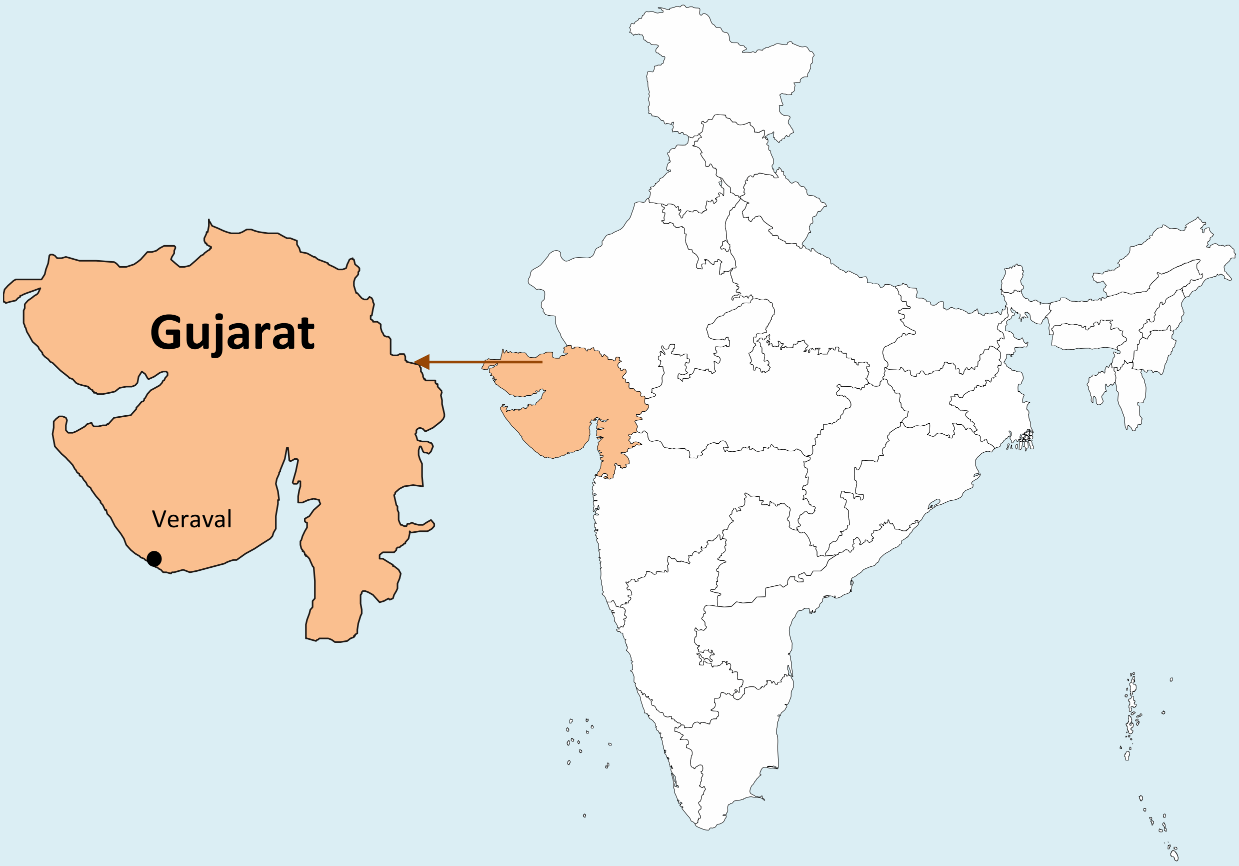
Cluster Profile
Veraval seafood processing industries



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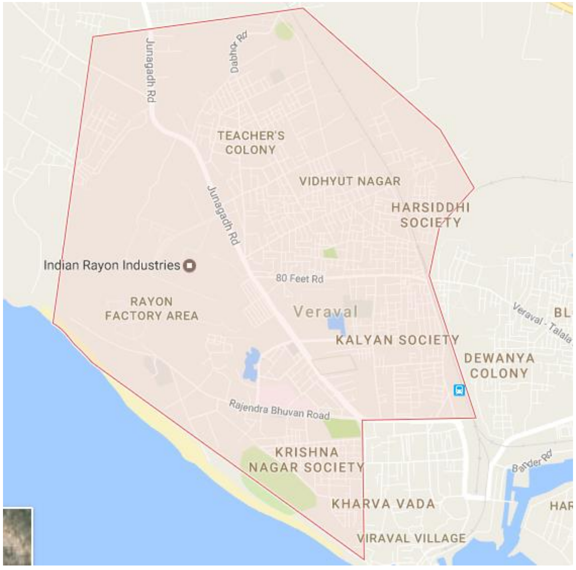
Last but not least, our sincere thanks to MSME entrepreneurs and other key stakeholders in the cluster for providing valuable data and inputs that helped in cluster analysis.

