March 2013 Final Report

Study on the sustainability of Biomass based power generation in Karnataka

Prepared for

Karnataka Electricity Regulatory Commission
Bangalore

The Energy and Resources Institute

...towards global sustainable development

T E R I. 2013
Study on the sustainability of Biomass based power generation in Karnataka
Bangalore: The Energy and Resources Institute; 46 pp.
[Project Report No. 2012IB09]

For more information

Industrial Energy (IE)
T E R I
Southern Regional Centre
4th Main Domlur II Stage
Bangalore – 560 071
India +91 •Bangalore (0) 80

Telephone +91 80 25356590-94
E-mail grnrao@teri.res.in
Fax +91 80 25356589
Web www.teriin.org

Project Team

TERI
Mr. G R Narsimha Rao
Mr. T.Senthil Kumar
Mr. D Ramesh
Mr. C S Kumaraswamy
Mr. Atulkumar Yashwanth Auti
Mr. Rahul Raju Dusa

Project Advisor
Mr. P R Dasgupta
Mr.B S Dwajan

Secretarial Assistance
Ms. S. Vijaya Lakshmi

Acknowledgements

We are thankful to the management for giving us the opportunity to be involved in this very interesting and challenging project.

We received full co-operation and support from the concerned personnel. We would like to particularly thank:

Mr. Sreenivasmurthy M R	-	Chairman
Mr. Viswanath Hiremath	-	Member
Mr. Srinivasa Rao K	-	Member
Mr. Parthasarathy T A	-	Secretary
Mr. Pandit V G	-	Director (Tariff)
Mr. Nagaraju. B R	-	Director (Technical)
Mr. Manjunath B R	-	Deputy Director

and all other supporting staff who have given full co-operation and support. They took keen interest and gave valuable inputs during the course of study. We would be happy to provide any further clarifications.

Table of Contents

List of Tables

List of Figures

Executive Summary

Biomass is a renewable resource and estimated to be surplus across the country. It has been identifed as a potential source for power generation. Biomass is derived from the by-products of various resources like agricultural crops such as paddy, corn and sugarcane, wood waste and forest residues. It is estimated that Karnataka has a biomass based power generation potential of 1000 MW and till date close to power projects totalling to 90 MW have been commissioned.

Karnataka Electricty Regulatory Commission (KERC) believes that the slow growth of biomass based power generation projects could be due to the prevailing buyback tariff and the fuel cost which is dynamic. KERC commissioned this study called '*Sustainability of Biomass based Power Generation in Karnataka*' in order to review the situation and suggest improvements so that there could be a healthy mix of biomass generated power in the State under the renewable energy category.

TERI has been engaged to review the operational features of existing biomass plants, fuel linkages and to advice variable cost component of tariff in order to make it attractive. KERC also sought suggestions for mitigating fuel risks so as to support future growth of biomass power plants in the state. The status of biomass power plants of neighbouring states was studied for a comparative analysis.

During the study period, it was found that six biomass based power plants (53 MW) were in operational. Five out of the six power plants are in the rice growing belt and rice husk is used as a major fuel. Other biomass fuels are used as supplementary fuel based on availability. As the price of rice husk has steeply increased during the last three years, power plants are in constant search for a low cost biomass so that the fuel costs could be kept under check.

Due to a mismatch between the discom buy back tariff and actual generation unit cost, some of the power plants have stopped their operations and one power power plant has recently shifted to open access in the state. The situation is similar in other states too as revealed during the study. In Tamil Nadu, as on 31st March 2012, out of 169 MW with PPA to supply power to TANGEDCO, 163.15 MW was allowed to exit out of the PPA and 5.85 MW are still supplying power to TANGEDCO. In Maharashtra only five projects out of the 14 projects are operational in the State presently, which amounts to 147 MW of installed capacity hardly being utilised. In Andhra Pradesh, most of the biomass power plants are operational on a seasonal basis when biomass fuel prices are low.

The installed existing biomass power plant in Karnataka are of the 6 MW range and the design heat rate of such plants is 4300 k.Cal/kWh. These power plants have specific fuel consumption (rice husk as base fuel) of 1.4 kg per kWh and the auxillary power power consumption percentage is 12%. It is essential to take into account these technical parameters including particular rating of plants while computing the tariffs, instead of taking general rating plants. During the study, gasifier based power plants connected to the grid were visited. It revealed that the unit power generation costed Rs 6.50 per kWh as against the buy back tariff under PPA of Rs 2.25 per kWh. This was despite that the biomass fuel purchase price was restricted to Rs 1500 per ton for gasifier based power plants.

The buyback tariff varied from Rs 3.58 to 5.13 per kWh due to various reasons/issues with discoms. The present prevailing buyback tariff offered for power plants is not attractive to run biomass power plants profitably. Taking into account the prevailing average fuel price variable cost component for the biomass power plants has been worked and given below in table and more details presented in the report.

Parameters	Biomass Power Plant Rating/Type			
	Water Cooled Condenser		Air Cooled Condenser	
	6 MW	15 MW	6 MW	15 MW
Variable Cost, Rs per kWh	**3.53**	**3.08**	**3.78**	**3.30**

To sustain the operation of biomass power plants in the state and to meet the minimum purchase obligation for procurement of power from renewable sources, these power plants should be categorised as ‘must run’ plants. The following recommendations have been made to ensure the sustainability of biomass power plants.

Immediate Measures
☞ ***Uniformity in buyback tariff****:* It is essential to review the present prevailing tariff of running biomass power plant and make an uniform tariff structure applicable to biomass power plants; ☞ ***Technology accountability***: It is important to note that the existing biomass power plants are in the 6 MW range. Appropriate technical parameters (like SFC, APC) relevant as well as achievable during normal operations have to be considered while computing buyback tariffs; ☞ ***Adopt two part tariff (Fixed & Variable cost):*** To encourage biomass based power generation plants through competitive bidding Cost-Plus method is followed. As the fuel cost varies from time to time it is advisable to adopt a two part tariff and the fuel cost is considered as a pass through. The variable component of tariff would take care of such a price escalation; ☞ ***Submission of Annual statement***: Every biomass power plant should furnish a monthly fuel procurement / usage / cost and power generation quantity (both Gross & Net) to the appropriate agency designated, duly certified by the chartered accountant.
Short Terms Measures (within 1 year)
☞ ***Follow MNRE Guidelines for New upcoming plants***: To avoid the price volatility of fuel due to local demand, it is suggested to follow guidelines of MNRE plants which have a minimum radial distance of 50 KMs while setting up new biomass power plants.
Mitigation Techniques – to avoid shortage of fuel
☞ Conduct energy audit programme for rice mills; ☞ Adopt policy change to stop export of paddy - APMC; ☞ Check on new industrial licences – Use of Biomass; ☞ Encourage energy plantation scheme;

As the biomass weight attached to the variable expenses is more and rice husk is primary fuel for biomass power plants in Karnataka, it is recommended to link the minimum support prices (MSP) of Paddy fixed by the Government with the rice husk, which works out to be 20% (weight basis) of the paddy MSP. The same can be reviewed on a regular basis and compared with the submitted monthy statement of biomass utilisation and price.

As many projects have not come up in the State due to absence of a proper market mechanism, establishing the cost of biomass fuels is yet to be done. It is strongly recommended that the tariff is determined once in two years by working out the tariff for the fixed expenses and variable expenses. Implementation of the above recommendations can lead to sustainability of biomass power plants in the state.

CHAPTER 1 Introduction

1.1 Background

Over the last decade, the Government of India has recognised the importance of biomass as a reliable energy source. The Ministry of New and Renewable Energy (MNRE) has initiated several programmes for promotion of efficient technologies for biomass use in various sectors of the economy to derive maximum benefits. Biomass power generation in India is an industry. The estimated biomass availability in India is about 500 million metric tonnes per year of which close to 120 – 150 million metric tonnes per annum is assessed to be surplus which includes agricultural and forestry residues. The available total biomass has a power generation potential of about 18,000 MW.

The estimated power generation potential from surplus biomass in Karnataka State is close to 1000 MW. Out of which about 90 MW has been harnessed and over 300 MW has been allocated to prospective developers. Existing biomass based power producers (Independent Power Producers, IPP) are facing various challenges and some of the power plants are not operating to their full potential.

The Karnataka Electricity Regulatory Commission (KERC) thinks that one of the reasons for the slow progress of biomass based power projects could be the mismatch between the prevailing tariff and the dynamic cost of fuel, which is a key factor. Considering the above, KERC in July 2012 sought for this study *'Sustainability of Biomass based power generation in Karnataka'*. .

