Danish Energy Agency

Energy efficiency improvements of kilns and melting processes

Experience and best practice from Danish businesses

Kilns and melting processes
- an energy intensive part of Danish industry

Every year, Danish businesses consume large amounts of energy for kilns and melting processes, and businesses involved in these processes are among the largest energy users in Denmark. Products such as cement, lime, light expanded clay aggregates, molar products and asphalt are manufactured in rotary kilns. Other types of furnace are used for steel, cast iron, mineral wool, tiles/bricks and glass.

Did you know that...

- Optimised kilns and melting processes often provide higher capacity and better product quality?
- Energy efficiency improvements can improve the market position of a business?

Kilns and melting processes are responsible for more than 6% of energy consumption in the corporate sector

2016 saw consumption of 3,790 GWh, corresponding to 6% of total energy consumption by Danish businesses. Total costs are close to DKK 1 billion (approx. EUR 134 million) in 2018 prices for heavy industry.

There are several reasons why kilns and melting facilities consume considerable amounts of energy. For example

- The processes often have to be carried out at very high temperatures, requiring considerable amounts of energy for heating and for actual firing or melting
- Kilns and melting processes are used by investment intensive industries where facilities have high capacity and long service lives
- Kilns usually need to operate continuously, even when there is a production stoppage elsewhere at the factory

Capitalise on the energy efficiency experience of other businesses

Through voluntary energy efficiency agreements with the Danish Energy Agency, Danish businesses have implemented numerous energy saving projects and have performed analyses of energy intensive processes and supply facilities, etc.

The Danish Energy Agency has compiled the most important experiences from businesses into a number of feature articles targeted at businesses with energy efficiency potentials.

This feature article presents some of the results of energy saving efforts and offers a guide to working with kilns and melting processes.

CASE • **A/S Jydsk Aluminium Industri (JAI)**

JAI analysed the energy consumption in the company's drying hall and optimised both the drying process and heating of the hall. This resulted in total annual savings of DKK 100,000 (approx. EUR 13,000).

Payback period after subsidies: Approx. 1 year

Exploit your untapped potentials
- and benefit from large savings on existing kilns

Due to the very high energy consumption involved in many processes, there is much to gain from improving energy efficiency. Kilns are usually operating continuously, and therefore, it is important to ensure optimal production planning all the time. Stoppages at different stages of the production process or inadequate capacity utilization on the production line will result in superfluous energy consumption to keep kilns warm.

For some types of kilns, compact loading offers a way to achieve energy savings. Focus should be on reducing waste and rejection of faulty products, not least when processes are carried out at very high temperatures.

In addition to optimising planning and operations, energy optimisation projects can be feasible because of the high number of annual operating hours involved. Optimisation could involve improved insulation of kilns, design changes such as new lid designs for ladles or replacement of transformers and frequency converters with newer and more efficient models.

Did you know that...

- Much of the ancillary equipment may also require considerable energy, and that improvements can be implemented with short payback times?

Energy efficiency is a competition parameter

When you optimise and improve your energy consumption, you immediately reduce your costs. Moreover, you become part of the green transition and help Denmark reduce its carbon footprint and strengthen its position as one the most energy efficient countries in the world. transition and help Denmark reduce its carbon footprint and strengthen its position as one the most energy efficient countries in the world.

Did you know that...

- LEAN production with high Overall Equipment Effectiveness (OEE) may be the key to low energy consumption?
- There is often a potential for utilizing waste heat?

When you make optimal use of your energy resources, you also improve your competitiveness and prepare the ground for new business opportunities, increased exports and growth. This is good for Danish exports and it is good for your bottom line.

CASE • New lining in Aalborg Portland's white cement kiln saves 13.5 GWh per year

Aalborg Portland runs Denmark's only cement factory. The company maintains its competitiveness by regularly investing in energy efficiency improvements.

Most recently, the company tested a new type of lining in its white cement kiln. Firing white cement requires higher temperatures than ordinary grey cement, and this makes the kiln a huge energy consumer.

