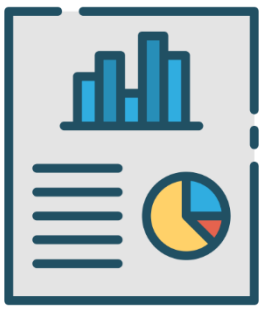
Final Report

Assessment of biomass demand-supply value chain and entrepreneurship development for pellet production in selected clusters/districts



Prepared by

Bio Trend Energy Pvt. Ltd.

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LIST OF ABBREVATIONS

LPG	:	Liquefied Petroleum Gas
MNRE	:	Ministry of New and Renewable Energy
UP	:	Uttar Pradesh
UPNEDA	:	Uttar Pradesh New and Renewable Energy Development Agency
MSMEs	:	Micro, Small and Medium Enterprises
HHs	:	Households
MDM	:	Mid-Day Meal
KVK	:	Krishi Vigyan Kendra
DIC	:	District Industry Center
DAO	:	District Agriculture Office
SHG	:	Self Help Group
LDO	:	Light Diesel Oil
PNG	:	Piped Natural Gas
CNG	:	Compressed Natural Gas
CRR	:	Crop to Residue Ratio
CFA	:	Central Financial Assistance

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Chapter 1: Introduction

Agriculture in India is the means of livelihood for almost two-thirds of the work force in the country, with more than 600 million people involved in agriculture or agriculture-related activities. India has 140 million hectares of land under crop cultivation with a large variety of crops being grown. A substantial amount of crop residues is generated post-harvest and is not utilized and burned to clear fields for sowing the next crop. It is estimated that about 683 million tons of crop residue is produced annually from 11 major crops grown in India. The total annual surplus crop residues are estimated to be approximately 178 million tons.

Air pollution is a serious concern in India, which becomes even more severe during post-harvest seasons. Agricultural residue burning has emerged as an important contributor to very high pollution levels during the months of October and November. This results in release of high volume of particulate matter which has not only serious repercussions on health and the environment but is also a major loss of nutrients and energy which could be tapped for more productive use.

There are many energy-intensive industries among MSMEs that use fossil fuels like coal, oil and gas lead to adverse environmental impacts, especially at the local level. In recent times, the prices of fossil fuels have gone up substantially higher and are in short supply. Higher input energy cost has adversely affected their operating margins. For this reason, fuel switching, and use of biomass pellets is at the centre stage for improving the competitiveness of the sector and reducing carbon emissions. The use of pellets in a cleaner energy form can contribute significantly to meeting the overall energy needs of the country in a sustainable manner's.

Agriculture residues have always played a major role in meeting the energy requirements for many centuries. By virtue of recent policy initiatives, technology advances, modern biomass conversion technologies/processes which can convert these biomass resources into various new energy forms and are playing an important role in bringing about a change in energy transition by providing sustainable fuels for meeting energy demand in industries, power generation and transportation applications. In India's quest for sustainable and affordable energy sources to bridge its supply demand imbalance, bio-energy can plays an important role to meet this challenge

Biomass as renewable resource for India can play important role to achieve a net-zero carbon emissions economy by 2070.

1.1 KEY OBJECTIVE:

- ❑ To undertake an in-depth study for assessments of biomass demand-supply value chain and entrepreneurship development for pellet production in two clusters/Districts viz. Indore in Madhya Pradesh and Bareilly in Uttar Pradesh.
- ❑ Development of qualification Pack for different job roles in collection and manufacturing of biomass pellet.
- ❑ Recommend potential model and skilling plan in the sector.
- ❑ Identify five locations per cluster/District for setting up decentralized pellet production plants.

1.2 SCOPE OF WORK

- ❑ Supply and demand of various types and quantity of agro-residues availability.
- ❑ To assess the existing and future demand of processed biomass fuels in industries, power plants, HHs and commercial establishments.
- ❑ Formulation of an optimized plan for supply chain management
- ❑ Literature review and desk-based research to assess the demand and supply scenarios for pellets considering institutional, industrial, and commercial users in shortlisted locations.
- ❑ To collect the input data for this study by relevant agencies and physical verification.
- ❑ To prepare a questionnaire to identify demand and willingness to pay for pellet-based applications.
- ❑ Interviews with stakeholders and local agencies to identify potential demand.
- ❑ Latest Conversion technologies in the market for converting solid biomass into pellets.
- ❑ Suggest models for setting up decentralized pellet production plants.
- ❑ Detailed assessments in terms of availability of biomass resources, aggregation, transportation and storage requirements, conversion and its linkage with end-users and identification of five locations per cluster viz. Indore in Madhya Pradesh and Bareilly in Uttar Pradesh for setting up of decentralized pellet manufacturing unit.
- ❑ Analyses value-chain covering demand & supply of biomass fuel considering a suitable catchment area in the identified locations.

- ❑ Industrial/Institutional visits to understand the use of pellet application, projected seasonal demand trends to set up a small-scale decentralized production plant in the identified sites.
- ❑ Conduct Skill gap study, prepare occupation map and identify probable job roles in collection and manufacturing of biomass pellet.
- ❑ Develop qualification pack in the identified job roles in supply and demand aggregation, transportation and storage of feedstock operations and services for biomass pellet manufacturing.

1.3 Study Methodology and Process

- The methodology primarily consisted of desk-based literature research, consultations with key stakeholders at State/district level, field visits to study districts and field data analysis. The activities were grouped in three distinct phases as presented in figure 1.

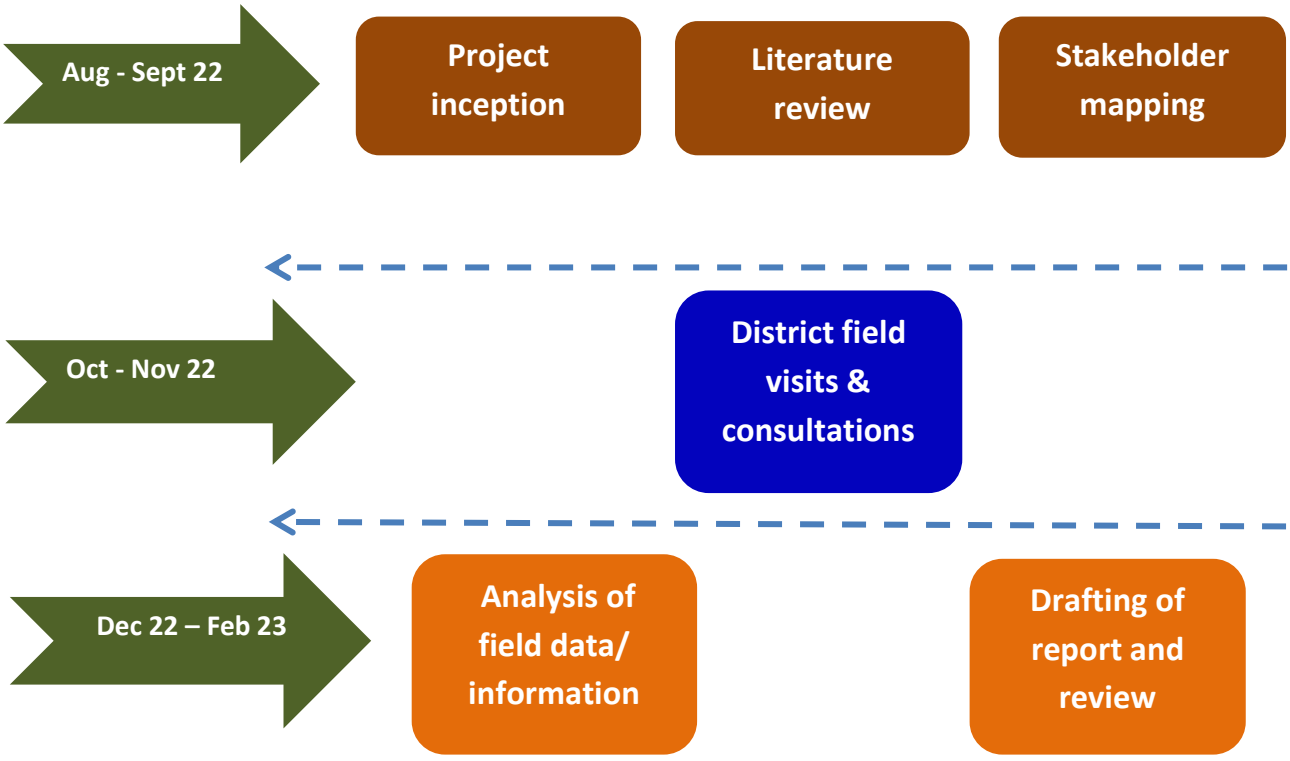


Figure 1: Methodology adopted to undertake study of the district

- The overall approach includes mapping and collection of various policies, programs and schemes in these states, following up it with identification of agro-residues value chain, prevalent fuel and energy applications with focus on agricultural value chains, and stakeholders' identification. The work is supported with field surveys and stakeholder consultations at district level industries and agencies. Field visits were conducted to the study districts and interactions were held with farmers and relevant stakeholders and got direct feedback from the field. Based on the above methodology and activities, analysis was done.

1.3.1 The methodology used in study is outlined below:

i) Collection of information/data

Table 1.3.1 List of different stakeholder interviews during the survey

S.No.	Stakeholder agencies	Purpose
Supply Side		
1	State / district Agriculture Department	• To collect information related to crop-wise production data of specified crops in different blocks of the district
2	Farmers	• To collect information about biomass residue production, its current uses, disposal methods, and other details
3	Biomass Aggregators, Processors and Traders	• Collection of data related to biomass price dynamics, seasonal availability, storage and freight details
5	Transporters	• Collect the data related to logistics issues related to transportation of biomass
Demand side		
7	District Industrial Center (DICs) and MSME-DI	• Number of registered and un-registered MSMEs in the district • Information about plywood industries, paper mills, sugar mills, and jaggery units • Energy consumption details in the MSMEs in the district

ii) Survey Questionnaire

A detailed questionnaire, provided in Annexure I, was prepared to capture information/data from farmers, institutions, MSMEs, biomass traders, and biomass user industries and institutions. The sample size selected to cover different stakeholders for primary research work during field visit is given in Table 1.3.2

Table 1.3.2 Sample size for primary survey work

S. No.	Demand/supply units	Indore	Bareilly	Total
1	MSMEs (Demand Side)	8	5	13
1.2	Midday Meals/Hostel Mess, etc.	2	2	4
1.3	Hotels/ Dhaba/ Restaurants	2	2	4
	Sub – Total	**12**	**9**	
2.1	Biomass Traders	3	2	5
2.2	Transporter	2	2	5
2.3	Farmers	10	12	22
	Sub – Total	**15**	**16**	
	Total	**27**	**25**	

iii) Interview with district-level agencies

Visits to district headquarters were conducted in order to obtain information about production of crops residues, its current utilization, surplus availability, cost parameters, demand of fuels in MSMEs, institutions and commercial establishments, and interaction with local stakeholders. The key stakeholder interviews of concerned officers at the district level in the Krishi Vigyan Kendra, District Industry Centre, were made through one-to-one meetings.

iv) Primary survey research

The work involved visits to 21 units across two districts and the primary research work conducted to study the supply chain of agricultural residues. During primary research work the status of biomass from demand and supply side were studied

thoroughly by interviewing industrial sector, farmers and biomass traders. Data was collected from sample MSME units, such as brick kilns, , sugar mills, namkeen units and institutions like midday meals, hostel mess, beside hotels/dhabas about their present energy consumptions, type of fuel used, daily/annual quantity of fuels used and its cost. The survey conducted the willingness to shift to cleaner forms of biomass fuels. The prices of different fuels used in the district were also collected during the survey.

v) Recommendations for implementation of pellet production plant

Based on the primary survey findings and analysis combined with BTE's expertise in the sector, recommendations were made. Specific recommendations with regard to biomass collection, its supply chain management, and awareness about biomass pellet fuels have been provided.

- An extensive review of available literature published reports, and web portals of different Ministries and Government of India and Government of Uttar Pradesh was carried out. Based on this review, details about data collected from various sources for shortlisting potential districts on the basis of biomass assessed are given in Table 1.3.3.

Table 1.3.3 Secondary data collected from different sources

Data collected	Source
District-wise land use and land cover	District Agriculture Office, Barielly and Indore
District-wise crop production data	District Agriculture office, Barielly and Indore
Crop to Residue Ratio (CRR)	Report of Technology Information, Forecasting and Assessment Council (TIFAC), 2018
Crop wise residues surplus fraction	References: Based on Ministry of Agriculture and Farmers Welfare Statistics (MoA), 2015 Estimates; Jain et. al. (2014), IARI.
District-wise number of MSMEs	District Industries Centre, Indore and Barielly www.msmeindore.nic.in/http://dcmsme.gov.in/old/dips/Bareilly.pdf

1.4. Review of key bioenergy policies and programs undertaken by National and State Government

1.4.1 National Government

- MNRE has launched a programme Scheme to Support Promotion of Manufacturing of Briquettes & Pellets and Biomass (Non-Bagasse) Based Cogeneration in Industries in the Country" for the period of FY 2021-22 to 2025-26. The objective of the Biomass Programme is to support setting up of Biomass Briquette/Pellet manufacturing plants and to support Biomass (non-bagasse) based cogeneration projects in Industries in the country. The broader objectives of the scheme are to reduce stubble burning by utilizing surplus agricultural residue, to provide additional source of income to farmers through sale of surplus agro residue and to enable better environmental practices and reduce pollution. CFA provision of Rs. 9 Lakh per MTPH (metric ton/hour) manufacturing capacity (maximum CFA of Rs 45 Lakhs per plant)
- Ministry of Power has recently notified revised policy for Biomass utilization for power generation through co-firing in coal-based power plants. As per the policy, all the coal-based power plants are mandated to use 5% blend of biomass pellets along with coal from October 2022. Further such blending is to be increased to 7% from the subsequent year. This has resulted in demand of agro residues-based pellets in TPSs. It is estimated that annually about 35 million tons of biomass pellets is needed to meet this target.
- National Biofuel Policy 2018 - This policy outlines development of biofuels to utilize waste. The policy is aimed at taking forward the indicative target of achieving 20% blending of biofuels with fossil-based fuels by 2025. Thrust is given to advanced 2G biofuels technologies including conversion of agricultural residues/waste which can be converted to ethanol and bio-CNG. Under this program, Sustainable Alternative Towards Affordable Transportation (SATAT) was launched by Minister of Petroleum and Natural Gas an initiative with PSU Oil Marketing Companies (OMCs, i.e. IOC, BPCL and HPCL) inviting Expression of Interest (EoI) from potential entrepreneurs to set up Compressed Bio-Gas (CBG) production plants and make available CBG in the market for use in automotive fuels by better usage of agricultural residue, cattle dung and municipal solid waste. The policy aims to roll out 5,000 Compressed Bio-Gas plants across India in a phased manner. This initiative is expected to produce 50 million tonnes of bio-manure for crops.

1.4.2 State Governments

Uttar Pradesh Bio Energy Policy

- Uttar Pradesh government launched its Bioenergy Policy 2022 to boost bioeconomy and reduce dependence on fossil fuels. Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) is the nodal agency for implementing this scheme across the state. The scheme provides a subsidy of Rs 75 lakh per tonne of CBG, Rs 75,000 per tonne of bio-coal and Rs 3 lakh per kilolitre of biodiesel, with a cap of Rs 20 crores.

- Key highlights of the policy are.

a. Electricity tariffs and tax exemptions

i. Bioenergy units will get a 100 per cent electricity charge waiver for ten years from the date of product commencement. Stamp duty for rent agreement, lease and sale deed registration fees for the land for units has been waived too. Additionally, the state's development authority will charge no development charges.

b. Land on lease @Rs 1 per acre

i. Under this policy, the state's revenue department will provide land (on non-transferable lease) at the rate of Re 1 per acre to feedstock aggregators and bioenergy plant establishers for a maximum of 30 years.
ii. Moreover, if an investor infuses Rs 50 crores or more in a bioenergy plant, a 5 km approach road connecting it with the main highway will be constructed as well.

c. Incentives on equipment

i. Agricultural equipment receives a subsidy under the central government's Sub-Mission on Agricultural Mechanization (SMAM) scheme.
ii. The state government will also provide a 30 per cent subsidy (max Rs 20 lakh) on purchasing equipment like balers, rakers and trolleys that collect compress and transport agricultural waste from farms.
iii. The scheme was established to boost agricultural mechanization in the nation and increase inclusivity. It provides subsidies going

up to 40-50 per cent for purchasing certain types of agricultural machinery and equipment in almost all states.

iv. In the north-eastern states, the subsidy is 100 per cent, going up to a maximum of Rs 1.25 lakh per user.

d. Online portal for single window clearance

i. UPNEDA's Bioenergy online portal went live on October 15, 2022, for easy application and improved transparency. It has a single-window clearance for potential investors, wherein they could directly file and monitor the progress of their applications.

e. Coordination among state departments

i. A project officer will be deployed in each district to help potential investors and will be the focal point of contact to facilitate necessary approvals from the district magistrate's office.

The study report is prepared with aims at to enhance access to clean forms of bioenergy at affordable prices through detailed need assessment and availability of biomass resource potential in two specific districts namely, Bareilly in UP and Indore in MP.

Uttar Pradesh and Madhya Pradesh are one of the large states with varied cropping patterns in different districts and regions, has been selected to conduct this study. The Bio Trend Energy (BTE) team undertook a thorough study on the supply and demand side factors for setting up decentralized pellet production plants and identified high potential sites in Bareilly and Indore—and presented its findings in this report.

Chapter 2: District Bareilly

This chapter provides an overview of Bareilly district, its location, social conditions, potential of different types of biomass resources, its current usage and demand of fuels in institutional, industrial, and commercial applications, different fuel types used and their respective cost details. Various factors such as climatic conditions, geology, social status, industries, and institutions which can influence the availability of biomass and its subsequent usage are also discussed.

2.1. Location

Bareilly is a city in the northern Indian state of Uttar Pradesh, located near Ramganga. It is a Commissionery district and falls under geographical region Rohilkhand. The city is 252 kilometres (157 mi) north of the state capital, Lucknow, and 250 kilometres (155 mi) east of the national capital, New Delhi. It is the seventh-largest metropolis of Uttar Pradesh and the 50th-largest city of India. Bareilly also figured among the ambitious 100 Smart City project in India. The city is also known by the name NathNagri (known for the four Shiva temples located in four corners of the region – DhopeshwarNath, MadniNath, AlakhaNath and TrivatiNath), Bareilly Sharif (AlaHazrat, ShahSharafat Miyan and KhankaheNiyazia (derived the famous Muslim Mausoleum)), Zarinagari and historically as Sanjashya (where the Buddha descended from Tushita to earth). The city is a center of furniture manufacturing and trade in cotton, cereal and sugar. Its status grew with its inclusion in the "Counter Magnets" list of the National Capital Region (NCR). The city is also known as Bans-Bareilly.

Geographically, the district lies at 28037'N latitude, 79043'E longitude and 166 m altitude. In the year 2019, there was a total 1.09% forest area of total geographical area. The district encompasses a geographically area of 4,120 sq. km, and in terms of geographical area it occupies the ranks of 21st in the state and 286th in India. It is surrounded by Udham Singh Nagar district of Uttarakhand on the north, Badaun district on the south, Pilibhit district on the east and Rampur district on the west. The major river in the district that passes through the district is Ramganga River.The district is administratively divided into 06 tahsils namely Aonla, Baheri, Bareilly, Faridpur, Nawabganj and Meerganj. For implementation and monitoring of development scheme the district is divided into 15 Development Blocks namely Shergarh, Richa, Baheri, Nawabganj, Bhadpura, Mirganj, Fatehganj Pashchimi, Bhojipura, Kyara, Bithrichampur, Ramnagar, Alampur Jafarabad, Majhgawan, Faridpur, and Bhutta. Total area of the district is 4120.0 Sq. Km and district map as shown in Fig. 2.1. The rural area covers 3841.9 Sq. Km. and urban recorded 278.1 Sq. Km. There are 1007 Gram

Panchayats and 2051 Revenue villages with 1855 inhabited villages and 196 uninhabited villages in the district. In urban area there are 21 statutory Towns and 10 Census Towns. Statutory Towns comprises of 01 Nagar Nigam (Municipal Corporation), 04 Nagar Palika Parishad, 15 Nagar Panchayats and 01 cantonment Board.

