Reduce energy costs and CO$_2$ emissions.

Energy-efficient solutions for chocolate and cocoa production.
It all starts with an in-depth process analysis. Buhler energy audit reveals opportunities.

Buhler offers customers a seamless range of products and services, from raw cocoa beans to the finished moulded chocolate articles. The company's philosophy is to support customers at every relevant step. Buhler regards climate change as a call to create new services and solutions. That includes analyzing the current situation, defining relevant and appropriate measures for improving efficiency, implementing the proposed measures and, finally, checking whether the implemented measures achieve the proposed targets.

The energy audit can be viewed as a starting point for improving efficiency. It helps to provide a picture of the current situation of all the product and energy streams of a production plant. For this, Buhler uses a specific approach, known as the ‘Pinch’ method.

At the heart of the Pinch method – which is recommended by the Swiss Federal Office for Energy – is the process itself. But another important point is that this approach also allows economic factors to be considered, e.g. desired pay back time. The Pinch method therefore not only helps to optimize a production plant in terms of energy, but also economically, i.e. the plant is energetically optimized to the economic criteria of the processor.

The most important aspect of the entire energy analysis is detailed knowledge of the process, which means that suggested measures for improving energy efficiency will be verified by Buhler process experts regarding their technological feasibility.

The result of the energy audit offers a clear picture of all energy and product streams that are relevant for the production of your products. The Sankey diagram shows the production process in terms of energy flows, and is thus
a perfect starting point for defining measures for improving energy efficiency.

Buhler process experts will work out a catalog of measures which contains proposals as to how the energy efficiency of your plant can be improved. For these measures, the economic criteria that you specify, such as investment or desired pay back time, will be considered. Furthermore, since Buhler process experts are deeply involved in the energy audit process, Buhler can guarantee that all proposed measures can also finally be implemented without affecting the product quality or production reliability.

Sankey diagram: energy and product streams at a glance.
New approaches to cocoa processing.

Energy-efficient debacterizing and roasting systems.

Debacterizing and roasting processes are decisive factors when it comes to saving energy and costs. However, common systems only make use of a fraction of the energy they consume. Buhler Barth debacterizing and roasting systems are more cleverly designed. They not only convince with their quality, throughput and total productivity, but also by using energy efficiently.

Process configuration for debacterizing cocoa beans.

A newly developed STP™ (short-time-peak-pressure) process allows shorter retention time in the reactor and significantly reduces the specific steam consumption. Furthermore, a process configuration in which the debacterization step is situated after the roasting process enables additional savings in steam consumption. Overall savings of up to 50% for the debacterizing process step can be achieved.

Heat recovery systems designed for high efficiency.

Specialized heat recovery systems for the Buhler Barth TORNADO drum roaster and RoaStar™ fresh air roaster provide savings of between 15–30% of the primary energy demand.

The heat recovery system for the Buhler Barth TORNADO drum roaster consists of two main components. Firstly the heat exchanger itself, which is specially designed to suit the air volume and temperature used. Secondly, a specialized gas burner application which enables the utilization of preheated combustion air. The heat recovery systems for the Buhler RoaStar™ fresh air roaster are designed on the principal of a double water circuit. This enables the utilization of at least an additional 10°C of heat recovery temperature compared with a single water circuit heat recovery system. Heat recovery systems for Buhler Barth roasters are designed to realize a payback period of approx. 2–3 years (at 7,000 h/a production time and 3.5 Euro-Cent/kWh).

Savings energy and CO₂ emissions.

<table>
<thead>
<tr>
<th>RoaStar™ type</th>
<th>Yearly energy savings [€]</th>
<th>Reduction of CO₂ footprint (t/a)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>4t/h</td>
<td>150,000</td>
<td>850</td>
</tr>
<tr>
<td>3t/h</td>
<td>95,000</td>
<td>540</td>
</tr>
<tr>
<td>2t/h</td>
<td>68,000</td>
<td>390</td>
</tr>
<tr>
<td>1t/h</td>
<td>41,000</td>
<td>230</td>
</tr>
<tr>
<td>0.5t/h</td>
<td>23,000</td>
<td>130</td>
</tr>
</tbody>
</table>

Efficiency degree of 90% considered
* cost of energy 0.035 €/kWh @7000 h/a, ** natural gas 200 g/kWh
Buhler Barth RoaStar™ continuous fresh air roaster.

Buhler Barth TORNADO drum roaster.

