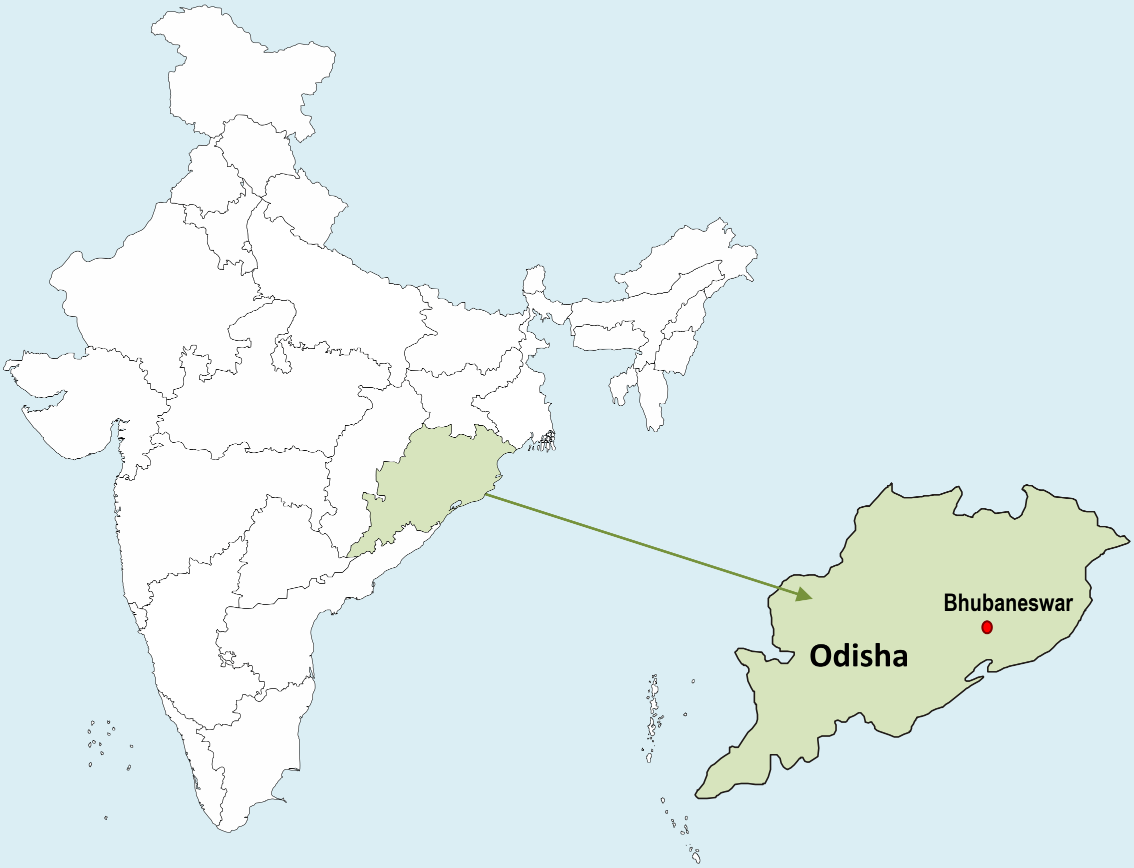
Cluster Profile
Bhubaneshwar seafood processing industries



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Promoting Energy Efficiency in SMEs
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Contents

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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.

Odisha seafood processing industries

Overview of cluster

Fish is one of the most important foods for habitat in costal India. Organized fish culture in India started flourishing in early 20th century and by mid-century Fisheries Department was established in states such as Tamil Nadu, Andhra Pradesh, Odisha and West Bengal to support the activities, not only to meet domestic demands but also to promote as a business option. Till mid 1950s culture of crap was restricted in India. Technological breakthroughs revolutionized aquaculture and seafood processing in late 50's. The growth in processing infrastructure in India is a result of (1) increase in marine fishery, inland fishery, freshwater aquaculture, brackish-water aquaculture and better utilization of catch within country and (2) increase in fish trade of high value product to developed countries and low value products to developing countries. The processing infrastructures were setup near landing centres to minimize time lost in transport of the catch. About 95% of the seafood processing units are concentrated in 20 major clusters located in 9 states[1]. India stands 11th in processed seafood exporters in the world.

