Cluster Profile
Ludhiana Bakeries

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Promoting Energy Efficiency in SMEs
SAMEEEKSHA

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Certificate of originality

Original work of TERI done under the project "INDIA: TERI-SDC Partnership: Scaling up Energy Efficient Technologies in Small Enterprises (EESE)"

Suggested format for citation

TERI. 2017
Cluster Profile Report – Ludhiana bakeries
New Delhi: The Energy and Resources Institute 14 pp.
[Project Report No. 2014IE15]

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This document is an output of a research exercise undertaken by TERI supported by the Swiss Agency for Development and Cooperation (SDC) for the benefit of MSME sector. While every effort has been made to avoid any mistakes or omissions, TERI and SDC would not be in any way liable to any persons/organisations by reason of any mistake/ omission in the publication.

Published by

T E R I Press
The Energy and Resources Institute
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi-110 003
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Acknowledgements

TERI places on record its sincere thanks to the Swiss Agency for Development and Cooperation (SDC) for supporting the long-term partnership project focusing on energy intensive MSME clusters in India.

TERI team is indebted to Mr Vijay Kumar (Director, MSME-DI, Ludhiana) Mr R K Parmar, (Assistant Director, MSME-DI, Ludhiana) for organising field visits interactions with entrepreneurs of bakeries in the cluster during the study. The support provided by Mr S S Bedi, (Senior Manager, Chamber of Industrial & Commercial Undertakings, Ludhiana) and Mr Ramesh Mago, (President, All India Bread Manufacturer's Association) were extremely useful in understanding bakery cluster in Ludhiana. We are extremely thankful to Mr Amit Sharma, Mr Sandeep Sharma and Mr Sahil Dhingra of Vast Linkers Pvt Ltd for coordinating industry visit and accompanying us to industrial site during interaction with entrepreneur and shop floor visit. The data and information provided by entrepreneurs Mr Inderjit Singh (Khalsa Engineers), Mr Vikram Malik (Anand Kartar Bakery), Mr Narinder Singh (Bawa Bakery) and Mr Mohit Arora (Kipps Bakery) were immensely useful for analysis of energy consumption and preparation of cluster profile report.

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

Ludhiana bakeries

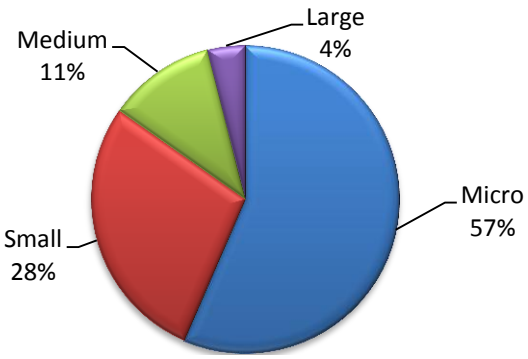
Overview of cluster

Ludhiana is known as the industrial capital of Punjab. The city lies between north Latitude 30°34' & 31°01' and east longitude 75°18' & 76°20'. It is bounded on the north by River Sutlej which separates it from Jalandhar district. Post-independence of India, number of industries started booming in the city to support the agriculturally rich area. Initial development was of agricultural implements, tractor industries; slowly growth was seen in allied industries such as forging, foundry, sheet metal and auto-parts as well. The city is home to some of top national cycle brands such as Hero and Avon. In early 1990s Ludhiana started supplying products to entire India and also to Middle East and Europe. There are about 39,000 industries distributed over 20 industry estates in Ludhiana. A variety of products such as cycle & its parts, sewing machine parts, auto parts, forging, machine tools, hosiery, knitwear and woollen garments, electronics goods, plastic & rubber goods are being produced in the city in big way by small and medium industries. A few prominent industries in Ludhiana cluster are Vardhman Spinning and Polytex, Oswal Cotton Spinning Mills (Textile) and Hero, Avon, Rockman (cycle).