Heat recovery system for Buhler Barth RoaStar™.

Heat recovery system for Buhler Barth TORNADO drum roaster.

Specialized gas burner for Buhler Barth TORNADO drum roaster.

Temperature profile – heat recovery system for RoaStar™ fresh air roaster.
A natural source of energy.
Cocoa shell combustion.

Cocoa shells are an inevitable by-product when it comes to cocoa production. Buhler has developed a tailor-made combustion system to generate energy from cocoa shells. What was formerly a waste product is thus turned into an energy source that even allows the design of thermally self-sufficient roasting and debacterizing processes.

**Cocoa shell combustion system.**
Cocoa shells are the future source of energy in cocoa processing. The advantages of generating energy from cocoa shells are manifold. Firstly, enormous savings in the cost of energy can be achieved by utilizing the cocoa shells which are produced as waste during cocoa processing. Secondly, by utilizing cocoa shells as a source of energy, modern cocoa processors are able to reduce their carbon footprint tremendously. Especially in combination with the *RoaStar™* and *Debac™*, which are steam based roasting and debacterizing systems, a thermally self-sufficient processing system can be realized. That means all the thermal energy required for roasting and debacterizing cocoa beans is generated from the cocoa shells. Furthermore, modern cocoa processors are independent of fluctuations on the energy market as no fossil fuel is required and calculation of future production costs is more accurate. As the EU sponsors projects designed to save fossil fuels, producers within the EU can essentially benefit from partial government and EU funding of the capital that they spend on cocoa shell combustion systems.

**Key criteria in cocoa shell combustion.**
From a commercial and ecological viewpoint, two main criteria must be fulfilled by a shell combustion system. Trouble-free operation must be ensured with a maintenance requirement that is acceptable to the cocoa processor. From an ecological viewpoint, the emissions caused by combustion must be within the acceptable range.

**Savings energy and CO₂ emissions.**

<table>
<thead>
<tr>
<th>RoaStar™ type</th>
<th>Yearly energy savings [€]**</th>
<th>Reduction of CO₂ footprint [t/a]**</th>
</tr>
</thead>
<tbody>
<tr>
<td>4t/h</td>
<td>490,000</td>
<td>2,800</td>
</tr>
<tr>
<td>3t/h</td>
<td>368,000</td>
<td>2,100</td>
</tr>
<tr>
<td>2t/h</td>
<td>245,000</td>
<td>1,400</td>
</tr>
<tr>
<td>1t/h</td>
<td>123,000</td>
<td>700</td>
</tr>
<tr>
<td>0.5t/h</td>
<td>61,000</td>
<td>350</td>
</tr>
</tbody>
</table>

Efficiency degree of 90% considered
* cost of energy 0.035 €/kWh @7000 h/a, ** natural gas 200 g/kWh
Combustion chamber for cocoa shells.

Heavy duty moving grate.

**Cocoa shell combustion system.**

- Steam boiler or 3-pass heat exchanger (with automatic cleaning feature)
- Secondary air-injection socket
- Low NOx-firebox
- Recirculation over grate (optional)
- Moving grate
- Fuel supply via hydraulic direct-push rod or screw conveyor
- Primary air supply
- Automatic firebox de-ashing
limits applicable to conventional biomass combustion systems. Within the EU, the German Clean Air Act can be used as a general benchmark.

In biomass combustion, particular attention needs to be paid to the residual ash content and ash melting point of the respective biomass. A combustion chamber grate which is purpose-designed for the cocoa shell application ensures complete ash incineration, preventing caking on the combustion chamber grate, and guarantees a constant combustion process temperature. At the same time, it enables acceptable CO, NOx, and dust emission values to be achieved, which are within the limits of the Clean Air Act. In the presence of more rigorous regional regulations, the exhaust air can be additionally treated using common dust collection filters and cleaning components. An automatic cleaning feature in the steam boiler helps to avoid power loss as a result of steam pipe contamination.

