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Singareni Bhavan, Red Hills, Lakdi ka Pool
Hyderabad

09 May 2014

Sub: Study report on Determination of Fixed Cost and Variable Cost norms for Biomass, Bagasse and MSW projects in Andhra Pradesh

Ref: Lr. No. APERC/E – 801(H)/Dir-Engg/JD(PPP)/D.No. 74/2014-01 Dated 17-01-2014

Dear Sir,

We have been retained by APERC to provide consultancy services vide the LOI cited under reference above.

Accordingly, we have analysed the performance of the Biomass, Bagasse and MSW players based on information furnished to us. Based on our findings, analysis and discussions held with the Commission, we have prepared the Study Report on "**Determination of Fixed Cost and Variable Cost norms for Biomass, Bagasse and MSW projects in Andhra Pradesh**".

Please find enclosed Final Study Report for your reference.

Yours Sincerely

Best Regards,

Srinivasa Rao Patnana

Associate Director, KPMG Advisory Services Private Limited

STUDY REPORT ON DETERMINATION OF FIXED COST AND VARIABLE COST NORMS FOR BIOMASS, BAGASSE AND MSW PROJECTS IN ANDHRA PRADESH

09 MAY 2014

Table of Contents

Introductory Note

This study report has been done by KPMG for Andhra Pradesh Electricity Regulatory Commission for determination of Fixed cost and Variable cost norms for Biomass, Bagasse and MSW projects in Andhra Pradesh for the future. This exercise was done over the period January, 2014 to April, 2014 and the recommendations on the adoption of fixed cost and variable cost norms for NCE sources have been documented in the study report.

List of Tables

List of Figures

Abbreviations

APERC	Andhra Pradesh Electricity Regulatory Commission
APTEL	Appellate Tribunal for Electricity
APTRANSCO	Transmission Corporation of Andhra Pradesh Limited
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CUF	Capacity Utilisation Factor
GCV	Gross Calorific Value
GERC	Gujarat Electricity Regulatory Commission
HERC	Haryana Electricity Regulatory Commission
KERC	Karnataka Electricity Regulatory Commission
MERC	Maharashtra Electricity Regulatory Commission
MNES	Ministry of Non-Conventional Energy Sources
MNRE	Ministry of New and Renewable Energy
MPERC	Madhya Pradesh Electricity Regulatory Commission
MSW	Municipal Solid Waste
NCE	Non-Conventional Energy
NREDCAP	New and Renewable Energy Development Corporation of Andhra Pradesh Limited
PLF	Plant Load Factor
PPA	Power Purchase Agreement
RERC	Rajasthan Electricity Regulatory Commission
RDF	Refuse Derived Fuel
SERC	State Electricity Regulatory Commission
SHR	Station Heat Rate
TERI	The Energy and Resources Institute
TNERC	Tamil Nadu Electricity Regulatory Commission
WPI	Wholesale Price Index

1 Background

Government of India (GoI) formulated a policy framework in FY 1993-94 for promotion of generation capacity from Non Conventional Energy (NCE) sources. The objective was to promote usage of clean sources of energy and secure India's long term energy security mix. The initial list of NCE sources that were promoted include:

- Biomass based Power Projects
- Bagasse based co-generation Power Projects
- Industrial Waste to Energy Projects
- Municipal Solid Waste to Energy Projects
- Mini Hydel Projects
- Wind Electricity Generation Projects

The policy framework provided for fiscal and financial incentives for promoting capacity addition from NCE sources. Accordingly, the tariff payable for power from the NCE sources was predetermined in 1993-94 to take effect from 01-04-1994 with year-on-year escalation.

Government of Andhra Pradesh took initiative to encourage NCE sources in the 1990's. Many wind farms were set up in Andhra Pradesh during this period - following the favourable policy conditions and incentives provided by both the Central and State Government(s). Before APERC was set up, the PPA's for different NCE sources were signed at the tariffs determined by the Ministry of Non-Conventional Energy Sources (MNES).

The tariffs determined by the Ministry of Non-Conventional Energy Sources for different NCE sources were in effect till March 2004. APERC directed APTRANSCO and NREDCAP to file tariff proposals for tariffs and incentives for various categories of NCE projects to be applicable from 01 April 2004. While determining

the tariff for NCE sources, APERC was guided by the following principles of The Electricity Act, 2003:

- Section 86 (1) (e) of the Electricity Act, 2003 provides that State Regulatory Commission would promote renewable and NCE sources
- Section 86 (1) (a) of the Electricity Act, 2003 empowers the State Commission to fix the tariff for generating stations in the State.

Based on the proposals submitted by APTRANSCO and NREDCAP, APERC determined the tariffs for NCE sources in its March 2004 order taking into account the economics as well as environmental benefits from NCE sources.

- A single part tariff was determined for Mini Hydel projects while a two part tariff methodology was adopted for Biomass, Bagasse and Industrial waste since these sources involved a fuel component.
- A single part tariff for Municipal Waste projects and Wind projects was determined for the period FY 2004-05 to FY 2008-09
- The fixed cost was determined for Biomass, Bagasse, Industrial Waste and Mini Hydel projects for their 1-10th year of operation
- The variable cost was determined for Biomass, Bagasse and Industrial Waste projects for the period FY 2004-05 to FY 2008-09.

Subsequently, APERC in its March 2009 order determined the variable cost for Biomass, Bagasse and Industrial Waste projects. In the same order, the single part tariff for Wind and Municipal Waste projects for the period FY 2009-10 to FY 2013-14 was also determined.

However, the APERC orders on tariff determination for NCE sources have been challenged by various NCE generators on grounds that the tariff was not remunerative at various forums like Hon'ble High Court, Hon'ble Supreme Court, and Hon'ble APTEL etc.

The Hon'ble APTEL passed an order in December 2012 with revised norms for Biomass, Bagasse and Mini Hydel players. It also directed APERC to determine the tariff based on revised norms for Biomass, Bagasse, Industrial waste and Mini Hydel players for the period FY 2004-05 to FY 2013-14 covering the 1-10th year of operation.

Based on the norms specified by the Hon'ble APTEL, APERC determined the following:

- Revised fixed cost with effect from FY 2004-05 for 1-10th year of operation for Biomass, Bagasse, Industrial waste and Mini Hydel projects. Revised variable cost for Biomass, Bagasse and Industrial waste projects for the period FY 2004-05 to FY 2008-09 by order dated 22ndJune 2013.
- Revised variable cost for Biomass, Bagasse and Industrial Waste projects for the period FY 2009-10 to FY 2013-14 - by order dated 6th August 2013.

The Hon'ble APTEL in its December 2012 order while revising the norms also directed APERC to carry out a scientific study for determination of norms for the future. Following is the relevant excerpt from the order – ***"we feel that there is a need for carrying out a scientific study for determining the normative parameters specific to the state for future. The study should also take into consideration the technological improvements that have since taken place in the generation by non-conventional energy sources. We direct the State Commission to arrange to undertake the study on priority and frame its Tariff Regulations for purchase of power by distribution licensees from NCE sources after considering the Study Report, Central Commission's Regulations and any other relevant information"***

APERC, in line with the directive of the Hon'ble APTEL has engaged KPMG as independent consultant to analyse the operating parameters/norms of Biomass and Bagasse projects and to prepare a study report to undertake the following:

- Determination of fixed cost norms for the 11-20th year of operation for existing Biomass and Bagasse projects

- Determination of variable cost norms for the period FY 2014-15 to FY 2018-19 applicable to existing Biomass and Bagasse projects

This report covers the analysis pertaining to determination of norms for Biomass and Bagasse plants in Andhra Pradesh. In addition to the above, a section is also devoted to MSW projects.

The approach and methodology adopted for determination of norms for existing and Biomass Bagasse and MSW projects is covered in the next section.

2 Approach and Methodology

For determining the fixed cost and variable cost norms for tariff computation for existing Biomass and Bagasse plants, the following key steps have been undertaken.

- Fixed cost norms for Biomass and Bagasse projects
  - Analysis of financial statements of Biomass and Bagasse players
  - Study of Hon'ble APTEL order and other relevant orders
  - Comparison of norms adopted by CERC, SERCs
- Variable cost norms for existing Biomass and Bagasse projects
  - Study of Hon'ble APTEL order and other relevant orders
  - Analysis of research reports published by regulatory bodies CEA and CERC
  - Primary research to determine the fuel price and fuel price escalation for the future
  - Comparison of norms adopted by CERC, SERCs

The Electricity Act of 2003, in Regulation 61, stipulates that the Appropriate Commission shall specify the terms and conditions for the determination of tariff and in doing so shall be guided by the principles and methodologies specified by the Central Electricity Regulatory Commission (CERC) for determination of the tariff applicable to generating companies and transmission licensees.

In the absence of any specific norms for MSW projects, an overall approach was adopted for MSW projects.

The next sections of the report cover in detail the exercise of determination of fixed cost and variable cost norms for Biomass, Bagasse and MSW projects

3 Determination of norms for Biomass projects

Biomass based power projects use the following fuel sources for power generation – rice husk, straw, cotton stalk, coconut shells chilly stalk, de-oiled cakes, groundnut shells, Juliflora etc. The fuels used in Biomass projects are mostly agricultural waste. The usage of such fuels in power generation provides the dual benefit of reduction in agricultural waste and increased power generation in the state. In Andhra Pradesh, rice husk is the predominant biomass fuel used, followed by groundnut shells, cotton stalks, coconut shells and to a certain extent Juliflora.

The total installed capacity of Biomass projects in Andhra Pradesh is around 200 MW contributing to 17% of the total installed capacity from NCE sources. While the installed capacity of Biomass plants is high in Andhra Pradesh, the actual generation from these plants is low. The next section covers the PLF analysis of Biomass projects in Andhra Pradesh in detail.

3.1 PLF analysis of Biomass projects

The average PLF of the biomass plants in the state has been in the range 35-55% for the period FY 2009-10 to FY 2012-13.

The average PLF includes even those Biomass plants which were non operational during this period. A total of five Biomass plants with a total installed capacity of 28.5 MW were non operational during this period.

By excluding the non operational Biomass plants from the sample, the average PLF improves to 40%.

The low PLF of biomass plants is a result of both external and internal factors.

- External Factors
  - High fuel cost
  - Non availability of fuel

- Internal Factors
  - Inefficient operation of the Biomass plant
  - Poor financial health of the Biomass player

It is observed that plants are operated at a PLF of less than 30% primarily due to internal factors, while the contribution of external factors is minimal. Such biomass plants would continue to operate at low PLF even in case of sufficient fuel availability at the right fuel price. Hence, a granular level analysis was undertaken by computing the average PLF while excluding biomass plants with PLF below a certain level.