Bakery units in Ludhiana

Source: Google map

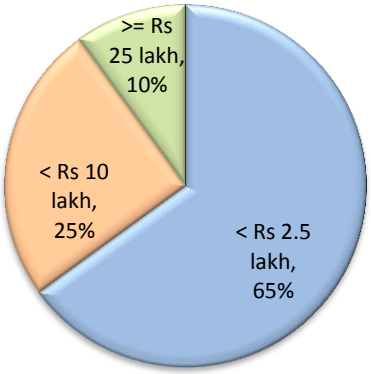
Under the food processing sector, bakery and soya processing are quite common in Ludhiana. There are a number of popular brands of bakery products like Bonn, Kitty, Cremica and Supreme. There are around 200 bakeries and soya industries under MSME sector. These industries are located in different locality like Sarabha Nagar, Hussainpura, Kohara, Bhai Himmat Singh Nagar. Most of the micro and small bakeries has mainly captive retail outlet, which bake in the back yard and sell at the front outlet. There are also established bakery units having production unit at one place from where all the products are made and distributed to different retail shops. Ludhiana bread industry enjoys the distinction of supplying bread to the entire north region comprising Punjab, Haryana, Himachal Pradesh, Chandigarh, parts of Rajasthan, Uttaranchal and Uttar Pradesh.



Distribution of bakeries (category-wise)

There are about 170 bakeries operating in the cluster which are scattered across the city. Apart from bakery, there are also around 30 soya processing industries engaged in manufacturing soya milk and paneer (Tofu as brand). The number of baking ovens in a bakery plant varies between 2 and 6 depending upon its daily production capacity. However, captive and micro level entrepreneurs mostly use one oven to meet demands.

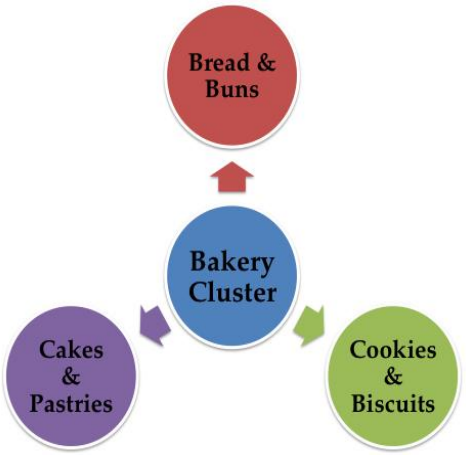
More than 100 units in the cluster have a turnover of less than Rs 2.5 lakh per month. A few units are of medium in size (20 numbers) with a turnover of over Rs 25 lakh per month. The total turnover of bakery and soya processing industries in Ludhiana cluster is estimated to be about Rs 125 crore with annual aggregate production about 2500 tonne (excluding 7 large bakeries). The bakery industries provide direct or indirect employment to more than 6000 people.



Distribution of bakeries
(Monthly turnover-wise)

Product types and production capacities

The bakery units in Ludhiana cluster are very popular for their tasty, quality and variety of baked food items like rusk, paav, pizza, bread, bun, biscuits, cream roll, matthi, namkeen, toasts, puffs and cakes. These products can be grouped primarily into three types of products such as (1) Breads and buns, (2) Cookies and biscuits and (3) Macaroons. These products have further categories based on their ingredients like there are cakes, which are made up of chocolate, strawberry, pineapple, etc. Products like cakes are custom made to meet the demands of customers. The production levels of bakeries quite varying based on demands. The production and installed capacity of the similar industries in the cluster vary from one unit to another; even production of a unit is also not constant during the year. The production data is generally available only in terms of number of pieces produced for a particular product.



