MANUAL ON ENERGY CONSERVATION OPPORTUNITIES IN SEAFOOD PROCESSING INDUSTRIES KOCHI

ENERGY IS LIFE
BEE
CONSERVE IT

Bureau of Energy Efficiency (BEE)

Ministry of Power, Government of India

Prepared By

Ernst & Young Private Limited

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1.1 About BEE SME Program

Worldwide the Micro, Small and Medium Enterprises (MSMEs) have been accepted as engines of economic growth to promote and accelerate equitable development. The major advantage of this sector is its enormous employment potential at significantly low capital involvement. This can be established from the simple fact that the MSMEs constitute over 90% of total enterprises in most economies and are credited with generating high rates of employment growth and account for a major share of industrial production and exports. In Indian context, MSMEs play a pivotal role in the overall industrial economy. In recent years the sector has consistently registered higher growth rate as compared to the overall industrial sector. With its agility and dynamism, the sector has shown admirable innovativeness and adaptability to survive the recent economic downturn and recession.

As per available statistics (the 4th Census of MSME Sector), this sector employs an estimated 59.7 million persons spread over 26.1 million enterprises. It is estimated that in terms of value, MSMEs have a 40% share in total industrial output at a huge volume of producing over 8,000 products. At the same time, MSMEs contribute nearly 35% share in Direct Export and 45% share in the Overall Export from the country. SMEs exist in almost all-major sectors in the Indian industry such as Food Processing, Agricultural Inputs, Chemicals & Pharmaceuticals, Electrical & Electronics, Medical & Surgical Equipment, Textiles and Garments, Gems and Jewellery, Leather and Leather Goods, Meat Products, Bioengineering, Sports goods, tea, Plastics Products, Computer Software etc.

However, despite the significant contributions made towards various aspects of the nation's socio-economic scenario, this sector too faces several critical issues that require immediate attention. One such factor that falls in the ambit of this publication is the prevalence of age old technologies across the sectors and inherent inefficiencies associated with resource utilization, including, energy. The National Mission for Enhanced Energy Efficiency in Industry under the National Action Plan for Climate Change (released by Government of India on June 30, 2008) has emphasized the need for improving Energy Efficiency (EE) in the manufacturing sector. A number of sector-specific studies have also unanimously confirmed that energy intensity in the industry can be reduced with the widespread adoption of proven and commercially available technologies, which will improve EE and produce global benefits from reduced Green House Gasses (GHGs) emissions.

As a result of increasing awareness towards efficient usage of energy and other resources, there has been a visible reduction in energy intensity in broad Indian industrial sector. However, focusing the observation on the MSME sector reveals that the energy intensity per unit of production is much higher than that of the organized large scale sector. Since energy cost is significant contributor to the overall production cost of SMEs due to high and rising energy costs in current scenarios, it is required to increase the Energy Efficiency (EE) levels in order to support the sustenance of SMEs. One of the ways to reduce the inefficiencies is by replacing the conventional/old/obsolete technology with feasible and adaptable energy efficient technologies. This would not only contribute towards reduction in production cost, but would also improve the quality and productivity of MSME products. However, while knowing the way out, there are still numerous barriers (as listed below) and market failures that have prevented widespread adoption of new energy efficient technologies.

Key barriers in promotion and adoption of EE technologies in Indian SME sector:

- Lack of awareness and capability on the part of SMEs to take up energy conservation activities
- Production loss due to downtime during the implementation of new technology
- Lack of scientific approach on monitoring and verification of performance assessment of installed equipments and utilities.
- Non availability of benchmark data for various equipments/process

- Low credibility and capability of the service providers such as equipment suppliers and their technologies
- The SME owners are more concerned on production and quality rather than energy efficiency and conservation
- The key technical personnel employed in the SME units are based on their past experience in similar industries rather than technically qualified personnel and hence, they are not aware of the latest technologies or measures which improve energy efficiency
- Lower priority to invest in improving efficiency than in expansion (this may be due to lack of knowledge on cost-benefit)

Majority of SMEs are typically run by entrepreneurs and are not staffed with trained technical and managerial persons to deploy and capture energy efficiency practice to reduce manufacturing cost and increase competitive edge. Therefore, it will be useful to build energy efficiency awareness in the SMEs by funding/subsidizing need based studies in a large number of units in the SMEs and giving energy conservation recommendations including short-term energy conservation opportunities, retrofit/replacement options, and technology up-gradation opportunities.

In this context, the Bureau of Energy Efficiency (BEE) has laid adequate emphasis on the SME sector as presented in the Working Group on Power for 11th Five-Year Plan (2007-2012)-Sub-Group 5. Consequently, BEE has initiated the Energy Efficiency Improvement program in 29 SME clusters in India under the BEE SME Programme.

1.2 Project Objectives

The BEE SME Program aims to improve Energy Efficiency (EE) in SME sector by technological interventions in the various industrial clusters in India. The EE in SMEs is intended to be enhanced by helping the industries in the 29 energy intensive SME clusters by:

- Technology interventions
- Implementation of EE measures and projects in clusters, and
- Capacity building for improved financial planning for SME entrepreneurs.

The program also aims at creating a platform for dissemination of the appropriate practices and the appropriate technologies available in the market for energy efficiency and conservation, to create awareness in the clusters, and to demonstrate the new technology interventions/ projects to stimulate adoption of similar technology/projects in the clusters.

The BEE SME program has been designed in such a way that it addresses the specific needs of the industries in the SME sector for EE improvement and to overcome the common barriers in the implementation of EE technologies in cluster through knowledge sharing, capacity building, and development of innovative financing mechanisms. The major activities in the BEE SME program are:

- Energy use and technology studies
- Capacity building of stake holders in cluster for building EE projects
- Implementation of energy efficiency measures
- Facilitation of Innovative financing mechanisms for implementation of energy efficiency projects

The brief objective of each of these activities is presented below:

1.2.1 Energy use and technology studies

An in-depth assessment of the various production processes, energy consumption pattern, technology employed and possible energy conservation potential and operational practices in cluster by means of conducting detailed energy audits and technological gap assessment studies were conducted in the cluster. The energy audit study shall include analysis of the

overall energy consumption pattern, study of production process, identification of energy intensive steps/sub-processes and associated technology gap assessment for the individual units. The study has also focused on identifying the appropriate operating practices and the EE measures already implemented in the units.

1.2.2 Capacity building of stakeholders

The aim of this activity is capacity building of the enrolled LSPs to equip them with capacity to carry on the implementation of the EE technology projects in cluster on a sustainable basis. It would be ascertained that the needs of the LSPs is identified as a preparatory exercise to this activity, as in what they expect from the BEE Program in terms of technical and managerial capacity building.

1.2.3 Implementation of EE measures

To recommend the EE and technology up-gradation projects in the clusters, technology specific Detailed Project Reports (DPRs) for five different technologies for three scales of operation will be prepared. The DPRs will primarily address the following:

- Comparison of existing technology with feasible and available EE technology
- Energy, economic, environmental & social benefits of proposed technology as compared to conventional technology
- Details of technology and service providers of proposed technology
- Availability of proposed technology in local market
- Action plan for implementation of identified energy conservation measures
- Detailed financial feasibility analysis of proposed technology

1.2.4 Facilitation of innovative financing mechanisms

The program aims to develop innovative and effective financing mechanisms for easy financing of EE measures in the SME units in the cluster. The easy financing involves following three aspects:

- Ease in financing procedure
- Availability of finance on comparatively easy terms and relaxed interest rates
- Compatibility and availing various other Central/ State Governments' incentive schemes like CLCSS, TUFF etc.

1.3 Expected Project Outcome

Expected project outcome of BEE SME program in clusters are:

1.3.1 Energy Use and Technology Analysis

The outcome of the activity includes identification of the EE measures, assessment of potential of renewable energy usage, fuel switching, feasibility analysis of various options, and cost benefit analysis of various energy conservation measures including evaluation of financial returns in form of payback period, IRR and cash flows. The cost liability of each measure, including the capital and operational cost will also be indicated.

The identified EE measures will be categorized as per the following types:

- Simple housekeeping measures/ low cost measures
- Capital intensive technologies requiring major investment.

The sources of technology for each of the suitable low cost and high cost measures, including international suppliers as well as local service providers (LSPs)/ technology suppliers, in required numbers shall be identified. It is envisaged to create a knowledge bank of detailed company profile and CVs of key personnel of these technology sources. The knowledge bank will also include the capability statements of each of these sources.

The EE measures identified in the energy use and technology audit study will be prioritized as per their energy saving potential and financial feasibility. Inventorization survey was done

to establish details like the cluster location, details of units, production capacity, technologies employed, product range, energy conservation potential along with possible identified EE measures and respective technology suppliers.

The specific outcomes of this activity are as follows:

- Determination of energy usage and energy consumption pattern
- Identification of EE measures for the units in cluster
- Development and preparation of case studies for already implemented EE measures and appropriate operating practices in the units
- Evaluation of technical & financial feasibility of EE measures in terms of payback period, IRR and cash flows.
- Enlisting of Local Service Providers(LSPs) for capacity building & training including creation of knowledge bank of such technology suppliers
- Capacity building modules for LSPs
- Development and preparation of cluster manuals consisting of cluster details and EE measures identified in cluster.

1.3.2 Preparation of DPRs

The aim of this activity is development and finalization of bankable DPRs for each of the EE projects, which would be presented before the SME units for facilitation of institutional financing for undertaking the EE projects in their respective units.

The activity will demonstrate that there is close match between the proposed EE projects and the specific professional of the Local Service Providers (LSPs). These DPRs will be prepared for EE, renewable energy, fuel switching and other possible proposed measures during course of previous activities. Each DPR will include the technology assessment, financial assessment, economic assessment and sustainability assessment of the EE project for which it has been developed. The technology assessment will include the details of the design of equipment/ technology along with the calculation of energy savings. The design details of the technology for EE project will include detailed engineering drawing for the most commonly prevalent operational scale, required civil and structural work, system modification and included instrumentation and various line diagrams. The LSPs will be required to report the progress of the implementation of each such project to BEE PMC. Such implementation activities can be undertaken by the LSPs either solely or as a group of several LSPs.

1.3.3 Capacity Building of LSP's and Bankers

The outcome of this activity would be training and capacity building of LSPs so as to equip them with necessary capacity to undertake the implementation of proposed EE projects as per the DPRs. Various training programs, training modules and literature are proposed to be used for the said activity. However, first it is important to identify the needs of the LSPs engaged, as in what they expect from the program in terms of technical and managerial capacity building. Another outcome of this activity will be enhanced capacity of banking officers in the lead banks in the cluster for technological and financial feasibility analysis of EE projects that are proposed by the SME units in the cluster. This activity is intended to help bankers in understanding the importance of financing energy efficiency projects, type and size of projects and ways and means to tap huge potential in this area. Different financing models would be explained through the case studies to expose the bankers on the financial viability of energy efficiency projects and how it would expand their own business in today's competitive environment.

1.3.4 Concluding workshop

The outcome of this activity will be the assessment of the impact of the project as well as development of a roadmap for future activities. The workshop will be conducted for the representatives of the local industrial units, industry associations, LSPs and other stakeholders so that the experiences gained during the course of project activities including implementation activities of EE project can be shared. All the stakeholders in the project will

share their experience relating to projects undertaken by them as per their respective roles. Effort from industrial units as well as LSPs to quantify energy savings thus achieved would be encouraged. This would lead to development of a roadmap for implementing similar programs in other clusters with greater efficiency and reach.

1.4 Project Duration

The mentioned activity of the project (in paragraph –2/chapter –1) was initialized in August 2009.

1.5 Identified Clusters Under The Program & Target Cluster For Implementation

29 most energy intensive MSME clusters across different end use sectors have been identified under the BEE SME program for EE improvement. The details of industrial sectors and identified clusters are provided in Table 1 below:

Table 1: List of clusters identified for BEE SME Program

S. No.	Cluster Name	Location
1.	Oil Milling	Alwar; Rajasthan
2.	Machine Tools	Bangalore; Karnataka
3.	Ice Making	Bhimavaram; Andhra Pradesh
4.	Brass	Bhubaneswar; Orissa
5.	Sea food processing	Kochi, Kerala
6.	Refractories	East &West Godavari, Andhra Pradesh
7.	Rice Milling	Ganjam, Orissa
8.	Dairy	Gujarat
9.	Galvanizing	Howrah, West Bengal
10.	Brass& Aluminium	Jagadhari, Haryana
11.	Limestone	Jodhpur, Rajasthan
12.	Tea processing	Jorhat, Assam
13.	Foundry	Batala, Jalandhar & Ludhiana, Punjab
14.	Paper	Muzaffarnagar, Uttar Pradesh
15.	Sponge iron	Orissa
16.	Chemicals& Dyes	Vapi, Gujarat
17.	Brick	Varanasi, Uttar Pradesh
18.	Rice Milling	Vellore, Tamil Nadu
19.	Chemical	Ahmedabad, Gujarat
20.	Brass	Jamnagar, Gujarat
21.	Textile	Pali, Rajasthan
22.	Textile	Surat, Gujarat
23.	Tiles	Morbi, Gujarat

S. No.	Cluster Name	Location
24.	Textile	Solapur, Maharashtra
25.	Rice Milling	Warangal, Andhra Pradesh
26.	Coir	Alleppey, Kerala
27.	Textile	Tirupur, Tamil Nadu
28.	Roof Tiles	Mangalore, Karnataka
29.	Glass	Firozabad, Uttar Pradesh

As a part of BEE SME program, one of clusters identified was the Kochi Seafood Processing Cluster. It was proposed to carry out energy use and technology audit studies in 30 units in the Kochi cluster covering all types and sizes of the industries to understand/give valuable insight into the process of developing energy efficiency approaches relevant to the SME industries in the Kochi Seafood Processing cluster

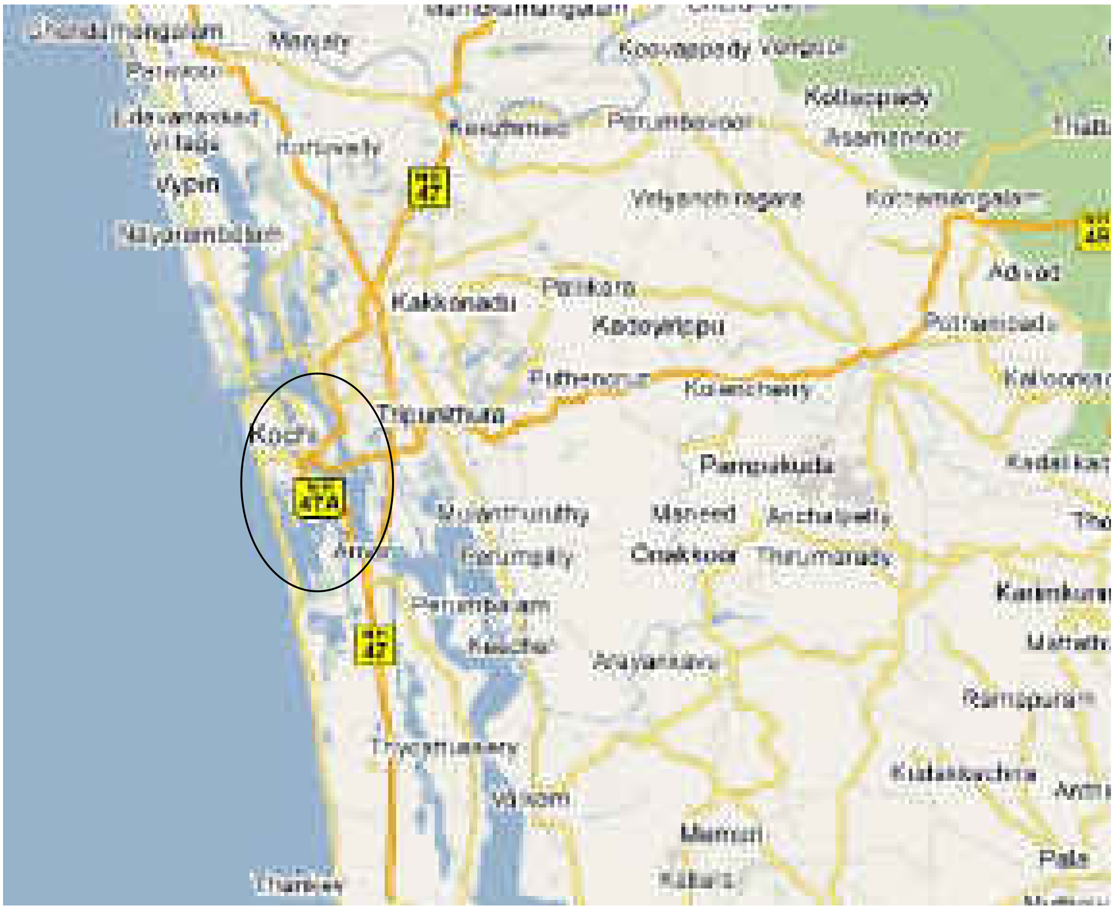
2. Kochi Seafood Processing Cluster Scenario

2.1 Overview Of Kochi Seafood Processing Cluster

The Kochi Seafood Processing cluster has approximately 35 units spread between the coastal Districts of Ernakulam and Alleppey in Kerala. Most of these units are located along the National Highway 47A and 47, between Thopumpady in Ernakulam District and Aroor in Alleppey District. The distance to these units from the commercial capital of Kochi City is approximately 5 km to 20 km.

Kochi pioneered seafood exports from India, taking advantage of good catch throughout the year, availability of skilled labor, and access to a port (Kochi Port). The first ever shipment of seafood exports from India was from Kochi. Today, the cluster exports a variety of frozen and chilled fish to markets around the world, including Japan, U.S., EU, Middle East, China, and many countries in SE Asia.

The peak season for production in Kochi is between August and November. The lean period is the monsoon season when there is 45-day fishing ban between the months of June and July.



The location of the Cluster between Kochi and Aroor along NH 47A (source: Google maps)

2.1.1 Cluster Background

Kerala has the largest number (about 80) of seafood processing units in the country. Of these, nearly half are located in the Kochi cluster. The cluster has traditionally been known for handling high value items like shrimp. In 2009-2010, Kochi Port has exported nearly 16%of the total seafood exports, both in terms of quantity and value, from India.

The cluster in Kochi has about 35 units of which 30 were selected for the study under the BEE SME Programme. All units studied are registered as small scale industries under the Government of Karnataka and many of them have entrepreneurship memorandum number issued by department of MSME. All of the units selected for the study are registered with the Seafood Exporters Association of India.

2.1.2 Product manufactured

The first ever seafood export from India was from the Kochi Port in 1953. Initially the industry focused on exporting canned shrimp and, later on, shifted to the export of frozen shrimp. In the 1960s, the export of other fish, squid, cuttlefish, octopus, crabs, clams, and mussels began. While shrimp continues to be the major export item, accounting for nearly 45%of the total earnings, export of other fish and cephalopods have steadily increased.

2.1.3 Classification of Units

All the units within this cluster are processing units for marine products (sea food) Production capacity of the seafood processing units depends on the type of fish being produced in unit. The high value items like shrimp and lobster generates larger revenues from smaller capacities. Production capacity in the cluster ranges from 155 TPA to 36960 TPA. The following figure shows the classification of the units in the cluster on production capacity.

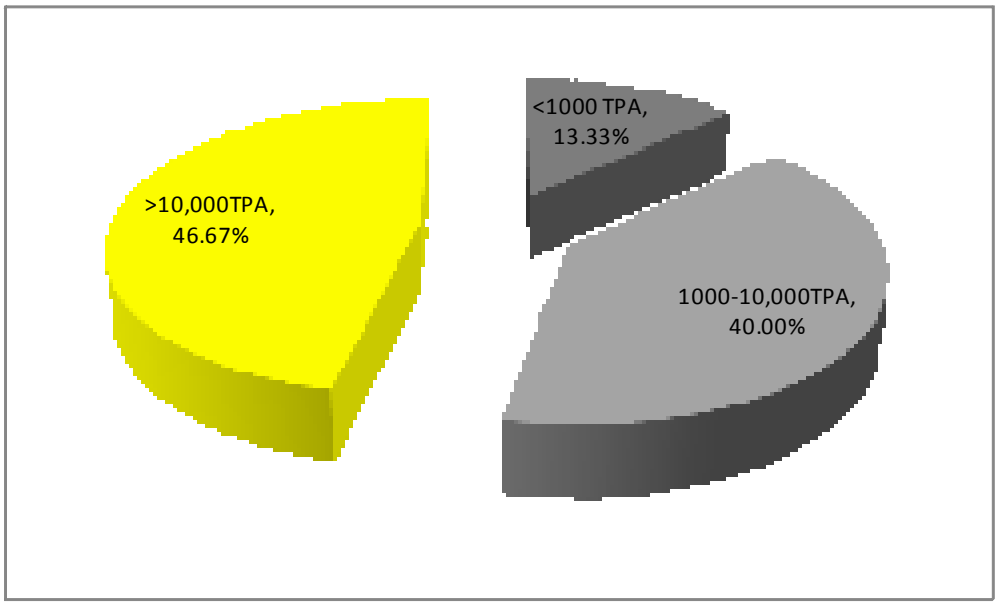


Figure 1: Annual production wise classification of seafood processing units

The electricity consumption in the cluster varies from 11,731 units to 268,433 units per month. The average electricity consumption for the cluster is 87,943 per month with an increasing trend in the consumption. The following figure shows the classification of percentage of the cluster units based on consumption of electricity.

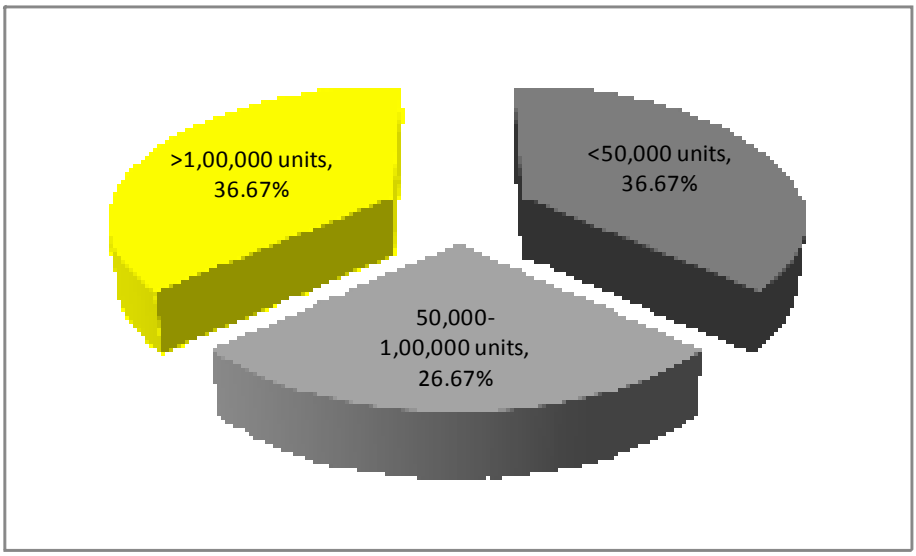


Figure 2: Classification based on electricity consumption

2.1.4 Installed Production Capacity

The units in the cluster do not have name plate capacities. The daily operating capacities vary based on the season, fish availability, and product demand.

2.2 Energy Situation In The Cluster

2.2.1 Energy Type & Prices

The Cluster uses electricity from grid to meet their electrical energy requirement. Some of the industrial units having the backup power generator (Diesel Based) to meet the demand in case of grid power supply failure or scheduled power cut from the grid. The main power requirement in the cluster is for running the refrigeration systems. Some units in the cluster depend completely on DG set generated power. The units have either HT-4 or LT-4 electricity connections from the Kerala State Electricity Board (KSEB). Electricity tariff for these connections are provided in Annexure 1.

2.2.2 Energy consumption in a typical unit

Electricity from the KSEB grid is the primary source of electrical energy for the cluster. The cluster in general does not use any thermal energy except for diesel, which is used for generating the power through D.G. sets as back-up power. Total energy cost constitutes 8 - 10% of the total production cost. The average electrical energy cost for the cluster is Rs.5.3/- per unit (kWh).

Total average energy consumption for the units in the cluster is 2,690,733 kWh and the average electricity bill is INR. 14,272,372.

2.2.3 Specific energy consumption (in appropriate Units)

The specific energy consumption at the cluster units ranges 375.10 kW/ton of product to 841.5 kW/ton of product.

2.3 Manufacturing Process/ Technology Overview in a typical unit

2.3.1 Process Technology

In the sea food industries, the three commonly observed freezers are:

- Individual Quick Freezer
- Blast Freezer
- Plate Freezer

Individual Quick freezer: Individual Quick freezer is an advanced type of freezer where each product is individually frozen in the chamber with a reduced cycle time compared to conventional freezers. The air temperature will be of the order of –40°C and the air speed over the product will be high, to get good heat transfer.

Blast Freezers: Blast freezers operate with blowers which force chilled air over the food in the freezer to cool it down rapidly. Blast freezers are equipped with movable trays for positioning foods, and they also include an assortment of compartments for freezing. The air temperature will be of the order of –40°C and the air speed over the product will be high, to get good heat transfer.

Plate Freezer: Plate Freezer is a type of freezer in which the stack of plates placed horizontally one on top of the other. The stack of plates is placed inside a steel frame and each plate connected to the adjacent plate, allowing the plates to be moved apart to form a gap of cartons to be placed between the two adjacent plates. The major advantage of this freezer is faster temperature reduction and reduced freezing time.

Condenser: In general, condenser is a device used for reducing a gas or vapour to liquid. In this sea food cluster, condenser is used to reduce ammonia vapour to liquid, which is commonly used as coolant. The four condensers used in the majority of the industries are as follows: 1) Plate Heat Exchangers 2) Shell & Tube Heat Exchangers 3) EVAPCO Condensers 4) BAC

Plate Heat Exchangers: This type of heat exchanger is commonly suited for higher-pressure applications. The plate heat exchanger normally consists of corrugated plates assembled into a frame. The hot fluid flows in one direction in alternating chambers while the cold fluid flows in true counter-current flow in the other alternating chambers. Plate heat exchangers are capable of nominal approach temperatures of 10°F compared to a nominal 20°F for shell and tube units. In addition, overall heat transfer coefficients (U) for plate type exchangers are three to four times those of shell and tube units. The Heat Exchanger Effectiveness can be calculated using the formula given below:

Effectiveness = Actual heat transfer ÷ Maximum possible heat transfer

Shell & Tube Heat Exchangers: shell & tube heat Exchangers are commonly suited for higher-pressure applications. This type of heat exchanger consists of a shell (a large pressure vessel) with a bundle of tubes inside it. One fluid runs through the tubes, and another fluid flows over the tubes (through the shell) to transfer heat between the two fluids. In this case, the two fluids flowing through the heat exchanger are hot ammonia and water. The Heat Exchanger Effectiveness can be calculated using the formula given below:

Effectiveness = Actual heat transfer ÷ Maximum possible heat transfer

The main advantages of shell-and-tube heat exchangers are.

- Condensation or boiling heat transfer can be accommodated in either the tubes or the shell, and the orientation can be horizontal or vertical.
- The pressures and pressure drops can be varied over a wide range.

- Thermal stresses can be accommodated inexpensively.
- There is substantial flexibility regarding materials of construction to accommodate corrosion and other concerns. The shell and the tubes can be made of different materials.
- Extended heat transfer surfaces (fins) can be used to enhance heat transfer.

EVAPCO: It is an evaporative type condenser. The vapor to be condensed is circulated through a condensing coil, which is continually wetted on the outside by a recirculating water system. Air is pulled over the coil, causing a small portion of the recirculating water to evaporate. The evaporation removes heat from the vapor in the coil, causing it to condense. The major advantages of EVAPCO are as follows:

- Heat rejection in an evaporative condenser takes place in a single unit which provides for maximum efficiency.
- Evaporative condensers can offer operating and maintenance savings by as much as 20%as compared to the shell & tube condenser-cooling tower alternative
- Compared to other condensers and cooling tower system, evaporative condenser is the only component in the system, which requires smaller area for layout.

Baltimore Aircoil condenser: It is an evaporative type condenser. The vapor to be condensed is circulated through a condensing coil, which is continually wetted on the outside by a recirculating water system. Air is pulled over the coil, causing a small portion of the recirculating water to evaporate. The evaporation removes heat from the vapor in the coil, causing it to condense.

