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Cluster Profile Report

E & W Godavari (Andhra Pradesh) Refractory Cluster

Prepared for

Bureau of Energy Efficiency (BEE)
Ministry of Power, Government of India
New Delhi

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List of abbreviations

Andhra Pradesh Eastern Power Distribution Company Limited	APEPDCL
Andhra Pradesh State Energy Conservation Mission	APSECM
Bureau of Energy Efficiency	BEE
Common Facility Centre	CFC
Detailed Project Reports	DPRs
District Industries Centre	DIC
Energy Efficiency	EE
Financial Institute	FI
Global Environmental Facility	GEF
Government of India	GoI
High Tension	HT
Industrial Training Institutes	ITI
Key Performance Indicators	KPI
Low Tension	LT
Micro & Small Enterprises - Cluster Development Programme	MSE-CDP
Micro Small and Medium Enterprises	MSME
Million Tonnes	MT
National Small Industries Corporation	NSIC
Piped Natural Gas	PNG
Singareni Collieries Company Limited	SCCL
Special Purpose Vehicle	SPV
Specific Energy Consumption	SEC
Strengths Weaknesses Opportunities and Threats	SWOT
The Energy and Resources Institute	TERI
Tonnes of Oil Equivalent	toe

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Last, but not least, the interactions and deliberations with the MSME-DI, MSME entrepreneurs, technology providers, and all others who were directly or indirectly involved throughout the study, were exemplary and a rewarding experience on the whole, for TERI.

TERI Team

Certificate of originality

This is to certify that this report is an original work of TERI. The TERI team held detailed discussions and collected data from numerous industry stakeholders, which included MSME entrepreneurs, plant engineers, industries' associations, local energy distribution companies, key local bodies, local service providers, suppliers, fabricators, experts, testing labs, academic institutes/ITIs, and banks/FIs. In addition to this, the team reviewed secondary literature available in the cluster. The cluster profile is an end product of both first hand interactions/data and secondary literature in the cluster. Appropriate references have been indicated in places where TERI has utilized secondary sources of data and information.

Chapter 1

1.0 About the Project

1.1 Project overview

The Micro, Small, and Medium Enterprise (MSME) sector in India is a unique mix of enterprises using conventional as well as modern technologies. Most of the enterprises in the MSME sector are traditional and deploy technologies that are inefficient and resource intensive. The MSMEs are generally located as clusters. There are several such clusters that are highly energy intensive in their operations.

At the national level, the data/information of energy intensive MSME sectors on various parameters like production, type, and quantity of fuel consumption, energy saving potential, details on energy efficient technologies, future growth scenarios, etc. are not readily available. This in a way limits the design of appropriate policy instruments to ensure sustainable growth of these sectors. To address this barrier, the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India, has initiated an ambitious project of mapping the energy intensive MSME sector across the country. Glass industry is one of the energy intensive sectors identified under the project. The BEE has entrusted The Energy and Resources Institute (TERI), New Delhi to undertake a detailed study of the glass industry sector in India.

1.2 Project objectives

The objectives of the study include the following:

- Map energy intensive glass and refractory manufacturing sector from energy perspective
- In-depth study of existing scenarios on energy consumption and identify opportunities for energy and resource saving
- Prepare a roadmap to develop the intervening sector energy and resource efficient as well as environment friendly

The five targeted glass & refractory clusters covered under the project are shown in table 1.2:

Table 1.2: Targeted clusters under the project

S. No.	Cluster	State	Sector
1	Chirkunda	Jharkhand	Refractory
2	Ambala	Haryana	Glass
3	E & W Godavari	Andhra Pradesh	Refractory
4	Jaipur	Rajasthan	Glass
5	Firozabad	Uttar Pradesh	Glass

1.3 Major components of the project

The major components of the project and their activities are shown in Table 1.3.

Table 1.3: Major component of the project

Components	Major activities
Component-1: Field study and data analysis	• Conduct detailed energy audits covering 10 representative units in each cluster • Conduct benchmark study to develop Key Performance Indicators (KPI) and Energy Efficiency (EE) benchmarks • Develop a sectorial profile for the refractory sector • Develop sectorial brochure
Component-2: Development of roadmap and outreach	• Prepare and publicize sectorial roadmap for refractory industry • Disseminate outreach and knowledge through; ○ Cluster level workshops ▪ Project inception workshops ▪ Post activities workshops ○ National workshops ▪ Stakeholder consultation ▪ Result dissemination

Chapter 2

2.0 Cluster Scenario

2.1 Background

Refractories provide resistance to thermal, mechanical, and chemical attacks in various industrial processes. Refractories can withstand high temperatures, ranging from 260°C to 1850°C, without major transformation in their physical properties. Refractory products are primarily used in iron & steel, non-metallic, non-ferrous metals, and others. The iron and steel industry is the major end-user of refractories, which accounts for around 75% of the market. Iron and steel require refractories to be used in blast furnaces, basic oxygen-making vessels, process gas heaters, troughs, and electric arc furnaces, etc.