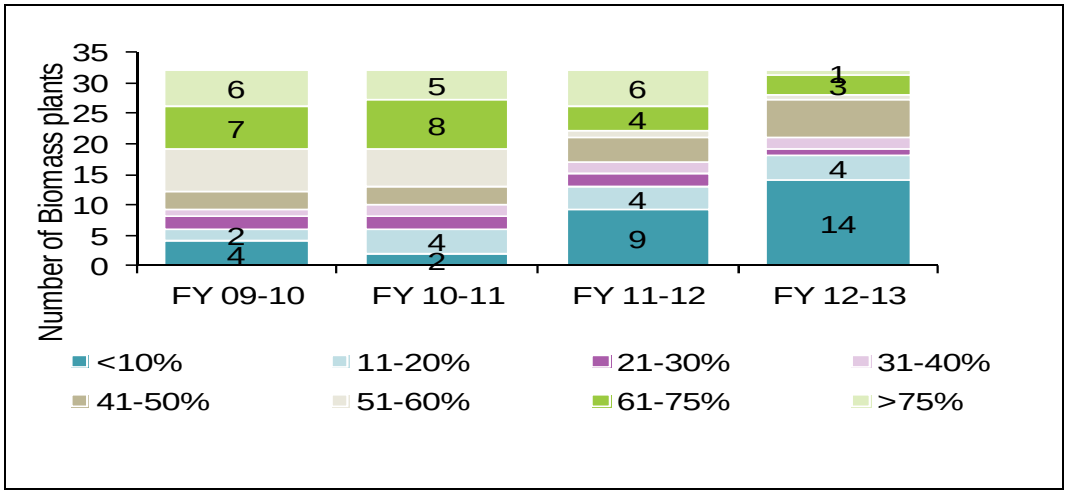
It can be observed that the average PLF after excluding plants with PLF less than 30% is 55%. The average PLF of 55% is still lower than the normative PLF of 80% primarily due to external factors.

Table 1: Average PLF of Biomass Industry during the period - FY 2009-10 to FY 2012-13

	No. of plants excluded	FY 09-10	FY 10-11	FY 11-12	FY 12-13	Average
Average PLF excluding plants having <10% PLF (avg) during the period FY 10 - FY 13	**4**	55%	57%	43%	28%	**46%**
Average PLF excluding plants having <20% PLF (avg) during the period FY 10 - FY 13	**12**	62%	65%	55%	36%	**54%**
Average PLF excluding plants having <30% PLF (avg) during the period FY 10 - FY 13	**13**	61%	65%	58%	38%	**55%**
Average PLF excluding plants having <40% PLF (avg) during the period FY 10 - FY 13	**19**	63%	69%	71%	51%	**64%**
Average PLF excluding plants having <50% PLF (avg) during the period FY 10 - FY 13	**20**	64%	71%	72%	53%	**65%**

The number of biomass plants operating at a lower PLF has increased over the period FY 2010-13.

Figure 1: No. of Biomass plants as per PLF range



The external factors affecting the PLF of biomass plants should be taken into consideration while determining the fixed cost and variable cost norms. On the other hand, the internal factors affecting the PLF of biomass plants should be addressed by the biomass players and should not be considered while determining the norms.

3.2 Additional revenue to Biomass players from APERC order of June 2013 and August 2013

The biomass players approached the Hon'ble APTEL for revision of the fixed cost and variable cost norms due to the following issues:

- Operating PLF of biomass plants was low
- O&M expenses were higher compared to coal fired power plants
- SHR of the boiler was high
- GCV of the fuel was low
- Fuel price was high

The Hon'ble APTEL in its December 2012 order has revised the norms for biomass plants. Subsequently, APERC issued a revised order in June 2013 and August 2013. The following table summarises the original and revised norms for biomass projects in Andhra Pradesh.

Table 2: Norms for Biomass Projects in Andhra Pradesh					
	Units	**APERC 2004 Order**	**APERC 2009 Order**	**APERC June 2013 Order (Based on APTEL norms)**	**APERC Aug 2013 Order (Based on APTEL norms)**
Applicability (Fixed Cost)	**Period**	1-10th year of Operation	NA	1-10th year of Operation	NA
Applicability (Variable Cost)	**Period**	FY 04-05 to FY 08-09	FY 09-10 to FY 13-14	FY 04-05 to FY 08-09	FY 09-10 to FY 13-14
Capital Cost	**Rs. Cr/MW**	4		4	
Threshold PLF	**%**	80%		80%	
O&M expenses (1st year of operation)	**% of Capital Cost**	4%		**5.50%**	
O&M Annual escalation	**%**	4%		**6.69%**	
Debt:Equity Ratio	**Ratio**	70:30		70:30	
Depreciation	**%**	7.84% (First 8 years) 7.28% (9th year) Balance 20% spread evenly over 11 years		7.84% (First 8 years) 7.28% (9th year) Balance 20% spread evenly over 11 years	
Interest on Debt	**%**	12%		12%	
Return on Equity (ROE)	**%**	16%		16% (MAT/Income Tax pass through)	
Interest on Working Capital	**%**	12%		12%	
SHR	**kCal/kWh**	3,700	3,700	**4,500**	**4,500**
Auxiliary Consumption	**%**	9%	9%	**10%**	**10%**
GCV	**kCal/kg**	3,200	3,200	3,300	3,300
Fuel Price	**Rs./tonne**	1,000 (FY 2004-05)	2,000 (FY 2009-10)	**1,300 (FY 2004-05)**	2,000 (FY 2009-10)
Fuel Price escalation	**%**	5%	5%	**6%**	5%

Amongst the fixed cost components, O&M expenditure and O&M escalation rates were revised, while SHR, Auxiliary consumption, GCV, Fuel Price and Fuel price escalation were revised amongst the variable cost components.

The revised APERC orders of June 2013 and August 2013 resulted in higher fixed cost per unit and variable cost per unit for biomass players. The below table summarises the initial and revised fixed cost and variable cost for biomass players.

Table 3: Initial Fixed cost and Revised Fixed cost for Biomass players		
Year of Operation	**Fixed cost as per APERC March 2004 order**	**Revised fixed cost as per APERC June 2013 order**
1	1.61	1.77
2	1.57	1.74
3	1.53	1.72
4	1.49	1.69
5	1.45	1.67
6	1.41	1.67
7	1.37	1.65
8	1.33	1.64
9	1.26	1.59
10	0.87	1.23

Table 4: Initial Variable cost and Revised Variable cost for Biomass players		
Year	**Variable cost as per APERC March 2004 and March 2009 order**	**Revised Variable cost as per APERC June 2013 and August 2013 order**
FY 04-05	1.27	1.97
FY 05-06	1.33	2.09
FY 06-07	1.4	2.21
FY 07-08	1.47	2.35
FY 08-09	1.54	2.49
FY 09-10	2.54	3.03
FY 10-11	2.67	3.18
FY 11-12	2.8	3.34
FY 12-13	2.94	3.51
FY 13-14	3.09	3.68

The additional revenue accrued by a biomass player operating at a PLF of 55% is around Rs. 4 Cr./MW over a 10 year period.

Table 5: Additional Revenue from APERC June 2013 and August 2013 order for Biomass players at different PLF - Rs Crs/MW*				
Year	**PLF**			
	55%	**60%**	**65%**	**75%**
1	0.37	0.41	0.44	0.51
2	0.40	0.44	0.48	0.55
3	0.43	0.47	0.51	0.59
4	0.47	0.51	0.55	0.64
5	0.51	0.55	0.60	0.69
6	0.33	0.35	0.38	0.44
7	0.34	0.37	0.40	0.47
8	0.37	0.40	0.44	0.50
9	0.39	0.43	0.46	0.53
10	0.41	0.45	0.49	0.56
Total	**4.02**	**4.39**	**4.76**	**5.49**

** Auxiliary consumption considered - 10%, Assumed that FY 04-05 is the first year of operation for the Biomass player*

3.3 Determination of Fixed cost norms for existing Biomass projects

3.3.1 Comparative analysis of actual data of Biomass players as against the Fixed Cost norms

This section compares the actual data of sample biomass players as against the fixed cost norms determined in the APERC March 2004 order and the revised APERC Order of June 2013 for such plants

A sample of four biomass players from different parts of the state was selected for the analysis – **Matrix, Greenko, Varam and Rithwik**. The actual information was gathered from these biomass players on parameters like the capital cost incurred for the project, loan amount taken, equity amount infused, operation & maintenance expenditure etc. The audited balance sheet and profit & loss statement of the sample biomass players were also analysed to gain further insight into the performance of these players.The following table summarises a comparative analysis of the biomass players as against the norms specified by APERC.

Table 6: Comparative analysis of Biomass players as against the APERC norms for the period FY 04-05 to FY 12-13						
Parameter	**Norms as per APERC March 2004 Order**	**Norms as per APERC June 2013 Order**	**Varam (Etcherla, Srikakulam)**	**Rithwik (Penuballi, Khammam)**	**Greenko (Sattenpalli, Guntur)**	**Matrix (Karempudi, Guntur)**
Capital Cost (Rs. Lakh/MW)	400	400	407	482	425	378
PLF (%)	80%	80%	69-88%	48-83%	59-83%	55-79%
Debt (Rs. Lakh/ MW)	280	280	305	333	323	256
Equity (Rs. Lakh/MW)	120	120	102	149	126	125
Interest on Term Loan (%)	12%	12%	10-16%	7-15%	8-16%	8-12%
Incremental Debt (Yes/No) (Rs. Cr.)			Yes (19)	Yes (22.5)	No	No
Outstanding Debt at the end of 10 years (Rs. Cr.)			0.61	12.00	0.00	0.00
O&M Expenses (Rs. Lakh/MW)	17-24	25-42	34-62	33-53	34-51	42-51
No. of years Net Profit is +ve			9	3	5	9

It can be observed that some parameters like capital cost, interest on term loans have already been incurred by the biomass players in the past and these parameters need no revision for future tariff determination exercise.

Some of the biomass players have taken incremental debt to either pay off their initial debts or to pay off miscellaneous loans and advances. Hence, any relief to the biomass players for taking incremental debt in the form of depreciation or loan repayment tenure is not required. Other fixed cost items like Return on Equity,

Debt/Equity ratio have been set at the same levels as that of the other NCE sources and no change is required in these norms also.

O&M expenses would be incurred every year by biomass players to meet the salary expenses, administrative expenses and plant maintenance expenses. The plant maintenance expenses increase over the years due to ageing of the plant while the overall O&M expenses increase due to inflation. Hence, there is a need to determine the norms for O&M expenses.

The following table captures the fixed cost norms which need revision and those which do not for existing biomass projects.

Table 7: Revision of Fixed Cost norms for existing Biomass projects

Need no Revision	Need Revision
Capital Cost	**O&M expenses**
Interest on Term Loans and Working Capital	**O&M expenses annual escalation**
Return on Equity	
Debt:Equity Ratio	
Depreciation	

An analysis of O&M expenses has been carried out in the next section to determine the future O&M expenses norm for the existing biomass players.

3.3.2 O&M expenses analysis

The following graphs capture the three main components of the O&M expenditure – Staff Expenses, Plant Maintenance Expenses and Administrative & General Expenses for the period FY 2004-05 to FY 2012-13 for the sample biomass players.