2.3.2 Process Flow Diagram

The typical process followed in the seafood processing industry is shown in the flowchart below. For all of the units surveyed, the preprocessing of fish was done outside the units and the operations in the units started with the cleaning of preprocessed/cleaned fish. While most of the units follow the general process of cutting, cleaning, grading, weighing, freezing, packing, and storing; the difference arise in the way fish is frozen and the freezers used for the purpose.

Freezing is an effective form of seafood preservation because the pathogens that cause food spoilage are killed or do not grow very rapidly at reduced temperatures. Foods may be preserved for several months by freezing. The role of a freezer is to extract heat from a stream of product, lowering its temperature and converting most of its free moisture to ice. This needs to occur sufficiently fast so that the product will experience a minimum degradation of quality, the rate of freezing keeps pace with the production schedule, and upon exit, the average product temperature will roughly match the subsequent temperature of storage.

From the flowchart, it can be inferred that the energy intensive steps in the process are the freezing and the storage. Freezing alone accounts for nearly 75% of all the electricity consumed in the cluster.

2.4 Current Policies And Initiatives Of Local Bodies

Various incentive schemes of state and central government are available to the units. However, these incentives are available only for capital expenditure and are tied with availing of loan. There are no schemes available exclusively to promote energy efficiency projects. Financial Institutions like SIDBI, Bank of Baroda, KFC, and PFC offer credit at concessional interest rate for Energy Efficiency Projects. The detailed schemes for energy efficiency is given in Annexure - 2

2.5 Issues Related To Energy Usage And Conservation And Barrier In Technology Up Gradation

Traditionally, small and medium scale industries in India lack the technical knowledge to identify and evaluate energy efficiency technologies and products. Typically, they also do not have internal financial resources (although the seafood processing cluster is an exception to this) and need external capital to fund EE projects. Further, they need assistance in identifying and managing technical and financial risks. Major barriers in up-gradation of technology in the cluster are:

- Energy efficiency not on priority list
- Lack of awareness on energy efficiency
- Lack of local service providers who can support the initiatives

- Limited technical manpower
- Fear of production disruption and quality issues

2.5.1 Energy availability

The power supply to the cluster is by KSEB, through LT and/or HT connections. Reliable and quality power has been a concern in the cluster. Power cuts are imposed, mainly in peak season such as the summer. Most of the units have back up power in the form of emergency DG Sets to have incessant working. The main concern regarding the power situation in the cluster is the quality of power delivered. Voltage drop has traditionally been a bane for this cluster.

2.5.2 Technological issues

The freezers used in the seafood processing units are typically built on-site by local providers. These freezers are operated without any automation or feedback control. Because of the fear of rejection of products that do not meet core temperature specifications, most units deliberately over-freeze the fish. Traditionally, energy consumption has not been a concern and not many initiatives to reduce consumption have taken place.

Although these units have easy access to foreign exchange and can, relatively easily import machinery and equipment, many have chosen not to do so. The major reason for preferring local makes over imported more efficient equipments are the delays and the costs associated with servicing the equipments.

Since most of the units have similar processes, there is a strong possibility of taking appropriate practices of one unit to the rest of the units.

2.5.3 Financial issues

The units in the cluster are generally not aware of financial incentives and schemes available for energy efficiency. Because they are export oriented units, getting loans have never been a concern at the cluster. While incentives and structured financing can go a long way in encouraging EE projects in the cluster, the major roadblock in this process is the approval and clearance of financing. It is strongly felt that rather than packaging the finances with incentives like lower interest rates and subsidy etc., the delivery mechanism of loans needs to be facilitated by proactive and transparent methodologies.

2.5.4 Manpower Related Issues

At Kochi, availability of skilled manpower is one of the limitations. The major equipment within these units is sub-zero freezers and the cooling towers. Though technicians are available to operate these equipments, specialized training is required for these operators on efficient operation and 52 weeks maintenance schedule.

2.5.5 Technology & Service Provider Related Issues

At Kochi, availability of technology provider is not a big hurdle. For high end system, the technology providers may not have a representative office in Kochi. However, the technology and service providers (who are not present in Kochi) can be brought in from Bangalore and Chennai.

3. Energy audit and technology assessment

3.1 Energy Audit And Technology Assessment In Cluster

Seafood business is one of the front line businesses in Kochi, Kerala. There are about 60 seafood processing units located in Cochin, which largely cater to export markets. Most of the units have a HT connection, while some of the units have a LT connection. Many of the units are in operation for more than ten years and the units normally operate in shifts. The peak season for production is between August and November, with a 45 day fishing ban period between the months of June and July, which is a lean period for production.

The major equipments in a typical seafood processing unit are compressors, condensers, cooling towers, freezers, ice making units, and the motors connected to these equipment. Compressors are the major energy consuming equipment in these seafood processing units. The energy cost comprises of approximately 5%of the total production cost, whereas the raw material cost comprises of approximately 70%of the total operational costs. Of the 30 units taken for the study, 18 detailed audits were conducted and 12 Preliminary audits were conducted.

3.2 Condenser Analysis

The following condensers are commonly observed in the sea food industries:

- Plate heat Exchangers
- Shell & Tube heat exchangers
- Evapco (Evaporative Condensers)
- BAC (Baltimore Condensers)

3.2.1 Plate Heat Exchangers

The following industries have installed Plate Heat Exchangers in their HVAC system to cool the ammonia which is the commonly used coolant in the cluster.

- Unit 1
- Unit 2
- Unit 19
- Unit 30

Table 2: Performance comparison of Plate Heat Exchangers

Company Name	No's	Effectiveness	Condenser TR_{CN}
Unit 1	1	0.54	97.26
Unit 2	1	0.95	96.43
Unit 19	2	0.9	203.57
Unit 30	1	0.95	37.14

It has been observed that effectiveness of plate heat exchangers vary 0.54 to 0.95. And it is observed that the plate heat exchangers.

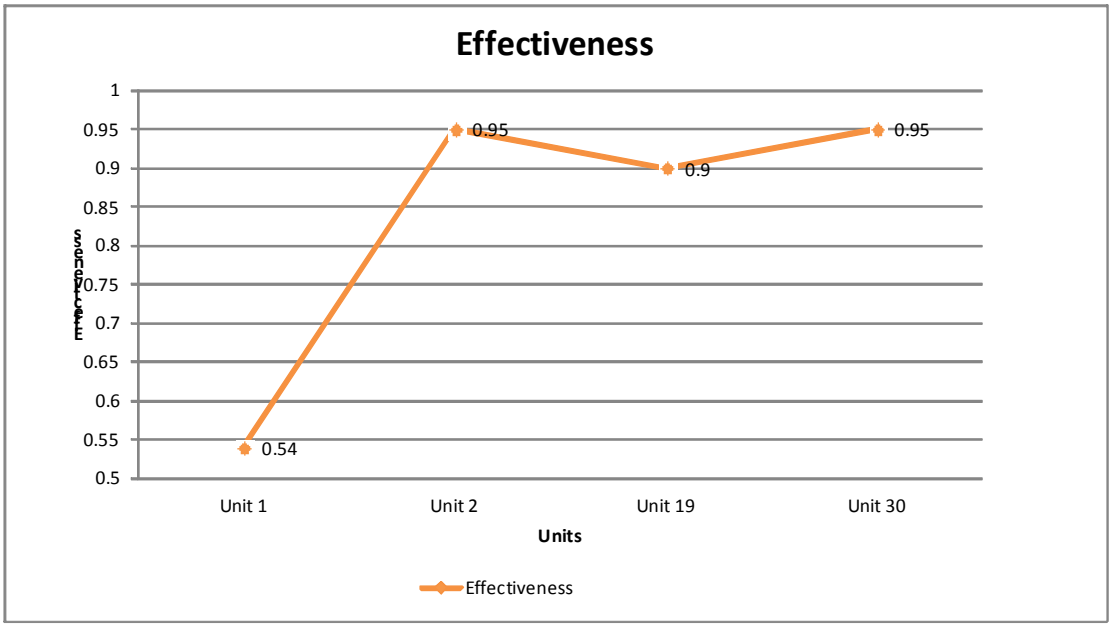


Figure 3: Comparison of Effectiveness of Plate Heat Exchangers

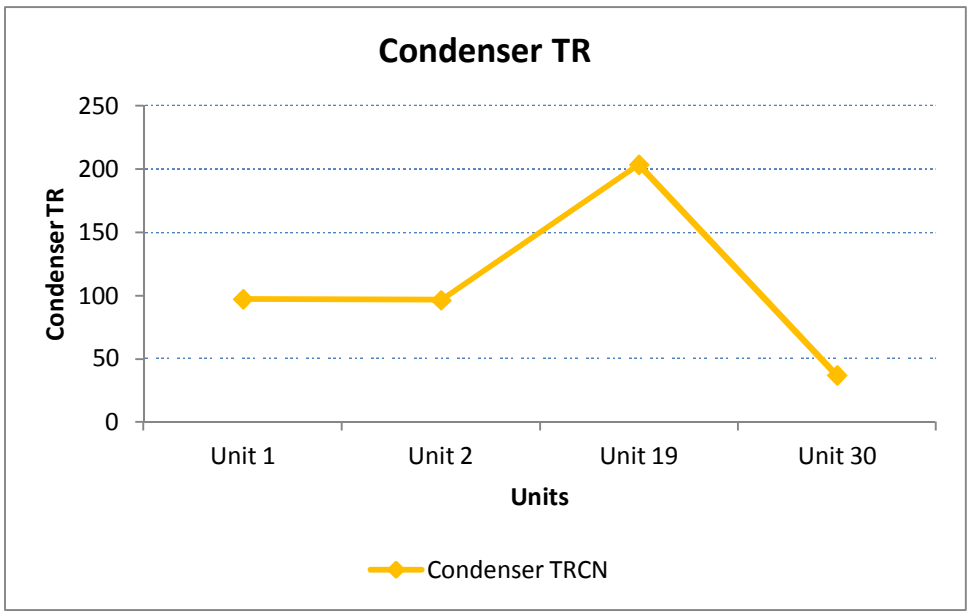


Figure 4: Comparison of Condenser TR for units using Plate heat exchangers

Table 3: Performance comparison of HVAC System

Company Name	Net Refrigeration capacity (TR)	KW/ TR	COP
Unit 1	66.67	1.06	3.5
Unit 2	72.59	1.15	3.1
Unit 19	15.9	2.05	1.8

Company Name	Net Refrigeration capacity (TR)	KW/ TR	COP
Unit 30	13.88	1.78	2.4

From the above table we can observe that Net refrigeration capacity of the HVAC system varies from 14 to -66.67 TR. Also the range in kW/TR is observed to be less. But the CoP varies from 1.8 for Unit 19 to 3.5 for Unit 1.

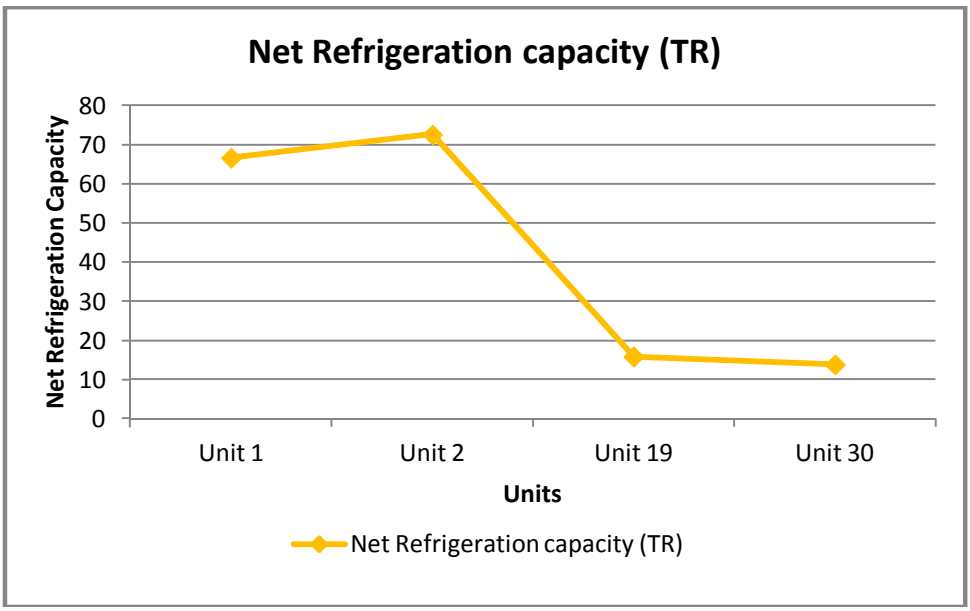


Figure 5: Comparison of net refrigeration capacity of the Freezer

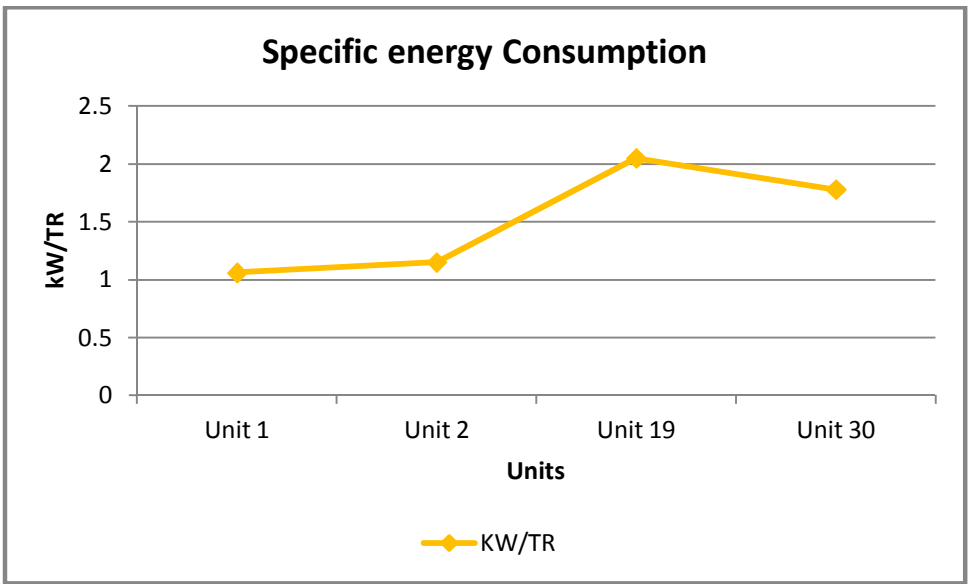


Figure 6: Comparison of kW/TR

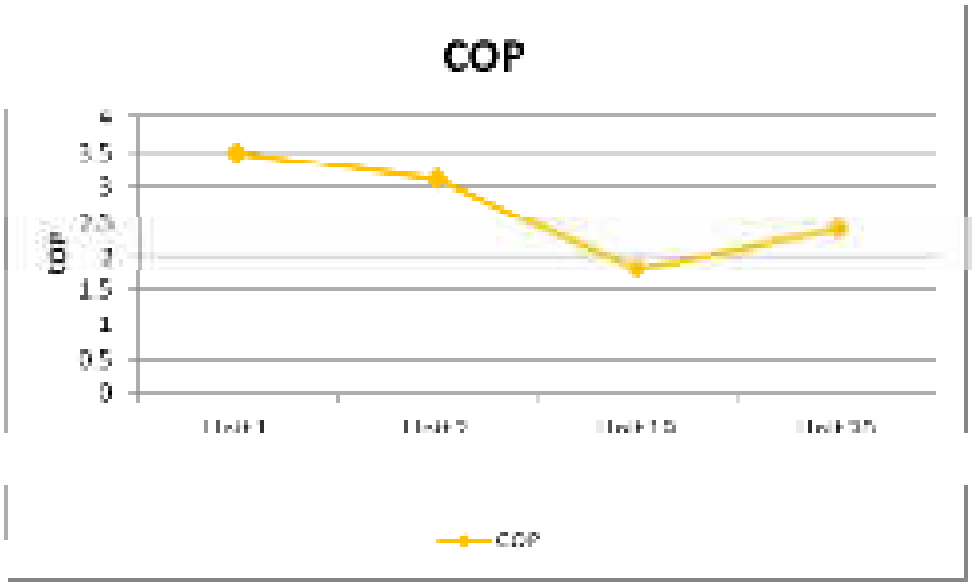


Figure 7: Comparison of COP for the HVAC System

3.2.2 Shell & Tube Heat Exchangers

The following industries have installed Shell & Tube Heat Exchangers in their HVAC system to cool the ammonia which is the commonly used coolant in the cluster.

- Unit 6
- Unit 10
- Unit 17
- Unit 18
- Unit 20
- Unit 29

Table 4: Performance comparison of Shell & Tube Heat Exchangers

Company Name	No's	Effectiveness	Condenser TR_{CN}
Unit 6	1	0.81	-
Unit 10	1	0.89	18.05
Unit 17	1	0.975	-
Unit 18	1	0.989	19.04
Unit 20	1	0.99	82.86
Unit 29	1	0.96	18.19

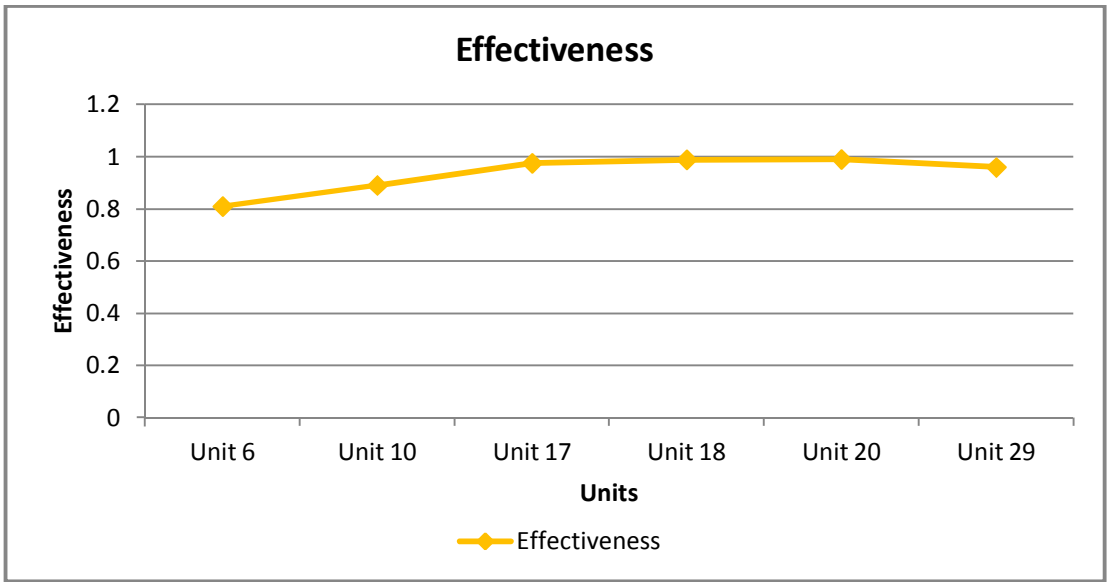


Figure 8: Comparison of Effectiveness of Shell & Tube Heat Exchangers used by the units

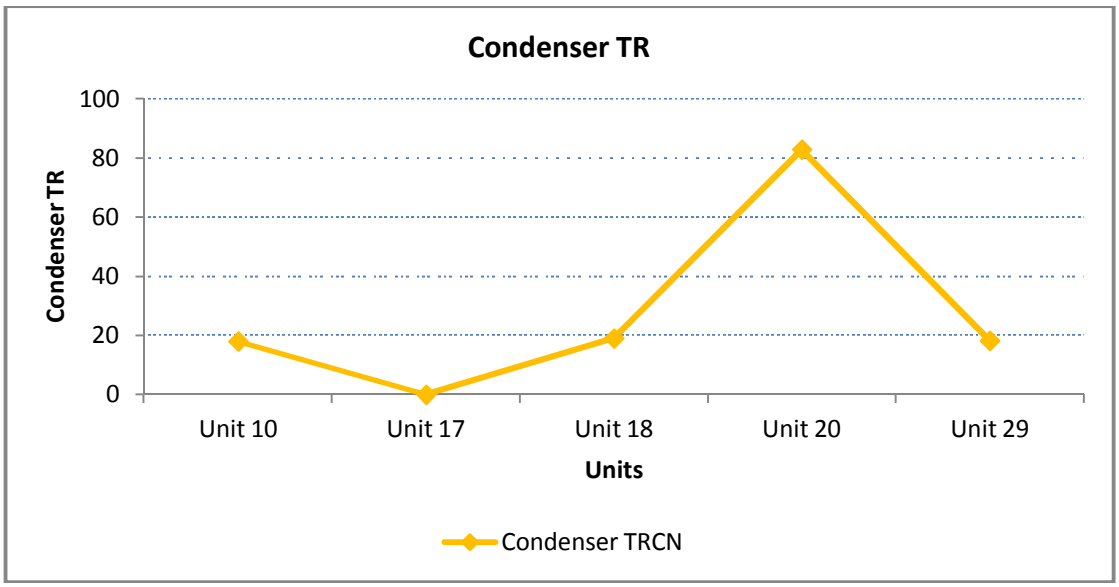


Figure 9: Comparison of Condenser TR for units using Shell & Tube heat exchangers

Table 5: Performance comparison of HVAC System

Company Name	Net Refrigeration capacity	KW/ TR	COP
Unit 10	13.49	1.18	3.0
Unit 18	112.24	1.4	2.7
Unit 20	13.49	1.18	3.0

- From the above table we can observe that Net refrigeration capacity of the HVAC system varies from 14 to 112 TR.

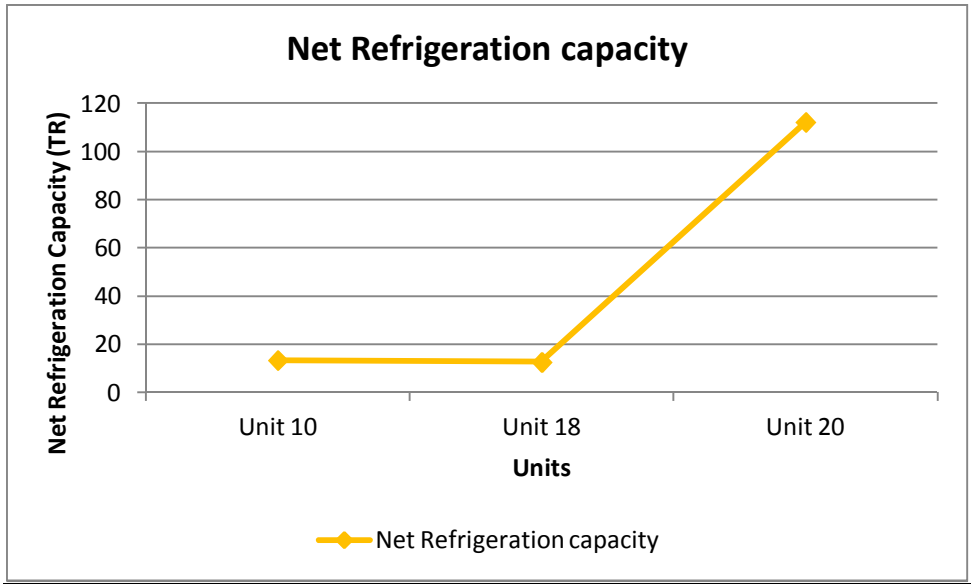


Figure 10: Comparison of net refrigeration capacity of the freezer

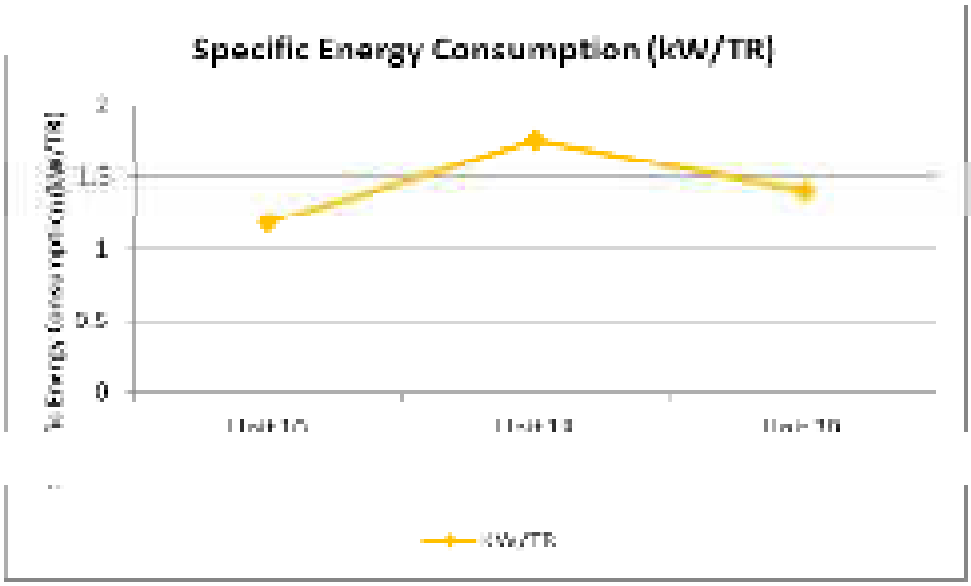


Figure 11: Comparison of kW/TR

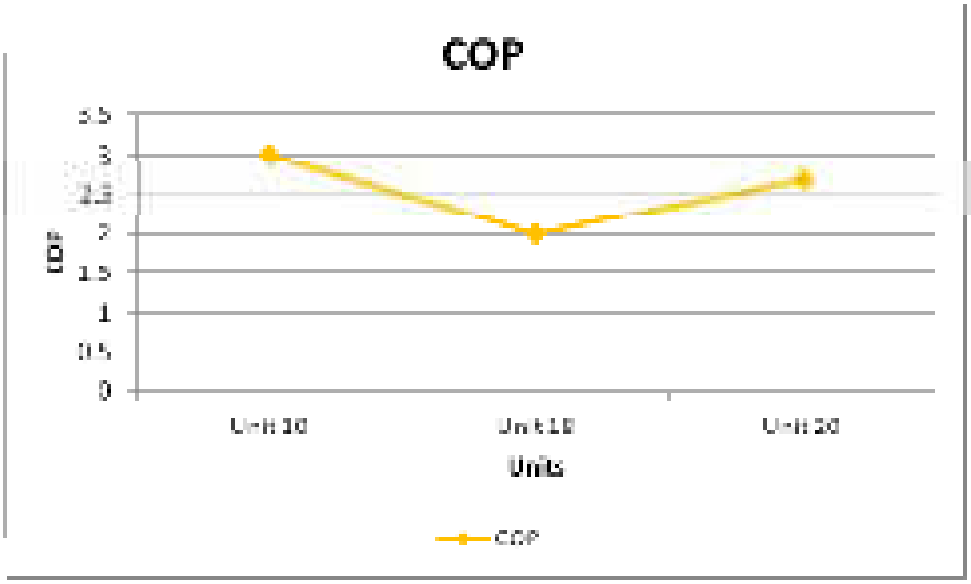


Figure 12: Comparison of COP for the HVAC System

3.2.3 EVAPCO

The following industries have installed EVAPCO condenser in their HVAC system to cool the ammonia which is the commonly used coolant in the cluster.

- Unit 4
- Unit 8
- Unit 11
- Unit 21

Table 6: Performance comparison of EVAPCO

Company Name	Condenser TR_{CN}
Unit 4	94.09
Unit 8	73.82
Unit 11	139.71
Unit 21	73.3

It has been observed from the above table that condenser TR for the companies using EVAPCO vary from 73.3 to 139.71 and the difference is based on mass flow rate of air.

