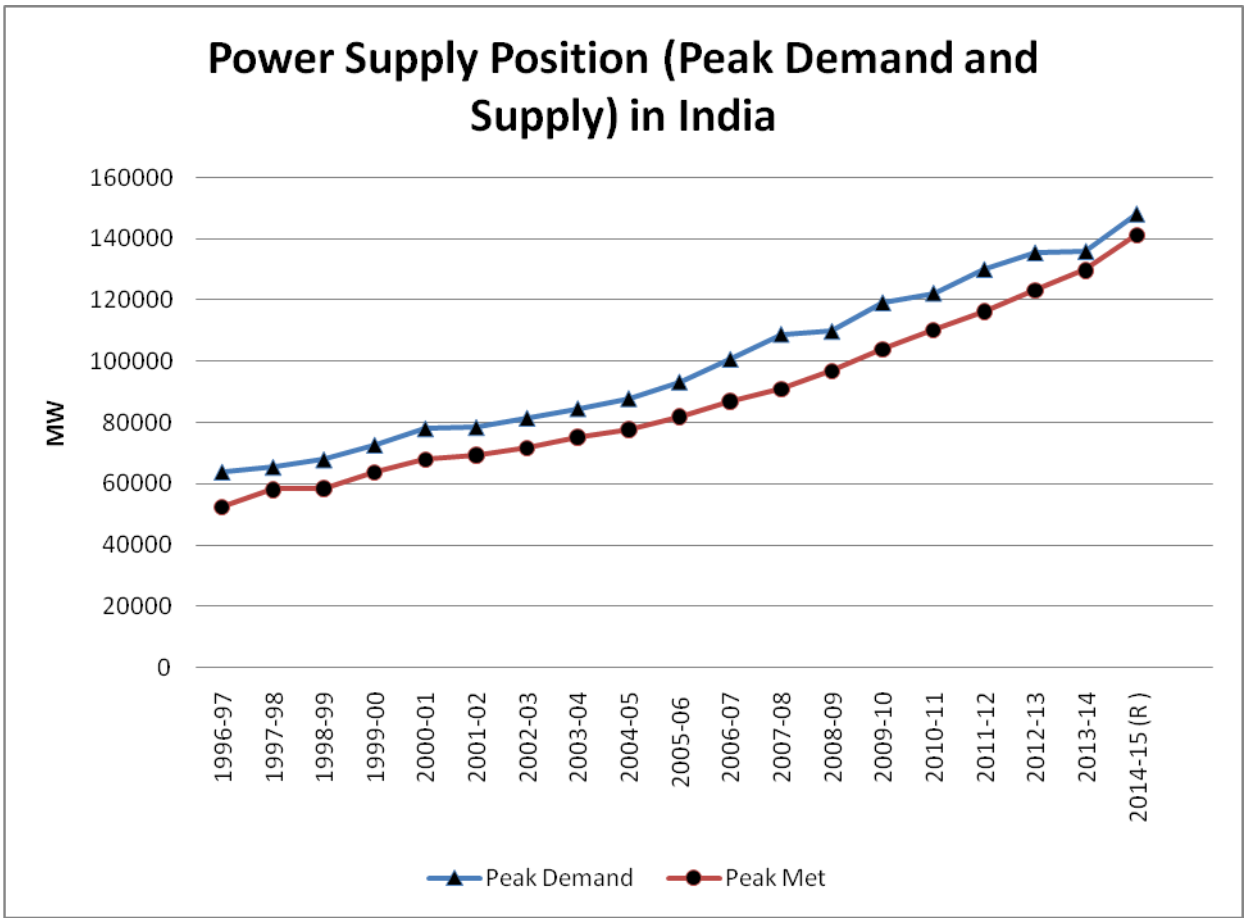

FIGURE 1 POWER SUPPLY POSITION (PEAK DEMAND AND SUPPLY) IN INDIA
[Source: (www.indiastat.com, as on January 2016)]

Biomass power plants are installed for three reasons;

1. To supply renewable and reliable power to the industry (captive power or wheeled through the point of generation to the point of use) in the areas facing power deficiencies.
2. To supply renewable and reliable power to the industry (captive power or wheeled through the point of generation to the point of use) to save on the electricity bills due to the high power tariff for industries.

3. To generate revenue from the biomass power plants through the sale of generated electricity to the state transmission and distribution companies or/and industries following the open access or third party sale processes.

Biomass power plant can be installed in any locations with a nearby supply source for biomass or the industries with substantial biomass waste. Almost all the states have biomass potential which in general is largely untapped. The central as well as state governments promote the biomass power through the investor friendly policies such as Renewable Purchase Obligations (RPO), benchmark tariff, tax exemptions, accelerated depreciation etc. Still barriers exists which leads to large untapped biomass resources.

