CENTRAL ELECTRICITY REGULATORY COMMISSION

NEW DELHI

Explanatory Memorandum for the "Draft Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) (First Amendment) Regulations, 2013"

Explanatory Memorandum

1. BACKGROUND

1.1. The Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012, (hereinafter referred to as "the RE Tariff Regulations-2012") provide for terms and conditions and the procedure for determination of tariff of the following for various renewable energy technologies inter-alia biomass based rankine cycle power plants. The various technical norms specified in the RE Tariff Regulations-2012 for biomass based rankine cycle power plant with water cooled condenser, are as under:

i. Station Heat Rate (SHR): 4000 kCal/kWh

ii. Gross Calorific value (GCV): 3300 kCal/kg

iii. O&M expenses: (5.72% annual escalation)

Rs. 24 Lakh/MW for FY 2012-13

Rs. 25.37 Lakh/MW for FY 2013-14

iv. Auxiliary Consumption: 10% (with water cooled condenser)

v. Capital Cost (excluding evacuation cost and cost of water cooled condenser considered):

FY 2012-13: Rs. 445 Lakh/MW

FY 2013-14: Rs. 463.336 Lakh/MW

vi. Biomass Price : Rs./ tonne

State Biomass Price	FY 2012-13
Andhra	2315
Haryana	2635
Maharashtra	2695
Punjab	2756
Rajasthan	2300
Tamil Nadu	2277
Uttar Pradesh	2355
Other States	2476

1.2. In accordance with the Regulation 8 of the RE Tariff Regulations- 2012, the Commission issued an Order on determination of generic levellised generation tariff for the above mentioned categories of RE generating stations. (Petition No. 35/2012 (suo-motu) dated 27th march, 2012.While dealing with the comments received from the various stakeholders regarding biomass sector, in the above referred Order the Commission observed as under:

"Based on the suggestions received from the projects developers, Industry associations representing the biomass sector and Ministry of New and Renewable Energy (MNRE), the Commission has decided to constitute a Committee which will visit existing plants and conduct a detailed study on the performance/viability of such plants operating in the country including the prevailing biomass prices."

1.3. Accordingly, the CERC constituted a Committee on 11th October, 2012 under the Chairmanship of the Secretary, CERC to undertake a detailed Study on the "Performance/Viability of Biomass based plants operating in the Country including the prevailing biomass prices". The Committee comprised of the following members:

i. Mr. Rajiv Bansal, Secretary, CERC — Chairman
ii. Dr. D.K. Khare, Director, MNRE — Member
iii. Mr. S.C. Shrivastav, Joint Chief (Engg.), CERC — Member
iv. Mr. P.K. Awasthi, Joint Chief (Finance), CERC — Member
v. Mr. S.K.Chatterjee, Dy. Chief (Reg. Aff.),CERC — Member
vi. Mr. S.K. Kassi, Director (TE &TD) Division, CEA — Member
vii. Mr. P. Krshnakumar Indian Biomass Power Association — Member
viii. Mr. Rakesh.H.Shah Advisor (Renewable), CERC — Member-Convener

1.4. The scope of work of the Committee was as under:

i. Assessment and evaluation of technical parameters like: Heat rate, Auxiliary Consumption, through performance assessment biomass plants commissioned in various states of India;
ii. Fuel analysis (both Proximate and ultimate analysis) of different biomass fuel by taking fuel and ash sample collected from different plants to arrive at representative value of GCV and moisture variation for different fuel;
iii. Analysis of losses in calorific value of fuel during storage;

iv. Evaluation of trend in the biomass power plant operation like break-up of fuel consumption (biomass types usage trends), generation v/s specific fuel consumption, PLF v/s Auxiliary Consumption;

v. Analysis of O &M expenses of the commissioned plants;

vi. Analysis of the Capital cost of the commissioned plants;

vii. Surplus biomass available for energy production;

viii. Study on prevailing Biomass prices and price trend in various states;

ix. Measures for viability of biomass plants.

x. Recommendation for removing the present hurdles coming in the sector for promoting the growth of the Biomass sector.

1.5. The Committee deliberated and collected information and data from different stake holders and also visited sites of power developers to understand the issues at stake in different operation of the biomass based power plants.

1.6. After detailed examination, the Committee felt that the challenges being faced by the biomass plants primarily stem out of fuel related issues, viz.:- lack of availability of surplus biomass, poor quality of biomass fuel, inadequate fuel collection, distribution & supply mechanism, competitive buyers of biomass and price rise, resulting into usage of waste biomass and lower plant load factor. After extensive deliberations, the Committee finalized its report and submitted to the Commission on 16th July, 2013, which is enclosed as Annexure-I.

1.7. The Committee recommended following normative parameters suggested by the Committee for the consideration of the Commission for determination of generic tariff:

i. Station Heat Rate (SHR):

   a. 4200 KCal/kWh for station using travelling grate boilers; and

   b. 4125 kCal/kWh for stations using AFBC boilers

ii. Gross Calorific Value (GCV): 3100 kCal/kg

iii. O&M expenses: Rs. 40 Lakh/MW

iv. Auxiliary Consumption:

   a. 10% with water cooled condenser, and

   b. 12 % for air cooled condenser

v. Capital Cost (excluding evacuation cost and cost of water cooled condenser considered):

a. For project with water cooled condenser: Rs. 540 Lakh/MW

b. For project with air cooled condenser: Rs. 580 lakh /MW

c. For rice straw based project: Rs. 630 lakh/ MW

vi. Biomass Price: to be decided annually by a committee to be formed at State level representing State Commission, Nodal Agency, Government

2. A Copy of Report of the Committee is enclosed as **Annexure-I.** Based on the recommendation of the Committee, the Commission has proposed amendments to RE Tariff Regulations-2012, on the basis of recommendations of the Committee as mentioned in Para 1.7 above and has invited comments / suggestions/objections from the stakeholders.

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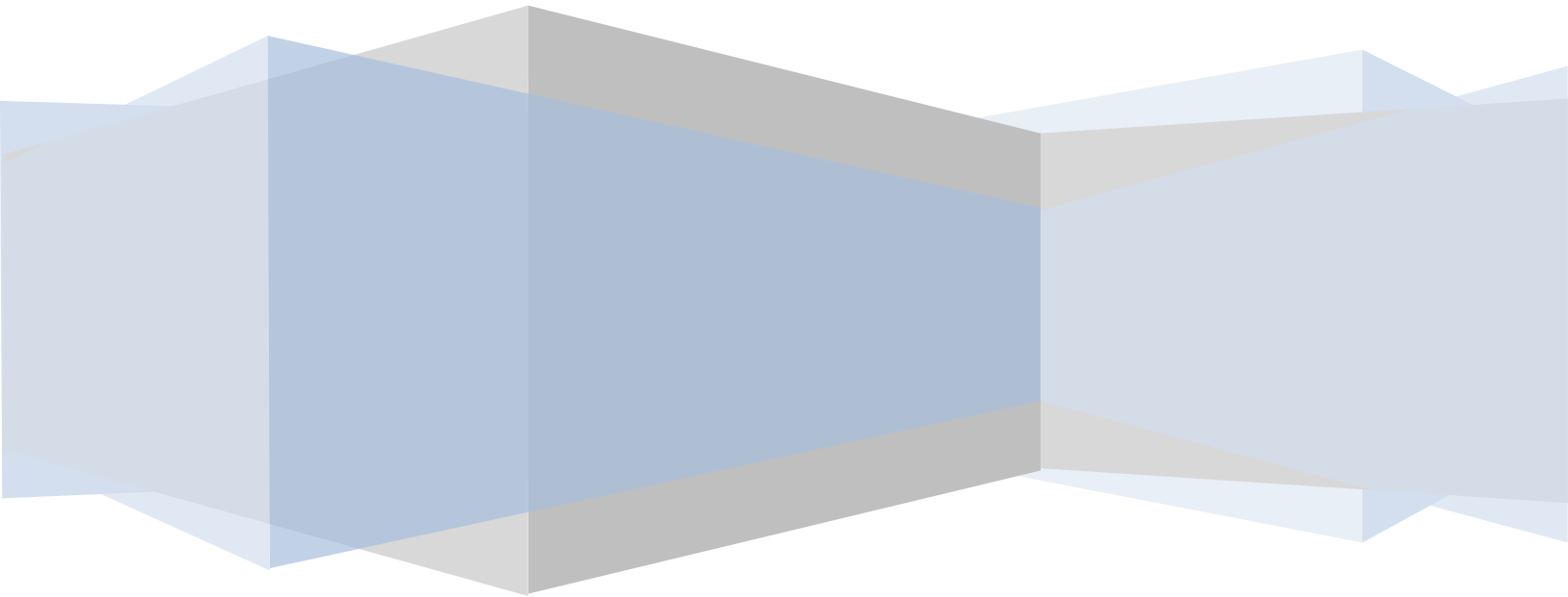
Central Electricity Regulatory Commission

Report of Committee constituted to undertake a detailed Study on the "Performance/Viability of Biomass based plants operating in the Country including the prevailing biomass prices

July, 2013



The Committee to undertake a detailed Study on the "Performance/Viability of Biomass based plants operating in the Country including the prevailing biomass prices" presents its report to the Commission

Sd/-

Mr. Rajiv Bansal, Secretary, CERC

Chairman

Sd/-

Dr. D.K. Khare, Director, MNRE

Member

Sd/-

Mr. S.C. Shrivastav, Joint Chief (Engg.), CERC

Member

Sd/-

Mr. P.K. Awasthi, Joint Chief (Finance), CERC

Member

Sd/-

Mr. S.K.Chatterjee, Dy. Chief (Reg. Aff.), CERC

Member

Sd/-

Mr. S.K. Kassi, Director (TE &TD) Division, CEA

Member

Sd/-

Mr. P. Krishna Kumar, Indian Biomass Power Association

Member

Sd/-

Mr. Rakesh Shah Advisor (Renewable), CERC

Member-Convener

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State Biomass Price	FY 2012-13	FY 2013-14
Andhra	2315	2480.55
Haryana	2635	2823.44
Maharashtra	2695	2887.73
Punjab	2756	2953.09
Rajasthan	2300	2464.48
Tamil Nadu	2277	2439.83
Uttar Pradesh	2355	2523.41
Other States	2476	2635.07

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vii.	Mr. P. Krshnakumar Indian Bio.s Power Association	Member
viii.	Mr. Rakesh.H.Shah Advisor (Renewable), CERC	Member-Convener

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vi. Analysis of the Capital cost of the commissioned plants;
vii. Surplus biomass available for energy production;
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ix. Measures for viability of biomass plants.
x. Recommendation for removing the present hurdles coming in the sector for promoting the growth of the Biomass sector.