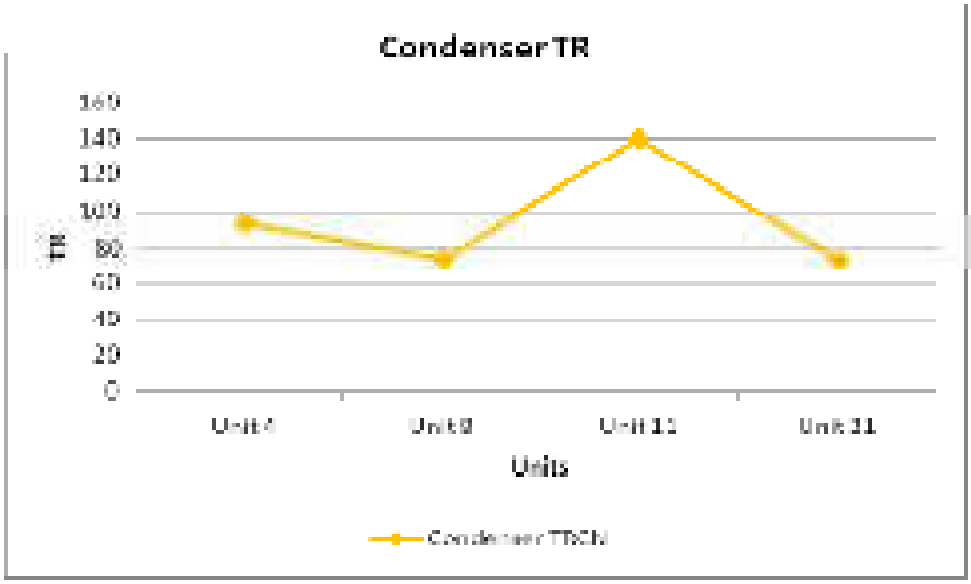


Figure 13: Comparison of Condenser TR for industries using EVAPCO

Table 7: Performance comparison of HVAC System

Company Name	Net Refrigeration capacity	KW/TR	COP
Unit 4	63.71	1.7	2.52
Unit 8	51.55	1.5	2.71
Unit 11	89.69	1.95	2.1
Unit 21	46.11	2.04	1.87

Net refrigeration capacity of the HVAC in industries having EVAPCO varies from 46.1 to 89.69TR. Also, the kW/TR varies to a large extent from 1.5kW/TR to a maximum of 2.0kW/TR.

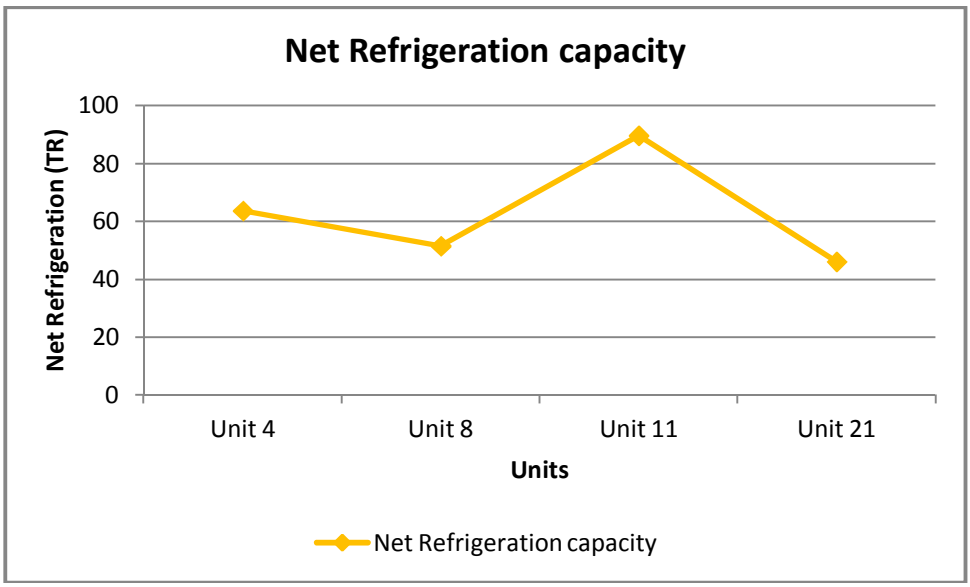


Figure 14: Comparison of net refrigeration capacity of the freezer

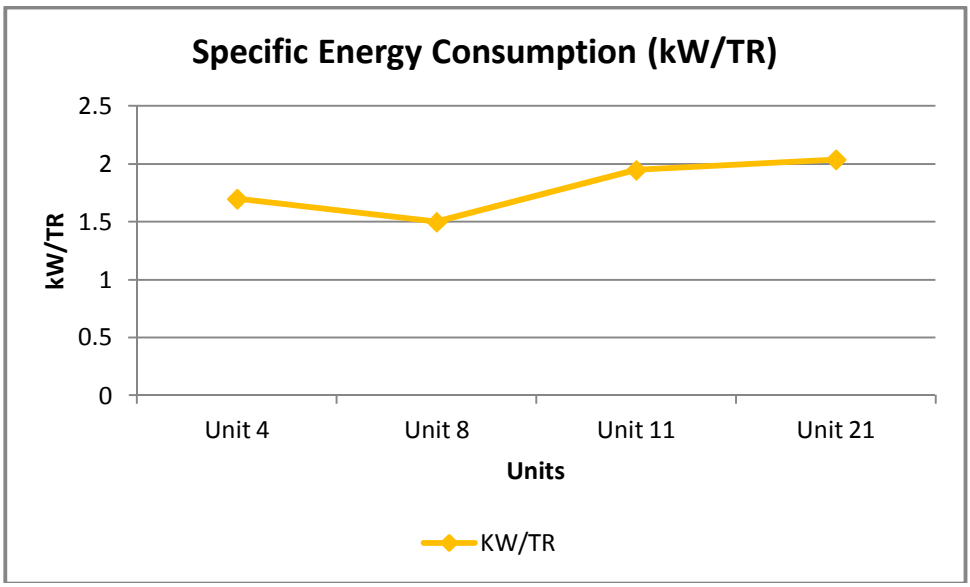


Figure 15: Comparison of kW/TR

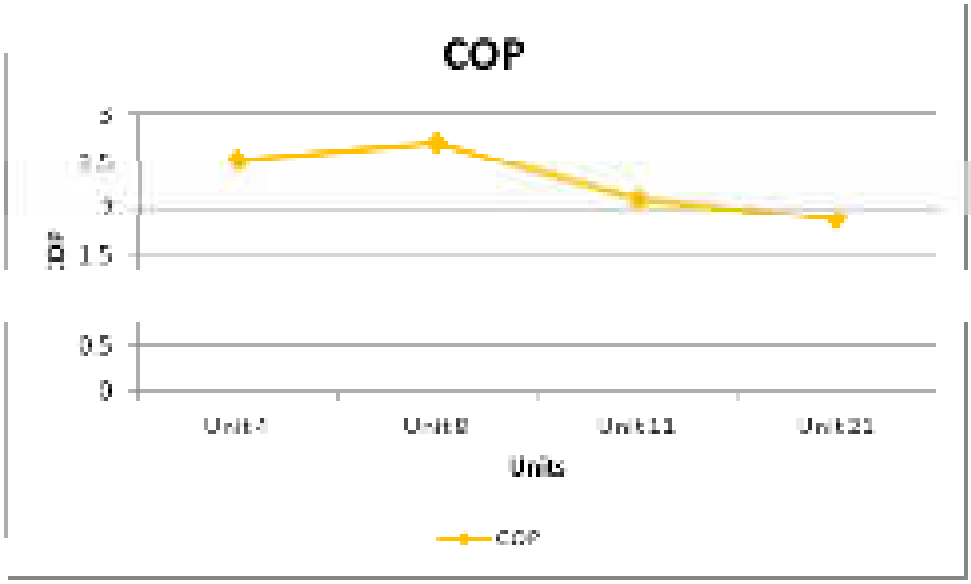


Figure 16: Comparison of COP for the HVAC System

3.2.4 BAC

The following industries have installed BALTIMORE condenser in their HVAC system to cool the ammonia which is the commonly used coolant in the cluster.

- Unit 26
- Unit 27

Table 8: Performance comparison of BAC

Company Name	Condenser TR_{CN}
Unit 26	130.01
Unit 27	37.12

From the above table huge difference has been observed in condenser TR between two industries.

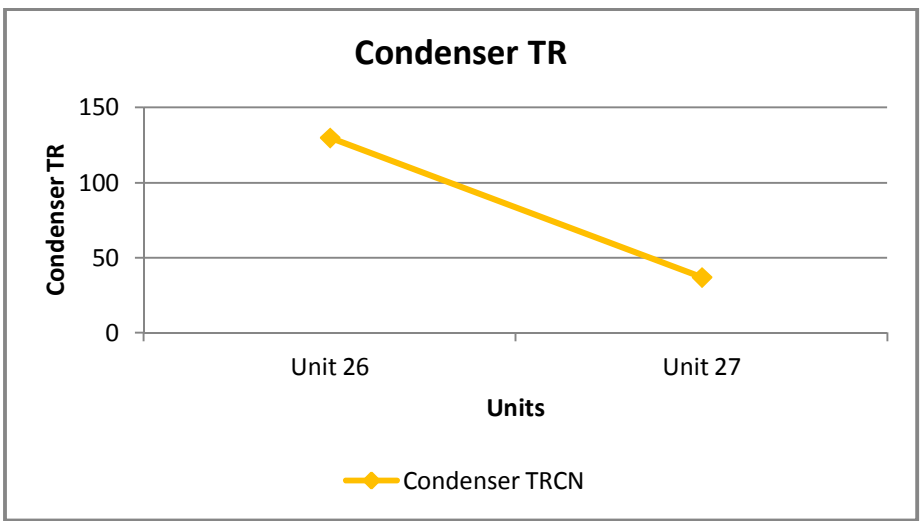


Figure 17: Comparison of Condenser TR for industries using BAC

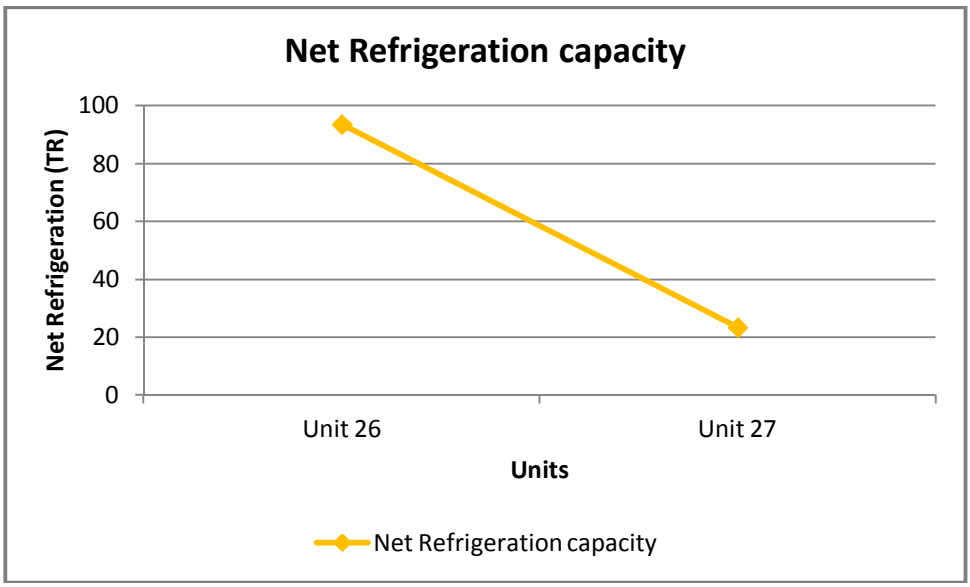


Figure 18: Comparison of net refrigeration capacity of the freezer

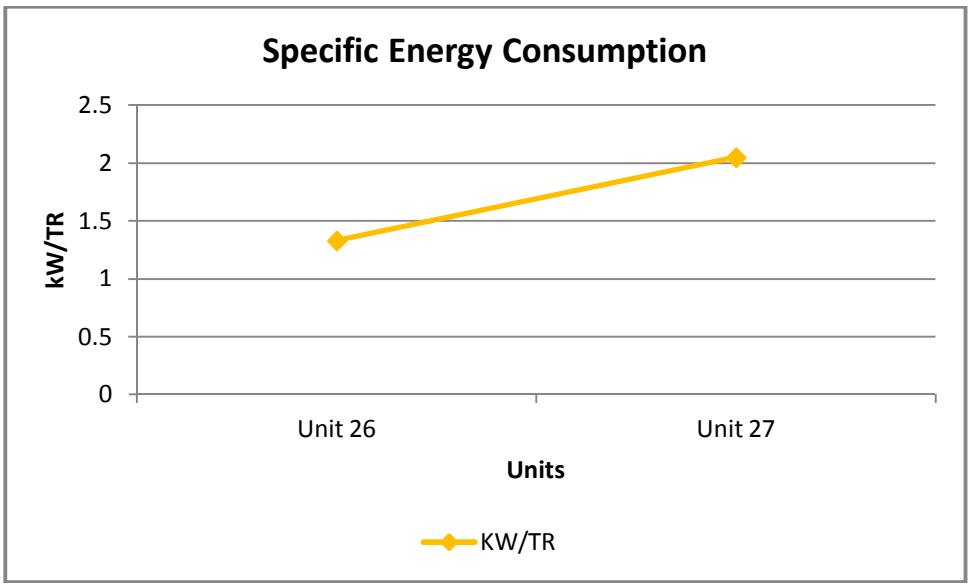


Figure 19: Comparison of kW/TR

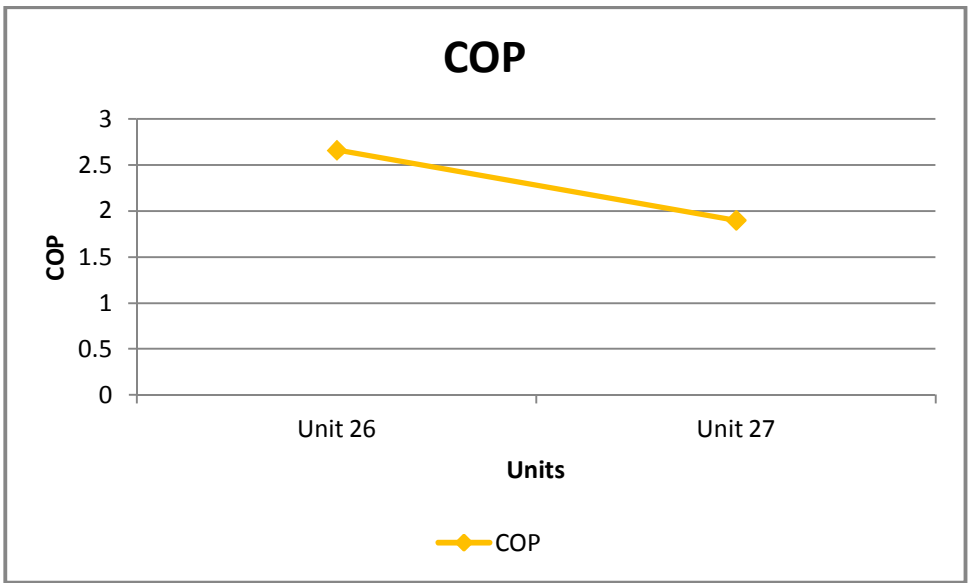


Figure 20: Comparison of COP for the HVAC System

Table 9: Performance comparison of HVAC System

Company Name	Net Refrigeration capacity	KW/TR	COP
Unit 26	93.55	1.33	2.66
Unit 27	23.38	2.05	1.9

3.3 Cooling tower Analysis

The three parameters, which highlights the performance of cooling towers has been compared for the following industries.

- Unit 10
- Unit 20
- Unit 29

Table 10: Performance comparison of cooling tower

Company Name	Range (°C)	Approach (°C)	Effectiveness
Unit 10	1.4	6	0.184
Unit 20	1	6.6	0.13
Unit 29	2.6	6.9	0.27

From the above table we can observe that the cooling tower in Unit 20 is having lowest effectiveness of 0.13 and Unit 29 is having effectiveness of 0.27.

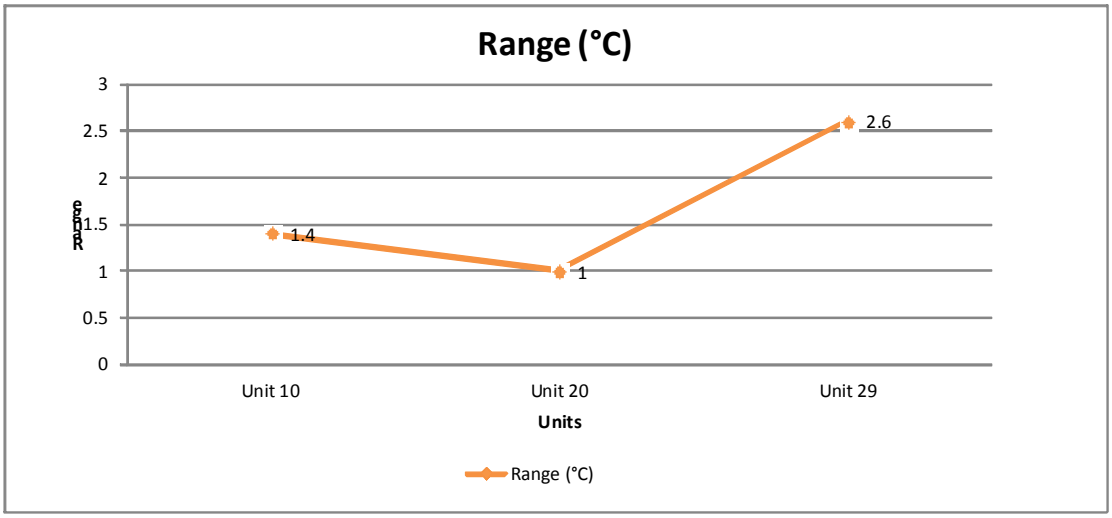


Figure 21: Comparison of range of the cooling tower among the three industries

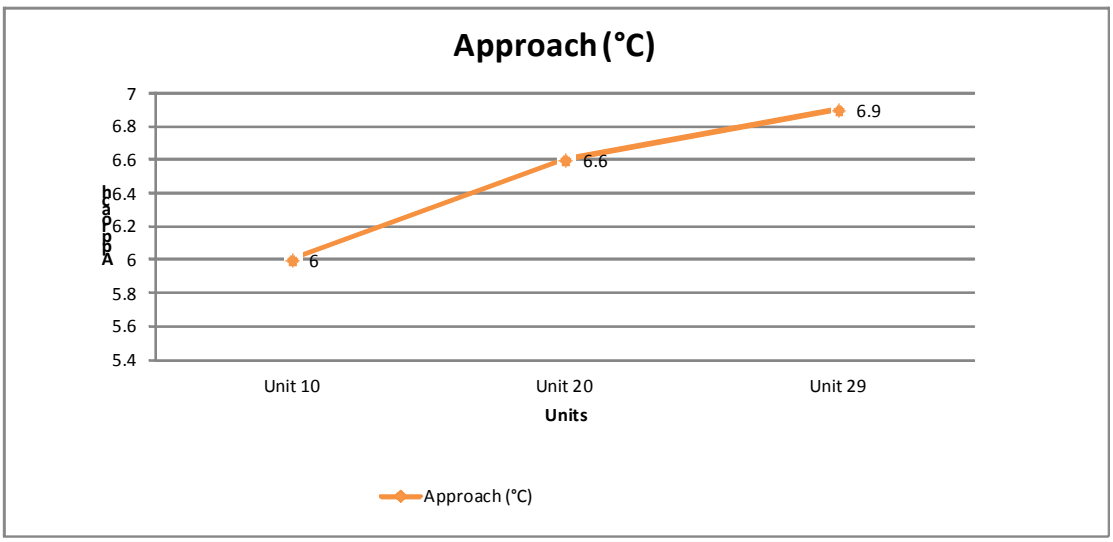


Figure 22: Comparison of Approach of the cooling tower among the three units

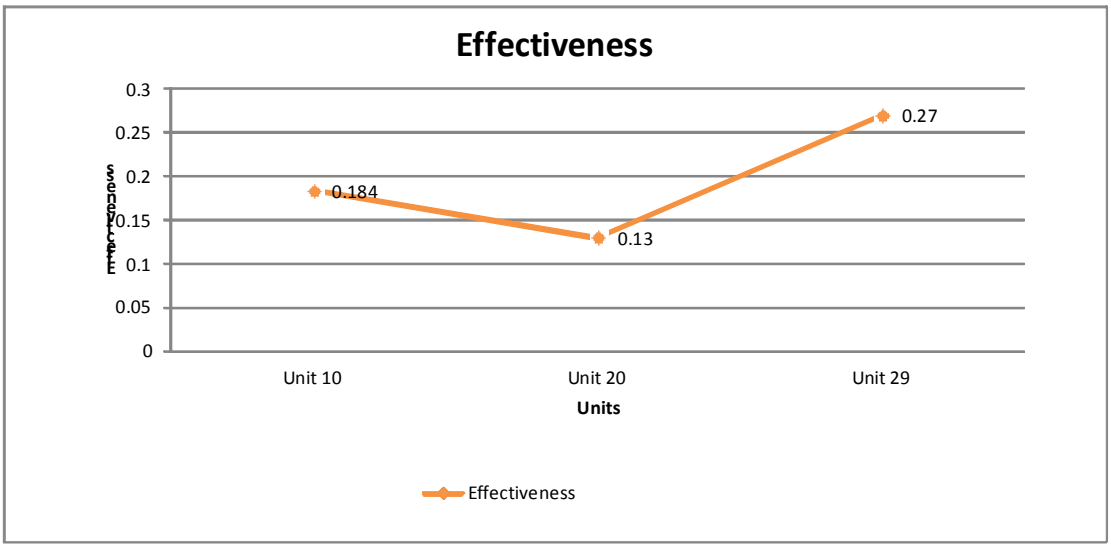


Figure 23: Comparison of Effectiveness in the cooling tower among the three units

3.4 Connected load analysis

3.4.1 Connected load of the Cluster

The total connected load of the cluster is 14902.42kW. The individual connected loads of the units are presented below:

Table 11: Connected Load of Cluster

S. No	Name of Unit	Total Connected Load (kW[1])
1	Unit 1	205.1
2	Unit 2	281
3	Unit 3	321.2
4	Unit 4	554.6
5	Unit 5	685.12
6	Unit 6	596.7
7	Unit 7	181.2
8	Unit 8	770.5
9	Unit 9	124.8
10	Unit 10	212.7
11	Unit 11	1478.2
12	Unit 12	-
13	Unit 13	341.5
14	Unit 14	1298
15	Unit 15	204.1
16	Unit 16	297.9
17	Unit 17	1807.8
18	Unit 18	184.3
19	Unit 19	498.6
20	Unit 20	372.6
21	Unit 21	82.9
22	Unit 22	728.9
23	Unit 23	619.2
24	Unit 24	465.3
25	Unit 25	498.6
26	Unit 26	769.9

[1] Based on the questionnaire.

S. No	Name of Unit	Total Connected Load (kW[1])
27	Unit 27	184.3
28	Unit 28	74.7
29	Unit 29	287.4
30	Unit 30	775.3

3.4.2 Air-conditioning load of the Cluster

The distribution of total Air conditioning load of the cluster is presented below. The average Air-conditioning load of the cluster is 52.76kW.

Table 12: Air Conditioning load of the cluster

S. No	Name of Unit	Air-conditioning Load (kW)
1	Unit 1	-
2	Unit 2	39.1
3	Unit 3	79.1
4	Unit 4	91.4
5	Unit 5	40.4
6	Unit 6	44
7	Unit 7	-
8	Unit 8	102
9	Unit 9	29
10	Unit 10	51
11	Unit 11	124.9
12	Unit 12	-
13	Unit 13	-
14	Unit 14	63.3
15	Unit 15	17.6
16	Unit 16	24.6
17	Unit 17	8.8
18	Unit 18	14.1
19	Unit 19	24.75
20	Unit 20	40.4
21	Unit 21	12.7
22	Unit 22	256.5
23	Unit 23	34.3

S. No	Name of Unit	Air-conditioning Load (kW)
24	Unit 24	100.2
25	Unit 25	24.75
26	Unit 26	10.8
27	Unit 27	14.1
28	Unit 28	10.6
29	Unit 29	10.6
30	Unit 30	102.8

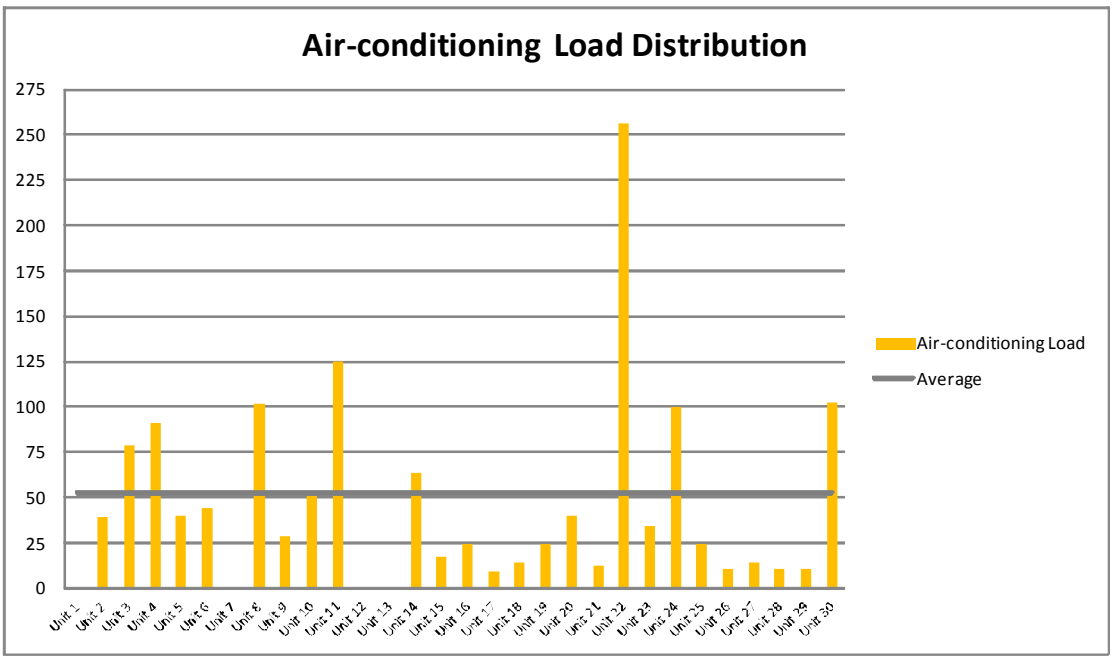


Figure 24: Distribution of Air-conditioning load of the cluster

From the above it can be inferred that eight of the thirty units of the cluster have an air-conditioning load above the average loads of the cluster.

3.4.3 Lighting load of the Cluster

The distribution of total Lighting load of the cluster is presented below. The average Lighting load of the cluster is 10.54kW.

Table 13: Lighting load of the cluster

S. No	Name of Unit	Load (kW)
1	Unit 1	-
2	Unit 2	12.2

S. No	Name of Unit	Load (kW)
3	Unit 3	5.7
4	Unit 4	5.83
5	Unit 5	17.12
6	Unit 6	30
7	Unit 7	12.7
8	Unit 8	21.5
9	Unit 9	4
10	Unit 10	6.3
11	Unit 11	-
12	Unit 12	-
13	Unit 13	12.62
14	Unit 14	-
15	Unit 15	6.7
16	Unit 16	-
17	Unit 17	-
18	Unit 18	3.1
19	Unit 19	12.64
20	Unit 20	14.2
21	Unit 21	0.1
22	Unit 22	17.9
23	Unit 23	4.696
24	Unit 24	18.5
25	Unit 25	12.64
26	Unit 26	-
27	Unit 27	3.1
28	Unit 28	2
29	Unit 29	2.4
30	Unit 30	16.37

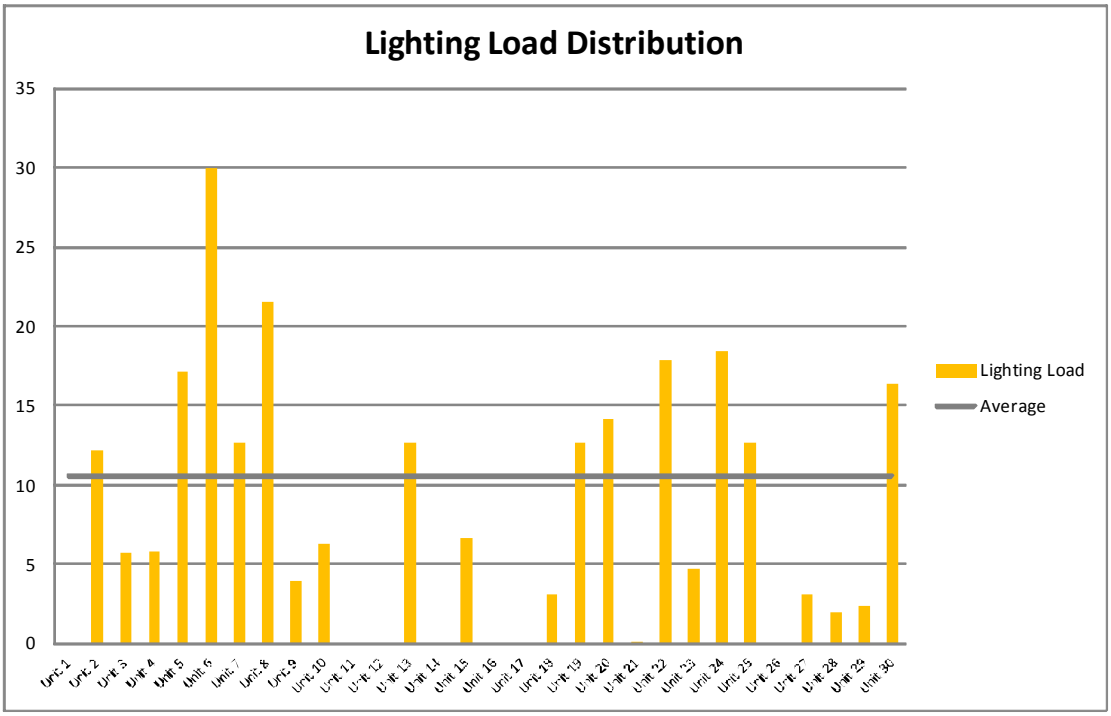


Figure 25: Distribution of lighting load of the cluster

Out of the thirty units, twelve units have a lighting load above the average lighting load of the cluster.

