BIOMASS ASSESSMENT STUDY FOR POWER GENERATION IN THE STATE OF RAJASTHAN 2021

FOR

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Rajasthan At A Glance

Biomass Overview

Macro-Economic Scenario

Rajasthan Key Facts FY 2019-20

Geographical Area
342,239 (Sq. Km.)

Biomass Installation Power Capacity
~101.95 (MW)

Total Biomass Power Projects 13
(Cumulative Capacity 120.45 MW)

Main crops
Wheat, Jau, Jowar, Bajra, Maize, and Pulses

As on December 2020, the installed power capacity of Rajasthan is 21,835.90 MW (Approximately 21.8 GW).

Climate Overview
Average Daily High Temperature
32 Degrees Centigrade

Total Tehsils
287

- ✓ State Government has even issued 'Policy for Promoting Generation of Electricity from Biomass 2010' for encouraging investments in the sector.
- ✓ The main source for biomass energy in the State of Rajasthan is Mustard Husk and Julie Flora.
- ✓ Punjab Renewable Energy Systems Pvt. Ltd. (PRESPL)- only and the largest organized player in biomass supply chain in the market
- ✓ Percentage of GDP produced by the agricultural sector was 25% in 2019-20

Cropping Pattern on Sample Farms in Rajasthan 2019-2020

Wheat	Barley	Gram	Pulses	Groundnut
Total Area **349,7209** (ha)	Total Area **301,244** (ha)	Total Area **246,3029** (ha)	Total Area **633,6006** (ha)	Total Area **734,556** (ha)
Production 138,87656 **(ha)**	Production 107,8576 **(ha)**	Production 266,0934 **(ha)**	Production 449,6978 **(ha)**	Production 161,2255 **(ha)**

Oil Seeds	Bajra	Jowar	Maize	Cotton
Total Area **5822,880** (ha)	Total Area **4249,674** (ha)	Total Area **642,841** (ha)	Total Area **875,162** (ha)	Total Area **760,490** (ha)
Production 733,2683 **(ha)**	Production 505,2392 **(ha)**	Production 456,072 **(ha)**	Production 113,5433 **(ha)**	Production 2787,614 **(ha)**

Source: Commissionerate of Agriculture, Govt of Rajasthan 2019-20

Key Biomass Agency

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KEY ABBREVIATIONS

ABT: Availability-based tariff
ACS: Average cost of supply
ARB - As-Received Basis
CERC: Central Electricity Regulatory Commission
CRR: Crop to Residue Ratio
ESMI: Electricity Supply and Monitoring Initiative
EFW: Energy Conversion from Waste
FY: Financial year
GBI: Generation-based incentives
GEC: Green Energy Corridor
GST: Goods and Services Tax
GW: Gigawatt
IEA: International Energy Agency
IPDS: Integrated Power Development Scheme
IPP: Independent power producer
IREDA: Indian Renewable Energy Development Agency
kW: Kilowatt
kWh: Kilowatt hour
MNRE: Ministry of New and Renewable Energy
MoEF&CC: Ministry of Environment, Forests & Climate Change
MoP: Ministry of Power
MoUD: Ministry of Urban Development
MSW: Municipal solid waste
MU: Million units
MW: Megawatt
NGT: National Green Tribunal
PRESPL: Punjab Renewable Energy Systems Pvt Ltd
PPA: Power purchase agreement
PSA: Power sale agreement
REC: Renewable Energy Certificate / Rural Energy Corporation
REMC: Renewable Energy Management Centre
RREC: Rajasthan Renewable Energy Corporation
SERC: State Electricity Regulatory Commission
SWM: Solid waste management
TOF: Trees Outside Forests
TPD: Tonne Per Day
TPES: Total Primary Energy Supply
WECI: Waste to Energy Corporation of India
WTE: waste to energy

PREAMBLE

With a population of 1.4 billion and one of the world's fastest-growing major economies, India will be vital for the future of the global energy markets. The Government of India has successfully implemented a range of energy market reforms and carried out a huge amount of renewable electricity deployment.

Over the past decades energy demand has steadily increased across all sectors, including agriculture, industry, commercial and residential, and is expected to grow. Nonetheless, India's per capita energy consumption stands at 30% of the world's average (0.44 tonnes of oil equivalent [toe] per capita versus the global average of 1.29 toe and the International Energy Agency [IEA] average of 2.9).

According to IEA data, bioenergy and waste is the largest source of renewable energy in India's primary energy supply (21% of Total Primary Energy Supply (TPES), the third-largest energy source in India). However, more than two-thirds of India's bioenergy consumption comes from traditional use of biomass in the residential sector resulting in negative environmental and health impacts. The GoI has introduced policies promoting modern and clean use of bioenergy in households, as well as the replacement of the traditional use of biomass with alternative cooking and heating fuels, both renewable (solar cooking) and non-renewable (such as LPG).

The largest power markets within India are the states of Maharashtra, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Gujarat, Tamil Nadu, West Bengal, Andhra Pradesh, Rajasthan and Karnataka.

Rajasthan has immense potential for electricity generation through renewable energy sources and wind power. Rajasthan Renewable Energy Corporation Ltd has actively promoted solar energy and biomass projects.

Rajasthan is the 4th Largest renewable energy in India with a total of 9.6 gigawatts (GW) of renewable energy capacity installed. It also added more solar power capacity (1.7GW) in financial year (FY) 2019/20 than any other Indian state. Karnataka (1.4GW) was next, followed by Tamil Nadu (1.3GW). Home to the world's largest operational utility-scale solar park in Bhadla, Rajasthan is a solar energy transition leader and is attracting massive ongoing new investment in renewables and supporting grid infrastructure, as well as associated manufacturing opportunities.

Renewable energy formed 43.5% of Rajasthan's total installed capacity and 14% of its total on-grid generation in FY2019/20.

The state has 9.8GW of coal-fired capacity, which makes up 45% of total installed capacity and produces 56.5% of its total on-grid generation.

Accounting for India's economic slowdown in FY2019/20, exacerbated by the COVID-19 pandemic in 2020/21, we project Rajasthan's electricity production requirements to grow by just 42% over the next decade, from 81TWh in FY2019/20 to 115TWh FY2029/30. This growth rate is well below any forecasts set even two years ago.

1. INTRODUCTION

With reference to work order Issued vide No. RREC/Biomass Fuel Supply Study/2020-21/D-656 dated 04/6/2021) Rajasthan Renewable Energy Corporation Ltd (RREC)., a nodal agency for the promotion of renewable energy in the state, commissioned Punjab Renewable Energy Systems Pvt Ltd (PRESPL) to conduct a detailed Biomass Fuel Supply Study to get the prices & price trend and potential (in MW) of biomass power in the state of Rajasthan. This biomass assessment study was be carried out for biomass fuels in view of power generation in Rajasthan State, particularly in respect of Estimate Overall Biomass Output - All Sources and Usage and Estimate Biomass Availability for Power Generation in Rajasthan.

The Main Objective of the study was as following:

1. Understanding Biomass Production, Output, Usage etc.
2. Assessing and analysing pricing trends of Biomass.
3. Determine the current market scenarios in Biomass Storage, Calorific Value of biomass for energy generation.
4. District Wise Potential of Biomass Power Generation.
5. Analyse the supply chain and its stakeholders involved in Biomass Supply to Power Generation.
6. Ascertain Utilization patterns, net quantity available for power generation to renewable energy projects in different districts.
7. Estimate and Record Crop to Residue Ratio (CRR) for different biomass species as per the study.
8. Record and estimate biomass growth using published data from various sources.
9. Analyse recent trend of biomass price and price spread by the existing operating biomass power plants out of list.
10. Determination of sale price of Prosopis-Juliflora/other energy plantation, a provision has been incorporated in the “Policy-2010".
11. Determine costing which includes cutting/uprooting, loading/unloading, transportation and chipping on lump sum basis.

2. EXECUTIVE SUMMARY

PRESPL conducted the biomass assessment study by carrying out extensive field survey covering all districts in the state of Rajasthan.

The Biomass Assessment Study covers district wise samples of Type of Biomass, Crop Cultivation Patterns, Biomass Availability for Domestic and Industrial Consumption, Surplus Availability for Power Generation, Average Calorific Value, Crop-To-Residue Ratio, Moisture Content in Crops and Biomass, Availability of Biomass in different seasons, Field Gate Prices of Biomass, Factory Gate Prices of Biomass, Power Generation from Biomass, Price of the Power Generated per unit etc.

The study includes primary, secondary and also field research for fulfilling various requirements of the study. The report consists of biomass price scenario, analysis, and conclusions on prevailing and projected prices of biomass for the power plants. The study also looks at the crop cultivation patterns and biomass cultivation across 33 districts of Rajasthan over the period of last few years. The crop cultivation across Rajasthan differs from region to region as the terrain changes and the surplus availability for the production of power from biomass.

The Average Calorific Value, Moisture content, Crop to Residue Ratio and losses during storage and transportation plays a very significant part in biomass usage in production of power. The usage of Biomass for different activities especially in rural areas such as Fodder for Livestock, Wood for Cooking, Heating Water and energy usage for traditional industries has been in fore- front of using biofuels. The surplus biomass generated after use in all the primary activities goes for the production of biofuels which in-turn will be used for power generation.

During the field survey, farmers, traders, operating power plants, forest department, agriculture department, other Govt. agencies, brick kilns and other industries were visited in different districts and requisite details were collected.

The summarized key outcomes are as following:

The scope of the study includes the identification of various sources of biomass and assessment of the surplus availability of biomass within the Rajasthan State. Also, the scope covers the price and price trend of main biomass fuel in the state of Rajasthan. The Rajasthan state consists of 33 districts and the last three years' average cultivation area is around **2,24,79,599 hectares**.

i. District wise biomass that is available for Power Generation:

The surplus biomass availability in each district of Rajasthan for generation of power on sustainable basis has been estimated and is presented in the Table 107 of the report.

Out of the total geographical area of 3,42,23,900 hectares in study area, 93,68,947 hectares were identified as wasteland out of which Prosposis Juliflora is grown in 58,47,268 hectares of cultivable waste land and fallow land in Rajasthan and district wise break up is provided in Table 31 of the report. The huge potential of Juliflora plantation indicates that power plant should rigorously follow Juliflora plantation in order to achieve long term fuel availability and power plant sustainability.

ii. Average calorific value of biomass:

Mustard Crop Residue and Juliflora are major biomasses being utilized by the power plant. The average GCV in Kcal/Kg and moisture level for Mustard Crop Residue and Juliflora are being tabulated below.

Table 1: Average GCV with dust and moisture level:

Biomass	Average Moisture (%)	GCV in Kcal/Kg
Mustard Crop Residue	10 to 12	3353
Prosopis -Juliflora	35 to 40	2845
Source: Table No. 110.		

Table 2:Average Biomass Stacking and Feeding Cost

Sr. No	BIOMASS STACKING & FEEDING COST	Rs per MT
1	Stacking & Covering Including LDPE Sheet Cost Rs/MT	133
2	Feeding Cost Rs/MT	364
	Average Total Cost	**497**
Sources: As per table 98		

Table 3: Specific Fuel Consumption

Sl.No.	Power Plant Name	SFC (Kg/kWh)
1	Surya Chambal Power Ltd	1.5
2	Transtech Green Power Pvt Ltd	1.8
3	S.M. Environmental Technologies (P) Ltd	1.8
4	Sanjog Sugar & Eco Power Pvt Ltd	1.7
5	Sathyam Power Limited	1.7
6	Orient Green Power Co. (Rajasthan)	1.6
7	Kalpataru Power Transmission Ltd. (Sri Ganganagar)	1.5
8	Kalpataru Power Transmission Ltd. (Tonk)	1.6
	Total Average	**1.63**
Sources: As per table 103		

iii. Biomass losses during storage:

The biomass power plants are facing about 4 % 4.5 % loss of fuel during storage due to various factors such as land settling, detioration of fuel and fuel being carried away during sandstorm. However, with better fuel management techniques such as proper levelling of ground for storage, proper drainage system and covering of fuel with tarpaulin, the total fuel losses can be targeted about 1.5 % to 2.0 %.

iv. Average Price escalation per annum:

Table 4: Total Average Biomass Cost Based on Fuel Used in Biomass Power Plant

Particulars	Total Average of all Major Biomass cost Rs. per Year	Escalation %
FY 2018-19	Rs. 2,754.75	
FY 2019-20	Rs. 2,668.19	-3.12 %
FY 2020-21	Rs. 2,778.92	4.12 %
Average Escalation of all Major Biomass cost from the year FY 2018-19 to FY 2020-21		0.87 % /- approx.
Note: calculated based on the actual fuel mix data collected from operating biomass power plants and the average cost evaluated through primary data.		
Sources: As per table 96		

Table 5: Mustard Stalks & Husk Biomass Details - A Glance

Sl. No.	Particulars	Biomass I
1	Name of the Biomass	Mustard Stalks & Husk
2	Generation Point	Agro – Field
3	Generation (MT/year)	76,01,947.0
4	Consumption (MT/year)	58,14,111.8
5	Surplus Availability (MT/year)	17,87,835.2
6	Present Use	Domestic fuel for local people, fuel for Brick kiln, Thermal energyconsuming Industries, Briquetting units, and Power Plants
7	Cost of Fuel at Plant (Rs. Per MT)	
	FY 2018-19	Rs. 2862 per MT
	FY 2019-20	Rs. 2961 per MT
	FY 2020-21	Rs. 3079 per MT
8	Storage & Feeding Cost Rs. Per MT	Rs. 364 per MT
9	Biomass Storage & Handling Loss	Minimum 8.0 (Percentage)
10	Potential Districts (Having Surplus more than 1.7 Lakh MT)	Bharatpur, Dhaulpur, S. Madhopur, Karoli & Jodhpur
11	Seasonality	Oct – Dec
12	Average Calorific Value in ARB (kcal/kg)	3353 Kcal per Kg
13	Moisture	About 10 to 12 %
Source: As per table no's, 35, 43 & 100		

Table 6: Prosopis Juliflora Wood Biomass Details - A Glance

Sl No.	Particulars	Biomass II
1	Name of the Biomass	Prosopis Juliflora Wood
2	Generation Point	Waste Land, Forest Area
3	Generation (tons/year)	3,01,40,622
4	Consumption (tons/year)	2,66,07,565
5	Surplus Availability (tons/year)	35,33,058
6	Present Use	Domestic fuel for local people, fuel for Brick kiln, Thermal energy consuming Industries, Briquetting units, and Power Plants.
7	Cost of Fuel at Plant (Rs. Per Ton)	
	FY 2018-19	Rs. 2118 per MT
	FY 2019-20	Rs. 2283 per MT (Escalation was Rs 165 PMT)
	FY 2020-21	Rs. 2570 per MT (Escalation is Rs 287 PMT)
8	Storage & Feeding Cost Rs. Per MT	Rs. 460 per MT
9	Chipping Cost Rs. Per MT	Rs. 450 per MT
9	Potential Districts	Dausa, Bharatpur, Bikaner, Ganganagar, Hanumangarh, Jalore, Pali, Sirohi, Bundi, Udaipur, Chittaurgarh
10	Seasonality	Nov - Dec
12	Average Calorific Value in ARB (kcal/kg)	2845 Kcal/Kgs
13	Moisture during harvesting	About 35 to 40 %

Source: As per table no's 42, 45 & 101

v. Biomass Project Commissioned:

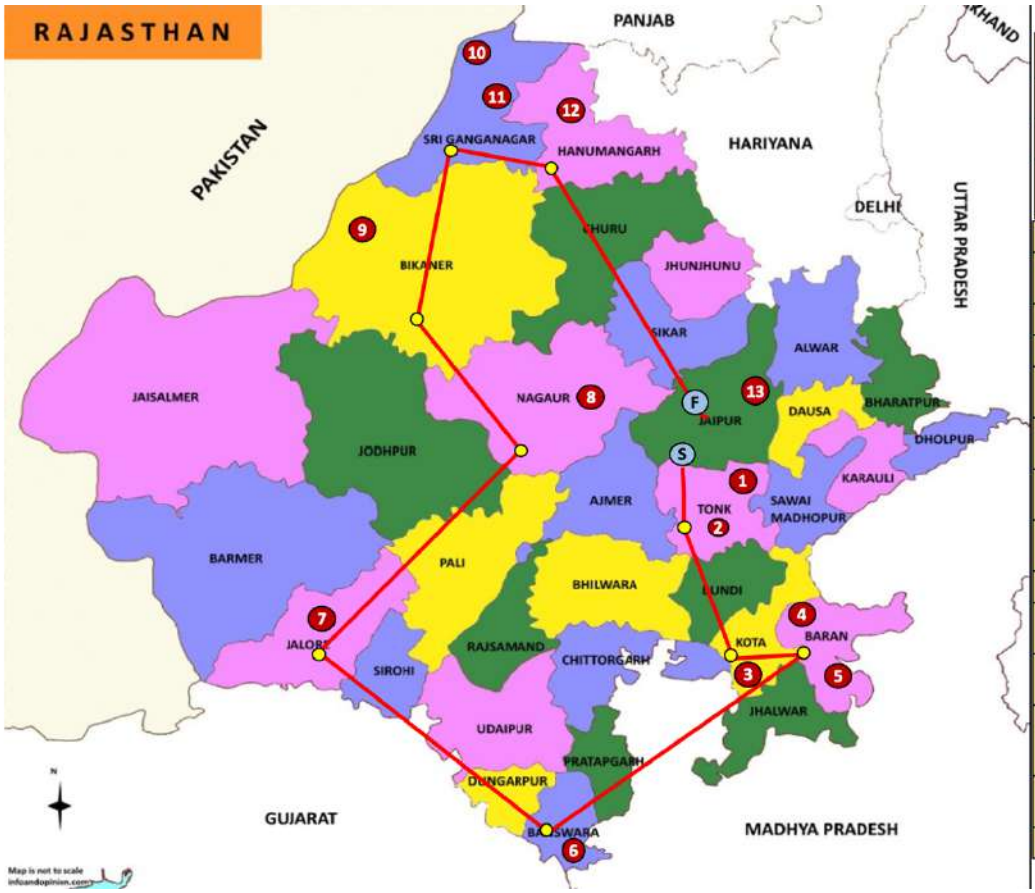
Table 7 : Details of commissioned biomass power projects (until 2021) are as below:

Sl. No.	Name of Power Producer	Capacity of Plant (MW)	Location of Plant	District	Date of Commissioning	Type of Biomass Used	Type of Technology
1.	Surya ChambalPower Ltd.	7.5	Rangpur-Ladpura	Kota	31-03-2006	Mustard Husk	Water Cooled
2.	Kalpataru Power Transmission Ltd.	7.8	Padampur	SriGanganagar	15-07-2003	Mustard Husk	Water Cooled
3.	Kalpataru Power Transmission Ltd.	8	Khatoli-Uniara	Tonk	10-11-2006	Mustard Husk	Water Cooled
4.	Amrit Envi.Tech.(P) Ltd.	8	Kotputli	Jaipur	01.10.2006 Not operative since July 2012	Mustard Husk	Water Cooled
5.	Sambhav EnergyLtd.	20	Rampura	Sirohi	19.02.2010 Not Operative since May2012	Prosopis Juliflora	Air Cooled
6.	Transtech Green Power Ltd.	12	Kachela Bagsari-Sanchor	Jalore	28.07.2010	Prosopis Juliflora	Air Cooled
7.	S.M. Environmental Technologies Pvt. Ltd.	8	Pachhar- Chhipa Barod	Baran	19.02.2010	Mustard Husk	Water Cooled
8.	Sanjog Sugar & Eco Power Pvt. Ltd.	10	Sangaria	Hanumangarh	07.10.2011	Mustard Husk	Air Cooled
9.	Sathyam Power Pvt Ltd	10	Punjiyas Tehsil-Merta	Nagaur	31.03.2011	Mustard Husk	Air Cooled
10.	Orient Green Power Co. (Rajasthan)	8	Bhanwargarh, Tehsil-KishanGanj	Baran	06.10.2013	Mustard Husk	Air Cooled
11.	Rajasthan State Ganganagar Sugar Mills Ltd.	4.95	Kaminpura, Tehsil Srikaranpu	Sriganganagar	09.05.2016	Bagasse	Water cooled
12.	Rajasthan State Ganganagar Sugar Mills Ltd.	1.2	Chak 23F, Kaminpura	Sriganganagar	19.11.2016	Bagasse	Water cooled
15.	Birla Corporation Ltd	-		Chittorgarh	Plant has stopped Using Biomass since 2013	Coal	
	Total (MW)	**105.45**					

Source: Rajasthan Renewable Energy Corporation, Rajasthan (2021).

vi. PRESPL Team Power Plant Visit:

The below route plan depicts the field visit of team PRESPL covered all the Power Producers which was suggested by RREC.



Summary	
Total Power Plants	14
Functional Plants	10
Under Construction Plants	4

Power Plants List in Rajasthan	
1	Kalpataru Power Transmission Ltd.
2	Indeen Biopower Ltd
3	Surya Chambal Power Ltd
4	S.M. Environmental Tech Pvt. Ltd.
5	Orient Green Power Company
6	Banswara Biomass Energy Pvt. Ltd.
7	Transtech Green Power Pvt. Ltd.
8	Sathayam Power Ltd.
9	Universal Biomass Energy Pvt. Ltd.
10	Kalpataru Power Transmission Ltd
11	Rajasthan State Ganganagar Sugar Mills Ltd (2 Units)
12	Sanjog Sugar & Power Pvt. Ltd.
13	Gee Tee Green Power LLP

3. ASSUMPTIONS & RESEARCH METHODOLOGY ADOPTED

The basic objective of the study was to assess the biomass resources availability, their consumption, the surplus biomass availability along with their price and price trend in the state of Rajasthan. These objectives were kept in mind while preceding the methodology.

In order to assess the surplus biomass availability for energy production on a long term sustainable basis, PRESPL team has visited Govt. Offices, Agriculture Department, Forest Department, Farmers, Traders, operating Biomass Power Plants, Brick Kilns & other industries in different districts in the state of Rajasthan.

The methodology for the study includes the field survey and secondary data available from various sources including Government departments and PRESPL database.

Primary Data Collection:

Data sheet included only the data relevant to the study, the geographical area, land details, agricultural activities, biomass generation, consumption and estimation of surplus availability of biomass.

The most crucial and important data that had to be established through this study area namely the surplus biomass availability was collected by;

- ✓ Having interactions with the Govt. Official, food grain dealers, biomass dealers, farmers and others.
- ✓ Manually taking account of the biomass leaving the village during a specific time period.
- ✓ Physically measuring the quantum of biomass utilized for thatching, fodder, fuel and manure on a sample basis and extrapolating the same to the required data size.

Secondary Data Collection:

The list below presents the list of the Government Departments visited and the type of secondary data collected from them.

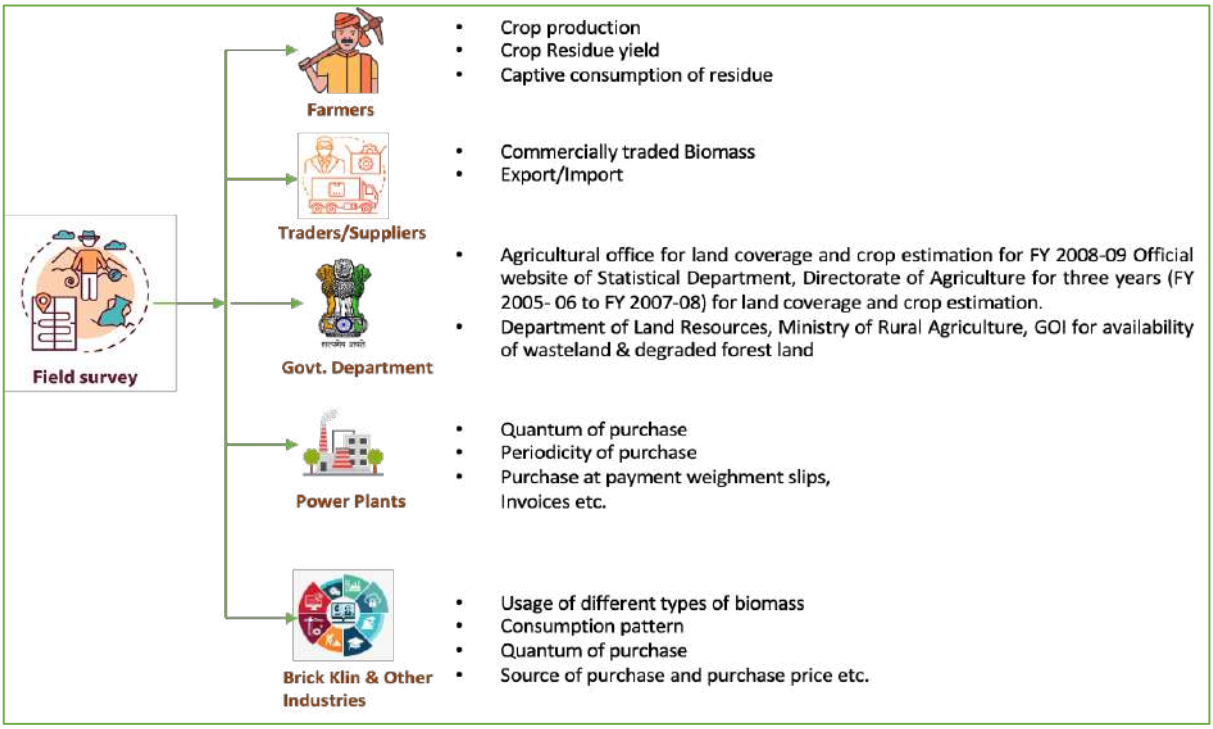
Sources for Secondary Data Collection

1. Agriculture Department, Rajasthan State.
   Data Collected: District wise total cultivated area and classification of crops, annual production of crops, production of crops per Hectare and wasteland biomass production
2. Statistical Department, Rajasthan State.
   Data Collated: Agricultural area, Cropping Area, Waste land details and Etc.

3. Department of Industries, Government of Rajasthan.
   Data Collated: Brick kilns and others biomass consuming industries details.
4. Indian Institute of Science (IISc.), Bengaluru.
   Data Collated – National Biomass Atlas, Residue generation analysis and calorific, value of residues.
5. CAZRI, Jodhpur.
   Data Collated - Juliflora Production, Consumption and Surplus. Crop Production and Re-Juvenation.

The methodology adopted for field survey is illustrated in the Figure 1.

Figure 1: Research Methodology Framework



THE FOLLOWING INFORMATION WAS COLLECTED IN THE FIELD STUDY:

- By interacting with farmers in various districts, the information about the crops being grown, crop residue yield, generation of various biomasses and captive consumption of biomass was gathered.
- Agricultural department was visited to collect the crop area and yield data for the FY 2019-20.
- Crop area and yield data for FY 2018-19, FY 2019-20 and FY 2020-21 was collected from the official website of the Statistical Department, Directorate of Agriculture, Government of Rajasthan (www. agriculture.rajasthan.gov.in).
- Data on area under degraded Forest Land, Govt. barren/saline/waste land and Panchayat waste land/ barren land/ saline land suitable for development of Prosopis- Juliflora/ other energy plantation was collected from Department of Land Resources, Ministry of Rural Development,

GOI. Mining department was visited to gather information on number of operating brick kilns in various districts.

- The local brick kilns and other industries such as briquetting units etc. in various districts were visited to know about the biomass being used by the industry for power and steam generation and quantum of consumption.
- The survey team interacted with traders in various districts to collect information on commercially traded biomasses and export/import of biomass in the area.

The detailed survey data and statistical information have been provided in the **Annexure I.**

4. Chapter 1: MARKET DYNAMICS

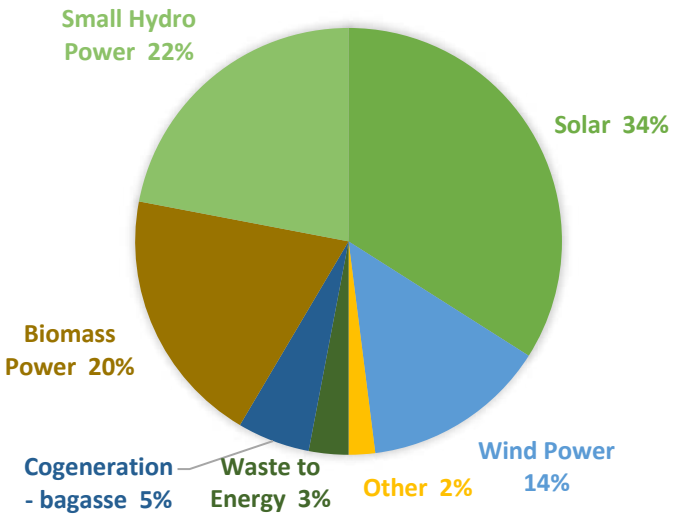
4.1. India's Electricity Scenario

While the Indian economy has grown very strongly over the last decade, the country faces a multitude of challenges. It must adhere to international climate commitments to dramatically reduce carbon emissions intensity relative to GDP by 33-35% by 2030 from the 2005 level and reduce its unsustainable reliance on fossil fuel energy imports. At the same time, it must 'keep the lights on' to increasingly support social and economic growth.

As on March 2020, there is high potential for generation of renewable energy from various sources- wind, solar, biomass, small hydro, and cogeneration bagasse. The total potential for renewable power generation in the country is estimated at 1097465 MW. This includes solar power potential of 748990 MW (68.25%), wind power potential of 302251 MW (27.54%) at 100m hub height, SHP (small-hydro power) potential of 21134 MW (1.93%), Biomass power of 17,536 MW (1.60%), 5000 MW (0.46%) from bagasse-based cogeneration in sugar mills and 2554 MW (0.23%) from waste to energy.

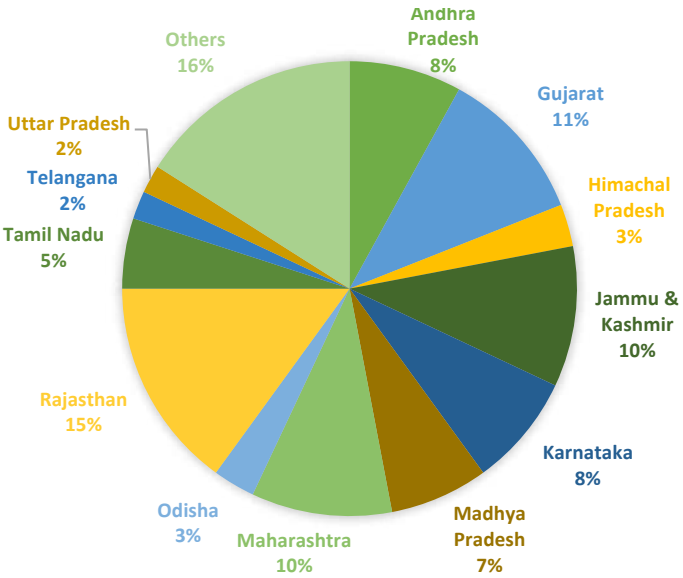
The geographic distribution of the estimated potential of renewable power reveals that Rajasthan has the highest share of about 15% (162223 MW), followed by Gujarat with 11% share (122086 MW), and Maharashtra and Jammu and Kashmir with 10% share (113925 MW and 112800 MW respectively), mainly on account of solar potential except Gujarat where the share of wind Power is the highest.