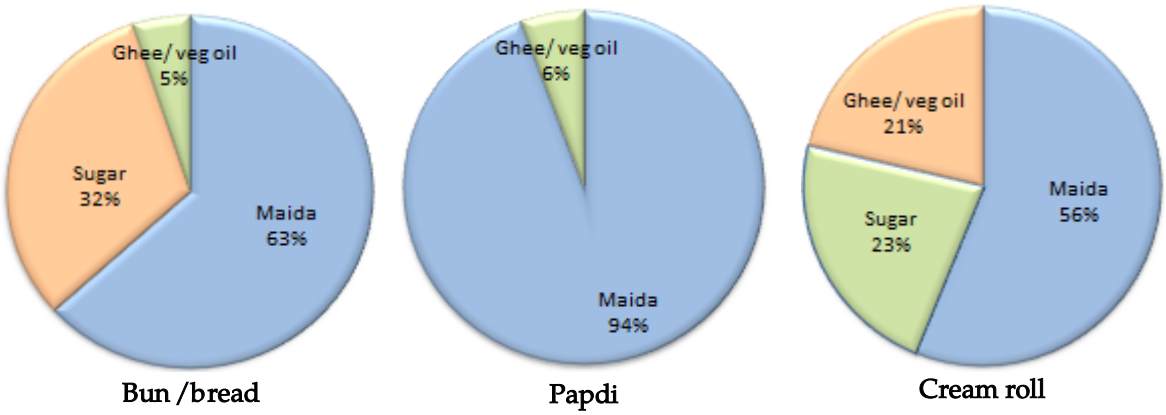
Primary products

Raw material usage in the cluster

Different ingredients used for preparation of bakery products include maida, sugar, ghee/ vegetable oils. The finite share of each ingredient depends on type of bakery product and bakery involved in making those. These ingredients are sourced from local retails market by small bakeries but medium units make bulk procurement from wholesalers.

Basic ingredients for bakery products

The weight of products depends on their type e.g. bun – 240 mg, papdi – 275 gm and cream roll – 750 gm. Of these, cream roll fetches better revenues. A vast majority of these bakery products caters to local market. The base ingredients across all bakery products include maida, wheat powder, ghee and vegetable oil, which may be around 70% except for papdi/matthi (100%).



Raw materials used in bakery products

Energy scenario in the cluster

A majority of the baking ovens (83%) uses diesel as fuel in baking process. Electricity is used to drive equipment such as grinder, mixer, blower, air compressor and motor. Diesel is procured from local market. There are captive bakeries with electrical ovens for baking; few medium size bakeries have switched over from diesel fired to LPG fired systems. LPG is procured in commercial cylinder from local vendor. Electrical power supply to the bakeries is either under non-residential supply or industrial consumers for small power. The average connected load of a bakery unit depends on installed capacity and type of products. Most of the units have LT connection (excluding large units). The power situation is good and hence the dependence on DG set is generally negligible.

Prices of major energy sources

Raw material	Remarks	Price
Electricity	Non-residential supply (for loads up-to 50 kW)	Energy charge (up to 100 kWh) : Rs 6.53 per kWh Energy charge (above 100 kWh) : Rs 6.75 per kWh Demand charge: Rs 190 per kW per month
	Industrial consumers for small power	Energy charge : Rs 5.47 per kWh Demand charge: Rs 157 per kW per month
Diesel	Retail shop	Rs 60 per litre
LPG	Local vendor	Commercial cylinder, Rs 50 per kilogram

Production process of bakery products

The major steps involved in bakery products are mixing of ingredients, shaping and sizing, baking, curing and packing & despatch. The generic process steps followed by the unit are briefed below:

(i) Raw material procurement and weighing

Raw materials such as sugar, flour, ghee and other ingredients are procured and weighed as per recipe requirement. Weighing is done carefully to avoid any changes in proportions of ingredients which otherwise may affect the product quality.

(ii) Raw materials mixing, dividing and shaping

Different ingredients are mixed in blending machine and poured into the moulds as per required shapes. In some products, the moulds are cut into various sizes.

(iii) Resting /proofing and baking

The prepared moulds are kept for yeast action where mixer of ingredients balloons up in case of buns and breads. The fermented products are baked in ovens at different temperatures as per product type. Baking operation is done in batches.