At local level, the benefit is that the biomass power plants are labour intensive industries with the ability to provide significant level of local level employment. A 10 MW biomass power project can create approximately employment for 100 workers during the 18-month construction phase, 25 full-time workers employed in the operation of the facility, and 35 persons in the collection, processing, and transportation of biomass material (Ministry of New and Renewable Energy, as on January 2016).

III. POTENTIAL AND INSTALLED CAPACITIES OF BIOMASS POWER GENERATION

The Installed capacities of Grid Interactive Biomass Power plant in India, in the past five years are presented in Table 1. Form Table 1, it may be noted that the total installed capacity of grid interactive biomass power has increased by about 50% in the year 2014, when compared to the year 2010. Yet, 77% of the biomass power potential still remains untapped. Table clearly indicates that the share of biomass power in the total grid interactive renewable power is declining across the years 2010- 2014 indicating the increasing share of other renewable energy sources compared to biomass power.

TABLE 1
POTENTIAL AND INSTALLED CAPACITY OF GRID INTERACTIVE BIOMASS POWER IN INDIA

Details	**Year wise Installed Grid Interactive Biomass Power**					**Total Biomass power potential (MW)**
Year	2014	2013	2012	2011	2010	
MW	4013.55	3601.03	3135.33	2199.63	2664.63	17538
% of total Grid Interactive Renewable Power	12.66	12.83	12.58	13.08	13.34	11.88

[Source: (Ministry of Statistics and Programme Implementation, 2011) (Ministry of Statistics and programme Implementation, 2012) (Ministry of Statistics and Programme Implementation, 2013) (Census of India, 2011) (Ministry of Statistics and Programme Implementation, 2014) (Ministry of Statistics and Programme Implementation, 2015)]

In India, implementation of Renewable Energy (RE) projects including the policies and regulations for Renewable Energy are realized through states and primarily by the state nodal agencies for renewable energy development at state level. Table 2 provides the potential and grid interactive capacities of biomass power at state level. The leading state for biomass power projects are Chhattisgarh, Uttar Pradesh, Maharashtra, Andhra Pradesh and Tamil Nadu and the states which have taken position of leadership of baggase cogeneration[1] projects are Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Uttar Pradesh (Kumar, Kumar, Baredar, & Shukla, 2015). Only seven states are able to utilize 15% or more of the biomass power potential to convert into grid interactive biomass power while 13 states are almost unable to utilize the existing biomass power potential. However, Biomass power has a major share (above 25%) in the total grid interactive renewable power in eight states; Chhattisgarh, Andhra Pradesh, Bihar, Haryana, Punjab, Uttar Pradesh, Uttarakhand and West Bengal. Among these eight states, six[2] states still possess more than 50% of the untapped biomass power potential. Thus, the biomass potential is largely unutilized even in the states where biomass power plays a predominance role in the grid interactive renewable power mix.

[1] In baggase cogeneration waste of sugar mills known as baggase (The dry pulpy residue left after the extraction of juice from sugar cane) is used as fuel for electrical energy generators by gasification technology.

[2] Bihar, Haryana, Punjab, Uttar Pradesh, Uttarakhand and west Bengal

TABLE 2
POTENTIAL OF BIOMASS POWER AND INSTALLED CAPACITY OF GRID INTERACTIVE BIOMASS POWER IN INDIA

Potential of Biomass Power and Installed Capacity of Grid Interactive Biomass Power in India (MW)					
	Biomass power				
States/UTs	Biomass Power Potential (MW)	Installed Grid Interactive Biomass Power (MW) 2014	Utilization % of biomass power potential	Untapped potential percentage	% of Biomass power in total Grid Interactive Renewable Power
Andhra Pradesh	578	381	66%	34%	25%
Arunachal Pradesh	8		0%	100%	0%
Assam	212		0%	100%	0%
Bihar	619	43	7%	93%	38%
Chhattisgarh	236	236	100%	0%	76%
Goa	26		0%	100%	0%
Gujarat	1221	31	2%	98%	1%
Haryana	1333	45	3%	97%	36%
Himachal Pradesh	142		0%	100%	0%
Jammu & Kashmir	43		0%	100%	0%
Jharkhand	90		0%	100%	0%
Karnataka	1131	391	35%	65%	10%
Kerala	1044		0%	100%	0%
Madhya Pradesh	1364	16	1%	99%	2%
Maharashtra	1887	757	40%	60%	14%
Manipur	13		0%	100%	0%
Meghalaya	11		0%	100%	0%
Mizoram	1		0%	100%	0%
Nagaland	10		0%	100%	0%
Orissa	246	20	8%	92%	17%
Punjab	3172	125	4%	96%	43%
Rajasthan	1039	91	9%	91%	3%
Sikkim	2		0%	100%	0%
Tamil Nadu	1070	539	50%	50%	7%
Tripura	3		0%	100%	0%
Uttar Pradesh	1617	777	48%	52%	97%
Uttarakhand	24	10	42%	58%	66%
West Bengal	396	26	7%	93%	79%