Figure 2: Source wise Estimated Potential of Renewable Power in India



Source: Ministry of Petroleum and Natural Gas and Energy

Figure 3: Statewise Estimated Potential of Renewable Power in India



Source: Ministry of Petroleum and Natural Gas and Energy Statistics, 2020.

4.2. Rajasthan's Electricity Scenario

The total installed power generation capacity as of September 2021 is 28392.87 MW.

Rajasthan has thermal-based power generation capacity of 13344.49 MW comprising 10939.59 MW of coal-fired capacity, 824.9 MW of gas-fired capacity and 1580 MW lignite-fired capacity. All the three sectors, State, Private and Central are involved in thermal power generation. In terms of nuclear-based power generation, only Centre is involved in power generation contributing 556.74 MW of nuclear energy.

In terms of renewable energy, Rajasthan is one of the top states for wind with 4326.82 MW installed. Another 8076.7 MW of solar comprising of ground mounted at 7273.7 MW, roof top at 543 MW and off-grid/distributed at 260 MW. Biomass power generation with bagasse co-generation is 119.25 MW and without bagasse is 2 MW and waste to energy off-grid is 3.83 MW, mounting to a total of 125.08 MW of bio-power. Small hydro power generation constitutes 23.85 MW. All the small hydro power, wind, solar and bio-power energy makes for 12552.45 of power generation. Hydro-based power generation mounts to 1939.19 MW of installed power capacity.

Table 8: Installed Capacity (in MW) of Power Utilities in Rajasthan as on 30.09.2021

Modes of Power Generation				Installed Capacity (MW)
Thermal	**Coal**			**10939.59**
	Lignite			**1580**
	Gas			**824.9**
	Diesel			**0**
	Total			**13344.49**
Nuclear				**556.74**
Renewable	**Hydro**			**1939.19**
	RES*(MNRE)	**Small Hydro Power**		23.85
		Wind Power		4326.82
		Bio-Power	**BM Power/Bagasse Cogen.**	119.25
			BM Cogen. (Non-Bagasse)	2
			Waste to Energy	
			Waste to Energy (Off-grid)	3.83
			Bio Power Total	125.08
		Solar Power	**Ground Mounted**	7273.7
			Roof Top	543
			Off-grid/ Distributed	260
			Solar Power Total	8076.7
		Total		**12552.45**
Grand Total				**28392.87**
Source: Installed Capacity Report, Central Electricity Authority, 2021 https://cea.nic.in/installed-capacity-report/?lang=en, https://mnre.gov.in/the-ministry/physical-progress				

Transition To Renewable Energy

Rajasthan's power distribution business comprises three state-owned discoms and their franchises, namely: Jaipur Vidyut Vitran Nigam Ltd (JVVNL), Ajmer Vidyut Vitran Nigam Ltd (AVVNL), and Jodhpur Vidyut Vitran Nigam Ltd (JVVNL).

As per RERC Tariff Order – Approval of ARR and Tariff Petition of Discoms for FY2019/20, the Rajasthan Electricity Regulatory Commission (RERC) approved a DBST of Rs4.67/kWh for the Jaipur discom, Rs 4.18/kWh for the Ajmer discom and Rs 3.23/kWh for the Jodhpur discom.

Rajasthan is one of India's best states for renewable energy potential. It hosts a desert of approximately 102,000 square kilometres (3% of India's total landmass). It also has high solar irradiance and wind speeds and abundant barren land to deploy utility-scale capacity, all of which make it a top Indian destination for investment into renewable energy.

As of March 2020, Rajasthan had already installed 9.6 GW of renewable capacity- 5.2 GW of solar, 4.2 GW of wind capacity and a small-run-of-river hydro and biomass generation capacity of 0.1 GW.

The main source of biomass energy in the State of Rajasthan is Mustard Husk and Juli Flora.

State Government has issued 'Policy for Promoting Generation of Electricity from Biomass 2010' for encouraging investments in the sectors.

Total 13 Biomass Power Generation Plants of 119. 45 MW capacity have been established till December, 2020 in the State. Presently 2 Biomass power Plants of total 14 MW capacity are under execution.

Transmission of Electricity:

- ✓ Rajasthan Rajya Vidyut Prasaran Nigam Ltd., (RVPN)
- ✓ RVPN is engaged in transmitting bulk power from generating stations to inter-phase point of Discoms
- ✓ As of December 2020, the total Transmission network has increased to 42562.23 ckt km.
- ✓ RVPN has decided to implement Smart Transmission Network and Asset Management System (STNAMS). The system is intended to achieve the wide area monitoring and control of the transmission grid of Rajasthan along with enablement of smart-grid initiatives for reactive power management and predictive assessment of grid stability/security and asset management.

4.3. Key Trends Analysis - Demand Side

Rise in Demand for Eco-friendly and Renewable Energy

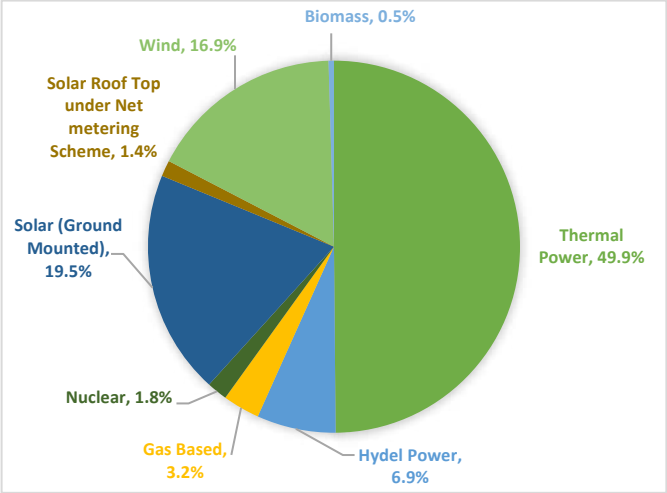
Biomass is an energy efficient solution to reduce carbon footprint. Due to rising energy concerns, solution providers are introducing solutions for the adoption of renewable energy-based technologies such as biomass. Increase in regulatory efforts to meet sustainable development goals related to providing access to clean energy is anticipated to boost the biogas market in Rajasthan. Figure 4 shows the installed power capacity as on December 2020, Rajasthan is 25,636.6 MW (Approximately 25.6 GW). The Government of is focusing on enhancing the domestic production and maximizing the utilization of clean energy resources, including biofuels, in order to improve energy security by minimizing the dependence on fossil fuel.

Biomass power is a renewable source of energy that is derived from plants and animals. Biomass is helpful in the process of photosynthesis, wood and wood processing wastes, agricultural crops and waste materials, food, yard, and wood waste, and can be used as a fuel for generating energy. Biomass provides relief from power shortages, and setting up renewable energy plants from biomass could generate employment in rural areas.

In northern India, particularly in the states of Punjab, Haryana, and western Uttar Pradesh, farm fires have become rampant, thus negatively impacting the environment and human health. Stubble burning leads to emissions, with implications on climate change and human health costs as well as disruptions in economic activity. All these factors are expected to increase the demand for environment-friendly renewable sources of energy. The use of renewable energy would help reduce global warming, and improve public health and air quality.

Favourable government regulations encouraging thermal power stations to switch from coal to cleaner fuels, such as biomass, are likely to play a vital role in driving the market during the forecast period. Renewable power generation using biomass has significantly reduced methane emission, which is relatively more harmful for the atmosphere as compared to CO_2 emissions. Governments of countries across the globe are establishing biomass-based power plants for rural/decentralised electrification. Even in renewable energy, biomass energy is better than solar power, as the capital cost per kWh is less than 30%. It is also cheaper than the wind energy. Solid biomass fuels can produce electricity more reliably than intermittent energy sources such as wind and solar, as the fuel can be stored and used when needed. As biomass contains large amounts of water per unit of weight, it does not have as much energy pot.

Figure 4: Installed Power Capacity of Rajasthan



Source: Various issues of Statistical Abstract of Rajasthan, Agricultural Statistics of Rajasthan, Government of Rajasthan, As of December 2020

Sources of Power	Installed Capacity
Thermal Power	12782.46
Hydel Power	1757.95
Gas Based	824.6
Nuclear	456.74
Solar (Ground Mounted)	4999.96
Solar Roof Top under Net metering Scheme	356.8
Wind	4337.64
Biomass	120.45
Total	**25636.6**

Source: Various issues of Statistical Abstract of Rajasthan, Agricultural Statistics of Rajasthan, Government of Rajasthan, As of December 2020

Emerging Direct Biomass Combustion Technology

The direct biomass combustion technology has relatively non-complex operations, higher reliability, and lower cost when compared to other advanced biomass power technologies. The combustion route is much better known for its time, both technically and commercially. The combustion process converts solid fuel into gaseous products of combustion through high temperature oxidation reactions. Combustion releases the energy into high temperature product gas.

Punjab, due to the abundant availability of agricultural waste besides municipal waste, is likely to emerge as a key area in the country for several biomass market players during the forecast period. The introduction of stringent policies to increase the utilization of renewable sources in order to minimize GHG emissions, and growth in efforts to reduce foreign import dependency in fossil fuels sector are also major factors that are anticipated to propel the biomass market in India.

Companies are increasingly emphasizing on R&D projects to manufacture application-specific biomass end products and increase their efficiency. The intense competition has driven manufacturers to invest in product development to better cater to customers' requirements.

The direct biomass combustion technology is anticipated to expand at the fastest rate during the forecast period, owing to the high operational efficiency of the process. The process converts solid biomass into gaseous fuels that are further used to generate electricity with remaining gas used as synthesis gas in chemical industries. The direct biomass combustion technology is gaining traction, owing to its ability to significantly reduce carbon emissions, while producing a high calorific gas from a renewable source.

Combustion is best suited to biofuels with low moisture content, as it uses a portion of the energy to evaporate water. The technology is usually limited to providing heating; however, it can also be used for electricity generation. Over-dependence on non-renewable forms of energy such as coal; increase in fuel prices; and rise in emission of greenhouse gases have compelled researchers to find alternative methods to obtain sustainable forms of energy. Fermentation, anaerobic digestion, combustion, and pyrolysis are some of the key technologies used for the conversion of biomass into biofuels such as biogas and bioethanol.

Thermal (combustion) is a common biomass conversion technology used for meeting power generation and thermal energy requirements in India. It is used in large scale grid connected and captive power plants. Combustion is an established technology working on the regular Rankine cycle. The combustion process comprises more than 85% of installed capacity for biomass-based power production in India.

4.4. Key Trends Analysis – Supply Side

Rising adoption of Biomass in Power Generation

Public and private players are investing significantly to build biomass-based power plants to fulfil the growing electricity demand across the nation. The biomass power plant installed capacity increased from 6.84 MW in 2014 to 15.99 MW in 2019.

Financial assistance has also been provided to promote the development of biogas plant in India. The state of Rajasthan provides subsidies of about 1/3 to ¼ of the cost for constructing a biogas plant in rural areas. The goal of introducing subsidies is to help households with easy availability of domestic cattle dung to set up biogas systems.

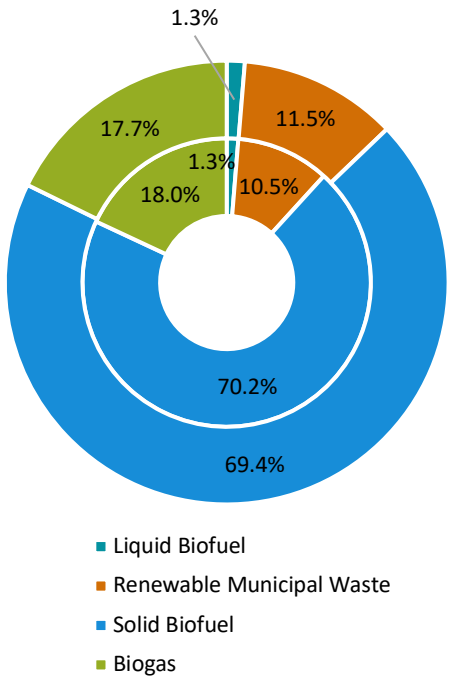
Although, liquid biofuel accounted for a minor share of the electricity production i.e. 1.3% of total nation's biomass electricity generation mix; however, it is expected to witness growth during forecast period on account of stringent government regulations to minimize carbon emissions from power generation facilities, as they can be used as feedstock for fossil fuel-based (such as diesel) systems.

In line with these initiatives & regulations, several small and large sized power generators have increased their investments in the development of biogas power plants.

In the current system of power generation, most of the electricity is produced from non-renewable sources such as oil, natural gas, and coal. However, these sources are limited. The sources of renewable type involve wind, water, solar, biomass, etc. These sources are friendly to the environment, infinite, and mostly free of cost.

The demand for electricity has increased significantly in India. It is expected to rise further over the next few years. The significant addition to the installed generating capacity is required to meet the increasing demand for electricity in the country. This has led to an increase in focus on the development of electricity production by harnessing renewable energy sources such as bioenergy, as these sources are widely available. As per the Energy Statistics Report 2018, 17.53 GW of power can be produced from available biomass resources.

Figure 5: Biomass Electricity Generation Mix (GWh), By Feedstock, 2014-2018



Source: International Energy Agency 2019-20.

Rising Adoption of Biomass in Heating Application

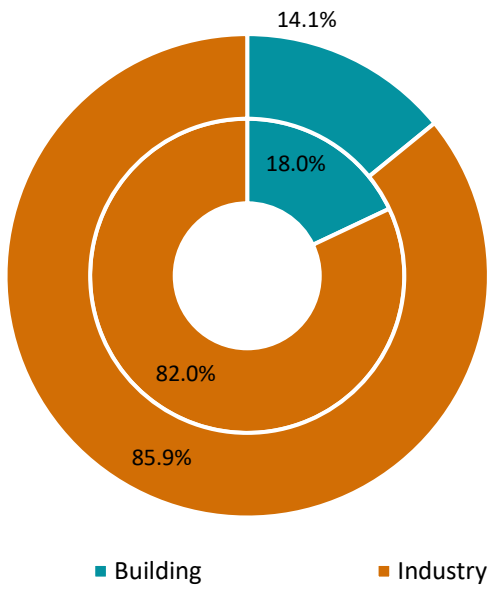
The heating segment held a moderate share of the biomass market in India in 2018. The growth of this segment can be ascribed to the rise in demand for space heating and hot water consumption in residential and commercial establishments and process heat application in the industrial sector.

Heat accounts for two-third share of the total final energy consumption in India. Increase in purchasing power, rapid industrialization & urbanization, and improvement in the standard of living are some of the factors driving the heating segment in the country.

Wood fuel, charcoal, and agriculture residues are extensively used biomass energy sources in heating application. Solid waste contributed almost half to the bioheat sector, followed by waste (including both municipal and industrial) and minor contributions from biogas and liquid biofuels. Growth of modern renewable heat in India has been modest, up by 14% between 2007 and 2015.

Fluctuation in prices of fossil fuel is also anticipated to propel the demand for renewable resources for heating, as renewable resources are economical in term of cost and ease to access.

Figure 6: Bioenergy Consumption in India (EJ), 2013-2024



Inner Pie: 2013-2018
Outer Pie: 2019-2024

Source: International Energy Agency 2019-20.

4.5. COVID-19 Impact

Impact on Overall Biomass Industry

- The COVID-19 pandemic has shaken economies globally and added to the existing problems such as unemployment, poverty, climate change, education, migration, and health.
- The Rajasthan Electricity Regulatory Commission (RERC) has issued an order directing stakeholders to adopt measures to ease the burden on power consumers, generators, transmission licensees, and distribution companies (DISCOMs) in the state amidst the ongoing coronavirus crisis.
- The Rajasthan state government has also announced a five-per cent rebate in the next bills for agriculture and domestic category consumers if they pay their bills by May 31, 2020.
- The Rajasthan government will allocate Rs 650 crore to power distribution companies against this relief. It has also decided to suspend the recovery of water bills for March and April 2020 for all consumers in the state.
- Small and marginal farmers as well as farm labourers are the most affected in the state due to the breakdown of supply chains. In addition, companies involved in biomass projects in Patiala are concerned about project delays due to initial slowdown of manufacturing in India.
- Power sector has been adversely impacted due to the COVID-19 outbreak and as a result of this, power demand has reduced by 25-30 per cent across the country.
- In a major relief to the farmers during the COVID-19 pandemic, Rajasthan has extended the last date for repayment of crop loans for the rabi season in 2020-21 from June 30 to August 31.
- TAFE Announces Free Tractor Rental Scheme for the Second Year in a Row to Support Small Farmers of Rajasthan as COVID Relief. This scheme is available from June 1 – July 31, 2021, for a period of 60 days in all the districts of Rajasthan.

4.6. Standards and Regulations

Government Scheme and Policy

- The Ministry of New and Renewable Energy (MNRE) in India announced a scheme to support biomass-based cogeneration in sugar mills and other industries. It is found that India has the capability to generate several thousands of megawatts of renewable energy from biomass available in bagasse cogeneration from sugar mills. Moreover, the Indian Government's financial assistance is projected to play an instrumental role in energy generation through biomass cogeneration projects.
- The Government of India is focusing on increasing its domestic fuel production and maximizing the utilization of clean energy resources, including biofuel, in order to improve its energy security. For instance, the Government of India introduced the National Policy on Biofuels - 2018 with the aim to increase the utilization of biofuels in energy and transportation sectors by promoting the production of biofuels from domestic feedstock.
- Besides the Central Financial Assistance, fiscal incentives such as 80% accelerated depreciation, concessional import duty, excise duty, tax holiday for 10 years, etc., and are available for biomass power projects. The benefit of concessional custom duty and excise duty exemption on equipment is also available.
- Indian Renewable Energy Development Agency (IREDA) provides loan for setting up wind power and bagasse cogeneration projects
- In addition, the State of Maharashtra and Gujrat Electricity Regulatory Commissions have determined preferential tariffs and Renewable Purchase Standards (RPS)
- In addition, capital subsidies area has also given for the establishment of bagasse and biomass-based units
- India encourages ethanol as a fuel for automobiles and regulations provide for the mandatory blending of 5% of ethanol with petrol (to be increased to 10%). The Government also plans to free the movement of ethanol across the country and eliminate local taxes, thereby increasing its usage.
- The Prime Minister of India has announced a goal of 10% share for RE or 10,000 MW in the power generation capacity to be added during the period up to 2022
- In April 2018, the Union Minister for Drinking Water and Sanitation, Sushri Uma Bharti, launched the GOBAR-DHAN (Galvanizing Organic Bio-Agro Resources) scheme to convert cattle dung and solid waste in farms to CBG and compost. The scheme aims to increase the income of rural households, and promote the generation of energy from cattle waste. The scheme envisages the implementation of 700 biogas units across the country in 2018-19. Until September 30, 2018, 211 biogas/CBG (Compress Bio Gas) plants were fully functional, 15 bio-gas/CBG plants constructions were completed, and 17 biogas/CBG plants construction were in progress across the country.
- The Government of India has set a target to reduce carbon emission by 33% to 35% by 2030 compared to the 2005 levels.

Biofuel Policy Rajasthan 2019

- Rajasthan Government had released State Biofuel Policy 2018. On the eve of World Biofuel day 2019 (10th August), the state government released Rajasthan biofuel rules 2019. Deputy Chief Minister of Rajasthan, Sachin Pilot stated that Rajasthan is the 1st state in the country that released biofuel rules-2019 (after the notification of the Centre on April 30,2019) with the vision to promote the use of biofuels.

Key Highlights

- The desert state will focus on increasing production of oilseeds and establish a Centre for Excellence in Udaipur to promote research in the fields of alternative fuels and energy resources.
- As per the state government:
  - ✓ A biodiesel plant of the capacity of 8 tonnes a day had already been installed in the State.
  - ✓ The state government would promote marketing of biofuels and generate awareness about the same.
  - ✓ The State Rural Livelihood Development Council would also encourage women's self-help groups to explore the scope for additional income through the supply of biodiesel.

POLICY FOR PROMOTING GENERATION OF ELECTRICITY FROM BIOMASS, 2010

- This Policy will be known as "Policy for Promoting Generation of Electricity from Biomass, 2010". This Policy has come into operation with effect from 26.02.2010 and will remain in force until superseded or modified by another Policy.
- "Biomass" means forestry based & agro-based industrial residues, energy plantations, forestry and agro- residues.
- "Biomass Power Plant" means the power plant which generates electricity from biomass sources.
- "Biomass Power Producer"/"Power Producer" means an entity which owns facilities to generate electric power for sale to Discoms/Licensees and to third party/captive use.
- The price of power to be sold by the Power Producer to consumers/ licensees other than Discoms will be determined by the mutual understanding/agreement between the seller and the purchaser.
- The development of Prosopis-Juliflora /other energy plantation will support power generation in the state and create large employment opportunities in the rural sector and spur the rural economy by utilizing rural resources and logistics, thus energy plantation should be encouraged.
- As per RERC order dated 17.08.2009; the Biomass Power Producers shall be allowed to use fossil fuel (such as coal/lignite/natural gas, municipal waste) up to 15% during the lean period in some years. Mining Department shall arrange to make lignite available to the Biomass Power Producers on priority at the rate/mechanism mutually agreed between the Biomass Power Producers and Rajasthan Mines and Minerals Corporation. The Mines Department shall arrange this facility from the nearest lignite mines as far as possible.

4.7. State Wise Comparison of Biomass Fuel Price and Tariff

CERC in Petition No. 2/SM/2021 (Suo-Motu), RE Tariff Order for FY 2021-22 (CERC website S.No. 177/2021) dated 31.03.2021 has given the ruling on Determination of levellised generic tariff for FY 2021-22 under Regulation 8 of the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2020. The relevant extracts from the said ruling specific to biomass based power projects are appended below in succeeding paragraphs:

Capital cost of Biomass based Power Projects

The Commission, under Regulation 31 of the RE Tariff Regulations has specified the normative capital cost for Biomass based Power Projects for FY 2021-22, as under:

Table 9: Cost of Biomass based Power Projects for FY 2021-22.

Biomass Rankine Cycle Projects	Capital Cost (Rs lakh/ MW)
Project [other than rice straw and juliflora (plantation) based project] with water cooled condenser	559
Project [other than rice straw and Juliflora(plantation) based project] with air cooled condenser	600
For rice straw and Juliflora (plantation) based project with water cooled condenser	611
For rice straw and Juliflora (plantation) based project with air cooled condenser	652
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22. https://cercind.gov.in/2021/orders/2-SM-2021.pdf	

Capital cost of Biomass Gasifier Power Projects

The Commission, under Regulation 50, has specified the normative capital cost for Biomass Gasifier power projects as Rs. 593 lakh/MW for FY 2021-22. After taking into account the capital subsidy of Rs. 150.00 lakh/MW (by Ministry of New and Renewable Energy), net project cost works out to be Rs. 443 lakh/MW for FY 2021-22.

Fuel Parameters

- **Fuel Mix:** Regulation 53 of the RE Tariff Regulations specifies that the normative specific fuel consumption shall be 1.25 kg per kWh for Biomass Gasifier based power project. Also, Regulation 60 of the RE Tariff Regulations specifies that the normative specific fuel consumption shall be 3 kg of substrate mix per kWh for Biogas based power project.
- **Calorific Value:** The Commission has considered the calorific value for biomass fuel used as 3100 kcal/kg as per Regulation 37 of the RE Tariff Regulations.
- **Fuel Cost:** The Commission, as per Regulation 38 of the RE Tariff Regulations, has specified the Biomass fuel price for first year of the Control Period (i.e. FY 2021-22) in the table below. The fuel prices have been derived by escalating the notified prices of first year of control period by 5%. For each subsequent year of the Tariff Period, a normative escalation factor of 5% per annum shall be applicable, unless reviewed and ordered otherwise by the commission.

Table 10 : Biomass fuel price FY 2020-21:

States	Biomass Price for FY 2020-21 (Rs/ MT)	Biomass Price for FY 2021-22 (Rs/ MT)
Andhra Pradesh	3,326	3,429.3
Haryana	3,786	3975.3
Maharashtra	3,872	4065.6
Punjab	3,960	4158
Rajasthan	3,305	3470.25
Tamil Nadu	3,272	3435.6
Telangana	3,32	3492.3
Uttar Pradesh	3,384	3553.2
Other States	3,557	3734.85
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.		

Table 11 : Biomass Power Projects based on Rankine cycle technology [other than Rice Straw and Juliflora (plantation) based project] with Water Cooled Condenser and travelling grate boiler:

States	Levelized Fixed Cost Rs/kWh)	Variable Cost (FY 2021-22) Rs/kWh)	Applicable Tariff Rates (FY 2021-22) Rs/kWh)	Benefit of Accelerated Depreciation (if availed) Rs/kWh)	Net levelized tariff (upon adjusting for Accelerated Depreciation Benefit) (if availed) Rs/kWh)
Andhra Pradesh	2.62	5.26	7.88	0.11	7.77
Haryana	2.68	5.98	8.66	0.11	8.55
Maharashtra	2.69	6.12	8.81	0.11	8.70
Punjab	2.70	6.26	8.96	0.11	8.85
Rajasthan	2.62	5.22	7.85	0.11	7.73
Tamil Nadu	2.62	5.17	7.79	0.11	7.68
Telangana	2.62	5.26	7.88	0.11	7.77
Uttar Pradesh	2.63	5.35	7.98	0.11	7.87
Other States	2.65	5.62	8.27	0.11	8.16
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.					

Table 12: Biomass Power Projects based on Rankine Cycle Technology [other than Rice Straw and Juliflora (plantation) based project] with Air Cooled Condenser and travelling grate boiler:

States	Levelized Fixed Cost Rs/kWh)	Variable Cost (FY 2021-22) Rs/kWh)	Applicable Tariff Rates (FY 2021-22) Rs/kWh)	Benefit of Accelerated Depreciation (if availed) Rs/kWh)	Net levelized tariff (upon adjusting for Accelerated Depreciation Benefit) (if availed) Rs/kWh)
Andra Pradesh	2.77	5.38	8.14	0.12	8.02
Haryana	2.82	6.12	8.94	0.12	8.82
Maharashtra	2.84	6.26	9.09	0.12	8.97
Punjab	2.85	6.40	9.25	0.12	9.13
Rajasthan	2.77	5.34	8.11	0.12	7.99
Tamil Nadu	2.76	5.29	8.05	0.12	7.93
Telangana	2.77	5.38	8.14	0.12	8.02
Uttar Pradesh	2.77	5.47	8.25	0.12	8.12
Other States	2.80	5.75	8.55	0.12	8.42
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.					

Table 13: Biomass Power Projects on Rankine Cycle Technology [Rice Straw and Juliflora (plantation) based project] with Water Cooled Condenser and travelling grate boiler:

States	Levelized Fixed Cost Rs/kWh)	Variable Cost (FY 2021-22) Rs/kWh)	Applicable Tariff Rates (FY 2021-22) Rs/kWh)	Benefit of Accelerated Depreciation (if availed) Rs/kWh)	Net levelized tariff (upon adjusting for Accelerated Depreciation Benefit) (if availed) Rs/kWh)
Andhra Pradesh	2.73	5.26	7.99	0.12	7.86
Haryana	2.78	5.98	8.77	0.12	8.65
Maharashtra	2.79	6.12	8.91	0.12	8.79
Punjab	2.80	6.26	9.06	0.12	8.94
Rajasthan	2.73	5.22	7.95	0.12	7.83
Tamil Nadu	2.72	5.17	7.89	0.12	7.77
Telangana	2.73	5.26	7.99	0.12	7.86
Uttar Pradesh	2.74	5.35	8.08	0.12	7.96
Other States	2.76	5.62	8.38	0.12	8.26
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.					

Table 14: Biomass Power Projects based on Rankine Cycle Technology [Rice Straw and Juliflora (plantation) based project] with Air Cooled Condenser and travelling grate boiler:

States	Levelized Fixed Cost Rs/kWh)	Variable Cost (FY 2021-22) Rs/kWh)	Applicable Tariff Rates (FY 2021-22) Rs/kWh)	Benefit of Accelerated Depreciation (if availed) Rs/kWh)	Net levelized tariff (upon adjusting for Accelerated Depreciation Benefit) (if availed) Rs/kWh)
Andhra Pradesh	2.87	5.38	8.25	0.13	8.12
Haryana	2.93	6.12	9.05	0.13	8.92
Maharashtra	2.94	6.26	9.20	0.13	9.07
Punjab	2.95	6.40	9.35	0.13	9.22
Rajasthan	2.87	5.34	8.21	0.13	8.08
Tamil Nadu	2.87	5.29	8.16	0.13	8.02
Telangana	2.87	5.38	8.25	0.13	8.12
Uttar Pradesh	2.88	5.47	8.35	0.13	8.22
Other States	2.90	5.75	8.65	0.13	8.52
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.					

Table 15: Biomass Power Projects based on Rankine Cycle Technology [other than Rice Straw and Juliflora (plantation) based project] with Water Cooled Condenser and AFBC boiler:

States	Levelized Fixed Cost Rs/kWh)	Variable Cost (FY 2021-22) Rs/kWh)	Applicable Tariff Rates (FY 2021-22) Rs/kWh)	Benefit of Accelerated Depreciation (if availed) Rs/kWh)	Net levelized tariff (upon adjusting for Accelerated Depreciation Benefit) (if availed) Rs/kWh)
Andhra Pradesh	2.62	5.16	7.78	0.11	7.67
Haryana	2.67	5.88	8.55	0.11	8.44
Maharashtra	2.68	6.01	8.69	0.11	8.58
Punjab	2.69	6.15	8.84	0.11	8.73
Rajasthan	2.61	5.13	7.75	0.11	7.63
Tamil Nadu	2.61	5.08	7.69	0.11	7.58
Telangana	2.62	5.16	7.78	0.11	7.67
Uttar Pradesh	2.62	5.25	7.88	0.11	7.77
Other States	2.64	5.52	8.17	0.11	8.06
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.					