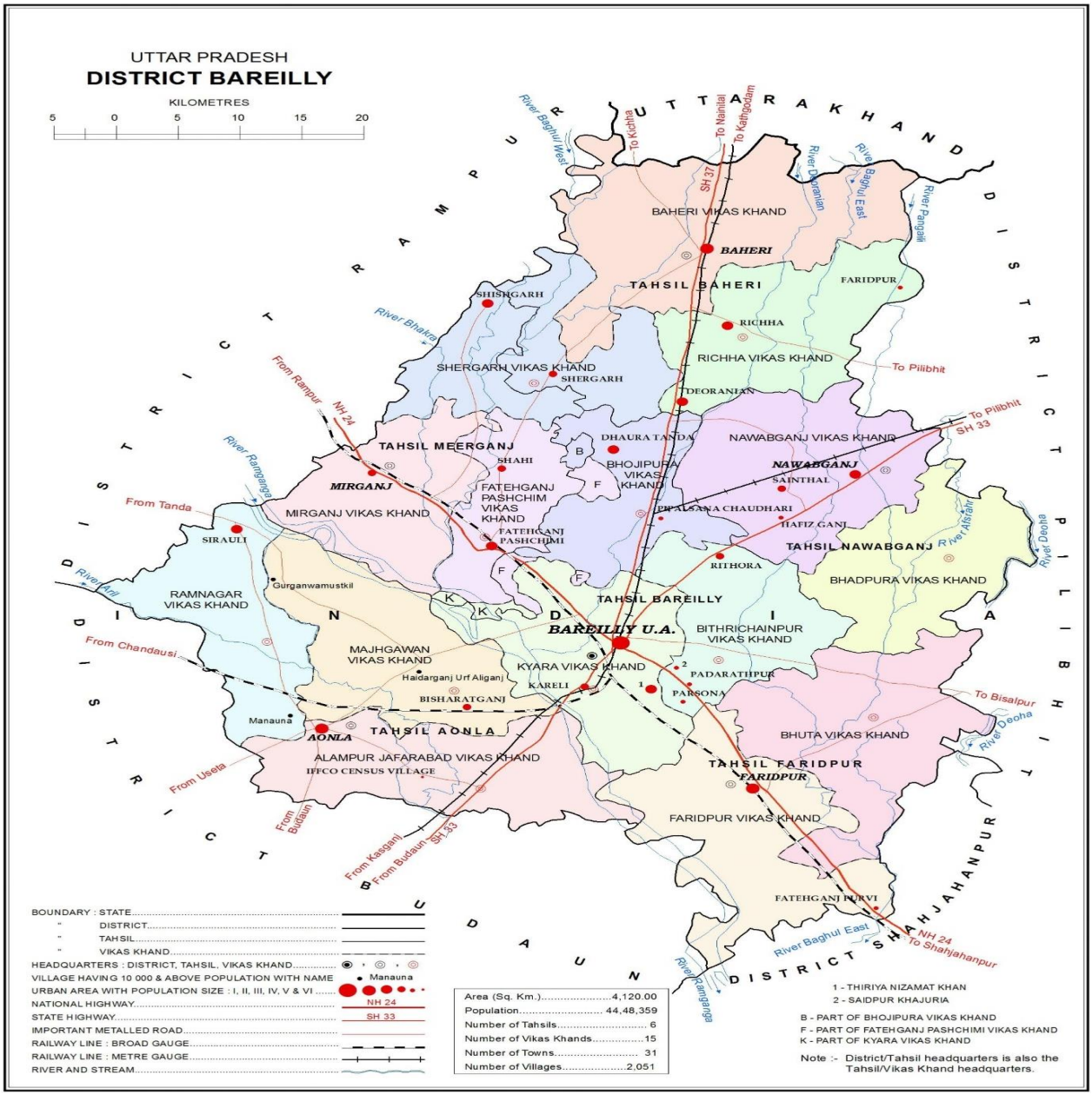


Figure 2.1 District map of Bareilly

Bareilly district has total area under agriculture about 478387 ha and major crops grown are Rice, Sugarcane, Mustard, wheat and others. As per estimate, there is about 4093 KT crop residue is generated annually in the district as given in Table 2.1

Table 2.1 Crop types, Area, and Biomass Generation

District Area	**412000 Ha**
Major Crops	Rice, Sugarcane, Mustard, Wheat
Minor Crops	Gram, Corn, Jowar
Area under agriculture	478387 Ha
Total Biomass Generation	4093 KT (Year 2021)

2..2 Climate

The climate of the district is same as that in the other sub-Himalayan districts in the state. It is influenced by district's proximity to the hills and tarai swamps of the north. Although the air is dry in summer it contains moisture during the rest of the year. The cold season from December to February is followed by summer, which continues till June. The southwest monsoon then ushers in rainy season and lasts till the end of September, October, November constitute the post monsoon season. There is a metrological observatory at Bareilly the records of which may be taken. The coldest month of the district is January with minimum temperature 4-6 °C and maximum temperature 40-46°C was observed in June. The hot dry and often dusty westerly blow in may to June months. The average rainfall of the district is 100-120 Millimeter. The rainfall generally increase from southwest towards the north-east.

2.3 Social conditions

The district of Bareilly has 6 tehsils, 15 blocks, 304-gram panchayats and 348 villages. Bareilly has a majority of Hindus, with 58.58% following Hinduism according to the 2011 Indian Census. Islam is the second most followed religion in the city, with about 38.80% followers. Sikhism (0.90% followers). Christianity (0.78% followers), Jainism (0.05% followers),and Buddhism (0.05% followers) are also practiced in the city. Apart from that, about 0.03% people follow some other religions, while about 0.81% of the people did not state their religion.

2.4 Agriculture Status- Bareilly

The cropping pattern in the district consists of three harvests Kharif, Rabi and Zaid, the first has always been the most important. The Kharif crop occupied more than 75 per cent of the cultivated area. The main crops under Kharif are Rice, Sugarcane, Jowar, Corn etc. Rabi is the next important harvest in the district. It occupied more than 55 per cent of the cultivated area the main crops are Wheat, Pea, Gram, Mustard etc. Zaid, the third extra harvest of the district has always covered less than 2 per cent of the district cultivated area.

Most of the area available for cultivation in the district is irrigated. The main source of irrigation in district is private tube well, which covers Maximum area of the total irrigated area in the district, second largest source of irrigation is canal.

Table 2.2 District Bareilly at a glance

Total Area	412000 Ha
Total Population	904797 (as per census 2011)
Population density	220/km^2
Crop cultivation	320006 Ha

2.5 Agriculture profile of the district

The block wise geographical area, net sown area and gross cropped area was collected and complied as given in Table 2.3. The block Nawabganj has maximum gross crop area 54328 ha and Ramnagar has minimum gross crop area 18005 ha.

Table 2.3 Block wise geographical, net sown and gross cropped area in the district

Blocks	Geographical Area (in ha)	Net Sown area (in ha)	Gross Crop area *(in ha)
Majhgawa	30483	22862.25	20361.84
Alampur Zafarabad	29505	25374.3	19912.13
Ramnagar	21951	18658.35	18004.91
Bhojipura	18656	15297.92	37705.31
Bhuta	31286	26905.96	26824.88

Bhadpura	25456	19855.68	45073.29
Fatehganj	16555	12912.90	29211.66
Nawabganj	32675	28754	54328.74
Damkhoda	25800	21930	46895.97
Bahedi	39895	35107.6	51076.30
Shergarh	26127	24298.11	32680.38
Meerganj	21107	16674.53	35266.66
Bithri Chainpur	19300	15633	22388.09
Fareedpur	27127	22244.14	19389.00
Kyara	14060	13497.6	19268.34
Total	379983.00	320006.34	478387.50

Source: Census 2011,

*Data obtained from District Agriculture Office, Bareilly

2.6 Biomass resources availability

2.6.1 Biomass from agriculture

Primary research work was conducted to analyze the average land holding, crops grown in different seasons and their productivity, and biomass generated and its use in domestic and other sectors.

As per the data collected from district agriculture office, Division wise crop residue data is analyzed to identify potential surplus clusters as shown in Table 2.4

Table 2.4 Block wise area, crop residue and surplus in Bareilly

Blocks	Total area in ha	Total crop residue in KT	Total Surplus in KT	Biomass density (tonne/ha)
Majhgawa	20361.84	57.20	24.62	2.81
Alampur Zafarabad	19912.13	67.28	26.19	3.38
Ramnagar	18004.91	62.81	26.35	3.49
Bhojipura	37705.31	255.24	83.23	6.77
Bhuta	26824.88	191.39	60.56	7.13
Bhadpura	45073.29	358.09	109.57	7.94
Fatehganj	29211.66	261.31	79.50	8.95
Nawabganj	54328.74	490.90	142.95	9.04
Damkhoda	46895.97	445.65	131.12	9.50
Bahedi	51076.30	501.46	144.85	9.82
Shergarh	32680.38	330.84	97.15	10.12

Meerganj	35266.66	361.58	104.81	10.25
Bithri Chainpur	22388.09	251.89	71.22	11.25
Fareedpur	19389.00	228.67	64.24	11.79
Kyara	19268.34	229.31	64.14	11.90
Total	**478387.50**	**4093.62**	**1230.50**	

Source: DAO, Bareilly

The total amount of crop residue generated from different crop types grown in the district is estimated based on RCR (Residue to crop ratio) and dry matter fraction factor for these crop types are given in in Table 2.5 to estimate crop residue and surplus quantity for each crop type.

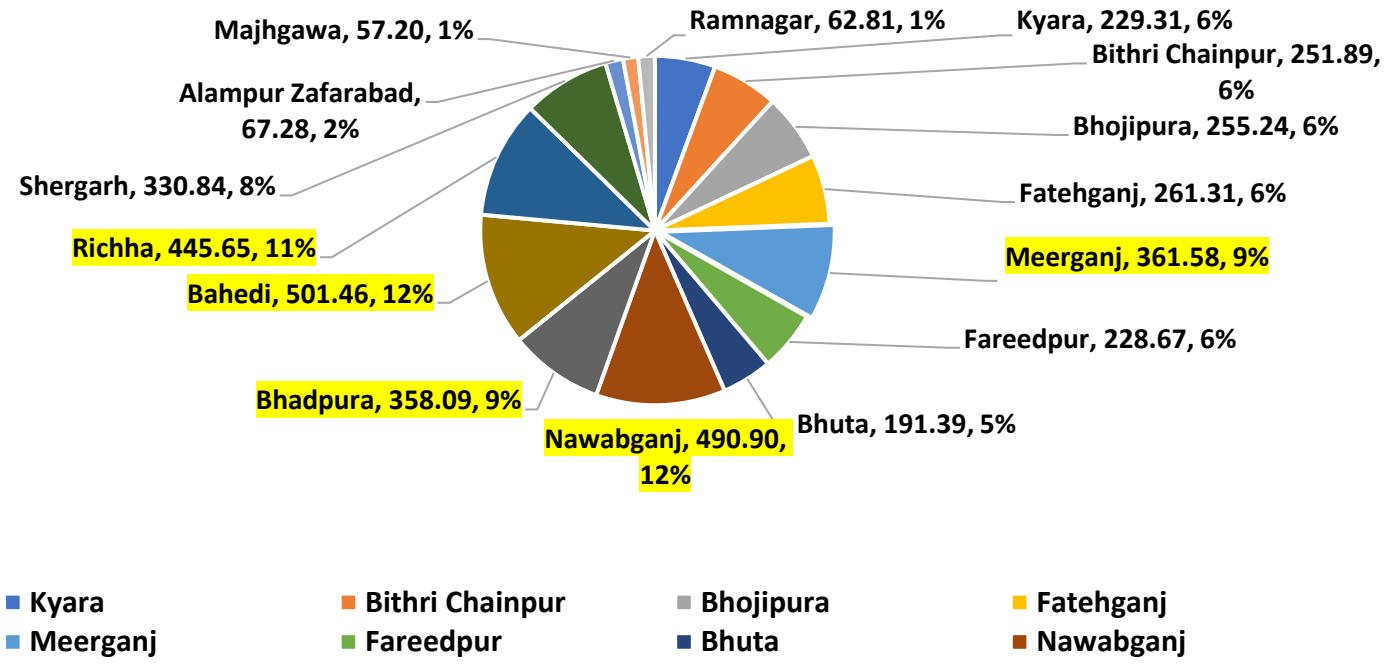
Table 2.5 crop residue ratio (CRR), dry matter fraction and surplus fraction of different crops

Crop	CRR	Dry matter fraction	Agri surplus fraction
Tur*	1.5	0.8	0.1
Gram*	1.5	0.8	0.1
Ground nut	2	0.86	0.3
Corn	1.5	0.8	0.4
Mustard	3	0.8	0.29
Sugarcane	0.4	0.88	0.25
Rice	1.5	0.8	0.86
Wheat	1.7	0.88	0.23
Sesame*	3	0.8	0.1

Source: TIFAC, 2018

**References: Based on Ministry of Agriculture and Farmers Welfare Statistics (MoA)*

Fig. 2.2 Block-wise distribution of crop residues generation (in KT)



It can be seen from the Figure 2.2, the maximum crop residue generation is in Bahedi and Naeabganj having 501 and 490 KT respectively followed by Richha, Meerganj and Bhadpura blocks in the district. However, crop residues density is maximum in Kyara block with 11.90 MT/ha and Fareedpur block with 11.79 MT/ha which are predominantly rural populations.

The crop residues in the district are mainly used as fodder to cattle feed and other household uses, such as roofing and manure purposes. The residues of rice, mustard and sugarcane are mainly not utilized and found to be surplus and can be potentially available for pellet-making applications.

The potential blocks identified based on maximum crop residues surplus generation potential are, Bahedi, Nawabganj, Richha, Meerganj, Bhadpura, in the district as highlighted in Fig. 2.2. These selected clusters are shortlisted for setting up biomass pellet Production enterprises.

Based on discussion with the district agricultural officer and local villagers, it was found that the surplus availability of rice, mustard and black gram residues is only in those blocks where farmers have large landholdings.

Crop wise residues generation and its surplus quantity data is further analyzed as shown in Table 2.6 It can be seen from the table sugarcane, rice, wheat, and mustard crop residues generation is maximum in the district. The crop residue types have good physio-chemical properties as fuel and recommended raw materials for pellet production applications.

Table 2.6 Various crop types with crop residue and surplus generation

Types of crops	Area under agriculture (in ha)	Crop residues generated (in tons)	Surplus Generated (in tons)
Sugarcane	108856.97	2946168	736542
Corn	335.70	949.55	379.82
Gram	21401.53	34480	3448
Tur	179.02	218	22
Mustard	27104.73	45538.52	13206.17
Rice	132963.16	410110	328088
Wheat	136011.65	642569	147791
Bajra	6860.77	14408	1441
Jowar	16404.07	24022	2402
Sesame	7436.32	1284	128
Total	**457554**	**4119747**	**1233448**

Source: DAO, Bareilly

The total amount of agri-residue generated from a particular crop can be estimated from of crop production, residue to crop ratio and dry matter fraction in the crop biomass. The RCR (Residue to crop ratio) ranges from 0.4 to 1.5 for different crops. For most of the crops the dry matter fraction factor ranges from 0.8 to 0.88 and given in Table 2.5 for estimating surplus generation. The maximum surplus agro-residues is from sugarcane, rice, wheat and gram.

2.7 Estimating raw material supply to Biomass pellet plant

The total number of biomass pellet plants that can be set up based on surplus biomass availability in each block assuming 5 km radius catchment area is calculated

for 1 TPH capacity biomass pellet mill capacity, about 4500 tons of agro-residues annually are required on 300 days operation cycle. The potential number of biomass pellet plants is estimated for each block in the district and given in Table 2.7. It can be seen from the Table 2.7 about 55 small scale pellet production plants can be potentially set up in the district.

Table: 2.7 Available amount of crop residue in different blocks at a radius of 5 km

Blocks	**Total area (in ha)**	**Total crop residue (in KT)**	**Total Surplus (in KT)**	**Available annual quantity of crop residue (Q_a) in a radius of 5 km (in MT)**	**Potential number of pellet plant (1 TPH)**
Majhgawa	20361.84	57.20	24.62	9491.2	2
Alampur Zafarabad	19912.13	67.28	26.19	10325.7	2
Ramnagar	18004.91	62.81	26.35	11487.7	2
Bhojipura	37705.31	255.24	83.23	17328.8	3
Bhuta	26824.88	191.39	60.56	17722.5	3
Bhadpura	45073.29	358.09	109.57	19083.6	4
Fatehganj	29211.66	261.31	79.50	21362.9	4
Nawabganj	54328.74	490.90	142.95	20654.3	4
Damkhoda	46895.97	445.65	131.12	21948.3	4
Bahedi	51076.30	501.46	144.85	22262.4	4
Shergarh	32680.38	330.84	97.15	23335.1	4
Meerganj	35266.66	361.58	104.81	23330.0	4
Bithri Chainpur	22388.09	251.89	71.22	24971.3	5
Fareedpur	19389.00	228.67	64.24	26010.2	5
Kyara	19268.34	229.31	64.14	26129.1	5
Total	**478387.50**	**4093.62**	**1230.50**	**295443.0**	**55**

2.8 Demand analysis: Fuel demand in the industries

Primary research work was conducted in various industries, institutions, and commercial establishments in the district to understand the demand of different fuel types, their usage, and cost parameters.

As per the data collected from DIC office, the district has total of 15626 industrial units are registered, out of which 1607 are agro-based units and 578 wood/furniture-making units. Majority of the other units belong to Garments, Agro and servicing as

shown in Table 2.8. As per data collected from DIC, Bareilly most of the small and medium industries are established in the industrial area known as Parsakhera and Bhojipura. There is no sub-classification of the industries; by the type of fuels used data is available with DIC to estimate the demand of fuels in MSMEs sectors. Based on survey and discussion with key local expert, the industry-wise estimated number of MSMEs using fuel for process heating is prepared as shown in Table 2.10.

The estimated total annual solid fuel consumption in Bareilly district is 19 KT. The following set of institutions/industries were contacted and required information/data was collected.