1.2 Objectives of the Study

The Energy and Resources Institute (TERI) was entrusted to carry out a study with the following objectives:

- To study the technical performance of existing power plants in terms of Plant Load Factor (PLF) and availability;
- To study the existing arrangements of procuring fuel / assessment of fuel risks in terms of quantum and cost;
- To study the cost structure of existing plants and assess its financial status;
- Evaluation of appropriate tariff to make biomass power generation financially sustainable;
- Suggest measures for mitigating fuel risks both in terms of quantum and cost.

1.3 Methodology

The study is based on direct interactions with various stakeholders which include biomass based power producers, rice mill owners, transport agencies, government agencies, biomass suppliers, etc., and analysing secondary information relevant to these areas.

During the study period existing power plants were visited to understand the root cause of the problems/issues, to evaluate possible options of sustainability of biomass based power projects.

TERI and KERC jointly defined the methodology to cover the following areas:

- Status of biomass based power plants;
- Fuel Linkage of existing power plants;
- Review of the biomass based power plants in other States;
- Evaluation of appropriate tariff;
- Review of the study findings.

The findings of this report are largely based on the information provided by various IPPs, agencies and through discussions, meetings, presentations and assessments made during field visits.

1.4 Duration

The study duration was 60 days and after completion of the field study, the findings were shared with the Commission. Based on discussions with the Commission, a draft report was prepared and submitted.

CHAPTER 2 Biomass as Fuel for Power Generation

2.1 Biomass as Source

Biomass materials used for power generation include bagasse, rice husk, straw, cotton stalk, coconut shells, soya husk, de-oiled cakes, coffee waste, jute wastes, groundnut shells, saw dust, stems of *Prospis juliflora* etc. Mainly the local agro waste/residue is found to be the major source of fuel to these power plants. In Karnataka most of the biomass based power plants use rice husk as a major source of fuel.

The husk surrounding the kernel of rice accounts for approximately 18% by weight of the harvested grain (paddy). The exterior of rice husks are composed of dentate rectangular elements, which themselves are composed mostly of silica coated with a thick cuticle and surface hairs. The mid region and inner epidermis contains little silica. The quantity of husk from small single stage mills and large mills vary 18 and 25% respectively. For every ton of paddy processed, around 200 kg of rice husk can be obtained.

The other crop residues like coffee husk, groundnut shells and *Prospis juliflora* are available on seasonal basis. Biomass fuels like coconut shells are available throughout the year in small quantities.

Forest wood is another source of biomass. Mainly, the wood is converted to value added products at saw mills and the waste generated at saw mills is used as biomass in power plants and other industries.

2.2 Potential assessment of Biomass in Karnataka

2.2.1 Biomass availability

Earlier, MNRE has conducted a detailed biomass assessment studies based on survey / investigations using Geographical Information System (GIS) tools. The survey reports gives Crop Yield [Tons/Hectare], CRR [Crop Residue Ratio = Residue yield (Tons/Ha) / Crop Yield (Tons/Ha)], surplus biomass available after basic uses such as fodder, fuel etc. The district wise biomass assessment along with surplus quantity is given in table 2.1.

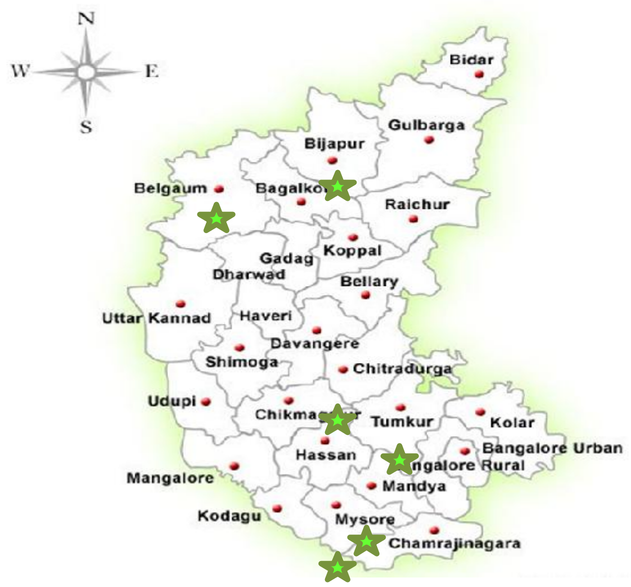
Table 2.1 District wise biomass assessment in Karnataka

District	Area (kha)	Crop Production (kT/Yr)	Biomass Generation (kT/Yr	Biomass Surplus (kT/Yr)
Belgaum	970.3	10585.4	4434.1	1381.1
Bijapur	1035.3	7401.1	2696.9	811.1
Mysore	433.1	3330.1	2144.7	531.4
Bellary	568.0	1629.1	2015.6	490.4
Mandya	272.8	5345.7	1972.1	520.1
Chitradurga	505.2	1686.4	1558.5	515.3
Gulbarga	1586.4	1416.0	2082.8	445.5
Dharwad	588.7	1745.2	1523.4	425.5
Tumkur	620.1	1226.0	1806.9	531.3
Shimoga	260.9	2863.2	1826.2	445.7
Raichur	714.4	1451.9	2011.2	410.9
Hassan	368.7	2119.2	1412.2	343.1
Bidar	436.4	2220.5	992.9	255.4
Kolar	305.0	1048.7	1081.9	251.7
Dakshina Kannada	31.9	96.6	883.6	176.4
Chikmagalur	238.2	553.2	794.9	188.0
Bangalore	93.6	373.1	458.1	128.2
Kodagu	33.7	134.1	227.9	36.2
Uttara Kannada	5.6	26.5	33.4	16.7
Total	**9068.2**	**45252.2**	**29957.5**	**7904.0**

Source : MNRE project*

The total forest and waste land in the state is accounted as 6993 kHa and produces wood equivalent to 10,000 KT per annum. The surplus biomass generated after processing the wood would be in the tune of 6600 KT per annum. The top six surplus biomass districts are highlighted below in figure 2.1.

Figure 2.1 Top six surplus biomass districts



Considering the biomass characteristics, it is important to note that a few types of agro waste/residues are popularly used in the power generation process. The quantity of surplus biomass pertaining to normal use in power plant operations across the state is given in table 2.2.

Table 2.2 Major crops and their residues available in surplus quantity

Crop	Residue	Area (kHa)	Crop Production (kT/Yr)	Biomass Generation kT/Yr	Biomass Surplus (kT/Yr)
Coconut	Shell	252.8	708.3	115.5	92.4
Cotton	Stalks	417.8	705.4	1587.7	476.3
Ground nut	Stalks	906.9	890.4	1780.7	534.2
Jowar	Cobs	1379.6	1210.6	2056.6	205.7
Maize	Stalks	251.8	677.8	1354.9	541.9
Maize	Cobs	251.8	677.8	203.2	142.3
Paddy	Husk	1002.4	4091.9	839.2	503.6
Ragi	Straw	810.8	346.4	2036.1	203.6
Sugarcane	Trash	329.1	31621.7	4743.2	1897.3
Sunflower	Stalks	651.7	213.2	425.5	85.1

Source : MNRE project

Apart from the above listed in the table, a large quantity of biomass is generated from sugarcane and by rice husk which are used as fuel in biomass based power plants. However, sugarcane is also used by the cogeneration facilities (for both season & off season). Other crops listed in the above goes for local consumption. If power plants are located in close vicinity the crop residues can be partially used directly (or) blended with rice husk.

Most of the biomass based power plants in Karnataka consider rice husk as the main source of fuel. The availability of rice husk is given in table 2.3.

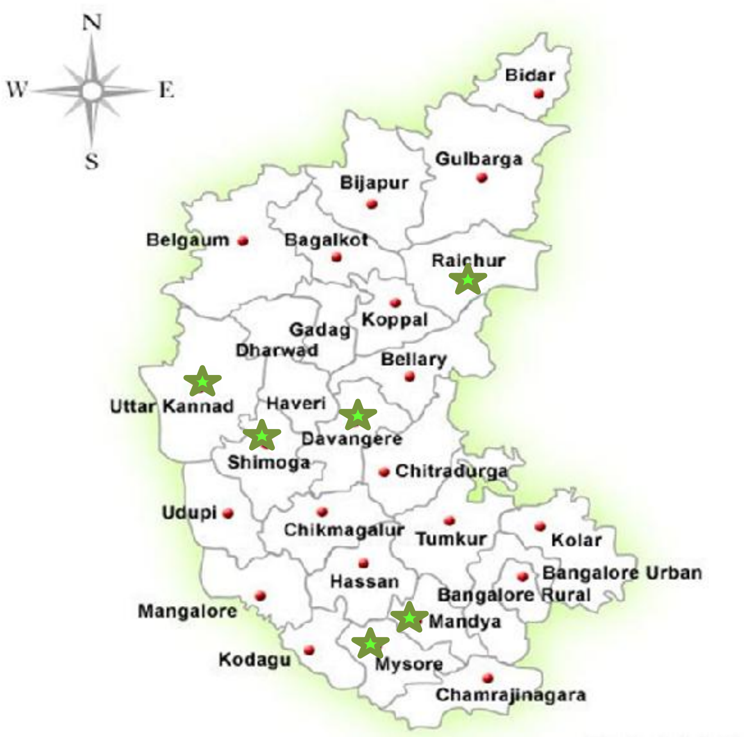
Table 2.3 Availability of rice husk in last few years

Paddy Crop	Area (Lakh Ha)	Crop Production (Lakh T/Yr)	Biomass Generation Lakh T/Yr	Biomass Surplus (Lakh T/Yr)
2007 -08	14.2	58.0	11.9	7.1
2008 -09	15.1	60.4	12.3	7.3
2009 -10*	14.8	62.1	12.7	7.6
2010 -11*	15.3	64.2	13.1	7.8

Source : Government of Karnataka, Directorate of Economics & Statistics (www.htpp://des.kar.nic.in)

From the above it is clear that the power generational potential due to the surplus husk quantity is around 65 MW. A significant quantity of rice has been used by other process industries (for boilers), brick manufacturers, etc.
The six major rice producing districts are highlighted in figure 2.2.