Major concentrations of seafood processing plants in Odisha
Source: Google Maps

Odisha is blessed with 480 km of coastline and is one of the important states with respect to the development in fishery sector. In 1949 a "Pond Culture Division" was established in Cuttack. The state fishery department is actively working for improving productivity and production capacities. Presently, major species processed in Odisha includes Tiger Prawn, Brown Shrimp, and some fishes. A species called "L. vannamei" primarily found in Latin America is being cultured in brackish-water in Odisha and is expected to increase production in coming years. Bhubaneswar has about 39 storages (cold and chilled) and is one of the important seafood processing hubs in the country.

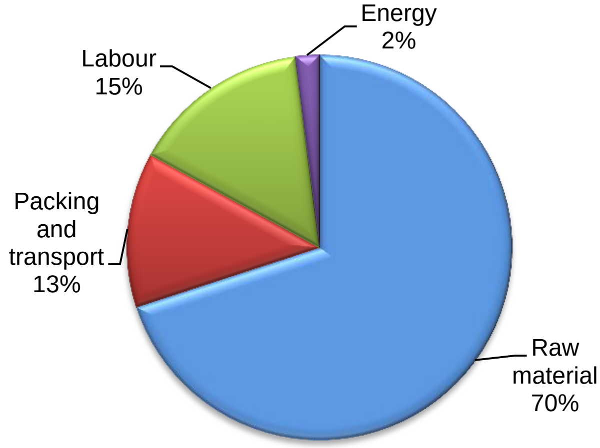
There are 43 registered exporters in the cluster of which 26 are active. There are 21 processing plant in the cluster and 16 of these are active throughout the year, remaining 5 units undertake processing only during peak season. About 10 merchant exports exist in the cluster, who utilize processing faciltities of other exporters to carry out their business. A major concentration of processing plants is located in Patia industrial area and Mancheswar industrial estate with six plants in each area. About three processing plants are located in Paradip and one processing plant is located on outskirts of Bhubaneshwar towards Berhampur.

The total annual turnover of Odisha seafood cluster is estimated to be Rs 2,070 crores, majority of which comes from exports. The cluster is known for exporting shrimps to several countries in five continents including Japan, USA and Southeast Asian countries such as Thailand, Vietnam. Four processing plants in the cluster are exporting to European Union. Shrimps production is in excess of 90% in the cluster and only about 10% of total production are other fish species. Some of the

[1] FAO, Fisheries and Aquaculture Department; ftp://ftp.fao.org/FI/DOCUMENT/fcp/en/FI_CP_IN.pdf

prominent seafood processing industry in the cluster includes Falcon Marine, Magnum Sea Foods, Surya Udyog and Teekay Marines.

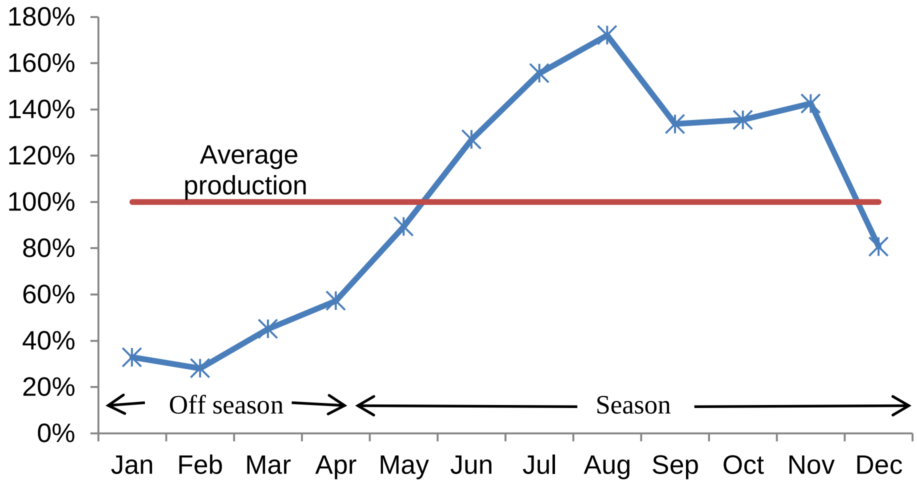
The raw material i.e. fish is the single major cost for processing industry and accounts for about 70% of total input cost. Other major costs include labour, packaging and transport and energy (figure). The yeild of the plant is related to the recovery from raw fish/ shrimp. The shrimp is the major product and production of headless shrimp (blocks made in plate/blast freezer) has a recovery of about 65-70%. The 'individually quick frozen' (IQF) shrimp is completely shell-less (mainly exported to European Union) and its recovery is about 55%.