3.4.4 Pumps load of the Cluster

The distribution of total pumps load of the cluster is presented below. The average pumps load of the cluster is 44.15kW.

Table 14: Pumps load of the cluster

S. No	Name of Unit	Pumps Load (kW)
1	Unit 1	-
2	Unit 2	25.7
3	Unit 3	67.9
4	Unit 4	141.3
5	Unit 5	26.5
6	Unit 6	53
7	Unit 7	-
8	Unit 8	22.4
9	Unit 9	10.4
10	Unit 10	-
11	Unit 11	-
12	Unit 12	-

S. No	Name of Unit	Pumps Load (kW)
13	Unit 13	4.5
14	Unit 14	87.6
15	Unit 15	27.6
16	Unit 16	73.59
17	Unit 17	-
18	Unit 18	5.2
19	Unit 19	77.2
20	Unit 20	28
21	Unit 21	4.3
22	Unit 22	-
23	Unit 23	9
24	Unit 24	83.5
25	Unit 25	77.2
26	Unit 26	82.1
27	Unit 27	5.2
28	Unit 28	-
29	Unit 29	14.9
30	Unit 30	-

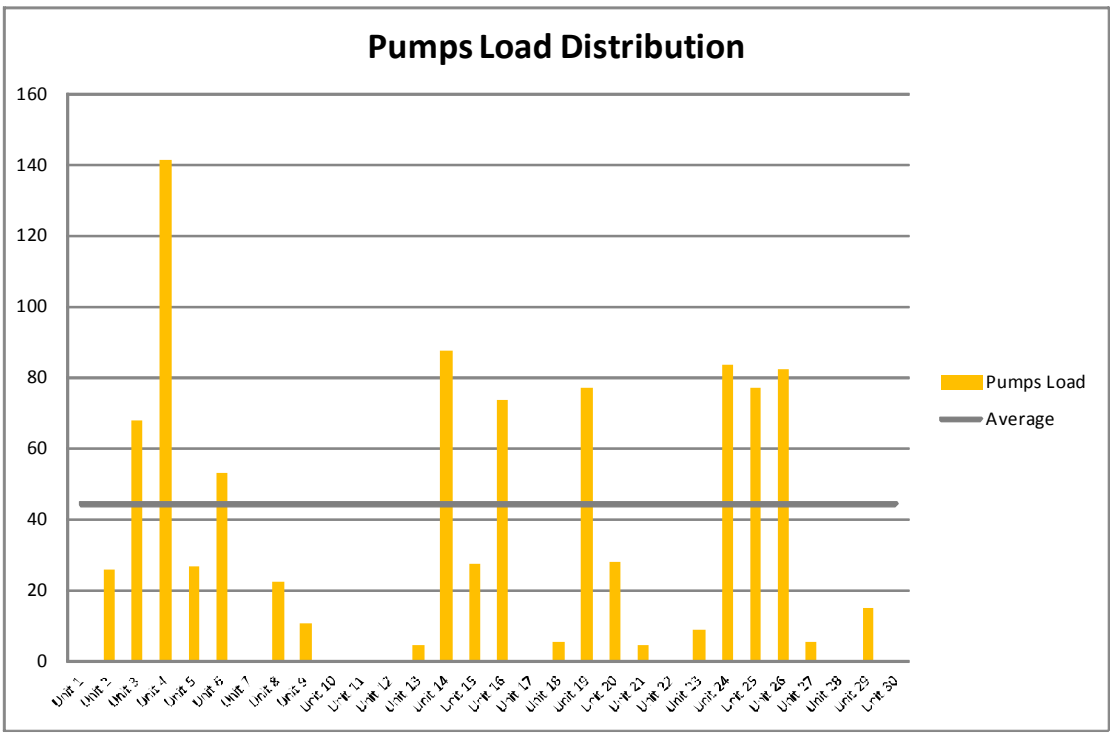


Figure 26: Distribution of pumps load of the cluster

From the above figure it can be inferred that nine of the thirty units have pumps load above the average pumps load of the cluster.

3.4.5 Compressor load of the Cluster

The distribution of total Compressor load of the cluster is presented below. The average compressor load of the cluster is 247.49kW.

Table 15: Compressor load of the cluster

S. No	Name of Unit	Compressor Load (kW)
1	Unit 1	205.1
2	Unit 2	164.1
3	Unit 3	160.3
4	Unit 4	274
5	Unit 5	205.1
6	Unit 6	433
7	Unit 7	141.7
8	Unit 8	499.6
9	Unit 9	52.5
10	Unit 10	145.4
11	Unit 11	553.3
12	Unit 12	-
13	Unit 13	268.8
14	Unit 14	443.7
15	Unit 15	130.5
16	Unit 16	185
17	Unit 17	179
18	Unit 18	123
19	Unit 19	295.3
20	Unit 20	205.1
21	Unit 21	49
22	Unit 22	-
23	Unit 23	134.2
24	Unit 24	261
25	Unit 25	295.3
26	Unit 26	634.1

S. No	Name of Unit	Compressor Load (kW)
27	Unit 27	123
28	Unit 28	48.5
29	Unit 29	197.6
30	Unit 30	522.4

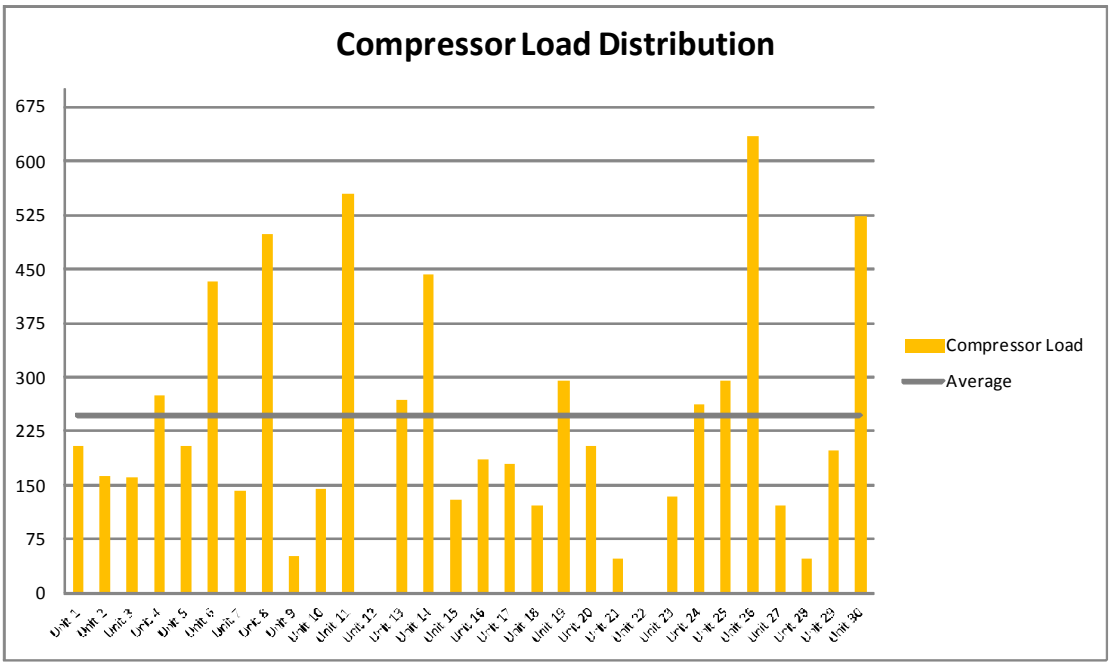


Figure 27: Distribution of compressor load of the cluster

Out of the thirty units, eleven units have a compressor load above the average compressor load of the cluster.

3.4.6 Distribution of Connected load of the Cluster

The distribution of the total connected load of the cluster is presented in the table below:

Table 16: Distribution of connected load

Application	Connected Load (kW)	Percentage of load (%)
Compressors	6930	73
Air –conditioners	1372	14
Lighting	242	3
Pumps	927	10
Total	9471	100.0

The graphical representation of the above distribution pattern has been presented below in the figure

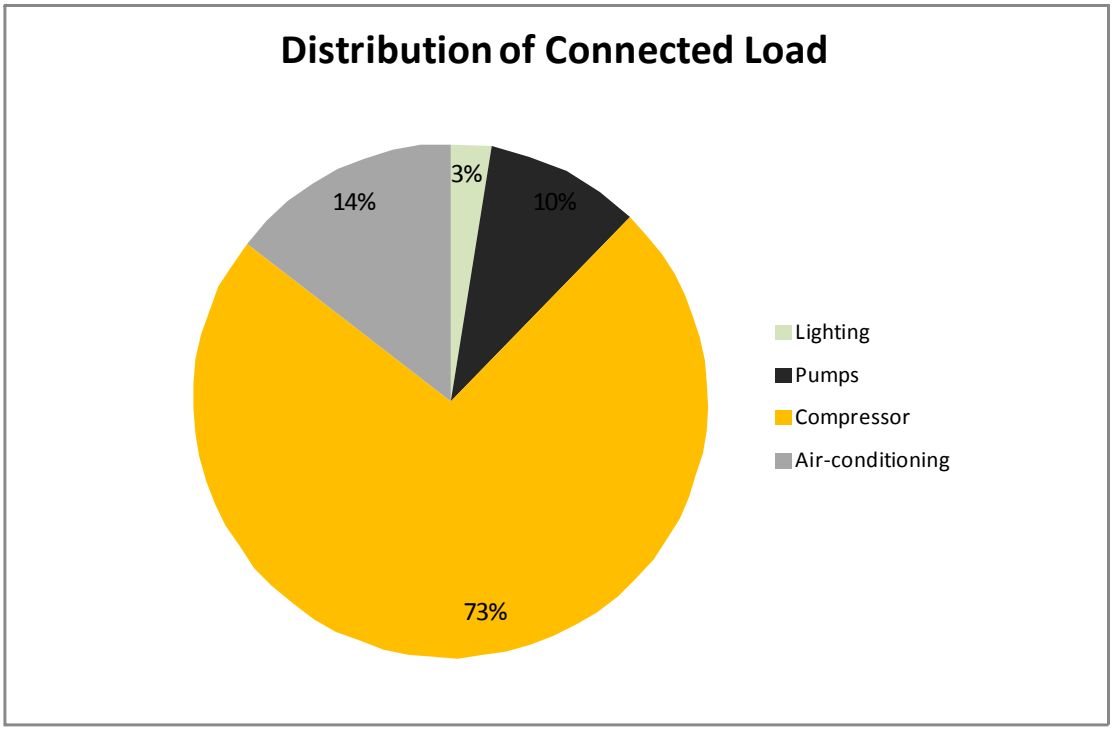


Figure 28: Distribution of connected load of the cluster

Out of the total connected load of the cluster, compressor contributes to the maximum load of 73%and lighting contributes to the minimum load of 3%

3.4.7 Distribution and Categorization of Compressors

Based on the compressor data collated from the individual units of the cluster, the distribution of compressors is as mentioned below:

Table 17: Distribution of Compressor

S. No	Compressor Capacity (hp)	Quantity
1	2	14
2	3	8
3	5	20
4	7.5	3
5	10	4
6	13	7
7	15	4
8	25	4
9	30	9
10	35	1

S. No	Compressor Capacity (hp)	Quantity
11	40	6
12	50	13
13	60	16
14	75	43
15	80	1
16	90	4
17	100	9
18	120	6
19	125	5
20	155	33
21	167	1
22	175	3

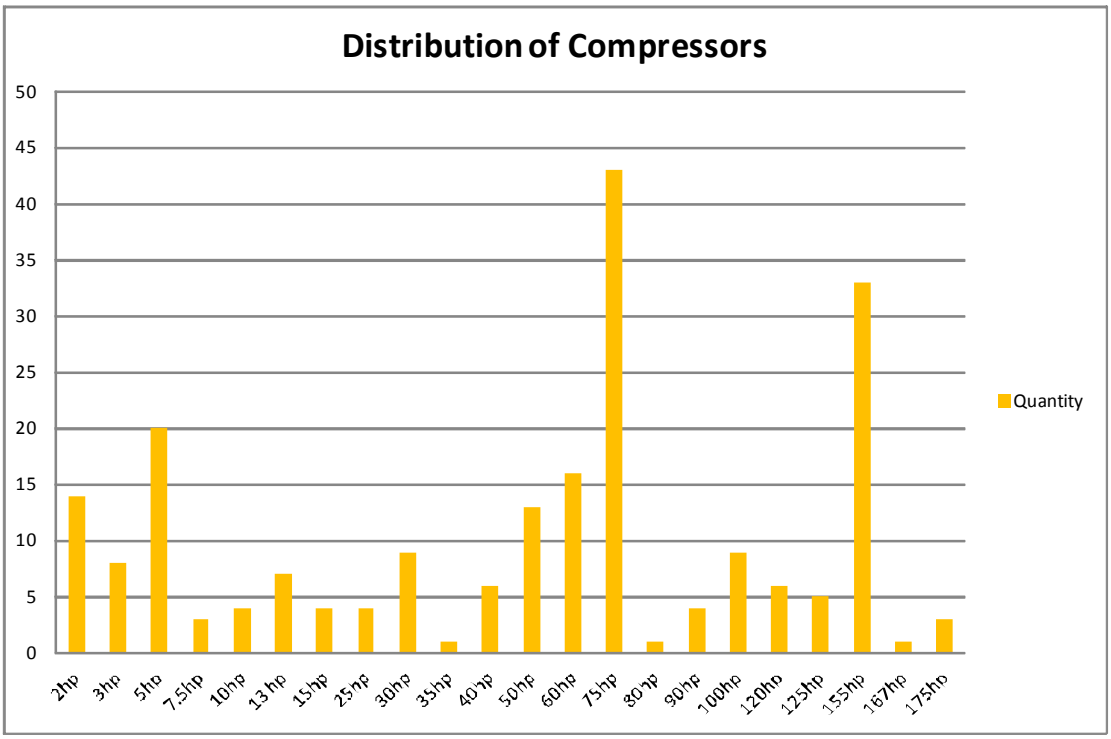


Figure 29: Distribution of compressor

From the above figure it can be inferred that 75 hp compressors are most widely used in the cluster, followed by 155 hp and 5 hp compressors.

For identification of main energy consuming areas/equipments, the connected load of individual units was categorized based on energy consumption pattern. The table below provides the categorization of compressors for the cluster:

Table 18: Categorization of Compressor

Category	Number of Compressors	Percentage (%) contribution
High energy consuming equipment/ areas (> 50 kW)	56	26
Medium energy consuming equipment/ areas (> 10 kW and < 50 kW)	53	25
Low energy consuming equipment/ areas (< 10 kW)	105	49
Total	214	100

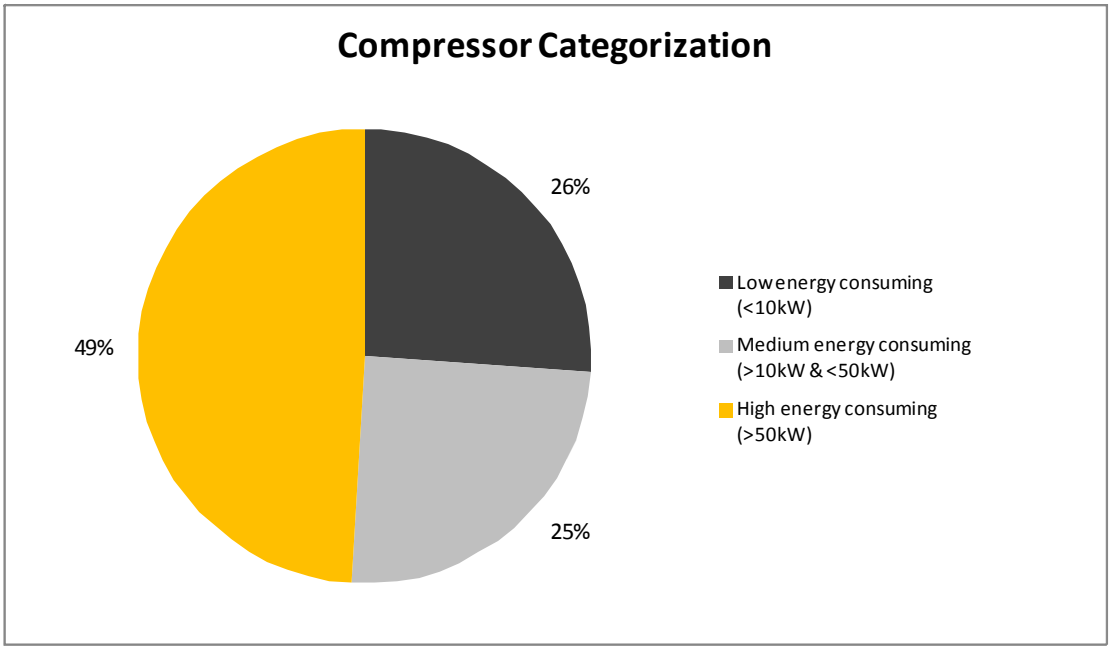


Figure 30: Categorization of Compressor

From the above figure it can be inferred that 49%of the compressors used in the cluster are high energy consuming. The various compressors in the cluster have been compared based on their energy consumption pattern.

3.5 Electrical analysis

3.5.1 Power factor of the Cluster

The average Power Factor for each of the units is presented below:

Table 19: Power factor of Cluster

S. No	Name of Unit	Average PF
1	Unit 1	0.95
2	Unit 2	-

S. No	Name of Unit	Average PF
3	Unit 3	0.90
4	Unit 4	0.96
5	Unit 5	0.92
6	Unit 6	0.92
7	Unit 7	-
8	Unit 8	0.94
9	Unit 9	-
10	Unit 10	0.94
11	Unit 11	0.88
12	Unit 12	0.95
13	Unit 13	0.96
14	Unit 14	0.87
15	Unit 15	0.94
16	Unit 16	-
17	Unit 17	-
18	Unit 18	0.84
19	Unit 19	0.97
20	Unit 20	0.98
21	Unit 21	0.93
22	Unit 22	0.94
23	Unit 23	0.94
24	Unit 24	0.96
25	Unit 25	0.95
26	Unit 26	0.94
27	Unit 27	0.93
28	Unit 28	-
29	Unit 29	-
30	Unit 30	0.90

The overall average Power Factor of the cluster is 0.932

Out of all the units in the cluster that has data on power factor, 14 (61%) units fall under the penalty zone of power factor less than 0.9 at least once in the overall period considered. 9 (39%) units do not fall under the penalty zone at all in the overall period

[2] Please note that out of 30 units, 6 units did not have the Power factor data and one unit used diesel as fuel instead of electricity. Hence the average power factor corresponds to the average of the remaining 23 units

considered.

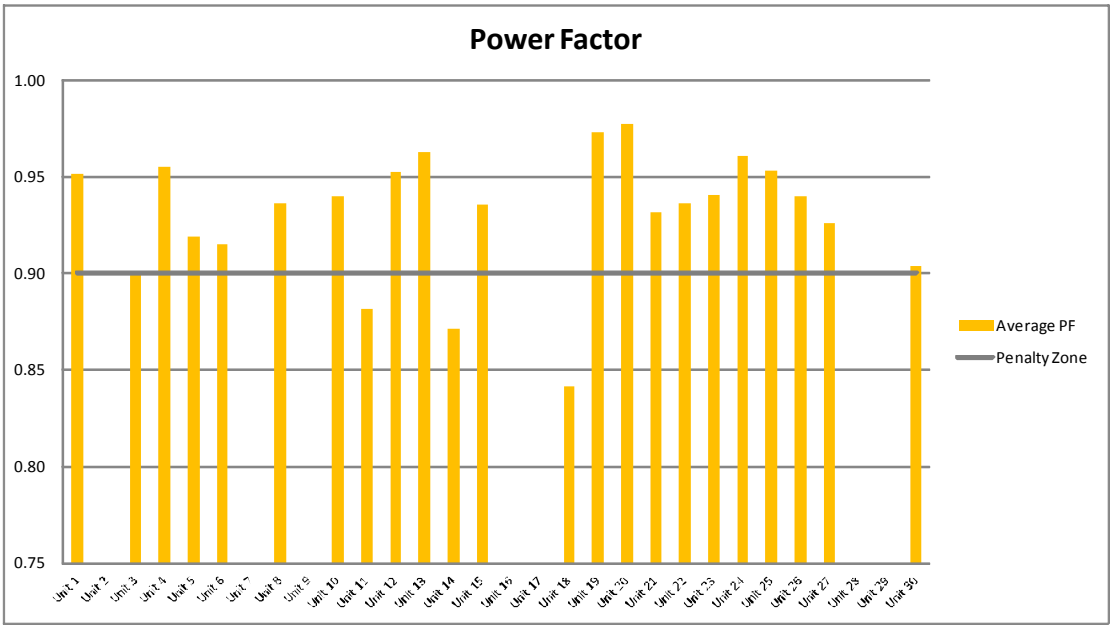


Figure 31: Power factor of cluster

Though the average PF of the cluster is 0.93, there are few units in the cluster having an average that falls under the penalty zone.

3.5.2 Electricity consumption analysis of the cluster

The average electricity consumption for each of the units is presented below:

Table 20: Electricity consumption of Cluster

S. No	Name of Unit	Monthly average of electricity consumption (kWh)
1	Unit 1	75223
2	Unit 2	-
3	Unit 3	41911
4	Unit 4	82597
5	Unit 5	113634
6	Unit 6	138814
7	Unit 7	15825
8	Unit 8	142989
9	Unit 9	12058
10	Unit 10	66180
11	Unit 11	136938
12	Unit 12	64587

S. No	Name of Unit	Monthly average of electricity consumption (kWh)
13	Unit 13	43807
14	Unit 14	221662
15	Unit 15	38331
16	Unit 16	268433
17	Unit 17	166813
18	Unit 18	41203
19	Unit 19	141056
20	Unit 20	89699
21	Unit 21	101134
22	Unit 22	77760
23	Unit 23	44373
24	Unit 24	102064
25	Unit 25	66924
26	Unit 26	136121
27	Unit 27	47476
28	Unit 28	21959
29	Unit 29	24351
30	Unit 30	166813

The average electricity consumption of the cluster is about 92,783 kWh per month. This has been calculated by considering the above data provided in the table.

3.5.2.1 Range of electricity consumption of the cluster

The range of electricity consumed across various units in the cluster varies from 12057 to 268433 kWh per month

3.5.2.2 Trend of electricity consumption of the cluster

The electricity consumption of the cluster follows either an increasing or a decreasing trend across the units. The share of the trend of electricity consumption is provided below:

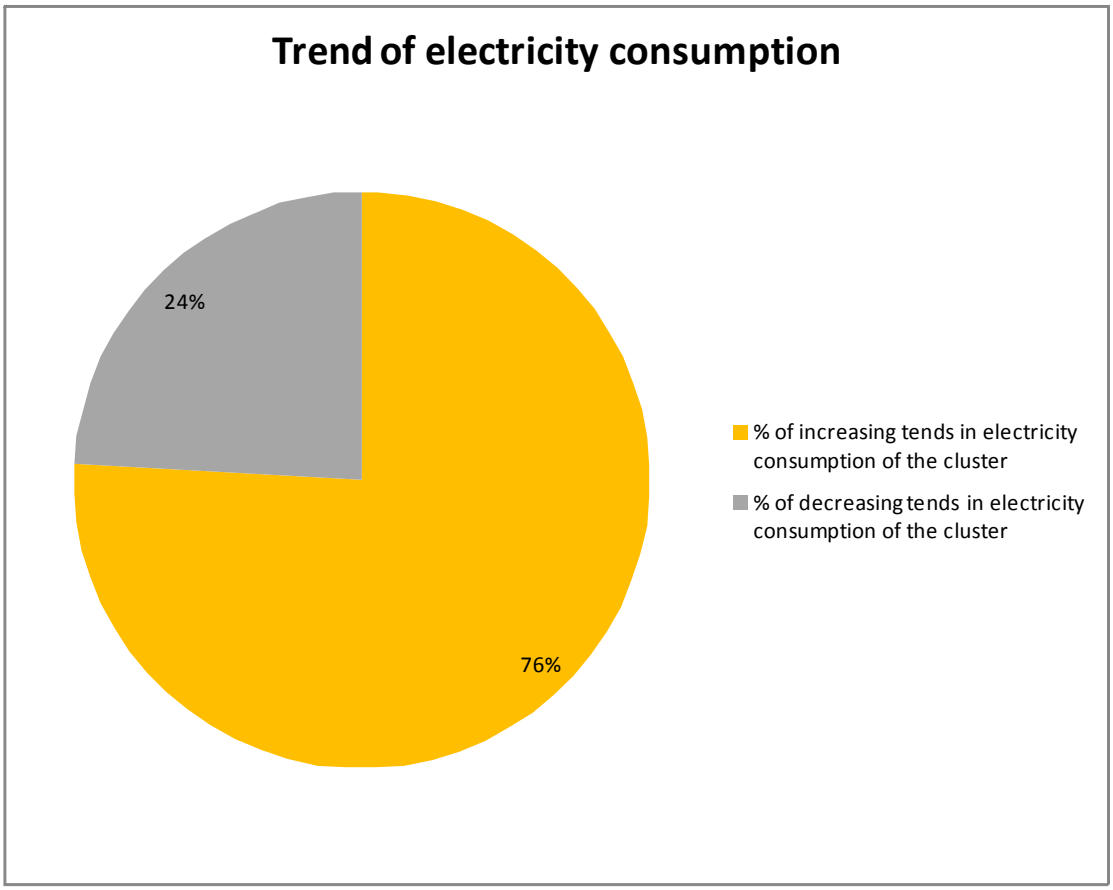


Figure 32: Trend of electricity consumption

It can be inferred that most of the units in the cluster follow an increasing trend in electricity consumption of the overall cluster.

3.5.3 Electricity bill analysis of the cluster:

The average electricity bill of the cluster is about INR 492150 per month. This has been calculated by considering each unit's average electricity bill and using all the averages to arrive at the cluster average:

The average electricity bill of each unit is as follows:

Table 21: Electricity bill of Cluster

S. No	Name of Unit	Monthly average of electricity bill (INR[3])
1	Unit 1	435793
2	Unit 2	-
3	Unit 3	237657
4	Unit 4	526372
5	Unit 5	383151

[3] Based on the electricity bill data provided by the indutries.