- Dhabas/Restaurants/Hotels
- Food processing
- Chemical Industries
- Paper Industries
- Fertilizers and others small MSMEs

Table 2.8 Type and number of Industries in Bareilly

S.No.	TYPE OF INDUSTRY	NUMBER OF UNITS
1	Agro based	1607
2	Soda Water	56
3	Jute & Jute based	8
4	Ready-made garments & embroidery	3158
5	Wood/wooden based furniture	578
6	Paper & Paper products	42
7	Leather based	21
8	Chemical/Chemical based	167

9	Rubber, Plastic & Petroleum based	103
10	Mineral based	48
11	Metal based (Steel Fab.)	437
12	Engineering units	627
13	Electrical machinery and transport equipment	1012
14	Repairing & servicing	1501
15	Others	5794
16	Misc.	467
	Total	**15626**

Source: DIC, Bareilly

Table 2.9 Fuel switching factors

Fuel type	**Agro-residues pellets**	**Conversion factor**	**Unit**
Wood	Agro Pellets	1	Kg/kg
Coal	Agro Pellets	1.1	Kg/kg
PNG	Agro Pellets	3	kg/Nm^3
Electricity	Agro Pellets	0.43	kg/kWh
Diesel	Agro Pellets	3.5	kg/l
LDO	Agro Pellets	2.5	kg/l

The survey was conducted in sample industrial units under various sub-categories; chemical, distillery and others to obtain quantity of fuel consumption data, type of fuels used and potential to use biomass pellets in their processes. The data obtained from these units are used to estimate the overall demand of fuels in different industries and complied in Table 2.10

Table 2.10: Bareilly MSMEs fuel consumption data

Sector	Type of fuel	Annual Fuel consumption	Unit	Replacement of Biomass pellets (in MT)
Chemical Industry	Wood	720	MT	720
Distillery	Bagasse	2200	MT	
	Rice husk	35	MT	
	Coal	276	MT	303.6
Fertilizer	Wood	120	MT	120
	PNG	3128000	SCM	9384
Food processing	Wood	120	MT	120
	Rice husk	180	MT	
Paper Industry	Wood	4800	MT	4800
	Rice husk	1032	MT	
	Coal	3600	MT	3960
Sugar	Bagasse	81132	MT	
Oil refinery	Rice husk	456	MT	
Total				**19407.6**

2.9 Fuel demand in the Thermal Power Station (TPSs)

In the study district and within 200 km radius, total of four number coal-based thermal power generating stations with cumulative capacity of about 2045 MW is mapped with estimated annually consumption of 8000 Kilo tonnes of coal. The details of these TPSs are given in Table 2.11. There is potential demand of about 392 KT crop -residues pellets considering 5% blending target with coal that can effectively be met from Bareilly district. The recent tenders floated by TPSs indicates the price of crop residues-based pellets are Rs 8 to 9 per kg result in overall market size of more than 50000 crore industry.

Table 2.11 Potential demand of Biomass Pellets in TPSs near Bareilly

S.No	Name of TPP	District	Capacity in MW	Distance from Bareilly in Km	Typical annual demand of pellet in kT (5% on co-firing)
1	Harduaganj Thermal Power Station	Aligarh	665	187	128
2	BARKHERA Thermal Power Station	Pilibhit	90	52	17
3	KUNDARKI Thermal Power Station	Gonda	90	110	17
4	ROSA Thermal Power Station	Shahjahanpur	1200	81	230
				Total	**392**

2.10 Different fuel types and their price in the district

The prevailing prices of different fuel types used in different sectors were obtained. The retail prices of different fuels in the district are given in Table 2.12

Table 2.12 Retail prices of different fuels used in the district

S.No.	Residue	Unit	Average Price (Rs/Unit)	Utility
1	Fuelwood/ End cuts	ton	17000	Fuel for small industries, cooking, hotels, Dhabas, brick kilns etc.
2	LDO	Litre	70	Fuel for furnaces
3	PNG	SCM		Fuel for industries
4	Coal	ton	28000	Industries, furnaces/tea vendors
5	Diesel	Litre	89	Used to some extent

Source: Primary Survey

Chapter 3: District Indore

This chapter provides an overview of Indore district, its location, social conditions, potential of different types of biomass resources, its current usage and demand of fuels in institutional, industrial, and commercial applications, different fuel types used and their respective cost details. Various factors such as climatic conditions, geology, social status, industries, and institutions which can influence the availability of biomass and its subsequent usage are also discussed.

3.1 Location

Indore is situated on the Malwa plateau at an altitude of 553 m above sea level, on the banks of two small rivulets – the Saraswati and the Khan. They unite at the centre of the city where a small 18th century temple of Sangamnath or Indreshwar exists. It is the largest city in Madhya Pradesh state in central India.

It is the commercial capital of the state of Madhya Pradesh. Indore city presents a happy blend of historical past and promises of rapid future modernization.

It serves as the headquarters of both Indore District and Indore Division. It is also considered as an education hub of the state and is the only city to encompass campuses of both the Indian Institute of Technology and the Indian Institute of Management. Located on the southern edge of Malwa Plateau, at an average altitude of 553 meters (1,814 ft) above sea level, it has the highest elevation among major cities of Central India. The city is 190 km (120 mi) west of the state capital of Bhopal.

Indore has been selected as one of the 100 Indian cities to be developed as a smart city under the Smart Cities Mission. It also qualified the first round of Smart Cities Mission and was selected as one of the first twenty cities to be developed as Smart Cities. Indore has been part of Swachh Survekshan since its inception and had ranked 25th in 2016. It has been ranked as India's cleanest city six years in a row as per the Swachh Survekshan for the years 2017, 2018, 2019, 2020, 2021 and 2022. Meanwhile, Indore has also been declared as India's first 'water plus' city under the Swachh Survekshan 2021.

Indore became the only Indian city to be selected for International Clean Air Catalyst Programme. The project with cooperation of Indore Municipal Corporation and Madhya Pradesh Pollution Control Board, will be operated for a period of five years to purify the air in the city.

Indore district has total area under agriculture about 5,75,445 ha and major crops grown are Soyabean, wheat, and Gram. As per estimate, there is about 2692 KT crop residues is generated annually in the district as shown in Table 3.1.

Table 3.1 Crop Types, Area and Biomass Generation

Major Crops	Soyabean, Wheat, Gram
District Area	3,89,800 Ha
Area under agriculture	5,75,445 Ha.
Total Biomass Generation	2692 KT (Year 2021)

3.2 Climate

Indore lies on a borderline between a humid subtropical climate and a tropical savanna climate . Because of its high elevation and inland location even during the hottest months the nights are relatively cool, which is known as *Shab-e-Malwa*. Three distinct seasons are observed: summer, monsoon and winter.

3.3 Agriculture Status – Indore

Indore is border with Ujjain district in the north side, Dhar district in the west side, Dewas in the east side and Khargone district in the south side. The district has a population of 3.2 million and ranks 43rd in area and 1st in population in the State. The district is sub-divided into 4 blocks and district glance is given in Table 3.3 The map of district is shown in Figure 3.1.

Table 3.2: District Indore at a glance

Total Area	3,89,800 Hectares
Total Population	32,76,697 (as per district website
Population density	840 /km^2
Crop cultivation	262000 hectares

Figure 3.1: District map of Indore

3.4 Agriculture Profile of the District

The block wise geographical area, net sown area and gross cropped area was collected and complied as given in Table 3.3. It can be seen that blocks; Indore, Hatod and Mhow combines has more than 75% of district gross cropped area.

Table 3.3 Block wise geographical, net sown and gross cropped area in the district (Area in ha)

Division	Geographical Area (in ha)	Net Sown area (in ha)	Gross Cropped area (in ha)
Deepalpur	104230	88596	99527
Hatod	124210	105579	118605
Indore	145210	104551	138658
MHOW	112120	61666	107061
Sawer	7500	6000	6038
Total	**493270**	**366391**	**469889**

Source: District Agriculture Office, Indore

Most of the farmers in the district are having land holding with less than 4 ha area. The district has mostly semi-medium and medium category farmers as per the classification based on their land holding pattern. Only small number of the farmers in the district is having land area more than 10 hectares.

3.5 Biomass Resources Availability

As per the data collected from district agriculture office, Division wise crop residue data is analyzed to identify potential surplus clusters.

The total amount of agri-residue generated from different crop types grown in the district is estimated based on RCR (Residue to crop ratio) and dry matter fraction factor for these crop types are given in in Table 3.4 to estimate surplus quantity for each crop type.

Table 3.4: Residue to crop ratio, dry matter fraction and agri-surplus fraction of different crops

Type of crop	Residue to Crop Ratio (RCR)	Dry Matter Fraction	Agri-surplus fraction
Soyabean	2.64	0.87	0.3
Cotton *	3	0.8	0.1
Pulses*	1.5	0.88	0.1
Wheat	1.7	0.88	0.2
Gram	4	0.87	0.3

Source: TIFAC, 2018

** References: Based on Ministry of Agriculture and Farmers Welfare Statistics (MoA), 2015*

It can be seen from the Figure 3.2 that the maximum residue generated are in Indore block having 614 KT followed by Hatod, Mhow and Deepalpur blocks. The five clusters that are maximum surplus biomass are Indore, Hatod, MHOW, Deepalpur and Saware. Biomass density is maximum in Hatod and Mhow blocks which are predominantly rural populations.

Table 3.5 Block wise crop residue and surplus generation (in KT)

Name of Block	Area of city (in ha)	Crop residue (in KT)	Surplus (in KT)	Biomass density (MT/ha)
Deepalpur	104230	425	100.41	4.1
Hatod	124210	561	132.02	4.5

Indore	145210	614	145.41	4.2
MHOW	112120	486	116.50	4.3
Saware	7500	18	4.70	2.4
Total		**2104.43**	**499.031**	

Source: District agriculture office, Indore

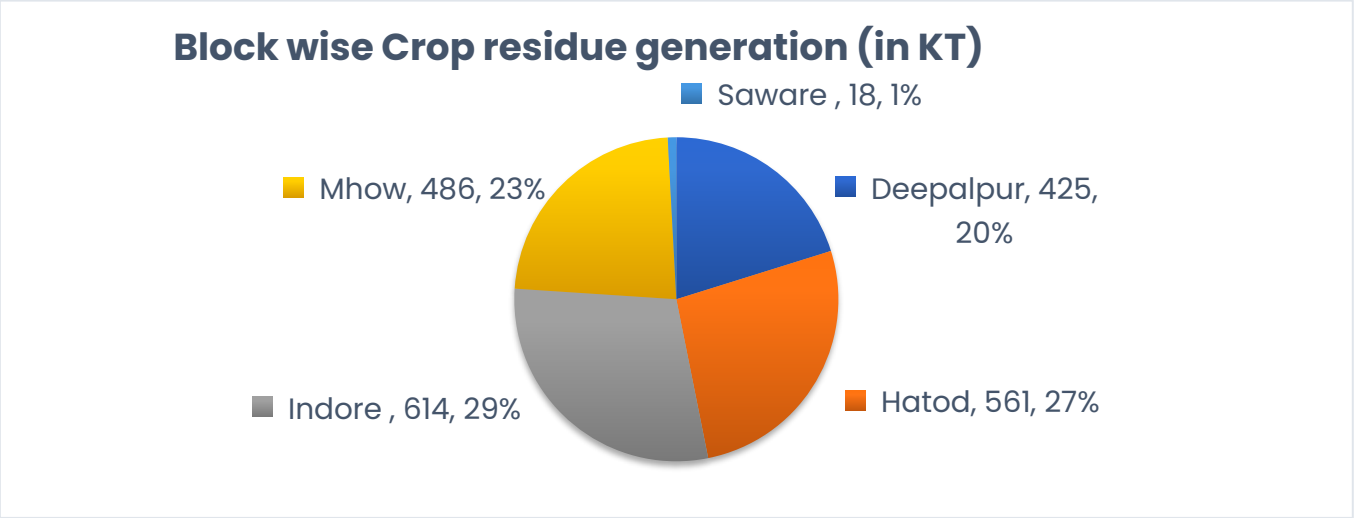


Figure 3.2: Block Wise Crop Generation (in KT)

It can be seen from Table 3.6 the maximum crop residue generation is from wheat crop with annual crop residues generation more than 11 lakhs KT and for Soyabean crop residues 6 lakhs KT in the district. The estimated total annual surplus crop residues are estimated to be 499 KT in the district.

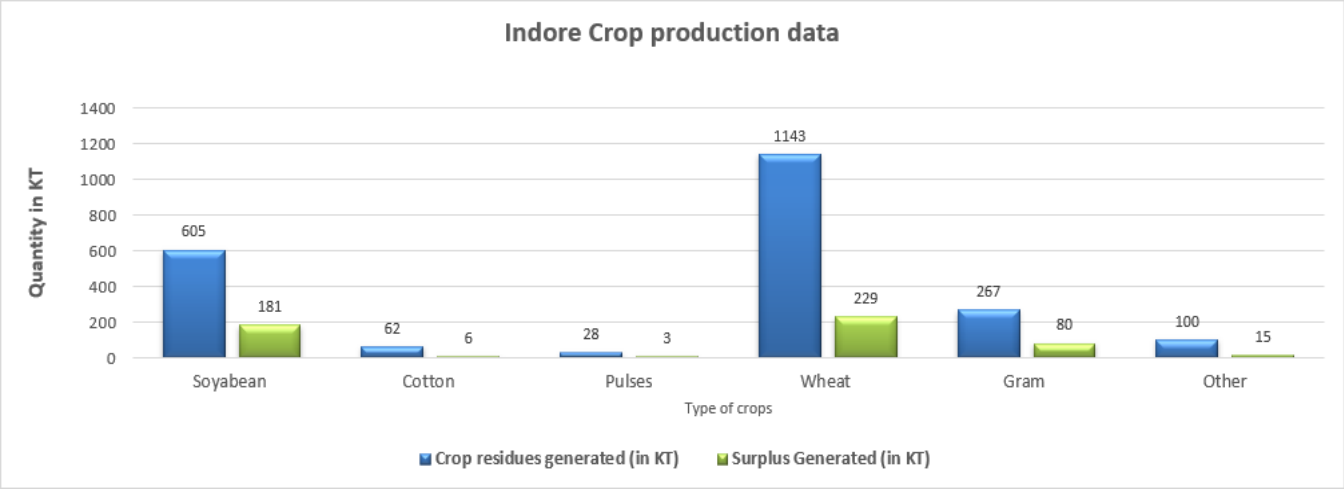
Crop wise residues generation and its surplus quantity data is further analyzed as shown in Table 3.6 It can be seen from the Figure 3.3 that wheat, soyabean and gram crop residues generation is maximum in the district. The available crop residues type is found to be favorable physio-chemical properties as fuel and recommended raw materials for pellet production applications.

Table 3.6: Crop-wise residue generation and surplus quantity in the district

Type of crop	Area (in Ha)	Crop residues generated (in KT)	Surplus Generated (in KT)
Wheat	160568	1143	228.6
Soyabean	171313	605	181.4
Gram	27790	267	80.0
Cotton	25733	62	6.2
Pulses	21361	28	2.8
Total	**406765**	**2104**	**499.0**

Sourcee: District Agriculture Office, Indore

Fig. 3.3 Crop residue generation



3.6 Estimating Raw material supply to Biomass pellet plant

The total number of biomass pellet plants that can be set up based on surplus biomass availability in each block assuming 5 KM radius catchment area is calculated. For 1 TPH capacity biomass pellet mill capacity, about 4500 tons of agro-residues annually are required on 300 days operation cycle. The potential number of biomass pellet plants is estimated for each block in the district and given in the

Table 3.7. It can be seen from the Table 3.7 about 6 small scale pellet production plant can be potentially set up in the district.

Table 3.7: Block wise estimated number of pellet mills based on surplus agro-residue

Name of Block	Total Area of the block (in ha)	Annual Crop residue generation (in KT)	Surplus (in KT)	Available annual quantity of crop residue (Q_a) in a radius of 5 km (in MT)	Potential number of pellet plant (1 TPH)
Deepalpur	104230	424.69	100.41	7563	1
Hatod	124210	561.16	132.02	8343	2
Indore	145210	614.44	145.41	7861	1
MHOW	112120	486.28	116.50	8156	2
Saware	75000	17.86	4.70	492	0
Total		**2104.43**	**499.03**	**32415**	**6**

3.7 Demand Analysis: Fuel demand in the industries

As per the data collected from DIC, Indore office, district has total of 12726 industrial registered units, out of which 370 are agro-based units and 30 wood/furniture-making units. Majority of the other units are mainly Garments, Namkeen, Chemicals and Pharma category.

In Indore district, most of the small and medium industries are established in the industrial area known as Sanwer Road Sector A, situated on the outskirts of town. There is no sub-classification of the industries; by the type of fuels used data is available with DIC to estimate the demand of fuels in MSMEs sectors. In discussion with DIC, Indore, the industry-wise estimated number of MSMEs using fuel for process heating is obtained as shown in Table 3.5. The estimated annual solid fuel consumption in Indore district is 77 KT in FY 2021-22.

Primary research work was conducted in various industries, institutions, and commercial establishments in the district to understand the demand of different fuels

types, their usage, and cost parameters. The following set of institutions/industries was contacted and required information/data was collected.

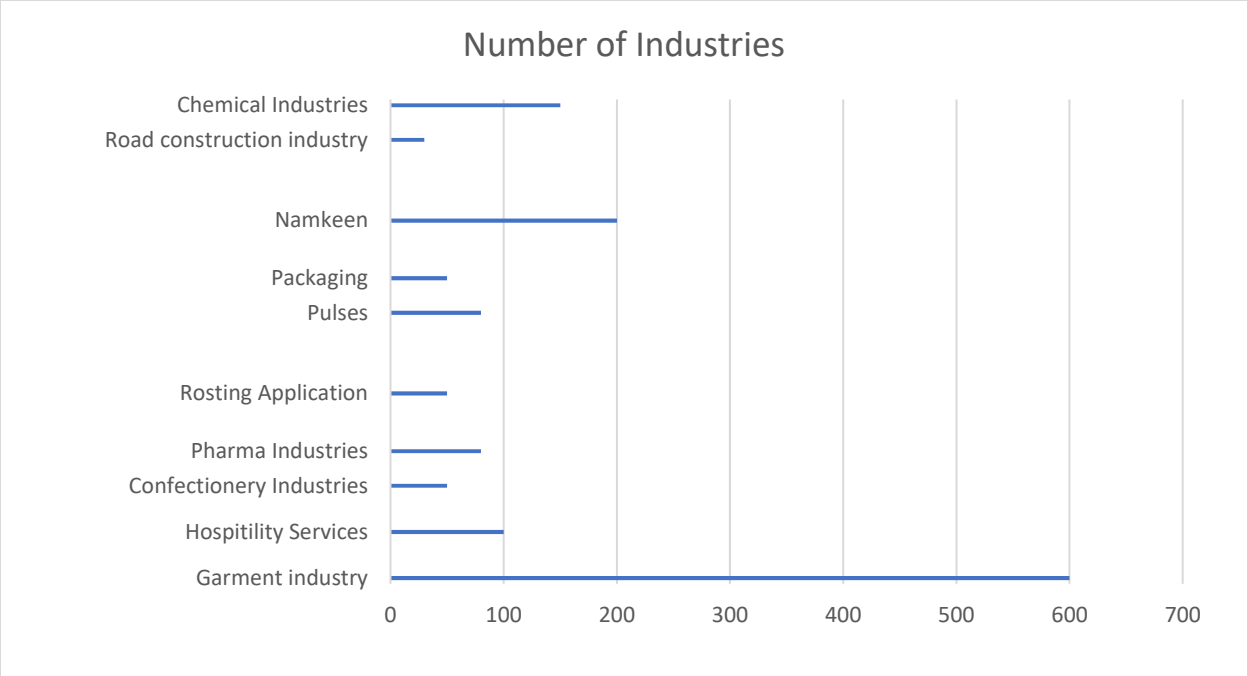


Figure 3.4 No. of Industries in Indore

The number of industries under each category is shown in Figure 3.4. It can be seen from the Figure 3.4 that garment, namkeen and chemical industries are maximum in the district. The survey was conducted in sample industrial units under various sub-categories; namkeen, pharma, roasting, garments, and others to obtain quantity of fuel consumption data, type of fuels used and potential to use biomass pellets in their processes. The collected data is given the data obtained from these units are used to estimate the overall demand of fuels in different industries and complied in Table 3.8 below.