Figure 2.2 Six major rice producing districts



The installed biomass plants are located in the major rice producing districts highlighted in the above map.

2.2.2 Seasonal variations

Most of the agro wastes is generated during the harvesting season. The rice mills operate in 2 seasons (January to March & August to October). The rice husk availability reduces during the rest of the year. As per the practices, most of the rice producers sell rice husk during the milling period to agents who in turn store it at their facilities and make it available throughout the year.

2.2.3 Price trend

The price of the husk varies during peak season and off season. There is a difference of Rs. 400 to 600 for every ton of husk. This price difference is not at the producer level because the husk is sold during the milling period. This off season higher prices are attributed to the agents / traders.

Other biomass (agricultural residues and waste wood) are sold directly (or) through agents to different power plants. The price of other biomass quantities is less compared to rice husk.

2.3 Technical feasibility of Biomass (including rice husk)

Rice husk is a proven fuel for power generation. It is used in different parts of the country like Maharashtra, Andhra Pradesh, and Tamil Nadu. Though it is not one of the best biomass as far as combustion characteristics are concerned, its availability as a processed fuel makes it a good choice. It has reasonably good calorific value of 3040 kCal/kg (refer Appendix 2/1). It is important to note that the calorific value of husk deteriorates if stocked for a longer period. The high ash content of rice husks and the characteristics of the ash impose restrictions on the design of the combustion systems. For example, the ash removal system must be able to remove the ash without affecting the combustion characteristics of the furnace. The temperatures must be controlled such that the ash melting temperature of approximately 1440°C is not exceeded and care must be taken that the entrenched ash does not erode components of the boiler tubes and heat exchangers. For power production using rice husks, water tube boilers are the most common choice. The combustion chamber is normally of rectangular cross section. The walls of the chamber are formed either by tubes welded to each other or with the interstitial space filled with refractory.

The chamber is closed at the base. The type of closure depends on the type of boiler but there is always a means of extracting ash from the base.

Taking into account the pooling cost of biomass, these power plants use other locally available agro fuels (whose cost is lower than rice husk) along with rice husk to minimise the operating costs. Apart from the boiler, the rest of the other equipment of a combustion based biomass power project is similar to any coal based power project.

2.3.1 Storage

Storage of rice husk requires a lot of space as its bulk density is very low. It ranges from 96 to 160 kg/M^3. For example, for a 10 MW power project, around 1188000 tons of rice husk is required annually. For 6 month storage, taking an average bulk density of 120 kg/M^3, 4, 95,000 M^3 space would be needed. Another major issue with rice husk storage or any other biomass is the high risk of catching fire.

2.3.2 Other biomass fuels

For any shortfall in the rice husk availability, there is always a possibility of filling the gap with other biomass options. Most of the old power plants of 6 MW range are installed with a traveling grate type boilers. These boilers are not suitable for other biomass fuel and these boilers operate at lower efficiency during the use of multiple fuels. However, most of the new coming up power plants are installed with fluidised bed combustion (FBC) boilers and designed to operate on multiple fuels. There are no technological limitations in mixing other type of biomass fuels. But there are different issues in using the other biomass options.

Calorific value of different biomass fuels is given in **Appendix – 2/1.**

2.4 Technological options

There are two main technological options to generate electricity by using rice husk & other biomass as fuel. They are

- Combustion
- Gasification

Combustion route is one of the oldest established technologies for power generation. Biomass combustion based power projects are similar to coal fired plants. The plant consists mainly of a boiler, steam turbine, alternator, fuel handling, ash handling etc. The only difference between a coal fired and biomass fired plant is the design of boiler. In the process, biomass is fired and the heat energy is used to generate steam in the boiler. The steam turns the turbine which in turn rotates the alternator thereby producing electricity. The range of these biomass fired plants varies between 1 MW to as high as 50 MW. There are many suppliers such as Thermax, Triveni engineering, BHEL, etc who provide services for Biomass power plants.

Gasification is process to convert biomass into gaseous fuel, which is termed as producer gas. The process is based on pyrolysis of biomass which results in the combustible gas. This gas is used to generate electricity by feeding it into internal combustion gas engines. The technology for the rice husk is available but not very well proven. The other limitation with the technology is the capacity of power projects. The maximum capacity for these projects goes up to 500 kW. Experience with grid inter-phasing is also limited.

Therefore the possible options for biomass based power projects in MW scale is the combustion route.

CHAPTER 3 Review of existing Biomass based IPPs

3.1 Present Status

The Karnataka Renewable Energy Development Limited (KREDL) is a nodal agency for the implementation of the Renewable Energy Policy in the state. KREDL is responsible for laying down the procedure for inviting proposals from Independent Power Producers (IPPs), detailed project reports (DPR), evaluation of project proposals, project approvals, project implementation, operation & monitoring.

As per the MNRE, the commissioned biomass and cogeneration plants across the state as on 31st March 2011 is about 365 MW. The year wise commissioned capacity (in MW) for last 10 years is given in figure 3.1.

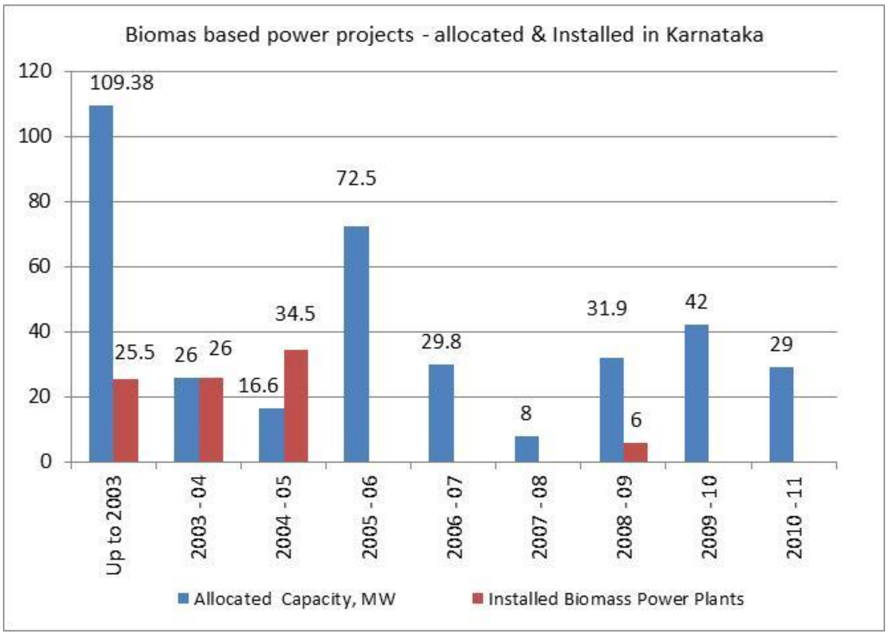


Figure 3.1 Year wise commissioned capacity (in MW) in last 10 years

Under the IPP category (12 power plants) using biomass as fuel, the installed capacity is 92 MW (as per KREDL). Most of these power plants were installed before 2005. In addition to the present installed capacity, additional 52 power producers are coming up with biomass based power plants of a total capacity of over 300 MW. A complete list of the biomass based power projects and its status as discussed with KREDL is given in **Appendix 3/1**. The status of the biomass based power plants in operation are given in table 3.1.