Figure 2: Staff Expenses of Biomass players as per the year of operation

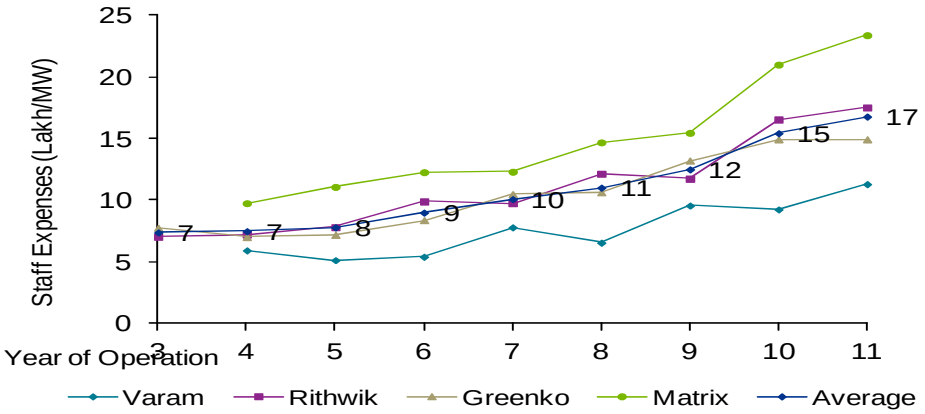


Figure 3: Administrative Expenses of Biomass players as per the year of operation

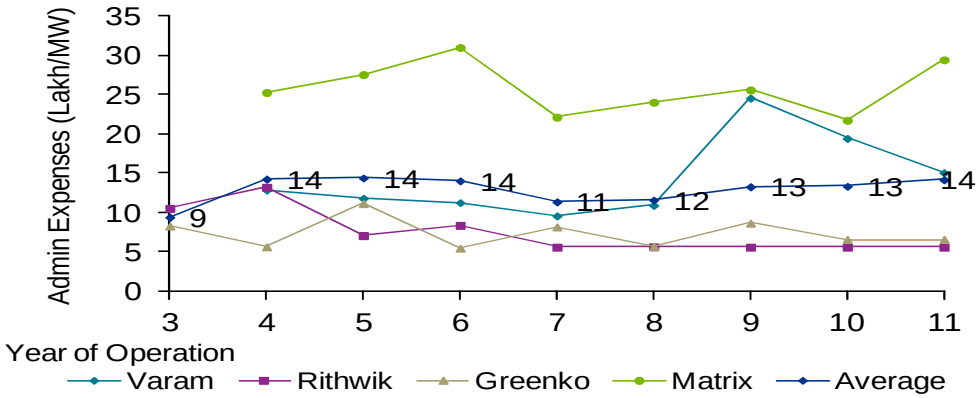
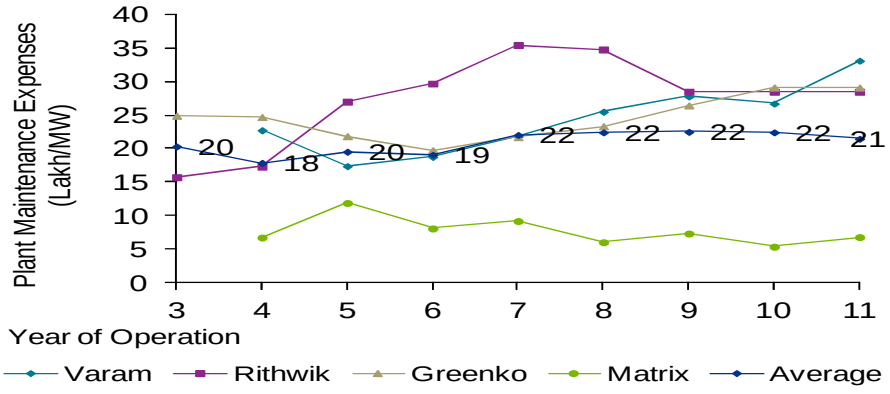


Figure 4: Plant Maintenance Expenses of Biomass players as per the year of operation



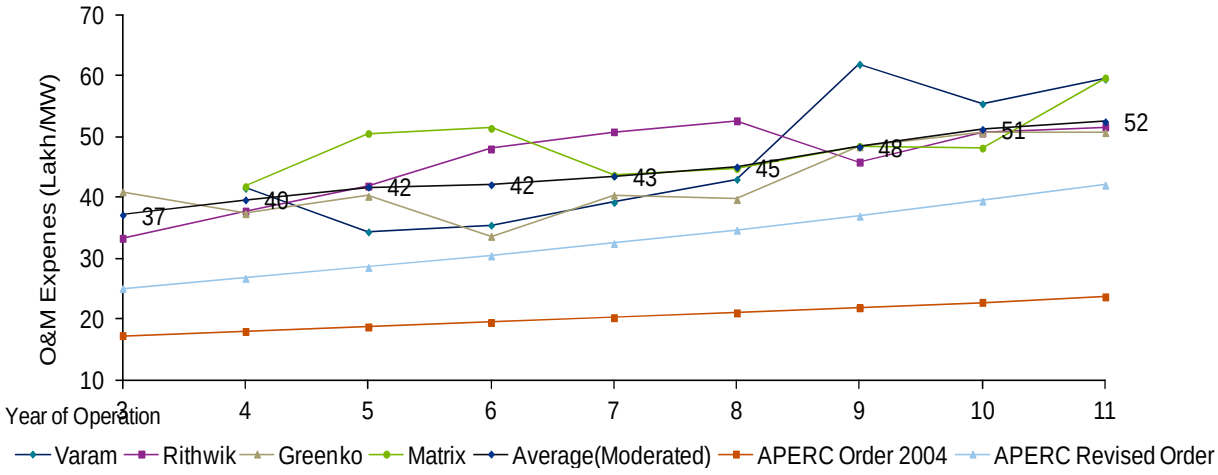
The staff expenses of all the biomass players are found to be within a similar range.

The high administrative expenses of some players are on account of miscellaneous costs like travelling and conveyance, legal fees, consulting fees etc.

The plant maintenance expenses of Matrix are very low as compared to the average value,thus compensating for the high administrative and salary expenses.

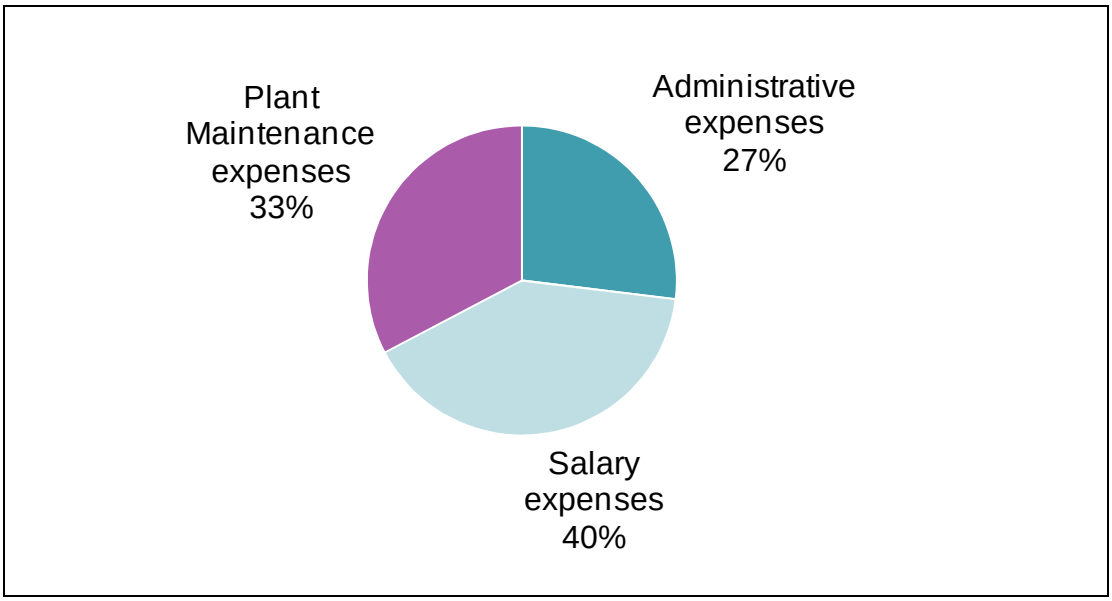
The average O&M expenditure trend was plotted for the sample biomass players by excluding outliers.

Figure 5: Total O&M expenses of Biomass players as per the year of operation



The average O&M expenses for the sample Biomass players is **Rs. 52 Lakh/MW** (Admin expenses – Rs 14 Lakh/MW, Salary expenses – Rs. 21 Lakh/MW, Plant Maintenance – Rs. 17 Lakh/MW) in their 11th year of operation. The actual O&M expenses of biomass players can be reduced if miscellaneous expenditures are curtailed.

Figure 6: O&M expenses break up of sample Biomass players – 11th year of operation



The following table captures the O&M expenses allowed by CERC and other SERC's for biomass plants.

Table 8: O&M expenses allowed by various Regulatory Commissions for Biomass Plants

Electricity Regulatory Commission	Date of Order/Regulation	O&M expenses (Rs. Lakh/MW) – First year	O&M annual escalation (%)	O&M expenses (Rs. Lakh/MW) – FY 2014-15
APERC	06/08/2013	25	6.69%	42.0*
CERC	18/03/2014	40	5.72%	42.2
KERC	11/12/2009	19.5	5%	24.9
MERC	07/06/2010	21.4	5.72%	26.7
RERC	08/10/2013	33.9	5.72%	35.9
GERC	30/09/2013	23.4	5.72%	24.7

**Considering FY 04-05 as the first year of operation of the biomass plant*

Considering that O&M expenses for biomass players as allowed by CERC and various SERCs are in the range Rs. 24.7 Lakh/MW- Rs. 42.2 Lakh/MW, and APERC has

allowed a higher value as compared to other SERCs, the existing norms for O&M expenses and escalation can be continued.

3.4 Determination of Variable Cost norms for Biomass players

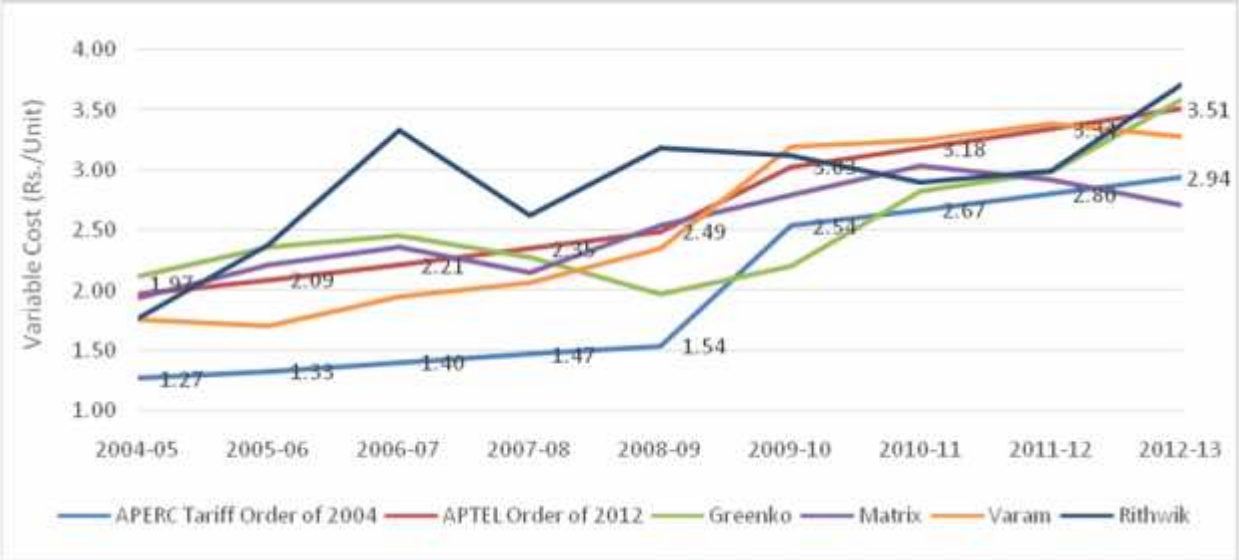
This section analyses the parameters affecting the variable cost and suggests the variable cost norms which can be considered for biomass plants.

The variable cost of biomass players is affected by the following parameters – SHR, GCV, Auxiliary Consumption, Fuel Price and Fuel price escalation.