Veraval seafood processing industries

Overview of cluster

Gujarat state holds top position in fisheries as it covers about 1/ 5th part of India along the coast (about 1600 km coastal line) as well as it comes under exclusive economic zone. It contributes about 25% of total marine production of India. There are abundant inland fisheries opportunities in Gujarat due to the presence of 6 large reservoirs, Sardar Sarovar command area and small water bodies. There is a significant growth in processing infrastructure in India due to (1) increased marine fishery, inland fishery, freshwater aquaculture, brackish-water aquaculture and better utilization of catch and (2) increased fish trade with both developed and developing countries. The processing infrastructures were setup near landing centres to minimize time lost in transport of the catch. The state fishery department is actively working for improving productivity and production capacities. Major species processed in Veraval include ribbon fish, crocker, cuttle fish, squits, shrimps, lobster etc.

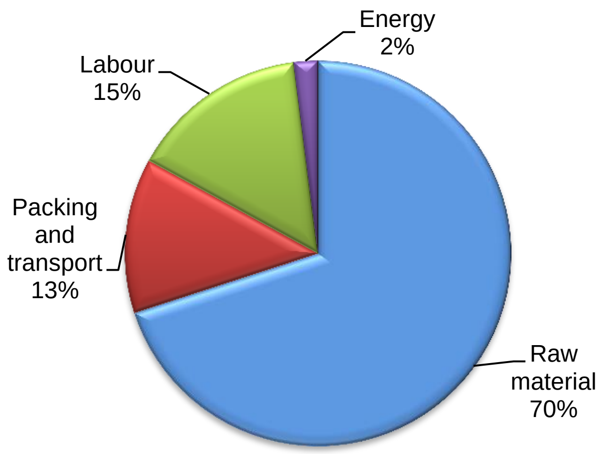


Veraval seafood processing industries

Source: Google map

There are total 60 registered fisheries units in the cluster which are distinguished as Europian Union exporting units (EU units) and Non Europian Union exporting units. There are about 10 units which exports to EU while remaining units export to south asian countries and China. Almost all the units operate only storage plants during off seasone i.e during June to September as there are no fresh fish available due to non-fishing activity during monsoon. The total annual turnover of Veraval seafood cluster is estimated to be Rs 3,350 crores, a majority of which comes from exports. Some of the prominent seafood processing industry in the cluster includes J M Marine Exports, Jini Marines and Shivganga Marine Products.

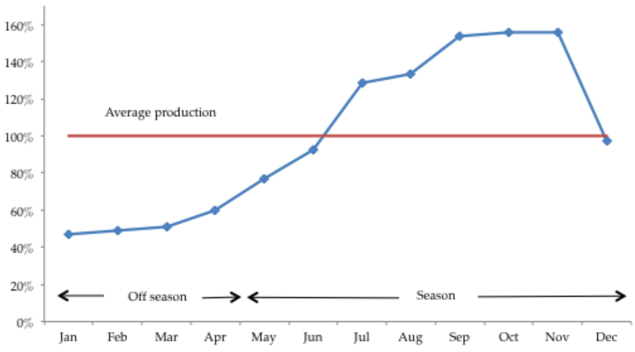
The raw material i.e. fish is the single major cost for seafood processing industry accounting for about 70% of total input cost. Other major costs include labour, packaging and transport. Energy accounts for about only 2% of total processing costs. The yeild of the plant is related to the recovery from raw fish. Due to low labour cost, manual operation is preferred over automated processing.



Break-up of processing costs

Product types and production capacities

The cluster has 60 active processing units. The capacity utilization of these units varies according to fish capture and culture (season and off-season period)[1]. January to early April is "off-season" period and is marked by a product[1]ion level as low as 25% of annual average production. May to December is known as "season" with peak occurring during July to September (about 160% of annual average production). The average month-wise variations in production are depicted in figure. All of the processing plants produce ready-to-cook (RTC) products. Based on their production levels, seafood processing units can be categorised into following categories.