The first meeting of the Committee was held on 25th October, 2012. A record of decision taken and list of participants are annexed as Annexure II

1.5. As discussed in the first meeting the Indian Biomass Association vide its letter dated 12.11.2012 submitted following details sought by the Committee:

i. Actual annual performance data of 3 years (2009-10 to 2011-12) some of biomass based power plants and details of operation and maintenance costs;
ii. Plant characteristics with technical details;

iii. Operational details of biomass plants submitted to UNFCCC for parameters reference to generation, average GCV of fuel and Station Heat Rate;

iv. Balance sheet of 2010-11 & 2011-12 one of the plant operating in Rajasthan and one plant in Tamil Nadu.

1.6. The Indian Biomass Association suggested following norms for consideration of the Committee:

i. SHR: 4631 kCal/kWh as against normative SHR specified at 4000 kCal/kWh;

ii. GCV: 2665 kCal/kg as against normative GCV specified at 3300 kCal/kg;

iii. O&M expenses: Rs. 61 Lakhs/MW as against norm of 24 Lakh/MW.

1.7. Subsequently, it was decided to constitute a sub-Committee to examine the technical/operational parameters like: SHR, GCV, Auxiliary Consumption and incidental matters based on the data available from the biomass associations or by visiting some biomass plants. The sub-Committee comprised of the following persons:

i. Dr. D.K.Khare, Director, MNRE

ii. Sh. S.C.Shrivastava, Joint Chief (Engg.), CERC

iii. Sh. Chandra Prakash, Deputy Chief (Engg.), CERC

iv. Sh. Rakesh Shah, Advisor (Renewable), CERC

1.8. In this connection, apart from considering the details given by the Indian Biomass Power Association, field visits of biomass power plants in various states of the country were undertaken by the sub-Committee for reviewing the performance of the plants. The facilities visited for the review are as under:

i. Biomass power plant at Rangpur, Kota District, Rajasthan (7.5 MW) operated by M/s Surya chambal Power Limited.
ii. Biomass power plant at Bhaguara, Patiala District, Punjab (12 MW) operated by M/s Punjab Biomass Private Limited.
iii. Biomass power plant at Pebair, District, Andhra Pradesh (6.0 MW) operated by M/s Surya Teja Power Project Limited.
iv. Biomass power plant at Ahmedabad District, Gujarat (4.5 MW) operated by M/s Abellon Clean Energy Limited.

1.9. During the visits basic operations of the facilities were observed. The plant officials were very co-operative during the visit to the facilities and shared their experiences and views regarding operation of plants, fuel availability, fuel quality and fuel processing etc. However, the veracity of data and measurement of quantity of fuel, its quality etc. could not be ascertained, as such measurement was not done on scientific basis nor its a regular practice.

1.10. Subsequently, a second meeting of the Committee was held on 9th July, 2013. A record of decision taken and list of participants are annexed as Annexure III.

1.11. Findings on each parameter as suggested above are consolidated in subsequent sections.

2. ASSESSMENT AND EVALUATION OF TECHNICAL PARAMETERS:

2.1. STATION HEAT RATE

2.1.1. Station Heat Rate (SHR) is an important factor to assess the efficiency of a biomass based power station. Efficiency is a function of Station Heat Rate and it is inversely proportional to SHR. If SHR reduces, efficiency increases, resulting in fuel saving. In the RE Tariff Regulations-2012, the Commission specified SHR of 4000 kCal/kWh. The statement of object and reasons of 2012 Regulations recorded as under:

> *"The Commission is of the view that with biomass power generation projects based on Rankine cycle technologies, essentially two types of boilers are being used, viz. travelling grate combustors (stokers) or atmospheric fluidised bed boilers. However, while fluidised boilers offer higher efficiency as compared to travelling grate, there are limitations in use of fluidised bed boilers due to fuel quality and fuel size requirements.*
>
> *On the other hand, travelling grate type boilers offer flexibility as it can handle variety of type/quality of fuel without significant modifications. Further, it has been observed that biomass project developers, as industry practice have deployed predominantly travelling grate type boilers for biomass based power generation. Considering the same the Commission has decided to retain the norm of Station Head Rate at 4000 kCal/kWh and the same has been reflected in the final regulations."*

2.1.2. In the Explanatory Memorandum to the Draft Regulations 2012 circulated for public consultation, the Central Commission dealt with the Report of the Central Electricity Authority (CEA) Committee, field study carried by the National Productivity Council (NPC) and the recommendation of Ministry of New and Renewable Energy (MNRE)

before suggesting SHR of 4000 kCal/kWh. The recommendations of MNRE and NPC and CEA were as follows:

MNRE recommendation on SHR for different Biomass source:

Biomass Source	IPP (> 5 MW)	Tail End (< 2 MW)
	kCal/kWh	kCal/kWh
Rice Husk	4100	5200
Straw	4400	5500
Others	4150	5200

National Productivity Council recommendation on SHR for different Boiler technology:

Project with Boiler Type	Station Heat Rate kCal/KWh
AFBC	4000 – 4100
Traveling Grate	4150 - 4250

2.1.3. The Expert Committee of Central Electricity Authority (CEA) in its report of September, 2005 on "Operational Norms for biomass based power plants" recommended specific fuel consumption of 1.36 kg/kWh with average calorific value of fuel as 3300 kCal/kg and implicit assumption of SHR of 4500 kCal/kWh.

2.1.4. For availing the capital subsidy all the Biomass Power Plants have conducted a detailed Performance Assessment Study of the plants by National Productivity Council and as per the Assessment the average Station Heat Rate for biomass power plants is around 4300 kCal/kWh.

Station heat rate data based on performance assessment of biomass power plants by national productivity council is as under:

Plant	Date	Unit Generation (kWh)	Biomass Consumption (MT)	SFC (kg/kWh)	Average GCV of Fuel as fired (kcal/kg)	Station Heat Rate (kCal/kWh)
Shriram Powergen Limited, Dindigul	09.11.10 to 10.11.10	148800	280	1.88	2076	3906.45
	10.11.10 to 11.11.10	144600	275	1.90	2076	3948.13
	11.11.10 to 12.11.10	152900	292	1.91	2076	3964.63
Global Powertech Equipments Limited, Vandavasi	27.09.10 to 28.09.10	179400	309	1.72	2540	4374.92
	28.09.10 to 29.09.10	172200	294	1.71	2568	4384.39
	29.09.10 to 30.09.10	178200	294	1.65	2559	4221.92
ShriramNon-Conventional Energy Limited Pattukottai	26.12.10 to 27.12.10	152400	236.22	1.55	2696	4178.80
	27.12.10 to 28.12.10	154500	243.18	1.57	2696	4243.45
	28.12.10 to 29.12.10	165300	249.04	1.51	2736	4122.11
Orient Green Power Company Limited Pollachi	11.02.12 to 12.02.12	236600	455.91	1.93	2379	4584.15
	12.02.12 to 13.02.12	236100	431.11	1.83	2379	4343.97
	13.02.12 to 14.02.12	236600	433.13	1.83	2379	4355.10
Sanjog Sugars & Eco Power Pvt. Limited	07.08.12	227000	281.5	1.24	3495	4334.11
	08.08.12	234400	305.55	1.30	3495	4555.88
	09.08.12	196200	264.87	1.35	3495	4718.25
					Average Station Heat Rate	**4282.42**

2.1.5. It can be seen that data pertain to two or three days of the year and cannot be taken as representative number. Further, the specific fuel consumption has been worked out based on biomass consumption. The methodology of assessing the biomass consumption has been found to be

very sound and not based on scientific measurement. In the light of the above, it is not feasible to rely upon the above data.