Input cost components

Product types and production capacities

The cluster has 16 active processing units. The capacity utilization of these units varies according to fish capture and culture (season and off-season period). January to early April is "off-season" period and is marked by a production 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.



Seasonal variation of production

All of the 16 processing plants produce ready-to-cook (RTC) products. The two large processing plants are also involved in production of ready-to-eat (RTE) products apart from RTC products. However, RTC is the predominant product in the cluster. Based on their production levels, seafood processing units can be categorised under A, B and C as follow:

Categorization of seafood processing plants

Category	Production (tonne/month)	Employment* Season (off-season)	Turnover (Rs crore/year)
A	50	100 (25)	25
B	150	200 (50)	70
C	750	500 (150)	200

It may be noted that a majority of seafood processing units fall under category A and can be termed as small scale. About six units fall under category B and are medium scale. The two large industries Magnum Sea Foods and Falcon Marines fall under category C. The total production of processed seafood in the cluster is about 110 tonnes per day (~33,600 tonnes per annum). During peak season, the plants run at 100% capacity but in remaining time the capacity utilization is as low as 20%. Average capacity utilization of plants is in range of 40–60%. Some of the major products in the cluster such as tiger shrimp and fish (figure).

Major products of the cluster

Production process

The major steps of process are 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) Raw material reception

Fresh or frozen fish/shrimp is received from cold storage transport at reception yard. It is visually inspected for product specifications such as appearance, odour, texture, foreign matter, species homogeneity and physical characteristic such as size of fish as per procurement order. The raw material is visually inspected by skilled personnel before washing it. Fish is rejected if it contains harmful, decomposed or extraneous substances which cannot be removed or reduced below a tolerable level. The fish is washed in a special washing table. After washing, it is stored in container with flake ice to maintain its temperature 0°C to +4°C.

Washing table

(ii) Fish preparation

Fish preparation includes beheading, gutting, skinning and trimming. The shrimp is brought to working platforms (steel tables with proper drain arrangement). Skilled workers remove the heads of fish/shrimp, de-gut it and 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, thus causing faster cooling of product, but in the meantime it 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 ice demands. Once shrimp 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 five tonnes of water is used. The shrimp is then sent for further processing.

Fish preparation

(iii) Grading

In category-A units, grading is manually done by skilled workers, whereas the category B & C units have installed grading machines. In these machines, size/grade can be set based on product (species of fish/shrimp). The shrimp is graded based on size; size plays an important role in selling price of the shrimp.

Grading

(iv) Freezing

The graded product is brought to preparation platform. Based on market requirement, the shrimp 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 little water. This package is stacked in plate freezer or blast freezer. The plate freezer operates in batch mode. Shrimps for European market is segregated and sent to IQF machine. The typical operating temperature of plate freezer is –40°C with a cycle time of 2-4 hours per batch. Typically category-A units have two plate freezers and one blast freezer. Category B & C units have about four to six plate freezers. Units exporting to Europe are equipped with 2 to 3 IQF machines.

IQF product

(v) Labelling and packing

The output is glazed and sent for packing in cartons and labelled accordingly. In freezer the product can develop surface drying due to excess cooling. To avoid excessive drying, glazing is done. Glazing is the application of protective coating of ice on frozen shrimp.

Product packing

Moreover, 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 are equipped to maintain products at or lower than –18°C. The set temperature of cold storage facility is typically –23°C.