IV. BIOMASS POWER TECHNOLOGY IN BRIEF

Biomass is a carbon neutral fuel and it does not contribute to Green House gas (GHG). Hence biomass power can be used to protect the earth from climate change and natural disaster. Biomass resources include agricultural residues; wood wastes from forestry and industry; residues from food and paper industries; municipal green wastes; sewage sludge; dedicated energy crops such as short-rotation (3-15 years) coppice (eucalyptus, poplar, willow), grasses (Miscanthus), sugar crops (sugar cane, beet, sorghum), starch crops (corn, wheat) and oil crops (soy, sunflower, oilseed rape, jatropha, palm oil) (International Energy Association, as on January 2016). Organic wastes and residues have been the major biomass sources so far, but energy crops are gaining importance and market share. Biomass power plants have lower NO_x and sulfur emission when compared to conventional coal fired power plants.

A biomass gasifier based power project consists of biomass preparation unit, biomass gasifier, gas cooling and cleaning system, internal combustion engine suitable for operation either in DF (dual fuel) mode with diesel as pilot fuel and producer gas as main fuel, electric generator and electricity distribution system (Nouni, Mullick, & Kandpal, 2007). The thermo chemical processes for conversion of biomass to useful products involve combustion, gasification or pyrolysis with the most commonly used route being combustion (Ministry of New and Renewable Energy, as on January 2016). In case of biomass power plants, the capital cost of installation are Rs.4.5 to 5.0 Crore/MW, depending upon boiler pressure and capacity, costs of generation around Rs. 3.50 to Rs. 4.00/kwh (Ministry of New and Renewable Energy, as on December 2015). The Plant Load factor (PLF) of biomass power projects is about 70% - 75%.

In India, cogeneration by using bagasse as a fuel is practiced in sugar industry. With the advancement in the technology for generation and utilization of steam at high temperature and pressure, sugar industry can produce electricity and steam for their own requirements which can also produce significant surplus electricity for sale to the grid using same quantity of bagasse (Ministry of New and Renewable Energy, as on January 2016). The capital cost of installation of bagasse based co-generation projects is in the range of Rs. 4.5 to Rs. 5.0 Crore/MW depending upon technical, financial and operating parameters. Costs of generation are expected to vary from Rs. 3.25 to 3.75/kwh, depending upon the plant load factor, and interest on term loans. (Ministry of New and Renewable Energy, as on December 2015). The PLF of bagasse cogeneration projects is about 45% - 55%.

Central Electricity Regulatory Commission in its Tariff Order dated 3.3.2015 had considered the CAPEX for independent Biomass Projects as Rs.610.437 lakhs per MW (Central Regulatory Electricity Commission, as on January 2016). The CAPEX component increase in the Bagasse based cogeneration power plants when compared to Biomass Power Plants due to changes needs to in Sugar plant suit steam and power supply from cogeneration power plant, like change in steam driven motors to electrical driven motors (Central Regulatory Electricity Commission, as on January 2016). New technologies are emerging that show significant potential for further cost reduction (International Renewable Energy Agency, 2015).

V. MATERIALS AND METHODS

The primary objective of the paper is to identify the factors that influence the biomass power industry through the lens of an entrepreneur investing and operating in biomass power industry. Through the identified factors, the later part of the paper tries to identify the barriers and challenges faced by the entrepreneurs in sustaining and augmenting biomass based power generation. The objectives of the paper are reached through four key steps;

5.1 Review of secondary literature: Published reports of the studies conducted by the government institutions, consultancy units, academic institutions and related international agencies are reviewed along with the published papers in peer reviewed journals to understand the overall scenario and factors impacting biomass power generation in India. The key factors, identified through the literature are collated to build up the overall scenario.

5.2 Interviews with the biomass power entrepreneurs: A format for semi structured interviews was developed for the biomass power entrepreneurs. Biomass power entrepreneurs from two states, Tamil Nadu and Haryana, were interviewed. The rationale behind identifying the states is that Tamil Nadu is able to harness about 50% of its biomass power potential while Haryana has harnessed only 3% of the biomass power potential in spite of being the share of biomass power as 36% in the total grid interactive renewable power.

5.3 Expert's interview: Industry expert with about 30 years of experience has been interviewed to understand the broader view of influencing factors and challenges. One of the author also possess more than 30 years of national and international experience in the field of biomass power.