Seasonal variation of production

Categorization of seafood processing plants

Category	Production (tonne/month)	Employment days	Turnover (Rs crore/year)
A	50	100	15
B	150	200	50
C	250	350	120

It may be noted that a majority of seafood processing units (about 40 units) fall under category B and can be termed as medium size. About 40 units fall under category B. About 10 units are of large size and fall under category C. The total quantity of processed seafood at cluster level is about 108,000 tonnes. During peak season, the units run at 100% capacity but for remaining period it is as low as 50%. Cold storage units are operated throughout the year.

Mackerel Fish **Ribbon fish**

Major products of the cluster

[1]Based on data collected from Fisheries units in Rajkot

Production process

The major steps involved in processing of seafood include washing, gutting, skinning, trimming, grading, freezing, glazing, wrapping, metal detection, frozen storage and despatch. The entire processing area is air-conditioned. The major steps are explained below.

(i) Inspection and washing of raw material

Fish washing

Fresh or frozen fish is received from cold storage at reception yard; mostly raw fish are brought in ice filled buckets to keep them fresh. It is visually inspected by skilled personnel for product specifications such as appearance, odour, texture, foreign matter, species homogeneity and physical characteristic such as size as per procurement order. The fish is rejected if it contains harmful, decomposed or extraneous substances which cannot be removed or reduced below a tolerable level. After washing, it is stored in container with flake ice to maintain at 0°C to +4°C.

(ii) Fish preparation

Fish grading

Fish preparation includes beheading, gutting, skinning and trimming. The raw fish is brought to working platforms (steel tables with proper drain arrangement). Skilled workers remove the heads of fish and de-gut it. Depending on requirement of product, de-shelling may or may not be performed. During the entire process, the fish is covered with flake ice to maintain a temperature of 0°C to +4°C. The reason for using flake ice (instead of tube or block ice) is its higher surface area that would help in faster cooling of product. However, flake ice also melts faster. Typically for processing one tonne of fish about two tonnes of flake ice is consumed. The processing units have separate ice plants to meet the demands. Once fish is prepared, it is washed with clean water from tap installed above working platform and temporarily stored in container with flake ice. Typically, for one tonne of fish, about two tonnes of flake ice is used. The fish is then sent for further processing.

(iii) Grading

Fish receipt from fisherman

Grading is manually done by skilled workers in all the units. Though automatic grading machines are available in market, the units in the cluster do not employ machines due to high capital investment. In these machines, size/ grade can be set based on product (species of fish). The parameters which are checked while grading include colour of fish, dehydration rate, black spots, broken pieces, texture, deterioration, foreign objects, loose legs/ veins. Graded fish are sent for further processing while rejected fish are sent for secondary processing.

(iv) Freezing

The graded fish is brought to preparation platform. Based on market requirements, the fish is either frozen in bulk in block form or individually quick frozen. For block, the product is weighed as per requirements and filled in a plastic bag along with a small quantity of water. It is stacked in blast freezer which operates on batch mode. Fish for European market is segregated and sent to IQF machine. The typical operating temperature of blast freezer is (-) 40°C with a cycle time of 2-4 hours per batch. Typically categories A and B units have two blast freezers. Category C units have about two or four blast freezers. Units exporting to Europe are equipped with one to two IQF machines.

(v) Glazing, labelling and packing

In freezer the product can develop surface drying due to excess cooling. To avoid excessive drying, glazing is done which is the application of protective coating of ice on frozen fish. After glazing, the output is sent for packing in cartons and labelled. Glazing would devoid surface of air and reduce rate of oxidation. The product is sent through metal detector to inspect for foreign metallic material. In case of presence of any foreign metallic material, the packet is rejected and the others are sent to cold storage.