The Indian refractory industry started its journey with the first line of production in West Bengal in 1874. Today, the industry comprises over 350 established units, with 13 large plants, 40 medium sizes, and about 300 small-scale manufacturing units. Currently, the Indian refractory industry has an aggregate production capacity of about 2.0-2.2 million tonnes per annum. The capacity utilization, however, currently stands at around 75 percent or 1.6-1.7 million tonnes per annum.

The important refractory clusters are located in different parts of the country include (1) Asansol (West Bengal), (2) Chirkunda (Jharkhand), (3) East & West Godavari (Andhra Pradesh), (4) Katni (Madhya Pradesh), (5) Ramgarh (Jharkhand) (6) Ranchi (Jharkhand), (7) Virudhachalam[1] (Tamil Nadu) and (8) Wankaner (Gujarat). Figure 2.1 shows the location of different refractory clusters in India.

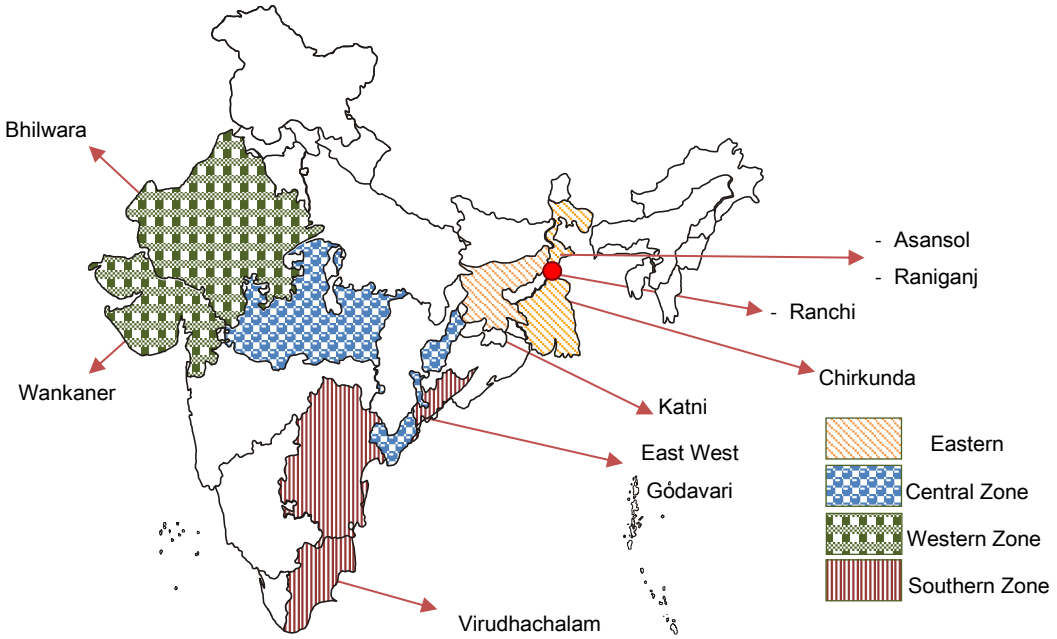

Figure 2.1 Major refractory MSME clusters in India

[1] *Production of Virudhachalam cluster is reported to be negligible due to limited and need based operation of refractory kilns.*

2.2 Overview of E & W Godavari Refractory cluster

The East & West Godavari districts of Andhra Pradesh have rich mineral resources like fire clay, ball clay, and china clay and this led to the establishment of many small-scale refractory manufacturing units in Rajahmundry, Morampudi, and Dhavaleswaram in East Godavari district and Chebrolu, Bhimdole, Dwarka Tirumala, Timmaya and Palem Road in West Godavari district[2]. The units manufacture solid/ hollow bricks, acid resistance bricks, and other products which are widely used in many applications like steel and other metallurgical industries, furnaces, etc. There are 26 refractory manufacturing units of small and medium capacities in the cluster: 19 are in East Godavari and 07 in West Godavari. The cluster produces about 62,530 tonnes of refractory products. These products are marketed in southern India and some parts of northern India. The cluster has an annual turnover of about Rs 36 crores and provides regular employment to more than 300 people. Almost all refractory units use downdraft kilns for the refractory manufacturing process.