S. No	Name of Unit	Monthly average of electricity bill (INR[3])
6	Unit 6	712358
7	Unit 7	78833
8	Unit 8	759158
9	Unit 9	107661
10	Unit 10	342530
11	Unit 11	852363
12	Unit 12	852363
13	Unit 13	305719
14	Unit 14	1234762
15	Unit 15	206112
16	Unit 16	1241766
17	Unit 17	46961
18	Unit 18	251005
19	Unit 19	660506
20	Unit 20	450786
21	Unit 21	514906
22	Unit 22	522810
23	Unit 23	253376
24	Unit 24	558903
25	Unit 25	364017
26	Unit 26	1014981
27	Unit 27	255870
28	Unit 28	87923
29	Unit 29	161366
30	Unit 30	852363

3.5.3.1 Range of electricity bill of the cluster

The range of electricity bill across various units in the cluster varies from 46960 to 1241766 INR per month

3.5.3.2 Trend in electricity bill of the cluster

The electricity bill of the cluster follows either an increasing or a decreasing trend across the units. The share of the trend of electricity bill is provided below:

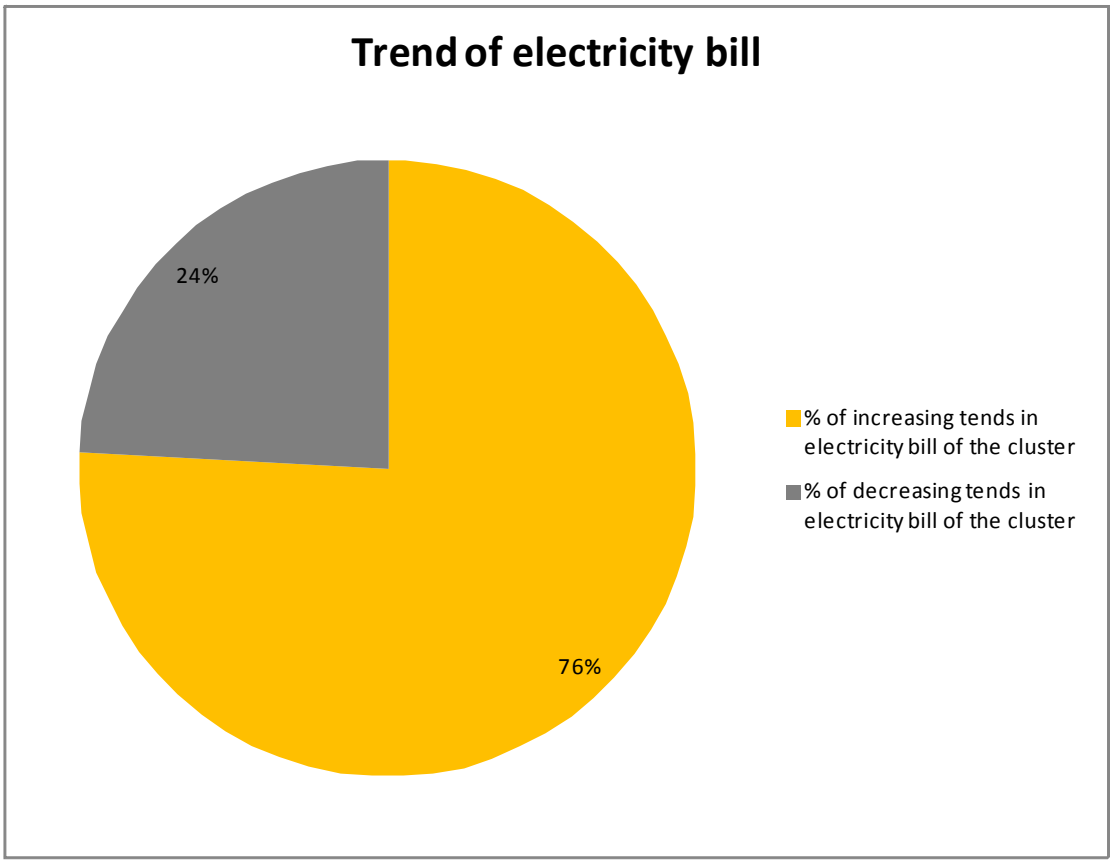


Figure 33: Trend of electricity bill

It can be inferred that most of the units in the cluster follow an increasing trend in electricity bill of the overall cluster.

3.5.4 Contract demand of the cluster

The contract demand for various units in the cluster is as follows:

Table 22: Contract demand of Cluster

S. No	Name of Unit	Contract demand (kVA) of each unit in the cluster
1	Unit 1	310
2	Unit 2	-
3	Unit 3	310
4	Unit 4	750
5	Unit 5	310
6	Unit 6	450
7	Unit 7	-
8	Unit 8	310
9	Unit 9	-
10	Unit 10	310

S. No	Name of Unit	Contract demand (kVA) of each unit in the cluster
11	Unit 11	500
12	Unit 12	310
13	Unit 13	310
14	Unit 14	310
15	Unit 15	310
16	Unit 16	700
17	Unit 17	-
18	Unit 18	310
19	Unit 19	360
20	Unit 20	310
21	Unit 21	410
22	Unit 22	310
23	Unit 23	310
24	Unit 24	380
25	Unit 25	250
26	Unit 26	380
27	Unit 27	310
28	Unit 28	-
29	Unit 29	-
30	Unit 30	310

The average contract demand for the cluster is about 367 kVA. A pictorial representation of the contract demand is as follows:

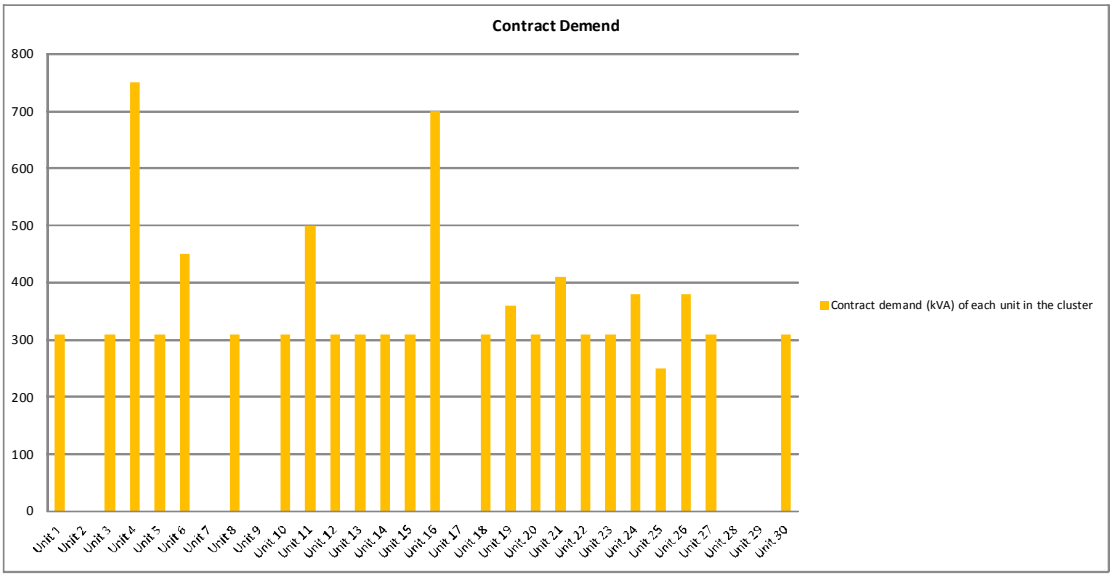


Figure 34: Contract demand of cluster

3.5.5 Energy and demand charges of the cluster

The average energy and demand charges of all units in the cluster are as follows:

Table 23: Energy and demand charges of Cluster

S. No	Name of Unit	Monthly average of energy charges (INR)	Monthly average of demand charges (INR)
1	Unit 1	280221	95406
2	Unit 2	-	-
3	Unit 3	162031	56949
4	Unit 4	315205	186519
5	Unit 5	262214	73415
6	Unit 6	496806	138316
7	Unit 7	51826	-
8	Unit 8	547778	162498
9	Unit 9	39269	68392
10	Unit 10	245270	71164
11	Unit 11	640141	143647
12	Unit 12	247913	88257
13	Unit 13	209872	79820
14	Unit 14	836356	298643
15	Unit 15	144933	48500
16	Unit 16	973208	198487
17	Unit 17	46961	46961

S. No	Name of Unit	Monthly average of energy charges (INR)	Monthly average of demand charges (INR)
18	Unit 18	157459	68392
19	Unit 19	513194	114543
20	Unit 20	322030	82960
21	Unit 21	335702	108449
22	Unit 22	295773	185686
23	Unit 23	169130	66091
24	Unit 24	379784	104539
25	Unit 25	251025	91112
26	Unit 26	512674	133203
27	Unit 27	182182	56721
28	Unit 28	69846	-
29	Unit 29	-	-
30	Unit 30	640141	160235

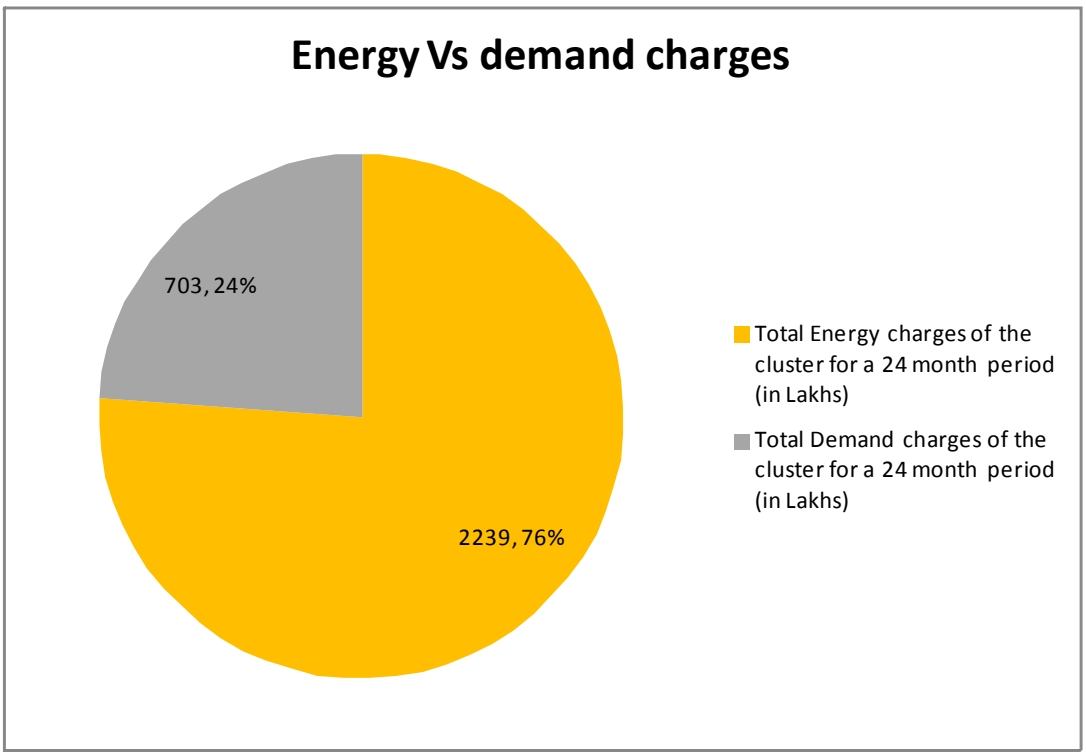


Figure 35: Energy and demand charges of Cluster

The total energy charges of the cluster for a 24 month period are about 2239 Lakhs. The total demand charges of the cluster for a 24 month period are about 703 Lakhs[4].

[4] For the calculation of total energy and demand charges, the monthly average of each units in the cluster were multiplied by 24, irrespective of the period for which the energy and demand charges were provided.

3.6 Observations Made During Energy Use And Technology Audit

- Lack of insulations in ammonia flow areas
- Lack of proper maintenance of air curtains
- Belt sagging in compressors
- Improper ante room maintenance
- Leakage of ammonia in compressor room
- High suction temperature compressors
- Operation of cold stores with 75hp compressors instead of package HVAC systems
- Thick ice deposition around compressor suction point
- Evapco kept in semi-enclosed space rather than in open space
- Replacement of freezer coils from MS to Aluminium reduced freezing time in plate freezers from 5-6 hours to 2-3 hours.

3.7 Opportunities/energy conservation measures Identified

Proposal – 1: Proper maintenance of condenser coils

Present Status

- The seafood industries have banks of condenser coils. Heat rejection to the atmosphere takes place through them.
- Condenser coils are cooled by circulating water continuously

Observation

- During the study various measurements were taken on the condensor coil and it was observed that in many places algae formation as well as scale formation were found. It may lead to increase in power consumption.

Recommendation

- Cleaning of coils results in higher temperature gradient thereby reduction in power consumption.
- Approximately 5%on energy savings can be achieved.

Proposal – 2: Replacement of existing V-belt drive with synthetic energy efficient flat belt drive in the compressor motor

Present Status

- Many places compressor motor is connected to the chiller by V-belt drive.
- The compressor operates for 14-16 hours per day during peak period and 10 hours per day during off peak period.

Observation

- Recent trend is to replace V-belt drive with flat belt drives due to the efficiency of flat belt drives.
- Some of the key advantages are (i) higher frictional coefficient, (ii) light weight, (iii) high elasticity resulting in lower shaft loads and (iv) reduction on power consumption

Recommendation

- Considering the above aspects, it is recommended to replace V-belt with flat belt.
- Power savings would be around 8%

Proposal – 3: Proper insulation of identified insulation damaged areas.

Present Status

- Most of the units have poor insulation for the ammonia lines leading to large exposed areas and ice accumulation.
- Exposed ammonia lines absorb significant amount of thermal energy thereby reducing the evaporative capacity within the freezer.

Observation

- The average surface temperature were 4-5 oC higher than the insulated area of the ammonia lines

Recommendation

- By providing complete and proper insulation, thermal energy transgression across exposed surface can be cut off.

Proposal – 4: Replacement of existing thermocole insulated doors with puff insulated doors

Present Status

- Some of the cold storage doors have been insulated using thermocole
- Each floor of the chamber has a door for better accessibility and operations.

Observation

- The rubber seals of the doors are worn out, damaged leading to the leakage of cold air to the atmosphere.
- In many areas, the surface temperature of the door is as low as -5 oC

Recommendation

- Hence it is recommended to put thermocole insulated doors with puff insulated doors.
- Approximately 1-2%energy saving would be possible

Proposal – 5: Segregation of commodities as low and very low temperature applications

Present Status

- Most of the cold storage areas have been facilitated either with one or two chambers
- Commodities are stored in this chambers without any segregation

Observation

- Average temperature inside the cold room is of the order of -20 oC but actual temperature required is -18 oC due to no segregation of commodities such as prawns, crabs, squids, octopus, etc

Recommendation

- Hence it is recommended to segregate the cold storage room into various temperature according to temperature application and thereby save on energy. Cost savings cannot be quantified but substantial savings may be anticipated.

Proposal – 6: Installation of Servo stabilizers for lighting feeders

Present Status

- Most of the industries did not have separate feeders for lighting circuits.

Observation

- The average voltage across the circuit varies between 230 to 240V.
- The rating of the fluorescent lamps varies between 180 to 210V. Therefore there is substantial potential to optimize the voltage without affecting the illumination.

Recommendation

- Hence it is recommended to have a separate feeder for lighting circuit and install Servo stabilizers to save on energy.
- Approximately 10-12%of energy savings can be achieved.

Proposal – 7: Installation of automatic star delta star starter for lightly and partly loaded motors

Observation

- Most of the motors will be operated under delta mode and star mode would be used only during startup.
- During our visit, it was observed that some of the motors were partially loaded during operation.
- Operating these motors in part load in delta mode leads to significant iron losses thereby there is a possibility of losing energy and also the life of the motor.

Recommendation

- These recent trends automatic start delta starters are available in the market and depends upon the load of the motor, the starters will automatically change to star or delta mode and thereby save on energy .
- Cost savings would be approx 2-4%

Proposal – 8: Revamping of existing refrigerant circuit with ethylene glycol as secondary refrigerant

Present Status

- Most of the industries have ammonia based refrigeration cooling system.
- The ammonia is used since it has very low freezing point (-77 ºC)

Observation

- During our visit leakage of ammonia has been observed in various places. Since ammonia is toxic in nature, it is harmful to the people who are in the working area of the system.

Recommendation

- Hence wherever possible ethylene glycol can be used as a secondary refrigerant.
- This proposal has been given to have environment friendly secondary refrigerant as well as for internal safety rather than economics.

Proposal – 9: Surrender of contract demand and reduction of kVA charges payable to electricity board

Present Status

- The average contract demand for most of the industries ranges between 200 to 300 kVA. Minimum of 75%should be paid to the local electricity board.

Observation

- During our visit it was observed in most of the industries that the maximum recorded demand is well below the threshold limit (75%).
- Hence there is huge potential to surrender the additional kVA demand

Recommendation

- Considering the future expansion and after doing a thorough analysis, if possible some amount of kVA demand can be surrendered and thereby save on cost to the company.

Proposal – 10: Installation of thermal storage system to benefit from tariff mechanism for ice making process

Present Status

- The following tariff mechanism is being followed by EB in the state
  1.1 Normal tariff - (10 AM to 6 PM)
  2.1 Peak tariff - (6 PM to 10 PM)
  3.1 Off-Peak tariff - (10 PM to 6 AM)

Observation

- During our visit the refrigerant plant was operated for approximately 14 – 18 hours in a day in addition, a separate compressor is being operated for manufacturing ice plant

Recommendation

- It is recommended to install a thermal storage system thereby the chiller used for ice manufacturing can be used during night time for thermal storage system and ethylene glycol or other secondary refrigerant can be used during daytime and thereby industry can avail differential tariff during peak and off-peak period.

Proposal – 11: Replacement of reciprocating compressors with screw compressors with VFD.

Present Status

- Most of the industries are using ammonia based reciprocating compressors for chilling purpose.

Observation

- The average kW/TR varies between 1.5 to 2.
- Recent trends being energy efficient screw compressors are there in place whereas the specific energy consumption would be around 0.82 to 1kW/TR.
- The units having poor coefficient of Performance (COP) of around 1.9
- Through there is a substantial investment, the investment can be recovered with a payback period of 3-5 years.

Recommendation

- Hence it is recommended to go for screw compressors in place of old inefficient centrifugal compressors.

Proposal – 12: Installation of Variable Frequency Drives (VFD) for centrifugal pumps

Present Status

- Most of the industries are using centrifugal pumps for supplying cooling water to condensor for cooling purpose.

Observation

- During our visit, it was observed that the pumps are being operated continuously irrespective on the load in the secondary side.
- In some of the pumps, the outlet valves were throttled to avoid excessive water flow.
- Recent trend being Variable Frequency Drives (VFDs) have come in place which can be connected to the pump.
- VFD will be operated based on the temperature and the pressure (head) and adjust the frequency of the motor accordingly. As per the Fan's law, substantial amount of power can be saved.

Recommendation

- Hence it is recommended to install VFDs in the condensor pumps.
- Energy savings vary from industry to industry depending upon the usage.
- On an average the savings would be around 10-15%

Proposal – 13: Replacement of Shell & Tube condensor or plate heat exchangers and cooling towers with Evaporative condensers

Present Status

- Most of the industries use Shell & Tube or plate heat exchangers for condensing operation.
- The outlet water from these condensors are passed on to the cooling tower and chilled water is returned back to the condensor.

Observation

- Heat transfer through Shell & Tube exchangers are less efficient when compared to Plate heat exchangers
- But plate heat exchangers require high pressure (head) to operate which requires high amount of energy.
- Some of the cooling towers in the industries were old and dysfunstional.
- Present trend is to replace Shell & Tube condensor or plate heat exchangers and cooling towers with high efficient Evaporative condensors.
- Heat rejection in an evaporative condenser takes place in a single unit which provides for improved efficiency.
- Evaporative condensers can offer operating and maintenance savings by as much as 20%as compared to the shell & tube condenser-cooling tower alternative
- Evaporative condensers also requires only smaller area for layout.

Recommendation

- Hence it is recommended to install Evaporative condensors instead of conventional shell & tube or plate heat exchangers and cooling tower.
-

Proposal – 14: Replacing existing ammonia compressors with poor specific energy consumption with ammonia vapour absorption system (LNG Fuelled or Biomass based)

Present Status

- In a fish processing unit, freezing of fish and cold storage of the frozen fish, accounts for a significant portion the energy consumption. The facilities under consideration use a multi-stage vapor compression cycle for freezing marine products, up to a temperature of -40°C. Ammonia (R 717) is the commonly used refrigerant in the refrigeration system of the plant.

Observation

- The Cop for these identified systems is around 1.9
- The specific electricity consumption for the units under consideration is 2kW/TR. This makes the units under consideration energy inefficient.

Recommendation

- With the rapidly changing global energy scenario and an increased focus on energy and environment conservation, Vapour Absorption Machines (VAM) provides the option for process cooling requirement. Unlike electrical machines, VAM are powered by heat sources like steam, hot water, waste heat, natural gas and other readily available low cost fuel. The Ammonia VAM can produce refrigeration up to -40 degree C.

Benefits of proposals

- Low running cost due to use of cheap fuels like agro based fuels, CNG etc.
- Uses only about 10%of electrical energy required for the vapor compression cycle
- Very low maintenance costs due to no moving parts and negligible wear & tear
- No loss of efficiency at part loads
- No fouling of evaporator surfaces due to lubricating oil

Details of the identified technology supplier/local service providers are furnished in Annexure – 3.

Proposal 15: Replacement of standard fluorescent tube lights with energy efficient ones

The units in the cluster use large numbers of 40W standard fluorescent tubes for its indoor and outdoor purposes. Use of 36W tube lights in place of 40W tube lights saves 10% energy. The 40 W tubes can also be replaced by 20W T5 tubes for better energy efficiency. Replacement of 40W tube lights to 36W tube lights should be gradually done.

Proposal 16: Addition of capacitors to improve the Power Factor

More than 60% of the units have had PF values dipping below 0.9 mark on several occasions. These units not only pay a severe penalty at the rate of 1% for every 0.01 value PF below 0.9, but also lose the incentive that they could have earned if the PF was maintained above 0.9. Adding capacitance can bring up the PF closer to unity.

Benefits of the proposal

The benefits of this proposal are:

- Lower operating cost
- Easy maintenance

List of other identified Energy Conservation measures

- Replacement of energy inefficient motors with energy efficient motors
- Installation and proper maintenance of air curtains in cold rooms
- Installation of automatic temperature cut-off sensors for freezers
- Improving Energy consumption monitoring by utilizing Multifunction Energy Monitor system

3.7.1 Identified Technologies For DPR Preparation

The selected technologies/equipments considered for preparation of detailed project reports is given in table below.

Sl. No.	Item/ Description
1	Installation of Ammonia based Vapour Absorption Machine (VAM) Chillers – Biomass based energy
2	Replacement of Shell & Tube heat exchangers or plate heat exchangers and cooling towers with Evaporative condensers
3	Installation of Star – Delta – Star Starter for units where motors are partly and lightly loaded.
4	Installation of Variable Frequency Drives (VFD) for centrifugal pumps
5	Installation of Ammonia based Vapour Absorption Machine (VAM) Chillers – LNG Fuelled

4. Systematic Approach for Energy Conservation by TEM/SGA

4.1 Introduction to energy conservation by TEM/SGA

Energy is one of the most important resources to sustain our lives. At present we still depend a lot on fossil fuels and other kinds of non-renewable energy. The extensive use of renewable energy including solar energy needs more time for technology development.

In this situation Energy Conservation (EC) is the critical needs in any countries in the world.

Of special importance of Energy Conservation are the following two aspects:

- Economic factors
- Environmental impacts

4.1.1 Economic factors of Energy Conservation

Energy saving is important and effective at all levels of human organizations – in the whole world, as a nation, as companies or individuals. Energy Conservation reduces the energy costs and improves the profitability.

Notably, the wave of energy conservation had struck the Indian intelligentsia three years earlier when a Fuel Policy Committee was set up by the Government of India in 1970, which finally bore fruits three decades hence in the form of enactment of the much awaited Energy Conservation Act, 2001 by the Government of India. This Act made provisions for setting up of the Bureau of Energy Efficiency, a body corporate incorporated under the Act, for supervising and monitoring the efforts on energy conservation in India.

Brief History of energy efficiency movement in India and associated major milestones are as follows

- 1974: setting up of fuel efficiency team by IOC, NPC and DGTD (focus still on industry)
- 1975: setting up of PCAG (NPC main support provider) : focus expanded to include agriculture, domestic and transport
- 1978: Energy Policy Report of GOI: for the first time, EE as an integral part of national energy policy – provided detailed investigation into options for promoting EE
- Post 1980, several organizations started working in EC area on specific programs (conduct of audits, training, promotion, awareness creation, demonstration projects, films, booklets, awareness campaigns, consultant/product directories)
- Some line Ministries and organizations like BICP, BIS, NPC, PCRA, REC, Ministry of Agriculture, TERI, IGIDR, CSIR, PETS (NPTI)
- State energy development agencies
- Industry associations
- All India financial institutions

The Government of India set up Bureau of Energy Efficiency (BEE) on 1st March 2002 under the provisions of the Energy Conservation Act, 2001. The mission of the Bureau of Energy Efficiency is to assist in developing policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy. This will be achieved with active participation of all stakeholders, resulting in accelerated and sustained adoption of energy efficiency in all sectors

Private companies are also sensitive to energy costs, which directly affects their profitability and even their viability in many cases. Especially factories in the industrial sectors are of much concern, because reduced costs by Energy Conservation mean the more competitive product prices in the world markets and that is good for the national trade balance, too.

4.1.2 Environmental impacts of Energy Conservation

Energy Conservation is closely related also to the environmental issues. The problem of global warming or climate change is caused by emission of carbon dioxide and other Green House Gases (GHG). Energy Conservation, especially saving use of fossil fuels, shall be the first among the various countermeasures of the problem, with due considerations of the aforementioned economic factors.

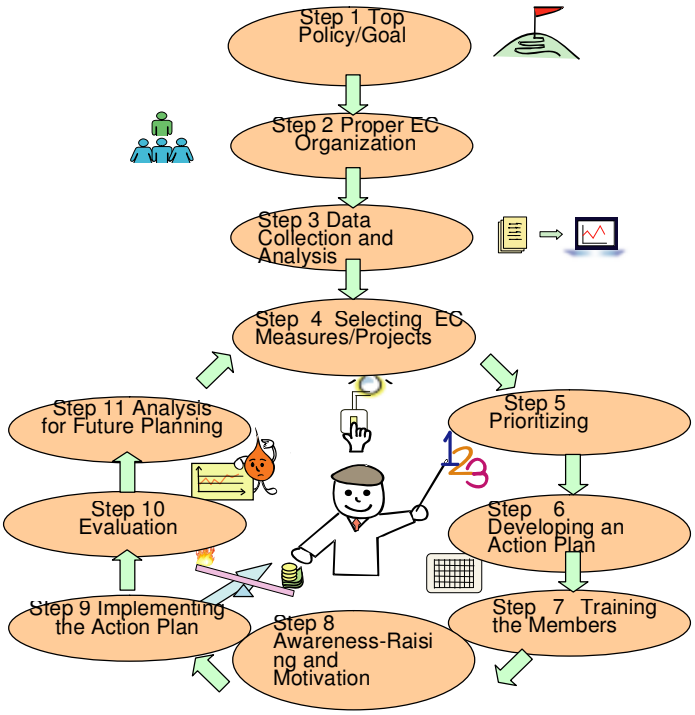
4.2 Total Energy Management (TEM)

Every point in factories has potential for Energy Conservation. Total Energy Management is implemented, by all the people's participation, step by step utilizing "Key Step Approach" in a systematic manner, as shown below:

- Top management policy/Goal
  - Develop a policy statement
  - Set targets
- Proper EC Organization including Assignment of Energy Manager
  - Establish proper EC organization (utilizing SGA)
  - Assignment of Energy Manager
- Data collection and Analysis
  - Collect data on current energy use
  - Analyze the collected data
  - Identify management strength and weakness
  - Analyze stakeholders' needs
  - Anticipate barriers
  - Estimate the future trend
  - Selecting EC Measures/Projects
  - Selecting EC Measures
  - Selecting EC Projects
- Make out a plan/program
- Prioritizing
- Developing an Action Plan
- Training the related members
- Awareness-raising and Motivation
- Implementing the Action Plan (including monitoring and controlling)
- Evaluation (Management review)
- Analysis for future planning (Standardization and Dissemination)

The following figure shows these Key Steps for implementing Energy Conservation activities.

Steps of the Key Step Approach.



Each step is explained in this order as below:

4.2.1 Step 1: Top Management policy/ Goal

It is the most important for the success of Energy Conservation activities within companies or factories to have clear and official commitment of top management – either the corporate top (senior) management or factory managers. The top (senior) management shall announce explicit commitment to the Energy Management (or Energy Conservation) and behave along this line – for example, participate in EC (Energy Conservation) events and encourage the people there for EC promotion.

This Handbook is primarily meant for Energy Managers for the use of EC promotion within factories, on the assumption that top management has already committed to that. However, there may be cases where top management would learn about Energy Management (or Energy Conservation) by this Handbook, or Energy Managers would make efforts to persuade top management to support or commit to Energy Management (or Energy Conservation) with the help of this Handbook.

