

WHITE PAPER

# Improving energy efficiency in the food and beverage industry



# Opportunities to reduce energy use in food and beverage production

The food and beverage industry provides the nutrition essential to our daily lives and it will always be required. However, providing food for all over 8 billion people on the planet consumes a lot of energy.



It has been estimated that the food industry consumes 30% of global energy and accounts for 20% of greenhouse gas emissions.<sup>[1]</sup> Demand for food is likely to increase because the global population is projected to grow to over 9 billion people by 2050.<sup>[2]</sup> This, combined with the challenges of reversing climate change, mean that it is becoming increasingly important to reduce both the emissions from and energy used in the food and beverage industry. This white paper takes a look at some of the ways to improve energy efficiency across the industry.



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### Assessing energy use in the food and beverage industry

Because of the importance of food production to society, companies, governments and authorities around the world have assessed the amount of energy used in the industry, and which parts of the value chain consume the most energy. For example, in the EU, the food and beverage industry is one of the most energy-intensive industrial sectors. Looking more closely, it is estimated that food processing alone accounts for 28% of the total energy use in the EU.<sup>[3]</sup> While globally, food processing and transport are estimated to account for about 40% of end-use energy demand.<sup>[4]</sup> As a result, leading organizations like the European Commission, as well as the UN and the OECD, are trying to drive energy efficiency measures throughout the industry.<sup>[5]</sup>

Energy assessments guide decision-making at all levels. At the government level, these assessments are industry-wide reviews which are used to inform energy efficiency policy and the development of new regulations. At the corporate level, the assessments are consultants' reports that give an overview of the business and its operations, and these are used to set sustainability goals and improvement targets. However, it's at the facility level where the real changes are made. This is where new regulations and company guidelines are put into practice. It's where the energy is used during food and beverage production. And it's where equipment and processes can be updated and improved to reduce actual energy consumption.



Food processing in the EU accounts for 28% of total energy consumption.

At the facility level, too, energy assessments help support businesses in making better decisions and they are the first step in improving energy efficiency. With the right tools, customers can perform assessments themselves or they can ask an expert service partner for help. Energy assessments will provide the information and insights needed to identify the energy saving potential of the installed electrical equipment, including motors and drives.

ABB offers expert Energy Appraisals as a service. In addition to our in-depth knowledge of motors, drives, and food and beverage processes, we can offer complete solutions to improve energy efficiency and reduce energy costs.

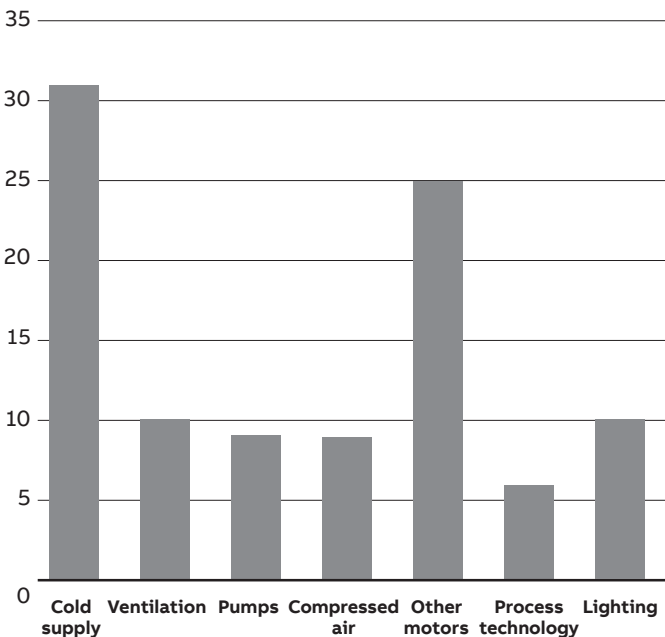
# Identifying areas to improve

In the food and beverage industry the processes that consume the most energy vary by segment. In some segments fans and pumps are responsible for most of the energy use. For example, in the agriculture segment these are feeding and ventilation applications for animals, while in the dairy sector they are cooling and refrigeration. In other segments milling and mechanical processing use the most energy. For example, mills and centrifuges in sugar processing, and grain milling in the ingredients sector. And in confectionary, milling as well as conches, compressors and mixers use most of the energy.