2.1.6. It has also been noticed from the data submitted to the UNFCCC for claiming the CDM benefits by the Biomass Plants which are in operation for monitoring purposes that the Station Heat rate is above 4700 kCal/kWh. Station Heat Rate data based on monitoring reports of biomass power plants available in the official website of UNFCC is as follows:

Monitoring Report Reference Record	Gross Power Generation (kWh)	Biomass Used (MT)	SFC (kg/kWh)	Average GCV of Fuel (Kcal/kg)	Station Heat Rate (kCal/kWh)
01.04.2008 to 31.03.2009	58236846	74504	1.28	3538	4526
25.09.2009 to 24.09.2010	46454600	62693	1.35	3354	4526
23.07.2009 to 21.07.2011	64775700	106530	1.64	2936	4829
24.07.2009 to 24.07.2010	28781400	44956	1.56	2898	4526
29.12.2009 to 28.12.2010	40051500	70013	1.75	3318	5799
25.02.2008 to 30.09.2009	75148000	108261	1.44	3167	4562
01.09.2009 to 31.08.2010	56,026,252	70387	1.26	3369	4233
22.09.2010 to 21.09.2011	28,881,184	44323	1.53	3074	4718
01.05.2009 to 30.06.2010	23,392,200	45374	1.94	2860	5548
23.08.2007 to 20.07.2009	46,881,300	81290	1.73	2874	4983

01.04.2008 to 31.03.2009	39,548,700	64906	1.64	2758	4526
09.03.2007 to 31.12.2008	65,214,150	88906	1.36	3320	4526
16.02.2010 to 31.03.2011	33375200	44161	1.32	3200	4234
24.08.2008 to 31.03.2009	37,250,500	63874	1.71	2637	4522
18.09.2009 to 24.03.2011	31,067,000	51737	1.67	2877	4791
AVERAGE STATION HEAT RATE	**45005635**	**68128**	**1.55**	**3079**	**4723**

2.1.7. This data is also not of any assistance for the same reason that it is also based on biomass consumption and in the absence of technical details of the plants; it is not possible to take any view.

2.1.8. Design Station Heat Rate has been stated by the Indian Biomass Power Association based on design data of turbine heat rate and boiler efficiency as submitted by suppliers are as under:

Plant	Steam parameters			Enthalpy of steam (kCal/kg	Enthalpy of Condensate kCal/kg)	Design Boiler Effi. (%)	Design Specific Steam Consum. (kg/kWh)	Design Station Heat Rate (kCal/kWh)
	Flow TPH	Pressure (KSC)	Temp (°C)					
Shriram Powergen Limited Dindigul	35	66	495±5	814.4	50	79.50%	4.49	4317
Global Powertech Equipments Limited Vandavasi	35	66	495±5	814.4	50	79.50%	4.3	4134

Shriram Non-Conventional Energy Limited Pattukottai	35	66	495±5	814.4	50	79.50%	4.49	4317
Orient Green Power Company Limited Pollachi	52	66	465±5	796.9	50	76.50%	4.38	4276
Sanjog Sugars & Eco Power Pvt. Limited Hanumangar	47	66	475±5	802.6	50	80%	4.65	4374
OrientGreenPower Company (Rajasthan)Pvt. Ltd. Kishanganj	40	66	480±5	805.6	50	78%	4.275	4141
OrientGreenPower Company Limited, Narsingpur	52	66	465±5	796.9	50	75%	4.38	4362
PSR Green Power Projects Pvt Ltd, Mehbubnagar	40	45	420±5	775.3	50	72%	4.76	4795
S M Environmental Technologies Pvt Ltd, Chippabarod	40	45	425±5	781.2	50	76.80%	4.34	4132
							AVERAGE STATION HEAT RATE	4317

Year	Fuel (MT)	SFC (kg/kWh)	PLF (%)	Fuel Rate (Rs/MT)	Ave. GCV (kCal/kg)	SHR kcal/kWh	Fuel Mix
2007-08	18299	**1.59**	65.19%		2970	4628	Maize waste, Cholam cobs, Juliflora, Coconut leaf stem, Plywood waste, Wood chips, Saw dust, Rice husk
2008-09	68984	**1.90**	74.07%	984	2552	4790	
2009-10	86426	**1.93**	68.93%	1331	2423	4635	
2010-11	89412	**1.86**	73.28%	1487	2463	4574	
2011-12	82993	**1.68**	74.93%	1831	2782	4681	
2012-13	86874	**1.70**	77.86%	1928	2793	4746	
2013-14	18948	**1.76**	65.66%	1969	2728	4804	
2008-09	10660	**1.84**	37.53%	1138	2662	4695	Cholam cobs, Juliflora, Coconut leaf stem, Casuarina, Wood chips, Saw dust, Rice husk
2009-10	81854	**1.73**	72.32%	1609	2626	4531	
2010-11	79422	**1.77**	68.46%	1784	2575	4548	
2011-12	79306	**1.79**	67.18%	1864	2684	4814	
2012-13	85386	**1.79**	72.58%	1829	2551	4566	
2013-14	23551	**1.84**	78.52%	2065	2670	4887	
2009-10	17132	**1.96**	82.63%	1680	2357	4611	
2010-11	80554	**1.76**	69.79%	1742	2542	4465	
2011-12	62736	**1.85**	51.60%	1904	2450	4530	
2012-13	83488	**2.02**	62.93%	1984	2275	4594	
2013-14	21409	**1.93**	67.54%	2523	2429	4696	
2011-12	40399	**2.03**	34.22%	1722	2342	4751	Mustard husk, Cotton stalk, Rice straw, Cow dung, Coriander husk
2012-13	35071	**2.10**	73.42%	1879	2287	4805	
2013-14	33548	**2.15**	71.96%	1754	2263	4824	
2011-12	37923	**1.68**	51.86%		3020	5071	
2012-13	55449	**1.45**	43.61%	2146	3194	4636	
2013-14	4030	**2.04**	2.27%	1709	2490	4986	
2009-10							Mustard husk, Coriander husk, Cotton stalk
2010-11	41131.6	**1.91**	30.01%	1089	2487	4755	
2011-12	52193	**1.68**	44.30%		2924	4906	
2012-13	52309	**1.56**	47.38%		3115	4873	
2013-14	19606	**1.39**	80.69%	1743	3292	4581	

SMETPL			SANJOG		SGPPL	
8 MW	**COD**	**FEB.'10**	**COD**	**OCT.'11**	**COD**	**AUG' 11**
2010-11	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
1,41,45,588	3,11,05,760	3,34,40,258	2,25,87,410	3,82,02,600	2,88,48,592	3,44,35,452
16,49,350	37,52,220	39,36,249	17,31,530	28,74,210	34,40,692	41,23,652
1,24,96,238	2,73,53,540	2,95,04,000	2,08,55,880	3,53,28,390	2,54,07,900	3,03,11,800
22665	52193	52309	37923	55449	41052	56049
1.60	**1.68**	**1.56**	**1.68**	**1.45**	**1.42**	**1.63**

2.1.9. The above data filed in case of Global Powertech and S.M. Environmental could not be reconciled with the balance sheet provided by the IBPA. Here also the data relating to separate biomass consumption is based on biomass consumption, which the Committee found, was not based on sound methodology. Therefore, it is not possible to rely upon the above data.

2.1.10. The Indian Biomass Association submitted that the fuel consumption ratio for 5 plants in Rajasthan for the last 2 years and in some cases last 3 years as shown in the above table reveals that the average fuel consumption ratio of majority of the plants is above 1.5 kg per unit. They have further submitted that higher SFC is due to the nature of fuel, which is agriculture waste. The quality of the waste has lot of variance due to moisture levels, sand-silica and other chemical characteristics, which cannot be controlled. This parameter is extremely critical in the operation of Biomass power plants.

2.1.11. The Station Heat Rate of the Biomass Power Plant depends predominantly on the pressure and temperature rating of the plants, type of fuel, Fuel Characteristics and variation in fuel quality from the time of purchase and time of actual use, loading of the units etc. All these variations in quality of fuel and operational parameters get refleced in the performance of boiler and its efficiency.

2.1.12. The IBPA has stated that most of the Biomass Power Plants are being operated with different kinds of biomass mix either due to non availability of the designed fuel or due to higher cost of those fuels. They are forced to operate the plants with the available Biomass sourced directly from the fields which quality wise might not meet the design fuel parameters.

2.1.13. They have further submitted that due to higher moisture content of the fuels, the Operating Station Heat Rate is always far higher than the design Station Heat Rate. The Committee members have found these fats to be true during their visit to various biomass plants. Further, there is deterioration in the quality of biomass in storage for various reasons such as rain, loss of heat value etc. and adversely affect the boiler efficiency.

2.1.14. It has also been noticed that the biomass plant due to shortage of biomass or due to poor quality of biomass are also unable to run on full load or high load. The data submitted by IBPA also suggest that average Plant Load Factor (PLF) varies between 65 to 75% in majority of cases. This adversely affects the boiler efficiency and turbine cycle heat rate.

2.1.15. The Committee has also noticed and appreciated that the Biomass Power Developers are using only Agro wastes and Residues and it is practically not possible to achieve and maintain uniform quality of GCV, considering the characteristics with respect to Moisture and Sand while collecting , adulteration during handling, and sizing and processing before feeding into the Boiler. The Committee has noted the Fuel Sourcing and feeding processes during visit to the power plants.

2.1.16. The details obtained from M/s Suryachambal Power Limited, during the visit of the Committee are as follows:

Description	Suryachambal Power Limited
Location	Village:Rangpur, District:Kota, State:Rajasthan
Capacity of the plant	7.5 MW
Date of Commissioning	31.03.2006
Biomass sourcing	Major biomass used: Mustard husk, Soya husk
PLF achieved	80.30% Maximum , 70.96% Average from April 2012 to January 2013
Total power generated so far	2011-12: 46.32 MU 2012-13(up to January 13): 35.12MU
Total fuel used so far	2011-12: 63860MT 2012-13(up to January 13): 47713MT
Specific fuel Consumption	2011-12: 1.38 kg/kWh 2012-13(up to January 13): 1.38 kg/kWh
Average Calorific value of fuel as fired	3076 kCal/Kg
Average Station Heat Rate based on GCV as fired (kCal/kWh)	4183 kCal/kWH (derived)

2.1.17. During the visit of Biomass plant of M/s Abellon Clean Energy Limited following was stated by them:-

The Station heat rate will vary with the variation in the steam parameters (pressure and temperature) leading to poor performance of the Boiler. The SHR of 3850 kCal/kWh may be achieved for a 10 MW capacity plant if the plant runs at full load for all the time. If the plant is running at part load, then the SHR could be higher. There are other factors like

ageing & degradation of capacity with time due to erosion and corrosion. The actual SHR may be 7% higher, around **4119 Kcal /kWh** due to these variations.