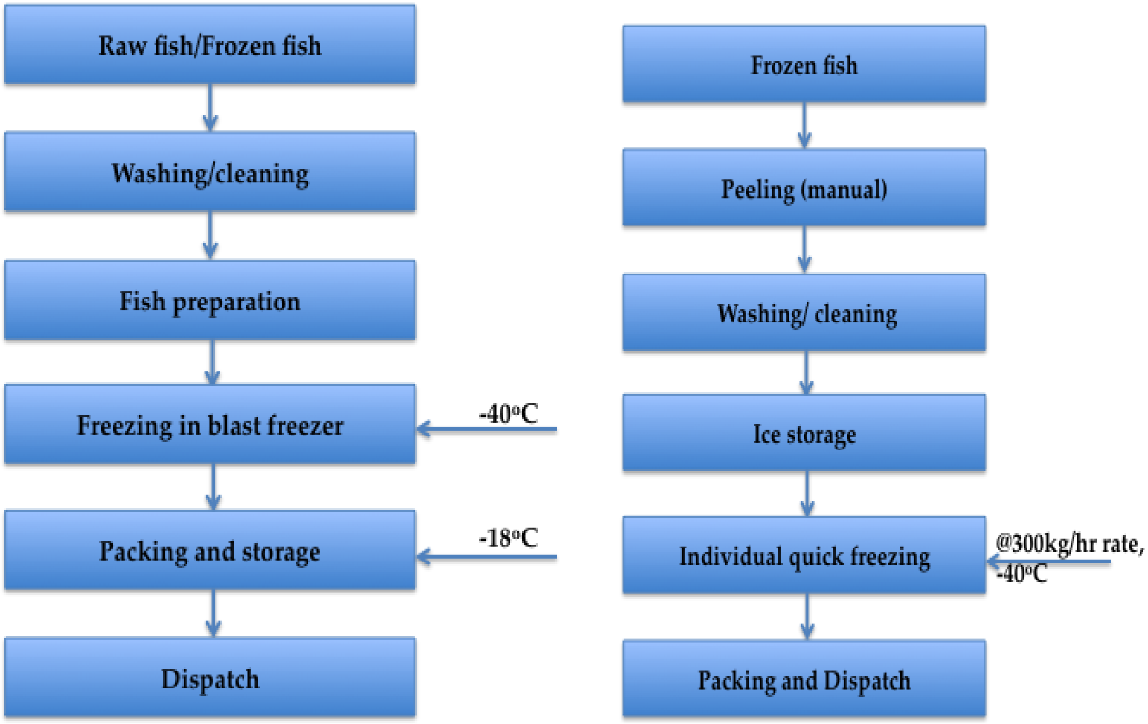
(vi) Cold storage

The final product is packed in boxes and sent to cold storage for storing until despatch. The cold storages help to maintain products at or lower than –18°C. The set temperature of cold storage facility is typically –24°C. Cold storages are ammonia based refrigeration system.
All the seafood processing units have installed diesel generator (DG) sets to support cold storage in case of scheduled or unscheduled power outage.

(vii) Despatch

The products in cold storage follow first-in-first-out principal. The products in cold storage can have shelf life of about twenty months without deterioration of quality. However, the products are generally despatched within three months. Category-A units have an overall storage capacity of about 200 tonnes; category B and C units have 450 tonne and 800 tonne storage capacities respectively.

The process flow diagram of a typical processing plant is shown in figure.



Process flow for non-EU products **Process flow for EU (IQF) products**

Technologies employed

Some of the major processes/ equipment in seafood processing are described below.

(i) Freezing

Fish starts spoiling immediately after death and this is termed as 'Rigor mortis'. Fish consists mainly of water (typically 60–80%) and freezing converts this water to ice by removal of heat. By lowering the temperature of fish below sub-zero level, the bacterial activity is either slowed down or inhibited, thus delaying the process of spoiling. Three types of freezers are used in the cluster.

Blast freezer

Freezing is achieved by blowing continuous high velocity stream of cold air over fish. Operation of these blast freezers can be continuous or in batch mode. In batch mode, the blast freezer is loaded with fish either in shelves or plates and once freezing is achieved the freezer is emptied and reloaded for next batch. The warmest part of fish must be brought to below –18°C and to achieve this cold air is blown at –40°C.

Blast freezer

IQF Freezer

IQF is mostly used for freezing fish to export as high value product to Europe. Unlike plate freezer which takes three hours, IQF takes only 15 minutes for freezing the products. This is to avoid degradation of texture by slow crystallization of ice in fish. Quick freezing is obtained either by placing fish in a bath of liquid nitrogen or by gradually passing it through a spray-stream of refrigerant liquid (usually nitrogen). IQF machines are generally custom made as per requirements and are dependent on feed rate, time of freezing and other process parameters. In Veraval cluster, IQF machines are of rate 300 kg/ hour or 350 kg/ hour.