The actual variable cost of the sample biomass players was analysed to ascertain if the current variable cost norms are sufficient for the biomass players. The actual variable cost was computed based on the ratio **Actual Fuel cost /Actual units sold**.

It can be observed from the below figure that the variable cost of generation of sample biomass players was higher than the variable cost allowed by the APERC orders - March 2004 and March 2009. However, the APERC revised order of June 2013 and August 2013 pursuant to the Hon'ble APTEL order of December 2012 has allowed a higher variable cost of generation to the biomass plants.

Figure 7: Variable Cost Comparison of Sample Biomass Players



The variable cost of generation for the period FY 2004-05 to FY 2012-13 for the sample biomass players was captured and the levelized variable cost of generation computed. It can be observed from the following table that the levelized variable

cost of generation for most of the biomass players is lower than what has been allowed by APERC in its June 2013 and August 2013 order. This indicates that the APERC June 2013 and August 2013 order has adequately compensated the biomass players on the variable cost front.

Table 9: Levelized variable cost of generation of Biomass players – FY 04-05 to FY 12-13 (Rs./Unit)*	
APERC 2004/2009 Order	1.80
Revised APERC 2013 Order	2.52
Matrix	2.42
Greenko	2.43
Varam	2.35
Rithwik	2.76

** Discount factor used for computing variable cost of generation – **13.20%***

The subsequent sections cover the determination of variable cost norms for Biomass projects.

3.4.1 Station Heat Rate and Gross Calorific Value

CERC, in the first amendment to 2012 RE Tariff regulations and CEA in its 2005 report, while recognising the issues being faced by biomass players have given certain allowances on the technical parameters which are summarised below.

Table 10: Allowances provided for Biomass players on Technical Parameters			
	CERC amendment to 2012 RE Tariff regulations	CEA 2005 report on Operation norms for Biomass plants referred by Hon'ble APTEL in December 2012 Order	APERC existing norms
Operational uncertainties owing to different fuel mixes	10-12% on SHR	5% on SHR	5% on SHR

Fuel handling and storage losses	7-10% on GCV	5% on SHR	5% on SHR
Norms	SHR – 4,200 kCal/kWh GCV – 3,100 kCal/kg	SHR – 4,500 kCal/kWh GCV – 3,300 kCal/kg	SHR – 4,500 kCal/kWh GCV – 3,300 kCal/kg

The Specific fuel consumption adopted by CERC is **1.35 kg/kWh** while CEA had adopted a specific fuel consumption of **1.36 kg/kWh**. It is to be noted that both CERC and CEA have provided the required allowances on either the SHR or the GCV. However, no allowance was suggested on the fuel price and both CERC and CEA have allowed a nearly equal value of specific fuel consumption.

The SHR of a biomass plant is affected by different fuel mixes and the moisture content of fuel. As a result, the additional allowance on SHR due to these factors should be taken into account. The Hon'ble APTEL had specified an SHR of 4,500 kCal/kWh in the order dated 20th December 2012 taking into account the following:

i. CEA report of 2005 which determined a Gross SHR of 4,033 kCal/kWh

ii. Allowed a 5% escalation in SHR due to operational uncertainties

iii. An additional 5% escalation due to loss in fuel GCV and loss in fuel weight due to long storage

CERC had constituted a Committee in October 2012 to undertake a detailed study on the "Performance/Viability of Biomass based plants operating in the country including the prevailing Biomass prices" for revisiting the norms of Biomass projects. This Committee had representations from the following organisations

- CERC
- MNRE
- CEA
- Indian Biomass Power Association

The scope of the work of the Committee was

- Field visit to select Biomass plants in the country to ascertain the technical parameters like SHR, Auxiliary consumption etc.
- Fuel analysis and analysis of losses in the GCV of fuel during storage
- Analysis of fixed cost norms like Capital cost, O&M expenses etc.
- Study on prevailing Biomass fuel prices and price trend
- Study on prevailing Biomass fuel availability

The Committee after its detailed study had submitted its report in July 2013. The report had specified an SHR of **4,200 kCal/kWh** taking into account the following:

i. The Committee determined the average design SHR of Biomass plants of 3,750 kCal/kWh.

ii. It was noted that Biomass Plants are forced to operate with all kinds of agro residues, irrespective of the moisture content of the fuel due to seasonal availability. The Committee also pointed out that in case of seasonal fuels, the longer storage time 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. Thus, the Committee recommended a 10-12% operating margin on the design SHR.

The Committee had proposed an SHR of **4,200 kCal/kWh** which was adopted in the first amendment to the CERC RE Tariff Regulations 2012.

Primary research was undertaken to determine the SHR of biomass plants in neighbouring states. It was found out that the SHR of biomass plants in Maharashtra and Tamil Nadu is in the range of 4,050 – 4,300 kCal/kWh.

Table 11: SHR of Sample Biomass Players		
Power Plant Name and Location	**Capacity (MW)**	**SHR (kCal/kWh)**
Saradambika Power Plant Pvt. Ltd., Chandrapur, Maharashtra	10	4,050
Shriram Non-Conventional Energy Ltd., Thanjavur, Tamil Nadu	7.5	4,400
Synergy Shakthi Renewable Energy Ltd., Krishnagiri, Tamil Nadu	10	4,300

The SHR values considered by CERC and other SERCs for biomass plants are captured in the following table.

Table 12: SHR considered by various Electricity Regulatory Commissions for Biomass plants		
Electricity Regulatory Commission	**Date of Order/Regulation**	**SHR - kCal/kWh**
APERC	06/08/2013	4,500
CERC	18/03/2014	4,200
MERC	07/06/2010	3,800
TNERC	31/07/2012	3,840
MPERC	03/05/2013	3,800
RERC	08/10/2013	4,440

Considering the SHR range of 3,800-4,440 kCal/kWh determined by various Electricity Regulatory Commissions and the SHR of 4,200 kCal/kWH considered by CERC after allowing for operational uncertainties, it would be prudent to set the SHR of **4,200 kCal/kWh** for existing biomass plants in Andhra Pradesh.

Gross Calorific Value

The CEA report of 2005 had proposed a GCV of 3,300 kCal/kg for biomass. Since, an allowance was already considered for determining the SHR - on account of fuel uncertainties, GCV and weight loss in the fuel due to long storage - it did not recommend any additional allowance on the GCV.

CERC Committee had referred to the Biomass Atlas which stated 56% of biomass fuel availability in Andhra Pradesh is from rice husk and around 33% is from agricultural residues. However, the fact that agricultural residues are varied depending on geographical location must be taken into consideration. Many biomass players in Andhra Pradesh use juliflora. The weighted average GCV of biomass fuel is computed by considering usage of 56% rice husk, 20% agricultural residues and 24% juliflora. The GCV of rice husk (3,032 kCal/kg) and agricultural residue (3,524 kCal/kg) has been captured by the CERC committee from a biomass project in Andhra Pradesh, while the GCV of juliflora as suggested by the CEA Report of 2005 has been considered.

The biomass fuel mix for Andhra Pradesh has been considered as suggested by the CERC technical committee, while arriving at the weighted average GCV.

Table 13: Computed GCV of Fuel (as fired) for Biomass plants[1]

Fuel Source (as fired)	% fuel mix	GCV (kCal / kg)
Rice Husk	56%	3,032
Juliflora	24%	2,800
Agri Residue[2]	20%	3,524

The weighted average GCV comes to3,075 kCal/kg.

The GCV of biomass fuels as obtained from M/S Jocil Ltd., which operates a biomass plant in Guntur district in Andhra Pradesh is captured in the table below. Considering the biomass fuel mix for Andhra Pradesh as suggested by the CERC technical committee, the weighted average GCV is equal to 3,300 kCal/kg.

[1]GCV of individual fuels has been rounded off for computation of the Weighted GCV

[2]CERC has specified Agri residue potential of 33% for Andhra Pradesh. However, only 20%, as suggested by the CEA Report of 2005 is considered and the remaining is accounted for by considering Juliflora.

Table 14: GCV of Fuel (as fired) for M/S Jocil Ltd		
Fuel Source (as fired)	**% fuel mix**	**GCV (kCal / kg)**
Rice Husk	56%	3,090
Juliflora	24%	3,800
Agri Residue (Cotton Stalk)	20%	3,320

The GCV of biomass players in the neighbouring states of Tamil Nadu was found to be along the same lines as can be observed from the table below.

Table 15: GCV of Sample Biomass Players		
Power Plant Name and Location	**Capacity (MW)**	**GCV (kCal/kg)**
Shriram Non-Conventional Energy Ltd., Thanjavur, Tamil Nadu	7.5	3,200
Synergy Shakthi Renewable Energy Ltd., Krishnagiri, Tamil Nadu	10	3,000

The other SERC's and CERC have also determined a GCV value in the range of 3,100-3,400 for biomass plants.

Table 16: GCV considered by various Electricity Regulatory Commissions for Biomass plants		
Electricity Regulatory Commision	**Date of Order/Regulation**	**GCV - kCal/kg**
APERC	06/08/2013	3,300
CERC	18/03/2014	3,100
TNERC	31/07/2012	3,200
GERC	30/09/2013	3,400
RERC	08/10/2013	3,400

A GCV value of **3,100 kCal/kg** can be considered for existing Biomass plants in Andhra Pradesh after considering the various Electricity Regulatory Commissions' norms and the information gathered from primary research.

3.4.2 Auxiliary Consumption

The data submitted by various biomass developers was analysed and it was found that the auxiliary consumption over a ten year period from FY 04-05 to FY 12-13 was in line with the existing normative auxiliary consumption of 10-13% apart from a few exceptions, as shown in the table below.

Table 17: Auxiliary consumption of Sample Biomass Players

Auxiliary Consumption (%)	FY 04-05	FY 05-06	FY 06-07	FY 07-08	FY 08-09	FY 09-10	FY 10-11	FY 11-12	FY 12-13	Normative Auxiliary Consumption (%)
Shalivahana	12%	13%	13%	13%	13%	13%	12%	11%	10%	10%
Varam	11%	12%	12%	11%	12%	13%	12%	11%	12%	
Rithwik	14%	15%	13%	13%	13%	14%	14%	14%	15%	
Greenko	11%	12%	12%	12%	13%	12%	13%	13%	13%	
Matrix	14%	14%	12%	11%	11%	12%	12%	12%	13%	

CERC and other SERCs have also considered an auxiliary consumption of 10% for biomass plants.

Table 18: Auxiliary consumption considered by various Electricity Regulatory Commissions for Biomass plants

Electricity Regulatory Commission	Date of Order/Regulation	Auxiliary consumption
APERC	06/08/2013	10%
CERC	18/03/2014	10%
KERC	11/12/2009	9%
MERC	07/06/2010	10%
TNERC	31/07/2012	10%
GERC	30/09/2013	10%

Hence, an auxiliary consumption of **10%** can be considered for Biomass projects.

3.4.3 Fuel Price and Fuel Price Escalation

A study has been carried out in order to ascertain the biomass fuel prices prevalent in the market currently. The prices were obtained directly from rice mills and other establishments dealing in biomass fuels, as captured in the table below.

Table 19: Biomass Fuel Prices captured through Primary Research

Name of factory/dealer	Fuel Price(Rs./tonne)
Tagore Modern Raw Rice Mill, Guntur	Rice Husk: 2,200
Subrahmanyeswara Swami Rice Mill, Guntur	Rice Husk: 2,700
Sri Ramana Solvex Groundnut Refinery, Mahaboobnagar	Rice Husk: 2,900 Groundnut Husk: 2,900
Siddhartha Industries, Kesamudram	Rice Husk: 2,300 Groundnut Husk: 2,700
Thirumala Rice Mill, Adilabad	Rice Husk: 2,350

The price of juliflora, as obtained from a biomass player in Tamil Nadu was found to be Rs. 3,000/tonne. The price prevalent in Andhra Pradesh would also be around the same level as there would not any factors responsible for a wide variation in prices between two neighboring states for juliflora. All the above prices are inclusive of transportation cost.