Table 16: Biomass Power Projects based on Rankine Cycle Technology [other than Rice Straw and Juliflora (plantation) based project] with Air Cooled Condenser and AFBC boiler:

States	Levelized Fixed Cost Rs/kWh)	Variable Cost (FY 2021-22) Rs/kWh)	Applicable Tariff Rates (FY 2021-22) Rs/kWh)	Benefit of Accelerated Depreciation (if availed) Rs/kWh)	Net levelized tariff (upon adjusting for Accelerated Depreciation Benefit) (if availed) Rs/kWh)
Andhra Pradesh	2.76	5.28	8.04	0.12	7.92
Haryana	2.82	6.01	8.83	0.12	8.70
Maharashtra	2.83	6.15	8.97	0.12	8.85
Punjab	2.83	6.29	9.12	0.12	9.00
Rajasthan	2.76	5.25	8.01	0.12	7.88
Tamil Nadu	2.75	5.19	7.95	0.12	7.83
Telangana	2.76	5.28	8.04	0.12	7.92
Uttar Pradesh	2.77	5.37	8.14	0.12	8.02
Other States	2.79	5.65	8.44	0.12	8.31
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.					

Table 17: Biomass Power Projects based on Rankine Cycle Technology [Rice Straw and Juliflora (plantation) based project] with Water Cooled Condenser and AFBC boiler:

States	Levelized Fixed Cost Rs/kWh)	Variable Cost (FY 2021-22) Rs/kWh)	Applicable Tariff Rates (FY 2021-22) Rs/kWh)	Benefit of Accelerated Depreciation (if availed) Rs/kWh)	Net levelized tariff (upon adjusting for Accelerated Depreciation Benefit) (if availed) Rs/kWh)
Andhra Pradesh	2.72	5.16	7.88	0.12	7.76
Haryana	2.78	5.88	8.65	0.12	8.53
Maharashtra	2.79	6.01	8.80	0.12	8.67
Punjab	2.80	6.15	8.94	0.12	8.82
Rajasthan	2.72	5.13	7.85	0.12	7.73
Tamil Nadu	2.71	5.08	7.79	0.12	7.67
Telangana	2.72	5.16	7.88	0.12	7.76
Uttar Pradesh	2.73	5.25	7.98	0.12	7.86
Other States	2.75	5.52	8.27	0.12	8.15
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.					

Table 18: Biomass Power Projects based on Rankine Cycle Technology [Rice Straw and Juliflora (plantation) based project] with Air Cooled Condenser and AFBC boiler:

States	Levelized Fixed Cost Rs/kWh)	Variable Cost (FY 2021-22) Rs/kWh)	Applicable Tariff Rates (FY 2021-22) Rs/kWh)	Benefit of Accelerated Depreciation (if availed) Rs/kWh)	Net levelized tariff (upon adjusting for Accelerated Depreciation Benefit) (if availed) Rs/kWh)
Andhra Pradesh	2.87	5.28	8.15	0.13	8.01
Haryana	2.92	6.01	8.93	0.13	8.80
Maharashtra	2.93	6.15	9.08	0.13	8.95
Punjab	2.94	6.29	9.23	0.13	9.10
Rajasthan	2.86	5.25	8.11	0.13	7.98
Tamil Nadu	2.86	5.19	8.05	0.13	7.92
Telangana	2.87	5.28	8.15	0.13	8.01
Uttar Pradesh	2.87	5.37	8.25	0.13	8.11
Other States	2.89	5.65	8.54	0.13	8.41
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.					

Table 19: Biomass Gasifier based Power Project:

States	Levelized Fixed Cost Rs/kWh)	Variable Cost (FY 2021-22) Rs/kWh)	Applicable Tariff Rates (FY 2021-22) Rs/kWh)	Benefit of Accelerated Depreciation (if availed) Rs/kWh)	Net levelized tariff (upon adjusting for Accelerated Depreciation Benefit) (if availed) Rs/kWh)
Andhra Pradesh	2.58	4.85	7.43	0.08	7.35
Haryana	2.63	5.52	8.15	0.08	8.07
Maharashtra	2.64	5.65	8.29	0.08	8.21
Punjab	2.65	5.78	8.43	0.08	8.34
Rajasthan	2.58	4.82	7.40	0.08	7.32
Tamil Nadu	2.58	4.77	7.35	0.08	7.26
Telangana	2.58	4.85	7.43	0.08	7.35
Uttar Pradesh	2.59	4.94	7.52	0.08	7.44
Other States	2.61	5.19	7.79	0.08	7.71
Source: Central Electricity Regulatory Commission (CERC), FY 2021-22.					

5. Chapter 2: AGRICULTURE SCENARIO IN RAJASTHAN

5.1. : Agriculture Production:

Agriculture production in the State largely depends on timely arrival of monsoon. During Kharif season, production and productivity not only depend upon the quantum of rainfall but also on proper and even distribution of rain over an adequate time span and its intensity.

The data on crop area, production and yield in the state of Rajasthan for the period FY 2018-19 , FY 2019-20 and FY 2020-21 for Kharif crops has been summarized in the following table:

Table 20: Area and Production of Kharif and Rabi crops in the State

Crops	Area in Lakh Hectare			Production in Lakh Tons		
	2018-19	2019-20	2020-21	2018-19	2019-20	2020-21
(A) Cereals	**90.92**	**97.96**	**96.38**	**194.02**	**220.86**	**222.45**
Kharif	58.66	59.94	60.92	66.22	71.25	**90.41**
Rabi	32.26	38.02	35.46	127.80	149.61	**132.04**
(B) Pulses	**59.06**	**63.36**	**64.81**	**37.58**	**44.95**	**48.88**
Kharif	42.75	38.39	39.95	18.68	17.76	**20.01**
Rabi	16.31	24.97	24.86	18.90	27.19	**28.87**
(A+B) Food Grains	**149.98**	**161.32**	**161.19**	**231.60**	**265.81**	**271.33**
Kharif	101.41	98.33	100.87	84.90	89.01	**110.42**
Rabi	48.57	62.99	60.32	146.70	176.80	**160.91**
(C) Oil Seeds	**48.13**	**57.98**	**52.65**	**76.64**	**72.74**	**87.15**
Kharif	19.88	23.17	24.49	28.43	25.20	**37.94**
Rabi	28.25	34.81	28.16	48.21	47.54	**49.21**
(D) Sugar cane	**0.05**	**0.04**	**0.05**	**4.48**	**3.26**	**2.84**
(E) Cotton (Lint) *	**6.29**	**7.60**	**8.08**	**20.43**	**27.88**	**28.33**

* Production in lakh bales (each bale of 170 kg.)

Source: Agricultural Department, Government of Rajasthan, for the period FY 2018-19, FY 2019-20 & Economic Review, Government of Rajasthan, 2020-21.

The kharif food grain production in the year 2020-21 is expected to be at the level of 110.42 lakh tonnes as against 89.01 lakh tonnes during the previous year showing an increase of 24.05 per cent. The rabi food grain production in the year 2020-21 is expected to be 160.91 lakh tonnes as against 176.80 lakh tonnes during the year 2019-20, showing a decrease of 8.99 per cent.

Production of kharif cereals during the year 2020-21 is expected to be 90.41 lakh tonnes as compared to 71.25 lakh tonnes during the previous year representing a growth of 26.89 per cent. Production of rabi cereals in the year 2020-21 is expected to be 132.04 lakh tonnes against 149.61 lakh tonnes during the year 2019-20 showing a decrease of 11.74 per cent.

The production of kharif pulses is estimated to be 20.01 lakh tonnes in the year 2020-21 against 17.76 lakh tonnes in the year 2019-20, showing an increase of 12.61 per cent. Production of rabi pulses in the year 2020-21 is expected to be 28.87 lakh tonnes against 27.19 lakh tonnes during the year 2019-20 showing an increase of 6.18 per cent.

Oilseeds include Groundnut, Sesamum, Soyabean and Castor seed in kharif season and Rape & Mustard, Taramira and Linseed in rabi season. The production of oilseeds in the year 2020-21 is estimated at 87.15 lakh tonnes against 72.74 lakh tonnes in the year 2019-20, showing an increase of 19.81 per cent.

The production of kharif oilseeds is estimated to be 37.94 lakh tonnes in the year 2020-21 as against 25.20 lakh tonnes in the year 2019-20, showing an increase of 50.56 per cent. The production of rabi oilseeds is likely to be 49.21 lakh tonnes in the year 2020-21 as against 47.54 lakh tonnes during the year 2019-20, showing an increase of 3.51 per cent.

Production of Sugarcane is likely to be 2.84 lakh tonnes in the year 2020-21 as against 3.26 lakh tonnes in the year 2019-20, showing a decrease of 12.88 per cent. The production of Cotton is likely to be 28.33 lakh bales during the year 2020-21 as against 27.88 lakh bales in the year 2019-20, showing an increase of 1.61 per cent.

5.2. Land Use Pattern

The total reporting area of the State is 342.87 lakh hectare during the year 2018-19. Out of this, 8.05 per cent is under forests (27.60 lakh hectare), 5.81 per cent area is under non–agriculture use (19.93 lakh hectare), 6.95 per cent under barren and uncultivable land (23.83 lakh hectare), 4.86 per cent under permanent pastures & other grazing lands (16.68 lakh hectare), 0.08 per cent land under miscellaneous tree crops and groves (0.26 lakh hectare), 11.04 per cent under culturable waste land (37.84 lakh hectare), 6.14 per cent under fallow land other than current fallow (21.06 lakh hectare), 5.22 per cent under current fallow (17.89 lakh hectare) and 51.85 per cent area is under net area sown (177.78 lakh hectare).

Net-Sown Area:

- The high density (above 50%) districts are Alwar, Jaipur, Bharatpur and Tonk in eastern Rajasthan and Churu, Jalore, Junujhunu, Sikar, Nagur and Sri Ganganagar, Hannumangarh is western Rajasthan.

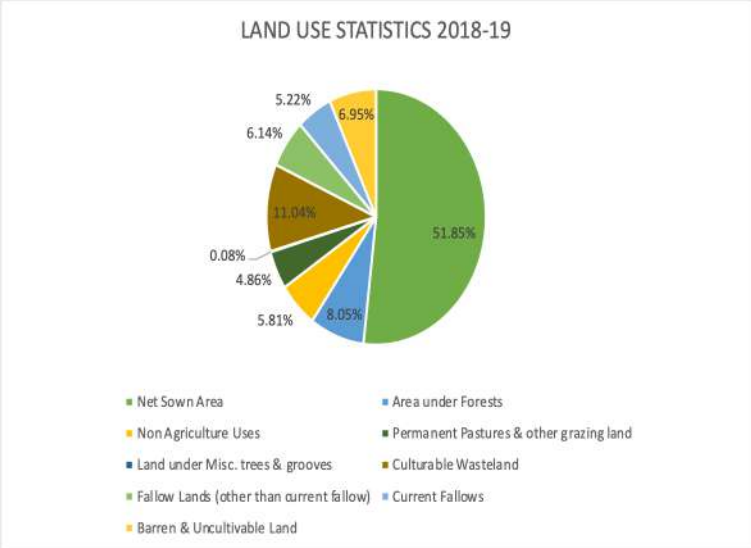
Area Under Forests:

- Area under Rajasthan is small, the concentration of forests being more in the districts adjoining Aravallis-like Ajmer, Banswara, Bundi, Chittorgah, Pali, Sawai Madhopur, Sirohi, Udaipur and Kota.
- Due to low rain fall and aridity forest areas are few and almost negligible in the arid zone districts of Barmer, Bikaner, Churu, Sri Ganganagar, Jaisalmer, Jalor and Jodhpur
- In rest of the districts the area under forest varies from 1 to 2% and are concentrated in the favourable locations of foothill slopes

Non-agricultural uses:

- These include settlements, building, roads, and other lands appropriated for non-agricultural use like mountains and shifting dunes etc.,

Figure 7: Land Use Pattern



Source: Various issues of Statistical Abstract of Rajasthan, Agricultural Statistics of Rajasthan, Government of Rajasthan, 2018-19.

Sl. No	Land Use	Area (in Lakh Hectare)	Percentage
1.	Net Sown Area	177.78	51.85
2.	Area under Forests	27.60	8.05
3.	Non Agriculture Uses	19.93	5.81
4.	Permanent Pastures & other grazing land	16.68	4.86
5.	Land under Misc. trees & grooves	0.26	0.08
6.	Culturable Wasteland	37.84	11.04
7.	Fallow Lands (other than current fallow)	21.06	6.14
8.	Current Fallows	17.89	5.22
9.	Barren & Uncultivable Land	23.83	6.95
	Reporting Area for land utilization	342.87	100
	Total Reported area of Rajasthan	342.87	

Source: Various issues of Statistical Abstract of Rajasthan, Agricultural Statistics of Rajasthan, Government of Rajasthan, 2018-19.

Permanent Pastures & Other Grazing land:

- The availability of permanent pasture and grazing land determines the status of livestock economy in the regions. It constituted about 5% of the reporting area in Rajasthan
- In irrigated North Western Plain, the grazing land is also found negligible
- The sub humid Southern Plain is endowed with pastures and grazing lands in one-tenth of the reporting area., Largely, it constituted about 4-7% across the zones
- Hanumangarh and Sri Ganganagar have the least area whereas Barmer, Jodhpur and Bhilwara have the largest area under this category

Land under misc trees & grooves:

- Area under fruit crop fall under this category of land use
- In Rajasthan, the area under fruit crops is also negligible i.e, less than 1%
- Churu and Rajsamand districts have no land under miscellaneous trees, crops, and groves. Districts Nagaur, Jalore and Hanumangarh cover the least whereas, Dungarpur, Ganganagar and Jhalwar cover the maximum area under the same category

Culturable wasteland:

- Culturable wastelands are wastelands that can be brought under cultivation by providing irrigation
- Culturable Wasteland is higher in Ajmer, Alwar, and Jaisalmer and minimum at Hanumangarh, Jhunjhunu and Bharatpur

Fallow Lands:

- A fallow field is land that a farmer plows but does not cultivate for one or more seasons to allow the field to become more fertile again
- Fallow lands includes two types of fallow lands-current fallow lands & other fallow (long-fallow) lands.
- Current year fallow are the lands that have been left fallow for the current year, while other fallow lands include lands that have been left fallow for more than a year
- In arid regions, except in the districts where irrigation is practiced the extent of such fallow land is very high; Barmer, Bikaner, Jaisalmer, Jodhpur dominate this category

Change in land use pattern in Rajasthan:

- In general there is an increase in total area under cultivation in Rajasthan
- Permanent pastures and grazing lands and miscellaneous trees and grooves are declining having serious unfavourable implications for the ecology of Rajasthan
- Although growth in forest area is positive in all the regions of Rajasthan still forest area is only 7.8% of total geographical area, which is well below the minimum norms of 33% of geographical area under forests as set under the National Forest Policy (1952)
- There has been declining growth in barren and other unculturable lands. Land that is being released from barren and unculturable land is shifting towards non-agricultural sector

6. Chapter 3: RAJASTHAN BIOMASS MARKET OVERVIEW

6.1. Utilization of Biomass in Industry across Rajasthan

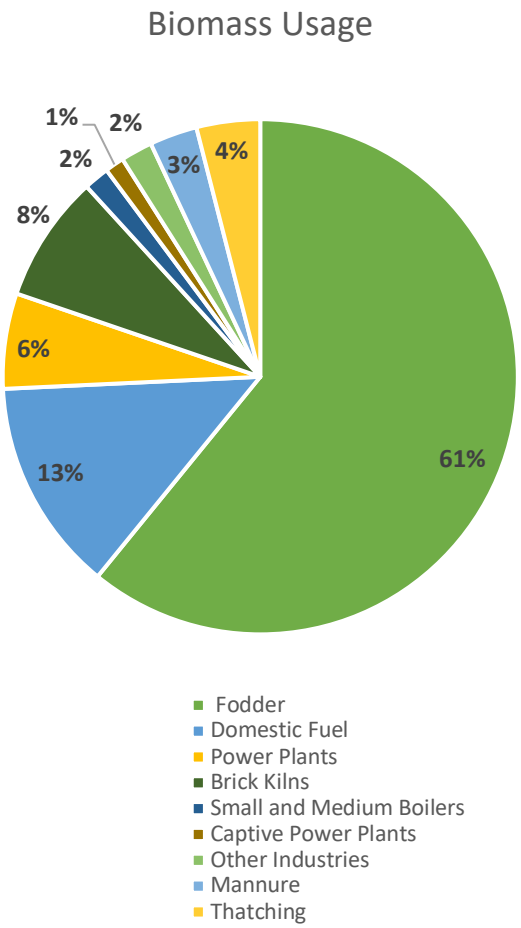
Potential of biomass for bioenergy production in India have been evaluated for the past decades with inclusion of updated technologies. Concerns about increasing energy demand and global warming has urged the world scientific community to search for renewable and sustainable alternatives. One of the best alternative include production of biofuels and biomaterials building blocks from biomass waste, which include solid waste of agricultural residues, agro-industrial wastes, liquid waste and food etc. This energy conversion from waste (Efw) technology requires pre-treatment of biomass which is subsequently converted to biofuels of different forms (methane, hydrogen, ethanol, biodiesel, etc.).

Government of India has taken some initiatives for economic and effective utilisation of biomass and biomass wastes. The possible co-products that could be produced in the bio refinery and their importance to reduce the processing cost of biofuel are encouraged. Recent estimates of biofuel production costs show that second generation biofuels are two to three times more expensive than petroleum fuels on an energy equivalent basis. To bring down the production cost, several challenges in converting lignocellulosic biomass to biofuels and chemicals using biochemical platforms need to be addressed.

These challenges are in the areas of, **(i) feedstock production, (ii) feedstock logistics**, **(iii) development of energy efficient technologies** (pre-treatment, enzyme hydrolysis, and microbial fermentation), **(iv) co product development**, (**v) establishment of biofuel and biochemical standards, (vi) biofuel distribution**, (**vii) societal acceptance, and (viii) environmental impact minimization.** All of these challenging areas require expertise in agronomy, biomass logistics, biomass conversion, process engineering, chemistry, conversion technology, genetic engineering, microbial fermentation, economics, and environmental science. In India, there is huge scope of utilisation of waste biomass in economic and environment friendly process.

The potential use of biomass residues are **Fodder, Domestic fuel, Thatching, Manure, consumption in process plants such as Power Plants, Brick Kilns, Industries (such as Food and Beverage, Textile, Paper and Pulp, Pharmaceuticals, Small and Medium Boilers, Captive Power Plants, Cements etc.)** and net import/export of biomass from catchment area. The result of the study has been given in the figure as percentage distribution of biomass usage for the state of Rajasthan. Some of the plants may be closed and some new plants may emerge in the near future.

Figure 8: Percentage Distribution of sample of Biomass usage in Rajasthan



Source: Biomass consumption assumptions arrived from primary data (the primary data collected at field level by discussion with farmers, biomass SUPPLIERS AND traders, other biomass consuming industries and personal observation by the field enumerators)

6.1.1.Industries Purchasing Cost of Biomass at Factory Gate:

The average price of agro- reside is between Rs 2–2.5 per kg (Rs 2,000–2,500 per tonne). These prices vary significantly with different varieties of crop residue. The main components of this cost are labour cost for collection of agro-residue from the fields, its loading–unloading and transportation. Farmers may earn between Rs 500– 1,500 per tonne of crop residue after deducting the labour and transport cost. Moreover, pellet manufacturing, storage, handling and transportation generates employment in rural areas.

Table 21: Purchasing Cost of Biomass at Factory Gate

Crop Residue	Rs per ton of agro-residue (including transportation and labour cost)
Mustard Stalks & Husk	2,800 - 2,900
Cane Trash	2,000 – 2,100
Maize Stalks	2,300 – 2,400
Cotton Stalks	2,500 – 3,500
Source: Data collected from Biomass Suppliers/Traders, Brick Manufacturing, and Industry Units.	

Few Challenges faced by Industries:

- ✓ The delivery, storage and handling of biomass due to its geographically scattered availability, it is mostly transported on trucks
- ✓ Low density and high volume require comparatively larger transportation arrangements and storage areas that should be covered because of hygroscopic nature of biomass
- ✓ High flammability and high abrasion resistance requires dedicated fire prevention and suppression systems
- ✓ Increased fire risk from pellets may also require large-scale dust extraction systems to minimize the hazard
- ✓ Covered conveyor and storage facilities are required to minimize the spread of dust for prevention of fire and to protect biomass from ingress of water, which reduces the quality of the fuel

6.1.2. Trend of Biomass Generation, Consumption and Surplus in Rajasthan:

The agriculture data of Area, Yield and Production was gathered from the Agricultural Department, Government of Rajasthan for FY 2017-18, FY 2018-19 & FY 2019-20. The below mentioned table elaborated the

1. **Biomass Generation**: was calculated based on the formula:

Biomass Generation = Area of Cultivation * Yield * Crop To Residue Ratio (CRR).

2. **Biomass Consumption:** was calculated based on the utilization pattern such as:

- ✓ **Societal**: which includes, Fodder, Domestic Fuel, Thatching and Manure.
- ✓ **Industrial:** which includes, industries like Brick Manufacturing, Small and Medium boilers and Captive Power Plants etc,.

Biomass Consumption has been arrived on the basis of Primary Research conducted with Farmers, Biomass Suppliers and Traders, Industries and personal observation by the field enumerators and have been analysed internally.

3. **Biomass Surplus:** was calculated based on the formula:

Biomass Surplus = Biomass Generation - Total Biomass Consumption

The above calculations have been provided in the **Annexure I.**

Based on the biomass study undertaken, Generation, Consumption and Surplus (FY 2017-18, FY 2018-19 and FY 2019-20), as mentioned below is in increasing trend.

Major reasons are attributed as below for increase in biomass cost despite of surplus of biomass is in increasing trend.

1. The biomass qty is more or less same and not increased so significantly wrt demand increases from stakeholders such as brick klins and other industries, the price also tend to increase.
2. The pricing is determined by the demand and supply of biomass to power plants. But due to consumption of biomass by other industries has pushed the price upwards and forces such as biomass being sold to other stakeholders in open market.
3. The pricing of biomass has been followed an upward trend due to buying of biomass for industrial purposes, especially process industries, briquette industries, brick klins and cement industries.
4. The Major component in biomass cost is the transport & manpower cost, since availability is in upward but demand side is more than the availability and diesel and manpower cost are being increased proportionally irrespective of biomass availability.
5. Shortage of manpower, resistance in biomass handling are main reason for increasing in labour cost.
6. Inflation is escalating about 5% Y-O-Y.
7. The increase in biomass price is also determined by other factors such as transportation, covering cost, storage cost etc. These price inputs also increase the final price of the biomass even though the biomass is available in surplus.
8. The Major Agro Based biomass considered for power generation are **Mustard Husk and Prosopis Juliflora**. However, as per the Biomass Policy 2010 Clause 13.1- Biomass as defined at clause No. 3.1 (2), following types of Biomass, produced within the State of Rajasthan, have only been considered for Power generation:
   1. Paddy Straw
   2. Maize Straw
   3. Ground Nut Stalks
   4. Castor Stem
   5. Cotton Stalks

6.1.3. District Wise Biomass Generation Trends:

Table 22: District Wise Biomass Generation Trends

Sl No	District	Biomass Generation in MT		
		FY 2017-18	FY 2018-19	FY 2019-20
1	Ajmer	1,56,966.9	1,83,204.3	1,96,497.9
2	Jaipur	3,10,786.4	3,54,914.5	4,62,399.4
3	Dausa	2,15,589.7	2,06,595.3	2,01,649.5
4	Tonk	6,07,906.2	8,56,413.8	9,37,192.9
5	Sikar	1,73,358.1	1,10,596.6	2,35,049.6
6	Jhunjhunu	2,12,890.0	4,29,320.3	2,46,534.7
7	Nagaur	2,46,432.2	3,13,920.2	3,34,555.5
8	Alwar	9,38,531.8	34,64,042.2	10,23,016.8
9	Bharatpur	7,08,320.5	8,86,125.1	7,42,611.9
10	Dholpur	2,47,173.6	2,76,109.5	2,50,227.4
11	Sawai Madhopur	3,16,646.5	5,48,943.5	5,18,933.1
12	Karoli	2,41,118.8	3,02,586.1	3,02,781.3
13	Bikaner	12,65,272.4	14,28,786.3	14,61,947.3
14	Churu	4,27,329.6	5,75,958.3	5,01,771.9
15	Jaisalmer	1,70,467.2	2,13,313.7	2,42,830.5
16	Ganganagar	12,39,139.4	12,18,343.2	13,34,698.6
17	Hanumanagar	8,87,454.8	10,17,620.5	10,36,308.4
18	Jodhpur	9,35,199.6	9,56,102.0	13,98,440.7
19	Barmer	84,037.3	70,398.8	1,10,538.0
20	Jalore	3,60,390.0	3,42,464.0	4,58,961.2
21	Pali	1,43,910.1	1,57,358.2	2,08,175.2
22	Sirohi	46,169.1	2,07,211.4	2,63,304.7
23	Kota	1,90,037.7	2,99,345.3	1,75,394.7
24	Baran	3,86,940.2	5,36,275.2	2,85,161.2
25	Bundi	3,05,247.0	4,68,446.1	3,20,608.1
26	Jhalawar	2,48,419.9	4,06,061.2	1,52,195.2
27	Banswara	2,97,687.3	2,94,629.3	2,38,201.2
28	Dungarpur	1,27,630.2	1,47,259.1	1,17,159.0
29	Udaipur	3,48,991.5	4,88,578.3	2,62,389.1
30	Pratapgarh	1,56,250.1	1,95,438.2	1,15,266.0
31	Bhilwara	7,17,778.3	7,74,669.2	5,76,697.6
32	Chittogarh	6,78,651.4	8,57,252.8	4,15,166.6
33	Rajsamand	2,39,505.1	2,16,207.3	1,77,755.9
TOTAL		**1,36,32,228.9**	**1,88,04,489.8**	**1,53,04,421.1**

Source: Biomass Generation was extracted from Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20 and Calculated based on the formula (Biomass Generation = Area of Cultivation * Yield * Crop To Residue Ratio (CRR).

6.1.4. District Wise Biomass Consumption Trends:

Table 23: District Wise Biomass Consumption Trends

Sl No	District	Biomass Consumption in MT		
		FY 2017-18	FY 2018-19	FY 2019-20
1	Ajmer	1,17,570.8	1,41,487.6	1,48,158.5
2	Jaipur	3,21,422.4	3,63,015.3	4,74,769.3
3	Dausa	1,49,805.3	1,43,138.2	1,39,322.7
4	Tonk	4,92,318.6	6,82,965.6	7,46,130.1
5	Sikar	1,27,333.2	91,710.8	1,74,804.0
6	Jhunjhunu	1,46,601.3	3,27,443.7	1,78,569.4
7	Nagaur	2,06,522.0	2,73,362.5	2,88,737.5
8	Alwar	15,70,230.8	41,87,690.1	16,77,559.5
9	Bharatpur	17356.6	13,952.50	18646.9
10	Dholpur	70,966.4	79,614.6	72,019.1
11	Sawai Madhopur	41,803.6	66,499.8	68,187.5
12	Karoli	38,280.8	48,230.0	48,126.4
13	Bikaner	1265272.4	1351233.8	13,74,110.0
14	Churu	2,80,015.8	3,52,940.9	3,24,271.8
15	Jaisalmer	1,31,745.6	1,67,959.4	1,95,199.8
16	Ganganagar	11,79,845.2	11,67,266.3	11,74,720.5
17	Hanumanagar	7,24,922.4	8,58,662.1	8,47,340.6
18	Jodhpur	2,16,026.3	2,10,540.9	3,35,441.5
19	Barmer	16,334.8	13,233.7	21,123.9
20	Jalore	2,28,113.9	2,19,600.7	2,50,389.6
21	Pali	46,756.1	62,173.5	66,646.6
22	Sirohi	11,178.1	90,088.0	1,07,602.9
23	Kota	1,88,869.5	2,98,665.1	1,74,994.8
24	Baran	4,70,056.7	6,83,239.7	3,62,777.5
25	Bundi	2,86,291.7	4,06,657.5	2,77,272.1
26	Jhalawar	2,28,734.6	2,28,666.3	63,634.6
27	Banswara	2,77,869.1	2,80,692.7	2,15,712.3
28	Dungarpur	1,25,598.9	1,46,301.1	1,15,870.9
29	Udaipur	3,39,259.2	4,79,373.6	2,54,605.4
30	Pratapgarh	1,30,991.1	1,51,280.9	91,929.4
31	Bhilwara	5,98,410.5	6,40,976.2	4,46,319.6
32	Chittogarh	5,76,145.3	6,64,350.5	3,57,058.2
33	Rajsamand	2,28,966.9	2,04,233.7	1,70,272.8
TOTAL		**1,08,51,615.9**	**1,50,97,247.3**	**1,12,62,325.7**

Source: Biomass consumption arrived from primary data (the primary data collected at field level by discussion with farmers, biomass suppliers and traders, biomass consuming industries and personal observation by the field enumerators).

6.1.5. District Wise Biomass Surplus Trends:

Table 24: District Wise Biomass Surplus Trends

Sl No	District	Biomass Surplus in MT		
		FY 2017-18	FY 2018-19	FY 2019-20
1	Ajmer	39,396.2	41,716.8	48,339.4
2	Jaipur	-10636.1	-8100.8	-12369.9
3	Dausa	65,784.4	63,457.1	62,326.8
4	Tonk	1,15,587.7	1,73,448.2	1,91,062.8
5	Sikar	46,024.9	18,885.7	60,245.6
6	Jhunjhunu	66,288.7	1,01,876.6	67,965.3
7	Nagaur	39,910.2	40,557.7	45,818.0
8	Alwar	-631699.0	-723647.9	-654542.7
9	Bharatpur	690962.3	886125.1	7,23,965.00
10	Dholpur	1,76,207.2	1,96,494.8	1,78,208.3
11	Sawai Madhopur	2,74,842.9	4,82,443.6	4,50,745.7
12	Karoli	2,02,838.0	2,54,355.9	2,54,654.9
13	Bikaner	96,770.1	77,552.3	87,837.3
14	Churu	1,47,313.8	2,23,017.4	1,77,500.1
15	Jaisalmer	38,721.7	45,354.4	47,630.7
16	Ganganagar	59,294.1	51,076.9	1,59,978.1
17	Hanumanagar	1,62,532.4	1,58,958.4	1,88,967.8
18	Jodhpur	7,19,173.3	7,45,561.1	10,62,999.1
19	Barmer	67,702.6	57,164.9	89,414.1
20	Jalore	1,32,276.0	1,22,863.3	2,08,571.7
21	Pali	97,153.9	95,184.8	1,41,528.6
22	Sirohi	34,991.1	1,17,123.5	1,55,701.6
23	Kota	1,168.2	680.2	400.0
24	Baran	-83116.5	-146964.5	-77616.3
25	Bundi	18,955.3	61,788.5	43,336.1
26	Jhalawar	19,685.3	1,77,394.9	88,560.8
27	Banswara	19,818.3	13,936.6	22,489.0
28	Dungarpur	2,031.4	958.0	1,288.2
29	Udaipur	9,732.3	9,204.7	7,783.6
30	Pratapgarh	25,259.1	44,157.4	23,336.8
31	Bhilwara	1,19,367.8	1,33,692.9	1,30,378.1
32	Chittogarh	1,02,506.2	1,92,902.1	58,108.3
33	Rajsamand	10,538.2	11,973.6	7,483.2
TOTAL		**28,77,382.0**	**37,21,194.2**	**40,42,096.1**

Source: Surplus biomass calculated from biomass generation and surplus was Calculated based on the formula (Biomass Surplus = Biomass Generation - Total Biomass Consumption)

Negative Surplus Elucidation:

The net surplus biomass in Alwar and Baran district is coming negative on account of more consumption than these districts generate by themselves. Additional quantity required is met through import of biomass from adjoining districts and states. After Primary survey and data collation in study, it has been identified that in Alwar district biomass demand is significantly higher due to various industrialization and promoting green fuel for their process industries as a cost economically and environment friendly.