The refractory units have formed associations called 'The Ceramic Manufacturers Welfare Association' in Rajahmundry and Dwaraka Tirumala Association in West Godavari. The Commissioner of Industries Department, Andhra Pradesh facilitates the supply of required coal from Singareni Collieries Company Limited (SCCL). Firewood is sourced from local vendors. All the units draw their required electricity from the Andhra Pradesh Eastern Power Distribution Company Limited (APEPDCL).

2.2.1 Classification of Refractory units

As per the latest notification by the Ministry of Micro, Small, and Medium Enterprises[3], all the MSME units are to be classified based on the investment of the plant including all its machinery and annual turnover with effect from 1st July 2020. Based on the new classification criterion, all the refractory units of E & W Godavari cluster fall under "Micro Category" and hence Unit production capacity is considered to classify and the details are provided below in figure 2.2.1.

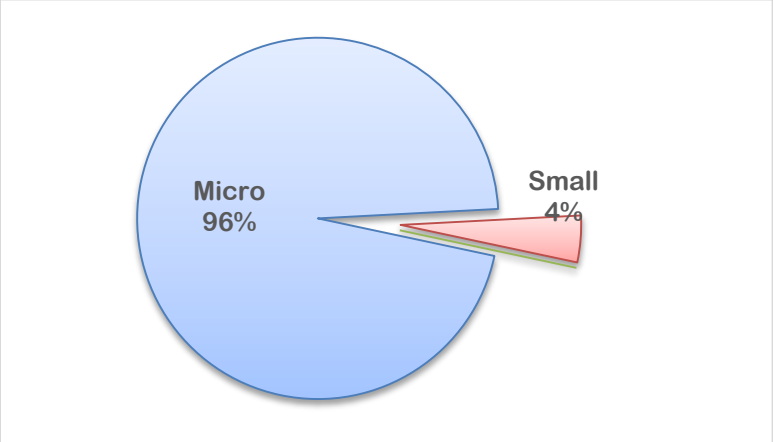

Figure 2.2.1: Classification of units in E & W Godavari Refractory cluster

2.2.2 Major products

Refractory industries in E & W Godavari were in operation for the last seven decades. Initially, ceramic potteries (Jars) were being manufactured which are mainly used domestically for food storage. Over time, the usage of such kinds of potteries has significantly reduced and all the industries diversified to refractory manufacturing due to market demand. At present these units manufacture solid/hollow bricks, BP sets, Bed materials, castables, and other refractory products which are widely used in many industries like cement, glass, steel, and other petrochemicals, etc. Refractory materials are widely utilized in applications such as linings for furnaces, boilers, kilns, incinerators, and reactors.

[2] http://www.sameeeksha.org/pdf/clusterprofile/Refractory_Manufactuirng_cluster_East_and_West_Godavari.pdf
[3] https://msme.gov.in/sites/default/files/MSME_gazette_of_india.pdf

2.2.3 Market scenario

Refractories are used in different types of industrial sectors with the steel industry being the major consumer. The refractory units of the E & W Godavari cluster find customers mostly in the domestic market within the states of Andhra Pradesh, Telangana, and other states of southern India. Major areas of usage of these cluster products are in steel plants like Vizag Steel and Cement plants. As most of the industries in the cluster are micro-scale in nature, the produced bricks are sold to the local vendors who sell them to different industries.

2.2.4 Raw materials

A variety of raw materials such as Fire clay, china clay, Graphite, and Laterite are available in E & W Godavari districts and accordingly, a different variety of industrial clusters was formed over time. The main raw material required for the manufacturing of Refractory products is mineral-based clay and other materials such as Bauxite, Ball clay, and Quartz, etc. are used in small quantities. Different varieties of clays like Fire clay, China clay, Vemagiri clay, and refractory grog are abundantly available locally which are suitable for manufacturing refractory products. During the process of refractory manufacturing, coal is used as fuel in DD kilns for prolonged heating of the material to attain the required properties.

2.3 Cluster level initiatives

The programs and initiatives undertaken by various organizations are listed in table 2.3.