Table 3.1 Status of the biomass based power plants

S No	Name Power Plant	District	Licenced Capacity, MW	Installed Capacity, MW
	Operating Power plants			
1	Indra Power Energies Ltd.	Koppal	6	6
2	Koganti Power Pvt. Ltd.	Raichur	8	7.5
3	Koppal Green Power Ltd.	Koppal	6	6
4	Power Onicks Ltd.	Bellary	6	6
5	Ravikiran Power Project Pvt Ltd	Koppal	8	7.5
6	RK Power Gen Private Ltd.	Chitradurga	20	20
	Sub Total		**54**	**53**
	Non-operational Power plants			
7	Konark Power Ltd	Tumkur	6	7.5
8	Malavalli Power Plant Private Ltd.	Mandya	4.5	4.5
9	Hassan Biomass Power Company Private Ltd.	Hassan	8	8
	Sub Total		**18.5**	**20**
	Cogeneration type Power plants			
10	Bhagyanagar Solvents and Extractions P Ltd	Raichur	11	7.5
11	Samsons Distilleries Private Ltd.	Davangere	2	2
12	Falcon Tyres Limited	Mysore	6	6
	Sub Total		**19**	**15.5**
	Total		**91.5**	**88.5**

Three power plants (of 15.5 MW) are operating as co-generation cum captive power plant for industries. Another three plants (of 20 MW) are non- operational. At present six biomass plants (of 53 MW) are operational across the state. The details of biomass based power plants are given in **Appendix 3/2**.

3.2 Review of the operational features of IPPs

During the study period, existing operational power plants were visited to understand the installed equipment and operational features. After the preliminary project review / discussions with the regulatory commission, a detailed questionnaire was developed to get adequate information from the field visits. It was mainly to obtain adequate qualitative and quantitative data from the operational power plants to assess the performance of individual plants.

The filled in questionnaires of the power plants are given in **Appendix – 3/3.**

Plant Load factor (PLF)

It is observed that most of the power plants are operating close to its rated capacity. Under normal circumstances these power plants are operational for around 300 days per annum. The PLF of the power plants is given in table 3.2.

Table 3.2 Details of operational capacity and PLF of biomass power plants

Name Power Plant	District	Installed Capacity, MW	Operation		
			Capacity, MW	PLF, %	Plant availability, days
Indra Power Energies Ltd.	Koppal	6.0	6.0	72	275
Koganti Power Pvt. Ltd.	Raichur	7.5	7.5	94	300
Koppal Green Power Ltd.	Koppal	6.0	6.0	90	300
Power Onicks Ltd.	Bellary	6 (8 MW upgraded)	7.5	80	275
Ravikiran Power Project Pvt Ltd	Koppal	7.5	6.2	82	220
RK Power Gen Private Ltd.	Chitradurga	20	12	< 50	250

Power Generation Potential

During the field visit only a few plants shared their last three years gross and net power generation. The data helped in analysing auxiliary power consumption of the power plants. The data collected for two power plants have been presented below in table 3.3.

Table 3.3 Biomass power plants three years operational data (2 Nos.)

Parameters	R K Power Gen (20 MW)			Indra Power (6 MW)		
	2008 -09	2009 - 10	2010 -11	2008 -09	2009 - 10	2010 -11
Power generated, MU	79.623	77.403	69.917	43.56	38.61	37.29
Power Exported, MU	69.918	67.943	61.707	38.22	33.26	32.0
Auxiliary power, MU	9.705	9.46	8.21	5.34	5.35	5.29
Auxiliary power, %	**12.19**	**12.22**	**11.74**	**12.25**	**13.85**	**14.18**
Power Import, MU	1.012	0.879	1.023	0.176	0.213	0.2
Plant Load Factor, %	**45.4**	**44.2**	**39.9**	**82.9**	**73.5**	**70.9**

It can be seen from the above table that the year on year plant load factor is decreasing. The higher capacity power plant (20 MW) PLF is less than 50% in the last three years, due to non- availability of biomass quantity. Biomass power plants operating rice husk as a major fuel (6MW plants) has operating PLF above 80%. The operating auxiliary power consumption of 6 MW biomass power plants is 12 ± 1% range.

3.3 Technical Performance of Biomass power plants

A majority of biomass power plants (6 – 7.5 MW capacity) has installed boiler of rated capacity of 30 ± 3 TPH water tube type travelling grate bi-drum boiler and 6.5 MW Impulse reacting turbine. The designed steam temperature from the boilers is 480 ± 15 °C. Steam is generated at 65 kg/cm^2 (g), 465°C and is fed to turbine. The steam is exhausted at 0.1ata from the turbines and is fed to the surface condenser.

Biomass such as rice husk, coconut waste, coconut coir, bengal gram dust, maize waste, palm fibre, wood chips, and saw mill dust are the main fuels. The average fuel consumption is around 225 – 250 MT per day. The boiler is with an in-built economiser, air pre-heater and wet scrubbing venture system. The operation of the boiler is centrally controlled with DCS system. The produced steam is passed through an expansion cum condensing turbine. Other auxiliary equipment are connected to support the operations. The power generated is exported to the grid.

A brief detail of the typical biomass based power plant is provided in table 3.4.

Table 3.4 Brief specifications of a power plant

Particulars	Boiler
Boiler type	Water tube, travelling grate
Fuel used	Biomass-rice husk, bengal gram dust, coconut waste.
Steam generation capacity	27 TPH
Steam generation pressure	66 Kg/cm^2 g
Turbine type	Impulse-Reacting.
Design inlet pressure and temp	64 ata, 480 °C
Generation capacity MW	6.5 MW

The detailed design specifications of the boiler and turbine are provided in **Appendix - 3/4** for reference.

The salient features of the installed boiler and turbine details of present running biomass power plants are given below in table 3.5.

Table 3.5 Boiler turbine details of operating power plants

Name Power Plant	District	Installed Capacity, MW	Boiler / Turbine	
			Quantity, TPH / Pressure, Bar	Condenser type Air / Water
Indra Power Energies Ltd.	Koppal	6	30 / 65	Water
Koganti Power Pvt. Ltd.	Raichur	7.5	35 / 65	Water
Koppal Green Power Ltd.	Koppal	6	30 / 65	Water
Power Onicks Ltd.	Bellary	6 (8 MW upgraded)	32 / 65	Water
Ravikiran Power Project Pvt Ltd	Koppal	7.5	33 / 75	Water
RK Power Gen Private Ltd.	Chitradurga	20	100 / 106	Air

Boiler & Turbine performance

The normal operating parameters of the boilers are mentioned in table 3.6.

Table 3.6 Operating Parameters of Boiler

Particulars	Units	Boiler # 4
Steam pressure	kg/cm^2	65
Steam temperature	^0C	465
Steam flow	TPH	29-32
Fuel consumption rate	TPH	9.4
Feed water temperature before economiser	^0C	104
Flue gas temperature before primary super heater inlet	^0C	515
Flue gas temperature after super heater	^0C	433
Flue gas temperature at boiler bank outlet	^0C	377
Flue gas temperature before air pre-heater	^0C	140
Flue gas temperature after air pre-heater	^0C	138
Measured carbon dioxide % in flue gas	%	16

The Biomass fuel fed into the boilers contains an average moisture content of 6-8 %. The boiler efficiency calculated using an indirect method is given in table 3.7.

Table 3.7 Boiler efficiency values

Particulars	Boiler
Heat Input	
Through heat value of fuel	96.0
Through APH air	4.0
Total input	100.0
Heat outputs	
Dry flue gas losses	4.0
Heat loss due to H_2 in fuel	3.9
Heat loss due to moisture in fuel	1.2

Particulars	Boiler
Heat loss due to moisture in air	0.2
Surface heat losses	0.8
Heat loss due to unburnt fuel	8.9
Heat losses due to ash	4.0
Total Heat losses	23
Efficiency	**77.0**

The evaluated efficiency of the boiler is 77 % as against a design efficiency of 80± 2%. The efficiency mainly depends on the type of the fuel mix and the moisture content of the feed material.

The Steam from the boiler is fed into the turbines at 64 kg/cm², 460°C and power to the tune of 6.5 MW is generated. During the same period around 790 kW of power is consumed in auxiliaries, which accounts to 12.1% of the generation. The major power consuming auxiliaries are the boiler feed water pump, cooling water circulation pumps, ID, FD and, SA fans. A list of these equipment along with their ratings are given in **Appendix – 3/5.**

The operating conditions and the power generation efficiencies of the turbo-generators (TG) are provided in table 3.8.

Table 3.8 Summary of the turbo-generator operating conditions

Particulars	Units	Turbo generator
Inlet steam pressure	kg/cm² (g)	64
Inlet steam temperature	⁰C	465
Inlet steam enthalpy	kcal/ kg	792
Average steam consumption	TPH	29
Exhaust steam temperature	⁰C	48
Exhaust steam Pressure	Bar	-0.86
Exhaust steam Enthalpy	kcal/ kg	585
Average power generation	kW	6500
Turbine efficiency	%	26
Overall power plant efficiency	%	20

It can be seen from the above table, a typical biomass based power plants of smaller rating (6 MW range) has an overall operating efficiency of about 20 ± 1%.