Although Alwar falls under a region which is irrigated than other areas, it still continues to face negative surplus biomass because of high consumption for different purposes such as domestic fuel, animal consumption, Industrial use, Brick klins etc. Also, the consumption of fodder has increased substantially due to increase livestock.

There are numerous industries such as Cement, solvent plant, Dairy-Milk Production, Snack Makers, Ceramics, Brick Klins, Agro-based industry, Chemical Industry, Pharma industry, dyes and printing, etc. which use Biomass to fulfil their energy requirements.

Process industries-companies use biomass as their main feed to generate steam /power. Approx. biomass consumption in solvent and other process industries are. 10000 MT/Year/nos.

Cement industries- In and around Alwar districts about 7 nos of cement factories are under operation, in which 3 nos are located in Alwar district. The cement plant is using high qty of biomass as an alternate fuel in the process to reduce the usage of fossil fuels in kiln.

Brick klins- There are more than 280 brick klins or factories in Alwar district. The number consists of both authorized and unauthorized brick klins.

Biomass Briquette producers – There are about 7 major biomass briquette suppliers, on an average, each of these biomass manufacturers and suppliers supply around 550 tons/month of different kind of biomass to various Industries located in NCR, Noida and UP, mainly to process industries.

HPPI – Green Action project – There are over 50 Biogas plants in 10 villages across Behror and Neemrana in Alwar District, HPPI is promoting biogas as a clean energy source in rural households, and the 'Green Action' project is part of the organization's larger biogas programme, which presently counts 700 biogas plants in villages of Rajasthan.

6.1.6.Controlling emissions from industry:

The industrial air pollution in the key industry clusters in Rajasthan are ***Jaipur, Alwar, Bhiwadi and Neemrana.***

- ✓ **Jaipur:** The major industries in Jaipur are ***metal based, stone works, mineral grinding, brick kilns etc***. There are overall 48 designated industrial areas and 8 of them are major ones. Vishwa Karma Industrial Area (VKIA), Jaipur is the largest coal and liquid fuel consumer and uses almost 30 percent of the coal used by industries in the district. On the other hand ***Kotputli is the largest agro residue consumer***. VKIA is one of the biggest contributors to the industrial pollution loading in the area and is responsible for 33 per cent of the total industrial pollution loading.

- ✓ **Alwar:** ***Alwar has quite a number of furnaces and boilers***. Most boilers are below the capacity of 2 TPH. Matsya Industrial Area (MIA),Alwar largest coal consumer, – using up 63 .5 percent of the coal used in the district.

- ✓ **Bhiwadi:** Bhiwadi Industrial Area contributes around 65 per cent to the industrial pollution load of the region. Bhiwadi with a total of 328 air polluting industries with predominance of metal based & chemical/pharmaceutical, has overall 3 major designated industrial areas – Bhiwadi, Chopanki & Khuskhera. Majority boilers are below the capacity of 3 TPH. Bhiwadi Industrial Area is the largest coal, agro and wood consumer. Chopanki Industrial Area is the largest liquid fuel consumer.

Alwar and Bhiwadi (as these were one of the most industrialized regions in this airshed). This has assessed the local industry profile, and nature of their pollution to chart a roadmap for more locally appropriate action. Some of the key industrial pollution hotspots identified includes Vishwa Karma Industrial Area (VKIA) in Jaipur, Matsya Industrial Area in Alwar, and Bhiwadi Industrial Area (Phase I to IV) in Bhiwadi.

- ✓ **Neemrana:** Neemrana together contribute more than 60 per cent to the industrial pollution load of the district. But this area also shows highest use of agro residue as a fuel and ***Neemrana is largest agro residue consumer***.

Even with the rapid growth in the renewable sector, India has to continue its reliance on coal to meet its base load energy demand. Coal-based power plants are resource-intensive and add up to a significant pollution load on the environment. Many of these power stations have become old and will be shut down due to their higher emissions, and replaced with new plants using cleaner coal technology.

What if we were to see the broader picture and make one problem the solution to the other problem? This can be achieved by identifying older units operating at a satisfactory efficiency within safe operating parameters, and promoting co-firing of biomass in them.

6.2. Biomass from Agricultural Land

This chapter covers biomass generation, biomass consumption and surplus biomass availability from agricultural land in the state of Rajasthan, India.

6.2.1. Biomass Residue Generation:

Crop residue forms the major portion of the biomass generation. The main crop residues of the study area are:

Table 25: Biomass Residue Generation in Tons per Ha per year in Rajasthan

Sl. No	Crops	Biomass	CRR
1	Paddy	Paddy Straw	**1.0**
2	Maize	Maize Stalks	**1.5**
3	Ground Nut	Ground Nut Stalks	**2.0**
4	Castor	Castor Stem	**1.3**
5	Cotton	Cotton Stalks	**3.8**
6	Mustard	Mustard Stalks & Husk	**1.8**

Source: IISc.. Biomass atlas of India. Combustion, Gasification and Propulsion Laboratory, Indian Institute of Science (IISc), Literature Review.

Note: The CRR value of each type of biomass has been taken from IISC, Bengaluru (Available at: http://cgpl.iisc.ernet.in/),

The table above shows the Crop to Residue Ratio (CRR) provided by Indian Institute of Science. Estimation of biomass availability was made for both the Rabi & the Kharif seasons using secondary data, where in important details like residue generation and area of cultivation for each crop are available. The data gives the average yield (of the last FY 2018-19, FY 2019-20 and FY 2020-21) expected per hectare for the representative crop grown in the study area.

Table 26: List of major crops and area of Cultivation in the state of Rajasthan

Sl. No.	Crops	Area of Cultivation (in Ha)
1	Paddy	2,02,685.3
2	Maize	8,58,636.7
3	Ground Nut	6,73,877.3
4	Castor	1,55,878.3
5	Cotton	6,52,987.0
6	Mustard	25,66,968.7
Total		**51,11,033.30**

Source: Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20.

Table below shows the computation of the biomass generation from the agricultural activity using the residue generation per ha per year and cultivated area for Rajasthan.

Table 27:Biomass Generations from Agricultural Activity in Rajasthan

Sl. No	Crops	Biomass	Average Biomass Generated (FY 2017-18, FY 2018-19 & 2019-20) Tons / Year	%
1	Paddy	Paddy Straw	5,48,626.4	**4%**
2	Maize	Maize Stalks	23,84,101.2	**16%**
3	Ground Nut	Ground Nut Stalks	28,51,075.3	**19%**
4	Castor	Castor Stem	2,92,791.5	**2%**
5	Cotton	Cotton Stalks	14,33,218.3	**9%**
6	Mustard	Mustard Stalks & Husk	76,01,947.0	**50%**
Total			**1,51,11,759.70**	**100%**

Source: Calculated value from the data of 2017-18, 2018-19 & 2019-20 years average cultivated area, average crop yield & Crop Residue Ratio., of year 2017-18, 2018-19 & 2019-20.

Biomass Generation from Agricultural Activity =1,51,11,759.70 MT/year.

6.2.2. Biomass Consumption and Surplus:

The households of the villages use biomass for one or many of the following purposes.

- ✓ as Fodder;
- ✓ as Fuel;
- ✓ as Manure;
- ✓ for Thatching, etc.

In our study, 6 Agro crops have been identified as major crops. The utility pattern of these crops is also analyzed with respect to the above applications. The utility pattern of the biomass in households was established using the under mentioned tools.

A. Physical observation in respect of usage of biomass for manure and thatching, fuel and etc,
B. Animal husbandry data for fodder consumption and statistical department data for livestockpopulation of the village / District.
C. Details gathered from Dealers, Elders and Businessmen on surplus availability There are manyactivities that take place ON / OFF the field before biomass is generated and transported. A few of these activities are:

i) Harvesting	**ii) Transportation**	**iii) Separation**
iv) Stocking	**v) Handling**	

The below Table presents the usage pattern of the biomass (from major crops) during various activities.

Table 28: District-wise Average Generation, Consumption & Surplus Biomass in Rajasthan

Sl. No.	Districts	Average Generation of (FY 2017-18 to FY 2019-20) Tons/Year	Average Consumption of (FY 2017-18 to FY 2019-20) Tons/Year	Average Surplus of (FY 2017-18 to FY 2019-20) Tons/Year
1	Ajmer	1,78,889.7	1,35,739.0	43,150.8
2	Jaipur	3,76,033.4	3,86,402.3	-10368.9
3	Dausa	2,07,944.8	1,44,088.7	63,856.1
4	Tonk	8,00,504.3	6,40,471.4	1,60,032.9
5	Sikar	1,73,001.4	1,31,282.7	41,718.7
6	Jhunjhunu	2,96,248.3	2,17,538.1	78,710.2
7	Nagaur	2,98,302.6	2,56,207.3	42,095.3
8	Alwar	18,08,530.3	24,78,493.5	-669963.2
9	Bharatpur	7,79,019.2	16,652.0	7,67,017.5
10	Dholpur	2,57,836.8	74,200.0	1,83,636.8
11	S.Madhopur	4,61,507.7	58,830.3	4,02,677.4
12	Karoli	2,82,162.1	44,879.1	2,37,282.9

13	Bikaner	13,85,335.3	13,30,205.4	87,386.6
14	Churu	5,01,686.6	3,19,076.2	1,82,610.4
15	Jaisalmer	2,08,870.5	1,64,968.3	43,902.3
16	Ganganagar	12,64,060.4	11,73,944.0	90,116.4
17	Hanumangarh	9,80,461.2	8,10,308.4	1,70,152.9
18	Jodhpur	10,96,580.8	2,54,002.9	8,42,577.8
19	Barmer	88,324.7	16,897.5	71,427.2
20	Jalore	3,87,271.7	2,32,701.4	1,54,570.3
21	Pali	1,69,814.5	58,525.4	1,11,289.1
22	Sirohi	1,72,228.4	69,623.0	1,02,605.4
23	Kota	2,21,592.6	2,20,843.1	749.5
24	Baran	4,02,792.2	5,05,358.0	-102565.8
25	Bundi	3,64,767.1	3,23,407.1	41,360.0
26	Jhalwar	2,68,892.1	1,73,678.5	95,213.7
27	Banswara	2,76,839.3	2,58,091.4	18,748.0
28	Dungarpur	1,30,682.8	1,29,257.0	1,425.9
29	Udaipur	3,66,653.0	3,57,746.1	8,906.9
30	Pratapgarh	1,55,651.4	1,24,733.8	30,917.8
31	Bhilwara	6,89,715.0	5,61,902.1	1,27,812.9
32	Chittaurgarh	6,50,356.9	5,32,518.0	1,17,838.9
33	Rajsamand	2,11,156.1	2,01,157.8	9,998.3
Total		**1,51,11,759.70**	**1,24,03,729.6**	**35,46,890.8**

Source: Biomass Generation was extracted from Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20. Biomass consumption arrived from primary data (the primary data collected at field level by discussion with farmers,, biomass suppliers and traders, other biomass consuming industries and personal observation by the field enumerators). Surplus biomass calculated from biomass generation and consumption.

It was found that, on an average of about **1,51,11,759.70 MT** per year of biomass was generated. **1,24,03,729.6 MT** per year of the biomass generated from agricultural activity goes for consumption in local for fodder, manure, fuel for thermal energy consuming industries, biomass power plants, brick kiln, etc, and about **35,46,890.8 MT** per year is available for other activities or exported to nearby states. The major portion of wheat stalks, barley stalks, paddy, jowar stalks, bajra stalks, animal as fodder consumes maize stalks and these biomass should not be used for power generation and as fuel per policy 2019 . The above was prepared based on fairly established data and hence can be counted as near realistic.

Table 29: Crop-wise Average Generation, Consumption & Surplus Biomass in Rajasthan

Sl. No.	Crop Name	Average Generation of (FY 2017-18 to FY 2019-20) Tons/Year	Average Consumption of (FY 2017-18 to FY 2019-20) Tons/Year	Average Surplus of (FY 2017-18 to FY 2019-20) Tons/Year
1	Paddy Straw	5,48,626.40	5,48,327.80	298.58
2	Maize Stalks	23,84,101.20	23,84,098.30	2.99
3	Ground Nut Stalks	28,51,075.30	19,25,623.50	9,25,451.71
4	Castor Stem	2,92,791.50	53,547.20	2,39,244.33
5	Cotton Stalks	14,33,218.30	8,46,997.90	5,86,220.47
6	Mustard Stalks & Husk	76,01,947.00	58,14,111.8	17,87,835.2
Total (MT/Year)		**1,51,11,759.70**	**1,24,03,729.6**	**35,46,890.8**

Source: Biomass Generation was extracted from Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20. Biomass consumption arrived from primary data (the primary data collected at field level by discussion with farmers, biomass suppliers and traders, other biomass consuming industries and personal observation by the field enumerators). Surplus biomass calculated from biomass generation and consumption.

6.3. Biomass from Waste Land

6.3.1. Prosposis Juliflora:

Out of the total geographical area of 3,42,23,900 hectares in study area, 93,68,947 hectares were identified as wasteland out of which Prosposis Juliflora is grown in 58,47,268 hectares of cultivable waste land and fallow land in Rajasthan. Prosopis Juliflora is the major wasteland biomass in this study area. Prosopis juliflora was introduced to India around 1877 to check encroaching desert sands as as a regreening tool. The first large-scale planting was in Gujarat in about 1894,and the species was introduced to Rajasthan in 1913. In all 11 districts of western Rajasthan, Prosopis juliflora has spread widely, with high plant densities encountered in the districts of Pali, Jalore, Jodhpur and Nagur. There has been a great spread into east and south Rajasthan in the last 25 years. Initially it was introduced along roads, it has now spread, the resulting shrinking pastured may have been the cause of the decline of many wild grassland animals. This species is prevalling in this area massively for quite some decades, may be due to soil and other related environmental features.

Prosopis Juliflora is well adapted to warm and dry tropical climates. It grows well in areas receiving 250-600 mm annual rainfall. It is a fast growing tree and has a deep to very deep, well- meshed root system. It does not require any special care for rehabilitating marginal lands or wastelands. This species is however susceptible to frost and its distribution is very much restricted in areas where there is a regular occurrence of frost during winter months. Such as the interdunal zones of Barmer, Jaisalmer, Bikaner and Churu. In areas, which experience frost once in every 4 to 8 years, the plant suffers dieback to ground level, and later in February. In March the plant sprouts back and assumes its original height within a 9-10-month period.

Figure 9: Technical manual on Prosopis Juliflora on the usage across different Industries.

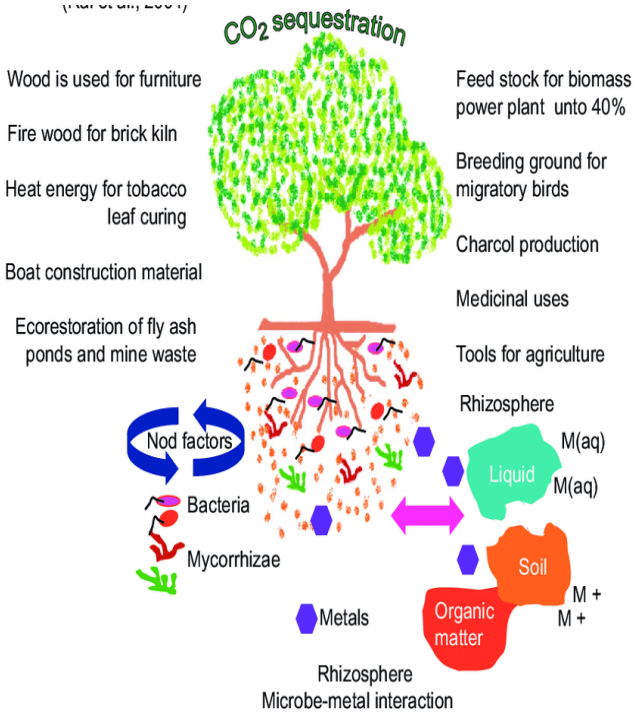
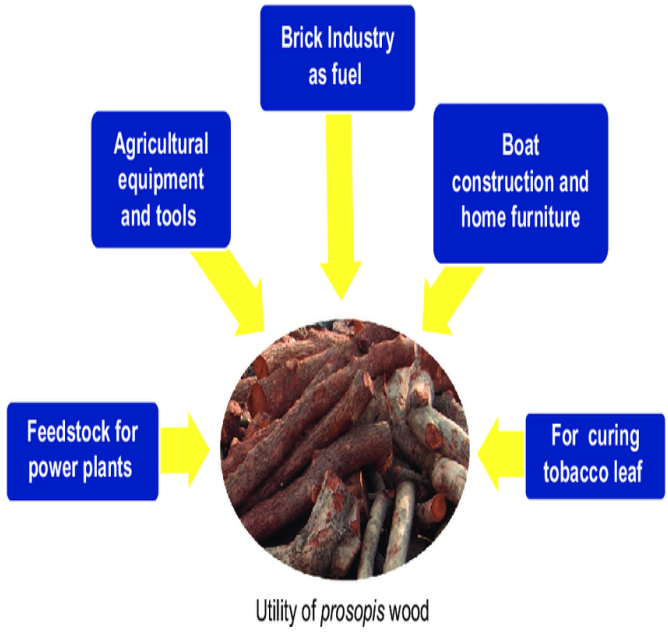


Figure 10: Utility of Prosopis Wood



6.3.2.Environmental Sustainability:

The Thar Desert (Rajasthan) is one of the driest place of the arid zone of the NW Indian subcontinent (Figure 11). Natural land-scapes have been changed by modern human activities modifying the original relief and contributing to the present environmental vulnerability and a loss of natural resilience. These natural processes pose major threats to the local ecosystems and limitations to the rural occupation habitats. In western Rajasthan, the annual rainfall is estimated to have dropped by ≈ 15% over the past 100 years **[1].**

The arid zone of NW India shows a differential degree of landscape degradation in terms of environmental stability, natural restoration capability and socioeconomic sustain- ability because of the variably co-acting adverse natural and human factors **[2].**

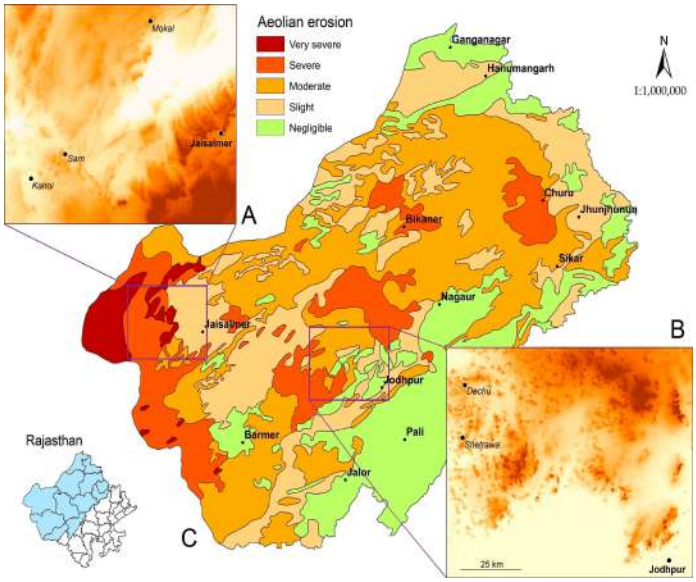
The same concerns the climatically more favourable and densely occupied northern and eastern areas of Rajasthan receiving an increased annual rainfall (300–500 mm) which allows for an intensive, largely irrigation-based agricultural economy. Presently, >5800 km2 of the land are severely degraded, 24,430 km2 degraded, 73,740 km2 moderately degraded, and 526,900 km2 are slightly degraded **[3].**

At present, about 80% of western Rajasthan is affected by a certain form of land degradation; >73% is subjected to wind erosion and sand dune deposition, Vegetation retreat, soil and water erosion, topsoil salinity/alkalinity and industrial (mining and construction) activities represent the other major regional ecological risks **[4]. Figure 12.** Aeolian erosion of western Rajasthan with the Digital Elevation Model (DEM) relief maps of the discussed areas: (A) Jaisalmer District and (**B**) Jodhpur District. The western and central parts of the country represent the most extreme SW wind- stream-affected geoenvironment with mass sand sediment-generating processes and the formation of barchanoidand longitudinal sand dune fields. Parabolic and transverse dunes are characterised by less severe, moderate to slight erosion–accumulation settings, respectively. The DEM sector relief (**A**,**B**) processing and projection this study; (**C**) the background wind-erosion map **[5].**

Figure 11: Arid zone of the NW Indian subcontinent

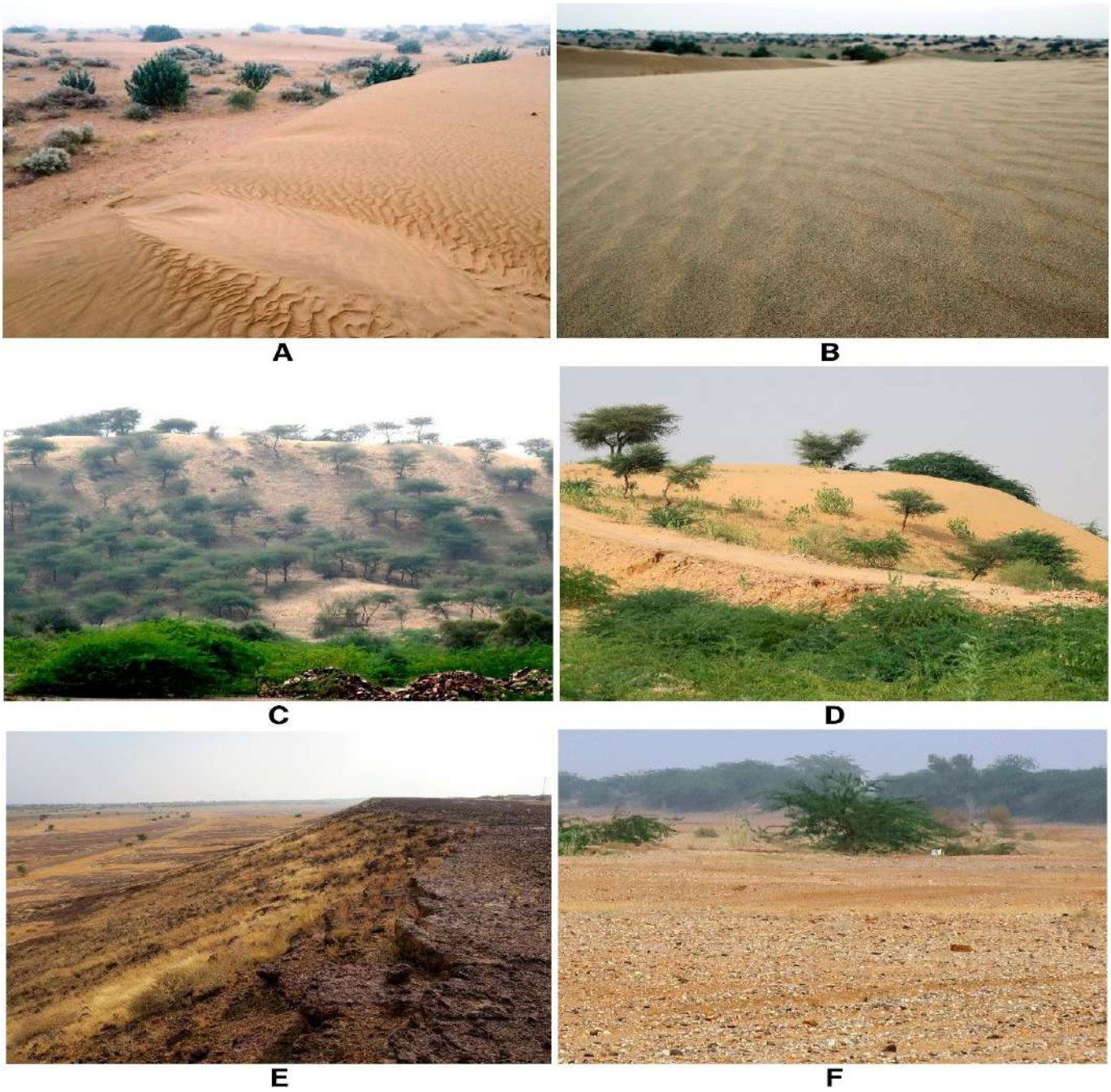
Source: Geography of the Thar Desert (West India–East Pakistan), Environmental Sustainability of the Thar Desert, West India. Sustainability 2021

Figure 12: Aeolian erosion of western Rajasthan subcontinent



Source: Environmental Sustainability of the Thar Desert, West India. Sustainability 2021

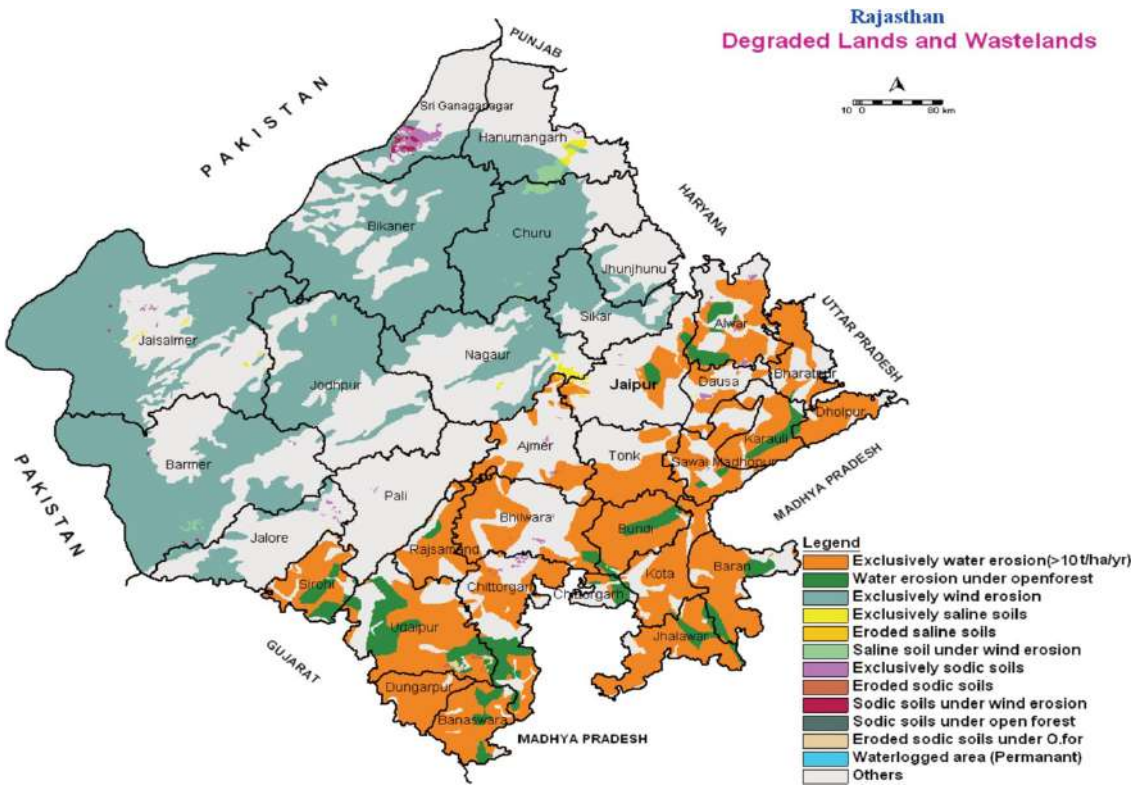
1. Jain, S.K.; Kumar, V. Trend analysis of rainfall and temperature data for India. Curr. Sci. 2012, 102, 37–49
2. Chlachula, J. Between Sand Dunes and Hamadas: Environmental Sustainability of the Thar Desert, West India. Sustainability 2021, 13, 3602. https://doi.org/10.3390/ su13073602
3. Chlachula, J.; Moharana, P.C. Geo-environmental feedback of present aridification in the Rajasthan State, NW India. In Proceed- ings of the 18th International Multidisciplinary Geo-Science Conference SGEM, Sofia, Bulgaria, 30 June–9 July 2018; pp. 469–476.
4. Moharana, P.C.; Santra, P.; Singh, D.V.; Kumar, S.; Goyal, R.K.; Machiwal, D.; Yadav, O.P. Erosion processes and desertification in the Thar Desert of India. ICAR-Central Arid Zone Research Institute, Jodhpur. Proc. Indian Nat. Sci. Acad. 2016, 82, 1117–1140. [CrossRef]
5. Moharana, P.C.; Gaur, M.C.; Choudhary, C.; Chauhan, J.S.; Rajpurohit, R.S. A system of geomorphological mapping for western Rajasthan with relevance for agricultural land use. Ann. Arid Zone 2013, 52, 163–180.



Picture. (**A**): Barchan and longitudinal sand dunes (image A) with wind-generated structural microforms, Sam (western Rajasthan); (**B**): Aeolian sand drifting of an active linear sand dune field at Kanoi (SW Thar Desert); (**C**): Parabolic dunes (30–50 m high) at Shetrawa (image B) fixed by tree plantation; (**D**): Parabolic sand dunes at Dechu stabilized by **Prosopis juliflora OR *Acacia torties;*** (**E**): A wind-eroded Jurassic sandstone bedrock platform (hamada) with the surrounding rocky desert near Mokal (40 km west of Jaisalmer); (**F**): Alluvial *wadi* plain draining seasonal rainwater with wind-sorted (deflated) sandy-gravelly beds at Bhojka partly transformed into arid fields of a marginal/risky rural agriculture (ACZ I) **[2]**.

6.3.3. Degraded and wasteland status of Rajasthan:

Figure 13: Extent and distribution of degraded and wasteland in Rajasthan



***Source**: Journal of Agriculture and Environment for International Development, 2019.*

Degraded soils are affected by erosion. Soil erosion is the process involving detachment and transport of soil particles by rain drop impact and wind. Detachment is the process of removal of finer particles from aggregates by the kinetic energy of rain drops. In India, the term, 'wasteland' is loosely used to define degraded lands.