2.1.18. Design Station Heat Rate as submitted by the Biomass Association of following plants is as under:

Sr. No.	Name of the biomass based power plant	Turbine Capacity (MW)	Turbine Make	Boiler efficiency (%)	Turbine Cycle heat rate (kCal/kWh)	Design Station Heat Rate as HMBD (kCal/kWh)
1	SPPL, Merta	10.00	Siemens	79.50%	3137	-
2	SPGEN	07.50	Triveni	79.50%	2897	3658
3	SNCEL	07.50	Triveni	79.50%	2897	3658
4	GPTL	07.50	Qingdao	79.50%	-	3702
5	OGPL	10.00	Triveni	78.00%	-	3923
6	TGPL	12.00	Triveni	79.50%	-	3750

2.1.19. All the above plants have same pressure parameters of 66 bar and temperature parameters of 490 +/- 5^0 C and has same boiler efficiency of the order of 79.5% except in case of OGPL. The reason for variation in turbine cycle heat rate of Simens and Triveni could be due to ambient temperature. The boiler efficiency of 79.5% is reflective of inferior quality of biomass fuel as against 87% for the conventional power plants. It can be seen that the prevailing norm of 4000 kCal/kWh provide for 2 to 9% variation in heat rate due to operating conditions.

2.1.20. The Boiler Manufacturers in India are offering Travelling Grate and Atmospheric Fluidized Bed Combustion Boilers for the Biomass Power Plants. The travelling grate boilers can handle multi fuels without major processing needs and hence most of the Biomass Power Plants opted for the same due to non availability of single fuel. Hence Station Heat Rate of the said plants is always high compared to the AFBC boiler operated Biomass Power Plants.

2.1.21. It is seen that the Biomass Plants are also forced to operate with all kinds of agro residues irrespective of the moisture content of the fuel due to seasonal availability. In the case of seasonal fuels, the longer storage time also affects the performance of the operating Biomass Power stations during season, and during off season they resort to burning low-priced, inferior quality fuel with limited combustion efficiency of boilers, due to unavailability of good quality fuel at affordable prices which also affects the performance.

2.1.22. In due consideration of above facts, and the discussions held during the visits to the Biomass Plants it is felt that the Station Heat Rate of the operating Biomass Plants needs to be prescribed with reasonable operational margin over the design heat rate. The Committee is of the view that the average design SHR of **3750 kCal/kWh** may be considered and may be provided with a operating margin of **10-12%** over the design heat rate. This will translate into a station heat rate of 4125-4200 kCal/kWh. Hence it is recommended that the Station Heat Rate of **4200 Kcal/kWh** for station using travelling grate boilers and **4125 kCal/kWh** for stations using AFBC boilers be considered for determination of tariff of bio-mass power plants.

2.2. AUXILIARY POWER CONSUMPTION

2.2.1. The Commission in the RE Tariff Regulations-2012 specified norms for auxiliary consumption for biomass based power project (Rankine Cycle) with Water Cooled Condenser (WCC) at 10% of gross generation of electricity.

2.2.2. In addition to the load being consumed by the biomass based power plant auxiliaries, utilities and various machineries for cutting, chipping and weighing for in-plant transportation of fuel also consume power. The auxiliary for Power plants using Juliflora is even more due to operation of Chippers, shredders and other fuel processing equipments.

2.2.3. The Indian Biomass Power Association represented that currently most of the Biomass Power Plants are being installed with Air Cooled Condenser (ACC) mainly to minimize and preserve the naturally available water for cooling purposes. ACC consumes more power as compared to WCC by way of the higher KW rating of the Forced draft fans. The power consumption for the ACC is based on the ambient temperature and the Steam flow. The ambient temperatures that prevail in most part of our country being of the order of 30Deg C and above for most part of the year, the Fans have to be operated at their maximum design condition.

2.2.4. The Indian Biomass Power Association also submitted that in order to adhere to the recently stipulated emission norms by the Pollution Control Boards of 50 mg/Nm3, an additional field has to be incorporated to the normal 3 fields ESP, which necessitates additional power consumption apart from additional capital expenditure. Installation of a suitable Dust suppression System in the fuel preparation area is also an additional Auxiliary power consumption source.

2.2.5. The data collected during the performance Assessment of the plants done by National Productivity Council and the data from the Monitoring Reports of operating biomass power plants from the website of UNFCCC have been used for reference.

2.2.6. Data on the Auxiliary consumption of biomass power plants from the Monitoring Reports of plants from the website of UNFCCC are as follows:-

Reference Record Monitoring Report available in UNFCCC website	Gross Power Generation (kWh)	Aux. Consumption (kWh)	Aux. Consumption (%)	Export to Grid (kWh)
01.04.2008 to 31.03.2009	58236846	5158146	8.86%	53078700
25.09.2009 to 24.09.2010	46454600	5128900	11.04%	41325700
23.07.2009 to 21.07.2011	64775700	8658600	13.37%	56117100
24.07.2009 to 24.07.2010	28781400	3169500	11.01%	25611900
29.12.2009 to 28.12.2010	40051500	4741774	11.84%	35309726
25.02.2008 to 30.09.2009	75148000	10849000	14.44%	64299000
01.09.2009 to 31.08.2010	56,026,252	6,382,752	11.39%	49,643,500
22.09.2010 to 21.09.2011	28,881,184	3,461,084	11.98%	25,420,100
01.05.2009 to 30.06.2010	23,392,200	3,586,630	15.33%	19,805,570
23.08.2007 to 20.07.2009	46,881,300	5,965,800	12.73%	40,915,500
01.04.2008 to 31.03.2009	39,548,700	4,665,150	11.80%	34,883,550

09.03.2007 to 31.12.2008	65,214,150	7,875,350	12.08%	57,338,800
16.02.2010 to 31.03.2011	33375200	4119400	12.34%	29255800
24.08.2008 to 31.03.2009	37,250,500	4542200	12.19%	32,708,300
18.09.2009 to 24.03.2011	31,067,000	4034860	12.99%	27,032,140
Average	**45005635**	**5489276**	**12.23%**	**39516359**

2.2.7. Considering the above, the Indian Biomass Power Association suggested to consider the Auxiliary Power consumption at 12% for all Biomass based Power plants installed with ACC with additional equipment for processing fuel etc. for the fuel preparation and feeding by way of running wood Chippers and wood Shredder, with unprocessed fuels.

2.2.8. The data collected (Annexure-III) during the plant visits in Rajasthan of M/s Suryaa Chambal Power Ltd. (SCPL) and Suryachakra Green Power Pvt Ltd, (SGPPL) confirms the auxiliary consumption to be in the range of 10 % for water cooled plant.

2.2.9. As per the M/s Abellon Clean Energy Limited, one of the reasons for higher auxiliary consumption in the biomass based power plants is that these plants are of relatively smaller size, second the electricity requirement for biomass pre-processing before feeding at plant, and thirdly due to variation in fuel quality (GCV, moisture, chemical properties). The plant generally does not run on rated capacity due to which the overall Auxiliary consumption increases. Lower bulk density & higher moisture will mean higher Auxiliary consumption. The

Auxiliary consumption is around 12 %. There will be variation of 2% in Auxiliary consumption due to variation in load factor & variation in fuel quality.

2.2.10. The Committee also collected data on Auxiliary Consumption of 6 MW M/s Surya Teja Power Plant in Hyderabad as under:

Auxiliary Consumption V/S PLF details			
Year	**Generation**	**Auxiliary Consumption**	**Auxiliary Consumption**
	kWh	**kWh**	**%**
2007-08	10086234	1159584	11.50%
2008-09	24726700	2743900	11.10%
2009-10	24758200	2770300	11.19%
2010-11	29414000	3330500	11.32%
2011-12	37816700	4201550	11.11%
2012-13	20284400	2235350	11.02%

2.2.11. Considering the above the Committee recommends that the auxiliary power consumption for the biomass plant using air cooled plants can be fixed at 12% and for the plant using water cooled plants can be fixed at 10%. In case of stations using rice straw or Juli Flora, the auxiliary power consumption may also be kept as 12% to cutting, shredding and drying operations.

2.3. GROSS CALORIFIC VALUE (GCV):

2.3.1. The Commission specified calorific value for eight States in the RE Tariff Regulation-2009, which comprises around 70% of estimated surplus biomass power potential in the country for the mix of biomass fuel available in a particular State. Further, in order to determine the weighted average calorific value of biomass fuel mix the calorific values of individual biomass as maintained by Indian Institute of Science, Bangalore has been considered. States wherein biomass potential is yet to be explored, have been considered under 'Other State' category.