The weighted average fuel price is computed considering the biomass fuel mix for Andhra Pradesh as specified by the amendment to CERC RE Tariff Regulations of 2012. The weighted average fuel price thus worked out comes to be **Rs. 2,708/tonne**.

Table 20:Computed Fuel price for Biomass players (as fired)

Fuel Source (as fired)	% fuel mix	Price (Rs./tonne)
Rice Husk	56%	2,800
Juliflora	24%	3,000
Agri Residue	20%	2,100

A report by The Energy and Resources Institute (TERI) prepared for KERC on "*Study on the sustainability of Biomass based power generation in Karnataka"*in March 2013 had determined the biomass fuel price in Andhra Pradesh as captured in the following table.

Table 21:Fuel price of Biomass fuels in Andhra Pradesh determined in the TERI report on Biomass sustainability in Karnataka – March 2013	
Fuel Source	**Price (Rs./tonne)**
Rice Husk	1,400-2,900
Maize/Corn cobs	1,500
Juliflora	<1,300
Chilli Stalks	1,600

The computedfuel price of **Rs. 2,704/Tonne** appears to be higher than the fuel prices determined in the TERI report.

The price of biomass fuels as obtained from M/s Jocil Ltd., which operates a biomass plant in Guntur district in Andhra Pradesh is captured in the table below. Considering the biomass fuel mix for Andhra Pradesh as suggested by the CERC technical committee, the weighted average fuel price works out being Rs.2664/tonne.However, it must be taken into account that the plant operated by M/s Jocil Ltd., is a co-generation plant, which also uses coal. As a result, the plant must be kept operational at all times with minimal down time. This may result in higher fuel prices being paid by the player in order to ensure continuous operation when availability of fuel is low.

Table 22: Biomass Fuel price for M/S Jocil Ltd.(as fired)		
Fuel Source (as fired)	**% fuel mix**	**Price (Rs./tonne)**
Rice Husk	56%	2,650 – 3,300*
Juliflora	24%	2,650
Agri Residue (Cotton Stalk)	20%	900

**For computation of weighted average fuel price, price of rice husk is considered as Rs. 3300/tonne*

An allowance for a higher SHR has been considered due to operational uncertainties. As a result, no additional allowance is required on the fuel price on account of the same.

The landed fuel price of another Biomass player which sells power on a merchant basis is captured in the following table.

Table 23:Landed price of Biomass fuels at a Biomass Plant in Andhra Pradesh (Rs./tonne)

Month	Rice Husk	Firewood	Groundnut Shells	Stalks
Apr-12	1,600.39	1,498.94	1,600.00	820.30
May-12	1,713.29	1,510.17	1,700.00	800.00
Jun-12	1,712.13	1,517.96	1,726.66	1,750.00
Jul-12	1,782.47	1,511.42	1,465.56	No purchases
Aug-12	1,983.65	1,491.37	No purchases	No purchases
Sep-12	2,432.49	1,664.04	No purchases	No purchases
Oct-12	2,683.52	1,779.06	2,624.27	No purchases
Nov-12	2,694.53	1,770.08	2,800.00	800.00
Dec-12	2,505.13	1,879.61	2,373.35	800.00
Jan-13	2,530.24	1,632.14	No purchases	1,064.38
Feb-13	2,545.82	1,622.83	No purchases	941.58
Mar-13	2,517.03	1,645.69	No purchases	908.04

The landed fuel price for FY 2014-15 was computed considering the H2 13-14 fuel prices for Rice Husk (56% usage), Groundnut shells (20% usage), Juliflora(24% usage) and the CERC specified escalation rate.

Table 24: Landed fuel price of Merchant Biomass player for FY 14-15 (Rs./Tonne)			
	Rice Husk	**Groundnut Shells**	**Juliflora**
H2 13-14 Average fuel price	2,579	2,599	
FY 14-15 expected fuel price*	2,861	2,883	3100
Weighted average Fuel price	56%	20%	24%
	1,602	577	744
Total Fuel price			**2,922**

**Considering escalation as per CERC index of 10.9%*

The biomass fuel price determined by other Electricity Regulatory Commissions is summarised in the following table.

Table 25: Fuel price considered by various Electricity Regulatory Commissions for Biomass plants		
Electricity Regulatory Commission	**Date of Order/Regulation**	**Fuel Price (FY 2014-15)**
APERC	06/08/2013	2,431
MERC	07/06/2010	3,507
TNERC	31/07/2012	2,510
MPERC	03/05/2013	2,786
GERC	30/09/2013	2,862

CERC has considered a biomass fuel price of Rs. 2748/tonne for FY 14-15 for the state of Andhra Pradesh.

Considering the fact that the biomass fuel price determined by the primary research exercise is Rs. 2,708/tonne, an additional allowance of 5-6% can be given on the fuel price side keeping in mind the uncertainties faced by developers on account of fuel prices of highly unorganised fuels like agricultural residue, juliflora etc.

Fuel Price Escalation

It is suggested to adopt the fuel price indexation mechanism proposed in the CERC RE Tariff Regulations of 2012. This mechanism is applicable for Biomass fuel price adjustment in subsequent years, by considering FY 2012-13 as the base year. It takes into account three parameters, namely, (a) Escalation of fuel handling cost, considering Wholesale Price Index (WPI) as the reference variable, (b) Escalation of fuel cost, considering CERC notified Annual Inflation Rate for indexed energy component in case of captive coal mine source, as the reference variable, and (c) Escalation in transportation cost, considering escalation in High Speed Diesel, as the reference variable. Three multiplying factors have been associated with each of these parameters.

The formula for the Biomass fuel price indexation mechanism is:

$$P_{(n)} = P_{(n-1)}*\{a*(WPI_{(n-1)}/WPI_{(n-2)})+b*(1+IRC_{(n-1)})+c*(Pd_{(n-1)}/Pd_{(n-2)})\}$$

CERC indexation mechanism provides an annual fuel price escalation for Biomass players at **10.9%**for FY 2014-15.

However, the fuel price escalation for FY 2014-15 would be 6.8%, considering that the Minimum Support Price (MSP) for rice has grown by 8%, groundnut by 17% and coconut by 4% for the period FY 2010-14.

Table 26: MSP of commonly used Biomass Fuels

	Unit	FY 08-09	FY 09-10	FY 10-11	FY 11-12	FY 12-13	FY 13-14	3 Year CAGR
Groundnut	Rs./tonne	2,100	2,100	2,300	2,700	3,700	4,000	17%
Rice	Rs./quintal	950	1,000	1,030	1,110	1,280	1,345	8%
Coconut	Rs./quintal	3,910	4,700	4,700	4,775	5,350	5,500	4%

Considering that the CERC indexation mechanism is a transparent mechanism which provides for an escalation based on the market conditions, it is suggested that this mechanism be adopted by APERC.

4 Determination of norms for Bagasse projects

Bagasse based power projects are normally operated by sugar mills on a co-generation mode. The sugar cane, after extraction of sugar cane juice, is dried and used as a fuel in the power plant. Some of the equipment used in the sugar mill and the power plant are common, while a portion of the power generated is used for the in-house operation of the sugar mill.

The total installed capacity of Bagasse projects in Andhra Pradesh is around 180 MW contributing to 15% of the total installed capacity from NCE sources. The following sections present a detailed analysis on the factors to be taken into account while fixing norms for tariff determination for bagasse projects in the state.

4.1 Additional revenue to Bagasse players from APERC order of June 2013 and August 2013

The Bagasse players had approached the Hon'ble APTEL for revision of the fixed cost and variable cost norms due to the following issues

- O&M expenses are high
- Auxiliary consumption is high
- Fuel price is high

The Hon'ble APTEL, in its December 2012 order has revised the norms for Bagasse plants. Subsequently, APERC issued a revised order in June 2013 and August 2013.The following table summarises the original and revised norms for Bagasse projects in Andhra Pradesh.

Table 27: Norms for Bagasse Projects in Andhra Pradesh					
	Units	**APERC 2004 Order**	**APERC 2009 Order**	**APERC June 2013 Order (Based on APTEL norms)**	**APERC Aug 2013 Order (Based on APTEL norms)**
Applicability (Fixed Cost)	**Period**	1-10th year of Operation	NA	1-10th year of Operation	NA
Applicability (Variable Cost)	**Period**	FY 04-05 to FY 08-09	FY 09-10 to FY 13-14	FY 04-05 to FY 08-09	FY 09-10 to FY 13-14
Capital Cost	**Rs. Cr/MW**	3.25		3.25	
Threshold PLF	**%**	55%		55%	
O&M expenses (1st year of operation)	**% of Capital Cost**	3.0%		**4.0%**	
O&M Annual escalation	**%**	4%		**6.69%**	
Debt: Equity Ratio	**Ratio**	70:30		70:30	
Depreciation	**%**	7.84% (First 8 years) 7.28% (9th year) Balance 20% spread evenly over 11 years		7.84% (First 8 years) 7.28% (9th year) Balance 20% spread evenly over 11 years	
Interest on Debt	**%**	10%		**12%**	
ROE	**%**	16%		16% (MAT/Income Tax pass through)	
Interest on Working Capital	**%**	12%		12%	
SHR	**kCal/kWh**	3,700	3,700	3,600	3,600
Auxiliary Consumption	**%**	9%	9%	9%	9%
GCV	**kCal/kg**	2,300	2,300	**2,250**	2,250
Fuel Price	**Rs./tonne**	575 (FY 04-05)	950 (FY 09-10)	**745 (FY 04-05)**	950 (FY 09-10)
Fuel Price escalation	**%**	5%	5%	5%	5%

Amongst the fixed cost components, O&M expenditure, O&M Escalation rate, Interest on Debt were revised, while SHR, GCVand Fuel Price were revised amongst the variable cost components.

The revised APERC order of June 2013 and August 2013 resulted in higher fixed cost per unit and variable cost per unit for bagasseplayers. Thefollowing table summarises the initial and revised fixed cost and variable cost for bagasse players.

Table 28: Initial Fixed cost and Revised Fixed cost for Bagasse players		
Year of Operation	Fixed cost as per APERC March 2004 order	Revised fixed cost as per APERC June 2013 order
1	1.72	1.92
2	1.67	1.88
3	1.63	1.84
4	1.59	1.8
5	1.55	1.77
6	1.51	1.73
7	1.47	1.7
8	1.43	1.67
9	1.35	1.6
10	0.9	1.16

Table 29: Initial Variable cost and Revised Variable cost for Bagasse players		
Year	Variable cost as per APERC March 2004 and March 2009 order	Revised Variable cost as per APERC June 2013 and August 2013 order
FY 04-05	1.02	1.31
FY 05-06	1.07	1.38
FY 06-07	1.12	1.44
FY 07-08	1.18	1.52
FY 08-09	1.24	1.59
FY 09-10	1.68	1.67
FY 10-11	1.76	1.75
FY 11-12	1.85	1.84
FY 12-13	1.94	1.93
FY 13-14	2.04	2.03

The additional revenue accrued by a bagasse player operating at a PLF of 50% is around Rs. 1.5 Cr./MW over a 10 year period.