Table 2.3: E & W Godavari refractory cluster level initiatives

Organisation	Programme/ initiatives	Brief description	Status
Andhra Pradesh Energy Conservation Mission (APSECM) and Bureau of Energy Efficiency (BEE)	Study of Energy saving potential of identified MSME clusters in the state of Andhra Pradesh	Establishing cluster level energy scenario and profiling, energy audits with the goal to reduce GHG emissions by the implementation of Renewable Energy and Energy Efficiency solutions.	Completed (Year 2018)
Bureau of Energy Efficiency (BEE)	BEE SME National Programme	Situation analysis, cluster profiling, energy audits and bankable detailed project reports (DPRs) on EE technologies	Completed (2009-2012)
Micro & Small Enterprises - Cluster Development Programme (MSE-CDP)	Special Purpose Vehicle (SPV)	• To support the sustainability and growth of MSEs by addressing common issues such as improvement of technology, skills & quality, market access, etc. • To build the capacity of MSEs for common supportive action through the formation of self-help groups, consortia, up-gradation of associations, etc. • To create/upgrade infrastructural facilities in the new/existing Industrial Areas/Clusters of MSEs. • To set up Common Facility Centres (for testing, training, raw material depot, effluent treatment, complementing production processes, etc.).	Operational

Organisation	Programme/ initiatives	Brief description	Status
		• Promotion of green & sustainable manufacturing technology for the clusters to enable units to switch to sustainable and green production processes and products.	

Chapter 3

3.0 Major cluster stakeholders

The primary stakeholder of the cluster is the refractory manufacturing units. The other stakeholders include industry associations, government agencies including regulatory bodies, research and academic institutions, and testing facilities and training institutes. These cluster-level stakeholders provide a range of services to the refractory manufacturing units. Some of the major stakeholders in the E & W Godavari refractory industry cluster along with their roles and activities are briefed below.

3.1 Industries associations

There are two major industry associations active in E & W Godavari refractory industry cluster namely

1. The Ceramic Manufacturers welfare Association, Rajahmundry
2. Dwaraka Tirumala Industrial Association, West Godavari

3.2 Government bodies

The government agencies involved in the cluster and their key activities in the cluster are given in table 3.2.

Table 3.2: Government bodies and key responsibilities

Name of organisation	Key roles
District Industries Centre (DIC), E&W Godavari	• Identify the new entrepreneurs and assisting them regarding their start-ups. • Provide financial and other facilities to smaller blocks for industrialization at the district level. • Enhance the rural industrialization and also the development of handicrafts. • Reach economic equality in multiple areas of the district. • Allow various government schemes to the new entrepreneurs. • De-size the regional imbalance of development. • Make all the necessary facilities to come under one roof
MSME-Development Institute (MSME-DI) Narsapur Cross Roads, Balanagar, Hyderabad - 500 037	MSME-DIs field offices of the Ministry of Micro, Small & Medium Enterprises provide a wide range of extension/ support services to the MSMEs in their respective state of operation.
National Small Industries Corporation (NSIC) Guru Nanak Colony, Vijayawada, Andhra Pradesh 520008	• Support and promote the MSME sector by providing combined support services encircling finance, marketing, technology, and allied services • Aid, foster, and promote the growth of MSMEs all across the country • Operates across the country through a network of technical centers and offices.

3.3 Technical, academic, and R&D institutions

Several engineering, polytechnic, and ITI institutes are there in and around E & W Godavari districts. Some of the famous names are GIET polytechnic college, Godavari Institute of Engineering and Technology, Government ITI and polytechnic colleges, Vivekananda ITC, etc. which offer a variety of academic as well as industrial training courses which are relevant for the cluster. These institutes provide the technical workforce to the cluster like electrical and mechanical engineers, plant operators, fitters, and electricians, etc. Currently, there are no proper national certified testing laboratories associated with the cluster.

3.4 Financial institutions

There are many nationalized, commercial, and cooperative banks operating in the cluster. However, the industrialists of the E & W Godavari refractory cluster are getting financial assistance from Andhra Bank and State Bank of India

Chapter 4

4.0 Production process and technology use

The production process in refractory industries includes (i) raw material preparation and shaping, and (ii) firing. The technologies and equipment used in different process steps of refractory product manufacturing are discussed in this section.

4.1 Manufacturing process

The refractory manufacturing process broadly consists of raw material preparation, shaping of green products, drying to remove the moisture, and firing to provide the strength and impart required properties. The raw materials include fire clays (plastic and non-plastic varieties), refractory grog (broken fire bricks), and other high alumina minerals like kyanite, sillimanite, and bauxite. A typical manufacturing process followed in the cluster for the production of refractory products is shown in the figure. 4.1.