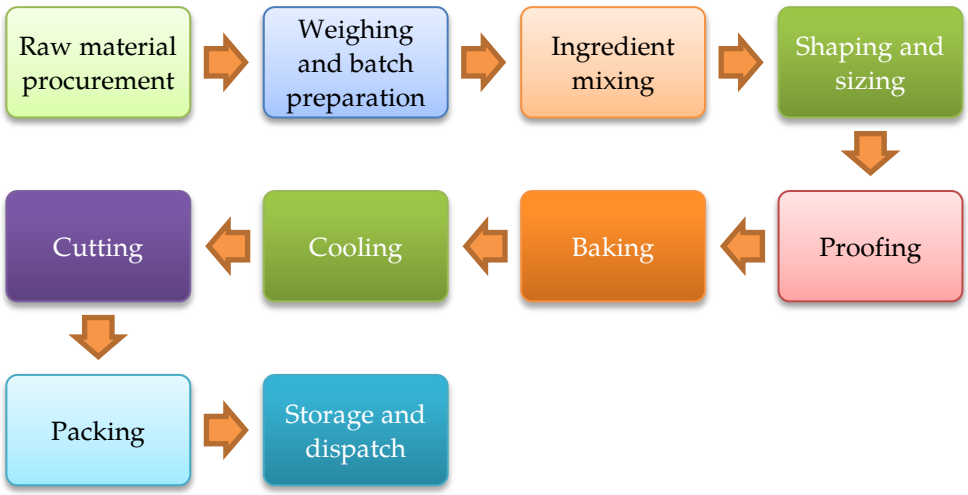
(iv) Cooling and cutting

The baked products are taken out and kept for natural cooling. Cutting of the baked products in case of buns and breads is done manually and then sent for packing.

(v) Packing and despatch

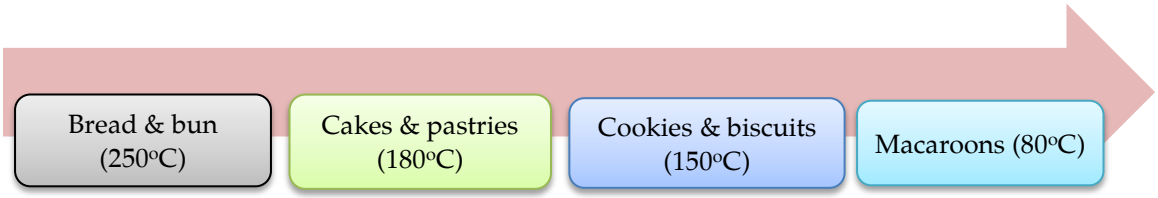
The final products are packed in the plastics wraps and sent to retail shops.

The generic production steps for bakery products are shown in figure.



Process steps for bakery products

The production processes for different bakery products are almost similar with difference being temperature and time required for baking. Depending on the product type, mixing time also varies. Many units now have started using machines for cutting and shaping purposes which reduce production time. The temperature requirement shows bread and bun require highest temperature of 250°C with longer soaking period in the oven (about one hour) while macaroons requires lowest temperature (~80°C) and time (around 20 minutes). Cakes and pastries are baked at about 180°C and cookies and biscuits are baked at 150°C.



Baking temperature of different products

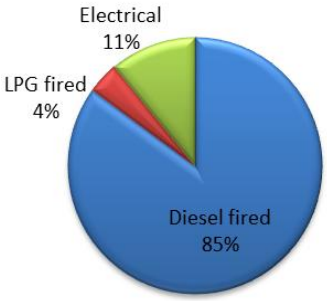
Technologies employed in bakeries

(i) Baking ovens

Baking ovens are used for baking of different types of bakery products. Of the total 170 bakeries existing in the cluster, more than 83% of the units use diesel fired system. A few LPG based units are also provided with moving hangers that help in improved quality of baked products. The rotary ovens are either diesel or LPG fired and are generally equipped with better control system. High-end rotary ovens are also used by few units, which have better control system.

Diesel fired oven

Electrical oven



Types of bakery oven

Most of the ovens in the standalone units are diesel fired while small retail shops have electrically heating ovens. Diesel fired ovens have been equipped with mono-block burners. These burners are of 5-8 litres per hour firing rate.

(ii) Mixers

Mixers are used for preparing homogenous mixture of raw materials or ingredients. Water, generally at room temperatures is added along with basic ingredients for preparing recipe which are product dependent. The mixing machines are conventional machines and require manual interventions for preparation of recipe. The mixers generally have 3-speed arrangement. The motors used in mixers are low capacity of 2 to 3 hp to handle low volume batch recipes. These are conventional machines with simple on-off control system. Some mixers come with timer settings. Presently, there are plenary mixers available, which give better mixing than old conventional mixers. New mixers also require less mixing time. Motors used for these mixers are generally of rating 3 or 5 hp. Some mixers are equipped with timer settings.