The soil degradation occurs due to the interactive effects of anthropogenic and biophysical factors on soil properties and leads to adverse alteration in soil properties, environmental quality, agricultural productivity and sustainability (Lal, 1994). United Nations Environment Programme (UNEP 1992) defined land degradation is the reduction or loss, in arid, semi-arid and dry sub- humid areas of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: ***(i) soil erosion caused by wind and/or water; (ii) deterioration of the physical, chemical and biological or economic properties of soil; and, (iii) long-term loss of natural vegetation.*** Land degradation, therefore, includes processes which lead to surface salt accumulation and water logging associated with salt-affected areas.

6.3.4. Potential Biomass Generation from Prosopis Juliflora:

As per the Biomass Policy issued by Government of Rajasthan in February 2010, the eligible biomass power producers shall identify suitable land for development of Prosopis- Juliflora within reserved area of power plant registered with RREC after approval of the project. Categories of land which are available for the development of Prosopis-Juliflora are as following:

i. Degraded forest land which suitable for the development of Prosopis-Juliflora/ otherenergy plantation.
ii. Govt. wasteland/ barren land/saline land
iii. Panchayat wasteland/ barren land/ saline land.
iv. Private Khatidari land, which is barren and unutilized. The state is having large area of private Khatidari land, which is alkaline, saline in nature and can be developed with energy plantation.

Maximum 500 Hectare/MW land in all categories shall be permissible for development of Prosopis-Juliflora / other energy plantation. The various advantages of Juliflora as being highlighted below:

i. Over time, Prosopis Juliflora exhibits the ability to improve soils via biological nitrogen fixation, leaf litter addition and incorporation, nutrient pumping, changes in soil structure and in soil fauna and microbial populations.
ii. Wood of Prosopis Juliflora is a very important source of domestic fuel for millions of people in many arid and semiarid zones of the world.
iii. Prosopis Juliflora wood burns evenly and hot. The good heat of combustion ofProsopis Juliflora wood is due to its high carbon content and high levels of lignin.
iv. Low water requirement.
v. Ability to grow on all types on soil- loamy, alkaline, saline, brackish water and sandy.

In order to calculate the yield of Juliflora from the plantation, area required for plantation of onetree of Juliflora is 2m* 2m considering maximum tree density and area required for movement of personnel around tree required for cutting branches, stems etc. The steams and branches can be harvested from the tree after period of 3 years.

Dominant tree species in Trees Outside Forests (TOF), P. Juliflora in numbers in Trees Outside Forests in Rajasthan in Rural and Urban areas are given in the below table 28 respectively.

Table 30: TOF (Rural & Urban) in Rajasthan

Sl. No.	Species	Relative Abundance (%)
1.	Prosopis juliflora (Rural)	7.57
2.	Prosopis juliflora (Urban)	6.78
Source: Forest Survey of India (2019), Rajasthan.		

6.3.5. Energy Plantation:

Cultivation of fast growing trees such as casurina, eucalyptus, bush crops such as Prosopis Juliflora, grass variety such as bamboo can serve as biomass fuel for exciting and new biomass power plants.

The district wise waste land available for energy plantation as per the wasteland atlas of India, Department of land Resources, Ministry of Rural Development is shown in the below table **[6]**.

6. *Department of Land Resource, (WASTELANDS ATLAS OF INDIA 2019)* https://dolr.gov.in/en/documents/wasteland-atlas-of-india

Table 31: District-wise Waste Land Available for Energy Plantation

Sl.No.	District	Under Utilised /Degraded Forest(Scrub Domin) (Sq.Km.)	Land affected by Salinity/alkalinity (Medium) (Sq.Km.)	Land affected by Salinity/ alkalinity (Strong) (Sq.Km.)	Barren rocky/stoney waste (Sq. Km.)	Total land available for energy plantation (Sq.Km.)
1	Ajmer	213.91	12.63	16.14	167.91	410.59
2	Jaipur	361.16	36.25	32.57	66.64	496.62
3	Dausa	56.22	0.31	0.06	14.74	71.33
4	Tonk	94.76	0	0	13.86	108.62
5	Sikar	272.81	9.37	1.25	26	309.43
6	Jhunjhunu	128.5	0	0	26.5	155
7	Nagaur	111.67	28.27	91.07	58.82	289.83
8	Alwar	181.09	1.09	1	223.68	406.86
9	Bharatpur	43.2	1.41	1.66	89.78	136.05
10	Dholpur	301.07	0	0	21.67	322.74
11	Sawai Madhopur	343	0	0.13	9.18	352.31
12	Karauli	1175.75	0	0	45.37	1221.12
13	Bikaner	67.55	0	0	20.18	87.73
14	Churu	17.98	17.06	1.85	3.32	40.21
15	Jaisalmer	107.76	41.65	88.77	1219.48	1457.66
16	Ganganagar	0	0	0	0	0
17	Hanumangarh	23.21	0	0	0	23.21
18	Jodhpur	59.3	52.63	10.84	495.06	617.83
19	Barmer	90.19	110.37	62.58	391.18	654.32
20	Jalore	120.13	40.32	35.76	173.35	369.56
21	Pali	150.27	84.84	7.74	262.73	505.58
22	Sirohi	471.01	9.16	0	104.25	584.42
23	Kota	524.26	0	0	5.25	529.51
24	Baran	1060.54	0	0	29.01	1089.55
25	Bundi	687.34	0	0	56.83	744.17
26	Jhalwar	515.46	0	0	9.92	525.38
27	Banswara	611.63	0	0	90.29	701.92
28	Dungarpur	564.4	0	0	46.22	610.62
29	Udaipur	1235.46	0	0	220.52	1455.98
30	Pratapgarh	0	0	0	0	0
31	Bhilwara	342.6	0	0	206.33	548.93
32	Chittorgarh	837.97	2.6	0	89.1	929.67
33	Rajsamand	22.25	0	0	357.25	379.5
	TOTAL	**10792.45**	**447.96**	**351.42**	**4544.42**	**16136.25**

Source: Department of Land Resource, (WASTELANDS ATLAS OF INDIA 2019)
https://dolr.gov.in/en/documents/wasteland-atlas-of-india

As per the Biomass Policy issued by Government of Rajasthan in February 2010, the eligible biomass power producers shall identify suitable land for development of Prosopis- Juliflora within reserved area of power plant registered with RREC after approval of the project.

Salient Features:

- ✓ Decrease of wastelands area by 4803.56 sq. km.
- ✓ Maximum decrease in land with dense scrub area by 3839.45 sq. km.
- ✓ Increase in land with open scrub area by 1576.97 sq. km. during this period.
- ✓ An area of 2146.11 sq. km.has been converted into cropland with maximum contribution from sand semi stabilized, land with dense and open scrub.
- ✓ Bikaner district has a decrease in wasteland area by 1034.97 sq. km.; followed by Jodhpur district by 482.67 sq. km.

When Prosopis Juliflora grows in organized plantation with care and attention, the average yield of Prosopis Juliflora through energy plantation has been estimated to be approximately **28 tons per ha per year or 113 T/ha/ 4 years cycle**. If the wastelands are utilized for energy plantation, then the estimated firewood generation is around **4,72,85,840** tons per year.

Table 32:Estimated Potential Biomass from Waste Land through Energy Plantation in Rajasthan

Sl. No.	Districts	Total land Available for Plantation (In Ha)	Average Yield Tons/ha/ year	Estimated Biomass Generation Tons/year
1	Ajmer	42,520	28	11,90,560
2	Jaipur	52,529	28	14,70,812
3	Dausa	10,299	28	2,88,372
4	Tonk	12,541	28	3,51,148
5	Sikar	43,842	28	12,27,576
6	Jhunjhunu	20,268	28	5,67,504
7	Nagaur	33,996	28	9,51,888
8	Alwar	38,500	28	10,78,000
9	Bharatpur	25,340	28	7,09,520
10	Dholpur	31,848	28	8,91,744
11	Sawai Madhopur	41,814	28	11,70,792
12	Karauli	1,17,651	28	32,94,228

13	Bikaner	9,050	28	2,53,400
14	Churu	2,004	28	56,112
15	Jaisalmer	1,42,603	28	39,92,884
16	Ganganagar	0	28	0
17	Hanumangarh	2,312	28	64,736
18	Jodhpur	61,288	28	17,16,064
19	Barmer	55,680	28	15,59,040
20	Jalore	38,293	28	10,72,204
21	Pali	57,235	28	16,02,580
22	Sirohi	51,676	28	14,46,928
23	Kota	53,275	28	14,91,700
24	Baran	1,23,295	28	34,52,260
25	Bundi	85,929	28	24,06,012
26	Jhalwar	61,826	28	17,31,128
27	Banswara	73,202	28	20,49,656
28	Dungarpur	37,768	28	10,57,504
29	Udaipur	1,62,550	28	45,51,400
30	Pratapgarh	0	28	0
31	Bhilwara	56,964	28	15,94,992
32	Chittaurgarh	99,351	28	27,81,828
33	Rajsamand	43,326	28	12,13,128
	Total	**16,88,775**		**4,72,85,700**

(S.K.Saxena) Source: Ecology of Prosopis juliflora in the arid regions of India - S.K. Saxena. Central Arid Zone Research Institute, Jodhpur.

7. Chapter 4: MAJOR BIOMASS IN THE STUDY AREA

7.1. Selection of Suitable Biomass for Plant:

The major biomass available in the state of Rajasthan are Mustard Husk, Ground Nut Stalks, Cotton Stalks and Castor Stem from Agricultural land and Prosopois Juliflora wood from Waste Land. The table below shows the surplus amount of biomass available.

Table 33:Surplus Biomass from Various Sources

Sl.No.	Biomass	Surplus Tons/year
Agro-field Biomass		
1	**Mustard Stalks & Husk**	**17,87,835.2**
2	**Ground Nut Stalks**	**9,25,451.71**
3	**Cotton Stalks**	**5,86,220.47**
4	**Castor Stem**	**2,39,244.33**
Waste Land Biomass		
5	**Prosopis Juliflora Wood**	**35,33,058**

7.1.1. Mustard Stalks and Husk

Mustard is an important crop in this study area. The average cultivated area is **25,66,968.7** (in Ha). The district-wise average cultivated area is mentioned in the below table.

Table 34: District-wise Mustard Cultivated Area in Rajasthan

Sl.No.	Districts	Cultivated Area - Average (Year FY2017-18, FY 2018-19, and FY 2019-20) (In Ha)	%
1	Ajmer	30,038.3	1.2%
2	Jaipur	82,951.0	3.2%
3	Dausa	51,146.7	2.0%
4	Tonk	2,46,405.0	9.6%
5	Sikar	39,445.0	1.5%
6	Jhunjhunu	67,146.7	2.6%
7	Nagaur	60,869.7	2.4%
8	Alwar	2,48,301.0	9.7%
9	Bharatpur	2,21,183.0	8.6%
10	Dholpur	67,225.3	2.6%
11	S.Madhopur	1,36,127.3	5.3%
12	Karoli	81,452.0	3.2%
13	Bikaner	1,37,472.0	5.4%
14	Churu	88,443.7	3.4%
15	Jaisalmer	44,742.7	1.7%
16	Ganganagar	2,26,122.3	8.8%
17	Hanumangarh	1,19,507.7	4.7%
18	Jodhpur	1,65,484.3	6.4%
19	Barmer	13,519.7	0.5%
20	Jalore	78,008.3	3.0%
21	Pali	46,335.3	1.8%
22	Sirohi	11,173.0	0.4%
23	Kota	41,070.3	1.6%
24	Baran	81,634.3	3.2%
25	Bundi	40,421.0	1.6%
26	Jhalwar	47,845.3	1.9%
27	Banswara	17.3	0.1%
28	Dungarpur	292.0	0.0%
29	Udaipur	6,510.3	0.3%
30	Pratapgarh	12,205.7	0.5%
31	Bhilwara	29,617.0	1.2%
32	Chittore	43,175.3	1.7%
33	Rajsamand	1,080.0	0.1%
	Total	**25,66,968.7**	**100.0 %**

Source: Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20.

Table 35:District-wise Mustard Stalks & Husk Generation, Consumption and Surplus in Rajasthan

Sl. No.	Districts	Average Mustard Generation (FY 2017-18 to FY 2019-20) MT / Year	Average Mustard Consumption (FY 2017-18 to FY 2019-20) MT / Year	Average Mustard Surplus (FY 2017-18 to FY 2019-20) MT / Year
1	Ajmer	95,634.3	68,316.1	27,318.2
2	Jaipur	2,36,215.9	2,94,117.5	(57,901.6)
3	Dausa	1,71,174.2	1,19,822.7	51,351.5
4	Tonk	7,35,971.9	5,88,778.2	1,47,193.7
5	Sikar	93,973.3	79,877.5	14,095.8
6	Jhunjhunu	1,99,415.7	1,39,591.0	59,824.7
7	Nagaur	1,36,758.8	1,36,758.8	-
8	Alwar	8,97,642.6	15,92,824.9	(6,95,182.4)
9	Bharatpur	7,64,106.3	5,323.0	7,58,783.3
10	Dholpur	2,56,378.2	72,925.1	1,83,453.2
11	S.Madhopur	4,51,353.8	52,929.3	3,98,424.5
12	Karoli	2,78,375.3	41,756.6	2,36,618.8
13	Bikaner	3,24,708.6	3,78,531.5	(53,822.9)
14	Churu	1,70,035.9	22,761.1	1,47,274.7
15	Jaisalmer	79,938.9	59,953.3	19,985.5
16	Ganganagar	7,12,923.0	7,84,217.0	(71,294.0)
17	Hanumangarh	3,46,787.3	3,46,787.3	-
18	Jodhpur	4,08,047.8	61,206.9	3,46,840.9
19	Barmer	24,966.0	3,745.4	21,220.6
20	Jalore	1,86,414.2	1,86,414.2	-

21	Pali	1,02,454.2	25,613.9	76,840.4
22	Sirohi	22,858.7	5,715.2	17,143.5
23	Kota	1,34,352.0	1,34,352.1	-
24	Baran	2,98,434.4	4,02,887.7	(1,04,453.3)
25	Bundi	1,15,192.2	74,877.0	40,315.3
26	Jhalwar	1,07,974.1	16,196.1	91,778.0
27	Banswara	51.1	51.1	-
28	Dungarpur	867.4	345.7	521.7
29	Udaipur	10,056.1	4,525.0	5,531.2
30	Pratapgarh	36,374.3	9,091.7	27,282.6
31	Bhilwara	75,628.0	34,032.7	41,595.3
32	Chittaurgarh	1,24,811.9	68,647.3	56,164.6
33	Rajsamand	2,070.4	1,138.9	931.5
	Total	**76,01,947.0**	**58,14,111.8**	**17,87,835.2**

Source: Biomass Generation was extracted from Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20. Biomass consumption arrived from primary data (the primary data collected at field level by discussion with farmers, local people, biomass suppliers and traders, other biomass consuming industries and personal observation by the field enumerators). Surplus biomass calculated from biomass generation and consumption.

Mustard stalks & husk are available in abundance in this study area, the estimated generation is based on the primary data and secondary data is around 76,01,947.0 MT/year in Rajasthan. Mustard Stalks & Husk are harvested during month of Feb-May.

7.1.2. Ground Nut Stalks

The average cultivated area of Ground Nut is **6,73,877.3** (in Ha). The district-wise average cultivated area is mentioned in the below table.

Table 36: District-wise Ground Nut Cultivated Area in Rajasthan

Sl.No.	Districts	Cultivated Area - Average (Year FY2017-18, FY 2018-19, and FY 2019-20) (In Ha)	%
1	Ajmer	1307.33	0.2%
2	Jaipur	33548.00	5.0%
3	Dausa	10196.67	1.5%
4	Tonk	15058.67	2.2%
5	Sikar	16992.67	2.5%
6	Jhunjhunu	6319.00	0.9%
7	Nagaur	17685.33	2.6%
8	Alwar	284.00	0.0%
9	Bharatpur	3.33	0.0%
10	Dholpur	37.33	0.0%
11	S.Madhopur	2364.33	0.4%
12	Karoli	291.67	0.0%
13	Bikaner	234824.00	34.8%
14	Churu	69686.00	10.3%
15	Jaisalmer	33785.00	5.0%
16	Ganganagar	6440.00	1.0%
17	Hanumangarh	16635.00	2.5%
18	Jodhpur	130928.67	19.4%
19	Barmer	3982.33	0.6%
20	Jalore	18193.00	2.7%
21	Pali	834.67	0.1%
22	Sirohi	14135.33	2.1%
23	Kota	263.67	0.0%
24	Baran	665.33	0.1%
25	Bundi	362.00	0.1%
26	Jhalwar	1202.00	0.2%
27	Banswara	262.33	0.0%
28	Dungarpur	27.67	0.0%
29	Udaipur	1380.67	0.2%
30	Pratapgarh	1247.33	0.2%
31	Bhilwara	10629.67	1.6%
32	Chittore	23134.33	3.4%
33	Rajsamand	1170.00	0.2%
	Total	**673877.33**	**100%**

Source: Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20.

Table 37:District-wise Ground Nut Stalks Generation, Consumption and Surplus in Rajasthan

Sl. No.	Districts	Average Ground Nut Generation (FY 2017-18 to FY 2019-20) MT / Year	Average Ground Nut Consumption (FY 2017-18 to FY 2019-20) MT / Year	Average Ground Nut Surplus (FY 2017-18 to FY 2019-20) MT / Year
1	Ajmer	3,379.0	2,196.0	1,183.0
2	Jaipur	1,35,805.5	88,272.9	47,532.6
3	Dausa	35,711.7	23,212.8	12,498.9
4	Tonk	38,427.8	26,899.7	11,528.1
5	Sikar	78,921.3	51,299.1	27,622.2
6	Jhunjhunu	81,422.9	73,284.0	8,138.9
7	Nagaur	68,680.8	68,333.3	347.5
8	Alwar	1,074.2	913.3	160.9
9	Bharatpur	9.8	9.1	0.7
10	Dholpur	155.3	47.4	107.9
11	S.Madhopur	6,121.0	1,869.5	4,251.5
12	Karoli	1,205.2	543.2	662.0
13	Bikaner	10,49,451.3	9,14,433.4	1,35,017.9
14	Churu	3,25,983.7	2,94,284.1	31,699.6
15	Jaisalmer	1,16,622.9	1,02,672.6	13,950.4
16	Ganganagar	26,708.8	8,157.4	18,551.4
17	Hanumangarh	69,559.3	21,244.8	48,314.4
18	Jodhpur	5,72,800.2	1,74,944.9	3,97,855.3
19	Barmer	12,954.3	3,956.5	8,997.8
20	Jalore	69,084.4	21,099.8	47,984.6

21	Pali	2,621.6	800.7	1,820.9
22	Sirohi	39,806.8	12,157.8	27,649.0
23	Kota	1,070.8	327.0	743.7
24	Baran	2,711.7	828.2	1,883.5
25	Bundi	1,500.0	458.1	1,041.8
26	Jhalwar	4,943.2	1,509.8	3,433.4
27	Banswara	1,087.3	332.1	755.2
28	Dungarpur	114.7	35.0	79.6
29	Udaipur	2,156.1	658.5	1,497.6
30	Pratapgarh	3,685.4	1,125.6	2,559.8
31	Bhilwara	24,591.8	7,510.8	17,081.0
32	Chittaurgarh	67,858.0	20,725.2	47,132.8
33	Rajsamand	4,848.6	1,480.8	3,367.7
	Total	**28,51,075.3**	**19,25,623.5**	**9,25,451.7**

Source: Biomass Generation was extracted from Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20. Biomass consumption arrived from primary data (the primary data collected at field level by discussion with farmers, local people, biomass suppliers and traders, other biomass consuming industries and personal observation by the field enumerators). Surplus biomass calculated from biomass generation and consumption.

Ground Nut stalks are available in this study area, the estimated generation is based on the primary data and secondary data is around 28,51,075.3 MT/year in Rajasthan. Ground Nut Stalks are harvested during month of Oct-Nov.

7.1.3. Cotton Stalks

The average cultivated area of Cotton is **6,52,987.0** (in Ha). The district-wise average cultivated area is mentioned in the below table.

Table 38: District-wise Cotton Cultivated Area in Rajasthan

Sl.No.	Districts	Cultivated Area - Average (Year FY 2017-18, FY 2018-19, and FY 2019-20) (In Ha)	%
1	Ajmer	10963.67	1.7%
2	Jaipur	447.00	0.1%
3	Dausa	4.00	0.0%
4	Tonk	749.33	0.1%
5	Sikar	43.33	0.0%
6	Jhunjhunu	8140.00	1.2%
7	Nagaur	54535.67	8.4%
8	Alwar	60619.67	9.3%
9	Bharatpur	7372.33	1.1%
10	Dholpur	49.67	0.0%
11	S.Madhopur	1.00	0.0%
12	Karoli	1.67	0.0%
13	Bikaner	8675.00	1.3%
14	Churu	3288.00	0.5%
15	Jaisalmer	263.33	0.0%
16	Ganganagar	155594.33	23.8%
17	Hanumangarh	194435.67	29.8%
18	Jodhpur	53461.33	8.2%
19	Barmer	0.00	0.0%
20	Jalore	939.33	0.1%
21	Pali	16133.33	2.5%
22	Sirohi	3295.67	0.5%
23	Kota	4.33	0.0%
24	Baran	3.00	0.0%
25	Bundi	204.67	0.0%
26	Jhalwar	1.67	0.0%
27	Banswara	10556.67	1.6%
28	Dungarpur	553.33	0.1%
29	Udaipur	1429.00	0.2%
30	Pratapgarh	897.33	0.1%
31	Bhilwara	42753.00	6.5%
32	Chittore	13088.00	2.0%
33	Rajsamand	4482.67	0.7%
	Total	**652987.00**	**100%**

Source: Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20.

Table 39:District-wise Cotton Stalks Generation, Consumption and Surplus in Rajasthan

Sl. No.	Districts	Average Cotton Generation (FY 2017-18 to FY 2019-20) MT / Year	Average Cotton Consumption (FY 2017-18 to FY 2019-20) MT / Year	Average Cotton Surplus (FY 2017-18 to FY 2019-20) MT / Year
1	Ajmer	30,472.4	15,822.8	14,649.6
2	Jaipur	995.7	995.7	-
3	Dausa	8.4	3.1	5.2
4	Tonk	1,873.7	562.6	1,311.1
5	Sikar	97.8	97.8	-
6	Jhunjhunu	15,357.6	4,611.1	10,746.4
7	Nagaur	92,773.2	51,025.4	41,747.8
8	Alwar	1,00,490.6	75,368.9	25,121.7
9	Bharatpur	12,507.9	12,485.6	22.2
10	Dholpur	107.0	38.4	68.6
11	S.Madhopur	2.2	0.8	1.4
12	Karoli	3.4	1.2	2.2
13	Bikaner	10,824.8	4,920.0	5,904.7
14	Churu	5,646.9	2,026.5	3,620.4
15	Jaisalmer	589.6	211.6	378.0
16	Ganganagar	4,05,939.0	2,63,863.7	1,42,075.3
17	Hanumangarh	4,58,712.9	3,44,034.7	1,14,678.2
18	Jodhpur	1,00,398.7	15,058.6	85,340.1
19	Barmer	-	-	-
20	Jalore	2,082.5	1,541.1	541.5

21	Pali	36,399.7	9,099.9	27,299.8
22	Sirohi	3,834.3	2,106.8	1,727.5
23	Kota	9.0	3.2	5.8
24	Baran	6.2	2.2	4.0
25	Bundi	434.2	434.2	-
26	Jhalwar	3.4	1.2	2.2
27	Banswara	21,180.9	3,192.5	17,988.4
28	Dungarpur	862.4	129.4	733.1
29	Udaipur	2,815.3	985.4	1,830.0
30	Pratapgarh	1,442.9	369.4	1,073.5
31	Bhilwara	92,131.7	23,025.9	69,105.8
32	Chittaurgarh	26,451.2	11,912.1	14,539.1
33	Rajsamand	8,762.6	3,066.0	5,696.6
	Total	**14,33,218.3**	**8,46,997.9**	**5,86,220.5**

Source: Biomass Generation was extracted from Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20. Biomass consumption arrived from primary data (the primary data collected at field level by discussion with farmers, local people, biomass suppliers and traders, other biomass consuming industries and personal observation by the field enumerators). Surplus biomass calculated from biomass generation and consumption.

Cotton Stalks are available in this study area, the estimated generation is based on the primary data and secondary data is around 14,33,218.3 MT/year in Rajasthan. Cotton Stalks are harvested during month of Oct-Dec.

7.1.4. Castor Stem

The average cultivated area of Castor is **1,55,878.33** (in Ha). The district-wise average cultivated area is mentioned in the below table.

Table 40: District-wise Castor Cultivated Area in Rajasthan

Sl.No.	Districts	Cultivated Area - Average (Year FY 2017-18, FY 2018-19, and FY 2019-20) (In Ha)	%
1	Ajmer	277.67	0.2%
2	Jaipur	0.33	0.0%
3	Dausa	0.33	0.0%
4	Tonk	105.33	0.1%
5	Sikar	0.33	0.0%
6	Jhunjhunu	63.00	0.0%
7	Nagaur	44.33	0.0%
8	Alwar	4.33	0.0%
9	Bharatpur	11.00	0.0%
10	Dholpur	6.67	0.0%
11	S.Madhopur	0.00	0.0%
12	Karoli	0.00	0.0%
13	Bikaner	284.33	0.2%
14	Churu	13.67	0.0%
15	Jaisalmer	4537.33	2.9%
16	Ganganagar	347.67	0.2%
17	Hanumangarh	3473.67	2.2%
18	Jodhpur	22063.00	14.2%
19	Barmer	27872.00	17.9%
20	Jalore	50524.67	32.4%
21	Pali	5502.00	3.5%
22	Sirohi	40544.00	26.0%
23	Kota	0.00	0.0%
24	Baran	0.00	0.0%
25	Bundi	2.00	0.0%
26	Jhalwar	0.67	0.0%
27	Banswara	9.67	0.0%
28	Dungarpur	90.67	0.1%
29	Udaipur	48.67	0.0%
30	Pratapgarh	2.33	0.0%
31	Bhilwara	44.00	0.0%
32	Chittore	2.33	0.0%
33	Rajsamand	2.33	0.0%
	Total	**155878.33**	**100%**

Source: Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20.

Table 41:District-wise Castor Stem Generation, Consumption and Surplus in Rajasthan

Sl. No.	Districts	Average Castor Generation (FY 2017-18 to FY 2019-20) MT / Year	Average Castor Consumption (FY 2017-18 to FY 2019-20) MT / Year	Average Castor Surplus (FY 2017-18 to FY 2019-20) MT / Year
1	Ajmer	239.7	239.7	-
2	Jaipur	-	-	-
3	Dausa	0.4	0.1	0.4
4	Tonk	42.9	42.9	-
5	Sikar	0.9	0.2	0.7
6	Jhunjhunu	50.7	50.7	-
7	Nagaur	46.8	46.8	-
8	Alwar	1.7	1.7	-
9	Bharatpur	14.3	2.6	11.7
10	Dholpur	8.7	1.6	7.1
11	S.Madhopur	-	-	-
12	Karoli	-	-	-
13	Bikaner	350.7	63.8	286.9
14	Churu	19.1	3.5	15.6
15	Jaisalmer	11,719.1	2,130.8	9,588.4
16	Ganganagar	954.6	173.6	781.0
17	Hanumangarh	8,751.3	1,591.1	7,160.2
18	Jodhpur	15,328.5	2,787.0	12,541.5
19	Barmer	50,366.4	9,157.5	41,208.9
20	Jalore	1,29,609.6	23,565.4	1,06,044.3

21	Pali	6,512.1	1,184.0	5,328.0
22	Sirohi	68,548.8	12,463.4	56,085.4
23	Kota	-	-	-
24	Baran	-	-	-
25	Bundi	3.5	0.6	2.8
26	Jhalwar	-	-	-
27	Banswara	5.2	0.9	4.3
28	Dungarpur	111.8	20.3	91.5
29	Udaipur	58.9	10.7	48.2
30	Pratapgarh	2.2	0.4	1.8
31	Bhilwara	37.7	6.9	30.8
32	Chittaurgarh	3.0	0.6	2.5
33	Rajsamand	3.0	0.6	2.5
	Total	**2,92,791.5**	**53,547.2**	**2,39,244.3**

Source: Biomass Generation was extracted from Agricultural Department, Government of Rajasthan, for the period FY 2017-18, FY 2018-19 & FY 2019-20. Biomass consumption arrived from primary data (the primary data collected at field level by discussion with farmers, local people, biomass suppliers and traders, other biomass consuming industries and personal observation by the field enumerators). Surplus biomass calculated from biomass generation and consumption.

Castor Stem are available in this study area, the estimated generation is based on the primary data and secondary data is around 2,92,791.5 MT/year in Rajasthan. Castor Stem are harvested during month of Jan-Feb.

7.2.1. Prosopis Juliflora:

Table 42: District-wise Prosopis Juliflora Generation Consumption and Surplus in Rajasthan

Sl. No.	Districts	Prosopis Juliflora Wood Generation Tons/Year	Prosopis Juliflora Wood Consumption Tons/Year	Prosopis Juliflora Wood Surplus Tons/Year
1	Ajmer	492350	435963	56387
2	Jaipur	492386	431190	61197
3	Dausa	79125	67505	11620
4	Tonk	356215	324511	31704
5	Sikar	264422	214461	49960
6	Jhunjhunu	197497	171948	25549
7	Nagaur	497078	407719	89359
8	Alwar	151920	110995	40924
9	Bharatpur	58859	46872	11987
10	Dholpur	82719	36727	45992
11	S.Madhopur	116272	73709	42563
12	Karoli	106167	75808	30359
13	Bikaner	3963322	3678218	285103
14	Churu	283379	220528	62850
15	Jaisalmer	12205459	11332561	872898
16	Ganganagar	465931	377662	88269
17	Hanumangarh	129028	118495	10533
18	Jodhpur	1489231	1284806	204425
19	Barmer	2394158	2079826	314332
20	Jalore	556082	502551	53531
21	Pali	786972	712243	74729
22	Sirohi	194696	175451	19245
23	Kota	183824	107854	75971

24	Baran	133323	103092	30231
25	Bundi	263551	237853	25699
26	Jhalwar	251449	202472	48977
27	Banswara	288627	266020	22607
28	Dungarpur	261213	235738	25475
29	Udaipur	942641	919133	23508
30	Pratapgarh	227120	211348	15772
31	Bhilwara	889894	805820	84074
32	Chittaurgarh	573241	518360	54882
33	Rajsamand	762473	690125	72347
	Total	**3,01,40,622**	**2,71,77,565**	**29,63,058**

Source: The primary data collected at field level by discussion with farmers, local people, biomass and food grain traders, other biomass consuming industries and personal observation by the field enumerator.