A sugarcane mill was using a steam turbine to run their crusher. When they replaced the turbine with a variable speed drive and electric motor they reduced energy use by over 40%.<sup>[8]</sup>

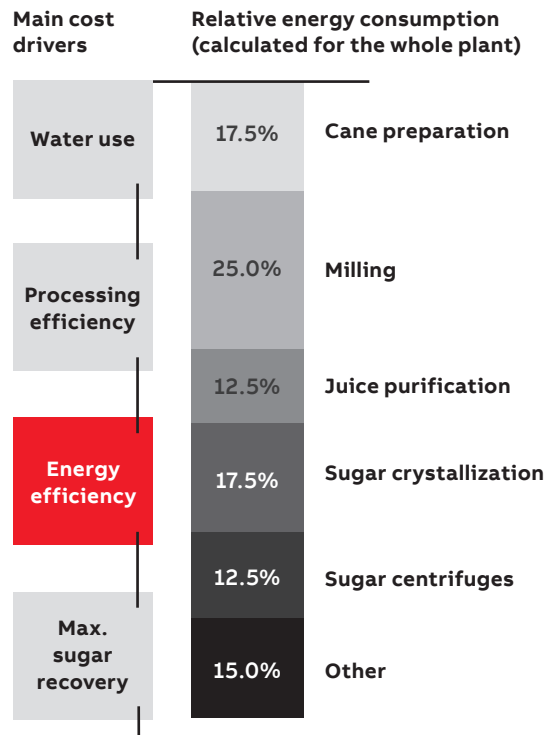
## The processes that consume the most electricity in the food industry rely on motors.<sup>[6]</sup>

Percentage of energy consumption



Most of these processes rely on electric motor systems, including steam systems, pumps and compressors, and heating, cooling and refrigeration systems. However, although electricity consumption in the industry is high, electric motor systems also offer opportunities to save energy, especially in processes that do not run full speed all the time.

## Relative energy in sugarcane processing.<sup>[7]</sup>



Let's take a look at sugar processing to illustrate some of the potential savings that can be found. Sugar production is very energy intensive and therefore sugar factories often have their own power plants. These power plants generally operate on a cogeneration basis, producing both steam and electricity. The amount of energy used by each process step varies and, for example, sugarcane preparation and milling use around 40% of all the energy used in a plant. However, many older sugar factories use a large amount of steam from their co-generation boilers to power their processes, which is inefficient. Converting steam-driven processes to electrically driven ones can significantly improve energy efficiency. For example, an ABB customer was using a steam turbine to run their crusher. When they replaced the turbine with a variable speed drive and electric motor they reduced energy use by over 40%.

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# Ways to improve energy efficiency

Once inefficiencies have been identified, then the most effective solution or combination of solutions can be proposed. This is where domain expertise and knowledge of food and beverage applications is vital. In particular, it is important to understand how modernizing and upgrading individual components will affect the process as a whole. It's also useful to know what the state-of-the-art is and what new options are available.

There are several technologies on the market that have great potential for reducing energy consumption throughout the production chain, including digitally enabled services. In this section, we will take a look at some of the possibilities that these offers.

## Optimize operations with variable speed drives

Many applications in the food and beverage industry are usually run at partial load, like fans, pumps, compressors and conveyor belts. However, these traditionally use mechanical control methods like valves, brakes and throttles to control their speed. In this kind of system, the motor is doing more work than necessary, and energy is being lost through the mechanical speed control.