Table 30: Additional Revenue from APERC June 2013 and August 2013 order for Bagasse players at different PLF - Rs Crs/MW*				
Year	PLF			
	35%	40%	45%	50%
1	0.14	0.16	0.18	0.20
2	0.15	0.17	0.19	0.21
3	0.15	0.17	0.19	0.21
4	0.15	0.18	0.20	0.22
5	0.16	0.18	0.20	0.23
6	0.06	0.07	0.08	0.08
7	0.06	0.07	0.08	0.09
8	0.06	0.07	0.08	0.09
9	0.07	0.08	0.09	0.10
10	0.07	0.08	0.09	0.10
Total	**1.07**	**1.23**	**1.38**	**1.53**

** Auxiliary consumption considered - 9%, Assumed that FY 04-05 is the first year of operation for the Bagasse player*

4.2 Determination of fixed cost norms for existing Bagasse projects

4.2.1 Comparative analysis of Bagasse players actual data as against the Fixed Cost norms

This section compares the actual data of sample bagasse players as against the fixed cost norms determined in the APERC March 2004 order and the revised APERC order of June 2013 based on the norms suggested by the Hon'ble APTEL.

The data of the bagasse power plant operated by **GMR** was analysed. Data was collected on parameters like capital cost incurred for the project, loan amount taken, equity amount infused, operating and maintenance expenditure etc. The audited balance sheet and profit and loss statement of GMR were also looked at in order to gain further insight into its performance.

The below table summarises a comparative analysis of GMR as against the norms specified by various APERC orders.

Table 31: Comparative analysis of Bagasse players as against the APERC norms for the period FY 04-05 to FY 12-13

Parameter	Norms as per APERC 2004 Order	Norms as per APERC 2013 Order (APTEL suggested norms)	GMR (Sankili Village, Srikakulam)
Capital Cost (Rs. Lakh/MW)	325	325	236
PLF (%)	55%	55%	23-54%
Debt (Rs. Lakh/ MW)	227	227	165
Equity (Rs. Lakh/MW)	98	98	71
Interest on Term Loan (%)	12%	12%	7-10%
O&M Expenses (Rs. Lakh/MW)	11-15	16-27	21-32
No. of years where Net Profit is +ve			5

GMR has made a net profit for 5 years out of the 9 year period. The fact that the entire loan has been paid off indicates strong financial health of the bagasse player.

It can be observed that some parameters like capital cost, interest on term loans have already been incurred by the bagasse players in the past and these parameters need no revision for future tariff determination exercise.

Other fixed cost parameters like Return on Equity, Debt/Equity ratio, Depreciation have been set at the same levels as that of the other NCE sources and no change is required in these norms also.

O&M expenses would be incurred every year by the bagasse players to meet the salary expenses, administrative expenses and plant maintenance expenses. The plant maintenance expenses increase over the years due to ageing of the plant

while the overall O&M expenses increase due to inflation. Hence, there is a need to determine the norms for O&M expenses.

The following table captures the fixed cost norms which need revision and those which do not for existing bagasse projects.

Table 32: Revision of Fixed cost norms for existing Bagasse players

Need no Revision	Need Revision
Capital Cost	**O&M expenses**
Interest on Term Loans and Working Capital	**O&M expenses annual escalation**
Return on Equity	
Debt:Equity Ratio	
Depreciation	

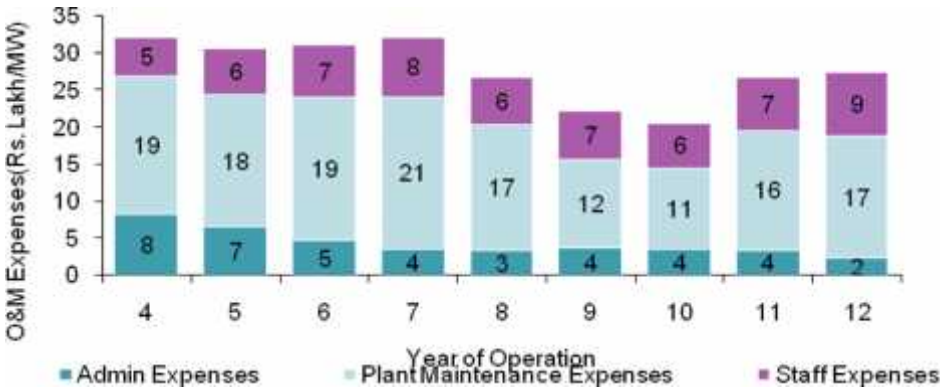
An analysis of O&M expenses has been carried out in the next section to determine the future O&M expenses norm for existing bagasse players.

4.2.2 O&M expenses analysis

The O&M expenses of bagasse players are slightly higher than the O&M expenses allowed as per the revised APERC Order of June 2013.

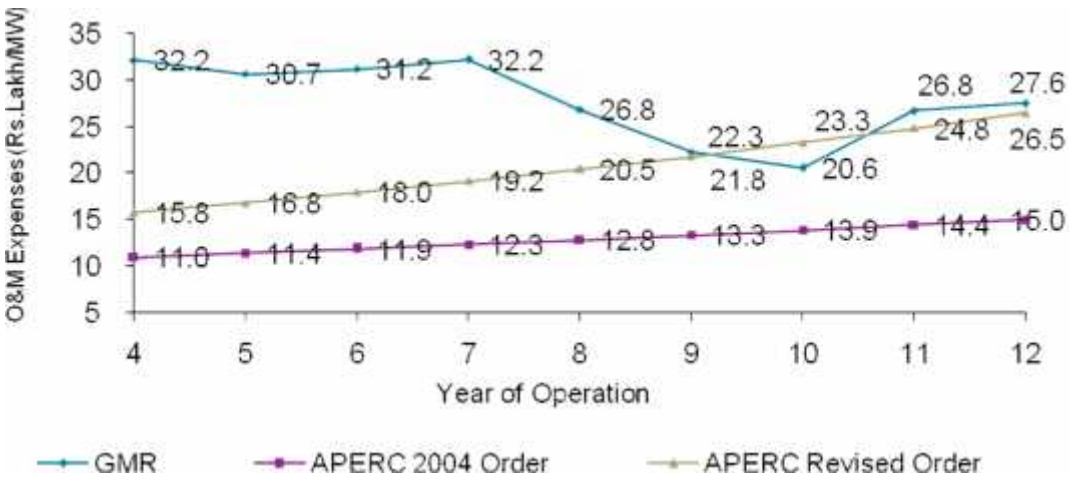
The following graph captures the three main components of the O&M expenditure – Staff Expenses, Plant Maintenance Expenses and Administrative & General Expenses for the period FY 2004-05 to FY 2012-13. GMR was in its 4th year of operation in FY 2004-05.

Figure 8: Component wise O&M Expenses of Bagasse Players as per year of operation



As can be seen, the high O&M expenses may be attributed to high plant maintenance expenses.

Figure 9: O&M Expenses of Bagasse players as per the year of operation



The O&M expenses of GMR were higher than APERC approved values till the 8th year of operation, subsequent to which the O&M expenses have almost been in line with the APERC approved values. The total O&M expenses for GMR for the 12th year of operation come out to be Rs. 28 Lakh/MW while the APERC allowed value for O&M expenditure was Rs. 27Lakh/MW.

The high plant maintenance expenses incurred by the bagasse player would also be taking into account the expenses incurred on account of sugar mills and there is a scope for reduction of these expenses in the future.

The following table captures the O&M expenses determined by CERC and SERCs for bagasse projects.

Table 33: O&M expenses considered by various Regulatory Commissions for Bagasse plants

Electricity Regulatory Commission	Date of Order/Regulation	O&M expenses (Rs. Lakh/MW) – First year	O&M annual escalation (%)	O&M expenses (Rs. Lakh/MW) - FY 2014-15
APERC	06/08/2013	13	6.69%	24.8*
CERC	28/02/2013	16.9	5.72%	17.9
KERC	11/12/2009	11	5%	14
MERC	07/06/2010	14.1	5.72%	17.6
TNERC	31/07/2012	12.6	5%	13.9
MPERC	01/04/2013	13.1	5.72%	13.8
GERC	01/08/2013	13.7	5.72%	14.5

**Considering FY 04-05 as the first year of operation of the bagasse plant*

The O&M expenses for Bagasse players allowed by CERC and various SERCs are in the range Rs. 13.8 Lakh/MW – Rs. 24.8 Lakh/MW. The APERC allowed O&M expenses are higher than what has been allowed by CERC and other SERCs. Hence, the existing norms for O&M expenses and escalation can be continued.

4.3 Variable cost analysis of Bagasse players

This section looks into the parameters affecting the variable cost and suggests the variable cost norms which can be considered for bagasse plants.

The variable cost of bagasse players is affected by the following parameters – SHR, GCV, Auxiliary Consumption, Fuel Price and Fuel price escalation.

4.3.1 Station Heat Rate and Gross Calorific Value

CERC, in the Statement of Reasons accompanying the RE Tariff Regulations of 2012, had analysed the information furnished by MNRE and heat mass balance diagrams for a few co-generation projects before specifying the normative SHR for non-fossil fuel based co-generation projects. It noted that *"Cogeneration plant operates in co-generation mode during crushing season and in Rankine cycle mode during off-season. For the purpose of tariff determination, fuel consumption corresponding to power generation alone should be considered."* Accordingly, CERC had adopted normative SHR of 3,600 kCal/kWh for power generation component for bagasse based cogeneration projects.

CERC has permitted a 10-12% allowance on SHR in the case of biomass plants owing to operational uncertainties caused due to different fuel mixes being used. However, in case of bagasse based plants, sugarcane bagasse is the only fuel which is to be used for power generation. As a result, no additional allowances on SHR are deemed to be necessary.

A majority of the SERCs had also considered the SHR for bagasse based cogeneration plants along the same lines as that of CERC.

Table 34: SHR considered by various Regulatory Commissions for Bagasse plants

Electricity Regulatory Commission	Date of Order	SHR (kCal / kWh)
APERC	06/08/2013	3,600
CERC	06/02/2012	3,600
MERC	07/06/2010	3,600
TNERC	31/07/2012	3,700
MPERC	03/05/2013	3,600
GERC	08/08/2013	3,600
HERC	20/11/2013	3,600

Hence, an SHR of **3,600 kCal/kWh** can be considered for Bagasse projects.

Gross Calorific Value

CERC, in the RE tariff regulations of 2012, has specified a GCV of 2,250 kCal/kg for Bagasse projects.

A study of the GCV values adopted by various SERCs indicates that most of the SERCs have adopted the CERC specified value of GCV for the purpose of tariff determination.

Table 35: GCV considered by various Regulatory Commissions for Bagasse plants

Electricity Regulatory Commission	Date of Order	GCV (kCal / kg)
APERC	06/08/2013	2,250
CERC	06/02/2012	2,250
MERC	07/06/2010	2,250
TNERC	31/07/2012	2,300
MPERC	03/05/2013	2,250
GERC	08/08/2013	2,250
HERC	20/11/2013	2,250

Hence, a GCV of **2,250 kCal/kg** can be considered for Bagasse projects.

4.3.2 Auxiliary Consumption

The auxiliary equipment is common between the sugar mill and power plant in case of bagasse based co-generation plants. As a result, the auxiliary consumption for Bagasse based power plants is lower than that of Biomass plants.

The Hon'ble APTEL in its order dated 20th December, 2012 had fixed auxiliary consumption for Bagasse plants at 9% for the purpose of tariff computation.