Local people for domestic fuel, local bakery and hotels industries, biomass power plant and other local thermal energy consuming industries consume the 87.6 % of the Juliflora wood generation in this study area. The remaining 12.4 % is considered as surplus quantity. Firewood dealers play major role in handling the biomass, on collection from source, they distribute for local consumption against the requirements by the industries and the rest to the other industries in neighbouring district as per the market demand.

Surplus Biomass from Wasteland = ***29,63,058 tons/year.***

8. Chapter 5: BIOMASS PRICE, TRENDS & FORECAST

Biomass power plants are located in various districts of Rajasthan namely Ganganagar, Hanumangarh, Kota, Baran, Tonk, Jaipur, Nagaur, Sirohi, and Jalore districts. The major biomasses consumed by the power plants are Mustard Stalks & Husk, Gaur Stalks, Prosopis Juliflora Wood and Cotton Stalks.

The variations in the procurement cost of major biomass with respect to the power plant consumption pattern for the past three years are discussed in the price trend analysis. Also, the trend analysis includes a prediction on the future escalation of biomass price.

The details of the price trend of each biomass are discussed in the following order

a. Mustard Stalks and Husk Price Trend
b. Prosopis Juliflora Wood Price Trend

8.1. Biomass Price, Trends & Forecast:

The mustard stalks & husk stands first in the discussion of price analysis because of its higher generation and consumption pattern in Rajasthan.

All the running biomass power plants in the Rajasthan state are using the mustard stalks & husk as a major fuel for biomass power plant.

The procurement of mustard stalks & husk starts within the harvesting period and ends with respect to the storage capacity & fund availability of the consuming industries. The table below shows the district wise Mustard Average Cultivated area and Mustard stalks & husk generation and surplus.

The table 36 shows the district wise price trend of mustard stalks & husk for the period of three years (FY 2017-18, FY 2018 –19 & FY 2019 -20).

Table 43: District Wise Biomass Fuel Price (in Rs.) for Last Three Years (2017-18, 2018-19 and 2019-20) – Mustard Stalks & Husk

Sl. No.	Districts	FY 2017-18	FY 2018-19	*FY 2019-20*	*FY 2020-21*	*FY 2021-22**
1	Ajmer	2600	2750	2850	3100	3200
2	Jaipur	3100	3200	3300	3400	3500
3	Dausa	2800	2850	2900	3000	3100
4	Tonk	2400	2450	2650	2800	3000
5	Sikar	2600	2700	2800	2900	3000
6	Jhunjhunu	2800	2900	3000	3100	3200
7	Nagaur	2700	2800	2900	3000	3100
8	Alwar	3200	3300	3400	3600	3600
9	Bharatpur	3100	3200	3350	3500	3600
10	Dholpur	3000	3100	3200	3300	3400
11	Sawai Madhopur	2900	3050	3150	3300	3400
12	Karoli	3100	3200	3300	3400	3500
13	Bikaner	2700	2800	2850	2900	3000
14	Churu	2900	2950	3000	3100	3200
15	Jaisalmer	2700	2800	2950	3100	3200
16	Ganganagar	2800	2800	2850	2900	3000
17	Hanumangarh	2800	2850	2900	3000	3100
18	Jodhpur	2900	2950	3000	3100	3200
19	Barmer	2800	2850	2900	3000	3300
20	Jalore	3000	3050	3100	3200	3400
21	Pali	2900	2950	3000	3100	3300
22	Sirohi	2900	2950	3000	3200	3300
23	Kota	2700	2900	3100	3300	3400
24	Baran	2700	2850	2950	3100	3200
25	Bundi	2700	2800	2900	3000	3100
26	Jhalwar	2600	2650	2700	2800	3000
27	Banswara	2600	2700	2800	2900	3000
28	Dungarpur	2600	2750	2850	3000	3100
29	Udaipur	2700	2750	2850	2900	3000
30	Pratapgarh	2400	2500	2750	2850	3000
31	Bhilwara	2500	2600	2750	2850	3000
32	Chittorgarh	2600	2700	2800	2900	3000
33	Rajsamand	2700	2800	2900	3000	3100
	Total	**2773**	**2862**	**2961**	**3079**	**3197**

** FY 2021-2022 price escalation is based on the assumptions that the average fuel price increase across district would be expected on an average 5 to 7% due to increase in Diesel and Petrol prices and WPI and CPI index.*

Source: The primary data collected at field level by discussion with Power Plants, farmers, local people, biomass suppliers & traders, other biomass consuming industries and personal observation by the field enumerator.

The average price in **FY 2017-2018 was Rs.2773**, price in **FY 2018- 2019 was Rs.2862** and price in **FY 2019 -2020 was Rs. 2961** respectively. However, based on the discussion with power producers, biomass traders and suppliers etc., it is to be noted that the biomass fuel price escalation for **FY 2021-22 is expected to be 3,197**, based on the assumptions that the average fuel price increase across district would be expected on an average **5 to 7%** due to increase in Diesel and Petrol prices and WPI and CPI index. Thus, it is clear from the data that the cost of biomass has got fluctuated.

8.2. Prosopis Juliflora wood Price Trend:

Firewood dealers play major role in handling the biomass, on collection from source, they distribute for local consumption against the requirements by the industries and the rest to the other industries within and outside the study area as per the market demand. The landed cost at site of Prosopis Juliflora wood include cutting cost, transportation cost, chipping cost, loading and unloading cost. The table shows the year wise breakup of cutting cost/ uprooting, transportation cost, chipping cost, loading and unloading cost.

Table 44: Cutting/Uprooting, Transportation, Loading &Unloading, Chipping Cost of Prosopis Juliflora Wood per Rs. Per Ton

Sl.No.	Activity	FY 2018-19		FY 2019-20		FY 2020-21	
		Min (In Rs/MT.)	Max (In Rs/MT.)	Min (In Rs/MT.)	Max (In Rs/MT	Min (In Rs/MT	Max (In Rs/MT.)
1	Cutting cost / uprooting	560	720	585	750	620	780
2	Transportation (with in 75 km distance)	800	900	900	1000	1000	1200
3	Loading and unloading cost	250	280	280	320	320	350
Sub Total		1610	1900	1765	2030	1940	2330
4	Chipping cost	355	370	370	400	420	450
5	Total	1965	2270	2135	2430	2360	2780
Average Cost (Rs/MT)		**2118**		**2283**		**2570**	

Source: The primary data collected at field level by discussion with Power Plants, farmers, local people, biomass suppliers & traders, other biomass consuming industries and personal observation by the field enumerator.

The average cutting cost / uprooting, transportation, and loading & unloading cost of Juliflora wood is almost 50 % of the landed cost biomass, and including chipping cost of Juliflora is 60 % Of the landed

cost of biomass. Thus, it is clear from the data that the cutting cost / uprooting, transportation, Loading and unloading cost and fuel chipping cost of biomass has got fluctuated in the increasing trend.

Table below shows the district wise landed cost of Prosopis Juliflora wood at site for the last three years.

Table 45:Price Trend in Rs. for Last Three Years (2017-18, 2018-19 and 2019-20) – Prosopis Juliflora

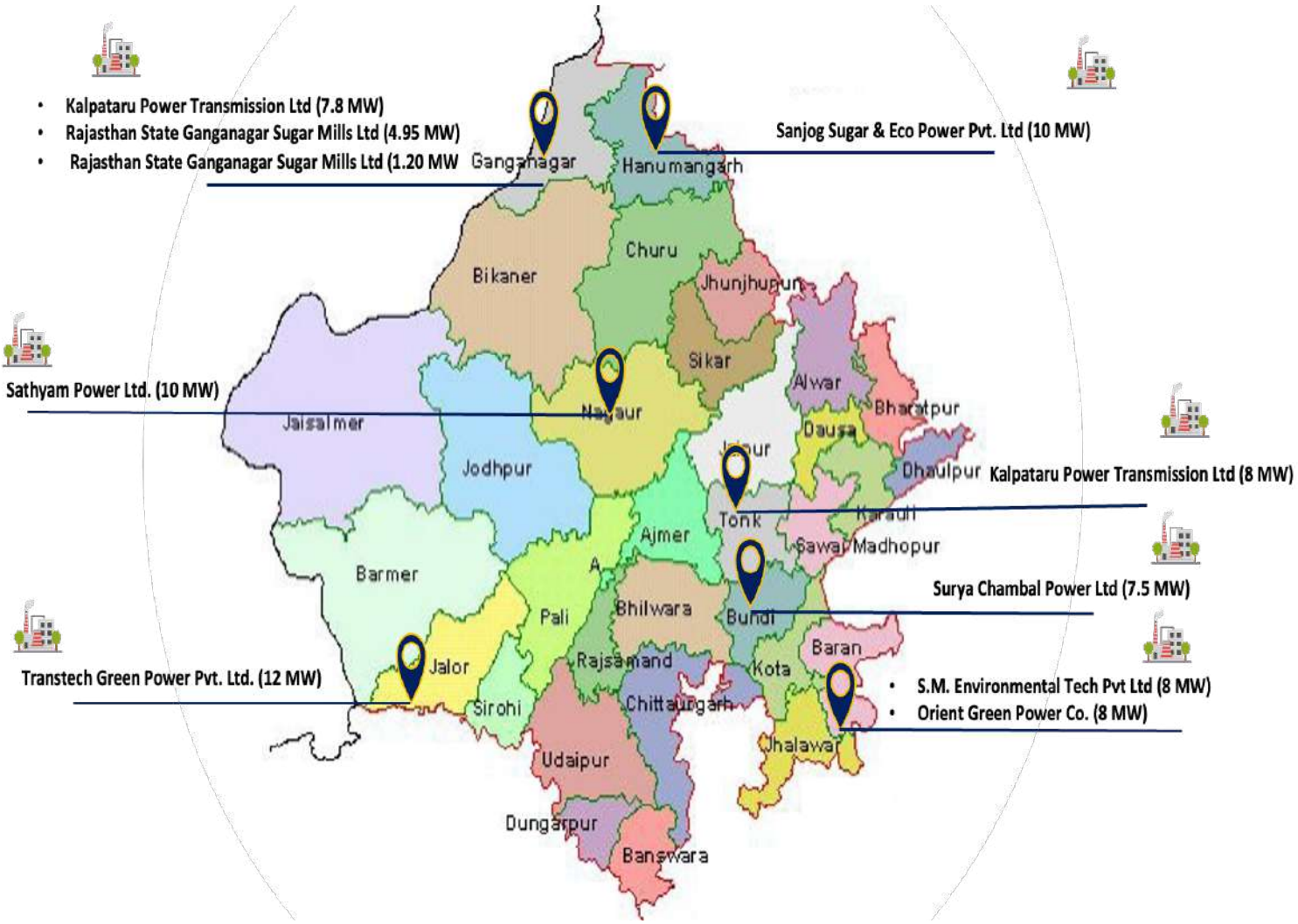
Sl. No.	Districts	FY 2017-18	FY 2018-19	*FY 2019-20*	*FY 2020-21*	*FY 2021-22**
1	Ajmer	3300	3300	3450	3500	3600
2	Jaipur	3100	3300	3400	3500	3700
3	Dausa	3100	3200	3400	3500	3600
4	Tonk	2600	3100	3300	3450	3600
5	Sikar	3200	3300	3400	3500	3600
6	Jhunjhunu	3000	3200	3300	3400	3600
7	Nagaur	3200	3300	3400	3500	3600
8	Alwar	3100	3200	3300	3450	3600
9	Bharatpur	3300	3400	3450	3600	3650
10	Dholpur	3000	3100	3350	3550	3600
11	Sawai Madhopur	3100	3200	3300	3550	3600
12	Karoli	3100	3200	3300	3550	3650
13	Bikaner	3000	3200	3350	3400	3600
14	Churu	3000	3100	3300	3400	3600
15	Jaisalmer	3100	3200	3300	3400	3650
16	Ganganagar	3200	3300	3400	3400	3600
17	Hanumangarh	2600	3100	3350	3500	3600
18	Jodhpur	3000	3200	3350	3450	3650
19	Barmer	3100	3300	3400	3500	3600
20	Jalore	3200	3400	3550	3650	3800
21	Pali	3100	3300	3500	3600	3750
22	Sirohi	3200	3300	3550	3600	3750
23	Kota	3100	3400	3500	3500	3600
24	Baran	3300	3300	3400	3500	3600
25	Bundi	3000	3100	3350	3450	3650
26	Jhalwar	3200	3200	3300	3400	3650

27	Banswara	3000	3100	3300	3400	3650
28	Dungarpur	3100	3200	3350	3400	3600
29	Udaipur	3100	3200	3300	3400	3600
30	Pratapgarh	3100	3200	3300	3400	3650
31	Bhilwara	2800	3200	3400	3500	3600
32	Chittorgarh	3100	3200	3300	3400	3700
33	Rajsamand	2900	3200	3300	3400	3600
	Total	**3070**	**3227**	**3370**	**3476**	**3633**
* FY 2021-2022 price escalation is based on the assumptions that the average fuel price increase across district would be expected on an average 5 to 7% due to increase in Diesel and Petrol prices and WPI and CPI index						
Source: The primary data collected at field level by discussion with Power Plants, farmers, local people, biomass suppliers & traders, other biomass consuming industries and personal observation by the field enumerator.						

9. Chapter 6: BIOMASS POWER PLANTS

The Rajasthan state consists of 33 districts and the average cultivated area of Rajasthan state for the past three years is coming around 51,11,033.30 Ha. The biomass power plants are managing The residues of Mustard, Guar, Cotton and Prosopis Juliflora are considered by the biomass power plants as the main fuel for power generation. Their fuel requirement by mixing the available crop residues like mustard stalks & husk, guar stalks, cotton stalks, other agro residues and wasteland biomass like Prosopis Juliflora wood. The generation of the mustard stalks & husk, guar stalks; cotton stalks are quite stable and predictable. There are totally eleven biomass power plants in Rajasthan.

Figure 14: District-wise Functional Power Plants



Two power plants *namely* ***Sambhav Energy Limited (20 MW) and Amrit Environmental Technologies (8 MW)*** are not in operation since 2012.

Birla Corporation Ltd have stopped using biomass since 2013 and they are currently using Coal to generate power.

Both units of ***Rajasthan State Ganganagar Sugar Mills Ltd*** **(1.2 MW & 4.95 MW*)*** are not considered for this study due to the unavailability of fuel procurement data.

There are a total of eight functional biomass Power Plants in Rajasthan namely,

1. ***Surya Chambal Power Ltd (7.5 MW), Kota;***
2. ***Transtech Green Power Pvt. Ltd (12 MW), Jalore;***
3. ***S.M. Environmental Technologies (P) Ltd (8 MW), Baran;***
4. ***Sanjog Sugar & Eco Power Pvt. Ltd (10 MW), Hanumangarh;***
5. ***Sathyam Power Limited (10 MW), Nagaur;***
6. ***Orient Green Power Co (8 MW), Baran.***
7. ***Kalpataru Power Transmission Ltd, (7.5 MW), Sri Ganganagar;***
8. ***Kalpataru Power Transmission Ltd, (8 MW), Tonk.***

All the below data are secondary data collected from the biomass power plants in the state of Rajasthan, which is verified during our site visit.

9.1. SURYA CHAMBAL POWER LIMITED

Technical Details of The Plant:

Surya Chambal Power Ltd has implemented a biomass power plant in Kota district with an installed capacity of 7.5 MW. The project was commissioned in 31/03/2006 and the technical specifications of the key equipment's in the power plant are as follows.

Table 46: Technical Specifications

Parameters	Details
Capacity of the plant	7.5 MW
Boiler Capacity	38 TPH
Make of Boiler	SISTON
Mainstream Pressure	67 kg/cm2
Mainstream Temperature	450 degree C
Make of The Turbine	TRIVENI ENGINEERING
Type of Cooling Tower	WATER COOLED
Source: Surya Chambal Power Ltd	

Biomass Produced and Cost Of Purchase:

Table 47 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2018-19.

Table 47:Year of Procurement FY 2018-19

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'18	25,304	7,70,50,680	3,045
May'18	8,655	2,88,21,150	3,330
Jun'18	1,063	36,29,082	3,414
July'18	85	3,26,315	3,839
Aug'18	40	99,080	2,477
Sept'18	56	1,30,088	2,323
Oct'18	1,074	30,84,528	2,872
Nov'18	285	7,49,265	2,629
Dec'18	690	21,23,820	3,078
Jan'19	1,926	58,08,816	3,016
Feb'19	1,907	60,07,050	3,150
Mar'19	27,704	10,99,84,880	3,970
Total	**68,789**	**23,78,14,754**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**3,457.16**
Source: Surya Chambal Power Ltd			

Table 48 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2019-20.

Table 48:Year of Procurement FY 2019-20

Month	Quantity of Biomass Procured (MT)	Total Cost of BiomassPurchased at Factory Gate (Rs.)	Purchase of Biomass atFactory Gate (Rs. /MT)
Apr'19	29,921	6,94,46,641	2,321
May'19	14,518	3,38,70,494	2,333
Jun'19	1,397	41,37,914	2,962
July'19	0	0	0
Aug'19	0	0	0

Sept'19	0	0	0
Oct'19	202	5,93,274	2,937
Nov'19	274	7,33,772	2,678
Dec'19	1,553	43,76,354	2,818
Jan'20	2,914	82,84,502	2,843
Feb'20	9,039	2,40,43,740	2,660
Mar'20	18,400	5,15,75,200	2,803
Total	**78,218**	**19,70,61,891**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,519.39**
Source: Surya Chambal Power Ltd			

Table 49 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2020-21.

Table 49:Year of Procurement FY 2020-21

Month	Quantity of BiomassProcured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'20	126	3,41,964	2,714
May'20	25,573	6,62,85,216	2,592
Jun'20	6,305	1,70,29,805	2,701
July'20	220	6,48,560	2,948
Aug'20	109	2,86,997	2,633
Sept'20	611	15,43,386	2,526
Oct'20	1,201	33,96,428	2,828
Nov'20	1,829	49,30,984	2,696
Dec'20	3,712	94,47,040	2,545
Total	**39,686**	**10,39,10,380**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,618.31**
Source: Surya Chambal Power Ltd			

Table 50 shows the Major Biomass consumed by Surya Chambal Power Plant for year FY 2018-19, FY 2019-20, FY 2020-21.

Table 50: Biomass Consumed, Average Price Escalation, Average Storage and Feeding Price and Biomass Storage & Handling Loss

1	Major Biomass Consumed by Biomass Power Plant.	Mustard
2	Average price of biomass acquired Rs. Per MT • FY 2018-19 • FY 2019-20 • FY 2020-21	• Rs. 3,457.16 • Rs. 2,519.39 • Rs. 2,618.31 **Total Average is Rs. 2,864.95**
3	Average Price Escalation of the Biomass cost from the year 2018 to 2021.	5% to 6 % every year.
4	Estimated Average prices for all major biomass in 2021-22 (Excluding Storage and Feeding Cost). Rs. Per ton	Rs. 2,864.95
5	Average Storage and Feeding Cost Rs. Per Ton	Rs. 407
6	Biomass Storage & Handling Loss.	Earlier it was 7-8 % but now due to better management and tarpaulin it come down to 3.5 %.
Source: Surya Chambal Power Ltd		

Table 51:Biomass Power Plant Fuel Mix for the FY 2020-21 (Tons/Year)

Power Plant Fuel Mix	Mustard Stalks & Husk	Cotton Stalks	Guar Stalks	Prosopis Juliflora Wood	Agro Waste	Total
FUEL	71,047 MT	NILL	NILL	NILL	NILL	71,047 MT
%	**100%**					**100%**
Source: Surya Chambal Power Ltd						

9.2. TRANSTECH GREEN POWER PVT LTD.

Technical Details of The Plant:

Transtech Green Power Pvt Ltd has implemented a biomass power plant in Jalore district with an installed capacity of 12 MW. The project was commissioned in 28/07/2010 and the technical specifications of the key equipment's in the power plant are as follows:

Table 52:Technical Specification

Parameters	Details
Capacity of the plant	12.0 MW
Boiler Capacity	60 TPH
Make of Boiler	Thermodyne
Mainstream Pressure	64 kg/cm2
Mainstream Temperature	485 degree C
Make of The Turbine	TRIVENI TURBINES LIMITED
Type of Cooling Keep	Air Cooled
Source: Transtech Green Power Pvt Ltd	

Biomass Produced and Cost Of Purchase:

Table 53 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2018-19.

Table 53:Year of Procurement FY 2018-19

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'18	5,790	1,52,80,470	2,639
May'18	9,108	2,40,57,264	2,641
Jun'18	8,970	2,36,77,810	2,640
July'18	5,486	1,44,89,034	2,641
Aug'18	0	0	0
Sept'18	0	0	0
Oct'18	10,339	2,90,82,201	2,813
Nov'18	8,949	2,44,80,810	2,736
Dec'18	9,823	2,68,37,256	2,732
Jan'19	8,464	2,31,53,272	2,736
Feb'19	8,476	2,38,92,435	2,819
Mar'19	7,395	1,94,95,599	2,637
Total	**82,800**	**22,44,46,151**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,710.70**

Source: Transtech Green Power Pvt Ltd

Table 54 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2019-20.

Table 54:Year of Procurement FY 2019-20

Month	Quantity of Biomass Procured (MT)	Total Cost of BiomassPurchased at Factory Gate (Rs.)	Purchase of Biomass atFactory Gate (Rs. /MT)
Apr'19	9,102	2,54,06,716	2,791
May'19	10,351	2,90,48,356	2,806
Jun'19	8,754	2,43,76,972	2,785
July'19	5,294	1,46,92,615	2,775
Aug'19	4,878	1,36,48,644	2,798
Sept'19	3,912	1,10,45,532	2,824
Oct'19	4,233	1,22,67,234	2,898
Nov'19	1,693	49,53,718	2,926
Dec'19	6,048	1,76,84,352	2,924
Jan'20	7,079	2,05,89,272	2,909
Feb'20	6,435	1,85,23,148	2,879
Mar'20	7,024	1,96,01,643	2,791
Total	**74,803**	**21,18,38,202**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,831.95**

Source: Transtech Green Power Pvt Ltd

Table 55 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2020-21.

Table 55:Year of Procurement FY 2020-21

Month	Quantity of BiomassProcured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'20	7,606	2,16,84,706	2,851
May'20	9,223	2,63,37,814	2,856
Jun'20	10,330	2,94,26,727	2,849
July'20	10,446	2,98,44,222	2,857
Aug'20	4,899	1,39,58,884	2,849
Sept'20	3,020	95,28,100	3,155
Oct'20	6,428	2,01,38,924	3,133
Nov'20	7,830	2,47,89,780	3,166
Dec'20	4,585	1,36,10,573	2,969
Total	**64,367**	**18,93,19,730**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,941.25**
Source: Transtech Green Power Pvt Ltd			

Table 56 shows the Major Biomass consumed by Transtech Green Power Pvt Ltd Power Plant for year FY 2018-19, FY 2019-20, FY 2020-21.

Table 56: Biomass Consumed, Average Price Escalation, Average Storage and Feeding Price and Biomass Storage & Handling Loss

1	Major Biomass Consumed by Biomass Power Plant.	Juliflora, Jeera Husk & Mix Agro
2	Average price of biomass acquired Rs. Per MT • FY 2018-19 • FY 2019-20 • FY 2020-21	• Rs. 2,710.70 • Rs. 2,831.95 • Rs. 2,941.25 **Total Average is Rs. 2,827.97**
3	Average Price Escalation of the Biomass cost from the year 2018 to 2021.	8 % to 9 % /MT approx.
4	Estimated Average prices for all major biomass in 2021.(Excluding Storage and Feeding Cost). Rs. Per ton	Rs. 2,827.97
5	Average Storage and Feeding Cost Rs. Per MT	Rs. 460
6	Biomass Storage & Handling Loss.	4.5%
Source: Transtech Green Power Pvt Ltd		

Table 57:Biomass Power Plant Fuel Mix in the year 2020-21 (Tons/Year)

Power Plant Fuel Mix	Prosopis Juliflora wood	Mustard Husk	Jeera Husk	Agro Waste	Total
Fuel	52,931	4,012	14,773	-	71,716
%	74%	6%	21%	0%	100%
Source: Transtech Green Power Pvt Ltd					

9.3. S.M. ENVIRONMENTAL TECHNOLOGIES (P) LTD.

Technical Details of The Plant:

S M Environmental Technologies Pvt Ltd has implemented a biomass power plant in Baran district with an installed capacity of 8.0 MW. The project was commissioned in 15/09/2010 and the technical specifications of the key equipment's in the power plant are as follows:

Table 58:Technical Specifications

Parameters	Details
Capacity of the plant	8.0 MW
Boiler Capacity	40 TPH
Type of Boiler	Bidrum, Water tube, Travelling Grate Boiler
Make of Boiler	M/s Cheema Boilers
Mainstream Pressure	45 kg/cm^2
Mainstream Temperature	420 degree C
Make of The Turbine	HANGZHOU STEAM TURBINE CO. LTD, CHINA
Type of Condenser	Water Cooled
Source : S M Environmental Technologies Private Limited	

Biomass Produced and Cost Of Purchase:

Table 59 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2018-19.

Table 59:Year of Procurement FY 2018-19

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'18	12,004	2,80,41,344	2,336
May'18	2,235	52,74,600	2,360
Jun'18	0	0	0
July'18	0	0	0
Aug'18	0	0	0
Sept'18	0	0	0
Oct'18	2,349	64,59,750	2,750
Nov'18	5,369	1,47,64,750	2,750
Dec'18	5,701	1,56,77,750	2,750
Jan'19	122	3,35,500	2,750
Feb'19	4,650	1,27,87,500	2,750
Mar'19	32,813	7,49,77,705	2,285
Total	**65,243**	**15,83,18,899**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,426.60**

Source : S M Environmental Technologies Private Limited

Table 60 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2019-20.

Table 60:Year of Procurement FY 2019-20

Month	Quantity of Biomass Procured (MT)	Total Cost of BiomassPurchased at Factory Gate (Rs.)	Purchase of Biomass atFactory Gate (Rs. /MT)
Apr'19	31,780	7,70,97,334	2,426
May'19	8,077	2,00,30,390	2,480
Jun'19	0	0	0
July'19	0	0	0
Aug'19	0	0	0
Sept'19	0	0	0
Oct'19	0	0	0
Nov'19	0	0	0
Dec'19	15,294	4,66,46,578	3,050
Jan'20	9,835	2,99,96,750	3,050
Feb'20	921	28,09,264	3,050
Mar'20	13,128	4,00,40,400	3,050
Total	**79,034**	**21,66,20,715**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,740.84**

Source : S M Environmental Technologies Private Limited

Table 61 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2020-21.

Table 61:Year of Procurement FY 2020-21

Month	Quantity of BiomassProcured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'20	34,013	9,52,37,500	2,800
May'20	14,058	3,93,62,364	2,800
Jun'20	493	13,80,607	2,800
July'20	0	0	0
Aug'20	0	0	0
Sept'20	6,226	1,74,32,775	2,800
Oct'20	5,947	1,66,52,132	2,800
Nov'20	539	15,08,847	2,800
Dec'20	5,910	1,65,47,370	2,800
Total	**67,186**	**18,81,21,595**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,800.00**
Source : S M Environmental Technologies Private Limited			

Table 62 shows the Major Biomass consumed by S.M. Environmental Technologies Private Limited Power Plant for year FY 2018-19, FY 2019-20, FY 2020-21.

Table 62: Biomass Consumed, Average Price Escalation, Average Storage and Feeding Price and Biomass Storage & Handling Loss

1	Major Biomass Consumed by Biomass Power Plant.	Juliflora, Jeera Husk & Mix Agro
2	Average price of biomass acquired Rs. Per MT • FY 2018-19 • FY 2019-20 • FY 2020-21	• Rs. 2,426.60 • Rs. 2,740.84 • Rs. 2,800.00 **Total Average is Rs. 2,655.81**
3	Average Price Escalation of the Biomass cost from the year 2018 to 2021.	-
4	Estimated Average prices for all major biomass in 2021 (Excluding Storage and Feeding Cost). Rs. Per MT.	2,655.81
5	Average Storage and Feeding Cost Rs. Per MT.	Rs. 278
6	Biomass Storage & Handling Loss Per MT.	Rs. 150 (5.2 % - arrived considering their total procurement and the rate)
Source: S M Environmental Technologies Private Limited		

Table 63: Biomass Power Plant Fuel Mix in the year 2020-21 (Tons/Year)

Power Plant Fuel Mix	Mustard Stalks & Husk	Cotton Stalks	Guar Stalks	Prosopis Juliflora Wood	Agro Waste – Paddy Straw	Total
Fuel	88,848 MT	NILL	NILL	NILL	NILL	88,848 MT
%	100%	NILL	NILL	NILL	NILL	100%
Source : S M Environmental Technologies Private Limited						

9.4. SANJOG SUGAR & ECO POWER PVT. LTD.

Technical Details of The Plant:

This biomass power plant of Sanjog Sugars & Eco Power Pvt Ltd is in Hanumangargh District with an installed capacity of 10 MW. The project has got commissioned in November 2011 and the technical specifications of the key equipment's in the power plant are as follows:

Table 64: Technical Specifications

Parameters	Details
Capacity of the plant	10.0 MW
Boiler Capacity	47 TPH
Make of Boiler	ISGEC JOHN THOMPSON
Mainstream Pressure	66 kg/cm2
Mainstream Temperature	475 degree C
Make of The Turbine	TRIVENI ENGINEERING
Type of Cooling Tower	Air Cooled
Source: Sanjog Sugars & Eco Power Pvt Ltd	

Biomass Produced and Cost Of Purchase:

Table 65 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2018-19.

Table 65:Year of Procurement FY 2018-19

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'18	19,675	4,82,47,540	2,452
May'18	20,648	4,90,66,965	2,376
Jun'18	6,374	1,50,55,190	2,362
July'18	6,407	1,52,37,021	2,378
Aug'18	6,010	1,48,79,882	2,476
Sept'18	3,970	1,12,59,385	2,836
Oct'18	16,592	3,37,01,588	2,031
Nov'18	26,446	4,18,46,752	1,582
Dec'18	13,653	3,13,52,186	2,296
Jan'19	5,161	1,10,56,324	2,142
Feb'19	2,299	44,92,392	1,954
Mar'19	5,630	1,30,63,152	2,320
Total	**1,32,866**	**28,92,28,639**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,176.84**
Source: Sanjog Sugars & Eco Power Pvt Ltd			

Table 66 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2019-20.