Table 3.8: Indore MSMEs Fuel Consumption data

Sector	Type of fuel used	No. of Industries	Unit	Total Annual Fuel consumption	Potential of Biomass pellets (in MT)
Garment Industry	Wood	120	MT	14400	14400
	Coal	30	MT	2400	2640

	PNG	180	SCM	84240	252.72
	Electricity	270	KWh	9720000	4179.6
Hospitality Services	Wood	40	MT	4800	4800
	Coal	10	MT	400	440
	PNG	30	SCM	14040	42.12
	Electricity	20	MWh	720	309.6
Confectionery Industries	Wood	30	MT	3600	3600
	Coal	15	MT	975	3960
	PNG	5	SCM	2340	7.02
Pharma Industries	Wood	16	MT	1600	1920
	PNG	6	SCM	2808	8.424
	Briquette	16	MT	560	
	LDO	20	KL	580	1450
	Diesel	22	KL	550	1375
Roasting Application	Wood	10	MT	1200	1200
	PNG	3	SCM	1404	4.212
	Briquette	3	MT	87	
	LDO	1	KL	30	75
	Diesel	1	KL	25	87.5
	Sawdust	15	MT	840	
	Husk	17	MT	1530	
Pulses	Wood	16	MT	1920	1920

	PNG	56	SCM	26208	78.624
	Briquette	8	MT	184	
Packaging	Electricity	10	MWh	320	137.6
	PNG	10	SCM	4680	14.04
	Wood	12	MT	1320	1320
	Diesel	18	KL	504	1764
Namkeen	Wood	60	MT	7440	7440
	PNG	30	SCM	13500	40.5
	Briquette	20	MT	580	
	LDO	60	KL	1200	3000
	Diesel	20	KL	600	2100
	Sawdust	5	MT	445	
	Husk	5	MT	490	
Road construction Industry	Coal	2	MT	90	99
	LDO	25	KL	600	1500
Total		**1237**			**60165**

Source: District Industries Centre, Indore

3.8 Fuel demand in the Thermal Power Stations (TPSs)

The Ministry of Power, Government of India (GoI) has initiated National Mission on use of biomass in coal based thermal power stations (TPSs) through co-firing in pulverized coal-fired boilers and mandated all the coal-based power plants to use 5% blend of biomass pellets along with coal effective from October 2022. This has been initiated with an objective to create market for biomass pellets and torrefied pellets in India and to achieve the national goal to reduce GHG emissions and decarbonize power sector in India. Approximately, 2.5 to 3.0 lakh tonnes of biomass pellets are required for 7% blending in a thermal power plant of 1000 MW capacity. In the study area, thermal

power plants in the vicinity of Indore district were carried out. It can be seen from the Table there are two TPSs that are in vicinity of Indore district with total combined power generating capacity 3840 MW.

The existing India's coal-based electricity production capacity is about 264 GW and annually about 689 million tonnes of coal is used in the power generation application. To meet 5% co-firing target, there is additional requirement of 35 million tons of biomass pellets in TPS. The recent tenders floated by TPS indicates the price of agro residues-based pellets are Rs 7 to 8 per kg result in overall market size of more than 50000 crore industry. There is annual demand of about 735 KT agro-residues pellets in these plants considering 5% blending target with coal that can effectively be met from Indore district.

Table 3.9 Potential demand of Biomass Pellets in TPSs near Indore

S.No.	Name of TPP	District	Capacity in MW	Distance from Indore in Km	Typical annual demand of pellet in KT (5% on co-firing)
1	Shri Singaji Thermal Power Station Dongalia	Khandwa	2520	128	485
2	NTPC Khargone Super thermal power plant	Khargone	1320	115	254
				Total	**739**

3.9 Different fuel types and their price in the district

From the above survey, the prices of different fuel type used in different sectors were obtained. The retail prices of different fuels in the district are given in Table 3.10.

Table 3.10 Retail prices of different fuels used in the district

S.No.	Residue	Unit	Average Price(Rs/ Unit)	Utility
1	Fuel-wood/ End cuts	ton	5000	Fuel for small industries, cooking, hotels, dhabas, brick kilns etc.
2	LDO	Litre	70	Fuel for furnaces
3	PNG	SCM	75	Fuel for industries
4	Coal	ton	1000	Industries, furnaces/tea vendors
5	Diesel	litre	90	Used to some extent

(Source: Primary Survey)

3.10 Overall projected demand of biomass pellets in the district

Based on the above survey, the demand forecast for biomass fuel pellets either to replace conventional fuels like coal or existing use of woody biomass in different sectors was made and is given in Table 3.10.

For estimating the potential of biomass pellets in different industries, fuel switching factors are considered as given in Table 3.11

Table 3.11: Fuel Switching Factors

Base Fuel type	**Agro-residues pellets**	**Conversion factor**	**Unit**
Wood	Agro Pellets	1	Kg/kg
Coal	Agro Pellets	1.1	Kg/kg
PNG	Agro Pellets	3	kg/Nm3
Electricity	Agro Pellets	0.43	kg/kWh
Diesel	agro Pellets	3.5	kg/l
LDO	Agro Pellets	2.5	kg/l

Considering the above factors, potential of biomass pellets in MSME industries are estimated and given in Table 3.8. It can be seen from the Table, there is annual demand more than 60,000 MT of biomass pellets in the district. This demand can potentially support about 15 number of biomass pellet enterprises with 15TPD capacity plants in the district.

3.11 Review of Government Schemes for promotion of biomass-based pellet production

There is no specific policy to promote the biomass pellet production in the State. It has been found vide circular 18.2.2016/2015 issued on November 9, 2016, that there is a provision benefitting bio energy product-based industrial units under divisional schemes. As per this scheme, MSMEs based on bio energy products like bio-diesel production programme, bio-ethanol programmes, biogas ethanol programmes, programme on production of producer gas, other supplementary programmes like bio coal (pellets/briquettes), and programmes related to upgradation of electricity generation from bio energy could be benefitted whose initial set up cost is upto Rs. 25 lakhs will be covered under the "Interest gratuity scheme under "Pradhan Mantri Rojgar Srijan Programme" and "Samajwadi Yuva Swarojgar Yojana".

3.12 Field Survey of MSMEs Units

Primary research work was conducted in various industries, institutions, and commercial establishments in the district to understand the demand of different fuel types, their usage, and cost parameters. The following set of institutions/industries were contacted and required information/data was collected.

- Mid-day Meal (MDM) serving institutions
- *Dhabas*/Restaurants/Hotels
- Garment industries
- Chemical Industries
- Namkeen-making industries
- Pharma Industries and others small MSMEs

The survey team visited sample industrial units under various sub-categories; namkeen, pharma, roasting, garments and others to obtain quantity of fuel consumption data, type of fuels used and potential to use biomass pellets in their processes.

Chapter 4: Financial Feasibility of Biomass Pellet Plant

In this chapter the financial feasibility of decentralized biomass pellet plant having capacity 0.5 TPH and 1 TPH operating with a commercial outlook by rural entrepreneur/local community has been made for shortlisted clusters. The detailed description of financial analysis is given in the following sections.

4.1 Background analysis

There are few key inputs have been adopted by team based on ground survey which were necessary for the purpose of simplifying the feasibility analysis as below.

4.1.1 Raw Material

In the study area, there are different crop residues available that can be potentially used for pellet production as raw material. In different cropping seasons, the types and quantity of different raw material will vary and the same is observed in field survey. Further, the most optimized pattern in the consumption of raw materials is determined based process requirement, quality, and economic consideration. Raw material wastage is assumed 10% during handling and processing including moisture weight loss during storage.

The price of raw material depends on season, monsoon, crop yields, fuel prices and market demand. The selection of raw material depends on the following factors:

- Cost of raw material
- Availability
- Moisture content and combustion properties

The most preferred and abundantly available crop residues in Bareilly are Corn cob, mustard, sugarcane, and paddy straw residues whereas in Indore are Soyabean, wheat and gram. From the field survey, the prices of these materials were determined and given in Table 4.1.1 and 4.1.2 for Bareilly and Indore district respectively. The annual weighted average price is considered in financial feasibility analysis.

The raw material used in the pelletizing unit is mostly sourced through intermediaries/agents. Supply agents normally own a fleet of vehicles for collection and transportation of raw material within 100 to 150 km radius and have huge stock yards for storing the raw material. Farmers do not have bargaining capacity as the

quantity of raw material they individually generate in their small land holding is not high enough to demand a good price.

Table 4.1.1 Crop residue types, quantity, and prevailing prices in Bareilly district

Type of crop waste	Raw material Price at farm (Rs/kg)	Annual Surplus Quantity (in KT)	Annual Weighted average availability percentage
Corn cob	1	0.38	0.04%
Mustard husk	2	13.2	1.22%
Sugarcane thrash	1.5	736.542	68.10%
Paddy Straw	1.5	328	30.33%
Gram residues	3.5	3.448	0.32%
Average price (Rs/kg)	**2.5**		

Table 4.1.2 Crop residue types, quantity, and prevailing prices in Indore district

Type of Agri waste	Raw material Price at farm (Rs/kg)	Annual Surplus Quantity (in KT)	Weighted average availability percentage
Soyabean husk	2	182	37.07%
Wheat residues	3	229	46.64%
Gram residues	3.5	80	16.29%
Average price (Rs/kg)	**2.71**		

4.1.2 Collection and Storage cost

It is important to collect and aggregate these waste materials during season and store it for supply to pellet production on regular basis. The cost of collection and storage is estimated from field/survey is 1350 Rs/ton this price include labor wages, transportation, and equipment's charges (raker, baler, etc).

4.1.3 Capital Cost

Based on input from pellet mill manufacturer, the capital cost for 1 TPH pellet plant is worked out. The plant and machinery would include major equipment like dryer, hammer mill, complete pellet mill and controls etc. and details is given in Table 4.1.3

Table 4.1.3 Capital cost break-up for 1 TPH

Description of item	**Rs (in lakhs)**
Land (3000 m^2)	Long term lease
Building and shed cost	10
Plant and Machinery	
Biomass Flash Dryer	17
Hammer mill with cyclone	10
Biomass Pellet Mill-16mm	23
Infrastructure cost (electricity connection)	3
Working Capital (Raw materials, work in progress, Inventories)	5
Total	**68**

4.1.4 Working Year for Unit

The biomass pellet plant will operate for 300 days annually and remains closed for the remaining days for preventive repair and maintenance purpose.

4.1.5 Output of Plant

The proposed plant will be designed to have pellet machines with an output of 16 MT per day on two shift basis. The pellet mills output is considered at 95% rated capacity with an output of 15 MT per day in the feasibility analysis. The estimated annual production is about 4050 tons considering 10% loss in operation.

4.1.6 Manpower

The total manpower for running 1 TPH pellet plant would require 1 skilled operator, 4 unskilled labor, and 1 administrative staff. In the plant, unskilled labor is required for purpose of handling of raw material, its pre-processing drying, sizing, storage of finished product, and assist the skilled operator. One skilled operator is required to operate the pellet machine and maintain all the mechanical/electrical equipment's. The details of manpower expenses are given in Table 4.1.4.

Table 4.1.4 Manpower details of 1 TPH pellet plant

Manpower Details	**No. of Persons per shift**	**No. of Shifts**	**Rate in INR/day**	**No. of Days**	**Total Monthly (in INR)**
Unskilled					
Shredder Feeding (After Delivery of material at Feed Point)	2	2	450	30	54,000
Dryer Cleaning Area	1	2	450	30	27,000
Spare	1	2	450	30	27,000
Total					**1,08,000**
Skilled					
Technician (Operation/Maintenance)	1	2	800	30	48,000
Administrative Staff	1	1	1000	30	30,000
Total Monthly Expense of Manpower	**Rs**				**1,86,000**

Effective Monthly Running (In Hours)	416
Production Efficiency	95%
Hourly Production Capacity (In Tons/hr)	1
Monthly Production (In Tons)	395
Per Ton Manpower Cost (In INR/Ton)	**471**

4.1.7 Sales

Based on the field survey, plant capacity and local market condition net sale pellet price is taken as Rs. 7300 per ton. This price is assumed to be 5% rise annually. Biomass Pellets can be sold in bulk quantities (one ton or more), in which case a truck would

deliver loads of pellets directly to the customer. Pellets can also be bagged for retail sale, in which case a bagging machine and storage space for bagged inventory would be required.

4.1.8 Power

Specific energy consumption is another important factor for production of pellets. The total power requirement for a pellet plant having 1 TPH capacity is about 216 HP. The detailed power consumption details of all mechanical and electrical equipment are mentioned in Table 4.1.5

Table 4.1.5 Power consumption details of 1 TPH pellet plant

Item	**Approx. Loading**	**Total Connected Load (In HP)**	**Total Running Load (In KWH)**
Primary Sizing	65%	50	24
Drying Section	75%	35	20
Hammer Mill System	55%	40	17
Pelletizing Section	75%	91	51
Total		**216**	**112**

Effective Monthly Running (in Hours)	416
The unit rate of Electricity (In INR/KWH)	11
Monthly Production (In Tons)	395
Per Ton Power Cost (Approx. In INR)	**1400**

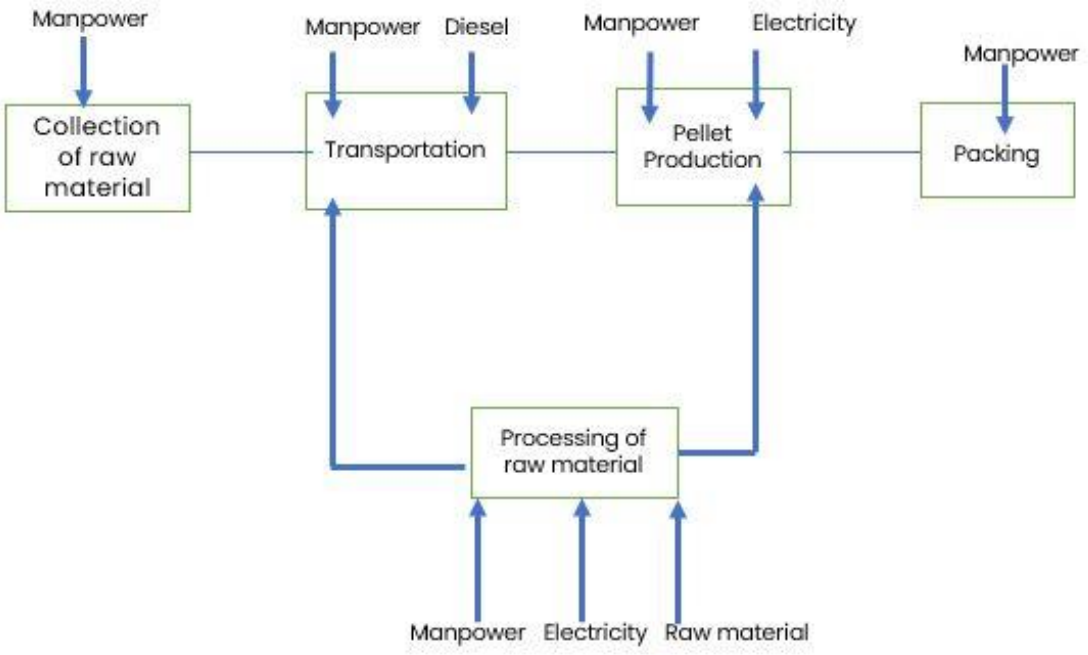


Fig. 4.1 Energy consuming area in pelletizing unit

Necessary arrangements should be made with the concerned electricity board for electricity connection. The energy needs for drying and hammer mill is depending on the type of raw material used. The energy flow chart is given Fig. 4.1 is represents the details the energy consumed in raw material handling, pre-processing of raw material, pellet production and packaging.

For financial analysis annual price escalation factors for different cost items are given in Table 4.2

Table: 4.2 Annual Price Escalation factors

1	Sales Price	5%
2	Raw Material cost	5%
3	Power	6%
4	Operating and Labor	6%
5	Maintenance and Spares	6%
6	Collection and Storage	5%
7	Administrative and Marketing Expenses	8%
8	Miscellaneous and other expenses	4%

4.2 Financial Feasibility of 1 TPH agro residues-based pellet project

The following financial parameters are considered in financial analysis:

1. The average cost of raw material to pellet unit is estimated to be 3.85 Rs/kg for Bareilly and 4.06 Rs/kg for Indore.
2. Annual working number of days is considered to be 300.
3. Electricity rate is considered to be 11 Rs/kWh.
4. Maintenance and spares are considered to be Rs 250 per ton.
5. The selling price of pellets is considered to be Rs 7300 per ton.
6. Interest @11% on the amount of loan from Banks/financial institutions.
7. Rate of depreciation is considered to be 4.67%.
8. Loan Repayment period of 8 years.

4.2.1 Debt Equity Ratio

The debt equity ratio is considered 60:40, which means 60 percent is debt by bank or financial institutions and 40 percent is equity by the promoter.

Table 4.2.1 Means of Finance

Particulars	**Capacity 1 TPH**
Promoter contribution (Equity)	17.52
Debt/Bank Financing	41.48
Central Financial Assistance (9 lakhs per TPH)	9
TOTAL (Rs in lakhs)	**68**

Table: 4.2.2 Cost Break up details for 1 TPH plant in Bareilly

S.No.	**Description**	**Amount (Rs/ton)**
1	Raw material	2496.56
2	Collection and storage	1350
3	Operating and labor	471
4	Cost of Electricity	1400

5	Maintenance and Spares	250
	Total	**5967.49**

Table: 4.2.3 Cost Break up details for 1 TPH plant in Indore

S.No.	Description	Amount (Rs/ton)
1	Raw material	2710.79
2	Collection and storage	1350
3	Operating and labor	471
4	Cost of Electricity	1400
5	Maintenance and Spares	250
	Total	**6181.73**

a. Financial Summary

The project financial feasibility summary for Indore is given in Table 4.2.4 and for Bareilly in Table 4.2.6. The cost break-up details for Indore and Bareilly are given in Table 4.2.2 and 4.2.3 respectively. The details about schedule for depreciation and interest on term loan is given in Annexure III and IV.

b. Return of investment (ROI)

ROI is a performance measure used to evaluate the returns of an investment. Due to its flexibility and simplicity, ROI is one of the most frequently used profitability metrics. It's extremely useful to gauge the efficiency and profitability of investments. It's often used to influence financial decisions, compare a company's profitability, and analyse investments. ROI is calculated over the 5 years in the financial feasibility tables. The results are given in Table 4.2.4 and 4.2.6.

c. Break Even Analysis (BEA)

Refers to the identifying of the point where the revenue of the company starts exceeding its total cost i.e., the point when the project or company under consideration will start generating the profits by the way of studying the relationship between the revenue of the company, its fixed cost, and the variable cost. The results are given in Table 4.2.5 and 4.2.7.