This new type of lining, made of magnesium spinel brick, considerably reduces the heat loss, and trials have provided convincing results. The new lining will now be installed in all the white cement kilns.

The investment

The total investment will amount to approx. DKK 5.3 million (approx. EUR 707,000).

The result

- Annual energy savings of 13.5 GWh
- Corresponds to an annual CO2 emissions reduction of 4,725 tonnes
- After energy subsidies, the payback period is 1.2 years

Aalborg Portland is the world's biggest exporter of white cement.

CASE • Wienerberger optimised its brickworks kiln and saved 25% per tonne of finished product

Shaping clay into bricks requires a certain content of water in the raw material. In the first step of the thermal process, this water has to be dried out. Subsequently, the clay is fired into bricks at higher temperatures. The efficiency improvement project covered both the drying process and the kiln itself.

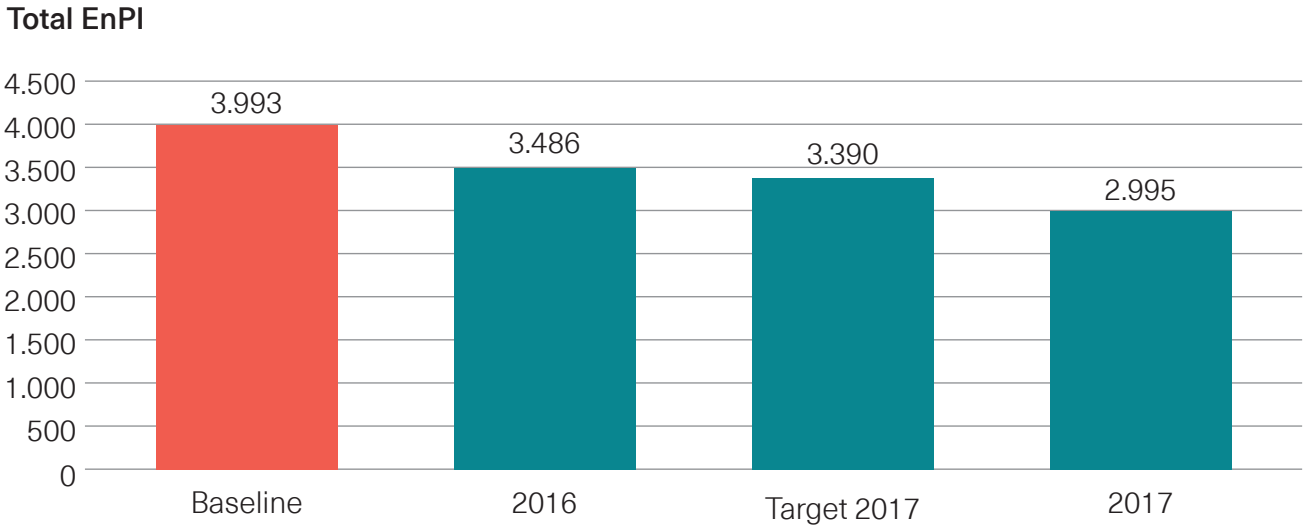
The initial solution was to recycle heat from firing for use in the drying process. Subsequently, the kiln was renovated, and insulation was improved. At the same time, productivity was improved by installing a robot to optimise the whole process. The two projects were carried out in 2016 and 2017.

The investment

The total investment was recouped in less than five years.

The result

- Annual energy savings of 5.5 GWh
- Corresponds to savings of 25% per tonne of finished product



Energy consumption at Wienerberger's brick works in Pedersminde kJ/tonne of product. (EnPi: Energy Performance Indicator)

How to save energy in kilns and melting processes
- experience and *best practice* from other businesses

Be systematic

Experience from other businesses shows that the best results are achieved if you systematically analyse your energy needs and the efficiency and operation of your system. You can do this by considering three overall topics:

1. **Needs reduction:** For example, is it possible to change the composition of raw materials or the process requirements to avoid the need for hardening after casting?

2. **System efficiency:** For example, can you reduce energy loss from the kilns and any ancillary equipment?