One of the installed power plants, RK Power Gen Private Ltd., has an installed higher pressure and capacity boiler (100 MT & 106 bar) of spread stoker type. The connected turbine also has a higher rating of 20 MW. The present operating load is 10 -12 MW due to fuel shortage. The plant uses a variety of agro residues and small quantity of rice husk. The average fuel consumption is 325 MT per day (during 12 MW power generation). The installed turbine is connected with an air cooled condenser.

3.4 Performance indicators

Based on the installed equipment design configuration and operational parameters of these biomass plants, the performance indicators (heat rate, kCal/kWh) are derived. The derived performance indicators are given in table 3.9.

Table 3.9 Operational performance indicators for biomass plants

Parameter	Unit	6 MW	15 MW
Boiler (Q, H)	TPH / bar	28 / 65	75 / 105
Boiler Efficiency	%	80 ± 2	82 ± 2
Turbine Efficiency	%	26 ± 1	29 ± 1
Plant Efficiency	%	20 ± 1	23 ± 1
Plant Heat Rate	K Cal / kWh	4300	3740
Fuel Gross Calorific Value, (Rice Husk as major fuel)	K Cal /kg	3040	
Sp. Fuel Consumption	Kg / kWh	**1.41**	**1.23**
Auxiliary Power Consumption	%	**12 ± 1**	**11 ± 1**

The specific fuel consumption of biomass power plants of 6 MW range is above 1.41kg/kWh. The multi-fuel stock feed to the boiler average gross calorific values will be 2700kCal/kg range (use of much lower calorific value also results into inefficient operations). One of the main parameter is the moisture content. Some of the fuels moisture content will be as high as 30%. During use of such fuels the specific fuel consumption will go as high as 2kg /kWh. Even though, the rice husk calorific value is in the tune of 3,040 kCal/kg, the share of rice husk in most of the power plants is less than 75%. The calorific values of other biomass fuels are lower compared to the rice husk (on net basis taking into account the moisture percentage).

3.5 Non-functional power plants

During the study period, all the three non- functional power plants were visited and reviewed. Their status is given in table 3.10.

Table 3.10 Status of non-functional biomass power plants

Name of Power Plant	District	Installed Capacity, MW	Remarks
Malavalli Power Plant Private Ltd.	Mandya	4.5	Plant has been sold to Shri Chamundi Captive Energy Pvt. Ltd during current financial year.
Konark Power Ltd	Tumkur	7.5	Belongs to Shalivahana Group and the same is under negotiations for sale. Due to non-workable tariff (‘ 3.80 per kWh) the plant has stopped its operations.
Hassan Biomass Power Company Private Ltd.	Hassan	8	The plant was commissioned on May 2006 and closed in 2007. Banker is in process of auction of the plant.

The main reason for stopping the power plant operations is due to non-workable tariff. The copy of issues raised by M/s Malavalli Power Plant Private Ltd. is enclosed as reference (**Appendix 3/6).**

3.6 Gasifier based grid connected biomass power plants

Using the gasifier technology, three power plants were installed and connected to the State grid under the BERI project. During the visit to these plants as part of the study only one installation of 500 kW was functional. The rest were not in operation due to shortage of fuel. The list of gasifier based grid connected biomass power plants are given in table 3.11.

Table 3.11 Status of gasifier based grid connected biomass power plants

Name of Power Plant	Village/District	Installed Capacity, KW	Status
BERI	Kabbugiri /Tumkur	150	Not in operation
BERI	Kabbugiri, Tumkur	225	Not in operation
BERI	Bethamangala, Tumkur	500	1 x 200 + 1 x 100 - operational

The specific fuel consumption for these plants is around 1.1 to 1.2 kg/kWh (dry-wood). The sourcing of the wood is mainly from the forest department through auction and a small quantity is purchased locally. The cost of the wood for purchase is fixed at Rs.1.5 per kg and Rs.1.6 per kg for local suppliers.

The Power Purchase Agreement (PPA) with KPTCL allows buy back of the power at Rs.2.25 per kWh. However, the actual operation cost works out to be Rs. 6.50 per kWh even though the cost for wood purchase is less.

The auxiliary power consumption for these plants is around 15%. The higher auxiliary power consumption is mainly due to wood chippers and cutters for sizing the wood. A small quantity of charcoal (less than 15% of input fuel) is sold at a price of Rs.6 per kg. The operational performance of the plant is given in **Appendix – 3/7.**

The present PPA is valid up to 2015 and the project is looking forward to having its own grid connecting an area of within 10 KM radius (covering 5-6 villages) and supplying power to these villages directly.

3.7 Issues with biomass projects

Biomass projects in Karnataka were commissioned in two phases. In the first phase 86 MW projects were to be installed before 2005 while it was 6 MW in the second phase in 2009. None of these projects are on schedule and they have been delayed from 1.5 years to 2.5 years. It was found during discussions with power producers that major reasons for the delay were the time taken for loan disbursal from banks, delay in land acquisition for building the project and tie ups with the partners & technology suppliers. According to the power producers, it took a lot of time and efforts to convince the bankers that the project was techno-economically viable. A few of the project promoters became a little wary on seeing the rising prices of biomass, which ultimately increases the cost of electricity generation and reduces projected revenue. According to KREDL, lack of established linkages for consistent biomass supply is another reason behind the delay for many of the projects.

CHAPTER 4 Fuel Linkages

4.1 Review of trading practices

Studies on the trading practices of various biomass (including rice husk) in the districts of Koppal and Tumkur showed that the pattern of trading is similar in both the districts. The local biomass (like coconut shells, agro residue straw) is carried by farmers (or) collections agents directly to power plants by tractors, autos and mini trucks. The cost of the local biomass is much lower compared to rice husk but it also consists of high moisture content.

Saw mills have a rate contact with power plants and the cut wood is directly transported to power plants. Similarly coffee husk collected by local agents is transported in bulk to power plants.

In Tumkur district nearly 75 rice mills are in operation. The rice shellers sell husk to the trading agents who generally have their own transportation arrangements. The collected husk is stored by the agent and users buy directly from these agents. The price of the husk is decided by the agent based on demand from the buyers. A large quantity of rice husk is used by many industries in Bangalore Rural / Urban districts. It also includes the brick industry supplied from neighbouring Tumkur district.

In Koppal district each power plant has a long term contact with rice mills. The rice husk produced on a daily / weekly basis is transported to the power plants. In most of the cases the rice shellers do not store rice husk. Uniform prices have been fixed on an annual basis by the power plants to the rice mills.

But some of traders (local agents) with a large storage capacity store part of the husk to sell during the off season to get more revenue since the prices are higher during off season. These agents maintain the stock of rice husk to make it available round the year and to attract better revenues during off seasons. Husk consuming power plants maintain the stock for not more than 15 days at their storage yard.

Actually there are two ways the husk is sold. One way is that agents buy it from the sheller and deliver to the end user. Second, the agent on behalf of the end user purchases and supply. The earlier route is more prevalent in Koppal region. As far as the profile of the agent goes, they are mostly individuals who deal in husk, bran and other wastes like broken rice from rice mills. There are records to state the exact numbers of agents available. But from discussions, it is estimated that there could be 20 to 25 agents in Raichur /Koppal / Sindanur areas. There is no association / lobby of husk traders.

It can be summarised that the stocks are being maintained predominantly at the agent's level and part of it are maintained at the sheller level.

4.2 Consumption practices and price trend

Rice husk is probably the largest mill generated source of biomass apart from bagasse, which is available for energy use. As large quantities of rice husks are normally available at the rice mills there are no additional efforts or costs involved in processing for use as an energy resource. Due to the availability of large quantities at any given location, rice husk becomes a prominent source of energy production. A small quantity (5 -8%) of husk is self-consumed within the rice mills.

Traditionally, rice husk in Karnataka is being used in industries for heat applications and a significant portion of it goes for brick manufacturing. Husk is mainly used for heat applications in small and medium enterprises instead of fossil fuels like coal and oil. During the initial period about 10 – 15 years ago small process industries located near rice mills started using it as fuel in their boilers and furnaces by taking advantage of its lower cost than other available conventional fuel options. Such small-sector process industries use fixed, great fire-tube boilers with low capacity, which are manually fired, using coal as the fuel. Such combustion practices and boiler designs are primitive in nature and have built-in problems such as partial fuel combustion and low efficiency. As husks were available virtually for free, the boiler efficiency and the degree of combustion were the issues receiving the least attention.

With time the prices of fossil fuel went up whereas the prices of husk did not rise in that proportion and therefore husk became an obvious choice for industries over other options. Another major advantage with rice husk is its availability in ample quantity throughout the year and almost in pure form. Therefore the lower prices and availability led to the development of rice husk fired fluidised boilers. These days even big industries like breweries, process units have implemented these boilers to be able to use rice husk efficiently as their major fuel.