CERC, in the RE tariff regulations of 2012, has specified the auxiliary consumption for bagasse based plants as 8.5%.

The auxiliary consumption considered by various SERCs is captured in the table below, which shows that most states have determined auxiliary consumption in the range of 8.5-9%.

Table 36: Auxiliary Consumption considered by various Regulatory Commissions for Bagasse plants		
Electricity Regulatory Commission	**Date of Order**	**Auxiliary Consumption (%)**
APERC	06/08/2013	9%
CERC	06/02/2012	8.5%
KERC	11/12/2009	8%
MERC	07/06/2010	8.5%
TNERC	31/07/2012	9%
MPERC	03/05/2013	9%
GERC	08/08/2013	8.5%
HERC	20/11/2013	8.5%

An auxiliary consumption in the range of **8.5-9%** can be considered for Bagasse projects.

4.3.3 Fuel Price and Fuel Price Escalation

The Minimum Support Price (MSP) for sugarcane for FY 13-14 was Rs. 2,100/tonne[3], which translates to Rs. 2,373/tonne for FY 14-15 considering a 13% MSP escalation for the period FY 10-14. Bagasse contributes nearly 30% of sugarcane by weight. On a weight basis, the price of Bagasse works out to be Rs. 710/tonne. Additionally, cane prices to be paid by sugar mills in Andhra Pradesh to the farmers till September 2013 was around Rs. 1,760/tonne[4].

However, it should be noted that the price of bagasse for Andhra Pradesh as suggested by CERC in its order dated 7th January 2014 is Rs. 1,551/tonne for FY 14-15. This price has been determined by CERC after applying the fuel price indexation mechanism on the price considered by CERC for Andhra Pradesh for FY 13-14. The price would serve as a true reflection of the market realities prevalent in the sector.

[3]Department of Food & Public Distribution, Ministry of Consumer Affairs, Food & Public Distribution
[4]Ministry of Consumer Affairs, Food & Public Distribution Order dated 22nd October 2013

Table 37: MSP of Sugarcane in India	
Financial Year	**MSP of Sugarcane (Rs./tonne)**
FY 09-10	1,298
FY 10-11	1,391
FY 11-12	1,450
FY 12-13	1,700
FY 13-14	2,100

The bagasse fuel price determined by various SERCs is summarized in the table below.

Table 38: Fuel price considered by various Electricity Regulatory Commissions for Bagasse plants		
Electricity Regulatory Commision	**Date of Order/Regulation**	**Fuel Price (FY 2014-15)**
APERC	06/08/2013	1,212
CERC	07/01/2014	1,551
MERC	07/06/2010	2,178
TNERC	31/07/2012	1,158
MPERC	03/05/2013	1,662
GERC	01/08/2013	1,894

Hence, a fuel price of **Rs. 1,551/Tonne** can be considered for bagasse projects for FY 2014-15.

Fuel Price Escalation

It is suggested to adopt the fuel price indexation mechanism to be used for Biomass plants can be used for Bagasse plants.

The formula for the Bagasse fuel price indexation mechanism is

$$P_{(n)} = P_{(n-1)}*\{a*(WPI_{(n-1)}/WPI_{(n-2)})+b*(1+IRC_{(n-1)})+c*(Pd_{(n-1)}/Pd_{(n-2)})\}$$

Considering that the CERC indexation mechanism is a transparent mechanism which provides for an escalation based on the market conditions, it is suggested that this mechanism be adopted by APERC.

5 Municipal Solid Waste (MSW) to Energy projects

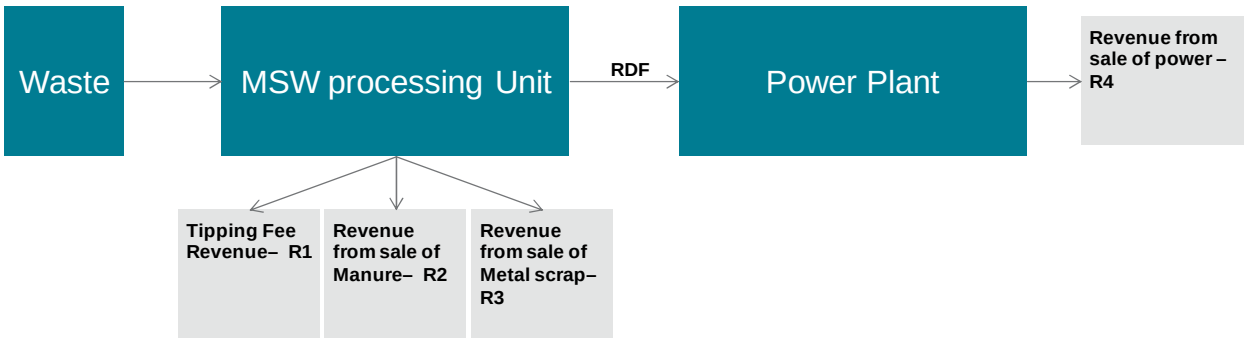
Municipal Solid Waste to Energy projects use processed waste as fuel to fire power plants. There are inherent benefits associated with such projects like garbage collection, garbage disposal, etc. In most of the Indian cities, the garbage collection and disposal system is unorganized. This industry should be promoted in a way which makes it economically viable and sustainable. This will ensure that the garbage collection and disposal system becomes organized. The associated problems of improper garbage disposal such as choking of drains with plastic waste, etc thus leading to water logging, etc, can also be solved to a fair extent. Such projects thus generate positive externalities.

There are two models through which power is generated from Municipal Solid Waste.

5.1 Integrated MSW to Power Plant

In an Integrated MSW plant, the responsibilities of garbage collection, garbage processing, sale of processed garbage and usage of required fuel in the power plant is the responsibility of the MSW project owner. Given below is a schematic diagram of an Integrated MSW to Power Plant.

Figure 10: Schematic Diagram of an Integrated MSW to Power Plant



The garbage collected by the MSW player is taken to its processing facility. The MSW player is paid a tipping fee by the concerned Municipal Corporations. The MSW player processes garbage which results in the following outputs – manure, metal scrap and Refuse Derived Fuel (RDF). The player can sell manure and metal scrap in the market for additional revenue while the RDF acts as a fuel for the power plant. In effect, an Integrated MSW player may not incur any fuel cost to operate the power plant. Additional revenue from sale of power is realised by an Integrated MSW player. The following table lists down the Revenue and Expenditure of Integrated MSW players.

Table 39: Revenue and Expenditure of an Integrated MSW player

Revenue	Expenditure
Tipping Fee Revenue – R1	Interest on Loan and Working Capital
Revenue from sale of Manure – R2	O&M Expenditure
Revenue from sale of Metal scrap – R3	Depreciation
Revenue from sale of Power – R4	Processing Charges
	Return on Equity

The capital investment required to set up an Integrated MSW facility is high as compared to other NCE sources, since a garbage processing facility is also required in addition to a power plant. The following table provides a comparative analysis of various Integrated MSW plants set up in India.

Table 40: Comparative analysis of Integrated MSW plants in India

Parameter	Timarpur Okhla Waste Management	SESL, Vijaywada	Shalivahana, Karimnagar	Integrated Waste Processing Plant, Ghazipur
PLF (%)	70%	70%	80%	70%
Capacity (MW)	16	6	12	10
Capital Cost (Rs. Lakh/MW)	1,088	764	1,051	1,359
Aux. Consumption (%)	18.3%	12.5%	10.0%	20.0%
SHR (kCal/kWh)			4200	
GCV (kCal/kg)	2,600	3,000	2,377	2,600
Fuel Cost (Rs/tonne)			2,000	

It can be observed that the average capital cost of Integrated MSW plants is around Rs. 1,000 Lakh/MW, which is very high as compared to Biomass and Bagasse plants. There is also a huge variation in the other parameters like O&M expenses, Auxiliary consumption, GCV pointing to the fact that each MSW project is unique in nature owing to different technologies being used.

On the other hand, Integrated MSW players get additional revenue in the form of Tipping fee, sale of manure and metal scrap. Hence, while determining the tariff of MSW projects, capital cost and expenses incurred only on account of the power plant should be considered. As the technology used is varied and the scale of operation is also different for different MSW projects, tariff for such Integrated MSW projects may be determined on a case to case basis.

Alternatively, Municipal Corporations can invite bids from Integrated MSW players for setting up Integrated MSW plants. The MSW players can quote the tipping fee they expect from the Municipal Corporations. The MSW player can be selected based on technical evaluation and financial evaluation (bidder who quotes the lowest tipping fee).

5.2 MSW based Power plant

Some MSW players may set up only power plants, which use RDF as fuel. Such MSW projects are similar to other NCE projects like Biomass and Bagasse. The MSW players incur a fuel cost for buying RDF and realise revenues from the sale of power. They incur a lower capital cost as compared to Integrated MSW projects as a processing facility need not be set up.

MSW players in the state of Andhra Pradesh have been paid a single part tariff based on a base rate of Rs. 2.25/Unit for FY 1994-95. This base rate has been escalated annually on a simple basis by 5%. The tariff determined for MSW players is not as per any stipulated norms. Though the APERC revised orders of 2013 had provided relief to Biomass and Bagasse players, no such relief was provided to MSW players and they are being paid as per the single part tariff as of today.

Considering the various advantages to the environment due to MSW projects, MSW projects should be provided encouragement in the state of Andhra Pradesh by making them financially viable. The MSW projects should be given a tariff which is

either determined in a similar method as for other NCE sources or should be provided a 2-5% premium over other NCE sources in terms of tariff.

The operations of a MSW power plant are very similar to that of a biomass plant and hence the tariff for MSW projects should be atleast equal to that of the biomass players. However, owing to variation in operating parameters for different MSW plants, it is advisable to determine tariff on case-to-case basis for MSW plants as also suggested by CERC.

This step would go a long way in making the existing MSW projects financially viable and would also encourage new MSW projects in the state of Andhra Pradesh.