IOF

(ii) Refrigeration and air conditioning

The processing units in the cluster have installed refrigeration units using ammonia as refrigerant and are driven by reciprocating type compressors. Ammonia is toxic in nature and precautions should be taken while handling as ammonia leaks may lead to potential health hazard. The general assembly of ammonia based refrigeration system consists of reciprocating compressor, ammonia pump, atmospheric/ evaporative condenser and fan coil units, which are installed in cold chamber area. In almost all units, all systems were operated at maximum load conditions during season and at part load during off-season. The system control is done manually. Mild steel piping is used to handle refrigerant (interconnecting compressor, condenser and cooling units). There are a large number of un-insulated areas/ locations were observed in the system. Most of valves and flange were found un-insulated.

(iii) Cold storage

Cold storage

Reciprocating Ammonia Chiller

Cold storages are typically of capacity 150–1,000 tonnes. The products are packed in boxes and vertically stacking in the cold chamber. To prevent air infiltration, the doors are air-sealed. The cold storage section has anterooms and product grading and sorting area. Anterooms are used mainly to avoid direct infiltration of warm ambient air into the cold rooms; it also serves as warm-up chambers for produce stored so they do not get wet due to condensation on unloading for despatch[2]. The cold storages are maintained below a temperature of –18°C.

Energy scenario in the cluster

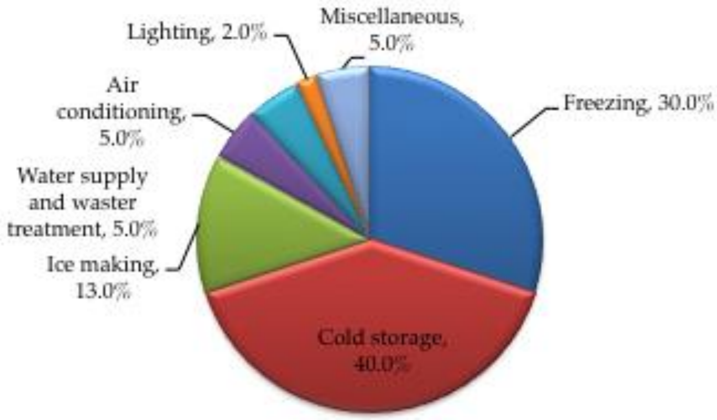
Electricity is single major source of energy for the seafood processing units. Electricity is supplied by Paschim Gujarat Vij Company Limited (PGVCL). The processing units typically have high tension (HT) connection at 11 kV. The transformers are installed within factory premises from which power is supplied to plant through power distribution system (PDS). All processing plants have DG set, which they run to meet plant demand during unscheduled outages. Diesel is procured from local market and its consumption is marginal in overall energy consumption. The industry falls under agricultural sector (processing) and gets electricity at a lower tariff than industry sector in the state.

Prices of major energy sources

Source	Remarks	Price
Electricity	Paschim Gujarat Vij Company Limited (PGVCL)	Average Energy charge : Rs 8.0 per kWh Demand charge : Rs 150 per kVA per month
Diesel	Local market	Rs 50 per litre

Energy consumption

Energy is consumed in raw material handling and movements, temperature control, water supply and ice production. Refrigeration equipment drives (mainly freezers, cold storages, chillers and icemakers) account for about 80% of total energy consumption of processing plant. The energy consumption depends not only on the level of technology but also on age, scale of the plant and level of automation.



Typical energy use in a seafood processing plant

(i) Unit level consumption

The specific energy consumption (SEC) varies considerably in a seafood processing unit. The average SEC of units is about 1,100 kWh per tonne of processing. DG sets account for under

[2] Source: Technical Standard for Cold Chain; http://nhb.gov.in/documents/cs3.pdf

3% of total energy consumption. The typical energy consumptions of different seafood processing units are given in table.

Typical energy consumption in processing plants

Production (tonnes/year)	Electricity (kWh/year)	Diesel (kL/year)	Total energy (toe/year)	Annual energy bill (million INR)
600	5,57,656	2	50	4.6
1800	17,07,176	5	152	13.9
3000	31,68,760	10	282	25.9

(ii) Cluster level consumption

The cluster level energy consumption is estimated based on energy consumption of processing plants in each category. The total annual energy consumption of Veraval seafood processing cluster is estimated to be 9,423 tonnes of oil equivalent (toe) per year. The equivalent carbon emissions from the cluster are about 104,695 tonne of CO_2. The overall energy bill of cluster is estimated to be Rs 864 million.