Mixer

Production process of soya products

Soya seeds are used to produce soya milk and soya paneer (Tofu as brand). Initially milk from soya is taken out and pasteurized to avoid any bacterial degradation of the milk. Depending upon product, milk is either bottled or used for paneer making. The major steps involved in soya products are soaking in water, milking, pasteurizing, skimming, cooling and addition of additives, chilling of product, storage and dispatch. The generic process steps followed by the unit are mentioned below:

(i) Raw material procurement

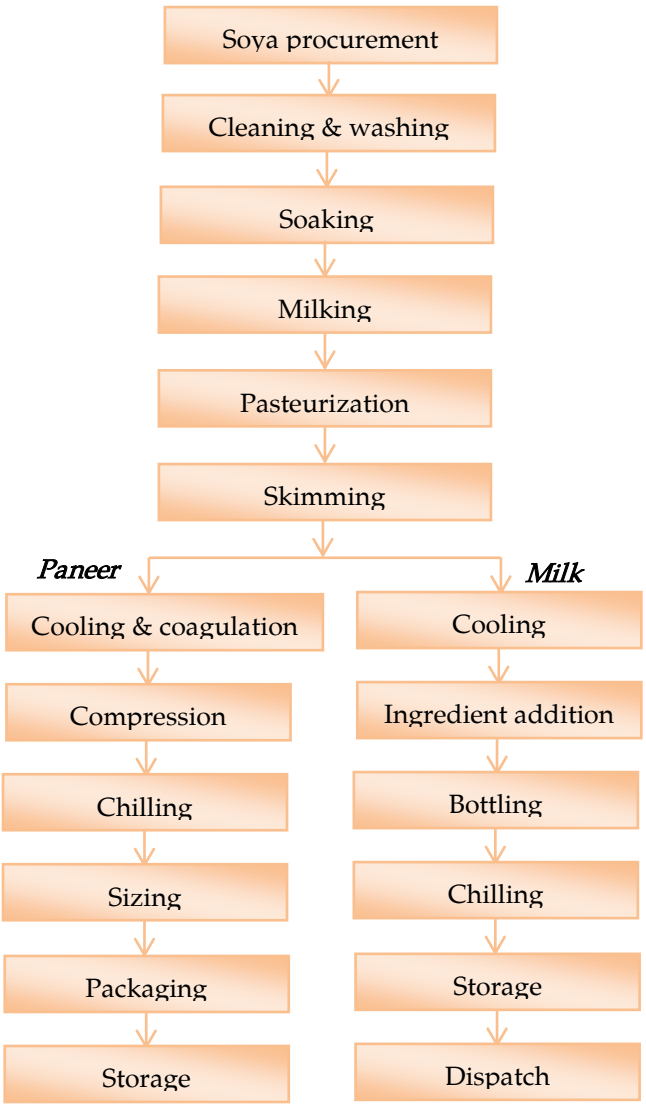
Soya farming is common in Madhya Pradesh, Uttar Pradesh, Maharashtra, Gujarat and Rajasthan. Out of these, Madhya Pradesh produces best quality soya. Soya units in Ludhiana make bulk procurement of soya seed from Madhya Pradesh and Rajasthan. Bulk purchase helps to reduce cost through better negotiation and generally it is bought at Rs 40 per kilogram.

(ii) Cleaning and washing of raw materials

Soya bought from commercial market contains impurities such as sand, stone, leaves, rind and immature soya. Impurities from soya are removed manually and cleaned with raw water.

(iii) Soaking

A batch of cleaned soya is kept immersed in a steel vessel using fresh RO water at normal temperature for a period of 6–8 hours for soaking. Every kilogram of soaked soya roughly becomes 3 kilogram mass by absorbing water. The volume of water for a batch depends on the target end product such as milk or paneer. For making paneer, 1 kg of soya



Production process of Soya products

requires 8-10 litres of water, whereas 6-8 litres of water is sufficient for making milk product.