Table 66: Year of Procurement FY 2019-20

Month	Quantity of Biomass Procured (MT)	Total Cost of BiomassPurchased at Factory Gate (Rs.)	Purchase of Biomass atFactory Gate (Rs. /MT)
Apr'19	27,568	6,30,41,834	2,287
May'19	8,615	1,97,80,681	2,296
Jun'19	3,915	91,33,546	2,333
July'19	65	1,49,285	2,286
Aug'19	3,196	74,52,418	2,332
Sept'19	2,519	60,15,943	2,388
Oct'19	9,260	1,64,70,239	1,779
Nov'19	41,965	6,02,24,077	1,435
Dec'19	19,269	2,96,69,488	1,540
Jan'20	5,089	79,78,016	1,568
Feb'20	16,319	2,77,99,624	1,704
Mar'20	12,323	2,08,73,434	1,694
Total	**1,50,102**	**26,85,88,585**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**1,789.37**
Source: Sanjog Sugars & Eco Power Pvt Ltd			

Table 67 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2020-21.

Table 67: Year of Procurement FY 2020-21

Month	Quantity of BiomassProcured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'20	8,167	2,06,51,628	2,529
May'20	25,227	5,38,14,585	2,133
Jun'20	10,151	2,04,40,668	2,014
July'20	4,709	1,27,78,500	2,713
Aug'20	3,739	1,08,43,362	2,900
Sept'20	6,492	1,62,30,388	2,500
Oct'20	12,561	2,11,32,373	1,682
Nov'20	37,002	6,02,89,893	1,629
Dec'20	7,509	1,55,03,143	2,065
Total	**1,15,557**	**23,16,84,540**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,004.94**
Source: Sanjog Sugars & Eco Power Pvt Ltd			

Table 68 shows the Major Biomass consumed by Sanjog Sugars & Eco Power Pvt Ltd Power Plant for year FY 2018-19, FY 2019-20, FY 2020-21.

Table 68: Biomass Consumed, Average Price Escalation, Average Storage and Feeding Price and Biomass Storage & Handling Loss

1	Major Biomass Consumed by Biomass Power Plant.	Mustard Husk, Cotton Stalk, Paddy Straw, Ground Husk
2	Average price of biomass acquired Rs. Per MT • FY 2018-19 • FY 2019-20 • FY 2020-21	• Rs. 2,176.84 • Rs. 1,789.37 • Rs. 2,004.94 **Total Average is Rs. 1,990.38**
3	Average Price Escalation of the Biomass cost from the year 2018 to 2021.	200 PMT.
4	Estimated Average prices for all major biomass in 2021 (Excluding Storage and Feeding Cost). Rs. Per MT.	Rs. 1,990.38
5	Average Storage and Feeding Cost Rs. Per MT.	Rs. 745.
6	Biomass Storage & Handling Loss.	12 % to 15 %
Source: Sanjog Sugars & Eco Power Pvt Ltd		

Table 69: Biomass Power Plant Fuel Mix for FY 2020-21 (Tons/Year)

Power Plant Fuel Mix	Mustard Husk	Cotton Stalk	Agro Waste Paddy Straw	Total
Fuel	**40,000**	**30,000**	**30,000**	**100,000**
%	40%	30%	30%	100%
Source: Sanjog Sugars & Eco Power Pvt Ltd				

9.5. SATHYAM POWER LIMITED.

Technical Details of The Plant:

Sathyam Power Ltd has implemented a biomass power plant in Merta Road, Nagaur district, Rajasthan. The installed capacity of this biomass power plant is 10 MW. The project was commissioned in March 2011 and the technical specifications of the key equipment's in the power plant are as follows:

Table 70:Technical Specification

Parameters	Details
Capacity of the plant	10 MW
Boiler Capacity	50 TPH
Type of Boiler	Water Tube, Traveling Grate Stocker
Make of Boiler	Walchand Nagar
Mainstream Pressure	66 kg/cm^2
Mainstream Temperature	475 +/- 5 dgree C
Make of The Turbine	SIEMENS Ltd.
Inlet Steam Flow	45 TPH
Type of Cooling Tower	Air Cooled
Source : Sathyam Power Limited	

Biomass Produced and Cost Of Purchase:

Table 71 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2018-19.

Table 71: Year of Procurement FY 2018-19

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'18	17,437	5,37,75,708	3,084
May'18	10,650	3,39,52,200	3,188
Jun'18	2,381	73,43,004	3,084
July'18	981	30,25,404	3,094
Aug'18	4,079	1,34,60,700	3,300
Sept'18	4,011	1,24,34,388	3,100
Oct'18	9,936	3,12,98,400	3,150
Nov'18	8,531	2,81,51,079	3,300
Dec'18	7,203	2,29,00,358	3,179
Jan'19	6,852	2,15,72,211	3,148
Feb'19	4,344	1,35,94,743	3,129
Mar'19	5,016	1,51,50,075	3,020
Total	**81,421**	**25,66,58,270**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**3,152.21**
Source : Sathyam Power Limited			

Table 72 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2019-20.

Table 72:Year of Procurement FY 2019-20

Month	Quantity of Biomass Procured (MT)	Total Cost of BiomassPurchased at Factory Gate (Rs.)	Purchase of Biomass atFactory Gate (Rs. /MT)
Apr'19	18,210	5,11,35,588	2,808
May'19	19,933	5,65,88,639	2,839
Jun'19	4,297	1,39,11,052	3,238
July'19	1,324	45,52,174	3,438
Aug'19	592	20,14,126	3,400
Sept'19	3,181	1,08,13,768	3,400
Oct'19	3,945	1,36,79,376	3,467
Nov'19	19,417	6,81,58,335	3,510
Dec'19	11,336	3,95,49,905	3,489
Jan'20	8,579	2,97,53,217	3,468
Feb'20	6,487	2,24,96,324	3,468
Mar'20	1,960	65,27,520	3,331
Total	**99,261**	**31,91,80,024**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**3,215.56**
Source : Sathyam Power Limited			

Table 73 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2020-21.

Table 73: Year of Procurement FY 2020-21

Month	Quantity of BiomassProcured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'20	424	12,14,424	2,863
May'20	22,924	6,58,31,890	2,872
Jun'20	21,046	6,27,96,658	2,984
July'20	2,541	82,64,622	3,252
Aug'20	2,067	73,29,145	3,546
Sept'20	3,391	1,20,38,444	3,550
Oct'20	10,420	3,71,45,984	3,565
Nov'20	23,476	8,37,92,491	3,569
Dec'20	8,131	2,93,27,428	3,607
Total	**94,420**	**30,77,41,086**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**3,259.28**
Source : Sathyam Power Limited			

Table 74 shows the Major Biomass consumed by Sanjog Sugars & Eco Power Pvt Ltd Power Plant for year FY 2018-19, FY 2019-20, FY 2020-21.

Table 74: Biomass Consumed, Average Price Escalation, Average Storage and Feeding Price and Biomass Storage & Handling Loss

1	Major Biomass Consumed by Biomass Power Plant.	Mustard Husk, Jeera Husk, Chipped cotton stalks, Julie flora, Heena husk & Groundnut shells
2	Average price of biomass acquired Rs. Per MT • FY 2018-19 • FY 2019-20 • FY 2020-21	• Rs. 3,152.24 • Rs. 3,215.56 • Rs. 3,259.03 **Total Average is Rs. 3,209.03**
3	Average Price Escalation of the Biomass cost from the year 2018 to 2021.	2.26 %.
4	Estimated Average prices for all major biomass in 2021-22. (Excluding Storage and Feeding Cost). Rs. Per MT.	Rs. 3,209.03.
5	Average Storage and Feeding Cost Rs. Per MT.	Rs. 225
6	Biomass Storage & Handling Loss.	10%
Source: Sathyam Power Limited		

Table 75: Biomass Power Plant Fuel Mix for FY 2020-21 (Tons/Year)

Power Plant Fuel Mix	Must.+	Juliflora	Heena	GNS	Cotton	Total
Fuel	**48,086**	**17,837**	**10,869**	**2,040**	**23,698**	**1,02,530**
%	47%	17%	11%	2%	23%	100%
Source : Sathyam Power Limited						

9.6. ORIENT GREEN POWER CO.

Technical Details of The Plant:

Orient Green Power Co (OGPL) (Rajasthan) has implemented a biomass power plant in Baran District with an installed capacity of 8 MW. The project has got commissioned in October 2013 and the technical specifications of the key equipment's in the power plant are as follows:

Table 76:Technical Specifications

Parameters	Details
Capacity of the plant	8.0 MW
Boiler Capacity	40 TPH
Make of Boiler	THERMAX LIMITED
Mainstream Pressure	66 kg/cm2
Mainstream Temperature	480 degrees Celsius
Make of The Turbine	TRIVENI ENGINEERING
Type of Cooling Tower	Air Cooled
Source: Orient Green Power Co.	

Biomass Produced and Cost Of Purchase:

Table 77 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2018-19.

Table 77:Year of Procurement FY 2018-19

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'18	13,027	3,62,28,087	2,781
May'18	5,638	1,69,14,000	3,000
Jun'18	4	9,824	2,456
July'18	0	0	0
Aug'18	0	0	0
Sept'18	0	0	0
Oct'18	2,106	62,12,022	2,950
Nov'18	5,351	1,57,84,477	2,950
Dec'18	6,110	1,80,24,500	2,950
Jan'19	140	4,05,304	2,900
Feb'19	7,520	2,03,40,434	2,705
Mar'19	40,480	9,54,56,554	2,358
Total	**80,375**	**20,93,75,201**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,604.93**

Source: Orient Green Power Co.

Table 78 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2019-20.

Table 78:Year of Procurement FY 2019-20

Month	Quantity of Biomass Procured (MT)	Total Cost of BiomassPurchased at Factory Gate (Rs.)	Purchase of Biomass atFactory Gate (Rs. /MT)
Apr'19	18,386	4,73,25,258	2,574
May'19	9,751	2,46,49,264	2,528
Jun'19	806	20,21,414	2,507
July'19	0	0	0
Aug'19	0	0	0
Sept'19	0	0	0
Oct'19	0	0	0
Nov'19	0	0	0
Dec'19	16,977	5,35,10,905	3,152
Jan'20	137	3,84,423	2,800
Feb'20	2,062	65,09,008	3,157
Mar'20	19,800	6,33,79,736	3,201
Total	**67,919**	**19,77,80,008**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,912.02**

Source: Orient Green Power Co.

Table 79 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2020-21.

Table 79:Year of Procurement FY 2020-21

Month	Quantity of BiomassProcured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'20	23,458	7,15,47,451	3,050
May'20	9,983	3,04,47,537	3,050
Jun'20	6,365	1,94,12,744	3,050
July'20	51	1,55,330	3,050
Aug'20	0	0	0
Sept'20	0	0	0
Oct'20	11,590	3,53,48,456	3,050
Nov'20	3,817	1,16,42,583	3,050
Dec'20	8,012	2,44,35,597	3,050
Total	**63,275**	**19,29,90,086**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**3,050.00**
Source: Orient Green Power Co.			

Table 80 shows the Major Biomass consumed by Orient Green Power Company Co. Power Plant for year FY 2018-19, FY 2019-20, FY 2020-21.

Table 80:Biomass Consumed, Average Price Escalation, Average Storage and Feeding Price and Biomass Storage & Handling Loss

1	Major Biomass Consumed by Biomass Power Plant.	Juliflora, Jeera Husk & Mix Agro
2	Average price of biomass acquired Rs. Per MT • FY 2018-19 • FY 2019-20 • FY 2020-21	• Rs. 2,604.93 • Rs. 2,912.02 • Rs. 3,050.00 **Total Average is Rs. 2,855.65**
3	Average Price Escalation of the Biomass cost from the year 2018 to 2021.	-
4	Estimated Average prices for all major biomass in 2021 (Excluding Storage and Feeding Cost). Rs. Per ton	2,855.65.
5	Average Storage and Feeding Cost Rs. Per MT.	Rs. 278
6	Biomass Storage & Handling Loss Rs. Per MT.	Rs. 150 (5.2 % - arrived considering their total procurement and the rate)
Source: Orient Green Power Co.		

Table 81:Biomass Power Plant Fuel Mix for FY 2020-21 (Tons/Year)

Power Plant Fuel Mix	Must.+	Cotton Stalks	Guar Stalks	Prosopis	Agro Waste	Total
Fuel	97,737	**NILL**	**NILL**	**NILL**	**NILL**	**97,737**
%	100%					100%
Source: Orient Green Power Co.						

9.7. KALPATARU POWER TRANSMISSION LTD, SRI GANGANAGAR.

Technical Details of The Plant:

This biomass power plant is located in Padampur with an installed capacity of 7.8 MW. The project has got commissioned in 10/11/2006 and the technical specifications of the key equipment's in the power plant are as follows:

Table 82:Technical Specifications

Parameters	Value
Capacity of the plant	7.8 MW
Boiler Capacity	35 TPH
Boiler Steam Pressure	66 kg/cm^2
Boiler Make	Themax Ltd., Pune
Boiler Steam Temperature	490^0
TG Set Make	Shin Nippon, Japan
Type of Cooling Tower	Paharpur Colling Tower Ltd
Source: Kalpataru Power Transmission, Sri Ganganagar	

Biomass Produced and Cost Of Purchase:

Table 83 shows the month wise biomass procurement and the average landed cost of biomass at factory gate for the year FY 2018-19.

Table 83:Year of Procurement FY 2018-19

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'18	47,071	11,96,07,411	2,541
May'18	3,598	86,78,376	2,412
Jun'18	103	2,54,101	2,467
July'18	106	2,43,376	2,296
Aug'18	16	39,168	2,448
Sept'18	220	4,74,320	2,156
Oct'18	2,636	49,58,316	1,881
Nov'18	8,582	1,47,61,040	1,720
Dec'18	2,022	55,42,302	2,741
Jan'19	6,657	1,21,29,054	1,822
Feb'19	999	19,90,008	1,992
Mar'19	2,209	45,17,405	2,045
Total	**74,219**	**17,31,94,877**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,333.57**

Source: Kalpataru Power Transmission, Sri Ganganagar.

Table 84 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2019-20.

Table 84:Year of Procurement FY 2019-20

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'19	52,561	11,57,39,322	2,202
May'19	18,670	3,58,83,740	1,922
Jun'19	494	9,12,418	1,847
July'19	206	4,06,026	1,971
Aug'19	84	1,93,200	2,300
Sept'19	4	9,200	2,300
Oct'19	20	92,000	4,600
Nov'19	12,345	2,55,04,770	2,066
Dec'19	-	-	-
Jan'20	4,025	64,19,875	1,595
Feb'20	-	-	-
Mar'20	-	-	-
Total	**88,409**	**18,51,60,551**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,094.36**
Source: Kalpataru Power Transmission, Sri Ganganagar.			

Table 85 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2020-21.

Table 85:Year of Procurement FY 2020-21

Month	Quantity of BiomassProcured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'20	17,149	2,98,90,707	1,743
May'20	27,576	5,09,60,448	1,848
Jun'20	12,563	2,44,60,161	1,947
July'20	2,666	53,79,988	2,018
Aug'20	1,663	34,74,007	2,089
Sept'20	1,253	26,92,697	2,149
Oct'20	4,818	1,05,99,600	2,200
Nov'20	12,242	2,50,83,858	2,049
Dec'20	4,264	72,95,704	1,711
Total	**84,194**	**15,98,37,170**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**1,898.44**
Source: Kalpataru *Power Transmission, Sri Ganganagar.*			

Table 86 shows the Major Biomass consumed by Kalpataru Power Transmission, Sri Ganganagar. Power Plant for year FY 2018-19, FY 2019-20, FY 2020-21.

Table 86:Biomass Consumed, Average Price Escalation, Average Storage and Feeding Price and Biomass Storage & Handling Loss

1	Major Biomass Consumed by Biomass Power Plant.	MCR, CCR, Julie Flora & Others
2	Average price of biomass acquired Rs. Per MT • FY 2018-19 • FY 2019-20 • FY 2020-21	• Rs. 2,333.57 • Rs. 2,094.36 • Rs. 1,898.44 **Total Average is Rs. 2,108.79**
3	Average Price Escalation of the Biomass cost from the year 2018 to 2021.	NILL
4	Estimated Average prices for all major biomass in 2021 (Excluding Storage and Feeding Cost). Rs. Per MT.	Rs. 2,108.79
5	Average Storage and Feeding Cost Rs. Per MT.	Rs. 244
6	Biomass Storage & Handling Loss.	10%
Source: Kalpataru Power Transmission, Sri Ganganagar.		

Table 87:Biomass Power Plant Fuel Mix for FY 2020-21 (Tons/Year)

Power Plant Fuel Mix	Must.+	Cotton Stalks	Guar Stalks	Prosopis Juliflora	Agro Waste	Total
Fuel	60,210	**13171**	**NILL**	**17**	**3176**	**76574**
%	78.63%	17.20%		.02%	4.15%	100%
Source: Kalpataru Power Transmission, Sri Ganganagar.						

9.8. KALPATARU POWER TRANSMISSION LTD, TONK.

Technical Details of The Plant:

This biomass power plant is located in Tonk with an installed capacity of 8 MW. The project has got commissioned in 10/11/2006 and the technical specifications of the key equipment's in the power plant are as follows:

Table 88:Technical Specifications

Parameters	Value
Capacity of the plant	8MW
Boiler Capacity	38TPH
Boiler Steam Pressure	45kg/cm2
Boiler Make	Sitson India Pvt Ltd, Thane
Boiler Steam Temperature	425-degree celcius
TG Set Make	Hangzhou Stream Turbine Company Limited, China
Type of Cooling Tower	Induced Draft Counter flow cooling tower
Source: Kalpataru Power Transmission, Tonk	

Biomass Produced and Cost Of Purchase:

Table 89 shows the month wise biomass procurement and the average landed cost of biomass at factory gate for the year FY 2018-19.

Table 89:Year of Procurement FY 2018-19

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'18	38,883	8,80,31,112	2,264
May'18	4,161	73,02,555	1,755
Jun'18	1,708	26,83,268	1,571
July'18	-	-	-
Aug'18	-	-	-
Sept'18	-	-	-
Oct'18	-	-	-
Nov'18	-	-	-
Dec'18	-	-	-
Jan'19	2,138	34,20,800	1,600
Feb'19	864	13,82,400	1,600
Mar'19	15,157	3,03,14,000	2,000
Total	**62,911**	**13,31,34,135**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**2,116.23**
Source: Kalpataru Power Transmission, Tonk			

Table 90 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2019-20.

Table 90:Year of Procurement FY 2019-20

Month	Quantity of Biomass Procured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'19	52,518	9,59,50,386	1,827
May'19	34,606	5,05,59,366	1,461
Jun'19	1,939	25,20,700	1,300
July'19	-	-	-
Aug'19	-	-	-
Sept'19	-	-	-
Oct'19	-	-	-
Nov'19	-	-	-
Dec'19	-	-	-
Jan'20	4,101	55,36,350	1,350
Feb'20	1,987	26,82,450	1,350
Mar'20	1,827	24,66,450	1,350
Total	**96,978**	**15,97,15,702**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**1,646.93**
Source: Kalpataru Power Transmission, Tonk.			

Table 91 shows the month wise biomass procurement and the average landed cost of biomassat factory gate for the year FY 2020-21.

Table 91:Year of Procurement FY 2020-21

Month	Quantity of BiomassProcured (MT)	Total Cost of Biomass Purchased at Factory Gate (Rs.)	Purchase of Biomass at Factory Gate (Rs. /MT)
Apr'20	3,304	62,77,600	1,900
May'20	55,808	9,73,29,152	1,744
Jun'20	11,472	1,73,68,608	1,514
July'20	-	-	-
Aug'20	-	-	-
Sept'20	-	-	-
Oct'20	-	-	-
Nov'20	2,431	38,89,600	1,600
Dec'20	575	9,20,000	1,600
Total	**73,590**	**12,57,84,960**	
Average Purchase Cost of Biomass at factory gate (Rs. /MT)			**1,709.27**
Source: Kalpataru Power Transmission, Tonk.			

Table 92 shows the Major Biomass consumed by Kalpataru Power Transmission, Tonk. Power Plant for year FY 2018-19, FY 2019-20, FY 2020-21.

Table 92:Biomass Consumed, Average Price Escalation, Average Storage and Feeding Price and Biomass Storage & Handling Loss

1	Major Biomass Consumed by Biomass Power Plant.	MCR, CCR, Julie Flora & Others
2	Average price of biomass acquired Rs. Per MT • FY 2018-19 • FY 2019-20 • FY 2020-21	• Rs. 2,116.23 • Rs. 1,646.93 • Rs. 1,709.27 **Total Average is Rs. 1,824.14**
3	Average Price Escalation of the Biomass cost from the year 2018 to 2021.	NILL
4	Estimated Average prices for all major biomass in 2021 (Excluding Storage and Feeding Cost)	Rs. 1,824.14.
5	Average Storage and Feeding Cost Rs. Per MT.	Rs. 274.
6	Biomass Storage & Handling Loss.	10%
Source: Kalpataru Power Transmission, Tonk.		

Table 93: Biomass Power Plant Fuel Mix for FY 2020-21 (Tons/Year)

Power Plant Fuel Mix	Must.+	Cotton Stalks	Guar Stalks	Prosopis Juliflora	Agro Waste	Total
Fuel	88669	**NILL**	**NILL**	**NILL**	**NILL**	**88669**
%	100 %	-	-	-	-	100%
Source: Kalpataru Power Transmission, Tonk.						

10. Chapter 7: CHALLENGES FACED BY POWER PLANTS

The biomass market is in a flux and the existing power plants are facing hardships to source the raw materials. As different industries are openly adopting biomass for their energy requirements. When most of the Biomass Power Plants were set-up there was surplus of available in the marketor was sourced from local points.

As the demand for Biomass from other industries increased, the availability of the biomass for power generation got decreased and the pricing of biomass was adjusted to the demand. As thedemand increased, so did the prices. Earlier it took 70-90 paise to produce a unit of energy frombiomass sourced mainly from agriculture outputs and forest/wasteland.

The power plants have the choice to use cheap coal for their energy requirements. But the powerplant would not have fetched the incentives the government offered for producing electricity using mustard crop residue. It bought the power so produced. Then there is money from carbon credits, earned under the UN's clean development mechanism (CDM) fund.

Different Rajasthan State Governments have revised the rate at which they buy power from thepower plants. The power plants feel that it is not in line with price of raw materials, which has drastically increased due to increase in demand, scarcity and increasing transportation costs.

As the demand for raw materials increase from power plants and other allied industries, the smalland marginal farmers are increasingly finding it difficult to source raw materials as fodder to feedtheir cattle and other animals. These problems will increase as biomass as fuel has gained wide acceptance.

This has also affected people who depend on crop residues for income, such as landless farm laborers in villages around the power plants.

The Central and State Governments are planning to provide permissions for more biomass powerplants to come up. This will lead to competition and demand going up for the raw materials. If the power plants were situated too close to each other, the power plants would end upcompeting for the same source of raw materials.

This will further aggravate the pricing and surplus availability of raw materials for biomass power generations. Some states have started to put a cap on raw material usage for power generation as the fodder crisis deepens. There are certain restrictions on using biomass such as Rice Husk for power generation; still there is little or no monitoring on the type of biomass being used by different entities.

Major Challenges:

Power Plants require biomass in huge quantities for production. It is sourced from different sources based on the crop, wood and the location. Few of the major challenges highlighted by the Power Plants are as below:

- ✓ Most of the annual fuel requirement is to be procured during the 3 month harvesting period, necessitating huge investment.
- ✓ Safe Storage of fuel is very difficult to protect against fire and other wind losses.
- ✓ Deterioration loss of fuel during storage is heavy.
- ✓ Competition from Cement and Brick Manufacturer.
- ✓ Dust also included in the biomass which affect the plant operation and we are paying as per weight
- ✓ Huge land required for storage
- ✓ Handling and Shifting of Biomass Logistic problems in procurement, storage, and handling of biomass fuels. Ensuring biomass quality – dust and moisture content in the biomass being procured. Dust and moisture in the biomass fuels affect operation of the plant. Plants require regular cleaning to remove choking in the plant caused by the dust in the fuel. Minimizing losses due to transportation, handling, storage, and wind / storms in the region.
- ✓ Additional transporting cost is involved in moving the stored material to the point of use.
- ✓ Escalation of Biomass Price, Adulteration of Sand etc
- ✓ Due to aging of plant major Expense on maintenance of Plant (Every year we have to change tubes of Primary / Secondary super heater, Change of all travelling Grate etc
- ✓ Escalation of Man Power cost due to Annual Increments
- ✓ Escalation of Diesel prices

Government policy is the biggest factor behind lack of investment in bio-power sector in states with high biomass potential. Defragmented nature of agricultural lands does not allow high mechanisation which results in reduction of efficiency and increase in procurement cost. Some other reasons, they are not able to run power plants solely on biomass economically which can be attributed to:

- ✓ Biomass price increases very fast after commissioning of power project and therefore government tariff policy needs an annual revision.
- ✓ Lack of mechanisation in Indian Agriculture Sector.
- ✓ Defragmented land holdings.
- ✓ Most of the farmers are small or marginal.

11. Chapter 8: BIOMASS PRICING, STACKING, FEED COST & CALORIFIC VALUE

11.1. AVERAGE COST OF BIOMASS

As per the primary survey data and interaction with various stakeholders (Power Producers, Farmers, Suppliers, Industries etc.) we summarized the average cost of biomass as per below table.

In the year FY 2018-19 is Rs 3,046, The average cost of biomass in the year FY 2019-20 was Rs. 3,164 and increased to Rs. 3,279 in the year FY 2020-21 and in FY 2021-22. The average percentage (%) of the biomass cost from the year FY 2018-19 to FY 2020-21 is 3.9.

Table 94:Average Cost of Biomass

Month (FY)	FY 2018-19	FY 2019-20	FY 2020-21
Apr	2415	2400	2550
May	2090	2215	2350
Jun	3000	3000	3000
Jul	3545	3550	3600
Aug	1756	2400	2400
Sep	1892	1960	2150
Oct	3600	3700	3800
Nov	2800	3100	3100
Dec	5200	5256	5550
Jan	4200	3890	4300
Feb	3250	3500	3500
Mar	2800	3000	3050
Total	**3046**	**3164**	**3279**
Escalation		**3.9 %**	**3.6 %**

Source: *Source: The primary data collected at field level by discussion with farmers, local people, biomass and food grain traders, other biomass consuming industries and personal observation by the field enumerators.*

Based on data received from various power plant as specified in table no 89, we summarized, the average cost of biomass in the year FY 2018-19 was Rs 2,754.75. The average cost of biomass in the year FY 2019-20 was Rs. 2,668.19 and increased to Rs. 2,778.92 in the year FY 2020-21. The percentage (%) variation of the biomass cost for the year FY 2019-20 is decreased by –3.14%. In the year FY 2020-21 it again got increased by 4.15 %.

The price escalation is estimated based on the formula as below:

Price Escalation=(Current Year-Base Year)/Base Year*100

Table 95: Average cost of Biomass for the following years

Total Average Biomass Cost Based On Power Plant Fuel Mix (Rs. Per FY)				
Sr. No.	**Power Producers**	**FY 2018-19**	**FY 2019-20**	**FY 2020-21**
1	Surya Chambal Power Ltd	3,457.16	2,519.39	2,618.31
2	Transtech Green Power Pvt Ltd	2,710.70	2,831.95	2,941.25
3	S.M. Environmental Technologies (P) Ltd	2,426.60	2,740.84	2,800.00
4	Sanjog Sugar & Eco Power Pvt Ltd	2,176.84	1,789.37	2,004.94
5	Sathyam Power Limited	3,152.24	3,215.56	3,259.03
6	Orient Green Power Co. (Rajasthan)	2,604.93	2,912.02	3,050.00
7	Kalpataru Power Transmission Ltd. (Sri Ganganagar)	2,333.57	2,094.36	1,898.44
8	Kalpataru Power Transmission Ltd. (Tonk)	2,116.23	1,646.93	1,709.27
Average		**2,754.75**	**2,668.19**	**2,778.92**
Escalation			**-3.12 %**	**4.12 %**
Sources: All power plant data as per chapter no-6				

Note: The major contributing factors towards inflation in the price of biomass fuel are Transportation Cost and Labour charges. The cost of transportation has increased substantially owing to continuous increase in the cost of Petroleum Products.

Table 96: Average of all Major Biomass Cost per MT

Particulars	Average of all Major Biomass cost Rs. Per MT per Year	Escalation %
FY 2018-19	Rs. 2,754.75	
FY 2019-20	Rs. 2,668.19	-3.12 %
FY 2020-21	Rs. 2,778.92	4.12 %
Average Escalation of all Major Biomass cost from the year FY 2018-19 to FY 2020-21		0.87 % /- approx.
Note: calculated based on the actual fuel mix data collected from operating biomass power plants and the average cost evaluated through primary data.		
Sources: All power plant data as per chapter no-6		

11.2. BIOMASS STACKING, LOADING/UNLOADING & FEEDING COST

Table 97:Biomass Stacking and Feeding Cost

Sr. No.	Power Producers	Stacking & Covering Including LDPE Sheet Cost Rs/MT	Storage and Feeding Cost Rs/MT
1	Surya Chambal Power Ltd	91	407
2	Transtech Green Power Pvt Ltd	121	460
3	S.M. Environmental Technologies (P) Ltd	91	278
4	Sanjog Sugar & Eco Power Pvt Ltd	97	745
5	Sathyam Power Limited	95	225
6	Orient Green Power Co. (Rajasthan)	98	278
7	Kalpataru Power Transmission Ltd.(Sri Ganganagar)	244	244
8	Kalpataru Power Transmission Ltd.(Tonk)	226	274
	Average	**133**	**364**
Sources: All power plant data as per chapter no-6			

Table 98:Average Biomass Stacking and Feeding Cost

Sr. No	BIOMASS STACKING & FEEDING COST	Rs per MT
1	Stacking & Covering Including LDPE Sheet Cost Rs/MT	133
2	Feeding Cost Rs/MT	364
	Average Total Cost	**497**
Sources: All power plant data as per chapter no-6		

11.3. AVERAGE PRICE ESCALATION

Table 99: Average Price Escalations for Major Biomass Used in Power Plants

1	Major Biomass Consumed by Different Biomass Power Plants	MUSTARD STALKS & HUSK, PADDY STRAW, MAIZE STALKS, GROUND NUT STALKS, CASTOR STEM & COTTON STALKS
2	Average of all Major Biomass cost Rs. Per FY	
	FY 2018-19	Rs. 2,754.75
	FY 2019-20	Rs. 2,668.19
	FY 2020-21	Rs. 2,778.92
3	Average Escalation of all Major Biomass cost from the year FY 2018-19 to FY 2020-21	0.87 %
4	Average Stacking, covering and Feeding Cost Rs. Per Ton	Rs.497
5	Biomass Storage & Handling Loss	Min 7.5 %
Note: calculated based on the actual fuel mix data collected from operating biomass power plants and the average costevaluated through primary data.		
Sources: All power plant data as per chapter no-6		

Loss during Handling and Storage: The accounting quantity (book volume) of biomass received by any plant starts from weighbridge of the plant. This quantity also involves varying percentage of moisture. However, percentage of moisture available in biomass is only indicative percentage and not the exact one, owing to huge quantity of biomass and method as well as device used for calculating the moisture percentage. The loss occurs at various stages namely, during offloading, reduction in moisture percentage during storage, reloading for consumption/processing, removal of mud/dust for processing and handling while feeding for processing.