3. **Optimisation of operations:** For example, can you optimise production and operations planning to reduce rejections?

Did you know that...

- Total energy consumption can be reduced by increasing raw materials recycling (for example recycling of metal scrap, cullet or trim-ends)?
- It may be a good idea to challenge customers' product requirements. In some cases, it is possible to relax the process requirements and save energy and costs.

Set ambitious energy efficiency targets for new installations

Installations often have long service lives, and this makes it particularly important to ensure energy efficiency from the beginning when building new installations. If postponed, many energy improvements will be unprofitable. Consequently, it is important to insist on BAT (Best Available Technology) with efficient energy transfer to the melt and key energy indicators that are as low as possible.

Waste heat is important

Even when energy efficiency is high, it is often possible to recover waste heat at temperatures suitable for space heating, for example.

If the company cannot use waste heat itself, it may be relevant to deliver waste heat to a district heating company. This is particularly relevant given that district heating companies have challenges phasing out all fossil fuels and are looking for profitable alternatives.

It is recommended that the requirements be broad enough to include transformers, frequency converters, cooling systems and ventilation systems. Moreover, performance tests of the main products must be carried out on the basis of realistic scenarios.

For new installations, heat loss can best be reduced through comprehensive insulation solutions, use of more energy efficient kiln bricks, sealing at dampers, etc. Effective lids must be placed on transfer ladles when transferring melt. All the energy initiatives involve higher investments, but calculations of their overall economics show that in just five or ten years, the initiatives will almost always be attractive.

CASE • **Imerys Absorbents**

The company produces various minerals for industry, using molar as the raw material and a rotary kiln as the key component in the production process. After ensuring comprehensive insulation of the kiln, Imerys saved 4.6% on energy consumption.

Payback time after subsidies: 2.2 years

How to get started
– and achieve the best results

Use this guide as a checklist to make sure you consider all aspects of your needs and your systems. This will give you the best work process and the best results.

Remember...

... to apply for subsidies before you start!

You can apply for subsidies from an energy company, but you have to do so before launching your project - otherwise this possibility will no longer exist.

1. Find the minimal energy consumption

- What will be the exact energy consumption of new optimised equipment?
- What is the additional consumption of energy on the existing system?
- What is the financial value of an energy reduction?

2. Does the system match the need?

- Is the size of the kiln in tune with the other equipment?
- Is the system suitable for the product type and any changes in product?
- What are the expected future tonnages?

3. Energy conscious planning for new installations

- Set energy requirements for the overall system
- Demand efficient individual components
- Keep in mind the long service life of the system and assess the overall economics

4. Optimise existing installations

- Consider all initiatives that may reduce the additional consumption of the existing installation
- Use the analysis to plan energy projects - including for ancillary equipment
- Also consider whether control and regulation can be improved

5. Optimise planning

- If consumption during idling is high, it may be relevant to shut down a kiln and move the tonnage to other kilns?
- Calculate the maximum idle period allowed before closing down a kiln will pay off
- Make sure the kilns are loaded at maximum capacity

6. Optimise operations

- Eliminate production bottlenecks that may cause waiting time for the kiln
- Remember to prioritise preventive maintenance for critical equipment
- Focus on avoiding waste and rejections

7. Define your key operating indicators

- Start by monitoring OEE
- Define key energy indicators for the overall process
- Follow up daily

8. Utilise waste heat

- Identify the potential and possible solutions
- Involve the district heating company in the project development process as early as possible
- Be aware of the options for receiving subsidies for energy savings

Learn more

You will find six remaining feature articles in this series:

- **Evaporation, drying and distillation**
- **Waste heat recovery and waste heat utilisation**
- **Cooling, compressed air and vacuum systems**
- **Ventilation and extraction systems**
- **Energy management and employee involvement**
- **LEAN and productivity**

Furthermore the Danish Energy Agency have elaborated checklists (in Danish) for efficiency improvement initiatives, specification requirements for equipment, and analyses of efficiency potentials in the Danish Industry.

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