(iv) Milking

The water from soaked soya seeds is drained out from steel vessel and kept ready for grinding process. A motorised roller arrangement similar to fruit juice extractor is used to extract milk from wet soya. RO water is supplied while grinding is in progress. Normally, about 7 litres of milk is produced from one kilogram of dry soya. Milk is filtered using fine muslin cloth to remove any carryover of soya seed or fibre before it is processed in next step. The by-product of milking process is okara/hull, which is residue of soya after grinding.

(v) Pasteurization

Milk is sterilized in a jacketed closed vessel where filtered milk is heated to 120 °C with the help of steam. A diesel fired baby boiler is used to generate required steam for this purpose. Pasteurization is essential to ensure disinfection of milk, which could be contaminated due to microbial growth.

(vi) Paneer making

Pasteurized milk is used to make either flavoured bottle milk or paneer as final product. For making paneer, the sterilized milk (upto 100°C) is cooled and diluted citric acid as coagulant is added to it for converting milk into paneer. Coagulant is added until clear whey separates from the coagulum. The precipitate is collected in a muslin cloth, hung for some time and then pressed lightly in order to further drain the whey. Paneer is compressed either pneumatically or manually depending upon the scale of operation and the facilities available in the plant. The moisture content in the paneer to be limited to 60% maximum; usually 50–54% is considered to be good. On removal of water, pressed hoops are cooled at 4°C for 10–15 minutes before cutting to size and packing for storage and marketing.

(vii) Milk bottling

Post pasteurization, soya milk is skimmed and cooled. Once cooled, the milk is conditioned with desired ingredients such as sweetener, flavour and other nutrients before either bottling or pouch packing. Packaged milk is chilled and store for delivery to retail shop.

The generic production steps for paneer and flavoured milk using soya are shown in figure.

Technologies employed in soya processing

(i) Grinder

An electrically driven roller shaft is used to extract juice from soaked soya, which is known as soya milk. Rating of motor depends upon the capacity to be handled, commonly 2–3 hp motor is used to process 50 kg soya per day, which is common in small capacity units in the cluster. The grinder consists of cylindrical stainless steel vessel with a funnel on top of a grinding roller. The soaked soya and RO water are fed from the top funnel. It has two separate outlet provisions, one for milk extract and other for removing soya residue (okara). Grinders are manually operated in batch mode.

(ii) Boiler and pasteurizer

A diesel fired small baby boiler is used meet the steam requirement for pasteurization of soya milk. Steam is supplied to the annulus space between the jacketed steel vessels. The consumption of diesel in the boiler for processing of 50 kg soya per day is 20 litres.

(iii) Air compressor and pneumatic compression

Cylinder mounted small reciprocating compressor is used to meet the compressed air requirement used in pneumatic compression to remove water from paneer. In small plant, this operation sometimes is undertaken manually.

Grinder

Boiler & pasteurizer

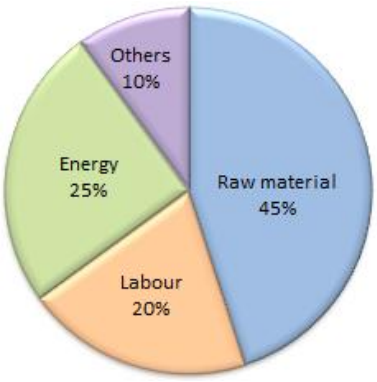
Pneumatic press

(iv) Chiller and refrigerator

Small chiller is used to generate required volume of chilled water to chill paneer and flavored milk at around 4 °C before it is placed in cold storage.

Energy consumption

The major share of energy is consumed in the baking furnace. Mixing of ingredients requires electricity. Other processes such as shaping, sizing, etc. consume less energy but are labour intensive. Raw material cost is the primary share of overall production cost of bakery products, which constitutes more than 45% of the total. The share of energy cost is in the range of 20–25% depending upon type of fuel in use, technology used and operating practices followed.