2.3.2. The Biomass Atlas prepared and maintained by the Indian Institute of Science, Bangalore maps State-wise availability of the different types of biomass fuel and also presents the power generation potential using each of the biomass fuels:

Table: State-wise Biomass fuel availability and fuel mix

Type of Biomass	GCV kCal/	MAH	UP	AP	T N	KAR	RAJ	PUN	MP	HAR
Paddy	3000	6%	46%	56%		11%		49%	7%	34%
Wheat	3800	6%	37%				51%	28%	16%	33%
Mustard	3400						28%			
Bajra	3950	6%					9%			
Maize	3500		10%	10%		18%				
Cotton	3636	47%		5%		18%		21%	37%	23%
Groundnut	4200			12%		9%				
Coffee	4300					9%				
Coconut	3300			6%	13%	16%				
Jowar	3500	13%				10%			9%	
Gram	3810									
Soyabean	3700	9%							19%	
Sunflower	2800									

Share in Total Biomass Surplus Available	86%	93%	90%	13%	91%	88%	98%	89%	90%
Share in Total Biomass Surplus kT/Yr	12,107	11,696	4,235	1,091	7,652	6,878	24,395	8,957	9,215
Total Biomass Surplus Available kT/Yr	14,002	12,537	4,689	8,092	8,442	7,808	24,789	10,080	10,288
Wt. Avg. Calorific Value for State kCal/kg	**3,611**	**3,371**	**3,275**	**3,300**	**3,576**	**3,689**	**3,368**	**3,612**	**3,458**
CV of Biomass kCal/kg	**3,476**								

2.3.3. While specifying the GCV norm in the RE Tariff Regulations-2012, the Commission considered the norms as suggested in the report of National productivity Council, Central Electricity Authority (CEA) as well as by MNRE. Based on the recommendation of MNRE, NPC and CEA, the Commission has considered the GCV of biomass at 3250 kCal/kg and after taking into account, use of 15% of coal (average coal GCV at 3600 kCal/kg and 85% uses of Biomass fuel of 3150 kCal/kg), the weighted average GCV has been considered at 3300 kCal/kg.

2.3.4. CEA in its report on "Operation Norms For Biomass based Power Plants" September 2005 assumed GCV of 3300 kCal/kg based on the calculation of weighted average GCV for 16 biomass power plant and also taking into account large variation in quality and variety of biomass used including variation in moisture content due to weather conditions.

2.3.5. The National Productivity Council (NPC) in its study mentioned that based on the fuel analysis report from the different plants, GCV & moisture variation could be as under:

Biomass	GCV (kCal / kg)	Variation in Moisture (%)
Rice husk	3000-3200	12-18
Maize Bhutia	3500	21
Cotton Stalk (Air Dried Basis)	3250	8

2.3.6. MNRE vide its letter dated 30th September, 2011 submitted that the GCV has to be decided based on the biomass type as per the following:-

Sr. No.	Name of Biomass	Moisture (%)	Dust (%)	GCV as on as received basis (kCal/kg)
1	Groundnut Shell	4.6	4	3167
2	Jeera Residue	6.8	3.85	3690
3	Saw Dust	30.0	12	2139
4	Sindhi Saunf	16.97	4.66	3186
5	Asalia	6.69	6.31	3505
6	Isabgol	6.79	5.18	3588
7	Mustard Residue	10	4.0	3300
8	Juliflora	13	1.0	2800
9	Paddy Straw	10	4.0	3300
10	Rice Husk	12	1.5	3200

2.3.7. There are other losses which are being encountered during the storage and handling of biomass, as per survey carried out by Dalkia Energy services limited under mandate from Rajasthan Renewable Energy Corporation Ltd. 9RREC) to assess such losses. Findings on various

losses being encountered during storage of biomass in the power plant are shown in the table below.

S. No.	Type of Losses	Description	Expected Losses (%)	Targeted Losses (%)	Remarks
1	Land Settlement	Grounded MCR cannot be lifted due to mixing with dust	0.7-1.0	0.4-0.5	MCR at bottom of heap gets mixed with sand and cannot be used in boiler. However, with leveling of ground and proper drainage system, land settlement loss can be reduced to about 0.4% - 0.5%.
2	Loss of Fuel during Sand Storm	Due to high velocity sand storm, MCR spreads out in nearby area up to half a KM and cannot be collected	0.5	0	This loss can be completely eliminated by covering the biomass with tarpaulin.
3	GCV Loss due to decaying of biomass	In rainfall, biomass gets wet and suffers from GCV loss due to decaying and release of methane gas in the atmosphere.	2	1.25- 1.5	Decaying loss can be reduced to about 1.5% by covering the biomass with tarpaulin and proper drainage system in storage yard.
Total Losses during Fuel Storage			**3.2-3.5%**	**1.65- 2.0%**	

2.3.8. The Ministry also considering the above report, further submitted that with better fuel management techniques such as proper leveling of ground for storage, proper drainage system and covering of fuel with tarpaulin, the total fuel losses during biomass storage can be targeted at

about 1.65%-2%. Thus, there should be provision of loss of fuel during storage at around 2% in the tariff order of various states for biomass based power plants. The Ministry finally suggested that the following general principles can be adopted for the GCV value:

Biomass	GCV (kCal / kg)
Rice husk	3200
Straw / Stalks/ Other husks	3300
Plantation	2800

2.3.9. Some of the stakeholders have submitted that none of the above referred organizations has conducted a study about the degradation of these seasonal fuels over the non-seasonal period. They have further submitted that due to the rains, storage, contamination by fuel suppliers and inherent mud in agricultural residues there is a significant reduction in GCV of biomass fuels.

2.3.10. As per the interaction and reference of records submitted by the Biomass Power Plants, it was observed that the most important property of biomass feed stocks with regard to combustion – is the moisture content of the fuel, which influences the energy content of the fuel and also the efficiency, fuel consumption and viability of the Biomass Power Plant.

2.3.11. It has been observed that the operation of the Biomass Power plants solely depends on the quality of the fuel received and also on the quality at the time of usage in the boiler after prolonged storage in

the case of seasonal fuels. But it is understood that most of the Biomass Power plants are being operated with “hand to mouth” fuel situation. That is, they are forced to buy the available fuels with inferior quality and fire them in the boiler. It is also noticed by the Committee during plant visit that the quality of fuel, which is waste is not uniform, containing varied moisture, sand and inert material, which has direct relation to GCV, as the waste is coming from different areas, farmers and soil profiles.

2.3.12. The GCV of fuel is determined based on the Moisture, Sand and ash content of the Biomass used. For reduction of moisture the only economical solution is the natural drying. But due to high inventory levels upon storage in the open space like Coal (which is normally less hygroscopic than Biomass) seasonal rains makes the fuel further wet. According to the Indian Biomass Association, on an average the Biomass plants are to be operated with the minimum moisture content of 25 to 30 %, which affects the heat content (GCV) further and what they get on as feed basis is only between 2200 to 3000.

2.3.13. The GCV analysis of mustard husk on as fired basis data collected from M/s Surya Chambal Power Ltd. (SCPL) during the visit is attached as Annexure-1. As per records verified mustard husk average GCV on as fired basis found at around **3077 kCal/kg.**

2.3.14. As per data collected from M/s Punjab Biomass Power Limited, the laboratory test report of GCV analysis of rice straw on air dried basis found at **3236 kCal/kg** and moisture content (as received basis) found at **57.02%.**

2.3.15. The Average GCV of the biomass used in the State of Gujarat, on dry basis is **3300 Kcal / Kg**, as it generally utilizes cotton stalk and castor stalk as fuel.

Sr. No.	Biomass Source	Area under cultivation in Gujarat as per Govt. data	Total Biomass waste in Gujarat	Percentage	Calorific Value
		Area in Ha			
1	Paddy Straw	2,062,500	6,877,406	56%	3000
2	Cotton Stalk	2,422,000	2,422,000	28%	3636
3	Wheat Straw	1,273,900	1,019,120	15%	3600
4	Castor Stalk	358,100	214,860	1%	3200
	Total		10,533,386		3300

Source: Gujarat Agriculture department

2.3.16. The Committee also collected GCV details of various fuels used in 6 MW project of M/s Surya Teja Power Project Limited, Hyderabad as fired basis as under:

GCV details of as fired basis	
Type of fuel used	**GCV kCal/kWh**
Rice Husk	3032
Ground Nut Shell	3469
Shank (seed less corn)	3580

2.3.17. Upon verification of the operating details of the Biomass Power Plants the net calorific value of the fuel received are far less than the GCV of 3400 Kcal/Kg to 4400 kCal/kg on air dried basis. In practice with the moisture content variation between 10 % in the case of Mustard Husk and 50 % in the case of cotton stalks and coconut wastes the actual heat content is almost 20 to 30 % less than the GCV on as dried basis. This has been observed during the plant visit to the operating plants. This moisture variation typically affects the performance of the Boiler and also the viability of the plants with the current tariff fixed with the High GCV.

2.3.18. Based on the data submitted by IBPA, it is also observed that some of the States like Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Maharashtra are using predominantly coconut wastes, Cotton stalk, Bagasse, Sugar Cane Trash apart from Juliflora . It is represented many times by the IBPA , that the use of Juliflora by other competitive industries has gone up extensively and availability to the Biomass Power Plants is not ensured. Hence it is certain that originally envisaged fuel for the Biomass Power Plant namely Juliflora has become costlier, forcing the Biomass Power Plants in these states to look for other Agro Residues with higher moisture content with lower GCV.

2.3.19. It was seen in the operating plants that a minimum inventory of three to four months of stocks of various types of fuels are stacked either in the plant premises or at the collection centers. The following points were observed based on the visit to the Biomass Power Plants:-

- The biomass is procured in a period of 3 months every year and preserved and used for the entire balance period of 9 months.
- In order to reduce the risk of fire, biomass is also stored in depots away from the plant.
- In this process, there are losses due to various reasons like mixing of sand, mud and foreign materials, losses by wind and small to major fires and losses in handling.
- There is also qualitative loss in terms of GCV due to exposure to wind and rain. Thus, the losses are between 7-10% for the entire year.