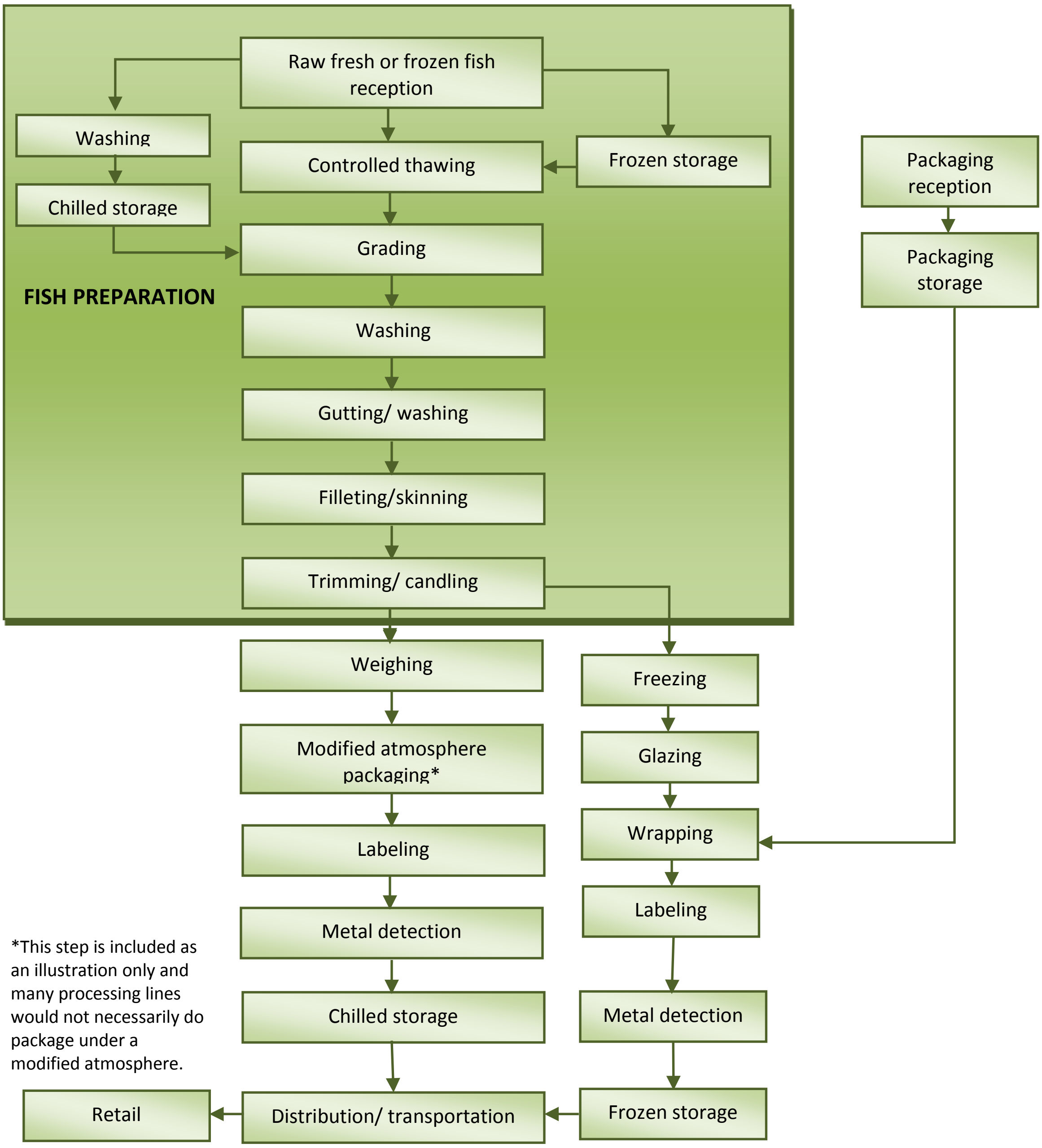
Cold storage

All the plants have diesel generator-set (DG set) installed to support cold storage in case of scheduled or unscheduled power outage from electricity utility. Most of the cold storages are ammonia based refrigeration system.

(vii) Despatch

The products in cold storage (CS) follow first-in-first-out principal. The products in cold storage can have self-life of about ten months without deterioration of quality. However, the products are generally despatched within three months. Category-A units have an overall storage capacity of about 150 tonnes; category B and C units have 450 tonne and 750 tonne storage capacities respectively.

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



Process flow diagram of seafood processing

Technologies employed

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

(i) Freezing

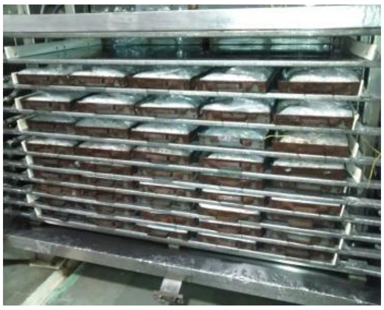
Fish starts spoiling immediately after death and this is termed as 'Rigor mortis'. Fish consists mainly of water (typically 60–80%) and freezing converts this water to ice by removal of heat. By lowering the temperature of fish below sub-zero level, the bacterial activity is either slowed down or inhibited, 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/shrimp either in shelves or plates and once freezing is achieved the freezer is emptied and reloaded for next batch. The warmest part of fish/shrimp must be brought to below –18°C and to achieve this cold air is blown at –40°C.