- Develop a policy statement - It is desired that the top (senior) management announces the "Energy Policy Statement". This is very effective to let people inside and outside the company clearly know the management's commitment to Energy Management (or Energy Conservation). The format of the energy policy statement is various, but it usually includes the goal or objective of the company and the more concrete targets in the field of Energy Management (or Energy Conservation). It often shows the major measures and timetables. The statement shall match the company's mission statement or overall management strategy plan.
- Set targets - The targets shall be concrete and specific so that everyone can understand it.

4.2.2 Step 2: Proper EC Organization including Assignment of Energy Manager

In some countries, where the EC Promotion Act is in force, the designated factories have obligation of assigning Energy Managers. In relation to Energy Management, however, the word "Energy Managers" is here used as a Manager or a Coordinator, separate from the above-said legal obligation, who works exclusively for Energy Management (or Energy Conservation) purposes, ranging from gathering energy-related information to drafting EC plans/programs and promoting or coordinating during implementation. To the proper Energy Management, this type of Energy Manager is indispensable. How to position this Energy Manager within the company organization is also an important issue and needs careful decision. In some cases, Energy Committee, with members from the major departments, may be formed to recognize the company-wide or factory-wide cooperation, as shown in the following figure.

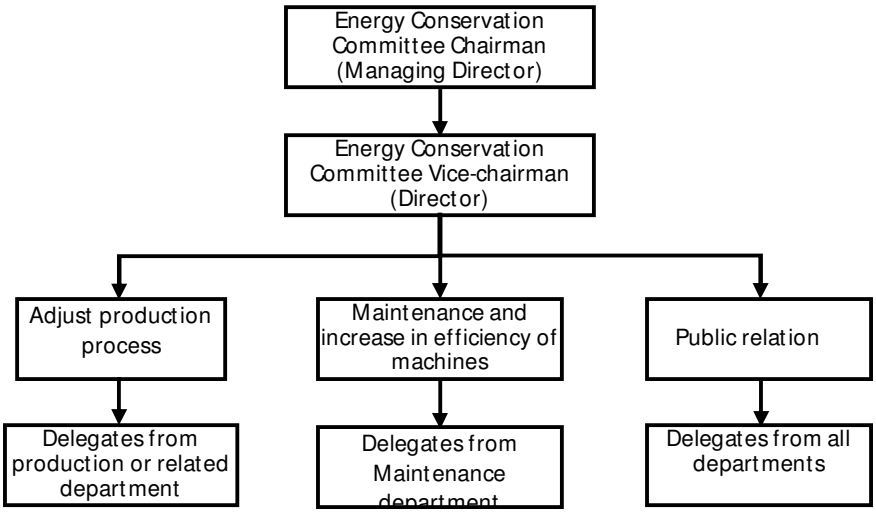


Figure 36: Example of energy conservation committee's organization

Actually there are many ways of forming EC organization, depending on the situation of factories or institutions, such as the size, kind of business, etc. In any case, it is very effective to utilize SGA (Small Group Activities) and there are also many ways to do that. The important thing is to design and make out the organization carefully to meet the purpose. In practical sense to do that, there may be the following five widely applicable ways of establishing the organization.

- Utilize Line (Formal) Job-related Organization for TEM purpose
- Use TPM Organization for TEM purpose
- Use TQM Organization for TEM purpose
- Add Employee Suggestion System to Energy Conservation Organization for TEM purpose
- Utilize another organization for TEM purpose
- The easy and practical way may be starting from easy form of TQM, or QCC (Quality Control Circle) activities

Furthermore, because TPM is closely related to job-related organization, (1) and (2) may be often give the same kind of results. (An example of this form is shown in Part 3, 2 "How is SGA related to Energy Conservation?".

4.2.3 Step 3: Data collection and Analysis

Before trying to make out any future programs or action plans, it is essential for the company or factory management to understand the current situation in a proper and accurate manner. This includes not only the status of their own operation but also other relevant information such as competitors' operation, circumstances around the company and their trend in future, positioning the company itself in the local and global markets, and so on.

The key steps for this purpose are shown below:

- Collect data on current energy use and analyze them - The current data of energy consumption shall be obtained by measurement, calculation or estimation for the individual operation units (energy cost centers) with classification of kinds of energy (fuels types, utility types, etc.). The data shall be gathered regularly and arranged/summarized daily, weekly, monthly, by seasons or annually. Then the data shall be checked for the past historical trend and interpreted with relation to operational modes and production scales. That shall also be utilized for the forecast of future trends.
- Identify Management Strength and Weakness - Then the data shall be compared with the appropriate practice data or benchmarks in the industry. If such reference data are hardly available, the historical data of their own operation and estimated data for the competitors would be utilized for this purpose. At the same time, the strength and the weakness of the company shall be evaluated considering the competitors' situations in the local and global markets. This would serve the purpose of making out a realistic Energy Management plan later.
- Analyze stakeholders' needs - Stakeholders are top (and senior) management, middle managers, staff/engineers and workers/operators. Other stakeholders in the normal business sense, such as the shareholders and lenders, need not be considered here for the moment. The needs and intention of those stakeholders shall be summarized and taken into consideration.
- Anticipate barriers to implement - Making out a realistic and practical program also needs consideration of anticipated barriers for the implementation of Energy Management program or action plan. Some possible examples of such barriers are:
    - Insufficient understanding and support by top management
    - Insufficient understanding and cooperation of managers within factories
    - Insufficient awareness of people to get successful results
    - Insufficient capability of people due to lack of training
    - Insufficient available technology due to lack of information
    - Insufficient availability of manpower for EC activities within factories
    - Insufficient budget for EC activities due to the company's financial status
- Estimate the future trend
- The future trend of energy supply-demand balance is estimated based on checking and analysis of the historical data. That data of future trend would also be a basis of the program of excellent Energy Management.

In analyzing the collected data and developing ideas of Energy Conservation, it is very often useful to think of the following techniques of finding problems and appropriate alternatives to the problems

- Suppress - Using during the time in which it is not necessary to use. Examples include using electricity before or after working hours or when there is no one working
- Stop - Using equipment when it is not necessary. Examples include using all lightings during break time.
- Reduce - Amount, pressure, temperature, speed, or brightness, or quality that exceed requirement. Examples include reducing intensity of lighting if not necessary.

- Prevent - Prevent leakage or loss of energy. Examples include reducing space that leads to outside in order to prevent the leakage of heat into air.
- Improve - Improve or repair machines to increase efficiency or modify manufacturing process to the one which enables us to conserve energy more. Examples include changing transparent sheet over the roof.
- Store - Re-use the discarded energy. Examples include re-using heat from exhaust fume in order to reduce use of electric heater to warm heavy oil.
- Change - Change how to use, type of energy, or energy sources to a suitable one from technical or economic point of view. Examples include changing the grade of heavy oil to an appropriate one or changing furnace systems or welding machines to the ones that use gas.
- Increase production - Examples include improving production process. This will lead to the reduction of energy usage per production amount.

4.2.4 Step 4: Selecting EC Measures/ Projects

Based on the aforesaid understanding of the current status and position of the company (factory), various EC measures are studied and many EC Projects are proposed. Comparison among these measures and projects are made with consideration of a lot of factors, such as technical, economic, intangible, and so on.

Then a plan/program is developed based on these study results. To do this, it is very important to consider the following issues:

The plan/program shall be realistic, practical and attainable with due consideration of many related elements and management resources of the company or factory. It also shall be expressed in terms of the measurable or quantifiable parameters, including Fuel Usage Index, Electricity Usage Index, Energy Usage Index, etc. It usually includes a lot of managerial measures of Energy Management (or Energy Conservation) promotion activities such as motivation techniques, means to improve awareness, training, and so on. In other words, the following items are often useful in comparing and selecting alternative plans:

- Effects of energy conservation: Activities that can conserve energy more than others are more promising.
- Investment amount: Activities that require less investment are more promising.
- Pay-back period: Activities with short pay-back period for investment amount in equipment are more promising because all energy conservation will be profits after pay-back period.
- Length of implementation: Activities that can be performed in a short period are more promising because they do not influence production process of the factory.
- Number of personnel required: Activities that require a large number of personnel tend to be burdensome.
- Importance to executives and reputation of the company: Some activities provide little financial benefit but cause good image or reputation.
- Risk of the project: Some activities bring about big financial benefits but involve high risk from various factors. In this case projects have less importance.

4.2.5 Step 5: Prioritizing

Many EC measures and projects are prioritized based on the internal studies including comparison among their alternatives, in the manner explained in the above.

4.2.6 Step 6: Developing an Action Plan

The priority consideration then gives birth to the Action Plan. The plan shall be clear, practical and detailed with proper schedule and budgeting. Shown below is an example of such a plan.

Table 24: Example of energy saving plan

Detail of the plan	Length (Months)						Person in charge	Budget	Inspected by
	1	2	3	4	5	6			
1. Turn off electricity when there is no one around	←					→	Mr.Prayat		
2. Turn off air-conditioner 30 minutes before stop working	←					→	Miss Aom		
3. Reduce welding machine's current according to the specification of the metal used for welding	←					→	Mr. Matthayas		
4. Close welding machine after working	←					→	Miss. Thanom		

4.2.7 Step 7: Training the related members

This issue is very important to secure the success of project Implementation, because the people are the most important resources that determines the success of the plan.

4.2.8 Step 8: Awareness-raising and Motivation

To have the total power of "all members' participation" combined together, it is also very crucial how to raise awareness and motivation of related people within the company (or factory). Shown below is an example of awareness raising plan.

Table 25: Example of awareness raising campaign

Detail of the plan	Length (Months)						Person in charge	Budget	Inspected by
	1	2	3	4	5	6			
1. Display the results of energy conservation every month	*	*	*	*	*	*	Mr.Prayat	-	Mr. Laaied
2. Evaluate every month	*	*	*	*	*		Miss Aom	-	Mr. Laaied
3. Perform energy conservation activity every 6 months	*					*	Mr. Matthayas	-	Mr. Laaied
4. Perform "Finding measures" activity in order to make energy conservation plan	*					*	Miss Thanom	-	Mr. Laaied
5. Provide rewards to sections that have achieved high efficiency						*		-	

4.2.9 Step 9: Implementing the Action Plan (including monitoring and controlling)

The organizational force established in the said planning step shall be utilized fully to assist with the smooth implementation of the program. Energy Manager and/or the committee shall continue working to promote the activities and report to top management on the status quo.

The actual records of implementation shall be closely watched and monitored. If some problems arise, or some variance between the planned figures and the actual record is observed, then necessary actions shall be taken immediately.

4.2.10 Step 10: Evaluation (Management Review)

After the program is completed, the report shall be submitted to the top (senior) management. The results shall be assessed and analyzed for any good and bad points. The lesson shall be utilized as a feedback in the subsequent plan/program. Thus the activities are repeated to form a cyclic movement. The result of evaluation must be announced on the board in order to inform employees, so that they will be given motivation for the next

activities. Evaluation can be divided into 2 types as follows.

- Short-term evaluation for the follow-up of the performance
- Long-term evaluation for the evaluation of the whole project that will be used for the future planning

Evaluation can be made in the following 3 levels.

- Self Audit: Self evaluation that is made in a small group or a department based on the predefined form. (Inspection may be made every month.)
- Upper Manager Audit: Evaluation that is made by the section/department manager intended to raise performance of the activity. (Inspection may be made every 3 month.)
- Top Management Audit: Evaluation made by the executives of the organization that will be used for the evaluation of annual bonus. (Inspection may be made every 6 month.)

In some cases, top management could think of adopting external people (outside consultants) to evaluate the results of Energy Conservation activities. Even in those cases, internal evaluation should be made to gain the fruits as much as possible.

4.2.11 Step 11: Analysis for future planning (Standardization and Dissemination)

The successful results and the lessons learned are to be analyzed and arranged into the standard form which can be easily utilized by anyone in the factory. The standardized documents or information are to be disseminated all over the company.

Moreover, Energy Conservation should be incorporated as a part of daily jobs and performed continuously in a systematic manner. For this purpose, activities for energy conservation must be incorporated as a part of company's basic or business plan. If a problem is found as a result of evaluation, improvement or modification will be done and the objectives will be achieved. If the results reach or exceed the objective, information must be gathered in order to set it as a "Work Standard," which will be used in setting a new activity plan.

4.3 Small Group Activities (SGA)

Small Group Activity (SGA) gives employees the problem solving tools they need to eliminate obstacles to Total Productivity, the cumination of zero break-downs, zero defects, and zero waste. Enterprising employees identify the problem, be it in "man, material, method, or machine," and develop cost-effective and practical methods for solving the problem.

4.3.1 Importance of SGA

SGA are activities by group of employees at operator (working Group) level. They aim to solve problems that occur at the place taken care of by each employee and put emphasis on participation and team work. Factories can apply small group activities to many kinds of work along with normal work or other measures that are already underway. The burden on employees will not increase because of small group activities. They are not only bringing benefits to factories but also boosting the knowledge and ability in performing jobs of employees, improving communication among employees, increasing creativity, and make it possible to express their own proposal with less hesitation to management. As a result, employees will start to think "This is our problem." This SGA can be applied to Energy Conservation, too, with successful results, as shown in Figure.

4.3.2 How SGA leads to Energy Conservation

An excellent example of organizational structure that promotes energy management emphasizing participation is that they form overlapping small groups as in figure 14. The feature of this structure is that a small group for energy management is distributed to various sections as in figure 15, which is a recipe for success of Total Energy Management

(TEM) and makes various communications and management of activities more efficient and effective.

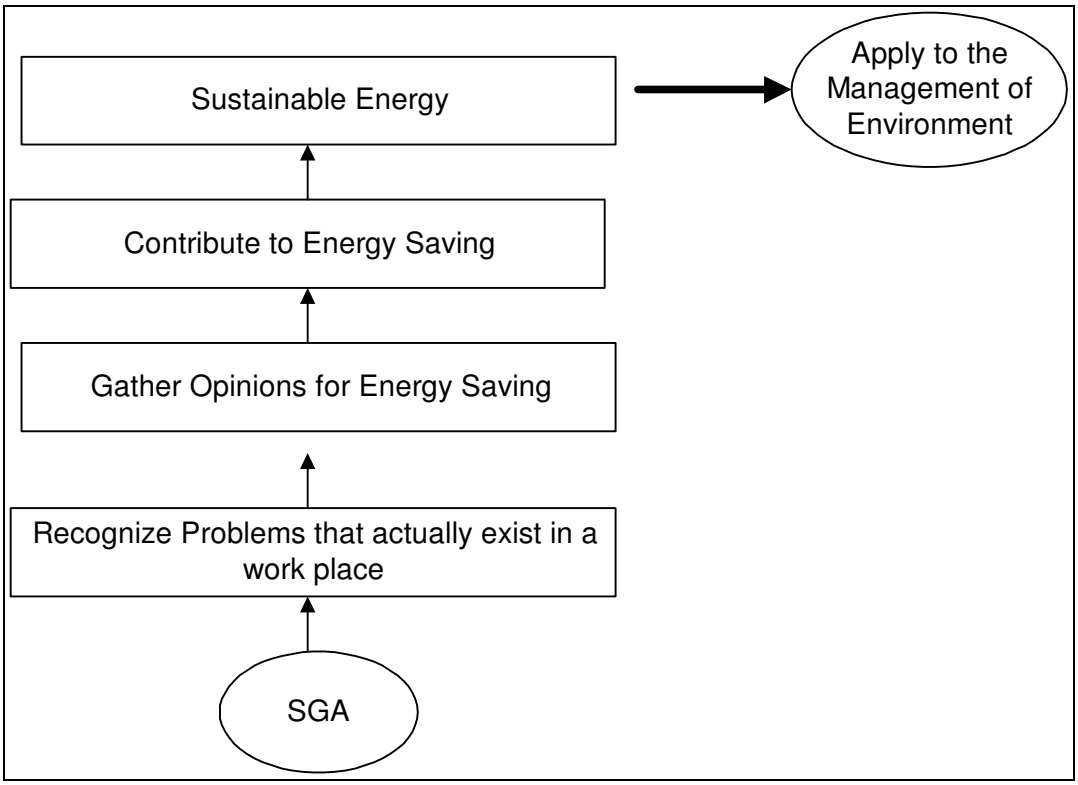


Figure 37: Relationship of SGA and energy saving

Small group activities for total energy management (TEM) are the activities in which employees of all levels in production or management, starting from the top to the bottom, participate in order to reduce loss related to their own job by improving their job. In order for the activities to succeed, management of all levels must provide support in necessary training and equipment, communication of policies, and the setting of problems to solve.
Small group activities for TEM can be divided into 4 or 5 levels depending on the scale of the organization. This division is in order to emphasize the fact that everyone must improve in their job under the responsibility to each other. It also enables us to make improvement without overlapping. The following example shows utilizing the existing job-related organization as much as possible, as already mentioned in Part 2, 2."Strategy for Improving the Efficiency of Energy Usage further", Step 2 Proper EC Organization including Assignment of Energy Manager".

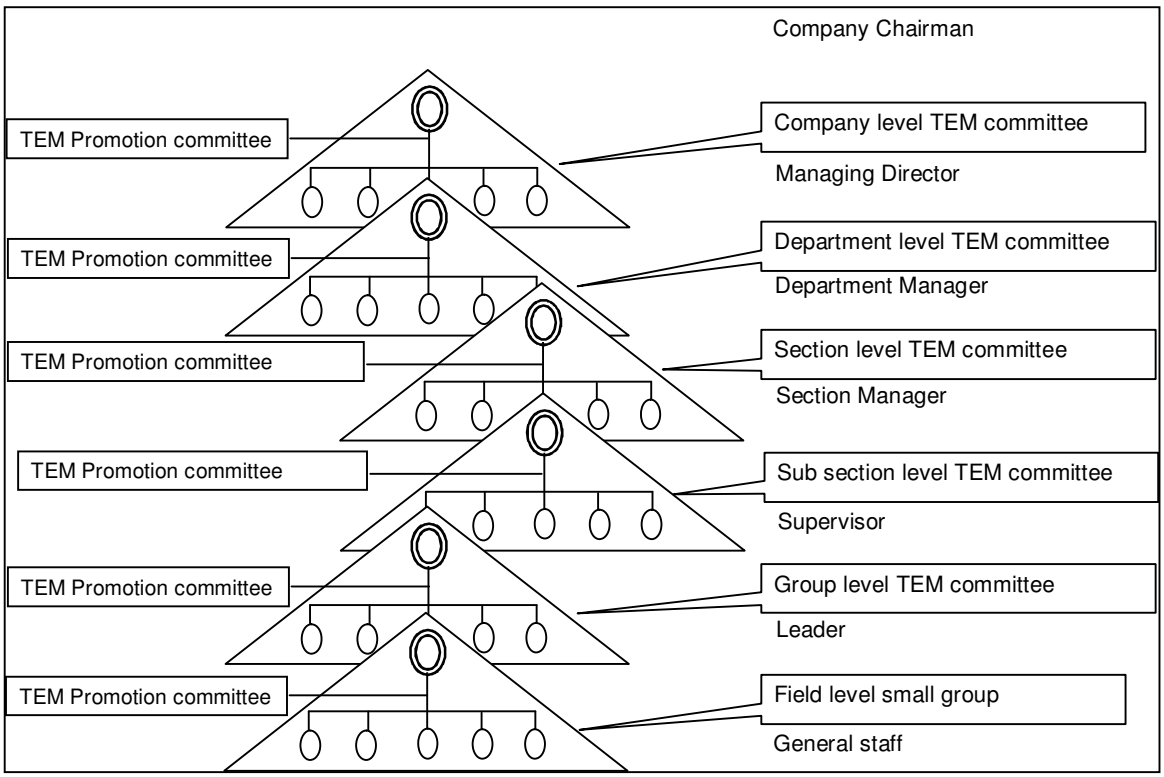


Figure 38: Example of Organizational Structure with Overlapping

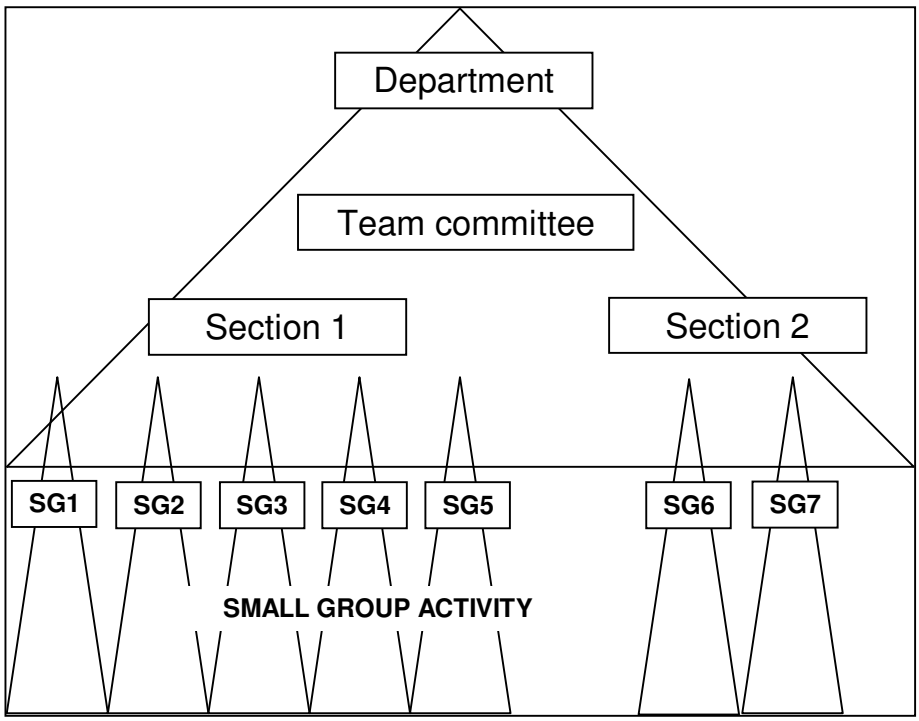


Figure 39: Positioning of SGA in Main Job Structure

4.3.2.1 Executives level

- Define the policy and target for Total Energy Management
- Follow-up and manage activities to make sure that activities are implemented according to the policy
- Consider opinions and suggestions from the promotion office

- Consider reports from promotion committee from various levels

4.3.2.2 Level of Total Energy Management promotion office

- Make sure that whole activities are done in the correct direction, without delay and smoothly
- Find a suitable method that makes it possible to implement activities continuously and without slowdown
- Listen to opinions and suggestions from small groups in order to use for improving
- Provide advice for Total Energy Management to various groups
- Persons in charge of the office must be those with good personal relationship, friendly, and with spirit of good service

4.3.2.3 Medium level

- Define the policies of each department that are consistent with the policy of the Total Energy Management and the target of the company
- Define numerical targets to sub-groups apart from the target of the company as a whole
- Follow-up the progress in order to provide to sub-groups
- Report the progress along with suggestions and opinions to upper level committee periodically

4.3.2.4 Workers/Operators level

- Implement small group activities with various themes and achieve target
- Report progress and problems encountered during implementation to upper level committee periodically
- Ask for support, suggestions, and opinions from upper level committee

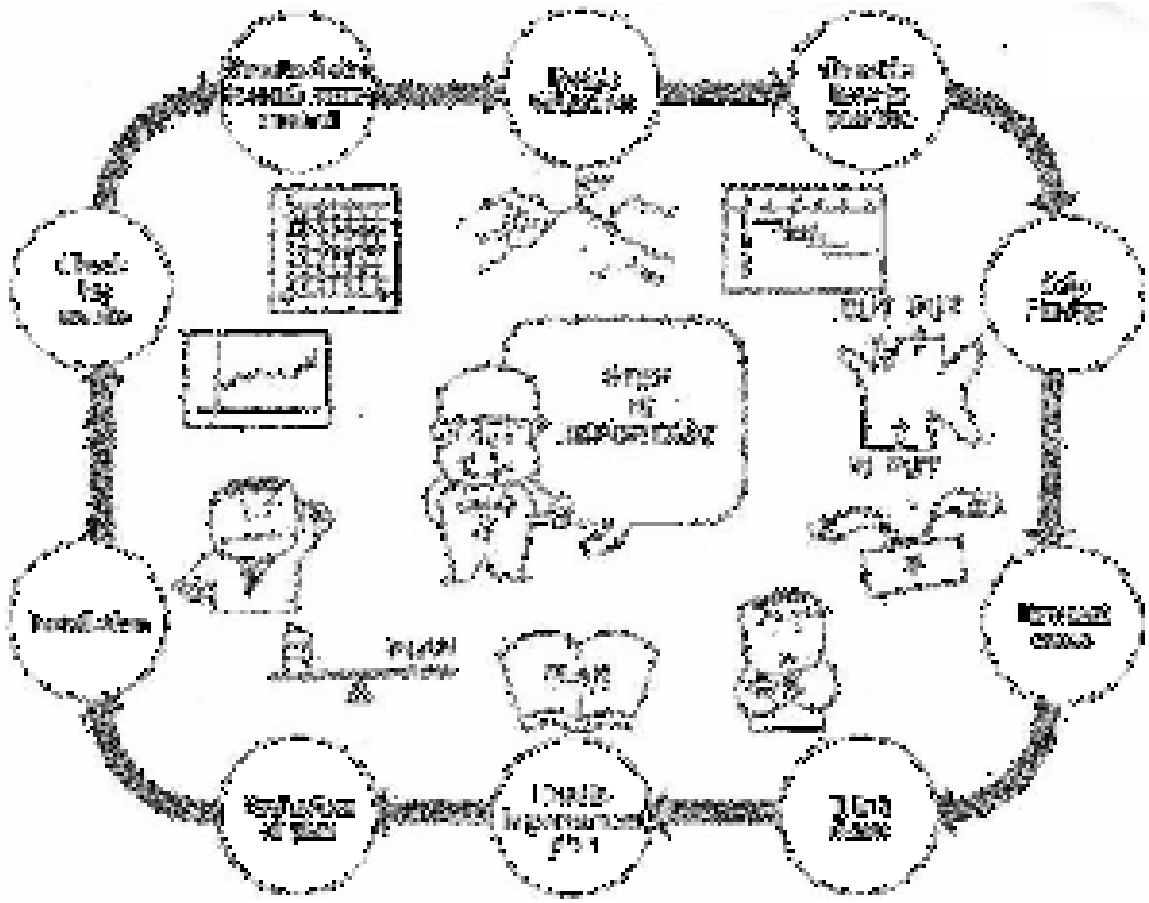
4.3.2.5 Responsibility of Energy Conservation committee

- Gather and analyze information on costs related to energy every month
- Analyze and solve problems related to energy
- Find a method for energy conservation
- Prepare energy conservation plan
- Follow-up the result of implementing the plan
- Perform activities such as public relationship for encouraging employees to participate
- Offer training to small group in each department

4.4 Steps Of Small Group Activities For Energy Conservation

Small group activities for Energy Conservation can be done by using "10 Stages for Success", based on "PDCA Management Cycle", as shown below and in pictorial forms.

- Plan: Make an efficient plan in order to improve operation
- Do: Implement according to the plan



- Check: Check if implementation was according to the plan
- Act: Judge what to improve, what to learn and what to do from what we have checked

Please note that these stages are substantially the same as "Key Steps" explained earlier, but put more stress on utilization of SGA. So readers could read and use either method up to their preference.