5.4 State level analysis: Major indicators are identified based on the literature and interviews. Relationship of the identified indicators with the biomass power capacities are analyzed to interpret the influencing factors identified through the interviews and literature review.

VI. FACTORS INFLUENCING ENTREPRENEURSHIP IN BIOMASS POWER GENERATION

The views of the entrepreneurs and experts on the influencing factors on biomass entrepreneurship are presented in this section. About 8 entrepreneurs and two experts engaged in biomass power are interviewed to understand the influencing factors, drivers and barriers in biomass power generation entrepreneurship.

6.1 Factors Influencing Scope of Investments in Biomass Power

6.1.1 Providing clean and reliable power to industries

In almost all the cases, the motivation behind investing and operating biomass power plants is to provide clean and reliable power to the industries. In general, the biomass power plants are associated with the industries to provide power to the industries either for captive use or for providing electric energy to the industries through wheeling of power. The surplus electricity generated is transmitted to the state electricity transmission and distribution companies through long term power purchase agreements based on the tariff fixed by the states. Unlike wind and solar, majority of the power produced through biomass is sold or used in industries rather than supplying to the state transmission and distribution companies.

6.1.2 Returns to investments

The most important deciding and sustaining criteria is the returns to the investments. The factors that influence the most is the fuel cost, tariff decided by states, state level policies on open access or third party sale and the tariffs agreed in case of third party sale / open access. Financial benefits such as tax exceptions enhances on the savings.

6.1.3 Profit based on the power tariff for Industries

In the biomass power plants linked to the industries, one of the motivation factors is to save on the power tariff for industries. The power tariff for industries in India ranges between INR 2.57 and 7.72 (Indiastats.com, as on December 2015). The states with higher power tariff for industries may like to save on electricity expenditure in case the power produced through biomass is cheaper. The cost of power generation through biomass largely depends on the availability and cost of the fuel stock supply in the proposed site.

6.1.4 Renewable purchase obligations3 (RPO) and high targets

In recent years, the central as well as state governments are revising the targets of RPOs. The increasing targets of non-solar RPOs are one of the motivating aspects for investing in biomass power. As per budget 2015, India targets massive renewable power production target of 1,75,000 MW by 2022 out of which share of biomass power will be 10000 MW (articles.economictimes.indiatimes.com). However, the major share of the target is to be achieved through solar (100000 MW) and wind (60000 MW).

6.2 Major Barriers in Biomass Power

6.2.1 Increasing fuel cost

One of the major barriers indicated is the rising prices of biomass for power generation. Biomass prices, in particular the agro residue, show variability with season and cropping pattern. Also, loose biomass is normally procured form the surrounding region within radius of 50-80km due to low bulk density and hence higher transportation cost per ton (Deloitte Touche Tohmatsu India Private Limited, 2009). High density wood biomass is procured from 50-150 km radius and sometimes even as high as 200-300 km. The one of the reasons identified is the competing use of biomass in small industries (Deloitte Touche Tohmatsu India Private Limited, 2009). A range of biomass power generation technologies are mature and biomass is a competitive power generation option wherever low-cost agricultural or forestry waste is available (International Renewable Energy Agency, 2015).

6.2.2 Supply of fuel stock

Supply fuel collection in majority of the cases in the biomass power plants is largely unorganized. The major barrier indicated by the biomass power entrepreneurs is the fuel supply particularly during the summer months.

6.2.3 Low tariff rates

The prices for biomass fuel are increasing as well as the transportation cost of the fuels are also increasing. However, the feed in tariffs are not revised as frequently as the prices of the biomass inputs are increasing. The decreasing gap between the biomass input prices and the tariffs leads to economic viability of the biomass power plants. In the year 2009, many biomass power plants in Tamil Nadu closed down their operations due to non-viability with increased fuel prices and started operation after getting assurance of revision in tariffs (Deloitte Touche Tohmatsu India Private Limited, 2009).

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[3]Renewable Purchase Obligation (RPO) is a requirement for an electricity purchaser (e.g., a Discom or an open access [OA] consumer) to procure a certain percentage of electricity from a specific source (e.g., RE) and recover the cost of that purchase through its regular ratemaking process.