Variable speed drives (VSDs) offer a more efficient way of running applications at partial load because they can control the speed and torque of an electric motor directly. This eliminates the need for mechanical speed control and oversized motors. With direct control of a motor, it can be controlled to match the actual process demand, enabling applications to run with high efficiency at a range of different speeds. As a result, VSDs can significantly improve energy efficiency throughout whole production chains. Such as in the agriculture sector where ABB solar pump VSD use the clean energy of the sun to operate.

ABB offers VSDs and control software that, together with our application expertise, can be used to optimize various processes throughout the food and beverage industry, ensuring that motor-driven applications, such as compressors, pumps, extruders, conches and conveyors, do the right amount of work at the right time.

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When variable speed drives are used, energy savings can be 25 percent or more.<sup>[9]</sup>

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Globally, around 14% of food produced is lost before it reaches the consumer.<sup>[10]</sup>

Another benefit of VSDs is that they enable precise speed control and this capability can be used to prevent energy and food going to waste during production. This is because maintaining the right machine speed, e.g. in mixing, is very important in the food industry, and entire product batches can be ruined if the ingredients are mixed too fast or too slow. However, since VSDs can ensure the correct mixing speed, they can also help minimize food waste and the associated energy consumption during production. In addition, because food waste is also a major source of greenhouse gas emissions, reducing waste during production also improves a company's sustainability.





### Modernize to more efficient motors

In addition to adding VSDs to improve the efficiency of existing applications, upgrading motors to more efficient models can also improve the overall efficiency of food and beverage applications.

In many countries, energy efficiency classes are set out by the International Electrotechnical Commission (IEC). Classification starts with IE1 which is the lowest motor class, while more efficient models are up to IE5 class. With each increase in IE number, such as from IE2 to IE3, a motor achieves 20 percent lower energy losses. Currently, many motors in use in the food and beverage industry have IE3, IE2, IE1 or even lower efficiency.

In Europe from July 2023, the minimum efficiency class will be IE4 for motors rated between 75 and 200 kW. However, old motors are permitted to continue operating. This means that many facilities are still using older, less efficient IE1 and IE2 motors. These old motors consume significantly more power than newer models, resulting in greater emissions. Synchronous reluctance motors (SynRM) offer an even higher level of efficiency – IE5. Upgrading from an IE3 motor to an IE5 cuts energy losses by 40 percent. Continuing to use older, less efficient motors is a false economy. When upgrading motor, highest motor efficiency should be considered. Payback time of additional investment is often only 6-24 months. This ensures the lowest energy bill and lowest emissions far into the future. In other words, the financial and environmental case for upgrading only becomes stronger as energy prices rise.

Therefore IE class delivers 20% lower losses, upgrading offers the potential for clear energy and cost savings. Furthermore, in some markets modernization is also supported by tax breaks, government grants and other financial incentives to encourage businesses to improve their energy efficiency.

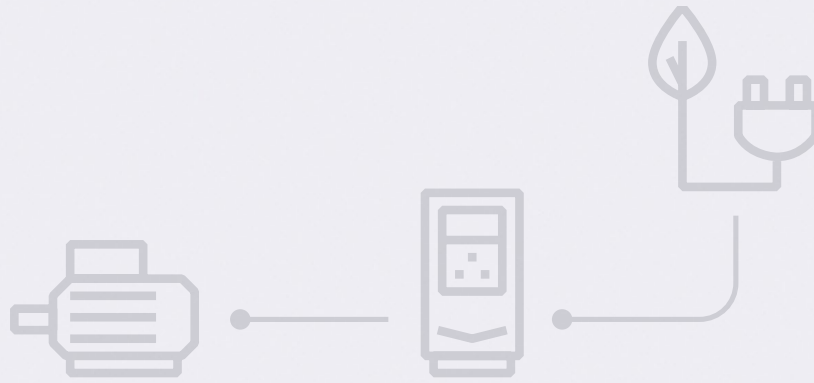
### Efficient motor technology

As well as being significantly more energy efficient, there are several additional advantages to SynRM technology for refrigeration applications. Compared with other types of motors, SynRM motors achieve lower winding temperatures and bearing temperatures, reducing the amount of heat transferred into the refrigeration system. This reduces the risk of failure and extends the equipment's lifespan. SynRM motors are also quieter than other types of motors.