Figure 4.1: Typical production process in a refractory industry

The general manufacturing process of ceramic products is described below.

4.1.1 Raw material preparation

The refractory units procure basic raw materials such as plastic clay and other ingredients as lumps or powder which are generally tested in the laboratories to match customer requirements. Jaw crushers are used to reduce the size of lumps before they are sent for grinding.

Grinding is a batch process used to maintain the particle size of batch material to ensures homogeneity. Jaw crushers (primary crushing) and disintegrators (fine particle sizing) are commonly used in the grinding process.

Mixing of raw materials is carried out in Muller machines (batch type) and/or U-mixer (continuous material preparation). It is done in batches of fixed quantity. These machines are used for the uniform and quick mixing of a heterogeneous mass of two or more materials of varying aggregate size mechanically into a uniformly blended batch of raw materials. Mullers are fitted with large mulling rollers for the mixing of raw materials. Water is added to raw materials in required proportions and loaded in Muller machines to have a homogeneous mass of raw material.

4.1.2 Shaping and formation

Pressing machines are used to provide shape to the product. Each refractory unit uses multiple press machines. The press machines are operated manually. Two types of press machines are commonly used namely (1) hydraulic press and (2) friction press. The type of press used is dependent on the type of product being produced by the unit. For large-size products, friction press is used whereas for others hydraulic press is used. The required quantity of homogeneously mixed raw material in Muller is loaded manually in hydraulic or friction press based on the type of product. The press is operated manually to provide shape and strength to the products. The pressed product is manually removed for further drying.

4.1.3 Drying

The moisture level of the green refractory products is in the range of 7-8% which must be reduced to 3-5% before firing. The shaped products from the shaping/formation process are stacked inside an open shed to allow slow and uniform drying.

4.1.4 Firing

Firing is the process by which refractories are thermally consolidated into a dense, cohesive body composed of fine and uniform grains. This process also is referred to as sintering or densification. Refractories are generally fired at 50-75% of the absolute melting temperature of the body material. The temperature profile of the refractory bricks varies in the range of 1150-1300 ^{0}C.

4.2 Major technologies and equipment

The refectory manufacturing industries in E&W Godavari use traditional technologies. The technology and equipment used in different refectories manufacturing processes are described below.

4.2.1 Raw material preparation and shaping

The raw materials are crushed and sieved to achieve defined particle-size distribution according to the recipe. The raw material crushing process uses a jaw crusher and disintegrator. A jaw crusher is used to reduce the input feed sizes to 50 mm (maximum). An electric motor-driven disintegrator is used to achieve a defined particle size of batch products. Most MSME units in the cluster are manpower intensive and use manual conveying of the raw material. About 10-15 manpower is required for the raw material preparation in a typical size MSME unit.

The grinded /prepared powder is stored in a chamber underneath the disintegrator, which requires additional manpower for material transfer as well as significant wastage of ready-to-use recipes. However, some of the progressive units use bucket elevators and silos reducing manpower requirements and minimising wastage.

Water is added to the mixture in Muller machines to prepare homogeneous batches as per the requirements of the final product composition. Press machines are used to provide shape to the product. Friction press and hydraulic screw press are primarily used in the shaping/moulding process of the products. The type of press used is dependent on the type of products being manufactured, density, and strength.

Friction press is suitable for large-size refractory products. The common capacity of the friction presses installed in the clusters is varying in the range of 80-250 tonnes. However, some of the medium and large units are using multiple cavities, friction presses of up to 800-tonne capacity. The hydraulic press is more suitable for refractory products that can be shaped generally within 30-180 tonnes in a single stroke.

Electricity is primarily used in the raw material preparation and shaping sections. More than 90% of the total electricity used in electric motors is associated with jaw crushers, disintegrators, U-mixer, Muller machines, and press machines. The installed electric motors are standard efficiency class and more than 60% of the motors are old and multiple times rewound.

4.2.2 Drying

The refractory sector uses a natural drying process for the removal of moisture from the green refractory product. Due to the natural drying process, the drying duration and the final moisture level are generally dependants on ambient conditions. For example, the firing cycle and the associated energy consumption of the kilns increase significantly during the rainy season. Hence, most of the refractory kilns are generally not operated during the rainy season.