VII. MACRO LEVEL ANALYSIS OF THE FACTORS INFLUENCING ENTREPRENEURSHIP IN BIOMASS POWER

Based on the interviews and literature survey, seven factors are evident that influence grid interactive biomass power industry. If viewed through the eyes of entrepreneurs engaged in investment and operation of biomass power, the seven influencing factors are;

i. Availability of biomass fuel
ii. Cost of biomass fuel
iii. Feed in tariff for biomass power
iv. Industries – the potential buyers/users of biomass power
v. Existing status of power generation capacity of the regions
vi. Power tariff for industries
vii. Capital cost

The section, explores the relationship of the identified indicators with the installed capacities of the grid interactive renewable power using the state level data. Secondary data for the selective indicators for 28 states are collated and analyzed. One of the limitations of the paper is that the cost of biomass input is not considered in this section as the cost is highly variable across seasons and states, and a wide range of fuel is used for the biomass power. To arrive at an average cost for biomass fuel stock input for biomass power generation for all the 28 states would require a primary survey which is beyond the scope of the paper. Again, very little variation is observed across states in case of benchmark capital cost identified by the states. Thus, the macro level analysis eliminates the capital cost as well.

7.1 Availability of biomass input

The indicator used to estimate the availability of biomass input is the biomass potential. The correlation of 0.304 indicates that the potential of biomass or availability of biomass inputs is not utilized to the extent in all states. Maharashtra and Uttar Pradesh provide for the most ideal scenario wherein the high biomass potential is translated into high installed grid interactive biomass power. Still, in Maharashtra 60% of the biomass potential and in Uttar Pradesh about 52% of the biomass potential is untapped. In Uttar Pradesh, biomass plays a predominance role in the total grid interactive renewable power (97% is biomass power in the total installed grid interactive renewable power). The corresponding figure is 14% in case of Maharashtra indicating a good focus towards other renewable energy sources as well in the state. Low R squared value indicates low variability of the response data around its mean. There is huge scope left for the biomass potential states to promote biomass power. The profile of the installed capacity of grid interactive power plants and biomass potentials is shown in Figure 2.

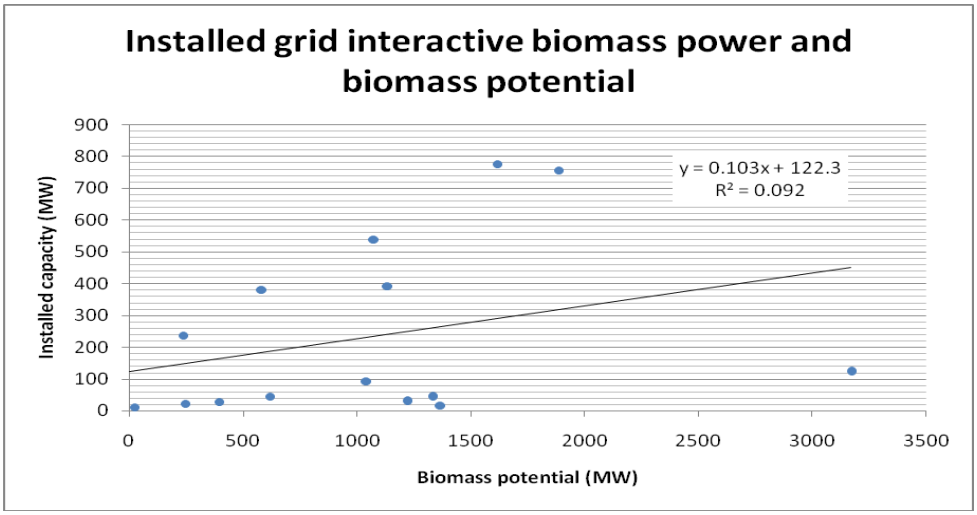

FIGURE 2 RELATIONSHIP BETWEEN THE INSTALLED GRID INTERACTIVE BIOMASS POWER AND THE BIOMASS POWER POTENTIAL

[Source: (Ministry of Statistics and Programme Implementation, 2015)]

7.2 Feed in tariff for biomass power

At present scenario, the installed grid interactive biomass is not responding to the Feed in tariff for biomass power. There are six states with high biomass power tariff (ranging between INR 6.39 and 4.49) but with low installed capacities (16 MW to 125 MW). Among these six states, Madhya Pradesh, Punjab and Haryana are agriculture intensive states while five among the six states has high biomass power potential. It is indicative that the states with high biomass potential and high tariff are not able to translate the potential into installed grid interactive biomass power capacities. The relation between the installed capacities of biomass grid interactive biomass power generation related to variation in tariff is shown in Figure 3.