### Recover energy from processes with regenerative drives

Although VSDs can run applications at the optimum speed without the need for brakes, some applications in the food and beverage industry do require some form of braking. For example, in the sugar industry batch centrifuges are used to separate sugar crystals from molasses and these use repeated cycles of acceleration and deceleration. If traditional mechanical braking systems are used in a process like this, the kinetic energy of the rotating centrifuge is lost as heat as the brakes are applied. If electrical braking is used in conjunction with a VSD, the kinetic energy is dissipated through braking resistors, and again it is lost as heat.

However, using regenerative drives, it is possible to use electrical braking and recover the energy as electricity. The energy recovered by regenerative drives can either be used elsewhere in the plant, for example, in the acceleration phase of another centrifuge, or it can be fed back into the grid. By recovering energy that would otherwise be lost, regenerative drives can improve overall energy efficiency, as well as reducing or eliminating the need for cooling systems that handle the waste heat.



Reduce electrical energy consumption and CO<sub>2</sub> emissions with energy efficiency solutions and services. Plug and play digital solutions securely collect data from applications, providing deeper status insights and a true indication of the condition of the installed base. By collecting and analyzing information directly from your powertrain, cloud-based technologies are utilized to help understand and predict any potential downtime, enabling the scheduling of maintenance services at a time that is convenient.

Using ABB's domain expertise and digital solutions helps you make better decisions to identify potential energy

savings and CO<sub>2</sub> emission reductions as well as to track and trace equipment to enable efficient operations, reduce waste, and comply with regulations.

Energy efficient solutions and services can also be implemented by modernizing motors and drives at the right time based on data and advanced analytics to determine optimal energy savings, minimize waste through circular service models, and improve financial returns for specific assets and applications.



## CASE STUDY



Source: Campbell's Australia

## Campbell's Australia reduces energy costs by 14% over 1 year

To help them meet their sustainability targets, Campbell's Australia's Shepparton plant in Victoria installed an ABB SynRM motor and drive package in their refrigeration plant. After 12 months, the investment had clearly reduced their

energy costs by 14% and reduced their CO<sub>2</sub> emissions. Thanks to this success, Campbell's Shepparton have since added another three ABB SynRM variable speed drive packages to their facilities.

## CASE STUDY



Source: Canal Sugar

## New sugar factory designed for optimal efficiency

Canal Sugar is constructing a major new agro-industrial complex in Egypt. As part of their investment they selected variable speed drives from ABB to run 15 batch and 10 continuous centrifuges. Using these energy efficient and state-of-the-art systems, they aim to increase the number of cycles and raise output, while also reducing energy consumption by 25% per tonne of massecuite compared to traditional machines. ABB will also deliver a multidrive system that is customized for regenerative operation. This will further save energy by recovering energy generated by centrifuges in the braking stage of the cycle and transferring it to the centrifuges that are accelerating.



## CASE STUDY



## SACMI Packaging & Chocolate adopted ABB IE5 synchronous reluctance motors for the conching process

Chocolate is one of the most energetic foods. The processing operations are very power hungry, especially for the processing of raw material (chocolate) and the preparation of the final product. Energy efficiency has become therefore a key topic in the engineering and manufacturing activity of SACMI Packaging & Chocolate, according to Franco Lumini, Corporate Technical manager of the Italian company. Our in-house energy consumption is limited," he explained, "while energy efficiency is a critical issue for our customers, who operate their plants intensively with massive power consumption. Hence, our commitment to review all our projects very accurately to guarantee the sustainability and optimization of energy consumption."