4.2.3 Firing

Almost all the refractory units in the cluster use DD kiln technology in the firing process. The production capacities of downdraft kilns vary in the range of 40 tonnes to 250 tonnes per batch depending on the internal diameter of the kiln. Coal is used as the major fuel in downdraft kilns; however, a few units also use firewood along with coal. A typical batch cycle of downdraft kiln unit includes the following steps.

Loading: Green refractory products are being stacked inside the chamber. Most of the units transfer green products manually from the production shed to the kiln chamber which takes almost 2-3 days using 10-15 manpower. A few units have installed motorized flexible conveyor systems.

Smoking: Slow firing is initiated in the kiln for removal of moisture from green products (the initial moisture level of stacked products is in the range of 3-5%). The duration of slow firing is about 2-3 days.

Firing: The firing takes about 5-7 days wherein a temperature level of about 1,150-1,300 ^{0}C is achieved. Coal is generally fed at set intervals but without weighing. The downdraft kilns also do not have a provision for temperature monitoring to maintain the standard temperature profile of the kiln.
Soaking: On achieving the desired temperature, the kiln is sealed completely for soaking of products to attain uniform temperature and required physical and chemical properties.

Cooling and unloading: Cooling of the kiln is carried out for about 2-3 days which includes up to 1 day for natural draft cooling and 2 days for forced cooling using fans.

Since downdraft kilns are batch-based, their specific energy consumption (SEC) levels are generally observed to be higher than continuous type kilns.

Chapter 5

5.0 Energy consumption profile and conservation measures

5.1 Details of energy use

The Refractory industries in E & W Godavari cluster use both thermal energy and electricity in the manufacturing processes. Energy accounts for a significant portion of the manufacturing costs of the refractory units of the cluster. The energy cost to produce per ton of product is in the range of 40 to 45%. The levels of energy consumption in these units are dependent on the type of products such as high alumina bricks, BP sets, etc. Different types of energy used in the cluster include coal and electricity.

5.1.1 Thermal energy

Thermal energy is used to meet the heating requirements of the processes followed in the refractory manufacturing units. The details of thermal energy use in the cluster are provided in Table 5.1.1.

Table 5.1.1: Details of fuels used for thermal energy requirements

Energy type	Source	Calorific value (kCal/kg)	Landed cost, (Rs./Ton)
Coal	Domestic local supplier/ quota	4,000-4,800	6,800-7,500
HSD	Retail outlets	10580	79,000

5.1.2 Electricity

Electricity is used in electric motors to operate types of machinery such as crushers, mixers, pug mills, ball mills, moulding, and fans. All the units have an LT connection of Category III and it is being supplied by Andhra Pradesh Eastern Power Distribution Company Limited (APEPDCL). The applicable tariff of various such categories is given in Table 5.1.2.

Table 5.1.2: Electricity tariff plans in E & W Godavari refractory cluster

Energy source	Availability	Tariff details
Electricity	Andhra Pradesh Eastern Power Distribution Company Limited (APEPDCL)	Tariff category: III Industry LT Voltage supply: 0.415 kV Fixed charges: Rs.75 per kW or HP Energy charges: Rs 6.7per kVAh

LT consumers are subjected to TOD billing and supply can be taken up to 150 HP load.

5.2 Energy consumption pattern

The energy consumption pattern of the refractory units varies based on product type, the technology employed, and production capacities. The unit-level energy consumption of typical production capacities and cumulative cluster level energy consumption of the E & W Godavari Refractory industries are summarised below.

5.2.1 Unit level

The energy consumption of typical refractory manufacturing units in the E & W Godavari cluster varies from 164 to 977 tonnes of oil equivalent (toe) per year (Table 5.2.1). Thermal energy accounts for 99.4 % of total energy consumption, with coal being used as the main fuel.

Table 5.2.1: Unit level energy consumption (Average of all units)

Category	Thermal energy (toe/year)	Electricity (kWh/year)	Total energy consumption (toe/year)
Downdraft kilns	380	26,145	382

5.2.2 Cluster level

East and West Godavari refractory cluster is located in Andhra Pradesh. There are about 26 refractory manufacturing units using downdraft kiln technology in the cluster. The total estimated production of the cluster is 62,530 tonnes per year (FY 2019-20). The primary fuel in the cluster is coal for kiln firing and uses mainly grid electricity for meeting the plant load. The total energy consumption of the East & West Godavari refractory cluster is estimated to be 9,941 tonnes of oil equivalent (toe) Table 5.2.2. The equivalent GHG emissions are estimated to be 40,313 tonnes of CO_2 per year.