Advantages at a glance.
- Less down time for maintenance
- Suits high ash content of cocoa shells (10%)
- Suitable for melting point of ash
- Optimizing of combustion behavior – enough surface on grate – long afterburning effect
- No deposit on combustion chamber grate
- No performance loss due to deposits in steam boiler

Value added with autarchic roasting system.
- Used in combination with the optimized variants of Debac™ and RoaStar™
- Appreciable cutting of energy costs
- Appreciable reduction of carbon footprint
- Process energy generated from shells
- Optimal utilization of shells – no extra disposal
- Emissions within acceptable limits of EU regulations
- Independent of fluctuations on the energy market
- Partial government and EU funding

Main features.
- Moving grate – special cocoa shell design
- Low-NOx-Firebox
- Screw or water cooled direct push rod
- De-ashing rod below grate
- Water cooled grates
- Large volume, heavy-duty construction
- Fully automatic de-ashing

Possible applications.
- Stand alone for RoaStar™ and Debac™
- Integrated into customer’s steam system:
  - biomass combustion provides basic load
  - peak consumption covered by gas or oil-fired steam boiler
  - e.g. steam for alkalization
- Redundancy configuration with gas or oil burner fitted at combustion chamber for emergency operation
Active energy management.
Efficient planning and real-time monitoring.

An efficient automation process is the prerequisite for saving energy and costs. The control system WinCoS.r2 monitors energy streams and consumption in real-time. Energy costs can be properly allocated to the products. The result: active energy management.

Automation.
An energy-efficient automation process enables potential reduction of energy costs through efficient planning and monitoring of consumption. Accurate recording over a long period of time allows the energy consumption to be analyzed. Additional features, such as optimization of energy consumption through automatic starting and stopping of process lines or definition of user-specific energy limits in combination with cost controlling, can also be implemented.

- WinCoS.r2 measures the current energy consumption and monitors this against a user-defined limit value. Excessive energy usage is prevented.
- Each process line can be individually configured and controlled.
- With real-time monitoring, the power factor compensation can be optimized.
- Actions performed by WinEnergy are stored in a dedicated data logger to enable traceability of events.
- Measurement points can easily be added.
- Long-term comparisons are possible at any time.
High efficiency motors for chocolate grinders.
By using high efficiency motors of class IE2 or IE3, an efficiency increase of between 2–8%, even at partial load of 60%, can be realized. The substitution of motors requires very little adjustment. The exchange of motors can easily be realized. However, further potential lies also in the respective drive concept of the chocolate grinder. There are various factors that influence the efficiency of the grinder (see box). Buhler engineers are able to verify the appropriate solution that fits perfectly to your application. The result is a highly efficient solution that is customized to meet your specific needs.

Advantages at a glance:
– Reduction of power consumption
– Reduction of electrical connected load
– Reduction of energy costs and CO₂

Energy saving potentials for grinders.

<table>
<thead>
<tr>
<th>Action</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>System installation or renewal</td>
<td>2 – 8%</td>
</tr>
<tr>
<td>Efficient motors</td>
<td>1 – 3%</td>
</tr>
<tr>
<td>Optimum dimensioning</td>
<td>0.5 – 2%</td>
</tr>
<tr>
<td>Efficient motor repair</td>
<td>2 – 10%</td>
</tr>
<tr>
<td>Drive system with frequency converter</td>
<td>2 – 15%</td>
</tr>
<tr>
<td>Belt drive, gear</td>
<td>0.5 – 3%</td>
</tr>
<tr>
<td>Quality power supply</td>
<td>1 – 5%</td>
</tr>
<tr>
<td>System operation and maintenance</td>
<td></td>
</tr>
<tr>
<td>Lubrication, settings</td>
<td></td>
</tr>
</tbody>
</table>
Secondly, depending on the application e.g. for a filled product – SeedMaster™ tempered chocolate from the overflow can be fed directly to the depositor again, and thus does not need to be de-crystallized and re-tempered again (see flow sheet comparison). This results in additional savings so that, when used for a filled product, up to 75% of energy can be saved compared with a conventional tempering system.

Advantages at a glance:
- Up to 40% lower electrical connected load
- Up to 75% reduction in energy costs
- Significantly increased product quality (e.g. fat bloom)

Through a seeding pre-crystallization, a large amount of very small cocoa butter crystal seeds are mixed homogeneously into a chocolate mass. This allows for prompt crystal solidification and a build up of a compact crystal network of the cocoa butter. The result is a product with improved fat bloom stability, higher strength and significantly better gloss.

However, the SeedMaster™ technology also offers high potential for energy savings. Savings of between 40–75% of energy can be achieved for two main reasons. Firstly, the SeedMaster™ technology requires approximately 40% less primary energy in the tempering process itself.

Comparison: SeedMaster™ vs. conventional tempering system.
(Capacity of moulding line: 4,000 kg/h – filled product)