Table 4.2.4 Financial Feasibility of 1 TPH Plant in Indore

Description	Year 1	Year 2	Year 3	Year 4	Year 5
Annual agro-residue requirement (Tons)	4500	4500	4500	4500	4500
Raw material cost (in lakhs Rs)	121.99	128.09	134.49	141.21	148.27
Collection and Storage (in lakhs Rs)	60.75	63.79	66.98	70.33	73.84
Direct Expenses					
Cost of Operating and Labor (in lakhs Rs)	21.19	22.46	23.81	25.24	26.75
Cost of Electricity (in lakhs Rs)	63.00	66.78	70.79	75.04	79.54
Maintenance and spare charges (in lakhs Rs)	11.25	11.93	12.64	13.40	14.20
Administration and Marketing Expenses (in lakhs Rs)	2	2.16	2.33	2.52	2.72
Indirect Expenses					
Interest on Term Loan (in lakhs Rs)	4.56	4.30	3.73	3.16	2.59
Depreciation	3.18	3.03	2.89	2.75	2.62
Miscellaneous and other expenses (in lakhs Rs)	5	5.20	5.41	5.62	5.85
Total Annual cost (in lakhs Rs)	292.92	307.73	323.06	339.27	356.39
Annual Sales (in tons) (consider wastage of 10%)	4050	4050	4050	4050	4050
Total Annual revenue from sale of pellets (@ Rs 7300 per ton)	295.65	310.43	325.95	342.25	359.36
Net Annual Income (in lakhs Rs)	2.73	2.70	2.89	2.98	2.97
ROI	21.00%				

Table 4.2.5 Break Even Analysis (BEA) of 1 TPH Plant in Indore

Fixed Cost (in lakh Rs)	110	116	122	128	134
Total Variable cost (in lakh Rs)	182.74	191.87	201.47	211.54	222.12
Sales (in lakh Rs)	295.65	310.43	325.95	342.25	359.36
Contribution	112.91	118.56	124.49	130.71	137.25
P/V Ratio	38.19%	38.19%	38.19%	38.19%	38.19%
B.E.P. in Lakh Rs	288	303	318	334	352
B.E.P. (% to Sales)	97.58%	97.72%	97.68%	97.72%	97.84%

Table 4.2.6 Financial Feasibility of 1 TPH Plant in Bareilly

Description	Year 1	Year 2	Year 3	Year 4	Year 5
Annual agro-residue requirement (Tons)	4500	4500	4500	4500	4500
Raw material cost (in lakhs Rs)	112.35	117.96	123.86	130.05	136.56
Collection and Storage cost (in lakhs Rs)	60.75	63.79	66.98	70.33	73.84
Direct Expenses					
Cost of Operating and Labor (in lakhs Rs)	21.19	22.46	23.81	25.24	26.75
Cost of Electricity (in lakhs Rs)	63.00	66.78	70.79	75.04	79.54
Maintenance and Spare	11.25	11.93	12.64	13.40	14.20
Administration and Marketing Expenses (in lakhs Rs)	2	2.16	2.33	2.52	2.72
Indirect Expenses					
Interest on Term Loan (in lakhs Rs)	4.56	4.30	3.73	3.16	2.59
Depreciation	3.18	3.03	2.89	2.75	2.62
Miscellaneous and other expenses (in lakhs Rs)	5	5.20	5.41	5.62	5.85
Total Annual cost (in lakhs Rs)	283.28	297.61	312.43	328.11	344.67
Annual Sales (in tons) (consider wastage of 10%)	4050	4050	4050	4050	4050
Total Annual revenue from sale of pellets (@ Rs 7300 per ton)	295.65	310.43	325.95	342.25	359.36
Net Annual Income (in lakhs Rs)	12.37	12.83	13.52	14.14	14.69
ROI (from date of sale)	99.34%				

Table 4.2.7 Break Even Analysis (BEA) of 1 TPH Plant in Bareilly

Fixed Cost (in lakh Rs)	110.18	115.86	121.60	127.73	134.28
Total Variable cost (in lakh Rs)	173.10	181.75	190.84	200.38	210.40
Sales (in lakh Rs)	295.65	310.43	325.95	342.25	359.36
Contribution	122.55	128.68	135.12	141.87	148.97
P/V Ratio	41%	41%	41%	41%	41%
B.E.P. in Lakh Rs	265.80	279.49	293.34	308.13	323.93
B.E.P. (% to Sales)	89.90%	90.03%	89.99%	90.03%	90.14%

4.3 Financial analysis of 0.5 TPH Pellet Plant

4.3.1 Capital Cost

The total cost to develop a 0.5 TPH pellet plant will depend largely on the characteristics of the chosen site. If the site is already developed, with some buildings and infrastructure, the conversion to a pellet mill can be easier and less costly. If the site is undeveloped, the costs to construct a pellet mill will be greater.

Table 4.3.1 Capital cost break-up for 0.5 TPH

Description of item	**Rs (in lakhs)**
Land (800-1500 m^2)	Long term lease
Building and shed cost	6
Plant and Machinery	
Biomass Flash Dryer	16
Hammer mill with cyclone	8
Biomass Pellet Mill-16mm	6
Infrastructure cost (electricity connection)	2
Working Capital (Raw materials, work in progress, Inventories)	3
Total	**41**

4.3.2 Working Year for Unit

The pellet plant can work in 300 days annually and remains closed for remaining days for preventive repair and maintenance purpose.

4.3.3 Output of Plant

The proposed plant will be designed to have pellet machines with an output of 8 MT per day on two shift basis. The pellet mill is assumed to be operated at 95% rated capacity an output of 7.6 MT per day in the feasibility analysis. The plant would operate for two shifts of 8 hours each in a day, would remain functional for 300 days in the year.

Therefore, for the purpose of preparing the financial feasibility, total annual net output considering 10% material loss in operation is estimated to be 2052 tons.

4.3.4 Manpower

The total manpower for running 0.5 TPH pellet plant would require 1 skilled operator, 2 unskilled labor, and 1 administrative staff. In the plant, unskilled labor is required for purpose of handling of raw material, its pre-processing drying, sizing, storage of finished product, and assist the skilled operator. One skilled operator is required to operate the pellet machine and maintain all the mechanical/electrical equipment's. The details of manpower expenses are given in Table 4.3.2.

Table 4.3.2 Manpower details for 500 kg/hr pellet plant

Manpower Details	**No. of Persons per shift**	**No. of Shifts**	**Rate in INR/day**	**No. of Days**	**Total Monthly (in INR)**
Unskilled					
Shredder Feeding (After Delivery of material at feed point)	1	2	450	30	27,000
Dryer Cleaning Area	1	2	450	30	27,000
Total					**54,000**
Skilled					
Technician (Operation/Maintenance)	1	2	800	30	48,000
Administrative Staff	1	1	1000	30	30,000
Total Monthly Expense of Manpower	**Rs**				**1,32,000**

Effective Monthly Running (In Hours)	416
Production Efficiency	95%
Hourly Production Capacity (In kg/hr)	500
Monthly Production (In Tons)	198
Per Ton Manpower Cost (In INR/Ton)	**667**

4.3.5 Sales

Net sale price is taken as Rs. 7800 per ton they are estimated based on the plant capacity, prevailing survey and market price discovered by TPS including NTPC and MSMEs.

4.3.6 Power

Specific energy consumption is another important factor for production of pellets. The total power requirement for a pellet plant having 0.5 TPH capacity is about 142 HP. The detailed power consumption details of all mechanical and electrical equipment are mentioned in Table 4.3.3.

Necessary arrangements should be made with the concerned electricity board because the provision for installation of its own generating capacity will make the operational cost very high. The energy needs for drying and hammer mill is depending on the type of raw material used.

Table 4.3.3 Power consumption details of 500 kg/hr pellet plant

Items	Approx. Loading	Total Connected Load (In HP)	Total Running Load (In KWH)
Primary Sizing	65%	30	15
Drying Section	75%	25	19
Hammer Mill System	55%	28	12
Pelletizing Section	75%	59	33
Total		**142**	**79**

Effective Monthly Running (in Hours)	416
The unit rate of Electricity (In INR/KWH)	11
Monthly Production (In Tons)	198
Per Ton Power Cost (Approx. In INR)	**1836**

4.4 Financial Feasibility of 0.5 TPH agro residues-based pellet project

The various financial parameters estimated from survey used in financial calculations are:

1. The average cost of raw material to pellet unit is estimated to be 3.85 Rs/kg for Bareilly and 4.06 Rs/kg for Indore.
2. Annual working number of days is considered to be 300.
3. Electricity rate is considered to be 11 Rs/KWh.
4. The selling price of pellets is considered to be 7.8 Rs/kg.
5. Interest @11% on the amount of loan from Banks/financial institutions.
6. Rate of depreciation is considered to be 4.67%.
7. Loan Repayment period of 8 years.

4.4.1 Debt Equity Ratio

The debt equity ratio is considered 60:40, which means 60 percent is debt by bank or financial institutions and 40 percent is equity by the promoter. as shown in Table 4.4.1. Central Financial Assistance (CFA) is considered to be 9 Lakhs per TPH (Ton per hour)

Table 4.4.1 Means of Finance

Particulars	**Rs (in Lakhs)**
Promoter contribution (Equity)	10.95
Debt/Bank Financing	25.55
CFA (9 lakhs per TPH)	4.5
TOTAL (Rs in lakhs)	**41**

Table: 4.4.2 Cost Break up details for 0.5 TPH plant in Bareilly

S.No.	**Description**	**Amount (Rs/ton)**
1	Raw material	2496.56
2	Collection and storage	1350

3	Operating and labor	667
4	Cost of Electricity	1836
5	Maintenance and Spares	100
	Total	**6449.38**

Table: 4.4.3 Cost Break up details for 0.5 TPH plant in Indore

S.No.	**Description**	**Amount (Rs/ton)**
1	Raw material	2710.79
2	Collection and storage	1350
3	Operating and labor	667
4	Cost of Electricity	1836
5	Maintenance and Spares	100
	Total	**6663.62**

The results of these analyses for 0.5 and 1 TPH are financially viable to implement the project in shortlisted clusters. The expected financial returns such as ROI and Break-Even Value and are quite satisfactory.

Table 4.4.4 Financial Feasibility of 0.5 TPH PLANT in Bareilly

Description	Year 1	Year 2	Year 3	Year 4	Year 5
Annual agro-residue requirement (Tons)	2400	2400	2400	2400	2400
Raw material cost (in lakhs Rs)	59.92	62.91	66.06	69.36	72.83
Collection and Storage cost (in lakhs Rs)	32.40	34.02	35.72	37.51	39.38
Direct Expenses					
Cost of Operating and Labor (in lakhs Rs)	16.00	16.96	17.98	19.06	20.20
Cost of Electricity (in lakhs Rs)	44.07	46.71	49.51	52.49	55.63
Maintenance charges (in lakhs Rs)	2.4	2.59	2.80	3.02	3.27
Administration and Marketing Expenses (in lakhs Rs)	1	1.10	1.21	1.33	1.46
Indirect Expenses					
Interest on Term Loan (in lakhs Rs)	2.81	2.55	1.98	1.41	0.84
Depreciation (in lakhs Rs)	1.91	1.83	1.74	1.66	1.58
Miscellaneous and other expenses (in lakhs Rs)	2	2.14	2.29	2.45	2.62
Total Annual cost (in lakhs Rs)	162.51	170.81	179.29	188.28	197.82
Annual Sales (in tons) (consider wastage of 10%)	2160	2160	2160	2160	2160
Total Annual revenue from sale of pellets (@ Rs 7800 per ton)	168.48	176.90	185.75	195.04	204.79
Net Annual Income (in lakhs Rs)	5.97	6.09	6.46	6.75	6.97
Return of Investment (ROI)	**78.66%**				

Table 4.4.5 Break Even Analysis (BEA) of 0.5 TPH PLANT in Bareilly

Fixed Cost (in lakh Rs)	68.28	72.05	75.77	79.75	84.02
Total Variable cost (in lakh Rs)	92	97	102	107	112
Sales (in lakh Rs)	168.48	176.904	185.7492	195.0367	204.78849
Contribution	76	80	84	88	93
P/V Ratio	45.21%	45.21%	45.21%	45.21%	45.21%
B.E.P. (in Lakh Rs)	151.04	159.39	167.61	176.42	185.87
B.E.P. (% to Sales)	89.65%	90.10%	90.24%	90.46%	90.76%

Table 4.4.6 Financial Feasibility of 0.5 TPH PLANT in Indore

Description	Year 1	Year 2	Year 3	Year 4	Year 5
Annual agro-residue requirement (Tons)	2400	2400	2400	2400	2400
Raw material cost (in lakhs Rs)	65.06	68.31	71.73	75.31	79.08
Collection and Storage cost (in lakhs Rs)	32.40	34.02	35.72	37.51	39.38
Direct Expenses					
Cost of Operating and Labor (in lakhs Rs)	16.00	16.96	17.98	19.06	20.20
Cost of Electricity (in lakhs Rs)	44.07	46.71	49.51	52.49	55.63
Maintenance charges @Rs 100 per ton	2.4	2.59	2.80	3.02	3.27
Administration and Marketing Expenses (in lakhs Rs)	1	1.10	1.21	1.33	1.46
Indirect Expenses					
Interest on Term Loan (in lakhs Rs)	2.81	2.55	1.98	1.41	0.84
Deprecation	1.91	1.83	1.74	1.66	1.58
Miscellaneous and other expenses (in lakhs Rs)	2	2.14	2.29	2.45	2.62
Total Annual cost (in lakhs Rs)	167.65	176.21	184.96	194.23	204.07
Annual Sales (in tons) (consider wastage of 10%)	2160	2160	2160	2160	2160
Total Annual revenue from sale of pellets (@ Rs 7800 per ton)	168.48	176.90	185.75	195.04	204.79
Net Annual Income (in lakhs Rs)	0.83	0.69	0.79	0.80	0.72
ROI	9.36%				

Table 4.4.7 Break Even Analysis (BEA) of 0.5 TPH PLANT in Indore

Fixed Cost (in lakh Rs)	68	72	76	80	84
Total Variable cost (in lakh Rs)	97	102	107	113	118
Sales (in lakh Rs)	168.48	176.90	185.75	195.04	204.79
Contribution	71.02	74.57	78.30	82.22	86.33
P/V Ratio	42.15%	42.15%	42.15%	42.15%	42.15%
B.E.P. in Lakh Rs	161.97	170.93	179.75	189.20	199.32
B.E.P. (% to Sales)	96.14%	96.62%	96.77%	97.01%	97.33%

Chapter 5: Estimates on potential jobs associated with the implementation and development of pellet plant

In this chapter the main two job potentials are considered in study are biomass pellet technician and Entrepreneur. The supply chain involves collection, storage, manufacturing, and transportation of biomass from field to plant for end-use. There is also a lot of direct and indirect jobs are generated by setting up the plant.

5.1 Job Projections of biomass pellet technician

The projected estimates number of jobs of biomass pellet technician is based on the surplus biomass availability in selected districts provided in the Table 5.1. This job is related to the handling and managing the production of biomass pellets. It includes both operation and maintenance of pellet plant. An estimated factor is considered that one person can handle a 1000 kg/hr capacity of pellet plant based on OEM consultations is taken to calculate the total number of jobs.

Table 5.1 Total estimated jobs of biomass pellet technician

Year	**Total Surplus Generated (in KT)**		**Potential number of pellet plant (1 TPH)**		**Number of Jobs of biomass pellet Technician**	
2022	Bareilly	Indore	Bareilly	Indore	Bareilly	Indore
	1230.5	499	232	94	232	94
Total	**1729.5**		**326**		**326**	

5.1.1 Brief job description of biomass pellet technician

The various role and responsibilities of biomass pellet technician are:

1. Biomass technician is responsible for production, storage, and management of biomass pellets at the plant. He/she looks after activities such as biomass receipt from suppliers, biomass pre- processing/densification and storage in a manner to ensure its quality and safety as per standards.

2. Dealing with all aspects of the equipment: electrical, electronic, mechanical, hydraulic, or pneumatic and doing regular servicing, checking for damage or wear and tear, and making adjustments.
3. Biomass plant technician is responsible to troubleshoot most problems, and to recognize problems that need to be outsourced to professional repairmen.
4. To controls and adjusts the production of biofuels (Pellets) and is responsible for performing maintenance to the mechanical and electrical equipment used in production and assist with all shutdown activities within the plant, ensuring plant downtime is minimized, also carry out front line maintenance to ensure plant availability is maintained.
5. It operates biomass fuel-burning boiler, Pellet Mill, Hammer Mill and other equipment's in accordance with specifications or instructions and they calculate on load biomass feedback, often report on the quality of the feedstock, making reports on the daily data.

5.1.2 Functions of biomass pellet technician

- Inspect biomass pellet plant or preprocessing equipment, recording, or reporting damage instruments.
- Biomass technicians have to keep and maintain records and log sheets.
- Check each machine to ensure they are running properly and adjust machines as needed.
- Ensure that all the operating parameters in all machines are working properly.
- Finding the cause of breakdowns using manuals, worksheets, and technical drawings.
- To do routine inspections and make any needed adjustments or repairs to specialized equipment.
- Clean work areas to ensure compliance with safety regulations.

5.2 Estimation of entrepreneur's generation

The projected estimate number of entrepreneurs is based on the surplus biomass availability 2022 are provided in the Table 5.2. An entrepreneur is a business owner who establish new biomass pellet plant and sells pellets in the market to achieve the business goals. It is also considered that one single person is sufficient to establish a plant.

Table 5.2 Number of potential entrepreneurs generated

Year	Total Surplus Generated (in KT)		Potential number of pellet plant (1 TPH)		Number of potential entrepreneurs generated	
2022	Bareilly	Indore	Bareilly	Indore	Bareilly	Indore
	1230.5	499	232	94	232	94
Total	**1729.5**		**326**		**326**	

5.2.1 Role and responsibilities of entrepreneur:

1. An entrepreneur sets up a biomass pellet production unit from agriculture waste material.
2. Entrepreneur should be able to build and manage their own businesses in all aspects such as idea generation, sales, marketing, and finance management.
3. He/she thinks about their business as an asset, need to consider the opportunity costs of every decision along with the risk involved with each decision.
4. Entrepreneur is to learn about biomass sector, so that He/she can gain knowledge about the business in general and they must be aware of what is happening with the market and identify what makes his/her company stand out before going all out with branding, marketing, and selling.
5. Perform all other duties necessary for the organization to achieve its goals.

5.2.2 Functions of entrepreneur:

- Entrepreneur, one must have self-confidence, a strong work ethic, ambition to succeed as well as business acumen to make it happen.
- It should be creative, resilience, and problem-solving ability.
- Entrepreneur should be able to handle both management and employee relations.
- He/She must have excellent communication skills and talent in recruiting while he must also be able to manage large amounts of data and track employee outcomes.
- Plan the company's strategy.

- Entrepreneurs are the makers of change, and his/her vision drives the company's strategy.
- He/She should be able to create a sustainable business model and grow over time.
- Develop the company's goals.
- Main goal is to build a company that has a sustainable and scalable business mode.
- Taking calculated risks to reach a goal.
- Learn about their industry so they can gain knowledge about the business in general.
- He must be able to create financial budget and developing a business plan.

5.3 Estimated number of direct jobs generated

It is projected that a single pellet unit of 1 TPH generated 4-person job based on OEM consultation and this factor is consider for calculate the total number of direct jobs as shown in Table 5.3.

Table 5.3 Number of direct employment generation

Year	**Total Surplus Generated (in KT)**		**Potential number of pellet plant (1 TPH)**		**Number of direct jobs**	
2022	Bareilly	Indore	Bareilly	Indore	Bareilly	Indore
	1230.5	499	232	94	928	376
Total	**1729.5**		**326**		**1304**	

5.4 Estimated number of Indirect jobs generated

Indirect job includes employment for biomass aggregators, biomass collection and storage labor, raker and bailing worker, trolley driver. It is estimated that one unit of 1 TPH capacity creates 15 indirect jobs, and this factor is consider to calculate the total number of indirect jobs as shown in Table 5.4.

Table 5.4 Number of Indirect employment generation

Year	**Total Surplus Generated (in KT)**		**Number of indirect jobs**	
2022	Bareilly	Indore	Bareilly	Indore
	1230.5	499	18457	7485
Total	**1729.5**		**25492**	

5.5 Overview of Biomass Potential in India

India is aiming to reduce its reliance on fossil fuels in its journey to reach net-zero emissions by 2070. According to recent study sponsored by MNRE, the current availability of biomass in India is estimated at about 750 million metric tons per year. The study estimated surplus biomass availability at approximately 230 million metric tons per year for agricultural residues. We consider 50 % of surplus biomass availability to estimates the total number of job potential in India for setting up 1 TPH pellet plant. This would create a lot of direct and indirect employment generation as shown in Table 5.5.

Table 5.5 Estimated number of potential jobs in India

Surplus Biomass	115 million metric tons
Potential number of pellet plants having capacity 1 TPH	21562
Annual production of biomass pellets	87326 KT
Total number of Direct Jobs (Operators, and workers)	107810
Total number of Indirect Jobs (biomass aggregators, labor, and local agents)	323430

5.6 Estimation of GHG Emissions Reduction

Gases that trap heat in the atmosphere are called greenhouse gases (GHG). Emissions are substances released into the air and the main emissions are carbon dioxide (CO_2), methane (CH_4), nitrogen dioxide (NO_2), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SFG) etc. This section provides information on estimation of GHG emissions reduced by comparison of fossil fuels as shown in Table 5.6.