Table 5.2.2: Energy consumption of E&W Godavari cluster

Kiln type	Number of units	Production (tpy)	Thermal (toe/yr)	Electricity (toe/yr)	Total energy consumption (toe)
Downdraft kiln	26	62,530	9,882	58	9,941

5.2.3 Specific energy consumption

The specific energy consumption for refractory production using different types of firing technologies i.e. downdraft is given in table 5.2.3.

Table 5.2.3: specific energy consumption

Parameters	Unit	Value
Downdraft kiln		
Firing of refractory product	GJ/ tonne of product	6.66
Raw material preparation	kWh/tonne of raw material	10.87
Specific energy consumption in vitrification of green refractories	GJ/ tonne of product	6.62

The weighted average specific energy consumption of the E&W Godavari refractory cluster considering downdraft as major firing technology is estimated to be 6.66 GJ per tonne of product.

5.3 Other resources

Apart from thermal energy and electricity, the refractory industries in the E & W Godavari cluster consume other resources such as raw water which is mainly sourced from bore wells nearby.

5.4 Energy conservation opportunities

The refractory units in E & W Godavari cluster mostly use locally fabricated technologies, especially for thermal and process equipment. These technologies/equipment are invariable energy in-efficient and polluting. The electrical motors are rewound multiple times that leads to inefficiencies in many of the motor-driven systems. All the above-mentioned activities in the cluster offer significant scope for energy saving. A list of different energy conservation measures applicable for E & E Godavari refractory units is provided in table 5.4.

Table 5.4: Major energy conservation opportunities in the cluster

Equipment/section/utility	Energy conservation measures
Downdraft kiln	• Improving damper system • Use of correct size of coal and improving feeding practices • Installing temperature indicators for monitoring furnace temperature • Preheating of green refractory by flue gases • Technology up-gradation: Switch to tunnel kiln based firing technology
Electrical distribution system	• Improvement of billing power factor
Other areas	• Replacement of rewound, old inefficient electrical motors with premium efficiency class (IE3) motors • Use of energy-efficient lighting system • Productivity enhancement in downdraft kiln • Installation of material feeding conveyor system

Chapter 6

6.0 Major challenges in the cluster

The overall energy consumption of the E & W Godavari Refractory cluster is quite significant. The analyses of energy consumption by various cluster units indicate the use of inefficient technologies and equipment and there exists significant scope for energy saving in the cluster. However, the cluster needs to address several challenges for the large-scale adoption of energy and resource conservation measures. Some of the major challenges faced by the cluster units are mainly related to technology, energy pricing, availability and quality of raw material and fuel (Coal), manpower skill sets, environmental, etc.[4].

6.1 Technology

A majority of the refractory industries in micro, small and medium categories use locally designed/ fabricated technologies that are less productive, obsolete, and consume more energy. DD kiln is highly energy inefficient and is being used in almost all the refractory units in the cluster. The process parameters and operating practices followed are also outdated. To minimize energy loss and reduce the operating cost in the refractory manufacturing industry, it is essential to adopt energy efficient technology in the process. Although most of the industry owners know about some of the energy efficient technologies like Tunnel Kilns, they are not able to adopt them mainly due to constraints such as the lack of financial support, high capital investment, availability of skilled manpower. The technology service Providers, equipment suppliers are another issue in the cluster.

To overcome this situation in the cluster it is essential to generate awareness by organizing relevant technologies with local service/ equipment suppliers within the cluster and also make some policy changes to create ease of getting financial assistance from lending institutions like SIDBI, NABARD, Andhra Pradesh State Financial Corporation, NSIC, and other Nationalized and private banks. Since all the units of the cluster are using DD Kilns, it would also benefit if BEE or MSME CDP can collaborate with Refractory R & D institutes to develop and transform the existing DD Kilns to energy efficient kiln like tunnel kilns.

6.2 Availability of quality fuel and energy pricing

Refractory Manufacturing units mainly require both Thermal and electrical energy. Coal is being used in kilns as fuel to meet thermal energy requirements. Electrical energy is being sourced from APEPDCL which is used to operate different equipment such as crushers, fans, and mills.

Thermal energy accounts for more than 99% of the total in all the refractory units and electrical energy contributes to less than 1%. All Industries in this cluster are having grid connections under the industrial tariff category (HT/LT).