The price of rice husk has been increasing every year since 2005. There has been a gradual increase in price except in 2009, which witnessed a steep increase due to a very high demand from recently commissioned co-generation projects as well as process industries. Since the prices this year increased exorbitantly, electricity generation projects started using agro wastes to reduce the cost of electricity generation. The last five year's price trend is provided in table 4.1.

Table 4.1 Price trend of rice husk (Landing cost)

Year	Average price (Rs. / ton)
2008 - 09	1800
2009 -10	2050
2010 -11	2050
2011 -12	2200
2012-13	2500

These are market prices including the transportation and agent margins. The ex-mill prices for the last three years are lower by Rs. 500 for every ton. Therefore the effective average price to the power produced in 2012 will be Rs. 2500 / ton.

The landing cost of other biomass fuels is lower when compared to the rice husk. The landing cost for various biomass fuel are given in table 4.2.

Table 4.2 Landing cost of Biomass fuels

Year	Average price (Rs. / ton)
Rice Husk Season	2200
Rice Husk Off Season	2800
Corn (Chitradurga)	2400
Coffee Husk (Chitradurga)	3000
Dry Chilli Powder	1600
Wood Chips	1500
Juliflora	< 1000
Coconut Shell	900

Considering the large variation in biomass prices, power plants are trying to maintain a lower average cost (at present < Rs 1800 per ton) by using multi fuel stock. However, the gross calorific value of input feed is much lower when different fuels of various proportions are used.

4.3 Fuel Linkage arrangements

The present plants in operation have established fuel linkages which is listed in the following table.

S No	Name of the Power Plant	District	Type of Major Fuel	% share of Major fuel	Fuel Linkage
1	Indra Power Energies Ltd.	Koppal	Rice Husk	75	Contract with 20 Rice Millers
2	Koganti Power Pvt. Ltd.	Raichur	Rice Husk	60 - 65	Contract with 20 Rice Millers & going upto 30 KM away for additional quantity
3	Koppal Green Power Ltd.	Koppal	Rice Husk	50	Contract with 10 Rice Millers and its own rice mill
4	Power Onicks Ltd.	Bellary	Rice Husk	80	Contract with 100 Rice Millers with in 5 KMs
5	Ravikiran Power Project Pvt Ltd	Koppal	Rice Husk	80	Contract with 8 Rice Millers
6	RK Power Gen Private Ltd.	Chitradurga	Agro Waste		Contract with Coffee processing units for Husk & Linkage with saw mills (with in 100 KMs range)

It can be seen from the above table, rice husk utilised by individual plants is 75-80% range and most of the plants are getting fuel within 20KMs range. Plant like Koppal Green, made a long term deal for other biomass fuels (like chilli powder) and uses less quantity of rice husk (% share).

R K Power uses all varieties of biomass fuels, it has a long term contract with Coffee husk suppliers and saw mills. Due to non-availability of required biomass quantity, plant is getting biomass from 100 KMs distance. Due to shortage of biomass, plant is running at part load (12 MW range).

CHAPTER 5 Evaluation of Tariff

The National Tariff Policy and Electricity Act 2003 also lays an emphasis on renewable energy development. The State Electricity Regulatory Commissions (SERCs) have also been mandated to develop an enabling framework to promote RE development in the states. In order to promote biomass power generation the Karnataka State Electricity Regulatory Commission (KERC) has announced the tariff for biomass based power generation. Two tariff orders were also passed in this regard in 2005 and 2009.

5.1 Present buy back Tariff

Biomass based power projects allocated before 2001 have a PPA signed with KPTCL for 20 years term. The PPA commences from the date of signature but the prescribed tariff is applicable only for a 10 years period. Further extension of the PPA will be on mutual agreement after the 10 years period. Most of the PPAs of the operating power plants came for extension during 2010 and 2011. It is important to note that after the initial PPA with KPTCL in 2003, distribution companies have established in the state. It is an obligation for power producers to have a PPA with Discoms. Individual power companies have attempted to revise their tariff with Discoms for economic viability.

The present prevailing tariffs for operational power plants are given in the following table 5.1.

Table 5.1 Present prevailing tariffs for operational power plants

S No	Name of Power Plant	District	Installed Capacity, MW	Buy back Price (‘ per kWh)	Remarks
1	Indra Power Energies Ltd.	Koppal	6	4.43	Initial ₹ 2.85 per kWh + 2% rise – Nov'11
					II PPA from November 2011 with GESCOM for ₹ 4.43 per kWh
2	Koganti Power Pvt. Ltd.	Raichur	7.5	5	Initial ₹2.85 per kWh + 2% rise (2001 -11)
				(3 days payment)	Supplementary PPA in 2005 with GESCOM at ₹ 3.43 per kWh for 10 years
				Open Access	II PPA from November 2011 with GESCOM ‘ 3.60 per kWh for 10 years
					As above cost not workable **ÓPEN ACCESS'**

S No	Name of Power Plant	District	Installed Capacity, MW	Buy back Price (‘ per kWh)	Remarks
3	Koppal Green Power Ltd.	Koppal	6	4.3	Initial ₹ 2.85 per kWh + 2% rise (2001 -11) Revised PPA in 2007 with GESCOM at ₹ 4.30 per kWh for 10 years After expiry of PPA 2011 plant is extended for another 10 years
4	Power Onicks Ltd.	Bellary	6 (8 MW upgraded)	5.13	Initial ₹ 2.20 per kWh + 5% rise : up to 2011 With KPTCL Revised PPA 2007 with GESCOM (short time) - Before turbine failure After expiry of PPA 2011 plant is operating with **last price**
5	Ravikiran Power Project Pvt Ltd	Koppal	7.5	3.43 +	Initial ₹ 2.85 per kWh + 2% rise (2001 -11) Supplementary PPA in 2005 with GESCOM at ₹ 3.43 per kWh for 10 years Continue with last PPA terms (Rise in Cost)
6	RK Power Gen Private Ltd.	Chitradurga	20	5.13	Initial ₹ 2.20 per kWh + 5% rise : up to 2011 With KPTCL After expiry of PPA 2011 plant is operating with **last price (5.13)**

It can be seen from the table that there is a large deviation in buyback tariff. At the same time few power plants have not extended their PPA after 10 years of operation. These plants are operating with the last price of PPA closure (end of 10 years).

5.2 Tariff Determination Approach

In Karnataka, the renewable energy tariff was fixed up with some escalation in 2009 after reviewing the renewable energy tariff in neighbouring states like Andhra Pradesh and Tamil Nadu. However, the approach adopted by KERC – Single part tariff for all renewable energy technologies is not preferred, as price of rice husk (main source of fuel) is highly sensitive to market fluctuations. However, for biomass projects where fuel cost component is variable it is important that the biomass tariff should have both separate fixed and variable tariff components. Recently, most of the SERCs including Maharashtra and Rajasthan have declared their two part biomass tariff, wherein the fixed cost is fixed for 20 years but the escalation in variable cost is linked with the indexation mechanism. Similarly, the two part tariff approach for biomass project has already got a buy-in from the Central Electricity Regulatory Commission.

5.3 Appropriate Tariff

Biomass based power plants in operation were visited during the study period to understand, basic infrastructure and it operational features. A detailed cost structure of the working plant was studied. The various cost components are discussed for a 6 MW range plant below.

Operational features of power plant

Rated capacity of plant	: 6.0 MW
Operating Plant load factor	: 80%
Annual Gross Power Generation	: 42.0 million units (MU)
Auxiliary power consumption	: 12%
Annual Net Power Generation	: 36.9 million units (MU)

A. Cost of Fuel

Plant heat rate	: 4300 k Cal/kWh
Average Fuel Gross calorific Value (Reference rice husk as base fuel)	: 3040 k.Cal /kg
Specific fuel consumption	: 1.41 kg / kWh
Cost rice husk as major fuel (Annual average cost of rice husk)	: Rs 2500 per ton
Cost of fuel consumption	: Rs 3.53 per kWh

B. Operations and Maintenance cost

i) Salaries – Staff & Labour

No. of staff	: 38
No. of un- skilled manpower	: 60
Annual cost towards salary	: Rs 125 lakhs

Spares per Month	: Rs 2.5 lakhs
ii) Annual cost towards spares	: Rs 30 lakhs

iii) Overhauling cost (average)	: Rs 75 lakhs for 3 years
(including insurance amount)	: Rs. 25 lakhs per year

The above cost is mainly towards boiler and turbine overhaul once in 3 years after first 6-8 years of operations.