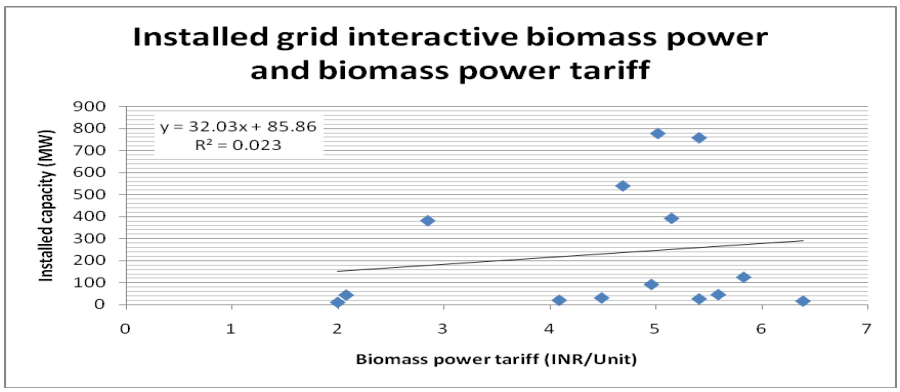

FIGURE 3 RELATIONSHIP BETWEEN THE INSTALLED GRID INTERACTIVE BIOMASS POWER AND THE BIOMASS POWER TARIFF

[Source: (Ministry of Statistics and Programme Implementation, 2015) Websites of state nodal agencies in renewable energy, (Indian Renewable Energy Development Agency Ltd, Ministry of New and Renewable Energy, 2015)]

7.3 Industries – the potential buyers for biomass power

The indicator used for the analysis is Net State Domestic Product (NSDP[3]). The indicator is the assessment of goods produced within the state's boundary. The figure is indicative of the strong and positive relationship between the installed grid interactive biomass power and the level of industrialization in the state. The states with high NSDP are more likely to have high installed capacities of grid interactive biomass power. The three states with high NSDP and Installed capacity also possess above average feed in tariff for biomass power. Thus, the states can promote the industries to install biomass power wherein biomass power potential is largely unutilized. The installed capacity of grid interactive biomass power plant with respect to the domestic product factor cost is shown in Figure 4.

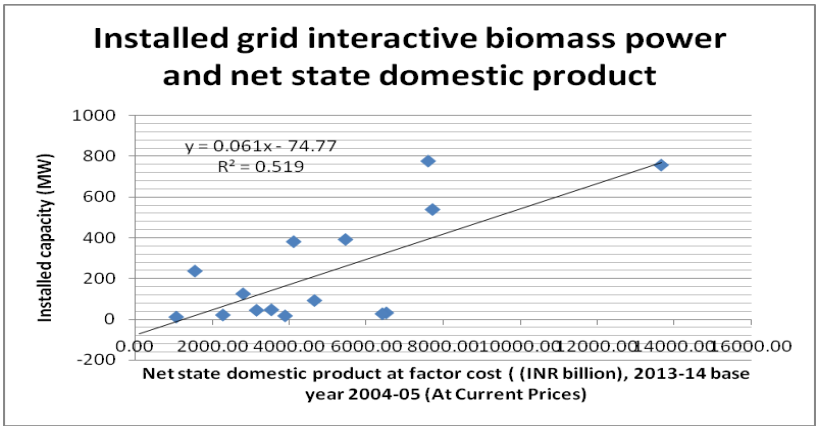

FIGURE 4 RELATIONSHIP BETWEEN THE INSTALLED GRID INTERACTIVE BIOMASS POWER AND THE NET STATE DOMESTIC PRODUCT

[Source: (Reserve Bank of India, as on January 2016) (Ministry of Statistics and Programme Implementation, 2015)]

[4] NSDP represents the net book value of all goods and services produced within a state's geographic borders over a specified period of time.

7.4 Power Tariff for Industries

The power tariff for industries, at present has positive and towards strong association with the installed biomass power. The two states, Bihar and West Bengal, possess high power tariff for industries (6.71 and 6.50 INR/kWh respectively). Both the states have low biomass power potential (619 and 396 MW respectively). The state of Gujarat has high biomass power potential of 1221 MW with high power tariff for industries (INR 6.08 INR/kWh), yet the state has low capacities of installed biomass power. The reasons are to be studied in detailed which are beyond the scope of this paper. The installed capacity of grid interactive biomass power plant with respect to the power tariff for industries is shown in Figure 5.