[4] https://beeindia.gov.in/sites/default/files/E%26W%20Godavari_Refractories_APITCO.pdf

The availability of coal is one of the major problems faced by the refractory manufacturing units in the cluster. The coal quota/allocation is regulated and controlled by the commissioner of industries. The quality of the coal is inferior and not suitable for refractory manufacturing, resulting in excess coal consumption and higher product costs. Some of the units are procuring coal from the open market which is compatible better in quality (GCV, size, and ash content), but, the landed cost of this coal is higher than the locally available coal.

6.3 Raw material

The cluster is located in the region having the availability of raw materials required for refractory production such as fire clay, China clay, Vemagiri clay, etc. All the refractory manufacturing units source raw material from local mining companies as well as a limited quantity of imported materials from local vendors. The rising price of raw materials poses a major challenge to the refractory units which directly influences the manufacturing costs. The scale of operation of micro and small scale units hinders the capacity to purchase raw materials at the most economic price structure.

6.4 Manpower and skillsets

All the refractory industries in the cluster engage skilled and unskilled manpower for carrying various jobs such as product formation and kiln firing. There is no formal training facility available for skill development as per the process/operations required for refractory manufacturing. Therefore the cluster is facing limitations such as a change in products and/or production technologies. Also, the units are sourcing skilled manpower from other refractory clusters.

6.5 Environmental issues

The refractory industries are among those industrial sectors which are identified as highly polluting. The industry associations have taken several initiatives to deal with the flue gas emission-related issues of the cluster. Environmental compliance remains an area of focus for most of the refractory units in the cluster alongside their challenges to adopt energy efficiency improvements

Chapter 7

7.0 SWOT Analysis

The refractory industries in the cluster face several challenges about the availability and quality of fuel and its pricing, pollution standards as well as production capacities, and market that can affect the adoption of energy efficiency measures by the cluster units. The units also face challenges of increasing the cost of energy and raw materials, resulting in an increased level of imports in the domestic market. E&W Godavari refractory cluster has many regional advantages that help the cluster remain at the forefront of the Indian refractory industry. There is a need for the refractory units to become efficient and maintain a better profit margin which would require the adoption of energy-efficient technologies in their processes and auxiliaries. A SWOT (Strength, Weakness, Opportunities, and Threats) analysis of the refractory manufacturing units in the E&W Godavari cluster was performed to understand the cluster situation. The SWOT analysis of the E&W Godavari refractory cluster is given below.

Strength	Weaknesses
• Local availability of coal and basic raw material (mineral-rich zone) • Located in the largest steel manufacturing hub • Most of the units are 50+ years old, thus experienced entrepreneurs • Entrepreneurship zeal in the local community • Progressive industrial policy of state government	• Dependency on conventional technologies thus, the limited scope of expansion without change in firing technology • Lack of completion with refractory products from other clusters • Lack of local service providers/technology providers at cluster level • Limited product portfolio to capture diverse end-use requirements
Opportunities	**Threats**
• Significant potential for energy saving • Potential for technology up-gradation • Growing end-use domestic market • Product customization and demand for new and alternative products • Upgradation of existing CFC for skill development and raw material banking	• Escalating fuel and raw material prices • Competition with low-cost imported refractory products • Low turnover limiting to invest in the new firing technologies • Unavailability of infrastructure for green/gaseous fuels

Chapter 8

8.0 Conclusions

E&W Godavari refractory cluster with its more than 26 units, is an important refractory manufacturing cluster under the MSME sector. The refractory units, producing refractory blocks & bricks, insulation bricks, graphite stopper heads, etc. use both thermal energy and electricity to meet their energy demands. The analysis shows that thermal energy accounts for a major share of energy consumption. The energy intensities of these units are also quite high which may be attributed to the use of conventional firing technology and limited automation/manual raw material and shaping processes. This also results in increased production costs.

Technology up-gradation for optimum use of energy and resource conservation emerge as appropriate solutions for the E&W Godavari cluster to achieve competitive manufacturing costs. Improved quality and availability of fuel also critical requirements of the cluster. However, to ensure large-scale adoption, the cluster needs to address some barriers which include non-availability of energy-efficient technologies, weak linkages with EE technology suppliers, lack of manpower and skillsets, etc.

The technical assistance with the support of the project would help the refractory industries in the cluster to (i) identify the potential process/ utility areas for energy saving, (ii) assess energy-saving potential through detailed energy audits of cluster units (iii) adopt EE technologies through increased awareness and by strengthening linkages with EE technology providers.

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