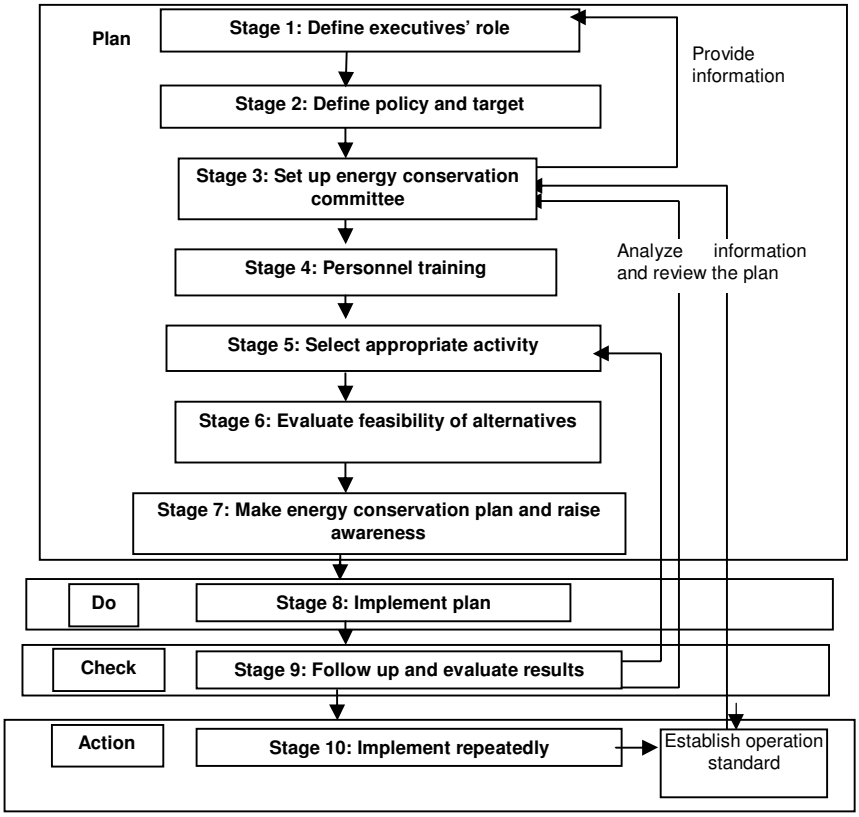


Figure 40: 10 Stages for Success

4.4.1 Stage 1: Define Executive's Role

In promoting small group activities, support must be provided such as basic environmental support. Therefore, executives must provide follow up support to employees of their companies.

- Establish a special unit that provides support to small group activities
- Prepare a system for managing small group activities in the company
- Prepare annual plan for small group activities
- Prepare a venue for meeting, consultation, advice or suggestion
- Establish a system for giving rewards to high achieving employees
- Establish a reporting system starting from informing what to do until reporting of the results
- Establish a fair system for evaluating results
- Establish a system for providing support and training to employees

4.4.2 Stage 2: Define Policy and Target

- Executives must announce a policy of supporting small group activities.
- Energy conservation committee must act as an advisor in order to set a numerical target that is consistent with total energy management (TEM) policy and the target of the organization. Specific targets must be set for each group.

We can see that responsibilities in stages 1 and 2 are mainly those of executives and committee. Responsibility of employees will become clearer from stage 3 and afterwards.

4.4.3 Stage 3: Set up Energy Conservation Committee

The principle of small group activities (SGA) is to divide into groups based on the scope of responsibility. The size of the group will depend on the size of organization. However, size of the group should not be too large. Usually a size of 5 to 10 persons is considered appropriate. It is important to define responsibilities clearly so that every member of the group can have their responsibility and participate in the activities.

4.4.4 Stage 4: Personnel Training

This stage will help employees to have more knowledge and understanding, have new ideas, and have more belief in their own responsibility.

4.4.5 Stage 5: Select Appropriate Activity

In doing small group activities, each member must be able to think, express their own ideas, and make decisions based on reality and by investigating electrical equipment, machines, and office equipment that exist in the area of their responsibility. Items to consider include size, number, where to use, situation of usage, current situation, and the number of hours usage per day.

By this we can evaluate the current situation of energy usage. Also by judging if there are more machines than needed, we can choose suitable activities and real problems for the organization.

4.4.6 Stage 6: Evaluate feasibility of alternatives (Analyze problems and decide on the measures and activities in each point)

Each group will gather ideas on the reasons for the problems, obstacles, and how to solve problems in order to decide on the problems, measures, and importance of activities and thus evaluate on the feasibility of activities to do based on advice from department manager. Basically, the following activities are not suitable for small group activities.

- Highly technical issues
- Issues that require a long time or many people to implement

We have identified the following problems through small group activities.

- Issues on material quality or production that influence energy usage
- Behavior on energy usage
- Efficiency of machines or equipment that uses energy
- Awareness toward environment and energy usage
- Safety costs for energy conservation

4.4.7 Stage 7: Make Energy Conservation Plan and Raise Awareness

Each group must prepare its activity plan. Generally, implementation for small group activities takes 6 months to 1 year. Activities to be implemented should correspond to the objectives of each group. Besides, it might help to listen to opinions of all organizations in order to receive support from all other organizations.

4.4.8 Stage 8: Implement Plan

Implement according to the plan of each group.

4.4.9 Stage 9: Follow Up and Evaluate Results

After implementing the plan, each member of small groups will follow up and evaluate the result by analyzing result, search for strong and weak points of activities, find a way to improve the activities and report on general achievement.

4.4.10 Stage 10: Implement Repeatedly

Energy conservation is an activity that must be implemented repeatedly. Therefore, it is necessary to implement each activity repeated and make improvement to each activity. If we are satisfied with the results, by achieving the objectives of activities, we should provide rewards in order to give motivation for continuing the small group activities and implement creative activities.

Dos and Don'ts in Energy Conservation

- Don't Emphasize the mistakes in the past. It is better to talk about the present.

- Don't Be worried about the theory or principles. Don't spend too much time in discussion or analysis of problems in meeting rooms.
- Don't Think that an activity can be done perfectly from the beginning. It is necessary to do the job continuously by having experiences and judging by ourselves.
- Do Start with an activity that requires small amount of investment.
- Do Raise awareness so that all employees understand the necessity and importance of energy conservation and participate in it.
- Do Start the activity now without postponing to tomorrow.
- Tools that are Used Often for Small Group Activities for Energy Conservation

4.5 5S

5S is a contraction derived from the Japanese words Seiri, Seito, Seiso, Seiketsu, and Shitsuke. It is simple methodology that is also extremely useful in practical and realistic life. 5S is a set of actions to be followed through every day activities to advance the operational surroundings and circumstances. 5S is made in order to provide fortification to every personage in diverse profitable and industrialized fields. 5S is an extremely practical contrivance and skill set for anyone who wants to generate a more prolific environment within the workplace or who wants to make it their profession to make other people's businesses more proficient and productive. 5S occupy a list of products including eyewear, ear protectors and safety gears. Look into these different products that make up the significance of an industrialized security supply. Lean Six Sigma professional promise or support for the efficiency of 5S as an enlightening enhancement to better working surroundings in an association. If you dig up Six Sigma guidance that is paid for by your company, you will be in a position to work for your company and make things better for you as well as for everyone. 5S is very useful in lots of industries and job markets, but can often fail simply because of the lack of recognition concerning changes in the office.

5S consists of five steps that are crucial for the completion of 5S. The 5S steps are described as follows-

- Seiri / Sort- This is very logical term in, which identification of the contents take place, data base of the products have been created and, then any kind of sorting take place just to arrange the products and removal of unwanted items. Classification of the products is necessary, which is called Red Tagging. It is important just to identify factors, right from whether it is needed, existing amount obligatory amount, occurrence of necessity, and so on.
- Seito / Systemize- This step in 5S process consists of removal of unwanted items permanently and one more task that to be take place is decision that means you have to decide that what is required to be in what place. Place the items in such manner that you could retrieve them within 30 seconds of requirement.
- Seiso / Brush away/ Sweep- Examine al the items on the daily basis. The process is not that much time consuming, but essential to clean up your workplace and most required in 5S. The conscientiousness to keep the office clean should be circulated between everyone in the group.
- Seiketsu / Homogenize- This important step of 5S involves the visual control, which is important to keep your organization well- organized and clean. It is a complete evaluation to improve the working conditions.
- Shitsuke / Self Control- This step is quite essential, but critical because it involves all the discipline to support the 5S standards, it also takes charge of dedication and commitment.

4.6 Quality Control Circle (QCC)

QCC (Quality control circle) means controlling quality through group activities. For this, it is necessary to work hand in hand and achieve objective quality or customers' request. With this, we can find weak points, find the cause of problems, gather ideas for problem solving and systematically prepare quality and thus, solve problems such as material loss, production costs, working hours, or productivity. This is also a very useful tool to tackle with Energy Conservation problem. So many factories or institutions are encouraged to utilize this tool.

5. Conclusion

5.1 Summary

Based on the energy use and technology gap analysis in 30 units in the Kochi seafood cluster, several leading practices, energy conservations opportunities, and technology up gradation opportunities have been proposed.

Details of these proposals are furnished in table below:

Table 26: Identified housekeeping opportunity

Sl. No.	Housekeeping opportunity	Key issues
1	Proper maintenance of condenser coils	Lack of awareness of the impact
2	Segregation of commodities as low and very low temperature applications	Lack of awareness of the impact
3	Avoid frequent opening and closing of freezer doors	Lack of awareness of the impact
4	Avoid leaving the cold storage doors open for longer periods	Lack of awareness of the impact
5	Switch off lights when not required	Lack of awareness of the impact

Table 27: Identified energy saving proposals

Sl. No.	Energy Saving Proposal	Service Provider
1	Replacement of existing V-belt drive with synthetic energy efficient flat belt drive in the compressor motor	Anjanaa Belting, Chennai
2	Proper insulation of identified insulation damaged areas	Lloyd Insulation – material supplier India Insulations - contractor
3	Replacement of existing thermocole insulated doors with puff insulated doors	Lloyd Insulation – material supplier India Insulations - contractor
4	Installation of Servo stabilizers for lighting feeders	Sagar Electric Power Services, Beblec India
5	Installation of automatic star delta star starter for lightly and partly loaded motors	Project & Supply Vijay Energy Products Pvt. Ltd Sagar Electric Power Services
6	Revamping of existing refrigerant circuit with ethylene glycol as secondary refrigerant	
7	Surrender of contract demand and reduction of kVA charges payable to electricity board	N/A
8	Installation of thermal storage system to benefit from tariff mechanism for ice making process	Cristopia Energy Systems (I) Pvt. Ltd
9	PF improvement by adding capacitors	Momaya Capacitors Sagar Electric Power Services
10	Switching to T5 tubes from 40 W tubes	Philips India Limited

Table 28: Identified technology upgradation proposals

Sl. No.	Technology Upgradation Proposal	Equipment/technology Provider
1	Replacement of reciprocating compressors with screw compressors with VFD	Johnson Controls
2	Installation of Variable Frequency Drives (VFD) for centrifugal pumps	Danfoss, Siemens, Schneider, ABB
3	Replacement of Shell & Tube condensor or plate heat exchangers and cooling towers with Evaporative condensers	Evapco – China Baltimore Aircoil Condensor
4	Replacing vapour compression refrigeration with vapor absorption machine (VAM) (LNG or Biomass Fuelled)	Thermax

Table 29: Identified technology for DPR preparation

Sl. No.	Item/ Description
1	Installation of Ammonia based Vapour Absorption Machine (VAM) Chillers – Biomass based energy
2	Replacement of Shell & Tube heat exchangers or plate heat exchangers and cooling towers with Evaporative condensers
3	Installation of Star – Delta – Star Starter for units where motors are partly and lightly loaded.
4	Installation of Variable Frequency Drives (VFD) for centrifugal pumps
5	Installation of Ammonia based Vapour Absorption Machine (VAM) Chillers – LNG Fuelled

Annexure 1 : Electrical Tariff

1.0 Low Tension -IV (LT-IV)

Tariff Schedule - LT-IV-Industry Applicable to

General purpose industrial loads (single or 3 phase) viz. Grinding Mills, Flour Mills, Oil Mills, Rice Mills, Saw Mills, Ice Factories with or without cold storage, rubber smoke houses, prawn peeling units, floriculture activities, tyre vulcanising/retreading units, workshops using power mainly for production and/or repair, pumping water for Non-Agricultural purpose, Public Water Works, Sewage Pumping, Power laundaries, Hatcheries, Screen Printing of glassware or ceramic, Printing Press, Milk Chilling/Plant, Freezing Plant, Cold Storage, Bakeries (where manufacturing process and sales are carried out in the same premises), Stone Crushing units, Diamond cutting, Book Binding and allied activities, Garment making, Electric crematorium, Pyrolators installed by local bodies, Mushroom farms, Shrimp farms, SSI Units engaged in computerized colour photo printing, computer consultancy services with SSI registration engaged in Software services and data processing activities and Desk Top Printing, Audio/Video Cassette recording/Duplication, CD recording/duplication, Software development for recording/duplication purpose, manufacture of audio/video cassette, Software Technology/Information Technology, Diary farms, Agricultural Nurseries (without sale) and marble cutting.

Tariff Schedule - LT-IV-Industry

LT-IV-Industry	**Fixed Charge**	**Rs/kW/month**	**45**
	Energy Charge	**Ps/unit**	**325**

2.0 High Tension – IV (HT- IV)

Tariff Schedule - HT-IV (Commercial) Applicable to

Tariff applicable to airports, hotels/restaurants, lodges, hostels, guest/rest houses, travelers bungalows, commercial cold storage, freezing units, commercial establishments, business houses, film studios, cinema theatres, self financing educational institutions, hospitals other than government owned, private nursing homes, Seafood Processing Units, milk chilling plants, private scanning units, private X-ray units, private clinical laboratories, offices/ telephone exchanges of telecom companies, radio stations, television broadcasting companies, television channels, construction works.

Tariff Schedule - HT-IV-Commercial

HT-IV-Commercial	**Demand Charge**	**Rs/kVA/month**	**350**
	Energy Charge	**Ps/unit**	**370**

3.0 Power Factor Incentive and Penalty

The following incentive and penalty shall be applicable to HT consumers for power factor improvement

Power factor range	**Incentive**
Power factor between 0.9 to 1.00	0.15%of energy charges for each 0.01 unit increase in power factor from 0.9

Power factor range	**Penalty**
Power factor below 0.9	1%energy charge for every 0.01 fall in power factor from 0.90

Annexure – 2: Financial schemes available with local banks for improving energy efficiency in cluster

1.0 Credit linked capital Subsidy scheme (CLCSS)

Under this scheme, the ministry of MSME is providing subsidy to upgrade technology (Machinery/plant equipments). Subsidy limit per unit is Rs. 15 lakh or 15%of investment in eligible machinery/Plant equipments whichever is lower. For more details of the scheme visit:

www.laghu-udyog.com/scheme/sccredit.htm

2.0 SIDBI Financing Scheme for Energy Saving Projects in MSME sector under JICA Line of Credit

The Japan International Corporation Agency (JICA) has extended a line of credit to SIDBI for financing Energy Saving projects in Micro, Small and Medium Enterprises (MSMEs). This project is expected to encourage MSME units to undertake energy saving investment in plant and machinery to reduce energy consumption, enhance energy efficiency, reduce CO2 emissions, and improve the profitability of units in the long run.

Eligible Sub Projects/ Energy Saving Equipment List under JICA line of Credit:

- Acquisition (including lease and rental) of energy saving equipments, including newly installing, remodeling and upgrading of those existing
- Replacement of obsolete equipments and/or introduction of additional equipment which would improve performance
- Equipments/ Machinery that meets energy performance standards/Acts
- Introduction of equipments that utilize alternative energy sources such as natural gas, renewable energy etc., instead of fossil fuels such as Oil and Coal etc.
- Clean Development Mechanism (CDM) projects at cluster level that involves change in process and technologies as a whole, duly supported by technical consultancy will be eligible for coverage.

Financial parameters:

The financial parameters for appraising the project are:

Parameter	Norms
Minimum Assistance	Rs. 10 lakh
Minimum promoters contribution	25%for existing units; 33%for new units
Interest rate	The project expenditure eligible for coverage under the line will carry a rate of interest rate of 9.5-10%p.a
Upfront fee	Non-refundable upfront fee of 1%of sanctioned loan plus applicable service tax
Repayment period	Need based. Normally the repayment period does not extend beyond 7 years. However, a longer repayment period of more than 7 years can be considered under the line if necessary

Eligibility criteria for units (Direct assistance):

- Existing units should have satisfactory track record of past performance and sound financial position.
- Projects will be screened as per Energy Saving List, which is available in SIDBI website.
- Units should have minimum investment grade rating of SIDBI.

- Projects which may result environmental impacts and negative social impacts are also not eligible under this scheme.

For further details eligible energy saving equipments/machinery, projects can be financed under this scheme and details of scheme, please contact the nearest SIDBI branch office or refer to SIDBI website (www.sidbi.in)

3.0 Scheme for Financing Energy Efficiency Projects: Bank of Baroda

Purpose

- Financing SMEs for acquisition of equipments, services and adopting measures for enhancement of energy efficiency/conservation of energy.

Eligibility

- SME units financed by bank as also other units desirous of shifting their account to Bank of Baroda.

Limit

- Upto 75%of the total project cost, subject to maximum of Rs. 1/- crore. (Minimum amount of loan Rs. 5/- Lakhs).

Project cost may include the following:

- Cost of acquisition/modification/renovation of equipment/software.
  - Cost of alterations to existing machinery.
  - Cost of structural / layout changes.
  - Cost of energy audit/consultancy.
  - Preparation of Detailed Project Report (DPR).

Rate Of Interest

- Bank's BPLR from time to time.

Repayment

- Maximum 5 years, including moratorium, if any.

Security

- For Sole Banking Accounts:
  Extension of first charge on all fixed assets.
- For Consortium/Multiple Banking Accounts:
  first charge on equipments acquired out of loan and collateral, if any, with the total security coverage being not less than 1.25.

Grant from IREDA:

- IRDEA, at present, gives a grant of Rs. 25,000/- for projects costing Rs. 1/- crore or below to meet partial cost of Energy Audit. This grant is available for the first 100 projects (SME Sectors only) approved by them.
-

4.0 POLICY FOR ENERGY SAVING PROJECTS: PFC

Purpose

- To extend finance to energy efficiency projects executed by Energy Service Companies (ESCOs) or by the entities taking energy efficiency measures themselves.

Eligibility

- Energy saving projects for govt. /PSUs owned buildings, townships, street lights owned by municipal corporations and other govt. agencies and industrial energy saving projects of PSUs.
- Energy saving projects for privately owned buildings, townships including street lights and other industrial energy saving projects.
- ESCO being the applicant should have successfully executed at least one project.

Type of Financing

- Term loan
- Re-financing / replacing existing high cost term loan.

Appraisal

- The detailed project report (DPR) shall be prepared and submitted by the applicant. The appraisal will focus on entity and project including promoters' technical and financial capabilities, their strengths & weaknesses, assessment of energy audit findings, load survey, assessment of baseline calculations, energy efficiency measures proposed, past experience with such measures, method/structure of execution of energy management system, measurement and verification protocol for establishing savings, payment mechanism, financial modeling, payback period, debt servicing, securities, etc. The corporation's appraisal will also focus on structuring of Energy Management Service agreement/contract and Payment Security Mechanism.

Extent of assistance

- State/Central Sector borrowers: Up to 90%of the total cost (irrespective of project cost)
- Private Sector borrowers: Where project cost less than Rs.25 crs. - Debt up to 70%of total project cost. Where project cost exceeds Rs.25 crs - Debt - 70%of Rs. 25 crore and 50%of the project cost exceeding Rs. 25 crore

Minimum loan amount

- Minimum loan amount of Rs.1.00crore shall be considered.

Upfront Equity

- The Promoter(s) will bring and invest 100%upfront equity in the Energy Saving Project.

Interest rate & other charges

- Special rates will be offered to energy saving projects being executed by private/ state/ central sector.

Financial Charges

- Financial charges such as upfront fee / commitment charges, processing fee, penal interest etc. shall be levied as per PFC policy.

Moratorium & repayment period

- The maximum repayment period of 5 years shall be allowed with the moratorium of 3 months from the date of commissioning of the project.

Security

- As per standard policy of PFC as applicable to state/private sector. ESCO to provide bank guarantee to meet any shortfall in Guaranteed energy saving. The Owner to provide support for the payment of substantiated energy savings and Deemed energy savings, as attributable to the acts of the Owner, to the satisfaction of PFC.

5.0 Scheme for energy saving projects - KFC

Purpose

- The objective of this scheme is to promote energy saving measures in SMEs by providing financial assistance for the implementation of Energy Saving Devices/Projects and thereby contributing to environmental improvement and economic development of the country. The modernization/expansion projects connected with implementation of energy saving measures are also eligible for financial assistance under this scheme. Similarly existing SMEs going for replacement of old machineries and equipments with modern energy saving devices will also come under the scheme. The following activities are also eligible for financial assistance under this scheme.

Upper loan limit

- For Corporation/Companies/ Co-operative Societies: Rs. 200 lakhs.
- Other cases including Trust: Rs. 100 lakhs.

Repayment period

- Up to 3 years (including gestation period up to 3 months).

Gross interest rate

- 12.5%(PLR - 0.5%).

Effective interest rate

- 5%(after allowing rebate of 6.5%and concession up to 1%for satisfactory credit rating).

Processing fee

- No processing fee

The additional criteria for the scheme are as follows:

- Well documented energy audit report carried out by an Energy Audit firm registered in BEE (Bureau of Energy Efficiency) or by Energy Management Centre (EMC).
- Clear narration of savings and investment.
- Action plan details for implementation.
- Application can be submitted to KFC a copy of which will be given to EMC, for vetting the proposal.
- EMC will recommend the proposal within 15 days from the date of receipt and forward its comments to KFC

6.0 Credit linked capital Subsidy scheme (CLCSS)

The Ministry of Small Scale Industries (SSI) is operating a scheme for technology upgradation of Small Scale Industries (SSI) called the Credit Linked Capital Subsidy Scheme (CLCSS). The Scheme aims at facilitating technology upgradation by providing upfront capital subsidy to SSI units, including tiny, khadi, village and coir industrial units, on institutional finance (credit) availed of by them for modernisation of their production equipment (plant and machinery) and techniques. The Scheme (pre-revised) provided for 12 per cent capital subsidy to SSI units, including tiny units, on institutional finance availed of by them for induction of well established and improved technology in selected sub-sectors/products approved under the Scheme. The eligible amount of subsidy calculated under the pre-revised scheme was based on the actual loan amount not exceeding Rs.40 lakh. Presently, the scheme is in operation up to March 31, 2007 or till the time sanctions of aggregate capital subsidy disbursed by the Nodal Agencies reaches Rs.600 crore, whichever is earlier.

- The ceiling on loans under the scheme has been raised from Rs. 40 Lakh to Rs. 1 Crore
- The rate of subsidy has been enhanced from 12%to 15%
- The admissible capital subsidy is to be calculated with reference to the purchase price and machinery, instead of the term loan disbursed to the beneficiary unit
- The practice of categorization of SSI units in different slabs on the basis of their investment

The operation of the scheme has been extended upto 31st March, 2007

For more details of the scheme visit:

http://www.dcmsme.gov.in/schemes/sccredit.htm

Annexure – 3: Details of technology/service providers

Evapco Condensor
ACS Consultancy Pvt. Ltd
276/5, Sangam Apartments
Belly Area, Anna Nagar West
Chennai-40, India
Ph: (91) 9840818637 / 9444048480
Fax: (91) 44-42026477
Email: evapco-india@airtelmail.in

Baltimore Aircoil Condensor
Densol Engineering Pvt. Ltd.
#43/C, 9th Main, R P C Layout
Vijayanagar 2nd Stage
Bangalore 560040

Cooking Equipments
B3 Equipment and Systems
Seaport Airport Road, Thrikakkara,
Kochi-21
Ph: 04846456309, Mob: 9447084551,
9495984551

Thermax Limited,
RNG Pallazzo, No. 1, 1st Floor
South End Street
Kumarapark East
Bangalore 560 001
Ph: +91 (80) 22371721
Fax: +91 (80) 22371726

India Insulations
NH Bypass, Vytilla,
Kochi – 682 019, Kerala
Ph: +91 (484) 2304465

Johnson Controls (India) Pvt. Ltd.
C/o. York India Limited,
Delphina Building 2nd floor
CMH Road, Indiranagar Stage 1
Bangalore, Karnataka 560 038 India
Ph: +91 (80) 3057 5730
Fax: +91 (80) 3057 5729

Evapco-India
272/5, Sangam Apartments
Belly Area, Annanagar West,
Chennai, India – 60004

Lloyd Insulations (India) Limited,
38/449, Panampilly Nagar
Manorama Junction,
Ernakulam, Kerala 680036
Ph: +91 (484) 2324472

Sagar Electric Power Services
#70, K. Kamaraj Road,
Bangalore, India – 560042
Ph: +91 9060133874; 9448073258

Balamurugan Refrigeration Engineers,
Liveiro building, Thoppumpady
Kochi 5
Ph: +91 (484) 2231844

Kirloskar Electric Co. Ltd
294 – 295, Lloyd's Road, Royapettah.
Chennai – 14.
Ph: 044 – 28133176

Project & Supply
A – 605, Sunswept
Lokhandawala Complex
Swami Samarth Nagar
4, Bungalow, Andheri (West)
Mumbai 400 050
Ph: 022 – 626 6584

Vijay Energy Products Pvt.Ltd.
SP – 75, Ambattur Indl. Estate
Chennai – 600 058
044 – 625 4326

Momaya Capacitors
401, Madhav Apartments
Jawahar Road, Opp.Rly.Stn.
Ghatkopar (East)
Mumbai – 400 077
Ph: 022 – 516 2899 / 1005 / 0745

Philips India Limited
Regional Office – South
No.3, Haddows Road
Chennai – 600 006
Ph: 044 – 826 9126 / 827 2341

Cristopia Energy Systems (I) Pvt. Ltd.
Village Umrikheda, 12th KM Indore-Khandwa
Road.Dist. Indore-452020
Ph: +91 731 422833

Siemens Ltd
3rd Floor, Jyoti Mahal, No. 49, St. Marks
Road,
Bangalore 560 001
+91 80 5119 1500

Enpro Industrial Automation Pvt Ltd.
Dealer: Danfoss VFD
F18 Ambattur Industrial estate, Ambattur
Chennai –600058
Ph: +91-44-26244583; 26244865; 26359850
email: projects@enproautomation.com

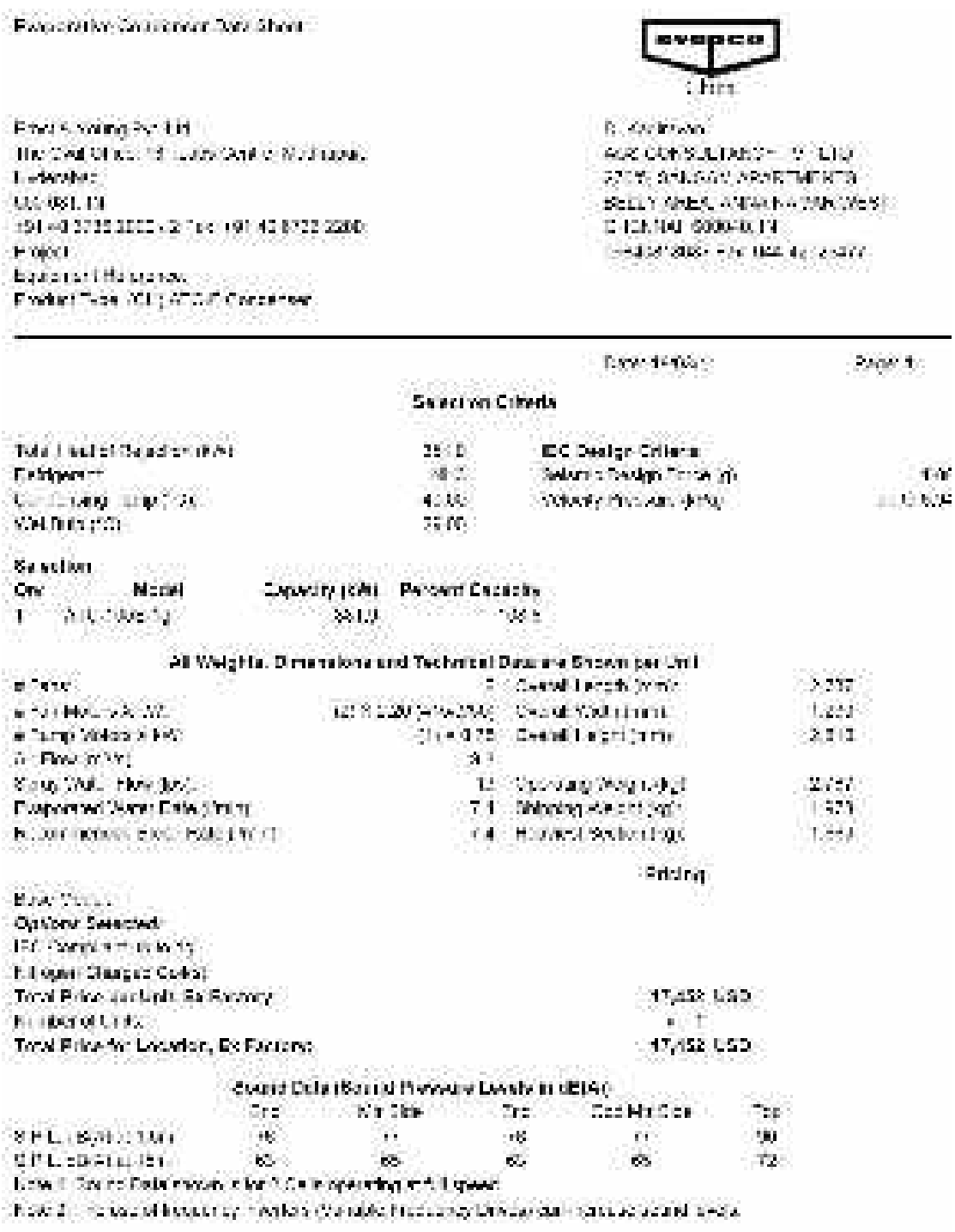
Beblec (India) Private Limited
Plot No. 126, Sipcot Indlustrial Complex
Hosur - 635 126
Tamil Nadu, India
Ph: +91-4344-276358 / 278658 / 400688 / 400687

BI Marketing & Services Pvt Ltd
Dealer: Grundfos Pumps
No.50, 3rd street, East Abhiramapuram,
Chennai –60004
Ph: +91-44-24671267

Anjanaa Belting
3857, TNHB, Ayapakkam,
Chennai –600077
Ph: +91-44 –64991300/9840186799

The service providers were selected considering the technology recommended and their ability to service the sea food processing units located in Kochi. Since not all service providers have dealership network in Kochi, hence dealers have been selected from Chennai & Bangalore.