Energy consumption of the Veraval Seafood Processing cluster (2016-17)

Energy type	Annual consumption	Equivalent energy (toe)	GHG emissions (tonne CO_2)	Annual energy bill (million INR)
Electricity	106 million kWh	9,116	1,03,880	848
Diesel	320 kL	307	815	16
	Total	**9,423**	**1,04,695**	**864**

Energy saving opportunities and potential

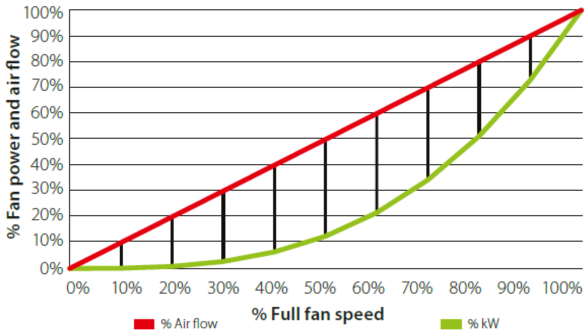
Some of the major energy saving opportunities in seafood processing units in the cluster are discussed below.

(i) Refrigeration piping network modifications

The pressure drop across the evaporator and condenser is generally within 0.2 bar. A thumb rule indicates that about 0.1 bar pressure drop corresponds about additional 7% power consumption. It calls for estimating pressure drop between generation and end-use points, by installing two identical calibrated pressure gauges at the compressor and at the evaporator. If the observed pressure drop is more than 0.2 bar, the unit may consider modificatio of existing piping network.

Apart from pressure drop, insulation of piping is also an important parameter affecting SEC of the system. Insulation generally deteriorates due to poor maintenance practices and corrosion on naked pipe. It is necessary to examine all pipes periodically with check list and master installation scheme. Frost formation on piping is a common indication of poor maintenance. An uninsulated pipe may increase the load on refrigeration system up to 0.035 ton per m^2. The estimated pipe length of typical installation in a processing facility in the cluster is about 70–200 meters. Replacement of pipe and the insulation, together with valves may reduce the electricity consumption up to 5–8% with payback period of under one year.

(ii) Refrigeration system controls



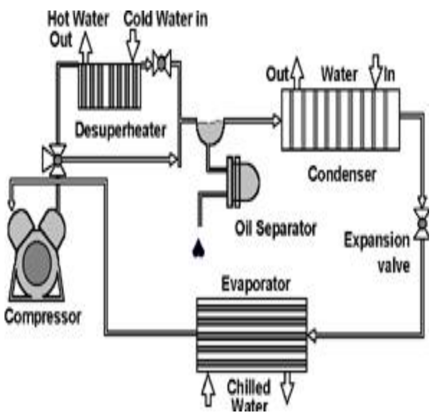
Effect of fan speed on power & air volume
Source: Oxford Cold Storage Company

The major components of refrigeration system in a seafood processing plant includes compressor, evaporator and condenser. The role of a control system in refrigeration system is to operate the system based on minimum temperature requirements and maximum temperature changes in the chambers while maintaining specific power consumption (i.e. kW per TR) close to design values. Most of facilities in Veraval cluster use traditional control system and the ON-OFF is done manually. The evaporator fans are operated on continuous basis with fixed speed irrespective of load varaitions. Control of evaporator fans is a key to reduce energy consumption level in a cold storage facility. When the chamber reaches to the set temperature, the evaporator fans should be switched off or the speed must be minimised. Moreover, the heat released by fan motor accounts for additional heat load on refrigetation system. It could be addressed by installing VFD on evaporator with ON/ OFF control. This will allow evaporator fans to circulate air as per load variations. For operation of compressor, condenser and evaporator in a closed loop system, the control assembly would require sensors to capture correct (average) temperature of entire chamber, variable frequency drives (VFDs) and monitoring system. The estimated investment requirement for a typical facility is about Rs 1.0-1.2 million with a simple payback period of 1.5-2 years.

(iii) Variable frequency drives in condenser fans

The electricity consumption of compressors increases with its discharge pressure. It is always recommended to operate the refrigeration unit at the minimum possible discharge pressure. Refrigeration units are generally designed to operate for peak load conditions and the condenser capacity must be controlled to maintain optimum operating conditions. VFD can be installed in condenser fans to maintain required condition with minimum energy consumption. About 20% reduction in fan speed will reduce power consumption by about 50%. The simple payback period for VFD system on condenser fans is less than a year.