Plate freezer

In this freezer, the fish/shrimp is under direct contact with refrigerated surface. The surface is metallic and hollow in nature in which the refrigerant circulates. Two types of plate freezers are commonly used – horizontal and vertical. In horizontal plate freezer (HPF), packed fish/ shrimp product is placed and made to have contact with both top and bottom plates by compressing them. In vertical plate freezer (VPF) fish is loaded directly in bulk from top without any packing and is typically used to freeze whole fish at factory near sea. These freezers typically are equipped with temperature sensors to cut-off the cold air flow once set temperature is achieved.



Horizontal plate freezer

IQF Freezer

IQF is mostly used for freezing shrimp 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 shrimp. Quick freezing is obtained either by placing shrimp 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.

IQF Freezer

(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.

Refrigeration system

(iii) Cold storage

Cold storages are typically of capacity 150–1,000 tonnes depending on plant production capacity. 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 to processing plants is supplied by Central Electricity Supply Utility of Odisha (CESU). 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. The consumption of diesel is marginal in overall energy consumption and is procured from local market. The industry falls under agricultural sector (processing) and get electricity at a lower tariff than industry sector in the state. The details of energy sources and tariffs are shown in table.

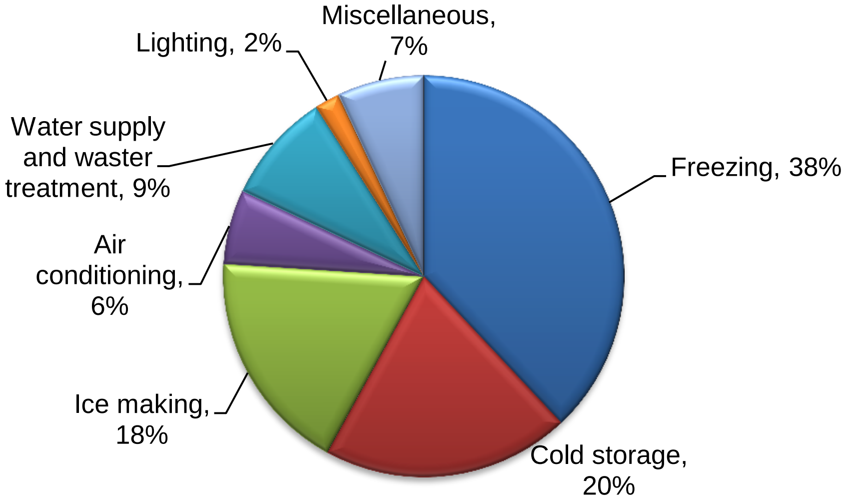
Prices of major energy sources

Source	Remarks	Price
Electricity	Central Electricity Supply Utility of Odisha	Energy charge : Rs 4.1 per kWh Demand charge : Rs 50 per kVA per month
Diesel	Local market	Rs 50 per litre

Energy consumption

Energy is consumed in raw material handling and movement, 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 plant and level of automation. The share of energy usage in a typical processing unit is given in the figure.

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



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 1,520 kWh per tonne of production (based on assumption that 90% of total production is shrimps and 10% is fish of other species). The SECs of category-C processing plants is as low as 1,100 kWh per tonne during season. It can be as high as 2,850 kWh per tonne for Category-A units during off-season. Diesel generator set (DG set) accounts for under 10% of total energy consumption. Overall SEC of shrimp processing plant in cluster inclusive of diesel consumption is about 154 kg of oil equivalent (kgoe) per tonne of production which is far more than the international SEC 83 kgoe per tonne as reported by FAO in 2015[3]. 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	950,000	20	101	5.3
1800	2,750,000	55	289	15.2
9000	13,000,000	200	1,310	69.0

(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 Odisha seafood processing cluster is estimated to be 5,170 tonnes of oil equivalent (toe). The equivalent carbon emissions from the cluster are about 46,859 tonne of CO_2. The overall energy bill of cluster is estimated to be Rs 275 million.