2.3.20. **Based on the above factors the Committee recommends that the normative GCV value for the Biomass Plants for determination of generic tariff may be kept as 3100 kcal/kg for mustard husk, rice husk and other kinds of biomass fuel under as fired condition.**

2.4. OPERATION AND MAINTENANCE EXPENSES

2.4.1. The various heads of accounts coming under O&M expenses are: Labour Charges, Courier charges, Mobile charges, Telephone charges, Consultancy charges (LEGAL), Donation, Electric charges, Hire Charges, Misc Expenses, Testing Charges, Transportation Charges, Watch & Ward, Comp spares & Consumables, Repair & Maintenance of equipment, Repairing & maintenance of vehicles, Printing & Stationary, Rep& Main of Buildings, Rates & Taxes, Other Bank Charges, Employees Cont to PF, Leave & Salary, Salary & Wages, Lunch & Tea exp, Medical exp, Pooja exp, Staff Welfare exp, Board& Lodge, Car Hire charges, Petrol & Diesel exp, Travel exp, Travel other exp, Insurance other, Rent, Audit fee, Fuel feeding, handling and fuel preparation expenses etc. all constitute Operation & maintenance charges. The O&M charges would also affect based on the location of the power plant if the location is near to the city, the O&M expenses would be lesser as compared to a rural location, where the O&M expenses would be a bit higher.

2.4.2. The O&M expenses incurred by various biomass power plants operated throughout the year for the financial years 2010-11 and 2011-12 submitted by the Indian Biomass Power Association are presented below.

Name of the Unit	Cap. (MW)	Financial Year 2010-11		Financial year 2011-12	
		Annual O&M Expenses (Rs)	Annual O&M expenses (Rs./ MW)	Annual O&M Expenses (Rs)	Annual O&M Expenses (Rs./MW
Shriram Powergen Limited Dindigul	7.5	52349351	6979913	41063786	5475171
Shriram Nonconventional Energy Limited,	7.5	50477018	6730269	37721802	5029574
Global Powertech Equipments Ltd.	7.5	54332826	7244377	50630790	6750772
SM Environmental Technoloes Pvt Limited, Chippabarod	8.0	84250853	10531357	44616142	5577018

Amrit Environmental Technologies Pvt. Limited, Kotputli	8.0	41785128	5223141	36663533	4582942
Sanjog Sugars & Eco Power Pvt. Limited, Hanumangarh	10.0	-	-	32653841	3265384
Orient Green, Pollachi	10.0	-	-	33157865	3315787

2.4.3. The O &M expenses on current level as per verified details of actual expenses of the plants visited are as under:

Name of the Unit	Capacity (MW)	FY 2011-12		FY 2010-11	
		Annual O & M Expenses (Rs Lakhs)	Annual O&M expenses (Rs Lakhs Per MW)	Annual O & M Expenses (Rs Lakhs)	Annual O&M Expenses (Rs Lakhs / MW)
Surya Chambal plant, Kota	7.50	5,36,38,063	71.52	5,50,86,367	73.45
Punjab Power, Patiala	12.00	4,20,66,782	35.06	-	-
Surya Teja Power Project Ltd. Hyderabad	6.00	4,70,92,800	78.49	5,01,82,975	83.64

2.4.4. It can be seen from the data that average O& M expenses per MW vary depending on the capacity of the plant. For low capacity plants it is comparatively higher, the primary reason being that the number of employees is not related to the capacity. The remote positioning of the plants adds to higher cost of labour and trained manpower unwilling to stay in places where minimum amenities of life are not met.

2.4.5. IBPA has further submitted that the financial conditions of the economy and the current high rate of inflation have direct impact to the O&M charges increasing rapidly every year. The manpower demands higher wages and salaries for staying in remote location and the nature of the Biomass operation is such, where experience and technically qualified

manpower is critical and required on 24 hours basis for operation of plant unlike other RE segment like Wind and Solar, which requires lesser manpower for O&M compared to Biomass. The data submitted for various plants by IBPA reflect higher O&M cost. .

2.4.6. The biomass based power plants are relatively smaller in size / capacity and hence the fixed costs like manpower cost, administration cost, consumables cost are significantly high in per MW terms. Further, due to high corrosion and high erosion in the biomass based boilers around 3% of Capital cost shall be incurred every 3 years against major replacement / major repairs / replenishment, such as boiler tubes, super heaters, etc. This should also be accommodated in the O & M cost. A typical analysis of O&M of the 10 MW biomass plant as submitted by M/s Abellon Green Energy Ltd is as follows:

O&M Cost for 9.9 MW Plant

Sr. No.	Particular	Amount in Rs. Lakh
1	Spares and consumate	120
2	Material Cost for Shutdown	45
3	Salary Cost	90
4	Mobile Allowance	2
5	Labour Cost (Fuel Handling)	80
6	Labour Cost (Operation+	36
7	Transportation Allowance for Staff and labour	10
8	General Administration and Misc.	24
9	Total O&M Cost in Rs. Lakh	407
10	Total O&M Cost in Rs. Lakh/MW	41

2.4.7. The data submitted by the Biomass Plants reveals that the O& M expenses are almost in the range of Rs 35 lakh/MW to 72.44 Lakh/MW and according to them such expenses are escalating at 10 % year on year. However, such high variation in O&M expenses of similar capacity plants is not very clear. Therefore, we are not very comfortable to rely upon the figures given by the Biomass Association. Nevertheless, considering the facts that the Biomass Power Plants are being operated

with skilled manpower and due to the locational disadvantage are required to be paid higher salaries to skilled manpower, and higher wages for the unskilled manpower as well. In addition, O&M expenses for fuel processing and feeding are comparatively higher when compared to other similar industries. In consideration of all these facts, there is a case for increasing the O&M expense norm and it is considered reasonable to raise it to **Rs.40** Lakhs per MW. This would be of the order of 7 to 10% of the capital cost for the biomass plants.

2.4.8. Regarding Annual escalation of O&M expenses for determination of tariff, in the Statement of Reasons Order issued while notifying RE Tariff Regulations 2012, the Commission clarified that the escalation factor of 5.72% per annum is in line with the escalation factor considered for conventional power projects as per CERC (Terms and Conditions for Tariff) Regulation, 2009 for the Control period FY 2009 to FY 2014. As and when the said 2009 Regulations is amended, during the new Control period of the Renewable Energy Tariff, the Commission may consider extending the same prospectively to all the RE projects as well.

2.5. CAPITAL COST

2.5.1. The Commission under Regulation 34 of the RE Tariff Regulations-2009 specified the normative capital cost for the biomass power projects based on Rankine cycle technology application using water cooled condenser as ` 450 Lakh / MW for FY 2009-10 and linked to the indexation mechanism specified under Regulation 35 of the RE Tariff Regulations-2009. Accordingly, the Commission determined the normative capital cost as Rs. 402.54 Lakh /MW for FY 2010-11 and Rs. 426.03 Lakh / MW for FY 2011-12.

2.5.2. The Commission also considered the following benchmark capital cost norm used by IREDA for financing the biomass based power projects during FY 2011-12:

Pressure Configuration (ata)	Biomass Power project (` Crore/MW)		
	6 MW	7.5 MW	10 MW
44	4.03	3.93	3.79
66	5.38	5.19	**5.03**
86	5.59	5.37	5.15
102	5.93	5.77	5.61
110	6.05	5.89	5.72

2.5.3. Based on analysis of the actual project cost approach as well as the benchmark norm developed by the IREDA for financing the biomass based projects for FY 2011-12, the Commission specified normative capital cost in the RE Tariff Regulation -2012 at Rs. 4.45 Crore/MW (Rs. 5.0 Crore – Rs.0.20 Crore (Evacuation infra. Cost beyond point of connection) – Rs. 0.35 Crore (Difference between Air Cooled Condenser (ACC) and Water Cooled Condenser (WCC) = Rs. 4.45 Crore/MW) for first year of the Control Period.

2.5.4. The Commission under Regulation 34 has specified the normative capital cost for the biomass power projects based on Rankine cycle technology application using water cooled condenser as Rs. 445 Lakh/MW for FY 2012-13, which shall be linked to the indexation mechanism specified under Regulation 35 of the RE Tariff Regulations. In accordance to the above referred Regulation, the normative capital cost of biomass power projects based on Rankine cycle technology application using water cooled condenser would be Rs. 463.336 Lakh/MW for FY 2013-14.

2.5.5. The capital costs of the Biomass Power Projects are unique when compared to the other renewable sector and the details are reproduced below.

- **Plant and Machinery** : The past Biomass Power Projects were completed with the water cooled condenser and without any major monitoring Equipment on the pollution abatement. The recent Governmental regulations on the Environment, warrant installation of Air Cooled Condenser and also the Pollution Control Monitoring and control equipment. This has increased the Capital cost of Biomass Projects. Other than this because of the non-availability of processed fuel for some of the Biomass Power Plants, they are forced to buy any unsized fuel and process them inside the plants before feeding into the Boiler. The processing needs additional chipping and shredding machines apart from the fuel shed for storing such processed fuel. This also increases the Project cost considerably.
- **Civil and Structural Cost:** In the recent days apart from the escalation factors on steel and cement, the Erection, Procurement and Construction Costs had also increased.
- **Land Cost** : Though the Biomass Projects are planned to be located in the rural areas , the land costs are high even in the rural

areas. The land requirement is about 20 acres per plant for 5 MW to 20 MW . The requirement of land block is more in the case of plants which depend mostly on the seasonal fuels like Mustard Husk , Paddy Straw , Wheat and Cotton stalk particularly in the northern states like Rajasthan and Punjab.