Breakup of production cost

(i) Unit level consumption

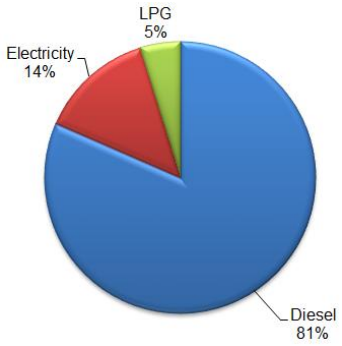
The major energy consuming centre is baking ovens, which are diesel/LPG fired or electrically heated. There are large variations in annual production and energy consumption irrespective of the type of ovens used, which greatly influence the specific energy consumption (SEC). The SECs of bakeries are as follows: 740 kcal/kg for LPG fired and 860–1060 kcal/kg for diesel fired and electrically heated oven. Higher SEC is estimated to higher for diesel fired micro captive bakeries. Depending upon base case, preliminary estimation indicates potential energy saving in the range of 15–30% exists for switching from diesel fired to LPG fired rotary oven. The use of electricity is minimal in case of micro diesel fired captive bakeries, mainly for lighting purposes as all other activities are carried out manually. The typical energy consumption of different types of bakery units is in the range of 3.6-84.1 toe per year as shown in the table.

Typical annual energy consumption of bakery units and soya plants

Unit type	Production (tonne)	Type of oven	Electricity (kWh)	LPG (tonne)	Diesel (kL)	Total energy (toe)	Cost (million INR)
Small	750	Diesel	65,350	-	63	60.3	4.3
Micro	36	Diesel	6,000	-	3.6	3.6	0.3
Micro	36	Electrical	34,100	-	-	2.93	0.30
Medium	1200	LPG	389,610	42.9	-	84.1	6
Small	300	LPG	77,500	12.9	-	21.8	2
Soya	15	NA	12,000	-	7.2	7.3	0.6

(ii) Cluster level consumption

The total annual energy consumption of Ludhiana bakery cluster including soya processing units is estimated 3,294 toe with total GHG emission equivalent to 8,848 tonne of CO_2. The major energy source is diesel accounting for about 81% of total energy consumption. Electricity is estimated to have a share of 14%. Use of LPG is very limited to only progressive entrepreneurs and contributes only 5%. The aggregate thermal energy use from diesel and LPG accounts for about 86% at cluster level.



Distribution of energy in cluster

Energy consumption of the Ludhiana bakery cluster

Energy type	Annual consumption	Equivalent energy (toe)	GHG emission (t CO_2)	Annual energy bill (million INR)
Electricity	5.26 million kWh	452	5,151	39.3
Thermal	1250 kL diesel	2,685	397	7.5
	133 tonne LPG	157	3,300	199.8
Total		**3,294**	**8,848**	**247**

Energy saving opportunities and potential

Some of the major energy-saving opportunities in Ludhiana bakery units are discussed below.

(i) Energy efficient burners for ovens

The diesel fired ovens use mono-block burners with attached blowers. These burners have limitation of reduction in temperature when diesel is off as blower is kept running. This would lead to lower the inside temperature of oven, which increases the overall operating time of the burner thereby increasing the specific energy consumption. These burners also require proper tuning. The mono-block burners may be replaced with energy efficient recuperative type burners which helps in fuel saving.

(ii) Insulating ovens

Rotary ovens are generally provided with ceramic insulation and refractory bricks are used in case of wood fired ovens. It is recommended to use hot face insulation to reduce surface losses. This would include ceramic fibre/ plates, insulating bricks, as required. The outside surface temperature may be

maintained close to a maximum of 20ºC above ambient temperature. This will also reduce heat losses and improve workplace environment.

(iii) Thyristor control for electrical ovens

Electrical ovens used are of resistance heating type. Normally on-off controls are used to control heating cycle. Due to continuous switching, life of heating coil reduces due to thermal shocks and frequent failure occurs. Thyristor control can be used instead of on-off control, which can give around 7-15% energy savings and can increase coil life due to smooth switching with the precise temperature control.

(iv) Direct coupled mixers

The mixers are driven using pulley and belt arrangement. It is preferable to have direct shaft arrangement that would help in reducing transmission losses. This arrangement can also be equipped with automatic 'variable speed drives' (VSDs) which would further energy efficiency of mixers.