[3] Fuel and Energy Use in the Fisheries Sector, FAO, 2015

Energy consumption of the Odisha Seafood Processing cluster (2015-16)

Energy type	Annual consumption	Equivalent energy (toe)	GHG emissions (tonne CO_2)	Annual energy bill (million INR)
Electricity	50.1 million kWh	4,310	44,589	230
Diesel	890 kL	860	2,270	45
	Total	**5,170**	**46,859**	**275**

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

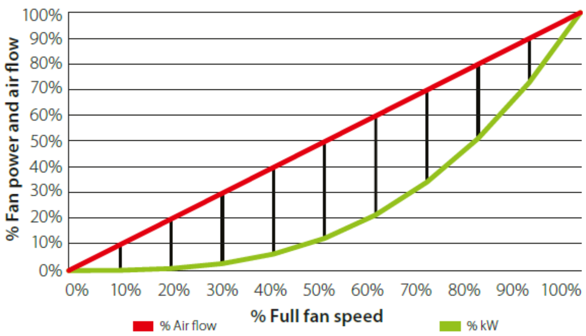
The pressure drop across the evaporator and condenser is generally within 0.2 bar. A thumb rule indicates that about 0.1 bar pressure drop corresponds about additional 7% power consumption. It calls for estimating pressure drop between generation and end-use points, by installing two identical calibrated 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. Frsot 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.

Frost formation

(ii) Refrigeration system controls

The major components of refrigeration system in a seafood processing plant includes compressors, evaporators and condensers. 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 (kW per TR) close to design values. Most of facilities in Odisha cluster do not have automatic control system and 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. Morover, the heat released by fan motor is added as additional heat load to the refrigetation system. It could be



Effect of fan speed on power & air volume

Source: Oxford Cold Storage Company

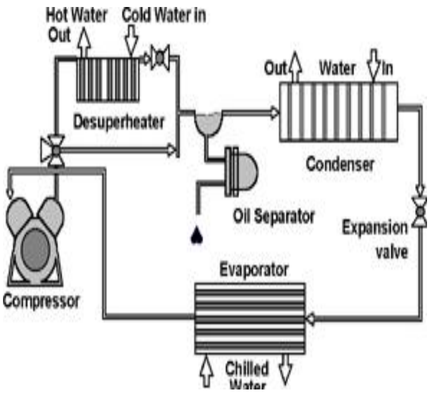
addressed by installing VFD on evaporator with ON/OFF control. This will allow evaporator fans to circulate air as per load variations. For operation of compressor, condenser and evaporator in a closed loop system, the control assembly would require sensors to capture correct (average) temperature of 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 lowest 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 on condenser fans can be installed 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 de-superheater on ammonia chiller

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.



Positioning of de-super heater

(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, whose SPC about 10–20% less than 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.

Major stakeholders

The major stakeholders for seafood processing plant are the following:

- *MPEDA (The Marine Products Export Development Authority)*: MPEDA was established by the Government of India in 1961. MPEDA played 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. Its action is to develop and augment the resources required for promoting the exports of all varieties of fishery products known commercially including shrimps and fish.
- *SEAI (Seafood Exporters Association of India)*: SEAI was incorporated with the main 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.

The Government of Odisha has ambitious plan to increase revenue from seafood sector fivefold by 2020 from baseline figures of 2014-15. The plan, programme and policies of Fishery Sector are carried out through the Directorate of Fisheries in the state. It is basically a service sector and extension oriented technical Department, which promotes scientific aquaculture in the state and look after the welfare of Fisher folk. In order to achieve the ambitious target the directorate had setup an Export Promotion Cell in 2015. The cell imparts training to farmer in best aquaculture practices and involves experts to promote export of fisheries product from Odisha[4].

Cluster development activities

Deras seafood park is a central seafood processing centre (CPC) located in Deras. The cluster is located strategically to capture domestic, national and international market. The cluster enjoys special incentives on investment and tax rebates through Odisha Food Processing Policy. The cluster will also have a research & development centre[5] along with skill development and training centre to provide continuous and timely inputs for enhancing efficiency and ensuring continuous skill availability respectively. It is expected to house about 35 processing plants employing about 10,000 people.

[4] http://www.odishafisheries.com/

[5] http://investodisha.org/Application/uploadDocuments/Content/Seafood_Park_Brochure.pdf

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.

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Swiss Agency for Development and Cooperation SDC

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.

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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