Table 5.6 Estimated number of potential jobs in India

Annual amount of CO_2 reduction	176 million Metric Tons (MMT)
Annual amount of CH_4 reduction	24 million Metric Tons (MMT)
Annual amount of NO_2 reduction	200 Kilo Tons (KT)
Annual amount of SO_2 reduction	1074 Kilo Tons (KT)

Key Conclusion and Recommendations

- From the above discussion, it is clear that the local farmers who own these agro-residues and other stakeholders are generally not aware of the opportunity to utilize as fuels through briquetting/pelletizing technology.
- Analysing the supply and demand scenario of both the shortlisted districts, it is clear that biomass-based pellet production offers tremendous potential for increasing the share of biomass energy for meeting clean energy requirements in MSMEs/industrial sectors of both the districts. However, setting up biomass supply chain mechanism holds the key to success. In this context, it is imperative to create local level biomass collection and storage system involving local entrepreneurs or FPOs, viable business models, creating awareness and skilling of local entrepreneurs/operators are critical factors for the success of this opportunity.
- Presently, residues from agricultural field are either used at local level for HHs use or disposed to local collection agents at very nominal price. Surplus biomass is burnt in the field to clear the farms. The survey revealed that there is huge local demand of solid fuels like coal, fuel wood, diesel, in the local economy even the prices of these fuels are high. The prices of fossil fuels are found to be high as these fuels are expensive options for local industries and in case of coal it is brought from other States. Despite huge availability of agricultural residues, the prices of these materials fluctuate widely due to seasonal availability, depend on various factors like monsoon, type of crop, alternate competing use, price of conventional fuels, labour cost etc. Therefore, it is imperative to create biomass supply chain mechanism involving entrepreneurs and setting up facility to convert these materials into pellets/briquettes.
- The major types of agricultural residue available in selected clusters are sugarcane thrash, paddy straw, mustard husk, soybean husk, and wheat residues.
- The study identified the following potential clusters for setting up of decentralized pellet production plant and implementation models.
    - District Bareilly-
        - Bahedi

        - Nawabganj
        - Damkhoda
        - Bhadpura
    - District Indore-
        - Indore
        - Hatod
        - MHOW
        - Deepalpur
- The study reveals that the biomass pellets have huge potential in the institutional, commercial, and industrial applications in both the districts.

Based on above conclusions, the following set of recommendations has been made:

- Based on the assessment study report involve local institutions, Entrepreneurs to invest in decentralized pellet production plants and develop new business models/opportunities.
- Need a detail implementation plan involving local institutions, Entrepreneurs and Farmer Producer Organizations (FPO) to develop a viable business model.
- Dialog with district administration, state and central PSUs for project implementation in selected clusters.
- Sensitising local industries, Dhaba, hotels for the used of biomass pellets as a clean source of energy.
- The study recommends to set-up biomass based decentralized pellet production facility in capacity range 500 to 1000 kg/h in identified clusters/sites.
- Based on the techno-commercial analysis, involve local entrepreneurs and Farmer Producer Organizations (FPO) to set-up decentralized pellet production plants and develop new business models/opportunities.
- Create awareness and sensitize FPOs/local entrepreneurs about the potential of agro residues for pellet production and its applications as clean fuel source in these districts and State at large. In particularly, to involve FPOs and local entrepreneurs in collection, storage and supply of agro-residues materials and to link with MNREGA and PMEGP- Prime Minister's Employment Generation

Program and setting up biomass depots facilities to address wild fluctuation of biomass material prices during season and off-season period.

- Awareness generation of local MSMEs and institutions about the harmful effects of emissions due to inefficient burning of conventional fuel (like wood logs, coal etc.) and sensitize them to shift to biomass pellets.
- Credit institutions, such as agricultural development banks, which are not familiar with biomass pellet technology and related opportunities, could be made aware through the awareness and capacity building program.
- Identify local entrepreneurs and youths to impart training/skilling program in agro-residues collection and biomass pellet production opportunity in both the districts.
- Develop CSR based funding plan for private and public sector companies for implementation of these community-based enterprises**.**

ANNEXURE-I

Questionnaires

Questionnaires for MSMEs Survey

1. General Information

a. Type of Industry: .....

b. Unit Name: .....

c. Name of contact person and designation: .....

d. Address .....

e. Contact No and Email id. .....

f. Year of establishment .....

g. Daily operational hours .....

h. Average annual operational days .....

2. Fuel consumption details

Primary energy source used for heat generation in process (mark tick)

a ☐ Electricity

b ☐ Natural gas

c ☐ Diesel

d ☐ LPG

e ☐ Furnace Oil

f ☐ Coal

g ☐ Any Other fuel type (please specify) .....

3. Process temperature requirement

a ☐ < 100 °C

b ☐ 100-400 °C

c ☐ 400-600 °C

d ☐ 600 -1000 °C

e ☐ > 1000 °C

4. Fuel consumption details

a. Daily fuel consumption (kg/Ltr/SCM): .....

b. Monthly fuel consumption (kg/Ltr/SCM): .....

c. Annual fuel consumption (kg/Ltr/SCM) .....

(SCM- Standard cubic meter)

5. Month wise fuel consumption (in case unit operation is seasonal)

Month		**Type of fuel used**	**fuel consumption (ton / day)**	**Remarks**
January		i. ii. iii.		
February		i. ii. iii.		

March		i. ii. iii.		
April		i. ii. iii.		
May		i. ii. iii.		
June		i. ii. iii.		
July		i. ii. iii.		
August		i. ii. iii.		
September		i. ii. iii.		
October		i. ii.		

		iii.		
November		i. ii. iii.		
December		i. ii. iii.		

6. Fuel cost details:

1 Source of fuel .....

2 What is the average price of fuel (Rs/unit)? .....

3 Average fuel expenditure:

a. Daily .....

b. Monthly .....

c. Annual .....

4 Are you interested in shifting to clean energy options like Biomass pellets?

.....

.....

5 What will be expected base price of biomass pellets (Rs/kg or Rs/Kcal)?

.....

.....

6 Any other comments

.....

.....

.....

(Signature of Surveyor)

Questionnaires for Mid-day meals /Hostels or other educational institutions/Hospital

1. Name of Unit .....
2. Year of establishment: .....
3. Type of Unit:

☐ Hotel

☐ Dhaba

☐ Mid-day Meal

☐ Hostels

☐ Any Other (please specify) .....

4. Address:

   .....

   .....

   .....

5. Name of Person Interviewed and designation:

   .....

6. Contact No. and Email Id:

   .....

7. Type and quantity of food cooked per day

   a ☐ Rice

   b ☐ Roti

   c ☐ Dal

   d ☐ Sabzi

   e ☐ Tea/coffee

f ☐ Any other (please specify) .....

8. Number of students / persons for which food cooked per day

.....

.....

9. Type of cooking fuel used:

a ☐ Wood

b ☐ LPG

c ☐ Coal

d ☐ Crop residues/cow dung

e ☐ Any Other (please specify) .....

10. Source of fuel .....

11. Month wise fuel consumption data (Indicative)

Month		**Type of fuel used**	**Fuel consumption (ton / month)**	**Remarks**
January		i. ii. iii.		
February		i. ii. iii.		
March		i. ii. iii.		
April		i.		

		ii. iii.		
May		i. ii. iii.		
June		i. ii. iii.		
July		i. ii. iii.		
August		i. ii. iii.		
September		i. ii. iii.		
October		i. ii. iii.		
November		i. ii. iii.		

December		i. ii. iii.		

Total cooking Fuel used	Type of fuel	Quantity
Daily	i. ii. iii.	
Monthly	i. ii. iii.	
Annual	i. ii. iii.	

1. Number of annual operation days .....

2. What is the average price of fuel (Rs/unit)? .....

3. Are you interested in shifting to clean energy options like Biomass pellets?

.....

.....

4. What will be expected base price of biomass pellets (Rs/kg or Rs/Kcal)?

.....

.....

5. Any other comments

.....

.....

.....

.....

(Signature of Surveyor)

Questionnaires for Farmer survey

1. Name of Farmer / Respondent/FPO: .....
2. Name of Village: .....
3. Name of Block: .....
4. Name of District: .....
5. General Information:

Head of the family: ..... Age: ..... Sex: .....

Type of family (Mark √):

(i). Joint Family: ..... (ii) Nucleus Family: .....

6. Family size:

Age Group	**Male (No.)**	**Female (No.)**	**Total (No.)**
Less than 05 year			
5 – 15			
15 – 25			
25 – 35			
35 – 45			
45 – 55			
Above 55 years			

7. Occupations Please tick (✓):

S. No.	Sector	Agriculture	Agricultural labour	Business	Service	Any other (Please specify)
1	Primary					
2	Secondary					

8. Land holding (Acre) Please tick (✓):

(i) Landless ☐ (ii) Small (*0 – 5 Acre)* ☐

(iii) Medium *(5 – 10 Acre)* ☐ (iv) Large *(> 10 Acre)* ☐

9. Land category

(i) Irrigated .....Acre (ii) Un-irrigated.....Acre

(iii) Barren.....Acre (iv)Total.....Acre

10. Agricultural biomass production:

Season	Crop	Irrigated land			Non – Irrigated				Barren land			
		Gross sown area (acres)	**Crop Yield (t/acre)**	**Type of agro residue**	**Total production**	**Gross sown**	**Crop Yield**	**Type of agro residue**	**Total production**	**Gross sown area**	**Crop Yield (t/acre)**	**Type of agro residue**	**Total production residue**

				generated (t/acre)	n residue (t/acre)	area (acres)	(t/acre)	generated (t/acre)	residue (t/acre)	(acres)		generated (t/acre)	(t/acre)
Kh													
Ra													
Zai													

1 ha = 10,000 sq. mts; 1 acre = 4,000 sq. mts; 1 ha – 2.47 acre

11. Quality of biomass:

S. No.	Type of biomass	Type of biomass (Mark F- (Fresh /S- Stored)	If stored (Duration of storage in months)	Moisture content (%)	Bulk Density	Other (If any)
1	Paddy straw					
1.1	Paddy husk					
2	Arhar stalk					
2.2	Arhar husk					
3	Cotton stalk					
3.3	Cotton husk					

4	Groundnut stalk					
5	Mung stalk					
5.5	Mung husk					
6	Mustard stalk					
7	Soyabean stalk					
8	Sugarcane bagasse					
8.8	Sugarcane top leave					

12. Crop residue used as fodder

Do you use any of the following crop residues as fodder for your cattle (Mark √). 1. Yes…… 2. No:…… If your answer is yes, then please elaborate the quantity and crops residue used as fodder

1. Paddy straw
2. Paddy husk
3. Arhar stalk
4. Arhar husk
5. Cotton stalk
6. Cotton husk
7. Groundnut stalk
8. Mung stalk
9. Mung husk
10. Mustard stalk

11. Soyabean stalk
12. Sugarcane bagasse
13. Sugarcane top leaf

13. Name and type of crop residue used as fodder:

S. No.	Season	Name of crop residue	Quantity used as fodder (quintal/day)	Remarks (If any)
1	Jan – March			
2	April – June			
3	July – Sept			
4	Oct. – Dec.			

14. Crop residue used for domestic purposes

Do you grow any additional fodder crops 1. Yes…… 2. No:…… If your answer is No, than please elaborate the quantity and crops residue used as fodder

15. Biomass consumption of Agro -residue:

Name of residue	Total residue produced (quintal./yr)	Residue used as fodder (quintal./yr)	Residue converted to manure (quintal./yr)	Residue used as fuel cooking (quintal./yr)	Residue burned in field (quintal./yr)	Surplus Biomass (quintal./yr)
Paddy straw						
Paddy husk						

Arhar stalk						
Arhar husk						
Cotton stalk						
Cotton husk						
Groundnut stalk						
Mung stalk						
Mung husk						
Mustard stalk						
Soyabeans stalk						
Soyabeans husk						
Sugarcane bagasse						
Sugarcane top leave						

If surplus biomass is sold to local buyers, what is the price of crop residue / biomass

16. Price dynamics:

S. No.	Type of biomass	During season of production Rs/Quintal	Duration Off Season Rs/Quintal	Remarks (If any)
1	Paddy straw			

1.1	Paddy husk			
2	Arhar stalk			
2.2	Arhar husk			
3	Cotton stalk			
3.3	Cotton husk			
4	Groundnut stalk			
5	Mung stalk			
5.5	Mung husk			
6	Mustard stalk			
7	Soyabean stalk			
8	Sugarcane bagasse			
8.8	Sugarcane top leave			

17. Farmer's perception for biomass production and marketing (Please ✓):

S. No.	Particulars	Yes	No	Don't know	Remarks (If any)
1	Are you willing to supply crop biomass/residues from your land to biomass pelleting company?				
2	Do you think supplying crop residues from your land could give you an extra income?				

3	Do you think you could supply crop residues from your land throughout the year?				
4	Are you willing to spend money in mobilizing crop biomass /residues from your land to mitigate the demand of energy producers?				
5	Are you willing to sell crop biomass residues to middlemen / supplier supplying biomass to pellet producers?				
6	Are you willing to sell crop residues directly to pellet producers?				
7	Are you willing to go for a contractual obligation with energy producers for supplying the crop residues from your land?				
8	Do you think there are other farmers in your area who are willing to supply crop residues for pellet production?				
9	Do you want the government to regulate the price (MSP) of crop biomass residues for pellet production?				
10	Are you in favor of a village-level cooperative body/ society that shall be involved in regulating the supply of crop biomass/ residues to the pellet producers?				
11	Do you think if the pellets are produced locally, would you like to use them as fuel for domestic cooking				
12	Do you think that pellet production can generate some additional income				

18. What is the expected selling price of crop biomass produced from their own land, selling to energy company/producers?

S. No.	Type of Biomass/ Crop residues	Average Annual Production (tons/ year)	Expected Selling Price at Farm land (Rs. /quintal.)	Remarks (If any)

19. In your opinion what are the major obstacles could be experienced for supplying crop residues from your land to the pellet producers?

.....

.....

.....

.....

20. In your opinion what are the important benefits that you can get from supplying crop residues from your land to the pellet producers?

.....

.....

.....

.....

.....

21. In your opinion, what are the possible impacts that may happen if there is a biomass-based pellet making plant established nearby your area?

.....

.....

.....

.....

.....

22. Any other comments

.....

.....

.....

(Signature of Surveyor)

Questionnaires for Transporter

1. General Information

a. Name of transporter :.....

b. Transporter since .....

c. Name of owner .....

d. Address

.....

.....

.....

e. Name of Person Interviewed and designation: .....

f. Contact no. .....

1. Transportation cost of biomass

Vehicle type	**Total Transport cost (Rs/ton)***	**Fixed cost (Rs)**			**Variable cost (Rs/ton/km)**	**Diesel consumption (Liter/km/ton)**	**Sold to whom (End user/ Buyer)**
		Driver cost (Rs/trip)	**Loading& unloading cost (Rs/ton)**	**Any Other**			
Bullock cart							
Tractor (+ trailer)							

Lorry							
Any other *(Please specify)*							

*Two ways (including empty return).

2. **Surveyor's General Observation (if any, observation can use additional sheet also):**

1. .....
2. .....
3. .....
4. .....

(Signature of Surveyor)

ANNEXURE- II

Field Survey of MSMEs Units

Our team visited various industries such as namkeen, pharma, roasting, garments and other to know their fuel consumption and mostly they are using wood, diesel, coal, CNG, and light diesel oil (LDO).

Type of Industry	**Namkeen**
Unit Name	Dhool Chand
Type of Fuel used	CNG
Process Temperature	100-400 °C
Annual Fuel Consumption	19200 SCM
Average Price	Rs 60/kg
Potential demand of biomass pellets	**5,76,000 kg annually**

Boiler of Dhool Chand Unit

Type of Industry	**Namkeen**
Unit Name	Rajshree Wafers
Type of Fuel used	Wood
Process Temperature	100-400 °C
Annual Fuel Consumption	616 MT
Average Price	Wood Rs 5/kg
Potential demand of biomass pellets	**6,16,000 kg annually**

Wood waste

Namkeen unit of Rajshree wafers

Type of Industry	**Namkeen**
Unit Name	Dollat Ram
Type of Fuel used	Light Diesel Oil (LDO)
Process Temperature	100-400 °C
Annual Fuel Consumption	750000 Ltr
Average Price	Rs 70/Ltr
Potential demand of biomass pellets	**2250 MT annually**

Namkeen Unit of Dollat Ram

Type of Industry	**Roasting**
Unit Name	Smart Global Foods
Type of Fuel used	Wood
Process Temperature	100-400 °C
Annual Fuel Consumption	120 MT
Average Price	Rs 5000/MT
Potential demand of biomass pellets	**120000 kg annually**

Roasting unit of Smart Global Foods

Type of Industry	**Roasting**
Unit Name	Rathod Roasting
Type of Fuel used	Rice Husk
Process Temperature	100-400 °C
Annual Fuel Consumption	1080 MT
Average Price	Rs 5/kg
Potential demand of biomass pellets	**1080000 kg annually**

Type of Industry	**Garment**
Unit Name	Jain Apparels
Type of Fuel used	Diesel
Process Temperature	100-400 °C
Annual Fuel Consumption	30000 Ltr
Average Price	Rs 90/Ltr
Potential demand of biomass pellets	**90000 kg annually**

Garment Unit of Jain Apparels

Annexure III

Schedule of Depreciation for 1 TPH Plant

Particulars	Land & Buildings & Civil Work	Plant & Machinery	Other	Total
Rate of Depreciation			Year 1-15	4.67%
			16th Year onwards	2.00%
Opening Balance	10.00	50.00	8.00	
Add:- Interest during construction period				
Total	10.00	50.00	8.00	68.00
Year 1				
Additions during the year	0.00	0.00	0.00	0.00
Depreciation				3.18
W.D.V.				64.82
Year 2				
Additions during the year	0.00	0.00	0.00	0.00
Depreciation				3.03
W.D.V.				61.80
Year 3				
Additions during the year	0.00	0.00	0.00	0.00
Depreciation				2.89
W.D.V.				58.91
Year 4				
Additions during the year	0.00	0.00	0.00	0.00
Depreciation				2.75
W.D.V.				56.16

Year 5 Additions during the year Depreciation W.D.V.	0.00	0.00	0.00	0.00 2.62 53.54

Schedule of Depreciation for 0.5TPH Plant

Particulars	Land & Buildings & Civil Work	Plant & Machinery	Other	Total
Rate of Depreciation			Year 1-15	4.67%
			16th Year onwards	2.00%
Opening Balance	6.00	30.00	5.00	
Add :- Interest during construction period				
Total	6.00	30.00	5.00	41.00
Year 1 Additions during the year	0.00	0.00	0.00	0.00
Depreciation W.D.V.				1.91 39.09
Year 2 Additions during the year	0.00	0.00	0.00	0.00
Depreciation W.D.V.				1.83 37.26
Year 3 Additions during the year	0.00	0.00	0.00	0.00
Depreciation W.D.V.				1.74 35.52

Year 4				
Additions during the year	0.00	0.00	0.00	0.00
Depreciation				1.66
W.D.V.				33.86
Year 5				
Additions during the year	0.00	0.00	0.00	0.00
Depreciation				1.58
W.D.V.				32.28

Annexure IV

Schedule of Interest & Repayment of Loan

Capacity 1 TPH		
Total Term Loan		41.48
Repayment Mode		Monthly
Repayment Period		8 Years
No. of Installments		96
Moratorium period		12 months
Rate of Interest		11.00%

(Rs in lakhs)

Particulars	Interest	Principal	Total	Balance of Loan Amount
Year 1				
1	0.38	0.00	0.38	41.48
2	0.38	0.00	0.38	41.48
3	0.38	0.00	0.38	41.48
4	0.38	0.00	0.38	41.48
5	0.38	0.00	0.38	41.48
6	0.38	0.00	0.38	41.48
7	0.38	0.00	0.38	41.48
8	0.38	0.00	0.38	41.48
9	0.38	0.00	0.38	41.48
10	0.38	0.00	0.38	41.48
11	0.38	0.00	0.38	41.48
12	0.38	0.00	0.38	41.48
Total	**4.56**		**4.56**	
Year 2				
1	0.38	0.43	0.81	41.05
2	0.38	0.43	0.81	40.62
3	0.37	0.43	0.80	40.18
4	0.37	0.43	0.80	39.75
5	0.36	0.43	0.80	39.32
6	0.36	0.43	0.79	38.89
7	0.36	0.43	0.79	38.46
8	0.35	0.43	0.78	38.02
9	0.35	0.43	0.78	37.59