6 Conclusion

The key takeaways from this study report with respect to each of the following points is as follows:

- *Determination of fixed cost norms for the 11-20th year of operation for existing NCE projects*: After an analysis of the performance of various NCE generators in the state and taking into account the additional revenue accrued by the developers due to the revised orders of APERC in 2013, it is recommended to consider the existing APERC fixed cost norms as per the order dated 22June 2013.
- *Determination of variable cost norms for the period FY 2014-15 to FY 2018-19 applicable to existing NCE projects*: A detailed analysis of the factors affecting the variable cost parameters was undertaken in the preceding sections. On the basis of this analysis, the following variable cost parameters are recommended for biomass and bagasse plants in the state of Andhra Pradesh for the period FY 2014-15 to FY 2018-19:

Table 41: Recommended Variable Cost Norms for Biomass and Bagasse Plants		
Parameter	**Biomass Plants**	**Bagasse Plants**
Aux. Consumption (%)	10%	8.5-9%
SHR (kCal/kWh)	4,200	3,600
GCV (kCal/kg)	3,100	2,250
Fuel Cost for FY 14-15 (Rs/tonne)	2,708 (with additional 5-6% allowance)	1,551
Fuel Cost Escalation (%)	CERC Indexation Mechanism	

Annexure

A. Determination of Fuel Price Escalation as per CERC Indexation Mechanism

CERC has explained a Fuel Price Indexation Mechanism in RE Tariff Regulations 2012. This mechanism is applicable for Biomass and Bagasse fuel price adjustment in subsequent years, by considering 2012-13 as the base year. It takes into account three parameters, namely, (a) Escalation of fuel handling cost, considering WPI as the reference variable, (b) Escalation of fuel cost, considering CERC notified Annual Inflation Rate for indexed energy component in case of captive coal mine source, as the reference variable, and (c) Escalation in transportation cost, considering escalation in High Speed Diesel, as the reference variable. Three multiplying factors have been associated with each of these parameters. The factors and parameters used for the computation and the detailed computation is given below

$$P_{(n)} = P_{(n-1)}*\{a*(WPI_{(n-1)}/WPI_{(n-2)}+b*(1+IRC_{(n-1)}+c*(Pd_{(n-1)}/Pd_{(n-2)})\}$$

where

$P_{(n)}$: Price per tonne of fuel for n^{th} year

$P_{(n-1)}$: Price per tonne of fuel for $(n-1)^{th}$ year

a : Factor representing fuel handling cost which is taken as **0.2**

b : Factor representing fuel cost which is taken as **0.6**

c : Factor representing transportation cost which is taken as **0.2**

$WPI_{(n-1)}$: Wholesale Price Index for April of $(n-1)^{th}$ year

$WPI_{(n-2)}$: Wholesale Price Index for April of $(n-2)^{th}$ year

$IRC_{(n-1)}$: Average Annual Inflation rate for indexed energy component in case of captive coal mine source for $(n-1)^{th}$ year

$Pd_{(n-1)}$: Weighted average price of High Speed Diesel for $(n-1)^{th}$ year

$Pd_{(n-2)}$: Weighted average price of High Speed Diesel for $(n-2)^{th}$ year

The detailed computation of the fuel escalation factor as per the above methodology is explained below

Sl. No.	Particulars	FY 09-10	FY 10-11	FY 11-12	FY 12-13	FY 13-14	FY 14-15
	WPI (April)	**125**	**138.6**	**152.1**	**163.5**	**171.3**	
	HSD (CERC- Calendar Year)	**130.33**	**147.91**	**160.99**	**175.24**	**210.91**	
	Energy Index	**3.0%**	**8.6%**	**7.6%**	**6.5%**	**9.8%**	
	Computation of Energy Index						
	Month of notification	Mar-09	Mar-10	Mar-11	Apr-12	Apr-13	
	Escalation Rate (%)	10.8%	8.7%	9.6%	9.5%	9.8%	
	Applicable Tenure (# days)	183	183	183	183	183	
	Month of notification	Nov-09	Dec-10	Oct-11	Oct-12	Oct-13	
	Escalation Rate (%)	-4.8%	8.5%	5.7%	3.4%	9.8%	
	Applicable Tenure (# days)	182	182	182	182	182	
	Wtd. Avg. Escalation Rate (%)	3.0%	8.6%	7.6%	6.5%	9.8%	
	Escalation Matrix						
1	**Fuel Handling cost**						
	A	0.20	0.20	0.20	0.20	0.20	0.20
	WPI_{n-1}	123.50	125.00	138.60	152.10	163.50	171.30
	WPI_{n-2}	114.50	123.50	125.00	138.60	152.10	163.50
	Escalation	0.22	0.20	0.22	0.22	0.21	0.21

Sl. No.	Particulars	FY 09-10	FY 10-11	FY 11-12	FY 12-13	FY 13-14	FY 14-15
2	**Fuel cost**						
	B	0.60	0.60	0.60	0.60	0.60	0.60
	IRC_{n-1}	6.04%	3.00%	8.59%	7.63%	6.47%	9.81%
	Escalation	0.64	0.62	0.65	0.65	0.64	0.66
3	**Transportation cost**						
	C	0.20	0.20	0.20	0.20	0.20	0.2
	PD_{n-1}	135.66	130.33	147.91	160.99	175.24	210.91*
	PD_{n-2}	125.62	135.66	130.33	147.91	160.99	175.24
	Escalation	0.22	0.19	0.23	0.22	0.22	0.24
4	**Total Escalation**	6.80%	1.26%	10.02%	8.29%	7.15%	10.91%

B. References

List of relevant regulation /order /judgement by various Electricity Commissions and Tribunal

Name of Commission / Tribunal	Date of Regulation/ Order/ Judgement	Name of Regulation/ Order / Judgement
APERC	20/04/2004	R.P.No..1075 / 2000
APERC	31/03/2009	O.P. No. 5 /2009
APERC	12/09/2011	Order in R.P No. 84/2003 in O.P.No.1075/2000 upon remand from Hon'ble Supreme Court in C.A No.2926 of 2006
APERC	22/06/2013	Order pursuant to judgement of Hon'ble APTEL dated 20th December 2012
APERC	06/08/2013	Order pursuant to judgement of Hon'ble APTEL dated 20th December 2012
APTEL	30/04/2013	Review Petition Nos. 3, 4 & 5 of 2013
APTEL	20/12/2012	Judgement in Appeal nos. 150, 166, 168, 172, 173 of 2011 and 9, 18,26, 29, and 38 of 2012
KERC	11/12/2009	Determination of Tariff in respect of Renewable Sources of Energy
MERC	07/06/2010	Terms and conditions for determination of re tariff) regulations, 2010
TNERC	31/07/2012	Order No. 7 of 2012, Order No. 8 of 2012

MPERC	03/05/2013	Order for procurement of power from Bagasse based cogeneration plants in Madhya Pradesh
GERC	08/08/2013	Order No. 4 of 2013. Determination of Tariff for Procurement of Power by the Distribution Licensees and Others from Biomass based Power Projects and Bagasse based Co-generation Projects
GERC	30/09/2013	Order No. 4 of 2013. Corrigendum on Determination of Tariff for Procurement of Power by the Distribution Licensees and Others from Biomass based Power Projects and Bagasse based Co-generation Projects
HERC	20/11/2013	Determination of Levelized Generic Tariff for Renewable Energy Projects to be commissioned during FY 2013-14 under Regulation 7 of the Haryana Electricity Regulatory Commission (Terms and Conditions for Tariff Determination from Renewable Energy Sources) Regulations, 2010.
CERC	16/09/2009	Terms and Conditions for Tariff determination from Renewable Energy Sources, Regulations, 2009.
CERC	06/02/2012	Terms and Conditions for Tariff determination from Renewable Energy Sources, Regulations, 2012
CERC	28/02/2013	Determination of generic levelized generation tariff for the FY2013-14 under Regulation 8 of the Central Electricity Regulatory Commission (Terms and

		Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012.
CERC	07/01/2014	Determination of generic levelized generation tariff for the FY 2014-15 under Regulation 8 of the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012.
CERC	18/03/2014	Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) (First Amendment) Regulations, 2014.

C. List of Research reports

Name of Body	Date of Publishing	Name of Report
CEA	September 2005	Operation Norms for Biomass Based Power Plants
CERC	July 2013	Performance/Viability of Biomass based plants operating in the Country including the prevailing biomass prices
The Energy and Resources Institute (for KERC)	March 2013	Study on the sustainability of Biomass based power generation in Karnataka

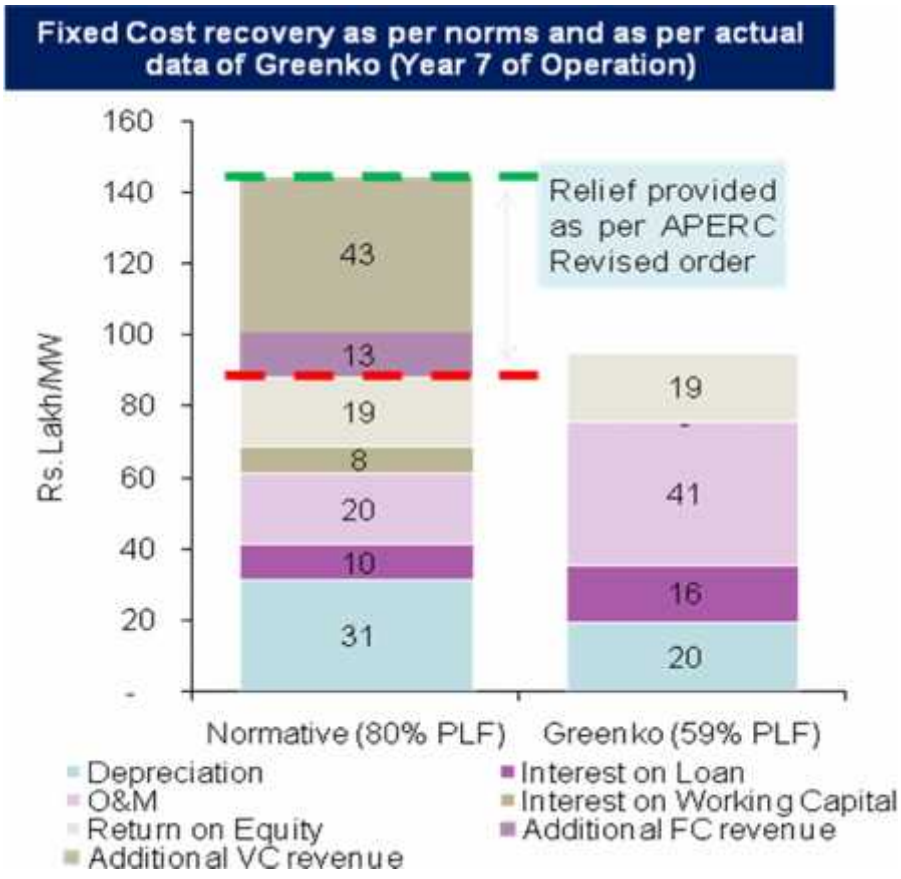
D. Fuel price of sample Biomass players

Fuel Price (Rs./tonne) as per the data furnished by Biomass developers									
Biomass Player	FY 04-05	FY 05-06	FY 06-07	FY 07-08	FY 08-09	FY 09-10	FY 10-11	FY 11-12	FY 12-13
Greenko	1,147	1,133	1,388	1,399	1,110	914	1,631	1,650	
Matrix	996	1,300	1,367	1,256	1,497	1,716	1,940	1,813	1,734
Rithwik	1,063	1,221	1,364	1,363	1,286	1,531	1,588	2,003	2,135
Varam	876	911	877	1,148	1,059	1,415	1,656	1,693	1,698

E. Landed fuel price of a merchant Biomass plant operating in Tamil Nadu

Landed fuel price of a merchant Biomas plant operating in Tamil Nadu	
April 2012	2,368
May 2012	2,322
June 2012	No purchases
July 2012	No purchases
August 2012	No purchases
September 2012	No purchases
October 2012	1,964
November 2012	2,277
December 2012	2,436
January 2013	2,399
February 2013	2,378

F. Relief provided by APERC June 2013 and August 2013 order to Biomass players – An illustration



Greenko incurred a higher Fixed Cost in Year 7 of operation as against the Fixed Cost allowed in APERC 2004 order. APERC orders of June 2013 and August 2013 has ensured Greenko has recovered higher fixed cost than the actual fixed cost incurred

G. Minimum Support Prices as recommended by Commission for Agriculture Cost and Prices

MSP Prices as recommended by Commission for Agriculture Cost and Prices									
	Unit	FY 07-08	FY 08-09	FY 09-10	FY 10-11	FY 11-12	FY 12-13	FY 13-14	3 year CAGR
Groundnut	Rs./quintal		2,100	2,100	2,300	2,700	3,700	4,000	**17%**
Rice	Rs./quintal	645	950	1,000	1,030	1,110	1,280	1,345	**8%**
Coconut	Rs./quintal	3,870	3,910	4,700	4,700	4,775	5,350	5,500	**4%**