- **Pre-Operative Expenses:** Biomass power projects are established in rural backward areas of the state. Unlike Solar and Wind, where plants once established require very less manpower and operation logistics for operation, Biomass requires both technical manpower and operation logistics. Biomass plants unlike other RE segment require 24 hours commitment and presence of technical and operational staff for running the plant. Building basic infrastructure for the stay of operational and technical staff at the Biomass plants is critical and essential and this support infrastructure has to be built. It is not possible to bring technical and operational staff from distances of 100 km every day for operations in a remote backward area. This is additional cost, which has to be taken into account and is very much part of the cost of the power plant.
- **Interest During Construction** : The interest rate indicated by the Biomass Power Plants is realistic and the current rate of interest is around 15 % for the capital cost and also for the working capital.
- **Transmission Line :** Biomass power plants are generally located in the rural areas where there is limited availability of the substations. Therefore, the plants needs to be grid connected with the long lead of transmission lines **.** The lower voltage connectivity with 22/33/66 KV is now becoming more unstable because of the remote access by the Discoms .This has forced most of the Biomass power plants though located in rural areas, to go for higher voltage connectivity with the grid to avoid unnecessary outages or fluctuations, whatever be the distance for the higher voltage

substations say 110/132 KV. This in turn has resulted in higher cost on the transmission lines.

2.5.6. Apart from the above factors , it is understood that the inordinate delay in getting the Right of way on account of the execution of transmission lines with most of the Biomass Projects, the projects has suffered time and cost overrun before completing the project .

2.5.7. The break up data pertaining to some of the operating Biomass Power plants based on the above factors are reproduced below with the supportive Balance sheets .

Plant Details	SPGN, Tamilnadu	GPT, Tamilnadu	Sanjog, Rajasthan	OGPL, Tamilnadu	Transtech Rajasthan
Year Of Commissioning	**2007**	**2009**	**2010**	**2011**	**2011**
Capacity in MW	7.5	7.5	10	10	12
Particulars	Amount (Rs. Lakh)	Amount (Rs. Lakh)	Amount (Rs. Lakh)	Amount (Rs. Lakh)	Amount (Rs. Lakh)
Plant & Machinery					
Boiler	783	1204	1477	1702	1546
Turbine	650	801	1299	829	838
ACC	397	364	478	400	519
ESP		226	299	240	309

Chimeny	included in Boiler	147	47	61	75
Fuel Handling & Feeding System	40	65	175	146	249
Ash handling system	15			51	204
Other Machinery **	1297	1597	1448	1912	1099
Plant & Mach. Sub total	**3182**	**4404**	**5223**	**5341**	**4839**
Civil Cost &Structure	309	359	1066	957	847
Land & Site Development	45	28	116	320	503
Pre-Operative Expenses	21	283	38	20	651
Interest During Construction					**373**
Total	**3557**	**5074**	**6443**	**6638**	**7213**
*** (Transformer, Cables, Metering System, LT HT Panel, Control System, Weigh Bridge, Transmission)*					
Capital Cost- Lacs per MW	**474.27**	**676.53**	**644.30**	**663.80**	**601.08**

2.5.8. Based on the above data and also verified Financial Documents and as claimed by the Biomass Power Project Developers that the Capital cost is more than Rs 600 Lakhs per MW .

2.5.9. The Committee also requested IREDA vide e-mail dated 23.05.2013 to furnish latest cost data of biomass based rankine cycle projects including 100% rice straw based power project. In this regard, IREDA submitted that they are following the following cost ceiling bench-marks while sanctioning the Biomass projects:

Capital Cost of Biomass based power project

Boiler Pressure Configuration (ata)	Recommended for 2010-11 & 2011-12		
	6 MW	7.5 MW	10 MW
44	4.03	3.93	3.79
66	5.38	5.19	5.03

86	5.59	5.37	5.15
102	5.93	5.77	5.61
110	6.05	5.89	5.72

2.5.10. The above cost ceiling bench-marks were carried out by M/s MITCON Consultancy Services Ltd. based on escalation factor mainly on the Wholesale price index for 2009-10, Inflation rate for 2010 and steel price index, etc. IREDA submitted that the above bench-marks are under revision for financial year 2013-14. IREDA also submitted that they have not sanctioned any Biomass projects using 100% rice straw so far and the cost of such projects are higher than the conventional biomass project due to additional investment on fuel procurement and collection equipments like baler, cutters, tractors, trolley, etc. Further, the rice is to be collected within 2 to 3 months (harvesting season) and the same has to be stored for the next 9 to 10 month to ensure regular fuel supply for the plant. This requires huge amount of working capital to procure and store the rice straw. On a similar basis the cost of Juliflora based power plant is also higher as they have to also invest in Chippers, Shredder, Cutters, trolleys for cutting, harvesting and handling Julfilora.

2.5.11. MNRE vide its letter dated 30th September, 2011 submitted that the Capital cost of the biomass based power project depends upon the type of fuel, which in turn decides the plant configuration and technology type. MNRE recommended project cost for various biomass categories for IPP and tail end projects as given in the table below:

Capital cost of the biomass based power project

Cost Head	**Project Cost – IPP (` Lakh /MW)**			
	Straw	**Stalk**	**Plantation**	**Husk**
Steam Pressure/ Temperature (ata/ ^{0}C)	68/435	68/435	87/515	87/515

Land Civil and Equipment Cost	545.5	522.6	517.2	517.2
Fuel Logistics equipment	49.6	3.6	5.6	1.5
PDD Charges	4.6	4.2	4.1	4.1
Finance Charges	31.1	28.7	27.4	28.4
Margin Money	19.3	19.2	19.2	18.8
Total Project Cost	**650.1**	**578.3**	**573.5**	**570**

2.5.12. MNRE finally recommended normative capital cost as shown below:

Capital Cost of Biomass based Power Plant

Biomass	IPP (>5MW) Rs. in Lakh
Rice husk	570
Straw	650
Others	580

2.5.13. It is important to note that the cost of biomass processing equipments, Plant & Machinery required in the Power plant and the cost of interest during construction (IDC) are part of total capital cost. Some biomass processing equipments like: Shredder, Chippers, balers, etc are required for sizing of biomass to make it ready to be feed in the Boiler.

Cost of Equipments for preprocessing of Biomass

Sr. No.	Equipment	Unit Cost (Rs. Lakh)	Units required/ 10 MW plant	Cost/MW (in Rs. Lakh)
1	Chipping & Shredding	200	2	40.00
2	Bailer	3	2	0.60
3	Loader cum Hydra	8	2	1.60
4	Fork lift truck	12	2	2.40
5	Tilted platform for unloading	5	2	1.00
				45.60

2.5.14. Looking to the small size of biomass based power plants the overall per MW capital cost is higher than the Thermal power plants as the fixed costs like, DM Plant, Civil work for Turbine house, Boiler foundation, road & other infrastructure inside the premises will be quite high. The costs of the pre-processing equipment used for a typical 10 MW size biomass plant are found in the range of Rs. 45 Lakhs/MW. The same is demonstrated below:

Capital Cost of the 10 MW Plant

Sr. No.	Category	Cost in Rs. lakh
1	Land Total	40
2	Civil Work	952
3	Electrification Work	504
4	P&M Indigeneous System	2379
5	BOP System	614
6	Project Management	382
7	Pre-Processing System	456
8	IDC	500
	Total Project Cost without Transmission Line	5826
	Transmission Line	250
	Total Project Cost with Transmission Line	6076

2.5.15. Considering the latest Capital Cost data submitted by the Indian Biomass Power Association as well as the data submitted by MNRE, we recommend a Capital Cost for biomass based plant at:

i. **Rs. 540 Lakhs/ MW** (excluding transmission infrastructure cost and including cost of water cooled condenser)

ii. **Rs. 580 Lakhs/ MW** (excluding transmission infrastructure cost and including cost of air cooled condenser),

iii. **Rs. 630 Lakh/MW** (excluding transmission infrastructure cost and including cost of air cooled condenser) for plant other than rice straw based plant, considering the additional investment on fuel procurement and collection equipments like baler, cutters, tractors, trolley, etc.

2.6. FUEL PRICE FIXING MECHANISM

2.6.1. IBPA has mentioned and even MNRE during the deliberation of FOR at Shimla has highlighted that a major problem being faced by the Biomass developers is the fuel price fixation mechanism. The data submitted by the IBPA reveals that most of the Biomass Power plants have the Fuel cost spent with 70 - 90 % on revenue , forcing the plants to shut down their operations during most of the days in a year and majority of the plants are operating in losses, with a negative financial view of the sector developing. This is true as even IREDA has submitted that they have not funded Biomass power plants in the last 2 years and the view of the sector is negative. There are also reports of many plants not being able to meet their loan and interest and have been declared as NPA by FI's.

2.6.2. The Fuel Price Fixation Mechanism for the Biomass Power Plants is based on the following factors:

- Factor Representing Basic Fuel Cost
- Factor Representing Processing Cost
- Factor Representing Transporting Cost

2.6.3. IBPA has also submitted that some of the SERCs like Rajasthan have kept fuel price as part of the regulation assuming 5% increase every annum. Revising regulation to correct the disparity, even if the SERC wants to do has to be done after following a lengthy process and is time consuming, which results in stressful condition for Biomass power plants. The Committee appreciates that fuel price fixation mechanism is a challenge and unless the fuel prices for Biomass power plants are fixed properly, the sector would continue to be under stress.

2.6.4. Majority of the states followed a fuel price indexation mechanism and a 5 % yearly escalation has been provided. But the current price prevailing for the Biomass Plants reveals that an annual escalation of around 15 – 18 % has been experienced due to abnormal prevailing financial conditions, decontrol of diesel and petrol prices and is increasing by more than 100% in the last 3 years, increase in inflation etc being some of the factors, which have increased the fuel prices by more than 5% per annum.