SACMI Packaging&Chocolate highlights the strong focus on chocolate and packaging: the factory in Rozzano (near Milan) ships machinery and lines for the entire processing cycle, from raw to semifinished materials, up to the finished product shaped into blocks, bars or pralines, plus primary packaging lines for wrapping and flow-pack operations, and secondary packaging with machines for cartons and trays.

The transformation of raw material into chocolate is executed on refiners that achieve very high electric consumption levels, driven by motors from 90 to 132 kW. Refiners work continuously with a capacity of up to 1,500 kg/hour. The resulting product is then processed and shaped in the conches, where the product magnifies its smell and taste, and is added with the final ingredients; the conches are equipped with motors from 110 to 160 kW. The conches process 6-ton batches for periods from 5 to 8 hours according to the type and quality of chocolate.



A mid-sized line processing 2-3 tons of chocolate per hour is made up of a couple of refiners and 4-5 conches, with total installed power exceeding 1 MW.

In the early 2000's, the company pioneered the use of IE3 efficiency class motors as standard, but the market was still "cold" in the propensity to invest more resources in exchange for greater energy efficiency. "Even the big US corporations with carbon dioxide reduction targets normally stepped back when they were presented with an offer that promised better energy performance at a slightly higher price," Lumini said. "This attitude has changed radically in recent years and companies are now considering high-efficiency alternatives with greater interest, looking beyond the short-term impact of the initial investment". The focus on sustainability and environmental awareness have certainly increased. The designers at SACMI Packaging & Chocolate have adopted the synchronous reluctance motors SynRM IE5 from ABB. The SynRM IE5 motors have proved to be the ideal solution for the conching process, where the product is worked for several hours.

## CASE STUDY



## ABB technology runs refrigeration system at Switzerland's largest bakery

150-year-old Coop reduces carbon dioxide (CO<sub>2</sub>) emissions by 10,000 tons per year at new logistics center for Switzerland's largest bakery. ABB and Johnson Controls contribute to this success by delivering energy efficient motors and variable speed drives (VSDs) to the ultra-modern refrigeration system. It houses Switzerland's largest bakery and patisserie, a national distribution center for frozen products and a regional distribution center for fresh food products and household goods.

Coop's large-scale bakery is one of the most modern facilities in Europe. Its workforce of 600 employees produces around 60,000 tons of baked products a year. They also produce deep freeze dough products that are frozen directly for distribution to Coop supermarkets throughout Switzerland, ready for baking fresh in-store. Cooling plays an important role in the production process. There are four refrigeration systems providing a total cooling power of 8 megawatts (MW) – the same as around 40,000 domestic refrigerators. The refrigeration systems support Coop's CO<sub>2</sub> vision, as they offer a high level of energy efficiency by using the natural refrigerant ammonia.

### Highest efficiency class motors and drives

ABB technology is integrated deep into the center's operations. The compressors in the coolant circuits are driven by ABB motors and variable speed drives. The motors have the maximum efficiency class rating, IE4, with up to 97 percent efficiency when operating at full load. The VSDs enable further electricity savings by accurately controlling the speed of the motors, in accordance with the cooling output required.

**“Combining an IE4 motor and a VSD is the best solution in terms of energy efficiency available today.”**

Beat Schuppisser, Branch Manager responsible for Industrial Refrigeration at Johnson Controls and overall Project Manager for the refrigeration systems, said it was important to Johnson Controls to procure motors and variable speed drives from a single source. This was the only way to make sure that the supply and installment process was coordinated as efficiently as possible.



# Conclusion

Although the food and beverage industry relies on a lot of energy intensive processes, there are many opportunities to optimize energy efficiency. Technologies and solutions are available now which can significantly reduce energy consumption, and service partners like ABB can also

provide expert advice and services to help businesses optimize their whole operations. Better still, energy savings also mean cost savings, so businesses can expect attractive Return On Investment (ROI) and payback times.

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- [7] Based on ABB measurements and calculations.
- [8] Based on ABB customer experience.
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