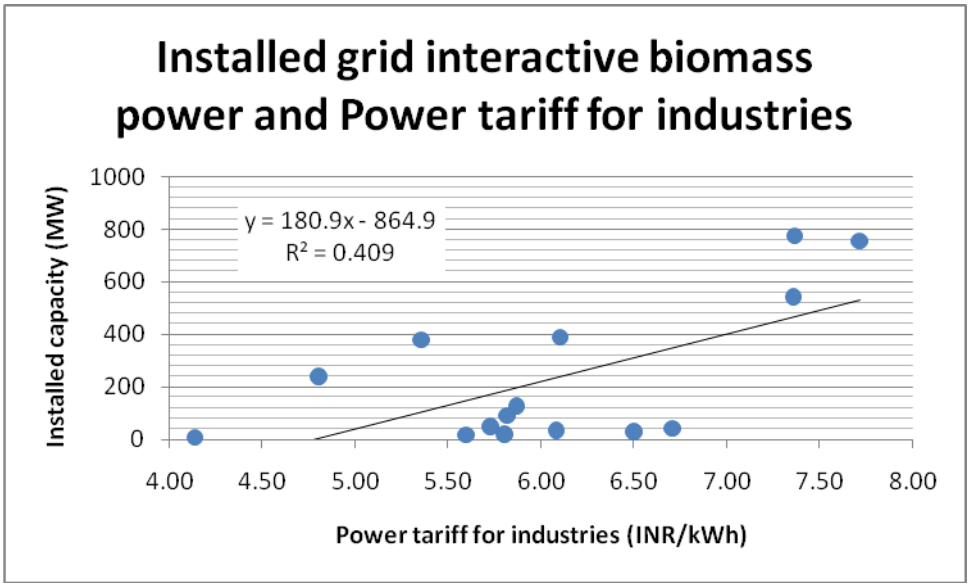

FIGURE 5 RELATIONSHIP BETWEEN THE INSTALLED GRID INTERACTIVE BIOMASS POWER AND POWER TARIFF FOR INDUSTRIES

[Source: (Ministry of Statistics and Programme Implementation, 2015) (Indiastats.com, as on December 2015)]

7.5 Power generation capacity of regional sectors

Power generation capacity of the regional sector is an important factor in promotion of the grid interactive biomass power plants. The existing power generation capacity is directly proportional to the grid compatibility and other infrastructure required for grid connected power plants. Grid existence and its compatibility promote the biomass power entrepreneurship. Infrastructure development demands additional investment for installation of grid interactive biomass power plants. Hence, the regions have high generation capacity and increased grid facility provides increased scope for grid interactive biomass power plants. The power generation capacity of different region is presented in table 3. The percentage of installed capacity of grid interactive biomass power plant with respect to the percentage of power generation capacity of the regional sectors is shown in Figure 6. The profile shows a strong correlation of existing power generation capacity and grid compatibility to the installed capacity of grid interactive power generation.

TABLE 3
REGION WISE POWER INSTALLED ELECTRICITY GENERATION CAPACITIES

Details	**Power generation capacity of different regions**				
Region	**North**	**East**	**West**	**South**	**North east**
Capacity in %	**26.3**	**12.3**	**36.2**	**24.0**	**1.2**