11.4. CALORIFIC VALUE

Mustard Husk

Table 100:Calorific Value of Major Biomass - Mustard Stalk/Husk

Sl.No.	Month (FY)	FY 2018-19		FY 2019-20		FY 2020-21	
		Moisture %	Gross Calorific Value in * ARB Kcal / Kg	Moisture %	Gross Calorific Value in ARB Kcal / Kg	Moisture %	Gross Calorific Value in ARB Kcal / Kg
1	Apr	8%	3,466	9%	3,480	9%	3,370
2	May	7%	3,477	8%	3,476	8%	3,439
3	Jun	8%	3,244	8%	3,484	9%	3,392
4	Jul	9%	3,319	9%	3,331	8%	3,362
5	Aug	10%	3,315	12%	3,226	10%	3,280
6	Sep	9%	3,378	10%	3,367	9%	3,435
7	Oct	10%	3,230	10%	3,253	8%	3,373
8	Nov	10%	3,216	10%	3,236	11%	3,435
9	Dec	10%	3,185	11%	3,256	13%	3,312
10	Jan	8%	3,409	14%	3,297	15%	3,304
11	Feb	7%	3,311	14%	3,324	13%	3,395
12	Mar	6%	3,412	11%	3,451	10%	3,462
Average Total		**8%**	**3,330**	**11%**	**3,348**	**10%**	**3,380**

Sources: The above as received by all Power Producers for FY 2018-19 to FY 2020-21, and then the average of them have been taken as shown in the above table.
Note: *ARB - As-Received Basis * GCV- Gross Calorific Value.

Prosopis Juliflora

Table 101:Calorific Value of Prosopis Juliflora Biomass

Sl.No.	Month (FY)	FY 2018-19		FY 2019-20		FY 2020-21	
		Moisture %	Gross Calorific Value in ARB Kcal / Kg	Moisture %	Gross Calorific Value in ARB Kcal / Kg	Moisture %	Gross Calorific Value in ARB Kcal / Kg
1	Apr	41%	2,773	41%	2,873	40%	2,816
2	May	39%	2,839	39%	2,839	42%	2,824
3	Jun	40%	2,767	40%	2,867	41%	2,867
4	Jul	38%	2,794	38%	2,894	39%	2,878
5	Aug	38%	2,802	38%	2,802	39%	2,887
6	Sep	37%	2,798	37%	2,898	38%	2,824
7	Oct	39%	2,817	39%	2,817	39%	2,956
8	Nov	39%	2,794	39%	2,894	37%	3,078
9	Dec	44%	2,867	44%	2,867	38%	2,798
10	Jan	46%	2,846	46%	2,846	38%	2,798
11	Feb	43%	2,788	43%	2,888	38%	2,798
12	Mar	42%	2,876	42%	2,876	38%	2,798
Average Total		**41%**	**2,813**	**41%**	**2,863**	**39%**	**2,860**

Sources: The above data as received by all Power Producers for FY 2018-19 to FY 2020-21, and then the average of them have been taken as shown in the above table.
Note: ARB - As-Received Basis

District-wise Average Biomass GCV

Table 102: District wise Average Biomass GCV:

Sl No	District	Biomass GCV (Mustard, Paddy, Maize, Ground Nut, Castor, Cotton etc.)
1	Ajmer	3026
2	Jaipur	3070
3	Dausa	3220
4	Tonk	3188
5	Sikar	3102
6	Jhunjhunu	3110
7	Nagaur	3312
8	Alwar	3142
9	Bharatpur	3235
10	Dholpur	3270
11	Sawai Madhopur	3257
12	Karoli	3202
13	Bikaner	3070
14	Churu	3096
15	Jaisalmer	2840
16	Ganganagar	2946
17	Hanumanagar	2960
18	Jodhpur	3117
19	Barmer	2834
20	Jalore	2862
21	Pali	2916
22	Sirohi	2911
23	Kota	3276
24	Baran	3278
25	Bundi	3265
26	Jhalawar	3073
27	Banswara	3129
28	Dungarpur	3164
29	Udaipur	3063
31	Bhilwara	3140
32	Chittogarh	3120
33	Rajsamand	3094
	TOTAL	**3103**

Sources: The above data was collected by all Power Producers for FY 2018-19 to FY 2020-21, and then the average of them have been taken as shown in the above table.

Specific Fuel Consumption

The average Specific Fuel Consumption (kg/kwh) was calculated as per the data provided by the below power plants.

Table 103:Specific Fuel Consumption

Sl.No.	Power Plant Name	SFC (Kg/kWh)
1	Surya Chambal Power Ltd	1.5
2	Transtech Green Power Pvt Ltd	1.8
3	S.M. Environmental Technologies (P) Ltd	1.8
4	Sanjog Sugar & Eco Power Pvt Ltd	1.7
5	Sathyam Power Limited	1.7
6	Orient Green Power Co. (Rajasthan)	1.6
7	Kalpataru Power Transmission Ltd. (Sri Ganganagar)	1.5
8	Kalpataru Power Transmission Ltd. (Tonk)	1.6
	Total Average	**1.63**
Sources: All power plant data as per chapter no-6		

11.5. GCV Value as Per CERC

As per CERC RE Tariff Order FY 2021-22 (wherein tariff value and GCV for Biomass in respect of States of the union have been outlined) stipulates the tariff value and GCV for biomass in respect of the State of Rajasthan which is as given below:

Table 104: GCV Value as per CERC

Sl.NO	Assumption Head	Sub-Head	Sub-Head (2)	Unit	Parameters
Biomass Power Projects [other than Rice Straw and Juliflora (plantation) based project] with Water Cooled Condenser and using Travelling Grate-Rajasthan					
1	Fuel Related Assumptions	Biomass	GCV-Biomass	Kcal/kg	3100
Biomass Power Projects [other than Rice Straw and Juliflora (plantation) based project] with Air Cooled Condenser and using Travelling Grate- Rajasthan					
2	Fuel Related Assumptions	Biomass	GCV-Biomass	Kcal/kg	3100
Biomass Power Projects [Rice Straw and Juliflora (plantation) based project] with Water Cooled Condenser and using Travelling Grate boiler - Rajasthan					
3	Fuel Related Assumptions	Biomass	GCV-Biomass	Kcal/kg	3100
Biomass Power Projects [Rice Straw and Juliflora (plantation) based project] with Air Cooled Condenser and using Travelling Grate- Rajasthan					
4	Fuel Related Assumptions	Biomass	GCV-Biomass	Kcal/kg	3100
Biomass Power Projects [other than Rice Straw and Juliflora (plantation) based project] with Water Cooled Condenser and using AFBC Boiler- Rajasthan					
5	Fuel Related Assumptions	Biomass	GCV-Biomass	Kcal/kg	3100
Biomass Power Projects [other than Rice Straw and Juliflora (plantation) based project] with Air Cooled Condenser and using AFBC Boiler- Rajasthan					
6	Fuel Related Assumptions	Biomass	GCV-Biomass	Kcal/kg	3100
Biomass Power Projects [Rice Straw and Juliflora (plantation) based project] with Water Cooled Condenser and using AFBC boiler - Rajasthan					
7	Fuel Related Assumptions	Biomass	GCV-Biomass	Kcal/kg	3100
Biomass Power Projects [Rice Straw and Juliflora (plantation) based project] with Air Cooled Condenser and using AFBC Boiler- Rajasthan					
8	Fuel Related Assumptions	Biomass	GCV-Biomass	Kcal/kg	3100

Data Source: CERC Tariff Order FY 2021-22 https://cercind.gov.in/2021/orders/2-SM-2021.pdf

12. Chapter 9: DISTRICT-WISE AND CROP-WISE BIOMASS GENERATION, CONSUMPTION & SURPLUS

This chapter brings out the District-wise and Crop-wise Biomass Generation, Consumption and Surplus across 33 districts of Rajasthan.

Table 105:Species and District-wise Biomass Generation Qty

Sl No	District	Cropwise Biomass Generation (For FY 2017-18, FY 2018-19 and FY 2019-20)						
		Paddy	Maize	G.Nut	Castor	Cotton	Mustard	Total
1	Ajmer	12.3	49,151.9	3,379.0	239.7	30,472.4	95,634.3	**1,78,889.7**
2	Jaipur	-	3,016.3	1,35,805.5	-	995.7	2,36,215.9	**3,76,033.4**
3	Dausa	-	1,050.0	35,711.7	0.4	8.4	1,71,174.2	**2,07,944.8**
4	Tonk	3.0	24,185.0	38,427.8	42.9	1,873.7	7,35,971.9	**8,00,504.3**
5	Sikar	-	8.1	78,921.3	0.9	97.8	93,973.3	**1,73,001.4**
6	Jhunjhunu	-	1.5	81,422.9	50.7	15,357.6	1,99,415.7	**2,96,248.3**
7	Nagaur	-	43.0	68,680.8	46.8	92,773.2	1,36,758.8	**2,98,302.6**
8	Alwar	298.6	7,069.5	1,074.2	1.7	1,00,490.6	8,97,642.6	**10,06,577.1**
9	Bharatpur	2,378.5	2.5	9.8	14.3	12,507.9	7,64,106.3	**7,79,019.2**
10	Dholpur	1,187.5	-	155.3	8.7	107.0	2,56,378.2	**2,57,836.8**
11	Sawai Madhopur	3,149.8	880.9	6,121.0	-	2.2	4,51,353.8	**4,61,507.7**
12	Karoli	2,519.5	58.5	1,205.2	-	3.4	2,78,375.3	**2,82,162.0**
13	Bikaner	-	-	10,49,451.3	350.7	10,824.8	3,24,708.6	**13,85,335.3**
14	Churu	-	1.0	3,25,983.7	19.1	5,646.9	1,70,035.9	**5,01,686.6**
15	Jaisalmer	-	-	1,16,622.9	11,719.1	589.6	79,938.9	**2,08,870.5**
16	Ganganagar	1,17,446.5	88.5	26,708.8	954.6	4,05,939.0	7,12,923.0	**12,64,060.4**
17	Hanumanagar	96,600.4	50.0	69,559.3	8,751.3	4,58,712.9	3,46,787.3	**9,80,461.2**
18	Jodhpur	-	5.5	5,72,800.2	15,328.5	1,00,398.7	4,08,047.8	**10,96,580.7**
19	Barmer	-	38.0	12,954.3	50,366.4	-	24,966.0	**88,324.7**
20	Jalore	-	81.0	69,084.4	1,29,609.6	2,082.5	1,86,414.2	**3,87,271.7**
21	Pali	-	21,826.9	2,621.6	6,512.1	36,399.7	1,02,454.2	**1,69,814.5**
22	Sirohi	-	37,179.7	39,806.8	68,548.8	3,834.3	22,858.7	**1,72,228.3**
23	Kota	78,781.1	7,379.6	1,070.8	-	9.0	1,34,352.0	**2,21,592.5**
24	Baran	46,684.1	54,955.8	2,711.7	-	6.2	2,98,434.4	**4,02,792.2**
25	Bundi	1,37,887.6	1,09,749.5	1,500.0	3.5	434.2	1,15,192.2	**3,64,767.0**
26	Jhalawar	10,360.4	1,45,611.0	4,943.2	-	3.4	1,07,974.1	**2,68,892.1**
27	Banswara	24,195.6	2,30,319.2	1,087.3	5.2	21,180.9	51.1	**2,76,839.3**
28	Dungarpur	17,154.3	1,11,572.2	114.7	111.8	862.4	867.4	**1,30,682.8**
29	Udaipur	5,094.2	3,46,472.2	2,156.1	58.9	2,815.3	10,056.1	**3,66,652.9**
30	Pratapgarh	1,833.5	1,12,313.1	3,685.4	2.2	1,442.9	36,374.3	**1,55,651.5**
31	Bhilwara	1,198.1	4,96,127.8	24,591.8	37.7	92,131.7	75,628.0	**6,89,715.1**
32	Chittogarh	1,779.0	4,29,453.8	67,858.0	3.0	26,451.2	1,24,811.9	**6,50,357.0**
33	Rajsamand	62.4	1,95,409.1	4,848.6	3.0	8,762.6	2,070.4	**2,11,156.1**
Total Generation		**5,48,626.4**	**23,84,101.2**	**28,51,075.3**	**2,92,791.5**	**14,33,218.3**	**76,01,947.0**	**1,51,11,759.8**

Table 106:Species and District-wise Biomass Consumption Qty

Sl No	District	Cropwise Biomass Consumption (For FY 2017-18, FY 2018-19 and FY 2019-20)						
		Paddy	Maize	G.Nut	Castor	Cotton	Mustard	Total
1	Ajmer	12.4	49,151.9	2,196.0	239.7	15,822.8	68,316.1	**1,35,738.9**
2	Jaipur	-	3,016.3	88,272.9	-	995.7	2,94,117.5	**3,86,402.4**
3	Dausa	-	1,050.0	23,212.8	0.1	3.1	1,19,822.7	**1,44,088.7**
4	Tonk	3.0	24,185.0	26,899.7	42.9	562.6	5,88,778.2	**6,40,471.4**
5	Sikar	-	8.1	51,299.1	0.2	97.8	79,877.5	**1,31,282.7**
6	Jhunjhunu	-	1.3	73,284.0	50.7	4,611.1	1,39,591.0	**2,17,538.1**
7	Nagaur	-	43.0	68,333.3	46.8	51,025.4	1,36,758.8	**2,56,207.3**
8	Alwar	-	7,069.5	913.3	1.7	75,368.9	15,92,824.9	**16,76,178.3**
9	Bharatpur	2,378.5	2.5	9.1	2.6	12,485.6	5,323.0	**20,201.3**
10	Dholpur	1,187.5	-	47.4	1.6	38.4	72,925.1	**74,200.0**
11	Sawai Madhopur	3,149.8	880.9	1,869.5	-	0.8	52,929.3	**58,830.3**
12	Karoli	2,519.5	58.5	543.2	-	1.2	41,756.6	**44,879.1**
13	Bikaner	-	-	9,14,433.4	63.8	4,920.0	3,78,531.5	**12,97,948.7**
14	Churu	-	0.9	2,94,284.1	3.5	2,026.5	22,761.1	**3,19,076.1**
15	Jaisalmer	-	-	1,02,672.6	2,130.8	211.6	59,953.3	**1,64,968.3**
16	Ganganagar	1,17,446.5	85.8	8,157.4	173.6	2,63,863.7	7,84,217.0	**11,73,944.0**
17	Hanumanagar	96,600.4	50.0	21,244.8	1,591.1	3,44,034.7	3,46,787.3	**8,10,308.3**
18	Jodhpur	-	5.5	1,74,944.9	2,787.0	15,058.6	61,206.9	**2,54,002.9**
19	Barmer	-	38.0	3,956.5	9,157.5	-	3,745.4	**16,897.4**
20	Jalore	-	81.0	21,099.8	23,565.4	1,541.1	1,86,414.2	**2,32,701.4**
21	Pali	-	21,826.9	800.7	1,184.0	9,099.9	25,613.9	**58,525.4**
22	Sirohi	-	37,179.7	12,157.8	12,463.4	2,106.8	5,715.2	**69,623.0**
23	Kota	78,781.1	7,379.6	327.0	-	3.2	1,34,352.1	**2,20,843.1**
24	Baran	46,684.1	54,955.8	828.2	-	2.2	4,02,887.7	**5,05,358.0**
25	Bundi	1,37,887.6	1,09,749.5	458.1	0.6	434.2	74,877.0	**3,23,407.1**
26	Jhalawar	10,360.4	1,45,611.0	1,509.8	-	1.2	16,196.1	**1,73,678.5**
27	Banswara	24,195.6	2,30,319.2	332.1	0.9	3,192.5	51.1	**2,58,091.4**
28	Dungarpur	17,154.3	1,11,572.2	35.0	20.3	129.4	345.7	**1,29,256.9**
29	Udaipur	5,094.2	3,46,472.2	658.5	10.7	985.4	4,525.0	**3,57,746.0**
30	Pratapgarh	1,833.5	1,12,313.1	1,125.6	0.4	369.4	9,091.7	**1,24,733.7**
31	Bhilwara	1,198.1	4,96,127.8	7,510.8	6.9	23,025.9	34,032.7	**5,61,902.1**
32	Chittogarh	1,779.0	4,29,453.8	20,725.2	0.6	11,912.1	68,647.3	**5,32,518.0**
33	Rajsamand	62.4	1,95,409.1	1,480.8	0.6	3,066.0	1,138.9	**2,01,157.7**
Total Consumption		**5,48,327.8**	**23,84,098.3**	**19,25,623.5**	**53,547.2**	**8,46,997.9**	**58,14,111.8**	**1,15,72,706.5**

Table 107:Species and District-wise Biomass Surplus Qty

Sl No	District	Cropwise Biomass Surplus (For FY 2017-18, FY 2018-19 and FY 2019-20)						
		Paddy	Maize	G.Nut	Castor	Cotton	Mustard	Total
1	Ajmer	-	-	1,183.0	-	14,649.6	27,318.2	**43,150.8**
2	Jaipur	-	-	47,532.6	-	-	(57,901.6)	**(10,368.9)**
3	Dausa	-	-	12,498.9	0.4	5.2	51,351.5	**63,856.1**
4	Tonk	-	-	11,528.1	-	1,311.1	1,47,193.7	**1,60,032.9**
5	Sikar	-	-	27,622.2	0.7	-	14,095.8	**41,718.8**
6	Jhunjhunu	-	0.2	8,138.9	-	10,746.4	59,824.7	**78,710.2**
7	Nagaur	-	-	347.5	-	41,747.8	-	**42,095.3**
8	Alwar	298.6	-	160.9	-	25,121.7	(6,95,182.4)	**(6,69,601.2)**
9	Bharatpur	-	-	0.7	11.7	22.2	7,58,783.3	**7,58,817.9**
10	Dholpur	-	-	107.9	7.1	68.6	1,83,453.2	**1,83,636.8**
11	Sawai Madhopu	-	-	4,251.5	-	1.4	3,98,424.5	**4,02,677.4**
12	Karoli	-	-	662.0	-	2.2	2,36,618.8	**2,37,283.0**
13	Bikaner	-	-	1,35,017.9	286.9	5,904.7	(53,822.9)	**87,386.6**
14	Churu	-	0.1	31,699.6	15.6	3,620.4	1,47,274.7	**1,82,610.5**
15	Jaisalmer	-	-	13,950.4	9,588.4	378.0	19,985.5	**43,902.3**
16	Ganganagar	-	2.7	18,551.4	781.0	1,42,075.3	(71,294.0)	**90,116.4**
17	Hanumanagar	-	-	48,314.4	7,160.2	1,14,678.2	-	**1,70,152.8**
18	Jodhpur	-	-	3,97,855.3	12,541.5	85,340.1	3,46,840.9	**8,42,577.9**
19	Barmer	-	-	8,997.8	41,208.9	-	21,220.6	**71,427.2**
20	Jalore	-	-	47,984.6	1,06,044.3	541.5	-	**1,54,570.3**
21	Pali	-	-	1,820.9	5,328.0	27,299.8	76,840.4	**1,11,289.1**
22	Sirohi	-	-	27,649.0	56,085.4	1,727.5	17,143.5	**1,02,605.4**
23	Kota	-	-	743.7	-	5.8	-	**749.5**
24	Baran	-	-	1,883.5	-	4.0	(1,04,453.3)	**(1,02,565.8)**
25	Bundi	-	-	1,041.8	2.8	-	40,315.3	**41,360.0**
26	Jhalawar	-	-	3,433.4	-	2.2	91,778.0	**95,213.7**
27	Banswara	-	-	755.2	4.3	17,988.4	-	**18,747.9**
28	Dungarpur	-	-	79.6	91.5	733.1	521.7	**1,425.9**
29	Udaipur	-	-	1,497.6	48.2	1,830.0	5,531.2	**8,906.9**
30	Pratapgarh	-	-	2,559.8	1.8	1,073.5	27,282.6	**30,917.7**
31	Bhilwara	-	-	17,081.0	30.8	69,105.8	41,595.3	**1,27,812.9**
32	Chittogarh	-	-	47,132.8	2.5	14,539.1	56,164.6	**1,17,838.9**
33	Rajsamand	-	-	3,367.7	2.5	5,696.6	931.5	**9,998.3**
Total Surplus		**298.6**	**3.0**	**9,25,451.7**	**2,39,244.3**	**5,86,220.5**	**17,87,835.2**	**35,39,053.3**

13. Chapter 10: CONCLUSION & RECOMMENDATIONS

Conclusion

The biomass generated from agricultural activity is **1,51,11,759.8 MT** for an average of three years (FY 2017-18 to FY 2019-20) across all districts of Rajasthan and about **1,15,72,706.5 MT** for an average of three years (FY 2017-18 to FY 2019-20) across all districts of Rajasthan is consumed by local people and other industries for fodder, manure, domestic fuel, cooking fuel, fuel for thermal energy consumption, power consumption from other industries such as brick kiln, sugar industry and only about **35,46,890.8 MT** for an average of three years (FY 2017-18 to FY 2019-20) across all districts of Rajasthan is available as surplus for power generation in biomass power plants.

It was found that, on an average about of the biomass generated from agricultural activity goes for consumption in local for fodder, manure, fuel for thermal energy consuming industries, biomass power plants, brick kiln, etc. and about only is available for other activities or exported to nearby states. The major portion of Biomass Fuel Supply Study.

The Major Agro Based biomass considered for power generation are **Mustard Husk and Prosopis Juliflora**. However, as per the Biomass Policy 2010 Clause 13.1- Biomass as defined at clause No. 3.1 (2), following types of Biomass, produced within the State of Rajasthan, have only been considered for Power generation:

1. Paddy Straw
2. Maize Straw
3. Ground Nut Stalks
4. Castor Stem
5. Cotton Stalks

Table 108:Biomass Generation and Power Generation Potential

Sl No	District	Surplus/Deficit Net Quantity of Average biomass from Agriculture crops in Tons/Year	District Wise Biomass based power potential in MW (A)	Surplus/Deficit Net Quantity of Average biomass from Wasteland Prosopis Juliflora in Tons/Year	District Wise Biomass based power potential in MW (B)	Total Power Potential in MW C=A+B
1	Ajmer	43,150.8	3.3	56,387	4.32	7.6
2	Jaipur	(10,368.9)	(0.8)	61,197	4.69	3.9
3	Dausa	63,856.1	4.9	11,620	0.89	5.8
4	Tonk	1,60,032.9	12.3	31,704	2.43	14.7
5	Sikar	41,718.7	3.2	49,960	3.83	7.0
6	Jhunjhunu	78,710.2	6.0	25,549	1.96	8.0
7	Nagaur	42,095.3	3.2	89,359	6.85	10.1
8	Alwar	(6,69,963.2)	(51.4)	40,924	3.14	(48.2)
9	Bharatpur	7,67,017.5	58.8	11,987	0.92	59.7
10	Dholpur	1,83,636.8	14.1	45,992	3.53	17.6
11	Sawai Madhopur	4,02,677.4	30.9	42,563	3.26	34.1
12	Karoli	2,37,282.9	18.2	30,359	2.33	20.5
13	Bikaner	87,386.6	6.7	2,85,103	21.86	28.6
14	Churu	1,82,610.4	14.0	62,850	4.82	18.8
15	Jaisalmer	43,902.3	3.4	8,72,898	66.94	70.3
16	Ganganagar	90,116.4	6.9	88,269	6.77	13.7
17	Hanumanagar	1,70,152.9	13.0	10,533	0.81	13.9
18	Jodhpur	8,42,577.8	64.6	2,04,425	15.68	80.3
19	Barmer	71,427.2	5.5	3,14,332	24.11	29.6
20	Jalore	1,54,570.3	11.9	53,531	4.11	16.0
21	Pali	1,11,289.1	8.5	74,729	5.73	14.3
22	Sirohi	1,02,605.4	7.9	19,245	1.48	9.3
23	Kota	749.5	0.1	75,971	5.83	5.9
24	Baran	(1,02,565.8)	(7.9)	30,231	2.32	(5.5)
25	Bundi	41,360.0	3.2	25,699	1.97	5.1
26	Jhalawar	95,213.7	7.3	48,977	3.76	11.1
27	Banswara	18,748.0	1.4	22,607	1.73	3.2
28	Dungarpur	1,425.9	0.1	25,475	1.95	2.1

29	Udaipur	8,906.9	0.7	23,508	1.80	2.5
30	Pratapgarh	30,917.8	2.4	15,772	1.21	3.6
31	Bhilwara	1,27,812.9	9.8	84,074	6.45	16.2
32	Chittogarh	1,17,838.9	9.0	54,882	4.21	13.2
33	Rajsamand	9,998.3	0.8	72,347	5.55	6.3
	TOTAL	**35,46,890.8**	**272.0**	**29,63,058**	**227.23**	**499.2**
Source: Table 28 & 42						

The power potential arrived based on the average specific fuel consumption (SFC = 1.63 Kg/kWh or 1.63 Tons/ MWH) of all the biomass power plants in Rajasthan state.

$$\text{Potential} = \frac{\text{Surplus Biomass in Tons per Year Power}}{\text{(SFC Tons per MWH * 8000 Hrs per Year)}}$$

a. The above surplus biomass and power potential was prepared based on established data and hence can be counted as near realistic. Major Surplus Biomass available from agricultural activity is around 35,46,890.8 MT / year.

b. It was found that, on an average about 87.9 % of the biomass generated from agricultural activity goes for consumption in local for fodder, manure, fuel for thermal energy consuming industries, biomass power plants, brick kiln, etc, and about only 12.2 % is available for other activities or exported to nearby states. The major portion of wheat stalks, barley stalks, paddy hay, jowar stalks, bajra stalks, maize stalks are consumed by animal as fodder and these biomasses should not use as a fuel per the Policy for Promoting for Generation of Electricity from Biomass, 2010", so we considered 100% for consumption.

c. The major biomass consumed by the power plants are Mustard Stalks & Husk, Gaur Stalks, Prosopis Juliflora Wood and Cotton Stalks. The average cost of fuel mix, based on field data collected through personal interaction with the group of farmers/traders etc. and the average cost of fuel mix received from running biomass power plants, the average cost of biomass and its price escalation in the last three years available in the below table.

Table 109:Average Cost of Biomass

Year	Average Biomass Fuel Cost Based on field data & Primary survey. (Rs. Per MT/Month) (A)	Average Biomass Cost Based on Power plant fuel mix. (Rs. Per MT/Month) (B)	Average biomass cost (Rs. Per MT/Month) C=(A+B)/2	Average Escalation Per Year
FY 2018-19	Rs. 3046	Rs. 2754.75	Rs. 2,899.88	
FY 2019-20	Rs. 3164	Rs. 2668.19	Rs. 2,917.10	**0.59 %**
FY 2020-21	Rs. 3279	Rs. 2778.92	Rs. 3,028.46	**3.81**
Source: Table No. 94 & 95.				

Considering the increase in the Diesel & Transportation price and above-mentioned Escalation trend biomass price will be increased at 4 % escalation, average biomass price forecasting in following two years for each MT would be as below:

1. FY 2021-22 – Rs. 3,149.60 Per MT
2. FY 2022-23 – Rs. 3,275.58 Per MT

Calorific Value and Moisture Content of Major Biomass:

Table 110:Calorific Value & Moisture Content

Sl.No.	Biomass	Moisture %	GCV in Kcal/Kg
1	Mustard Stalks & Husks	10 to 12	3353
2	Guar Stalks	10 to 12	3400
3	Cotton Stalks	35 to 40	2800
4	Juliflora	35 to 40	2845

Source: Primary Data and Chapter 6

Mustard Stalks and Husk is the primary biomass for biomass power plants in the state of Rajasthan. Guar Stalks, Cotton Stalks and Prosopis Juliflora Wood also used in Biomass power plants. The calorific value and moisture content of Mustard Stalks & Husk, Guar Stalks, Cotton Stalks and Prosopis Juliflora Wood are given in above Table.

Table 111:Average Biomass Stacking, Covering, Feeding Cost and Storage Loss

Sr. No	BIOMASS STACKING & FEEDING COST	Rs per MT
1	Stacking & Covering Including LDPE Sheet Cost Rs/MT	133
2	Feeding Cost Rs/MT	364
	Average Total Cost	**497**
3	Biomass Storage & Handling Loss	7.5 %
Sources: Table No 98 & 99.		

Recommendations

1. Factors Affecting Biomass Pricing. The Pricing Matrix of Biomass in a region (Upto 30 to 100 kilometres; when supplied as raw biomass) will eventually be governed by the following real-time and static factors: -(a) Weather disruptions and it's corresponding effect on both crop aggregation and storage. (b)Transportation model variations as that will / may include multiple modes including tractors, trucks etc. (c) Availability of labour at all concerned sites and depots. (d)Indulgence of the Village Level Entrepreneurs (VLE) and ex-trade suppliers, if any.

2. **Measures to Obviate Price Surges and Hikes**. Some of the measures listed below, which when taken singularly or, in combination, could lead to stable biomass pricing mechanisms: -

a) Capitalise the market supply through proactive negotiations prior to the cropping season and to be purchased from farmers only.

1. Develop Supply Chain Management through reputed Biomass Supply Chain Management companies which have better experience.
2. De-risk supply chain by having more suppliers, if dealing directly with farmers (Not going through a Supply Chain Management Company).
3. Have a technical-specification based pricing model and have transparency with the suppliers, if dealing directly with farmers (Not going through a Supply Chain Management Company).
4. De-risk the transportation system and have a Contract-based logistics system, if dealing directly with farmers and logistics companies (Not going through a Supply Chain Management Company).
5. Sign long-term contracts with Supply Chain Management Company or, all elements of Supply Chain if doing it independently.
6. Have enough reserves of suppliers to cater to market volatility.
7. Gradually earmark area and have self-produced or, contracted-production based, high GCV crops. State Government could allot dedicated land for the purpose.
8. Have State-of-the-Art Storage facilities and climate control systems for storage of biomass. Dedicated land may be allotted for this purpose too.

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