(iv) Install desuperheater on ammonia chiller



Positioning of de-super heater

The return ammonia in system is at over 100°C which is rejected to atmosphere through condenser. This sensible heat can be recovered by installing appropriate waste heat recovery (WHR) system between the compressor and condenser. De-super heater is used as WHR system for this purpose, which can generate hot water at about 70°C. In standard practice de-super heater can harness up to 12–15% of waste heat rejected in condenser. Apart from the direct energy saving after getting hot water, the heat load on condensing coil or cooling system will be reduced which will further open possibilities of downgrading the cooling water pumps. The hot water from desuperheater can directly be used for floor and working platform cleaning. Moreover, the plants producing RTE product can directly use this hot water as boiler feed water. The estimated investment requirement for a typical facility is about Rs 1.5–2.5 million with a simple payback period of 2-2.5 years.

(v) Replacement of existing refrigeration system with energy efficient system

The refrigeration systems in the plant were equipped with reciprocating compressors. The specific power consumption (SPC) of reciprocating compressors is high. These can be replaced with screw compressors having 10-20% less SPC as compared to reciprocating type. The estimated investment requirement for a typical facility is about Rs 2.0–2.5 million with a simple payback period of 1.5-2 years. Also the entrie system can be replaced with ammonia-carbon dioxide refrigerant system in which ammonia is avoided in the process area and secondary CO_2 circuit carries heat. These system can give energy saving of about 35%. The investment required for typical facility is about Rs 30– 40 million with a simple payback period of 5-6 years.

(vi) Use of high efficiency/low heat illumination system

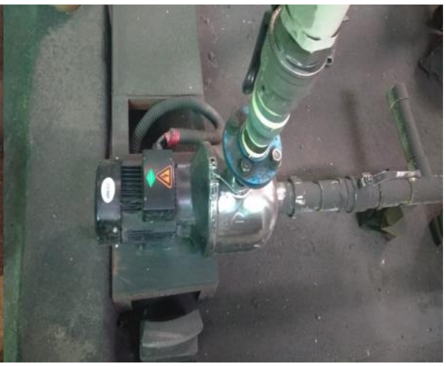
The electricity share of illumination system in a typical processing plant is about 1–3%. Use of inefficient lighting/ lamps not only consumes more power but also increases heat load on the refrigeration system. To avoid additional load due to illumination system, energy efficient lighting sources which produce low level of heat and equal lumen level may be installed. LED light is one of the best options which produces quite small quantity of heat but delivers equal lux level with comparatively very less power. LED lights are claimed to produce minimum 80% of original light output with a life of about 50,000 hours. Use of LED lighting will help in reducing electricity bills required for illumination system up to 55% with a simple payback period of 2 years.

(vii) Replacement of old centrifugal pumps with horizontal multistage mono-block pumps

Old single stage pumps consume more power due bigger size of motor with reference to its flow and pressure output. These pumps can be replaced with energy efficient horizontal multistage mono-block pumps, which can give 30 to 50% energy savings with immediate payback period. All the fisheries industries use mono-block pumps of rating 10-15 hp for cooling tower water circulation, which do not have long life, hence these pumps can also be replaced by multistage mono-block pumps of lower electric rating for same head and flow requirement.

(viii) Use of energy efficient IE3 standard motors

CT monoblock pump



Horizontal multistage pump

Rewinding of motors result in a drop in efficiency by 3-5%. It is better to replace all old motors, which have undergone rewinding three times or more. The old rewound motors may be replaced with EE motors (IE3 efficiency class). This would results into significant energy savings with simple payback period of 2 to 3 years. Reciprocating chillers have electric motors of rating 50HP and 75HP depending on TR rating of chiller, these motors are currently of IE2 standard and hence can be replaced by IE3 standard motors.