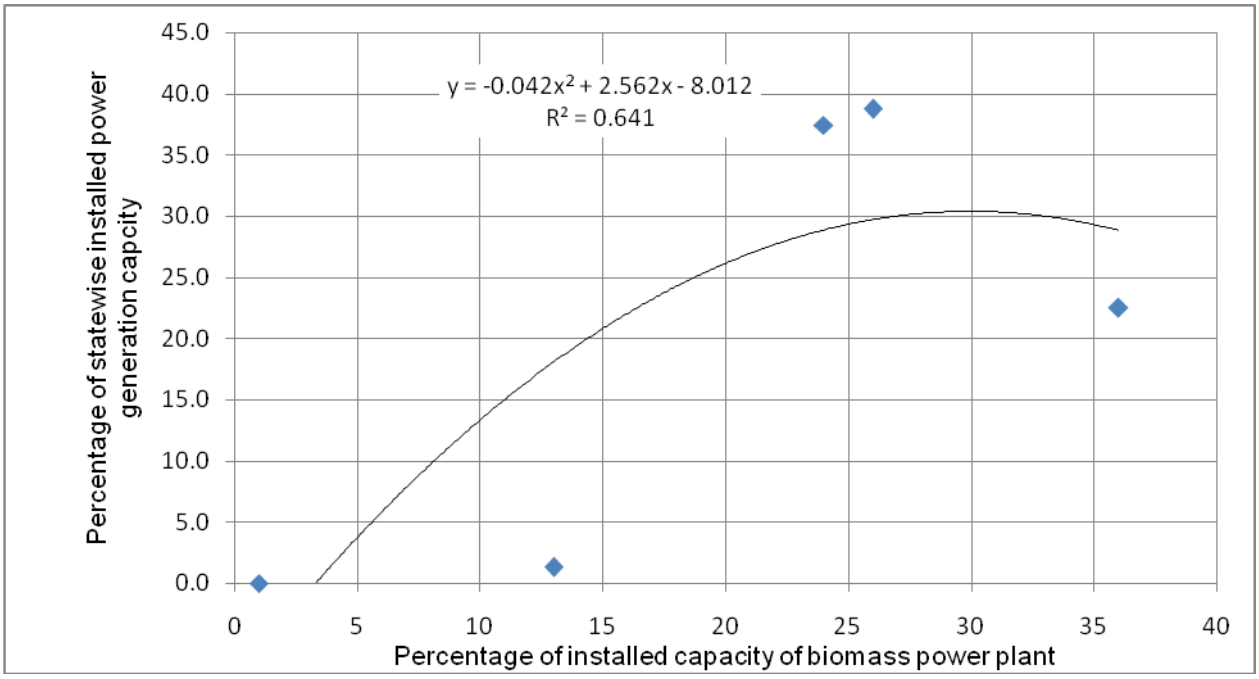

FIGURE 6: RELATIONSHIP BETWEEN THE % OF INSTALLED ELECTRICITY GENERATING CAPACITY OF THE REGIONS (WITH BASE AS TOTAL INSTALLED CAPACITY) AND THE % OF INSTALLED GRID INTERACTIVE BIOMASS POWER TO THE % OF INSTALLED ELECTRICITY GENERATING CAPACITY OF THE REGIONS

[Source: (Ministry of Statistics and Programme Implementation, 2015)]

VIII. CONCLUSION AND WAY FORWARD

The biomass power is a clean and reliable source of electricity and is an emerging industry which is able to provide power to the industries as well as to the grids for further transmission. The biomass power plants also contributes to the economic development at local level as it is a labour based industry and the fuel input is purchased locally in most of the cases. The fuels used are agricultural residues, fodders, woods and energy plantations. Presently, the biomass power plants in general are owned and operated by private sector. The technology of biomass power generation is mature with the scope for further improvements to bring down the capital and power generation cost. Unlike other renewable power sources such as wind and solar, the biomass power does not face the issue of variability. However, biomass power is also the only renewable power source that incurs continuous input cost. The country has huge biomass potential yet 80% of the biomass power potential is still untapped.

The paper analyses the factors influencing biomass power based on the first hand information collated through expert's interview and the sector representatives along with review of published reports and papers. Presently, biomass power plants are installed for providing power to the industries either as captive power or through wheeling.

States are primarily responsible for the policies and implementation of the biomass power plant projects though the central level policies such as subsidy for capital cost and tax exemption also influence the returns and savings in biomass power generation. However, the large variation existing among the state level policy needs to be narrowed down. One among the motivating factors is the return to investment which is determined by the biomass tariff as well as tariff determined for third party sale or open access. However, the revisions in tariff are not as frequent as the increase in the biomass input. The tariff in case of biomass power needs a detailed and frequent revision based on prevailing biomass cost and other variable costs (including man power, water, spare parts and maintenance). Biomass power has significant operating expenses unlike wind and solar apart from initial capital investment and more so of input fuel cost which becomes many times even higher than 2/3rd of total cost of generation. Andhra Pradesh was first to introduce two-part tariff (fixed and variable component). Many power plant promoters still feel though two part tariff is welcome step with inclusion of variable component for operating cost still the tariff is not rational and very attractive for attracting private investment and some feel even managing existing power plant is difficult with prevailing tariff due to very thin margin against wide fluctuating operating expenses (Deloitte

Touche Tohmatsu India Private Limited, 2009). A scope for detailed implication of two part tariff may be explored for the other states as well.

The installed capacities of biomass power responds strongly to the level of industrialization and power tariff for industries but not to the feed in tariff. Presently, the biomass power is primarily encouraged to provide power to industries. There are states with high biomass power potential as well as high biomass power tariff but with low installed grid interactive biomass power. These three states have average level of NSDP and power tariff for industries when compared to average for all states. Thus, only deciding sufficient tariffs are not sufficient but promotion of biomass power for industries is also important in the biomass potential states.

Similar to the policy aspect on tariff, the supply aspect of biomass input for biomass power plant is to be considered. Biomass-generated electricity can be very competitive where low-cost fuel stocks are available onsite at industrial, forestry or agricultural processing plants. In such cases, biomass power generation projects can produce electricity for as low as INR 2.04/kWh in developing countries (International Renewable Energy Agency, 2015). It is important to identify such industries and sites where biomass feedstock is available at cheap prices for development of biomass power.

In addition to the existing policies on power purchase and financial issues, emphasis should be given for policies, which include research and development to enhance the techno-economic viability. Biomass power policy must have dedicated clauses (related to tariff and wheeling, finance etc.) for large scale replication as in case of Solar and wind power generators.

India has huge potential of biomass power to supply reliable and clean power to the industries and grid. In spite of the huge potential and other benefits of being labour intensive industry, the biomass power industry is not taking up as it should. The paper identifies frequent revisions in biomass tariff along with measures to promote biomass power for the industries initially in the biomass potential states. The biomass power industry has the potential to generate revenue along with power provided the issues linked to tariff and fuel stock are addressed.

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