JCBs for material handling : 2 - 3
Diesel & Rent per month : Rs 4.5 lakh

iv) Annual cost towards material handling : Rs 55 lakh

Annual Operational cost (i +ii + iii + iv) : Rs 235 lakh *

C. Interest

i. Towards capital : Rs 15 lakh per month
ii. Towards fuel purchase : Rs 10 lakh per month
Annual cost towards interest : Rs 300 lakhs

***Note**: Taking into account of depreciation (due to overhaul)

Cost Component	Annual Cost (Rs lakh)	Unit cost on Gross generation (Rs per kWh)	Unit cost on Net generation (Rs per kWh)
Towards Fuel		3.53	3.53
Towards O & M	235	0.56	0.64
Towards Interest	300	0.71	0.81
Total		**4.80**	**4.98**

Based on the capacity of the plant and technology adopted (like water or air cooled condenser), variable cost has been worked out and presented below.

Variable Cost - Tariff				
Parameters	**Biomass Power Plant Rating**			
	Water Cooled Condenser		**Air Cooled Condenser**	
	6 MW	15 MW	6 MW	15 MW
Plant Heat rate, K.Cal/kg	4300	3740	4601	4002
Plant Efficiency, %	20	23	18.7	21.5
Rice Husk –Gross Calorific Value, K.Cal/kg : 3040				
Specific Fuel Consumption(kg/ Wh)	1.41	1.23	1.51	1.32
Prevailing average price of Rice Husk : Rs 2500 per MT				
Variable Charge, Rs per kWh	**3.53**	**3.08**	**3.78**	**3.30**

5.4 Deviations with the Tariff order

The specific deviations in the Tariff order issued by KERC in 2009 are in the following:

- Auxiliary Power Consumption
- Specific Fuel consumption

Auxiliary Power Consumption: The commission approved 9% auxiliary consumption, which is not practically achievable for biomass power plants in the 6 MW range. Based on the installed equipment and its operating load as well as efficiency, the normal best operating auxiliary power consumption will be 12%.

Specific Fuel Consumption: The commission approved 1.16 kg/kWh specific fuel consumption which is not possible as per design. The design plant heat rate of 6 MW biomass power plant is 4300 k.Cal/kWh. If a plant uses 100% rice husk as fuel (3040 k.Cal/kg), the specific fuel consumption works out to be 1.41 kg/ kWh. It is a known fact that to lower the cost of the fuel a variety of biomass fuel mix is used in these power plants. The moderate calorific value of the mixed fuel to maintain constant boiler load will be around 2700 k.Cal/kg. Considering the same caloric value the specific fuel consumption will be 1.6 kg/kWh.

Taking into account the above two parameters as deviations the approved order could be reviewed.

5.5 Operation of Biomass based power plants

Looking at the buy pack price of discoms and the derived appropriate tariff, some power plants are going under financial loss. It is important to note that discoms used to pay Rs 5.30 per kWh for three months during summer. This was mainly to meet the peak summer demand on the grid. However, in the year 2012-13 regulators have not been allowed by the Discoms to pay the same. The reason for the same is biomass power plants are under PPA with discoms, so no need to pay higher tariff.

At the same time most of the biomass power plants are availing Clean Development Mechanisms (CDM) benefits, by accruing Certified Emission Reduction CERs (except for Koppal Green Power Limited). The amount from CDM is an additional income source. The list of plants under the CDM is given in **Appendix – 5/1**.

The above two reasons allows biomass based power plants to meet their operational costs and profits.

5.6 Financial Status

The owners of biomass based power plants have well established business. Some of the plants are operated by groups who also own similar biomass plants in neighbouring states. By pooling in costs and profits from all the plants, these groups are able to offset any loss incurred when one of the plants breakdown or do not produce profits. As these groups are investing continuously in renewable energy sector by proposing new power plants in other states, taking advantage of tax benefits.

These groups are bundling CERs to get the best price in the international market. The most well-known groups operating in Karnataka are:

- Greenko Energies Pvt Ltd - AP & Karnataka
- Shalivahana Green Energy Ltd – AP, Karnataka, Maharashtra, MP
- Auro Mira Bio Power India Pvt Ltd – Tamil Nadu (Small Hydro in Karnataka)

CHAPTER 6 Comparative Analyses with other States

As a part of the study a comparative analysis of technical and financial analysis (tariff workings) of neighbouring states /progressive states was carried out. During the study a few working biomass power plants in other states were visited to understand their operational features, feedback on cost of biomass fuel, prevailing tariffs and future prospects. The situation of biomass power plants in other states is also not promising.

6.1 Status in other States

The biomass based Independent Power Projects (IPPs) in all the three neighbouring states (Andhra Pradesh, Maharashtra, and Tamil Nadu) were reviewed. It was found that most of plants were non-functional. Few plants were running on a seasonal basis. The status of the biomass power plants in these states are given in table 6.1.

Table 6.1 Status of biomass power plants

State	No of biomass based IPPs	Running Plants	Visited for Discussions
Andhra Pradesh	21	12 (8 plants On/Off)	5
Maharashtra	14	5 (4 plants On/Off)	1
Tamil Nadu	16	12 (6 plants On/Off)	4
Karnataka	9	**6 (3 plants Off)**	**9**

In case of AP most of the biomass plants were running during the paddy harvesting season when the rice husk price will be around Rs 1400 per MT (range). In Maharashtra except for one plant all the other installed biomass power plants have shut down. Four plants are operating on and off based on availability of fuel. The running plant uses maize stalk and cotton stalk as a main source of fuel. In Tamil Nadu biomass based power plants are not operating on a full scale. Due to third party sale, whenever wind energy is available, power purchase from biomass plants will come down and the same results in lower PLF. Except AP, rice husk is not a major input fuel for biomass based power plants in the other two states.

In Punjab three IPPs generate electricity through biomass combustion and feed into the grid. The biomass, being used in these power projects, is a mix of agro residue such as paddy straw, mustard stalk, lops and tops of eucalyptus and poplar trees, juliflora and other agro industrial waste like rice husk and saw dust. In one of the power plants rice husk was used in a limited way. Discussions with Punjab Energy Development Agency (PEDA) revealed that the Government was not promoting rice husk as major fuel for power projects as it was costly when compared to other available biomass.

In Madhya Pradesh (MP) there are a few power projects (in IPP) are in pipeline for commissioning. Till date close to 32 MW of biomass power projects have been commissioned. A large number of biomass based power plants is operating as captive units.

The details of operational features of visited biomass plants are given in **Appendix – 6/1.**

6.2 Biomass price

During the study, the cost of biomass fuels was collated from power plants, rice millers and agents. The type of biomass and its current price in different States are given in table 6.2.

Table 6.2 Type of biomass and its current price in different states

State	Karnataka	Andhra Pradesh	Tamil Nadu	Maharashtra
Rice Husk	2200 - 2800	1400 - 2900	2000 - 2700	
Maize / Corn	2400	1500		2400 - 2600
Coffee Husk	3000			
Wood Chips	1500		2600 - 2700	
Juliflora	< 1000	< 1300	1600	
Chilli powder	1400	1600		
Palm oil		< 600		
Agro waste			< 1200	< 1600

It can be seen from the above table that the cost of rice husk and maize stalks in AP are lower when compared to other states. However, the rice husk price during off season steeply increases in all the states. In Maharashtra maize stalks are used as the main source of biomass for power plants. It is important to note that a few local varieties of agro residues (like chilli powder, Palm oil) are available at a lower price compared to the main biomass fuel (rice husk).

6.3 Prevailing Buy Back Tariff

For the current financial year the prevailing buy back tariff approved by various regulatory commissions have been collated. As per the power producers the prevailing tariff is not economical to operate. Therefore, power plants in AP become more seasonal in operation and Tamil Nadu most of the plants have gone for third party sales. One plant in AP and Karnataka have opted for open access sales. In Maharashtra only one biomass power plant is functional.

The prevailing buyback tariff across various states is given in table 6.3.

Table 6.3 Buyback Tariff in different states

State	Karnataka	Andhra Pradesh	Tamil Nadu	Maharashtra
To Discoms	4.30 – 5.13	4.60	4.6	5.41
Open access plant	5.0 +	6.75	5.50 – 6.60	

The buyback tariff applicable to biomass power plants in Karnataka varies validly, because individual plants have agreed for different rates in PPA with discoms. Among the present buy back tariff, the best tariff is received by M/s R K Power Gen Private Limited, who is getting as per initial PPA rate (with KPTCL). After 10 years of PPA expiry, plant has not extended its PPA and is operating with last prices (end of PPA).

The open access buy back price was found to be much higher compared to the grid tariff (by Discoms). For example, Tamil Nadu open access buyback tariff varies widely, based on other sources of energy available to grid.

The recently approved biomass based power plant tariffs by State regulatory commissions are given in **Appendix – 6/2**.

For reference, fixed cost component for 20 years accounted in tariff order by M.P. and Tamil Nadu states are given in **Appendix – 6/3**.