2.6.5. IBPA has opined that the Basic Fuel cost has gone up drastically apart from the transportation cost due to ever increasing diesel prices. The sector would not be able to perform and come out of the present stress unless the fuel price mechanism is properly set.

2.6.6. Considering the above, the Committee is of the view that the fuel pricing mechanism has to be proper for the operation of the Biomass power plants, else the sector will not be able operate properly. This is a major problem and concern of the Industry as also deliberated and submitted on various occasions. The Committee recommends that the fuel prices be fixed at the beginning of the year on independent survey, which can be conducted by State Nodal agency, which is already there in all states. This would be most transparent and amiable fuel price mechanism. However the State nodal agency must ensure that the independent fuel price survey is conducted on time every year. This would end all confusion and problems currently being faced by the Biomass sector and is a rational solution to the fuel price fixing mechanism.

2.7. CONCLUSION AND RECOMENDATION

2.7.1. The Committee acknowledges and recognizes that Biomass as segment of renewable energy is facing problems in the country and the objective of the formation of the working group was to deliberate and identify those factors, which were hampering the operation of the Biomass sector.

2.7.2. The Committee has deliberated and minutely collected all information and data from different stake holders and also visited sites of power developers to understand the practical implication of Biomass operation and to also understand the factors, which were posing problems to the sector and the recommendation is based on the actual information collected from different stakeholders and site visits analyzing the technical, financial and operational information.

2.7.3. Committee also recognizes that Biomass is an integral part of renewable energy, which provides firm, reliable and clean power. It also assists in rural development and creation of employment opportunities in the rural sector. The optimum operation of the Biomass power plants would assist in power generation and rural development in the country.

2.7.4. The Committee is of the view that the requirement of higher specific consumption resulting into relaxed norm of Station Heat Rate and Gross Calorific Value stem out of fuel related issues, viz.:- lack of availability of surplus biomass, poor quality of biomass fuel, inadequate fuel collection, distribution & supply mechanism, competitive buyers of biomass and price rise, resulting into usage of waste biomass and lower

plant load factor. Following normative parameters suggested by the Committee for the consideration of the Commission for determination of generic tariff:

i. Station Heat Rate (SHR):
   a. 4200 Kcal/kWh for station using travelling grate boilers; and
   b. 4125 kCal/kWh for stations using AFBC boilers
ii. Gross Calorific value (GCV): 3100 kCal/kg
iii. O&M expenses: Rs. 40 Lakh/MW
iv. Auxiliary Consumption:
   a. 10% with water cooled condenser, and
   b. 12 % for air cooled condenser
v. Capital Cost (excluding evacuation cost and cost of water cooled condenser considered):
   a. For project with water cooled condenser: Rs. 540 Lakh/MW
   b. For project with air cooled condense: Rs. 580 lakh /MW
   c. For rice straw based project: Rs. 630 lakh/ MW
vi. Biomass Price: to be decided annually by a committee to be formed at State level representing State Commission, Nodal Agency, Government

2.7.5. The above suggested liberal norms on operating parameters should be allowed for the short term only. In order to resolve the issue on sustainable basis, to achieve long term fuel availability and to achieve biomass price stabilization, plantation backed biomass power plants need to be promoted. Development of Prosopis - Juliflora / other energy plantation on Government waste/barren/saline lands, Panchayat waste/ barren/ saline lands, degraded forest land, for use as supplementary fuel in Biomass Power Plants should be encouraged. The Committee is of the view that no biomass power plants should be licensed without plantation.

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ANNEXURE-I

A record of decision taken and list of participants in the Committee meeting held on 25h October, 2012 under Chairmanship of Shri Rajiv Bansal Secretary , CERC

- During the meeting briefly explained the background of the meeting called to discuss the terms of reference of the Committee as decided by the Commission and way forward to achieve the objectives.Various issues relating to the Terms of Reference were discussed and following course of action was suggested:
- The Committee should take help of external consultant for evaluating the parameters.
- The Committee should concentrate only immediately on factor affecting energy charges first like: fuel availability, its quality (Gross Calorific Value (GCV)) and biomass price, so that the issue can be sorted out immediately.
- Relevant data on Biomass prices, GCV, Station Heat Rate, specific fuel consumption Operation & Maintenance expenses etc of biomass based plants under operation in various states, to be provided by the Indian Biomass Power Association (IBPA) to the Committee.
- The Committee may co-opt representative of State Electricity Regulatory Commissions like: Andhra Pradesh, Maharashtra, Rajasthan & Tamil Nadu, as additional members of the Committee.

Following were present in the meeting:

i. Mr. Rajiv Bansal, Secretary, CERC
ii. Dr. D.K. Khare, Director, MNRE
iii. Mr. S.C. Shrivastav, Joint Chief (Engg.), CERC
iv. Mr. P.K. Awasthi, Joint Chief (Finance), CERC
v. Mr. S.K.Chatterjee, Dy. Chief (Reg. Aff.),CERC
vi. Mr. S.K. Kassi, director (TE &TD) Division, CEA
vii. Mr. Amitabh Tandon, Indian Biomass Power Association

viii. Mr. Ranjan Yadav, Indian Biomass Power Association

ix. D Radhakrishna Secretary General Indian Biomass Power Association

x. Mr. R.H. Shah Advisor (Renewable), CERC

ANNEXURE-II

GCV kCal/kg

Day	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12
1	3324.23				3297.18	2976.98	2949.57	
2	3212.62					3075.47	3095.25	2526.61
3	3276.65	3332.13					2913.06	2792.70
4	3369.55	3414.47						2794.80
5	3357.71	3406.55			2546.27	3302.11		2826.37
6	3291.51	3495.70			2783.07	3146.23	3106.39	2888.33
7		3471.23			2958.18	2870.11	3006.77	2959.70
8		3440.11			3006.35	2881.68	3152.84	3007.14
9		3486.38			2933.35	2857.81	3084.81	3097.22
10		3407.04			2695.72	2838.43	2816.83	2958.90
11		3388.46			2909.23	2923.83	2991.10	3073.08
12					3041.51	2983.18	3071.60	3185.89
13					3063.10	3118.76	2852.28	3039.15
14		3384.27			3032.48	3087.51	2706.93	3252.03
15		3440.51			2998.85	2608.27	2622.92	3090.61
16		3493.35				3469.00	2763.53	3152.11
17		3487.45			2924.67		2842.73	3221.87
18		3387.45			2937.66			
19		3468.85			3020.50	3017.35		3150.79
20		3499.02			3090.85	3026.53		3086.52
21		3358.35			3025.24	2959.18		3118.53
22	3110.50	3442.22			3062.24	3100.67		3072.05
23	3477.88	3450.88			296.69	2914.96	2430.55	3073.56
24	3321.12	3492.59			2918.29	3132.55	2460.56	2978.94
25	3445.13	3467.35			2997.66	2765.50	2689.83	3104.39
26	3226.31	3440.32			2911.78	2833.95	2776.84	2971.53
27	3345.13				3006.03	2926.78	2796.14	3072.75
28	3382.13	3412.54			2886.89	2959.13	2865.44	2889.16
29		3352.06			2901.69	3062.26	2736.23	2873.41
30		3445.56			2788.87	2903.82	2820.12	2994.14
31					3008.28			3164.19
Average	**3318.50**	**3434.59**			**2853.43**	**2990.08**	**2850.10**	**3014.36**

ANNEXURE-III

A record of decision taken and list of participants in the Committee meeting held on 9th July, 2013 under Chairmanship of Shri Rajiv Bansal Secretary , CERC

Based on the extensive deliberation, the Committee has unanimously recommended inter alia higher specific consumption norm resulting in relaxed norm of Station Heat Rate (SHR) and Gross calorific Value (GCV) should be allowed in the short-run and in long-run, in order to resolve the issue on sustainable basis, to achieve long term fuel availability and to achieve biomass price stabilization, plantation backed biomass power plants need to be promoted. The Committee decided to prepare a report based on the following parameters:

i. Station Heat Rate (SHR): 4200 kCal/kWh

ii. Gross Calorific value (GCV): 3100 kCal/kg

iii. O&M expenses: Rs. 40 Lakh/MW for FY 2013-14

iv. Auxiliary Consumption: 10% with water cooled condenser, and
12 % for air cooled condenser

v. Capital Cost (excluding evacuation cost and cost of water cooled condenser considered):
For project with water cooled condenser: Rs. 540 Lakh/MW
For project with air cooled condense: Rs. 580 lakh /MW
For rice straw based project: Rs. 630 lakh/ MW

vi. Biomass Price: to be decided annually by a committee to be formed at State level representing State Commission, Nodal Agency, Government

Following were present in the meeting:

i. Mr. Rajiv Bansal, Secretary, CERC
ii. Dr. D.K. Khare, Director, MNRE
iii. Dr. Meshram, Director, MNRE
iv. Dr. V.K. Jain, Director, MNRE
v. Dr. Ramesh Sawant, Director, MNRE
vi. Mr. S.C. Shrivastav, Joint Chief (Engg.), CERC
vii. Mr. P.K. Awasthi, Joint Chief (Finance), CERC
viii. Mr. S.K.Chatterjee, Dy. Chief (Reg. Aff.),CERC
ix. Mr. S.K. Kassi, director (TE &TD) Division, CEA
x. Mr. Amitabh Tandon, Indian Biomass Power Association
xi. Mr. Ranjan Yadav, Indian Biomass Power Association
xii. Mr. R. Kulothungan, Indian Biomass Power Association
xiii. Mr. R.H. Shah Advisor (Renewable), CERC