Annexure – 4: Quotations of techno commercial bids from service/ technology providers



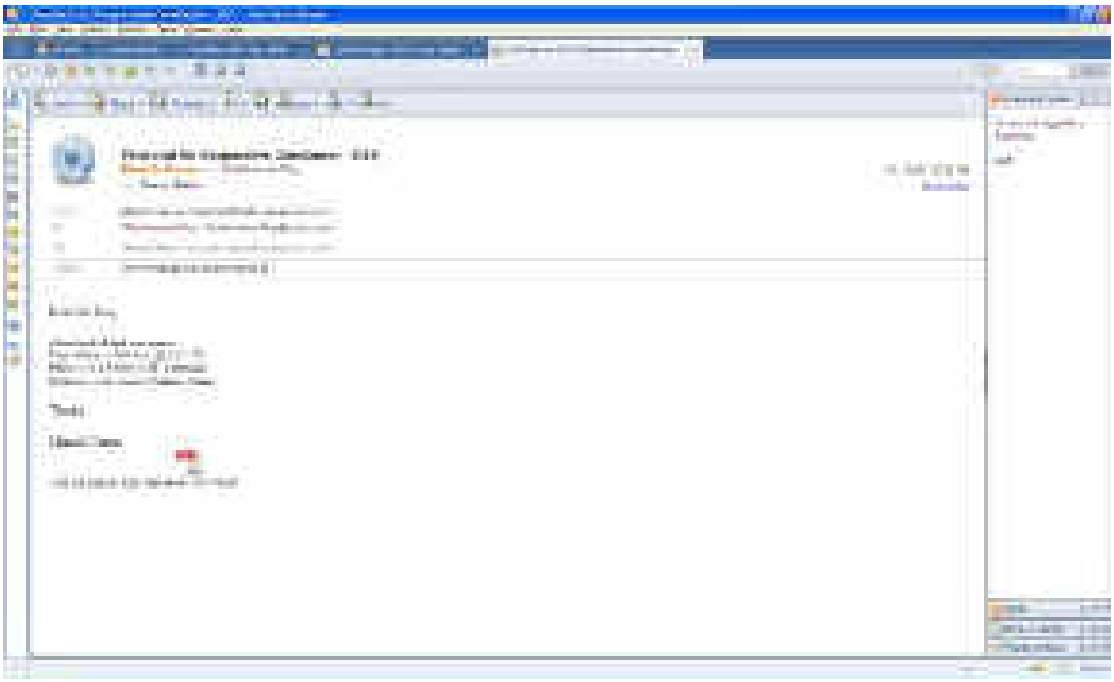
Evapco

Selection Criteria

All Weights, Dimensions and Technical Data are Shown per Unit

Pricing

Sound Data (Sound Pressure Levels in dB(A))

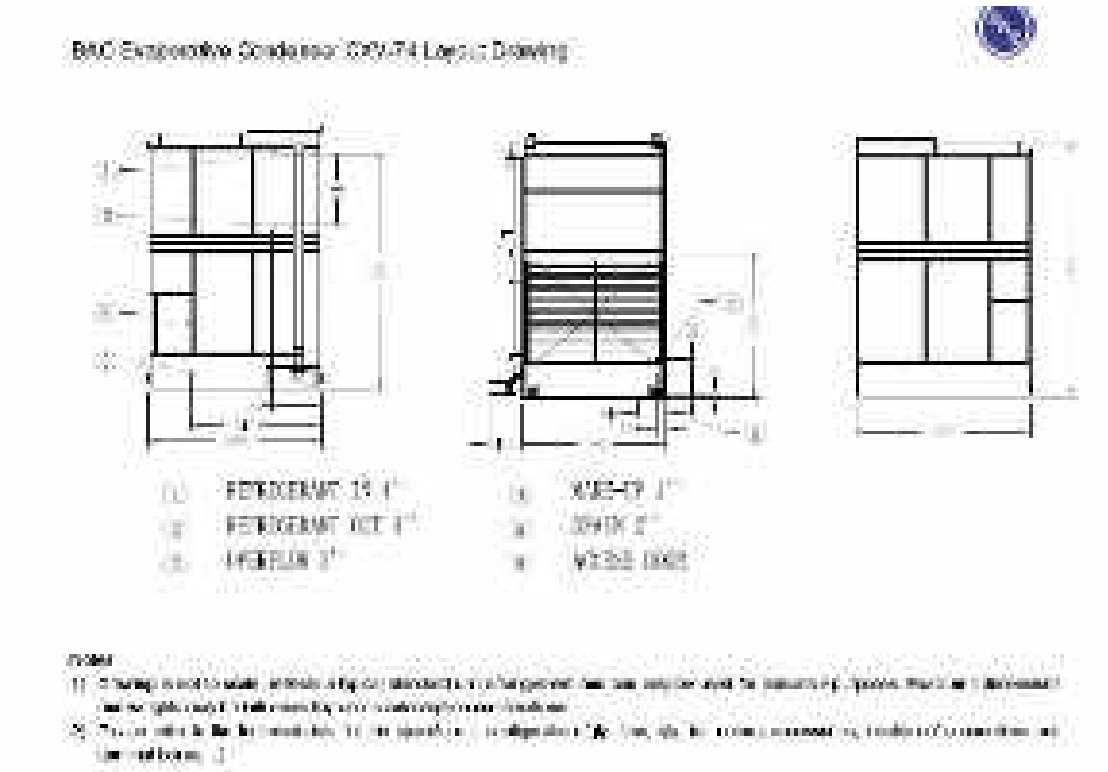


Quotation

DAC DAIKIN CO., LTD.

Technical Specification

Technical Data



THERMAX

[illegible]
Date: March 29, 2011

[illegible]
BANGALORE

[illegible]

Dear Sir,

Thank you very much for the courtesy extended to us when we discussed about the HVAC for your forthcoming project. Based on the discussions, we are pleased to submit our techno-commercial offer for our latest energy efficient HVAC of 100 TR capacity. Our offer consists of the following:

1. Technical Specifications
2. Scope of Supply & Performance Criteria at Site
3. Battery Limits & Cooling Water Quality
4. Exclusions
5. Price Schedule
6. General Conditions of Sale

We hope our proposal shall meet your expectations and expect your valuable order.

In case any further clarifications are required, please communicate undersigned. Thanking you and assuring you of our best attention at all times. We remain

Yours truly

Harish Iyer
SBU Cooling,
Cooling & Heating Division

Annexure 2.1
M/s. [illegible]
Specification for Refrigeration System

1. Technical Specifications

	A. Capacity		
1	Capacity (at -50°C)	TR	120
	B. Ammonia Circuit		
1	Ammonia concentration	%	99.9
2	Ammonia evaporation temp.	°C	-40
	C. Cooling Water Circuit		
1	Cooling water flow	m³/hr (@	150
2	Cooling temperature,		
	Inlet	°C	32
	Outlet	°C	38
	D. Steam Circuit		
1	Steam Pressure at the inlet of Steam control valve	Kg/cm²(g)	5.0
2	Steam Condition		Dry saturated
3	Steam Consumption	Kg/hr	1500
	E. Electrical Circuit		
1	Power Supply		3 Ph, 415 V +/- 10%, 50 Hz +/- 5%
2	Control Supply		230 V, 1 Phase,
3	Chilled Water Pump (TW - 1388)	kW	7.2 Nos
4	Ammonia Pump (TW - 1387)	kW	1.5
5	Power consumption		[illegible] kW

Note: The capacity & steam consumption mentioned above are for the insulated machine

Titanium Ltd
[illegible]

2. Scope of Supply

The following equipment shall be supplied as an assessment of the chilling package

No	Equipment	Quantity
1.	Absorber	1
2.	Chiller Tank for the absorber	1
3.	Refrigerant Heat Exchanger	1
4.	Solution Heat Exchanger	1
5.	Generator Heat Exchanger	1
6.	Condenser	1
7.	Condensate Heat Exchanger	1
8.	Chiller Tank for the Condenser	1
9.	Rectifier	1
10.	Stripping & Rectification column	1
11.	Flash vessel	1
12.	Refrigerant receiver	1
13.	Expansion valve	1
14.	Solution Pump (1w + 1s)	2
15.	Ammonia Pump (1w + 1s)	2
16.	Vacuum Pump	1
17.	[illegible]	Lot
18.	Control valves	set
19.	Valves	set
20.	Pipes for internal piping	Set
21.	Control Panel (PLC)	set
22.	Instrument & power cables for the unit	set
23.	Pneumatic tubing for control valves	set
24.	Mechanical Structure	set

Performance Criteria at Site

I Performance trials will be carried out within 15 days of commissioning of the unit, at the available load in case the purchaser fails to provide load or required utilities the unit will be deemed as handed over after the performance trials are taken on the available parameters.

II Performance trial on the machine shall be carried out to demonstrate the capacity of unit. The following inputs are to be provided by the purchaser.

a) Steam pressure

b) Inlet pressure of ammonia

- Cooling water inlet temperature not above normal conditions
- Ammonia inlet temperature not below the rated temperature
- Cooling water quantity as per the specifications mentioned.
- Flow meter Cooling water flow measurement with 10% of the rated flow
- Dry saturated steam at the rated pressure at the inlet of steam control valve

Contd...

[illegible]

3. Battery Limits

[illegible]		At inlet flange of low pressure receiver
Ammonia Outlet	:	At outlet flange of the ammonia station
Steam	:	At inlet / outlet flange of steam control valve
		At the inlet flange of generator
Condensate	:	At outlet flange of Condensate Heat exchanger
Cooling Water Inlet	:	At inlet Flanges of absorber, condenser and partial Condenser
Cooling Water outlet	:	At outlet flanges of absorber, condenser and partial condenser
Instrument air supply	:	Steam control valves, [illegible]
[illegible]	:	[illegible]
		Panels and all drives

[illegible]
[illegible]
Cooling & Blower Division

Cooling Water Specifications

Cooling water quality should be as per: IS:3306:1999

ITEMS	COOLING WATER CIRCULATING WATER
pH	To suit Langelier Index value and CO2
Total Hardness:	Not greater than 250ppm as CaCO3
Temporary Hardness:	Not greater than 250ppm as CaCO3
Chloride Hardness	Approximately 1:3
Mn/Cu No. (MgO Absorbed)	Not greater than 2ppm
Iron + Manganese	Not greater than 0.5ppm
Sulphate as SO	Not greater than 250ppm
Silicon as SiO2	Not greater than 50ppm
Turbidity (NTU)	Not greater than 50 NTU
Residual chlorine	0.2 - 0.5ppm
Total Residual Salts	Not greater than 500ppm
Carbon Dioxide	Corrosion with equilibrium
Chemical Oxygen Demand COD	Not greater than 4ppm

Note:

1. If water pretreatment is necessary (because of poor quality of water), attempt should be made either to treat the source water only once for the cooling water circuit, or to treat the source water only once in combination of all these other cooling units. Consult a water treatment expert.
2. Total hardness as CaCO3 mentioned in above specification is less than 250ppm, but in actual practice it should be less than 50ppm to avoid scale deposition in cooling tower.
3. It is strongly recommended that cooling water specifications mentioned above be maintained, to avoid scale deposition, and corrosion in Absorber, Condenser & Evaporator tubes.

[illegible]
SDU Cooling
Cooling & Blowing Division

A. Exclusions

1 Unloading, Transportation & Transit Insurance after Thermax factory.
2 Erection of the mechanical structures.
3 Erection of interconnection piping of the equipment, erection of the equipment and all accessories.
4 Insulation.
5 All civil work including:
a) Making, breaking / reconstruction / Trenches & Finishing of walls.
b) Design & construction of foundation for cooling plant and for related accessories. (The dimensions of foundation, static load data & removal requirement if involved, Thermax will furnish the same.)
c) Trenches for underground pumps cabling/ventilation
d) Civil structural support for piping/earthing/cabling etc.
6 Electrical power charges, D.M.Water, Make up water etc.
7 Compressed air system, Chillwater to provide instrument dry and oil, dust free quality air at 7 kg/cm2 (g).
8 Steam & Water supply at the rated conditions.
9 Steam drain / condensate lines.
10 415 V +/- 10%, 50 Hz +/- 3% power supply to control panel.
11 Internal Steam, Water, ammonia, cooling water piping work, including erection, survey
Valves, globe valves, including valves.
12 Pressure reducing & de-superheating station, if necessary.
13 Isolation and bypass valves for steam control valves.
14 Various pressure gauges, for Brine, cooling water & steam lines.
15 Nitrogen gas for pressure testing of lines, if required.
16 Cooling tower, cooling water pumps & brine pumps.
[illegible]
18 Soft water make-up for cooling tower.
19 Separate earth pit shall be provided for main control panel earthing.
20 It is assumed that the machine will be running in normal and operative working conditions, in case abnormal working conditions prevailed at site, necessary requirements to be arranged.
21 All Electrical & Instrumentation work
a) Motor Control Center.
b) All power, control and instrumentation cabling outside the machine battery limit
c) Cable trays, supports, cable termination
d) Earthing system
e) DCS/PLC/SCADA system, if required
f) Plant room lighting system.
g) Building lightening protection system
h) Any modification / interfacing with existing control system.
22 Water treatment plant / equipment, Chemical dosing system, Water chemicals, Resin etc, if required.
23 Fire detection, Alarm and protection system and Public address system.
24 Third party inspection (if any)
25 Power, water & compressed air for erection.
26 Lodging and boarding arrangements for our Supervisors.

[illegible]

[illegible]
SDU Cooling
Cooling & Blowing Division

27 Utilities control board and other auto necessary equipments
28 Any other item not specifically mentioned in our scope of supply

[illegible]
SDU Cooling
Cooling & Heating Division

5. Price Schedule

a. Price
Our Price for supply of [illegible] as mentioned above in our specification No. [illegible] and terms and conditions of supply and specifications mentioned above will be Rs. 80 Lacs Only.

Price for supply of Erection & Commissioning will be Rs. 1 Lacs only

b. Price basis :
1 The above quoted price is our exworks price at Pune
2 Packing charges will be extra at the rate of 1.5% of our ex works price
3 Octroi duty or ASAI shall be extra at actuals at the time of despatch.
4 CST or VAT against form C or as actuals as applicable at the time of despatch shall be extra. VAT could be extra
5 [illegible]
6 Transit insurance shall be arranged by you
7 Octroi if applicable shall be arranged by you
8 Any other taxes, duties, either than the above mentioned if applicable at the time of delivery shall be borne by you or actual. (Any variations in taxes and duties or imposition of new taxes/duties at the time of delivery shall be borne by you at actuals)

c. Terms of Payment
40% advance
60% against performance insurance before despatch

d. Delivery :
We will deliver the machine/system within 4 to 5 months from the date of receipt of clear order and advance.

Delivery is subject to:
- Finalisation of Layout from both the parties.
- Mutually beneficial terms and conditions of technical and commercial understandings.
- Finalisation of layout and all mutual discussions are have to be completed within 30 days from the date of order confirmation

e. Validity :
Our offer is valid for 30 days from the date of issue

[illegible] Ltd
[illegible]
[illegible]

4. Warranty :

The warranty, valid for 12 months from the date of despatch, is for our workmanship against manufacturing defects. The warranty is subject to,

1. Equipment / material or part thereof not being subject to accident, alteration or improper use.
2. The equipment / material and the whole system being operated and maintained by trained personnel of the purchaser in accordance with our recommended operating instructions and maintenance methods.
3. Repairs / replacements are carried out by the party authorised by us.
4. Fulfilment of maintenance responsibility by purchaser.
5. Warranty clause of all bought out items.
6. Electrical components and instruments (switches/heaters etc), rubber parts are not covered by warranty.
7. The warranty does not cover normal wear and tear.

Thermax Ltd

Cooling & Heating Division

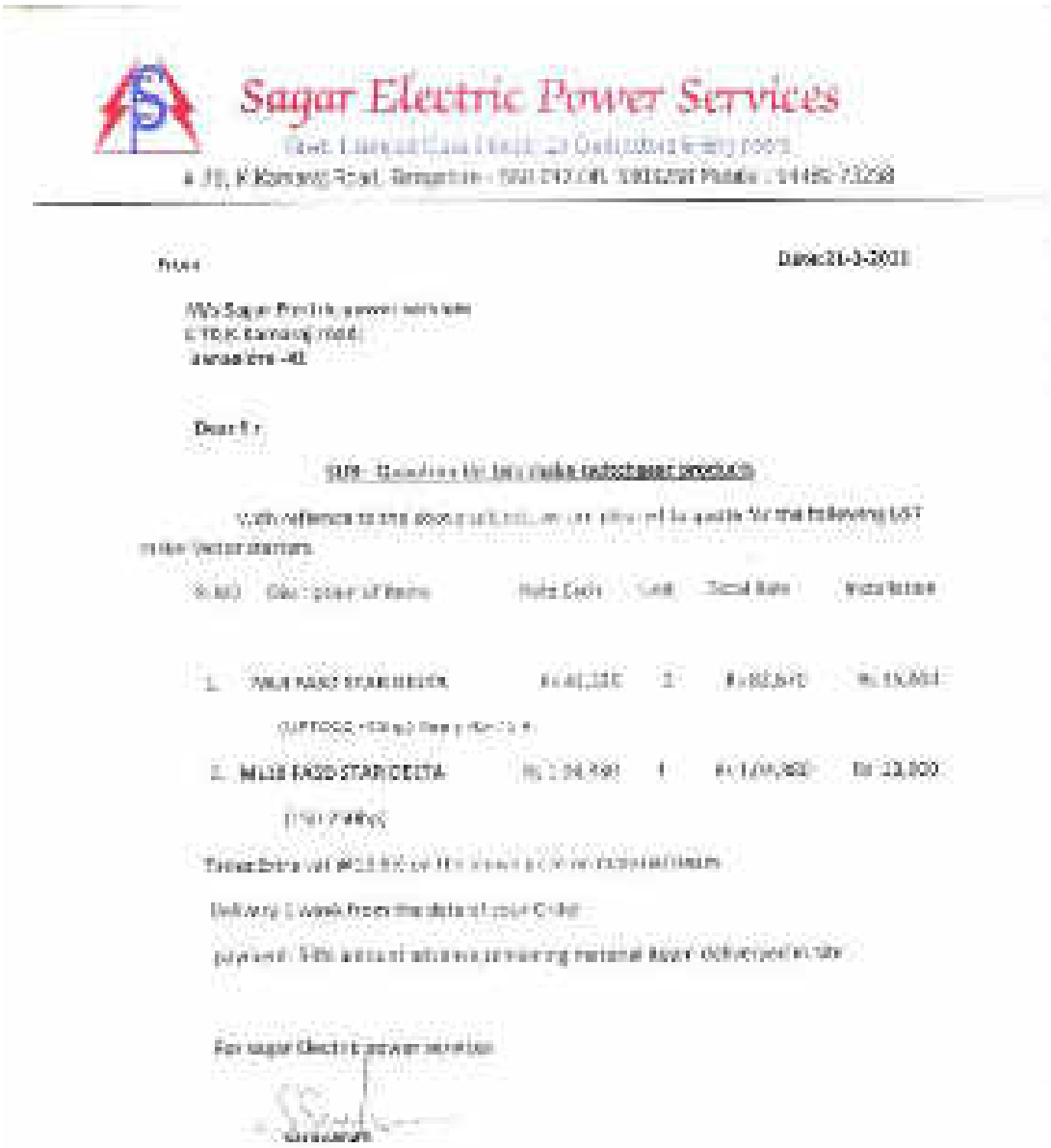
6. Terms & Conditions of Sale

[illegible] Ltd

SEU Cooling

Cooling for Processing Chambers

[illegible] Process Cooling systems for food, [illegible] Blast, Sandwich, Installation of machinery. Value to facilities, or offices, [illegible] [illegible] [illegible]



Sagar Electric Power Services

Dated:21-3-2011

Dear Sir,

With reference to the above subject, we are pleased to quote for the following VST make Vector stainless

Sl.No	Description of Items	Make Details	Unit	Unit Rate	Price Inclusive
1.	[illegible]	[illegible]	1	[illegible]	[illegible]
	[illegible]				
2.	MILLER EAGLE STAR DELTA	[illegible]	1	[illegible]	Rs 23,800
	[illegible]				

[illegible]

Delivery [illegible] from the date of your Order

[illegible]

For sagar Electric power services

Enpro Industrial Automation Pvt. Ltd.

Ref: EIQ/VFD/2011/569
MAY 17, 2011

M/s. Ernst & Young Private Limited
13th Floor, "UB City" Canberra Block,
Vittal Mallya Road,
Bengaluru - 560 001, India
Tel Ph: 080 4027 5000

Kind Attn: Mr. Shubhashis Dey / Senior Consultant
M: 09611136917

Dear Sir,

Sub: Offer for Supply of **'ENPRO' make 5.5KW, 7.5KW & 11KW VFD Panels – reg.**

We thank you very much for your e-mail enquiry dt. 16.05.11, and to the receipt of your enquiry, we herewith take pleasure in submitting our offer as under.

We trust that you will find our offer in line with your requirement and now we look forward to the pleasure of receiving your valued order.

Incase would you require any further technical / commercial clarifications please feel free to call us.

Thanking you and Assuring of our best services at all times up to satisfaction.

Yours faithfully,
ENPRO INDUSTRIAL AUTOMATION PVT LTD.,

J. Senthil Kumar
Engineer – Marketing.
044-26244860/70

Head Office, Design & Works:
[illegible] Ambattur Industrial Estate, Ambattur, Chennai 600 058.
Phone: 044-26244860, 26244861, 26248870, Fax: 044-26244871
E-mail: enpro@enproautomation.com, enpro@vsnl.com

PRICE SCHEDULE

ITEM NO.	DESCRIPTION	QTY	UNIT PRICE (RUPEES)
1.	Supply of **EMPRO** make **VFD Panel** along with **VACON make NXS 00165 5.5KW VFD** (as per BOM enclosed) (i) Alpha Numeric LCD Display (ii)IP21 Protection (iii) In built AC Choke (Input Voltage: 3Phase 415V)	1 No.	1,25,212/-
2.	Supply of **EMPRO** make **VFD Panel** along with **VACON make NXS 00225 7.5KW VFD** (as per BOM enclosed) (i) Alpha Numeric LCD Display (ii)IP21 Protection (iii) In built AC Choke (Input Voltage: 3Phase 415V)	1 No.	1,36,232/-
3.	Supply of **EMPRO** make **VFD Panel** along with **VACON make NXS 00315 11KW VFD** (as per BOM enclosed) (i) Alpha Numeric LCD Display (ii)IP21 Protection (iii) In built AC Choke (Input Voltage: 3Phase 415V)	1 No.	1,49,450/-
4.	TESTING & COMMISSIONING CHARGES	L.S.	30,000/-

Note: Cables & External Wirings are at your scope.

TERMS AND CONDITIONS

PRICES	: Ex works Chennai. P & F: Extra @ 2%.
EXCISE DUTY	: Extra applicable at the time of supply.
SALES TAX (VAT)	: Extra at actual at the time of supply.
DELIVERY	: 4 - 5weeks from the date of receipt of your P.O.
FREIGHT & INSURANCE	: Extra at actual to your account.
VALIDITY	: 30 Days from the date of this quote.
WARRANTY	: 12 Months from the date of invoice.
PAYMENT	**: 100% Against Proforma invoice before dispatch.**

Detailed Bill of Material

1) 5.5KW YED along with STAR DELTA Bypass Starter Panel

S.No.	Description	QTY	Make
1	Panel (1000Hx500Wx400D)	1	ENPRO
2	**SFU 63A**	1	SIEMENS/GE
3	**HRC Fuse, 32A**	1	SIEMENS/GE
4	Power Contactor, 9A	4	SIEMENS/GE
5	Over load Relay (7-10)A	1	SIEMENS/GE
6	Control MCB, 2A, 2P	1	SIEMENS
7	Cooling Fan & Filter	1	REPUTED
8	Temperature Controller	1	ORION/AUTONICS
9	Joey Selector switch	1	TERNIC
10	Indicating Lamps	6	TERNIC
11	Push button	5	TERNIC
12	Control Terminal Blocks	10	REPUTED
13	Power Terminal Blocks	10	REPUTED
14	Plug in Relay	2	RLA
15	Drive MX500165	1	VACON

2) 7.5KW VFD along with STAR DELTA Bypass Starter Panel

S.No.	Description	QTY	Make
1	Panel (1000HX500WX400D)	1	ENPRO
2	SFU, 63A	1	SIEMENS/GE
3	HRC Fuse, 32A	1	SIEMENS/GE
4	Power Contactor, 12A	4	SIEMENS/GE
5	Over load Relay (9-12.5)A	1	SIEMENS/GE
6	Control MCB, 2Pole, 2A	1	SIEMENS
7	Cooling Fan & Filter	1	REPUTED
8	Temperature Controller	1	OMRON/AUTONICS
9	3way Selector switch	1	TEKNIC
10	Indicating Lamps	6	TEKNIC
11	Push button	3	TEKNIC
12	Plug in Relays	2	PLA
13	Control Terminal Blocks	10	REPUTED
14	Power Terminal Blocks	10	REPUTED
15	Drive NX5I00225	1	VACON

3) 11KW VFD along with STAR DELTA Bypass Starter Panel

S.No.	Description	QTY	Make
1	Panel (1000HX500WX400D)	1	ENPRO
2	SFU, 63A	1	SIEMENS/GE
3	HRC Fuse, 32A	1	SIEMENS/GE
4	Power Contactor, 12A	4	SIEMENS/GE
5	Over load Relay (14-20)A	1	SIEMENS/GE
6	Control MCB, 2Pole, 2A	1	SIEMENS
7	Cooling Fan & Filter	1	REPUTED
8	Temperature Controller	1	BOURNS
9	3way Selector switch	1	TEKNIC
10	Indicating Lamps	6	TEKNIC
11	Push button	3	TEKNIC
12	Plug in Relays	2	PLA
13	Control Terminal Blocks	10	REPUTED
14	Power Terminal Blocks	10	REPUTED
15	Drive NX5I00315	1	VACON

Disclaimer

In line with our methodology for carrying out energy studies, our key findings and recommendations are based on the data made available to us, energy parameters observed at site and discussions held with the key officials at the works. Ernst & Young has exercised all reasonable skill, care and diligence in carrying out the study. This report is not deemed to be any undertaking, warranty or certificate.

It should also be noted that though the equipment/technology of many Indian or Foreign manufacturers/suppliers, installed at the cluster have been analyzed in this report, there is no intention of Ernst & Young to comment positively or adversely on the capabilities of these suppliers or their equipment/technology. The name of technology or equipment mentioned in this report belongs to respective suppliers.

Information presented in this report is based on information collected from site personnel and observation of energy parameters during site visits, and therefore, the findings of this report are valid as on the date of site visit.

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