Motor rating kW	IE2 Efficiency (2 Pole), %	IE3 efficiency (2 Pole), %	Percentage energy saving, %
2.2	83.2	85.9	2.7
3.7	85.5	87.8	2.3
5.5	87	89.2	2.2
7.5	88.1	90.1	2
11	89.4	91.2	1.8

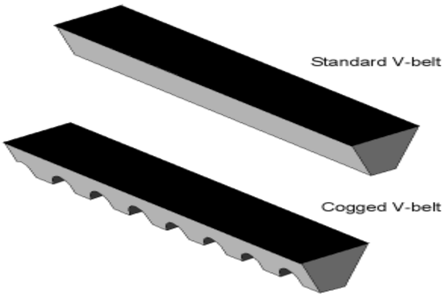
**Source: Siemens IE3 motors brochure*

(ix) Use of cogged v-belts

The driving motors are generally coupled with flat V-belts. The transmission efficiency of flat V-belt is around 90–92%. It is recommended to use cogged V-belt instead of flat V-belt. The transmission efficiency of cogged V-belt is 3–5% higher than flat belt. Reciprocating chillers compressors are belt driven using flat V-belts which have more slip and can be repalced with cogged V-belts.

Cogged V-belts use a trapezoidal cross section to create a wedging action on the pulleys to increase friction and the power transfer capability of belts. V-belt drives can have a peak efficiency of 95-98%. They play a dynamic role in allowing for heat dissipation and better contact with the pulley. There are several other potential benefits of using cog belts which include (i) less slippage at high torque, (ii) low maintenance and re-tensioning and (iii) suitable for wet or oily environments.

Flat V-Belt



Cogged V-Belt

Major stakeholders

The major stakeholders in Veraval seafood processing cluster include the following:

- *MPEDA (The Marine Products Export Development Authority)*: MPEDA was established by the Government of India in 1961. MPEDA plays the role of promoting and developing export of marine products and subsequently seafood export promotion has become an integral part of policy frame works of the Government of India. MPEDA works for facilitating subsidy on fishery exports. Its action is to develop and augment the resources required for promoting the exports of all varieties of fishery products.
- *SEAI (Seafood Exporters Association of India)*: SEAI was incorporated with the objective to protect and promote the interest of the companies engaged in the seafood business and to develop the international trade of seafood from India. SEIA work as an inspection agency which monitors quality and does sample testing for export oriented units.
- *Veraval GIDC Association*: Veral GIDC Association is a local entity which organises seminars and workshops for awarness about new financial schems, government rules and compliances for MSME industries in the cluster. The association has established, operates and maintains common effluent treatment plant (CETP) for water treatment of industrial areas and also looks after physical infrastructure development like roads, drainage system in the cluster.

Cluster development activities

Educated and trained man power is important towards development and management of vast fisheries resources. To meet these objectives, College of Fisheries was set up at Veraval under the aegis of the Gujarat Agricultural University by the Government of Gujarat. With the bifurcation of Gujarat Agricultural University, the college became constituent college of Junagadh Agricultural University. Trained and skilled manpower from this facility is available for industries for hiring.

About TERI

A dynamic and flexible not-for-profit organization with a global vision and a local focus, TERI (The Energy and Resources Institute) is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to tackling issues of global climate change across many continents and advancing solutions to growing urban transport and air pollution problems, TERI's activities range from formulating local and national level strategies to suggesting global solutions to critical energy and environmental issues. The Industrial Energy Efficiency Division of TERI works closely with both large industries and energy intensive Micro Small and Medium Enterprises (MSMEs) to improve their energy and environmental performance.

About SDC

SDC (Swiss Agency for Development and Cooperation) has been working in India since 1961. In 1991, SDC established a Global Environment Programme to support developing countries in implementing measures aimed at protecting the global environment. In pursuance of this goal, SDC India, in collaboration with Indian institutions such as TERI, conducted a study of the small-scale industry sector in India to identify areas in which to introduce technologies that would yield greater energy savings and reduce greenhouse gas emissions. SDC strives to find ways by which the MSME sector can meet the challenges of the new era by means of improved technology, increased productivity and competitiveness, and measures aimed at improving the socio-economic conditions of the workforce.

About SAMEEEKSHA

SAMEEEKSHA (Small and Medium Enterprises: Energy Efficiency Knowledge Sharing) is a collaborative platform set up with the aim of pooling knowledge and synergizing the efforts of various organizations and institutions - Indian and international, public and private - that are working towards the development of the MSME sector in India through the promotion and adoption of clean, energy-efficient technologies and practices. The key partners are of SAMEEEKSHA platform are (1) SDC (2) Bureau of Energy Efficiency (BEE) (3) Ministry of MSME, Government of India and (4) TERI.

As part of its activities, SAMEEEKSHA collates energy consumption and related information from various energy intensive MSME sub-sectors in India. For further details about SAMEEEKSHA, visit http://www.sameeeksha.org