CHAPTER 7 Recommendations

The following recommendations have been made based on the present scenario of the biomass power plants and the sustainability of these plants. It is also relevant to the new power plants coming up in Karnataka

7.1 Uniformity in buyback tariff

The prevailing buyback tariff for the existing power plants varies between Rs 3.58 to 5.13 per kWh. Five out of the six working power plants in the GESCOM area agreed with the different buyback tariff. The agreed buyback tariff for a few power plants is not really a workable tariff considering the present fuel cost. It is important to ensure that similar age and type/technology power plants should get uniform buy back tariff, when these units are under the same distribution company area.

7.2 Understanding the technology used

It is important to categorise existing biomass based power plants in terms of installed capacity and technology. Most of the installed power plants are 6 MW rating plants. The boiler and turbines are installed with 65 kg/cm^2 pressure and steam quantity 28 TPH and the type of boiler and turbines are of the same technology. The design heat rate for such plants will be 4300 k.Cal/kWh (range). These plants operate with an auxiliary power consumption of 12% (range). It is essential to take standard parameters (heat rate), pertaining to technology adopted by the plant, into consideration for tariff calculations.

R K power Gen Private Limited has installed a higher rating of pressure and quantity for its 20 MW power plant, but the plant is running at a lower plant load factor due to non-availability of low cost biomass.

7.3 Adopt two part tariff (fixed & variable cost)

The Cost Plus approach and single part tariff structure adopted by the state is a preferred approach for renewable energy technologies because of its non firm nature of generation. However, for biomass projects where fuel cost component is variable it is important that biomass tariff should have both separate fixed and variable tariff components. Recently, most of the SERCs including in Maharashtra and Rajasthan have declared their two part biomass tariff, wherein the fixed cost is fixed for 20 years but the escalation in variable cost is linked with the indexation mechanism. Similarly, two part tariff approach for biomass project has already got a buy-in from the Central Electricity Regulatory Commission.

A comparative analysis between different states is given below in table 7.1.

Table 7.1 Comparative analysis between different states

State	Fixed cost	Variable Cost	Total cost	Remarks
Unit : ‘ per kWh				
CERC	2.06 – 2.12	3.07 – 3.71	5.13 – 5.83	
Maharashtra	1.7	3.71	5.41	
Rajasthan	2.08 – 2.31	2.69 – 2.91	4.77 – 5.22	Water / Air cooled
Tamil Nadu	1.32 – 1.65	3.036	4.35 – 4.41	Year of Operation

A single part tariff for all renewable energy technologies is not preferred as the price of rice husk is highly sensitive to market demands.

The variable cost is worked based on a major fuel as rice husk. The prevailing rice husk cost during season and off season is Rs 2200 and 2800 per MT respectively. The average cost of rice husk of Rs 2500 MT is taken for the calculation. Rice husk is taken as the source fuel for specific fuel consumption calculation which is 1.41 kg/kWh (Plant heat rate 4300 k.Cal /kWh and Gross calorific value 3040 k.cal/kg).

Proposed Biomass based power plant Tariff				
Parameters	**Biomass Power Plant Rating/Type**			
	Water Cooled Condenser		**Air Cooled Condenser**	
	6 MW	15 MW	6 MW	15 MW
Variable Cost, Rs per kWh	**3.53**	**3.08**	**3.78**	**3.30**

The variable cost can be calculated based on the paddy minimum support price (MSP) fixed by the Government. During the paddy processing close to 20% rice husk is generated, of which 5 - 8% is internally consumed by the rice miller. However, the millers are looking for recovery of paddy price (share of husk) from sale of rice husk. The details of the MSP of paddy and rice husk market price for the last five years are tabulated in table 7.2.

Table 7.2 Details of the MSP of paddy and rice husk market price

Financial Year	MSP of paddy Rs per Quintal	Rice husk price (avg) Rs per MT
2008 -09	900* & 930**	1800
2009 -10	1000 & 1030	2050
2010 -11	1000 & 1030	2050
2011 -12	1080 & 1100	2200
2012 -13	1250 & 1270	2500
	* Common grade ** A grade	
Source : Rice husk price collected from millers & IPPs MSP of paddy from APMC		

The average rice husk price is 20% (weight basis) of the MSP of paddy fixed by the Government. The proposed correlation should be reviewed with secondary data and also compared with the below recommendation (7.4).

Sample calculation	
Cost of 1 MT of paddy (MSP)	Rs.12500/-
Cost of 1 MT of rice husk (on 20% weight basis)	12500 x 0.2 = Rs.2500/-

It is also recommended that the tariff is reviewed once in two years based on the prevailing market conditions which could be used for decision making.

7.4 Submission of Annual statement

It is essential to monitor the performance of biomass plants closely for its sustainability. The methods specified below need to be adopted at the earliest to monitor the performance.

The biomass power producers should furnish a monthly fuel procurement and fuel usage statement duly certified by a Chartered Accountant, to the appropriate agency designated by the Commission for the purpose of monitoring the fossil and non-fossil fuel consumption. However, the compliance of the condition of fossil fuel usage shall be monitored on an annual basis. The statement shall cover details such as:--

(a) Quantity of fuel (in tonnes) for each fuel type (biomass fuels and fossil fuels) procured and consumed during the month for power generation purposes;

(b) Cumulative quantity (in tonnes) of each fuel type procured and consumed till the end of that month during the year;

(c) Actual (gross and net) energy generation (denominated in Kwh) during the month;

(d) Cumulative actual (gross and net) energy generation (denominated in Kwh) until the end of that month during the year.

(e) Opening fuel stock quantity (in tonnes)
(f) Receipt of fuel quantity (in tonnes) at the power plant site and
(g) Closing fuel stock quantity (in tonnes) for each fuel type (biomass fuels and fossil fuels) available at the power plant site.

The above monitoring will help in future tariff fixation calculations as well as drawing rigid guidelines in the future.

7.5 Follow MNRE guidelines for new upcoming plants

MNRE has come out with the Biomass draft guidelines which states that states which are rich in biomass should have a minimum radial distance of 50 kM whereas in lean states the distance should be a minimum of 70 kM in-setting up biomass power plants. The same radius distance limitation is also in place in other states i.e Rajasthan and Haryana. In Rajasthan, power plant of 5 MW capacities should have an area reserved of 40 Km radius and the distance increases with the capacity of the power plant. However, Punjab, which has a very high biomass usage for power generation projects as well as for industrial boilers, misses out the radial distance limitation. Therefore, it is suggested that to avoid unhealthy competition amongst biomass power projects, reserved areas must be allotted.

7.6 Mitigation Techniques – to avoid shortage of fuel

i) Energy audit programme for Rice mills

It is recommended that the Commission gives instructions to KREDL to draw '*an energy conservation programme (audits)*' for rice mills across the states (cluster wise) to identify and implement technologies suitable for reduction of fuel consumption (rice husk) in rice mill operations. The objective of the proposed programme is capacity building and implementation of retrofits to minimise the internal rice husk consumption across rice mills. The reduction in rice husk achieved should be made available for biomass based power projects.

ii) Policy change to stop export of paddy – APMC

During interactions with power producers and millers, it was revealed that a significant quantity of paddy was being exported to Tamil Nadu. The estimated quantity was about 30% (no reference) of total paddy production. At the same time many millers have become agents for paddy supply, where margins found to be good in paddy distribution instead of processing (milling). The Commission can draw the attention of APMC in this regard. Any action in this regard will help increase in the availability of rice husk quantity within the State.

iii) *Check on new industrial licences*

It is also important to ensure that new upcoming industries fuel linkage (for process boilers) arrangements with existing (and allocated) locations of biomass power plants. Increased use of biomass for localised demand will definitely create price volatility. The industries department need to be alert in this regard or share the information / clearances to KREDL. In the coming years, use of biomass for cement industries is going to rise as they would need to meet the PAT (perform, achieve and trade) scheme targets. Therefore, it is important that a notification is issued to avoid the use of rice husk in energy intensive sectors (like cement, sponge iron etc.).

iv) Encouraging Energy plantation schemes

It is also important to encourage power producers to go in for energy plantations on a large scale. The existing guidelines in this regard can be reviewed if required.

CHAPTER 8 Conclusion

Globally biomass based power generation has been recognised as a technically and commercially viable source of power generation. The thrust on technology development and commercialisation of technology has led to development of the biomass power generation market.

Ensuring availability of biomass and reducing the biomass price volatility among biomass power projects is vital to achieve sustainability.

At the same time, it is also important to have attractive buyback tariff for renewable energy such as biomass for which a strong regulatory mechanism should be in place. Biomass is a perennial source of energy, unlike solar and wind which are seasonal. The best buyback tariffs will encourage power producers to go in for technology up-gradation (like FBC boiler of higher pressure) from time to time leading to increased returns and sustainability.