10	0.34	0.43	0.78	37.16
11	0.34	0.43	0.77	36.73
12	0.34	0.43	0.77	36.30
Total	**4.30**	**5.19**	**9.49**	
Year 3				
	0.33	0.43	0.76	35.86
	0.33	0.43	0.76	35.43
	0.32	0.43	0.76	35.00
	0.32	0.43	0.75	34.57
	0.32	0.43	0.75	34.13
	0.31	0.43	0.74	33.70
	0.31	0.43	0.74	33.27
	0.30	0.43	0.74	32.84
	0.30	0.43	0.73	32.41
	0.30	0.43	0.73	31.97
	0.29	0.43	0.73	31.54
	0.29	0.43	0.72	31.11
	3.73	**5.19**	**8.92**	
Year 4				
1	0.29	0.43	0.72	30.68
2	0.28	0.43	0.71	30.25
3	0.28	0.43	0.71	29.81
4	0.27	0.43	0.71	29.38
5	0.27	0.43	0.70	28.95
6	0.27	0.43	0.70	28.52
7	0.26	0.43	0.69	28.09
8	0.26	0.43	0.69	27.65
9	0.25	0.43	0.69	27.22
10	0.25	0.43	0.68	26.79
11	0.25	0.43	0.68	26.36
12	0.24	0.43	0.67	25.93
	3.16	**5.19**	**8.35**	
Year 5				
1	0.24	0.43	0.67	25.49
2	0.23	0.43	0.67	25.06
3	0.23	0.43	0.66	24.63
4	0.23	0.43	0.66	24.20
5	0.22	0.43	0.65	23.76
6	0.22	0.43	0.65	23.33
7	0.21	0.43	0.65	22.90
8	0.21	0.43	0.64	22.47
9	0.21	0.43	0.64	22.04

10	0.20	0.43	0.63	21.60
11	0.20	0.43	0.63	21.17
12	0.19	0.43	0.63	20.74
	2.59	**5.19**	**7.78**	

Capacity 0.5 TPH		
Total Term Loan		**25.55**
Repayment Mode		**Monthly**
Repayment Period		**8 Years**
No. of Installments		**96**
Moratorium period		**12 months**
Rate of Interest		**11.00%**

(Rs in lakhs)

Particulars	**Interest**	**Principal**	**Total**	**Balance of Loan Amount**
Year 1				
1	0.23	0.00	0.23	25.55
2	0.23	0.00	0.23	25.55
3	0.23	0.00	0.23	25.55
4	0.23	0.00	0.23	25.55
5	0.23	0.00	0.23	25.55
6	0.23	0.00	0.23	25.55
7	0.23	0.00	0.23	25.55
8	0.23	0.00	0.23	25.55
9	0.23	0.00	0.23	25.55
10	0.23	0.00	0.23	25.55
11	0.23	0.00	0.23	25.55
12	0.23	0.00	0.23	25.55
Total	**2.81**		**2.81**	
Year 2				
1	0.23	0.43	0.67	25.12
2	0.23	0.43	0.66	24.68
3	0.23	0.43	0.66	24.25
4	0.22	0.43	0.65	23.82
5	0.22	0.43	0.65	23.39
6	0.21	0.43	0.65	22.95

7	0.21	0.43	0.64	22.52
8	0.21	0.43	0.64	22.09
9	0.20	0.43	0.63	21.66
10	0.20	0.43	0.63	21.23
11	0.19	0.43	0.63	20.79
12	0.19	0.43	0.62	20.36
Total	**2.55**	**5.19**	**7.73**	
Year 3				
	0.19	0.43	0.62	19.93
	0.18	0.43	0.61	19.50
	0.18	0.43	0.61	19.07
	0.17	0.43	0.61	18.63
	0.17	0.43	0.60	18.20
	0.17	0.43	0.60	17.77
	0.16	0.43	0.59	17.34
	0.16	0.43	0.59	16.91
	0.15	0.43	0.59	16.47
	0.15	0.43	0.58	16.04
	0.15	0.43	0.58	15.61
	0.14	0.43	0.58	15.18
	1.98	**5.19**	**7.16**	
Year 4				
1	0.14	0.43	0.57	14.75
2	0.14	0.43	0.57	14.31
3	0.13	0.43	0.56	13.88
4	0.13	0.43	0.56	13.45
5	0.12	0.43	0.56	13.02
6	0.12	0.43	0.55	12.58
7	0.12	0.43	0.55	12.15
8	0.11	0.43	0.54	11.72
9	0.11	0.43	0.54	11.29
10	0.10	0.43	0.54	10.86
11	0.10	0.43	0.53	10.42
12	0.10	0.43	0.53	9.99
	1.41	**5.19**	**6.59**	
Year 5				
1	0.09	0.43	0.52	9.56
2	0.09	0.43	0.52	9.13
3	0.08	0.43	0.52	8.70
4	0.08	0.43	0.51	8.26
5	0.08	0.43	0.51	7.83
6	0.07	0.43	0.50	7.40

7	0.07	0.43	0.50	6.97
8	0.06	0.43	0.50	6.54
9	0.06	0.43	0.49	6.10
10	0.06	0.43	0.49	5.67
11	0.05	0.43	0.48	5.24
12	0.05	0.43	0.48	4.81
	0.84	**5.19**	**6.02**	

ANNEXURE V

Training Module of Biomass Pellet Manufacturing Junior Technician

Model Curriculum

QP Name: Biomass Pellet Plant Junior Technician

QP Code:

QP Version: 1

NSQF Level: 3

Model Curriculum Version: 1

Skill Council for Green Jobs (SCGJ)

3rd Floor, CBIP Building, Malcha Marg, Chanakyapuri, New Delhi 110021

Contents

Training Parameters

Sector	Green Jobs
Sub-Sector	Renewable Energy
Occupation	Process Line Operator
Country	India
NSQF Level	3
Aligned to NCO/ISCO/ISIC Code	
Minimum Educational Qualification and Experience	8th pass with 1 year of experience Or 8th pass+ ITI Or 10th pass Or Previous relevant qualification of NSQF level 2 with 1 year of Experience
Pre-Requisite License or Training	NA
Minimum Job Entry Age	16 years
Last Reviewed On	
Next Review Date	
NSQC Approval Date	
QP Version	1.0
Model Curriculum Creation Date	
Model Curriculum Valid Up to Date	
Model Curriculum Version	1.0

Minimum Duration of the Course	300 Hours including 210 Hours of domain NOS+ 30 hours of Employability+ 60 hours of On the Job Training (OJT
Maximum Duration of the Course	300 Hours including 210 Hours of domain NOS+ 30 hours of Employability+ 60 hours of On the Job Training (OJT

Program Overview

This section summarizes the end objectives of the program along with its duration.

Training Outcomes

At the end of the program, the learner will be able to:

- Learn basics of biomass sector
- Identify various components of biomass pellet plant
- Carry out the manufacturing of Biomass pellet
- Maintain personal health & safety at project site
- Improve employability at workplace

Compulsory Modules

The table lists the modules, their duration and mode of delivery.

NOS and Module Details	Theory Duration	Practical Duration	Total Duration
SGJ/NXXXX: Basic of Biomass availability and utilization **NOS Version No.1** **NSQF Level 3** **Credits: 1**			
Module 1: Basic of Biomass availability and utilization	**24:00**	**06:00**	**30:00**
SGJ/NXXXX: Preparation of Raw material and quality assessment **NOS Version No.1** **NSQF Level 3** **Credits: 1**			
Module 2: Preparation of Raw material and quality assessment	**15:00**	**15:00**	**30:00**
SGJ/NXXXX: **NOS Version No.1** **NSQF Level 3**			

Credits: 1			
Module 3: Equipment and machineries of Biomass pellet plant	**12:00**	**18:00**	**30:00**
SGJ/NXXXX: **NOS Version No.1** **NSQF Level 3** **Credits: 1**			
Module 4: Manufacturing of Biomass pellet	**10:00**	**20:00**	**30:00**
SGJ/NXXXX: **NOS Version No.1** **NSQF Level 3** **Credits: 1**			
Module 5: Operation and maintenance of various components of biomass pellet plant	**12:00**	**18:00**	**30:00**
SGJ/NXXXX: **NOS Version No.1** **NSQF Level 3** **Credits: 1**			
Module 6: Package and Storage of biomass pellet	**12:00**	**18:00**	**30:00**
SGJ/N0147: Maintain personal health & safety in a manufacturing facility. **NOS Version No. 2** **NSQF Level 3** **Credits: 1**			
Module 7: Maintain Personal Health & Safety in manufacturing facility	**15: 00**	**15 :00**	**30:00**

DGT/VSQ/N0101: Employability Skills (30 Hours) **NOS Version No. 1.0** **NSQF Level 2** **Credits: 1**			
Module 8: Employability Skills			**30:00**
On the Job Training			**60:00**
Total Duration (hours)			300 Hours including 210 Hours of domain NOS+ 30 hours of Employability+ 60 hours of On the Job Training (OJT)
	90	130	

Module Details

Module 1: Basic of Biomass availability and utilization

Mapped to SGJ/NXXXX:

Terminal Outcomes:

- Introduction to biomass sector
- Discuss the role and responsibilities of a Biomass Pellet Manufacturing Technician
- Participant will be able to understand the importance of agriculture waste as renewable source of energy.

Duration: 24*:00*	**Duration**: 06*:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Introduction to Biomass sector • Overview of biomass potential in India • Describe different types of farm waste and its source, supply chain and storage methodology. • Explain the importance of agriculture residue waste as a sustainable energy resource and its management and end use applications. • Explain about biomass supply chain and its challenges. • Discuss biomass energy conversion technologies and role of biomass pellets as green fuel. • Explain the terminologies used in pellet manufacturing plant sites • Role and responsibilities of Biomass Pellet Manufacturing Junior Technician. • Advantage of doing this course, future prospect, and career opportunities.	• Illustrate biomass energy conversion technologies and role of biomass pellets as green fuel.
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	

Module 2: Preparation of Raw material and quality assessment

Mapped to SCGJ/NXXX:

Terminal Outcomes:

- Discuss various features of raw material in use for biomass pellet production

Duration: 15*:00*	**Duration**: 15*:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• List the raw materials to be used • Describe the process of receiving, handling and storage of raw materials • Assess different parameters of feedstock for biomass pellet manufacturing • Explain different types of binder currently in use • Explain how to pre-process feedstock.	• Show samples of different types of raw materials and binders in use • Demonstrate the storage procedures for raw materials such as saw dust, wheat straw, etc. • Demonstrate how to measure moisture content of raw material • Check the raw material quality and grade • Prepare the raw material for feeding. • Calculate batch size and prioritize urgent orders based on the production schedule and machine capacity • Inspect the conformance of raw material quality to standards
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	
Hammer mill, Dryer, Pellet mill, bomb calorimeter, weigh machine having least count of 0.1 mg, moisture analyser, Muffle furnace and oxygen cylinder.	

Module 3: Equipment and machineries of Biomass pellet plant

Mapped to SCGJ/NXXX:

Terminal Outcomes:

- Explain specification and standard operating procedure of all equipment's/machinery by giving practical training.

Duration: 12*:00*	**Duration**: 18*:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Identify different components of biomass pellet plant • Discuss infeed hopper, screw auger and baggage device • Explain different types of dyes in use • Explain use of chipper, hammer mill and oven dryer • List of various tools, equipment and machinery used in biomass pellet plant. • Identify size, configuration and cost of key tools, machinery/equipment.	• Demonstrate how to operate equipment's/machine involved in manufacturing of pellets are dryer, hammer mill and pellet mill, etc. • Show chipper, hammer mill and oven dryer
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	
Hammer mill, Dryer, Pellet mill, bomb calorimeter, weigh machine having least count of 0.1 mg, moisture analyser, Muffle furnace and oxygen cylinder.	

Module 4: Manufacturing of Biomass pellet

Mapped to SCGJ/NXXX:

Terminal Outcomes:

- Discuss all the process involved in manufacturing of biomass pellets.

Duration: 10*:00*	**Duration**: 20*:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Explain placing of biomass on dyes • Explain extrusion process • Operate various machines in plant such as dryer, hammer mill, pellet mill, bomb calorimeter, etc. • Explain about speed, temperature and moisture control in pelleting process • Explain the process of cooling of biomass pellet and • Express what is backpressure • Explain about standard protocol for testing of pellets and important parameters are Gross Calorific Value, Ash and Moisture. • Explain Do's and Don't	• Demonstrate placing of biomass on dyes • Set the control parameters during manufacturing • Demonstrate use of die, dryer, chipper, hammer mill, pellet mill, bomb calorimeter, etc. • Adjust pellet producing machineries at dye of 3mm, specific speed, temperature and moisture control • Demonstrate use of moisture meter to measure water content in different agriculture waste. • Perform the post-production cleaning and maintenance process followed in the industry.
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	
Hammer mill, Dryer, Pellet mill, bomb calorimeter, weigh machine having least count of 0.1 mg, moisture analyser, Muffle furnace and oxygen cylinder.	

Module 5: Operation and maintenance of various components of biomass pellet plant

Mapped to SCGJ/NXXX:

Terminal Outcomes:

- Identified all the operation and maintenance activities in pellet plant.

Duration: 12*:00*	**Duration**: 18*:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Discuss about the electricity in use for different stages of process • Prepare and maintain logbook. • Ensure maintenance of all electrical and mechanical equipment's used in plant. • Display the procedure to rectify faults and minor repairs in process machinery. • Explain "wash through" and "clogging" in pelleting process	• Maintain logbook for operation records and test results. • Demonstrate how to prepare routine maintenance and breakdown maintenance report. • Demonstrate how to modify the moisture content or die dimensions to remove clogging of the process
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	
Hammer mill, Dryer, Pellet mill, bomb calorimeter, weigh machine having least count of 0.1 mg, moisture analyser, Muffle furnace and oxygen cylinder.	

Module 6: Package and Storage of biomass pellet

Mapped to SCGJ/NXXX:

Terminal Outcomes:

- Discuss packaging and storage of biomass pellet

Duration: 12*:00*	**Duration**: 18*:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Discuss the packaging and storage processes of finished product. • Discuss about of the temperature and moisture content of biomass pellet for packaging • Discuss about the sizing of bags for packaging • Discuss labelling of the bags with types of biomass pellet and grade	• Carry out packing of finished product • Label pellet bag with types of pellet and grade
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	
Hammer mill, Dryer, Pellet mill, bomb calorimeter, weigh machine having least count of 0.1 mg, moisture analyser, Muffle furnace and oxygen cylinder.	

Module 7: Maintain Personal Health & Safety in manufacturing facility

Mapped to SCGJ/N Maintain Personal Health & Safety in manufacturing facility

Terminal Outcomes:

- Explain how to follow established safe work procedure.
- Explain to use and maintain personal protective equipment.
- Discuss to identify and mitigate safety hazards.
- Demonstrate safe and proper use of required tools and equipment.

Duration: 15*:00*	**Duration**: 15*:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Identify the requirements for safe work area. • Explain how to Administer first aid. • Identify the personal protective equipment used for the specific purpose. • Identify the heavy electrical and mechanical equipment's associated with manufacturing. • Identify work safety procedures and instructions to operate biomass pellet machines. • Explain occupational health & safety standards and regulations for biomass pellet manufacturing process.	• Demonstrate how to Administer first aid. • Show how to Identify the heavy electrical and mechanical equipment's associated with biomass pellet manufacturing. • Demonstrate how to Identify and perform work safety procedures and instructions to operate biomass pellet machines. • Demonstrate good housekeeping practices and infection control guidelines. • Demonstrate how to Dispose- off any waste materials in accordance with safe working practices and procedures.
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	
Site Visit for Practical Learning	

Module 08: Employability Skill

DGT/VSQ/N0101

Terminal Outcomes:

- Communicate effectively with team members, clients, vendors, visitors and stake holders
- Build personal and professional
- Digital and financial literacy which includes basic components of computer system and related concept, saving money, opening bank account and filing tax return

Duration: *30:00*
Key Learning Outcomes
• Discuss the importance of Employability Skills in meeting the job requirements • Explain constitutional values, civic rights, duties, citizenship, responsibility towards society etc. that are required to be followed to become a responsible citizen. • Show how to practice different environmentally sustainable practices • Discuss 21st century skills. • Display positive attitude, self -motivation, problem solving, time management skills and continuous learning mindset in different situations. • Use appropriate basic English sentences/phrases while speaking • Demonstrate how to communicate in a well -mannered way with others. • Demonstrate working with others in a team • Show how to conduct oneself appropriately with all genders and PwD • Discuss the significance of reporting sexual harassment issues in time • Discuss the significance of using financial products and services safely and securely. • Explain the importance of managing expenses, income, and savings. • Explain the significance of approaching the concerned authorities in time for any exploitation as per legal rights and laws • Show how to operate digital devices and use the associated applications and features, safely and securely • Discuss the significance of using internet for browsing, accessing social media platforms, safely and securely • Discuss the need for identifying opportunities for potential business, sources for arranging money and potential legal and financial challenges • Differentiate between types of customers • Explain the significance of identifying customer needs and addressing them • Discuss the significance of maintaining hygiene and dressing appropriately • Create a biodata • Use various sources to search and apply for jobs • Discuss the significance of dressing up neatly and maintaining hygiene for an interview • Discuss how to search and register for apprenticeship opportunities
Classroom Aids

Laptop, white board, marker, projector, charts
Tools, Equipment and Other Requirements
Computer (PC) with latest configurations – and Internet connection with standard operating system

Trainer Requirements

Trainer Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training Experience**		**Remarks**
		Years	***Specialization***	***Years***	***Specialization***	
10th pass		Two years of relevant experience				**Personal Attributes:** Aptitude for conducting training, and pre/ post work to ensure competent, employable candidates at the end of the training. Strong communication skills, interpersonal skills, ability to work as part of a team; a passion for quality and for developing others; well-organised and focused, eager to learn and keep oneself updated with the latest in the mentioned field.
As per the Relevant Craft Instructor Training Scheme (CITS)						

Trainer Certification	
Domain Certification	**Platform Certification**
Certified for Job Role: "Biomass Pellet Plant Junior Technician" mapped to QP: "SGJ/QXXXX". Minimum accepted score as per SCGJ is 70%.	Recommended that the Trainer is certified for the Job Role: "Trainer", mapped to the Qualification Pack: "MEP/Q2601". Minimum accepted Score as per SCGJ is 80%.

Assessor Requirements

Assessor Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training/Assessment Experience**		**Remarks**
		Years	***Specialization***	***Years***	***Specialization***	
10th pass		Two years of relevant experience				Personal Attributes: Aptitude for conducting assessment. Strong communication skills, interpersonal skills, ability to work as part of a team; a passion for quality and for developing others; well-organized and focused, eager to learn and keep oneself updated with the latest in the mentioned field.
As per the Relevant Craft Instructor Training Scheme (CITS)						

Assessor Certification	
Domain Certification	**Platform Certification**
Certified for Job Role: "Biomass Pellet Plant Junior Technician" mapped to QP: "SGJ/QXXXX". Minimum accepted score as per SCGJ is 70%.	Recommended that the Assessor is certified for the Job Role: "Assessor", mapped to the Qualification Pack: "MEP/Q2701". Minimum accepted Score as per SCGJ is 80%.

Assessment Strategy

This section includes the processes involved in identifying, gathering, and interpreting information to evaluate the Candidate on the required competencies of the program.