Mixers

(v) Reduction of deadweight of baking racks

The products are baked by keeping them on fixtures with multiple shelves which are fabricated locally using mild steel (MS) angles and plates. The MS rack accounts for around 90% of total weight of trolley structure. Both the products and fixtures are heated inside the oven up to set operating temperature (250-80ºC). Since batch operation is followed, the fixture (which provides only support to the product) is subjected to alternate heating and cooling. The weight of fixture can be reduced by introducing stainless steel (SS) mesh trays to replace existing support plates which are kept in the middle. A potential weight reduction to the extent of 20% is feasible without affecting performance. This would enhance the product to fixture ratio and hence would lead to reduction in fuel consumption. The potential energy saving with this arrangement is around 5-10%.

(vi) Switch over from diesel based ovens to LPG based ovens

Diesel based oven are inefficient as well as polluting. The productivity is also low with diesel based ovens and it would be difficult to produce value added/ premium bakery products to meet niche market. It is recommended to switch over to energy efficient systems such as LPG based rotary ovens. The benefits of switchover would include (1) increased production level, (2) enhanced product portfolio, (3) improved product quality, (4) reduced energy costs and (5) lower emissions and improved work place environment. More than 20% diesel consumption can be reduced by converting diesel fired to LPG fired oven. This is equivalent to 645 toe of energy saving (around 95 tonne of CO_2 reduction) at cluster level.

(vii) Replacement of rewound motors with energy efficient motors

The bakery units use rewound motors quite extensively. Rewinding leads to drop in efficiency by about 3-5%. It is recommended to replace all old motors which have undergone rewinding two times or more with EE motors (IE3 efficiency class). This would result in an energy saving of 3-7% result in saving in energy costs. The payback period for EE motors varies from 2 to 3 years.

(viii) Use of cogged v-belts

The 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. They play a very dynamic role in allowing for heat dissipation and better contact with the pulley. There are several other potential benefits of using cogged belts which include (i) less slippage at high torque, (ii) low maintenance and re-tensioning and (iii) suitable for wet or oily environments.

Cogged v-belt

(ix) Residual heat utilisation in ovens

Baking ovens are built with refractory bricks, which stores heat for some time. As temperature requirement for different products is variable, product of highest temperature requirement i.e. bread can be baked in the oven at 250 ºC, after this residual heat in the oven can be utilized by keeping cakes in the oven which requires 180ºC temperature. After baking cakes, cookies or biscuits can be baked at 150 ºC and at last macaroons at 80 ºC can be baked. This gives the complete utilization of residual heat which will help in minimising fuel consumption.

(x) Solar energy for electricity and hot water

The bakery units generally have large area of roof tops which can be used to tap solar enregy. The solar energy can be utilized to replace existing arrangement to meet part of electrical loads. Customised soultions can be developed for unit specific applications.

(xi) Energy efficient lighting

T-12 tube lights (of 52W including choke) and CFL lamps (36W and 45W) are generally used by bakery units in the cluster. These inefficient lightings can be replaced with energy efficient LED lighting (LED tube lights of 10W and 20W) which would provide better illumination and energy savings. Since a large number of lamps are used in the units, the existing lighting may be replaced with EE lighting in a phased manner. The payback period is generally about 2 to 3 years.

(xii) Product branding

The bakeries cater to local demands and their product portfolios are restricted to local demands which are mostly low end products. The local industry associations should target to develop branded products apart from local demands with support from appropriate government bodies and availing financial schemes. This would help in improving market share and sustainability of local bakery industry.

Major stakeholders

The primary stakeholders in the cluster are the bakery units based in Ludhiana, District Industries Centre, (DIC), MSME-Development Institute (DI), government agencies, regulatory bodies, research and academic institutions, testing and training institutes and Business Development Service (BDS) providers in the cluster. The entrepreneurs collectively address the issues related to the local bakery industries and welfare of their employee.

Cluster development activities

There is very little cluster level development activities in Ludhiana with regard to bakeries.

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

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Swiss Agency for Development and Cooperation 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