1. Assessment System Overview:

- Batches assigned to the assessment agencies for conducting the assessment on SDSM/SIP or email
- Assessment agencies send the assessment confirmation to VTP/TC looping SSC
- Assessment agency deploys the ToA certified Assessor for executing the assessment
- SSC monitors the assessment process & records.

2. Testing Environment:

- Confirm that the centre is available at the same address as mentioned on SDMS or SIP
- Check the duration of the training.
- Check the Assessment Start and End time to be as 10 a.m. and 5 p.m.
- Check that the allotted time to the candidates to complete Theory & Practical Assessment is correct.
- Check the mode of assessment—Online (TAB/Computer) or Offline (OMR/PP).
- Confirm the number of TABs on the ground are correct to execute the Assessment smoothly.
- Check the availability of the Lab Equipment for the particular Job Role.

3. Assessment Quality Assurance levels / Framework:

- Question papers created by the Subject Matter Experts (SME)
- Question papers created by the SME verified by the other subject Matter Experts
- Questions are mapped with NOS and PC
- Question papers are prepared considering that level 1 to 3 are for the unskilled & semi-skilled individuals, and level 4 and above are for the skilled, supervisor & higher management
- Assessor must be ToA certified & trainer must be ToT Certified
- Assessment agency must follow the assessment guidelines to conduct the assessment

4. Types of evidence or evidence-gathering protocol:

- Time-stamped & geotagged reporting of the assessor from assessment location
- Center photographs with signboards and scheme specific branding
- Biometric or manual attendance sheet (stamped by TP) of the trainees during the training period
- Time-stamped & geotagged assessment (Theory + Viva + Practical) photographs & videos

5. Method of verification or validation:

- Surprise visit to the assessment location
- Random audit of the batch
- Random audit of any candidate

6. Method for assessment documentation, archiving, and access

- Hard copies of the documents are stored
- Soft copies of the documents & photographs of the assessment are uploaded / accessed from Cloud Storage
- Soft copies of the documents & photographs of the assessment are stored in the Hard Drives

On the Job:

OJT Monitoring Report

- As in Green Jobs Sector, reproducing the evidence for assessment is not feasible due to constraints like cost, confidentiality and controlled environment, every
- apprentice is required to record the evidences performed during the OJT and the same gets authorized by his/her supervisor.
- The evidence recording is done in a structured monitoring report, termed as OJT Monitoring report.
- During the OJT, every trainee is required to fill the OJT monitoring report which is required to be signed by his/her supervisor.
- Towards the end of OJT period these reports are submitted with the HR department of company
- These duly submitted reports are then verified by an Industry nominated assessor for verification of evidence.

Theory, Practical & Viva:

- Scope – Is used to test the knowledge and understanding and skills acquired during the OJT as well as to conform the OJT monitoring report.
- Some personality traits and generic skills (such as – promptness, sharpness, communication skills, depth of knowledge, comprehension, presentation, patience
- etc) can also be tested, which is also required for the QP.
- Tools – The assessment's questions should be aligned with the Qualification Pack, covering the PCs. There will be summative assessment at the end of the OJT.

- Method – Direct questions open and close ended questions, situation-based questions, analytical questions, and decision-making based questions for Viva,
- MCQ for the theory and performing QP related operations for practical. Different questions in theory, practical and viva are included to test relevant PCs from
- the QP
- Analysis – Assessor draws a spectrum of ready answers to be expected from trainee for Viva. This reduces effect of subjectivity of the assessor. Comparative
- quality of trainees within a batch or different institutes can be gauged. The skill is gauged by observing the practical work.

Execution of OJT Assessment:

- HR department hands over the individual OJT monitoring report with Industry nominated assessor and schedules an assessment meeting for each trainee.
- Industry nominated assessor assesses each trainee based on OJT monitoring report, viva on each PC and also takes into account attendance of each trainee
- towards the end of the OJT period.
- The OJT marks are compiled for each NOS by the Industry nominated assessor and submitted with HR department of company.
- The OJT assessment results are then sent to SCGJ by HR department of company in a sealed envelope for compiling the assessment results in case of offline
- assessment

References

Glossary

Term	Description
Declarative Knowledge	Declarative knowledge refers to facts, concepts and principles that need to be known and/or understood in order to accomplish a task or to solve a problem.
Key Learning Outcome	Key learning outcome is the statement of what a learner needs to know, understand and be able to do in order to achieve the terminal outcomes. A set of key learning outcomes will make up the training outcomes. Training outcome is specified in terms of knowledge, understanding (theory) and skills (practical application).
OJT (M)	On-the-job training (Mandatory); trainees are mandated to complete specified hours of training on site
OJT (R)	On-the-job training (Recommended); trainees are recommended the specified hours of training on site
Procedural Knowledge	Procedural knowledge addresses how to do something, or how to perform a task. It is the ability to work, or produce a tangible work output by applying cognitive, affective or psychomotor skills.
Training Outcome	Training outcome is a statement of what a learner will know, understand and be able to do **upon the completion of the training**.
Terminal Outcome	Terminal outcome is a statement of what a learner will know, understand and be able to do **upon the completion of a module.** A set of terminal outcomes help to achieve the training outcome.

Acronyms and Abbreviations

Term	Description
QP	Qualification Pack
NSQF	National Skills Qualification Framework
NSQC	National Skills Qualification Committee
NOS	National Occupational Standards

ANNEXURE VI

Training Module of **Entrepreneur Biomass Pellet Manufacturing**

Model Curriculum
QP Name: Entrepreneur Biomass Pellet Manufacturing
NSQF Level: 4

Training Parameters

Sector	Green Jobs
Sub-Sector	Renewable Energy
Occupation	Process Line Operator
Country	India
NSQF Level	4
Aligned to NCO/ISCO/ISIC Code	
Minimum Educational Qualification and Experience	Ability to read and write with 5 years of relevant experience Or 10th pass Or Previous relevant qualification of NSQF level 2 with 1 year of Experience
Pre-Requisite License or Training	NA
Minimum Job Entry Age	18 years
Last Reviewed On	

Next Review Date	
NSQC Approval Date	
QP Version	1.0
Model Curriculum Creation Date	
Model Curriculum Valid Up to Date	
Model Curriculum Version	1.0
Minimum Duration of the Course	330 Hours including 270 Hours of Mandatory NOS and 60 hours of On the Job Training (OJT)
Maximum Duration of the Course	330 Hours including 270 Hours of Mandatory NOS and 60 hours of On the Job Training (OJT)

Program Overview

This section summarizes the end objectives of the program along with its duration.

Training Outcomes

At the end of the program, the learner will be able to:

- The individual will become self-employed through creation a business model.
- Develop critical thinking skills on developing a career as entrepreneur.
- Gain knowledge on entrepreneurial potential as an individual.
- He will be able to understand changing environmental trends (economic, social, technological, political, regulatory, and demographic changes)
- Understand the biomass energy sector and technologies involved in manufacturing of biomass pellets.
- Carry out trends and market analysis that will create opportunities.

Compulsory Modules

The table lists the modules, their duration and mode of delivery.

NOS and Module Details	Theory Duration	Practical Duration	Total Duration
SGJ/NXXXX: Introduction to Entrepreneurship and describes the basics of biomass energy **NOS Version No.1** **NSQF Level 4** **Credits: 2**			
Module 1: Introduction to Entrepreneurship and describes the basics of biomass energy sector	**20:00**	**10:00**	**30:00**

Mapped to SGJ/NXXXX: Learn financial budget and developing business plans **NOS Version No.1** **NSQF Level 4** **Credits: 1**			
Module 2: Learn financial budget and developing business plans			
SGJ/N0147: Manage sales, supply, and marketing of biomass pellets **NOS Version No. 2** **NSQF Level 4** **Credits: 1**			
Module 3: Manage sales, supply, and marketing of Biomass pellets	**15: 00**	**15 :00**	**30:00**
DGT/VSQ/N0102: Utilize government schemes and perform financial management of the business (60 Hours) **NOS Version No. 1.0** **NSQF Level 4** **Credits: 2**			
Module 4: Utilize **government schemes and perform financial management of the business**			**60:00**
On the Job Training			**120:00**
Total Duration (hours)			330 Hours including 270 Hours of

			Mandatory NOS and 60 hours of On Job Training (OJT)

Module Details

Module 1: Introduction to Entrepreneurship and describes the basics of biomass energy.

Mapped to SCGJ/NXXXX:

Terminal Outcomes:

- Discuss the role and responsibilities of an Entrepreneur on Biomass Pellet Manufacturing
- Explain about biomass energy sector and conversion technology of biomass pellets.

Duration: ***20:00***	**Duration**: ***10:00***
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Explain the concept of entrepreneurship development. • Describe the steps of the entrepreneurial process (from idea generation to harvesting of the investment). • Gain knowledge on management challenges (financial, human resources, product/service development, operations) in managing an emerging business or MSMEs. • Explain the difference between a business model and a strategy. • Explain the importance of agro residue waste as a resource and its management for end use applications. • Discuss biomass energy conversion technologies and	• Discussion on benefit of biomass pellet as fuel and its applications • To demonstrate the field survey, to meet with farmers, aggregators, and farmer producer organization (FPO) to learn about the various types of agricultural residues and their seasonal availability. • Demonstrate to understand biomass resources potential, price, challenges & opportunities, procurement supply-chain and charting of arrangement of logistics and transport facility till plant site.

role of biomass pellets as green fuel. • Explain biomass procurement system and its challenges.	• To show the cropping pattern, harvesting pattern, storage, and sale. • To demonstrate the required quantity, consistency, quality, and cost of each option and their availability at selected locations.
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	

Module 2: Learn financial budget and developing business plans.

Mapped to SCGJ/NXXX: Learn financial budget and developing business plans

Terminal Outcomes:

- Discuss the understanding of financial calculations and different strategies to develop a viable business model.
- Discuss the characteristics of innovation to developing business plans.
- Explains to develop a sustainable business model and their financial requirements for new ventures.

Duration: 20*:00*	**Duration: 10*:00***
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Brief about the basic of the financial statement's concepts. • Define the characteristics of the two basic types of financing: debt and equity. • Explain the different stages of financing. • Identify the different sources of financing. • Explain the application and calculation of the break-even point. • Explain business development tasks and activities. • Identify the important issues in managing a firm's cash flows. • Understand how the sustainable growth model is derived and apply it to determine financing requirements for a new venture.	• To demonstrate a biomass pellet plant and explain about all operations such as unloading, production, loading and storage. • Demonstrate various tools, equipment and machinery used in biomass pellet plant. • To show the identification of suitable and proven technology for the manufacturing of pellet. • To demonstrate value-chain covering demand & supply of biomass pellet considering a suitable catchment area to set up pellet manufacturing unit. • To show storage options of Biomass pellets and its shelf life

• Explain the characteristics of a good innovation to develop a business plan.	• Demonstrate budgetary cost for setting up a Pellet plant.
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	
Plant visit for practical training and various machines required are shredder/chipper, feeding system, dryer, hammer mill, complete pellet mill, electrical and lab testing equipment's.	

Module 3: Manage sales, supply, and marketing of Biomass pellets.

Mapped to SGJ/N Manage sales, supply, and marketing of Biomass pellets.

Terminal Outcomes:

- Explain the biomass market demand and their forecasting to set up a venture.
- Evaluate cost of advertising and promotion of biomass pellets.

Duration: 15*:00*	**Duration:**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Discuss the use of sales promotion tools to increase demand of biomass pellets. • Review the 4Ps of product marketing (Product, Price, Promotion, Place) and 4Ps of service marketing (People, Processes, Physical Evidence, Productivity) • Learn how to prepare a sales forecast of biomass pellets for a new venture. • Describe sales process and sales steps. • Identify customer satisfaction and service tracking techniques. • Discuss global marketing and the potential for MSMEs as global enterprises. • Identify criteria to assess marketing performance. • Understand to use primary and secondary research to profile your target customer like	

thermal power stations. Industries and households.	
Classroom Aids	
Laptop, white board, marker, projector, charts	
Tools, Equipment and Other Requirements	
Site Visit for Practical Learning	

Module 4: Utilize government schemes and perform financial management of the business.

Mapped to DGT/VSQ/N0101: Utilize government schemes and perform financial management of the business

Terminal Outcomes:

- Discuss government schemes and programs to setup biomass pellet manufacturing plant.
- Explain the financial feasibility to set up pellet manufacturing plant.
- Describe technique like SWOT and value chain analysis.

Duration: 15*:00*	**Duration:**
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Discuss government assistance programs to setup biomass pellet manufacturing plant (grants, loans, schemes, and advice) • Discuss the most important factors in the process of obtaining start-up financing. • Describe the main content of the feasibility study (financial assessment) • Discuss government policy on entrepreneurship. • Explain the need for a business plan from the perspectives of the entrepreneurs, the investors, and the lenders. • Review some techniques like SWOT analysis and value chain analysis.	

• Explain simulation techniques and scenario analysis to assess the financing needs of a new venture.	

Trainer Requirements

Trainer Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training Experience**		**Remarks**
		Years	***Specialization***	***Years***	***Specialization***	
10th pass		Two years of relevant experience				Personal Attributes: Aptitude for conducting training, and pre/ post work to ensure competent, employable candidates at the end of the training. Strong communication skills, interpersonal skills, ability to work as part of a team; a passion for quality and for developing others; well-organised and focused, eager to learn and keep oneself updated with the latest in the mentioned field.

As per the Relevant Craft Instructor Training Scheme (CITS)

Trainer Certification	
Domain Certification	**Platform Certification**
Certified for Job Role: "Biomass Pellet Manufacturing Technician" mapped to QP: "SGJ/QXXXX". Minimum accepted score as per SCGJ is 70%.	Recommended that the Trainer is certified for the Job Role: "Trainer", mapped to the Qualification Pack: "MEP/Q2601". Minimum accepted Score as per SCGJ is 80%.

Assessor Requirements

Assessor Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training/Assessment Experience**		**Remarks**
		Years	***Specialization***	***Years***	***Specialization***	
10th pass						
		Two years of relevant experience				Personal Attributes: Aptitude for conducting assessment. Strong communication skills, interpersonal skills, ability to work as part of a team; a passion for quality and for developing others; well-organized and focused, eager to learn and keep oneself updated with the latest in the

					mentioned field.

As per the Relevant Craft Instructor Training Scheme (CITS)

Assessor Certification	
Domain Certification	**Platform Certification**
Certified for Job Role: "Biomass Pellet Manufacturing Technician" mapped to QP: "SGJ/QXXXX". Minimum accepted score as per SCGJ is 70%.	Recommended that the Assessor is certified for the Job Role: "Assessor", mapped to the Qualification Pack: "MEP/Q2701". Minimum accepted Score as per SCGJ is 80%.

Assessment Strategy

This section includes the processes involved in identifying, gathering, and interpreting information to evaluate the Candidate on the required competencies of the program.

1. Assessment System Overview:

- Batches assigned to the assessment agencies for conducting the assessment on SDSM/SIP or email.
- Assessment agencies send the assessment confirmation to VTP/TC looping SSC
- Assessment agency deploys the ToA certified Assessor for executing the assessment.
- SSC monitors the assessment process & records.

2. Testing Environment:

- Confirm that the centre is available at the same address as mentioned on SDMS or SIP
- Check the duration of the training.
- Check the Assessment Start and End time to be as 10 a.m. and 5 p.m.
- Check that the allotted time to the candidates to complete Theory & Practical assessment is correct.
- Check the mode of assessment—Online (TAB/Computer) or Offline (OMR/PP).
- Confirm the number of TABs on the ground are correct to execute the Assessment smoothly.
- Check the availability of the Lab Equipment for the Job Role.

3. Assessment Quality Assurance levels / Framework:

- Question papers created by the Subject Matter Experts (SME)
- Question papers created by the SME verified by the other subject Matter Experts
- Questions are mapped with NOS and PC

- Question papers are prepared considering that level 1 to 3 are for the unskilled & semi-skilled individuals, and level 4 and above are for the skilled, supervisor & higher management
- Assessor must be ToA certified & trainer must be ToT Certified
- Assessment agency must follow the assessment guidelines to conduct the assessment.

4. Types of evidence or evidence-gathering protocol:
   - Time-stamped & geotagged reporting of the assessor from assessment location
   - Centre photographs with signboards and scheme specific branding
   - Biometric or manual attendance sheet (stamped by TP) of the trainees during the training period.
   - Time-stamped & geotagged assessment (Theory + Viva + Practical) photographs & videos.

5. Method of verification or validation:
   - Surprise visit to the assessment location
   - Random audit of the batch
   - Random audit of any candidate

6. Method for assessment documentation, archiving, and access
   - Hard copies of the documents are stored
   - Soft copies of the documents & photographs of the assessment are uploaded / accessed from Cloud Storage
   - Soft copies of the documents & photographs of the assessment are stored in the Hard Drives

On the Job:

OJT Monitoring Report

- As in Green Jobs Sector, reproducing the evidence for assessment is not feasible due to constraints like cost, confidentiality and controlled environment,

every apprentice is required to record the evidence performed during the OJT and the same gets authorized by his/her supervisor.

- During the OJT, every trainee is required to fill the OJT monitoring report which is required to be signed by his/her supervisor.
- Towards the end of OJT period these reports are submitted with the HR department of company
- These duly submitted reports are then verified by an Industry nominated assessor for verification of evidence.

Theory, Practical & Viva:

- Scope – Is used to test the knowledge and understanding and skills acquired during the OJT as well as to conform the OJT monitoring report.
- Some personality traits and generic skills (such as – promptness, sharpness, communication skills, depth of knowledge, comprehension, presentation, patience etc) can also be tested, which is also required for the QP.
- Tools – The assessment's questions should be aligned with the Qualification Pack, covering the PCs. There will be summative assessment at the end of the OJT.
- Method – Direct questions open and close ended questions, situation-based questions, analytical questions, and decision-making based questions for Viva, MCQ for the theory and performing QP related operations for practical. Different questions in theory, practical and viva are included to test relevant PCs from the QP.
- Analysis – Assessor draws a spectrum of ready answers to be expected from trainee for Viva. This reduces effect of subjectivity of the assessor. Comparative quality of trainees within a batch or different institutes can be gauged. The skill is gauged by observing the practical work.

Execution of OJT Assessment:

- HR department hands over the individual OJT monitoring report with Industry nominated assessor and schedules an assessment meeting for each trainee.
- Industry nominated assessor assesses each trainee based on OJT monitoring report, viva on each PC and also takes into account attendance of each trainee towards the end of the OJT period.

- The OJT marks are compiled for each NOS by the Industry nominated assessor and submitted with HR department of company.
- The OJT assessment results are then sent to SCGJ by HR department of company in a sealed envelope for compiling the assessment results in case of offline assessment.

References

Glossary

Term	Description
Declarative Knowledge	Declarative knowledge refers to facts, concepts and principles that need to be known and/or understood in order to accomplish a task or to solve a problem.
Key Learning Outcome	Key learning outcome is the statement of what a learner needs to know, understand and be able to do in order to achieve the terminal outcomes. A set of key learning outcomes will make up the training outcomes. Training outcome is specified in terms of knowledge, understanding (theory) and skills (practical application).
OJT (M)	On-the-job training (Mandatory); trainees are mandated to complete specified hours of training on site
OJT (R)	On-the-job training (Recommended); trainees are recommended the specified hours of training on site
Procedural Knowledge	Procedural knowledge addresses how to do something, or how to perform a task. It is the ability to work, or produce a tangible work output by applying cognitive, affective or psychomotor skills.
Training Outcome	Training outcome is a statement of what a learner will know, understand and be able to do **upon the completion of the training**.

Terminal Outcome	Terminal outcome is a statement of what a learner will know, understand and be able to do **upon the completion of a module.** A set of terminal outcomes help to achieve the training outcome.

Acronyms and Abbreviations

Term	Description
QP	Qualification Pack
NSQF	National Skills Qualification Framework
NSQC	National Skills Qualification Committee
NOS	National Occupational Standards