Danish Energy Agency

Energy efficiency improvements of evaporation, drying and distillation facilities

Experience and best practice from Danish businesses

Evaporation, drying and distillation facilities consume considerable amounts of energy

- and is used extensively by Danish businesses

Evaporation, drying and distillation facilities are used to concentrate milk, dry agricultural products, manufacture medical products and to separate chemical substances when manufacturing building materials. Often, the facilities are closely linked to each other or to other manufacturing processes. In any case, they consume large amounts of energy, in particular thermal energy.

Did you know that…

- Danish businesses completed more than 1,000 energy saving projects from 2010 to 2016 under the voluntary agreement scheme (energy and carbon taxes subsidies in return for energy efficiency improvements)?
- Energy efficiency improvements can improve the market position of a business?

Evaporation, drying and distillation account for 14 % of heating consumption

In 2016, evaporation, drying and distillation operations were responsible for 5,308 GWh (19 PJ) of energy used by Danish businesses. This corresponds to 14 % of business' total heating consumption and up to 5 % of total energy costs.

There are several reasons why evaporation, drying and distillation processes consume considerable amounts of energy. For example

- The facilities are often in operation 24 hours a day
- The facilities remove (evaporate) large quantities of water from the product, and this makes them energy intensive
- The facilities have not been designed with sufficient internal heat recovery
- The facilities may use a lot of energy when starting up and closing down and during standby
- The facilities have often not been updated with the newest, most energy efficient technology

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 experience from businesses into a number of feature articles targeted at businesses with energy efficiency (and therefore energy saving) potentials.

This article presents some of the results and offers a guide to working with evaporation, drying and distillation facilities.

CASE • **Glycom A/S**

Glycom's lysine factory in Esbjerg, Jutland, optimised its operations and the spray drying process by increasing raw material pre-drying, eliminating bottlenecks and introducing key indicators for energy consumption. In this way, Glycom managed to increase its capacity and save 90,000 m^3 of natural gas and 100 MWh of electricity per year.

Payback period after subsidies: Approx. 1 year

Small changes, large savings
- and stronger competitiveness in the green transition

The large energy consumption of evaporation, drying and distillation facilities means that there is often a good potential for significant energy savings. For example, you can optimise the operating parameters so that drying, evaporation or distillation are more in line with requirements. Or you can optimise existing heat recovery systems when cleaning soiled heat exchangers. For many businesses, employing new technology will generate substantial savings in energy costs.

On top of the energy savings, by thoroughly analysing the systems and their operations you will obtain in-depth knowledge of other factors relating to capacity and quality. And in many cases, energy saving projects will also increase your production capacity.

Did you know that…

- You can save up to 31% of the energy used for evaporation, drying and distillation with a payback period of only four years?
- Danish industrial companies typically save 5-15 % of plant energy costs when optimising their evaporation, drying and distillation facilities?
- New heat pump technology provides new possibilities for optimising the energy consumption of evaporation, drying and distillation facilities?

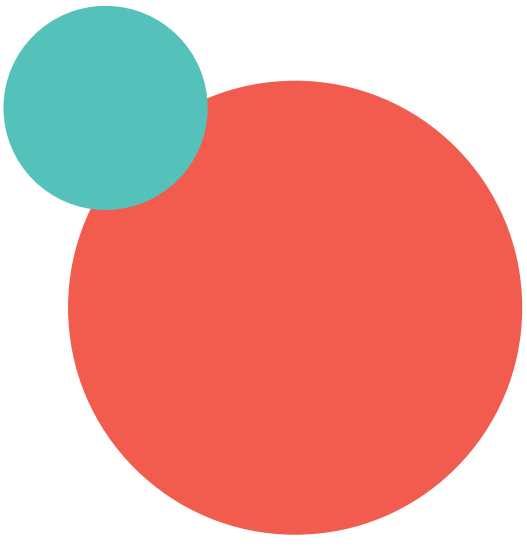
Energy efficiency is a competition parameter

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.

Did you know that…

- Danish businesses are among the most energy efficient businesses in the world?
- A strong green profile attracts more skilled employees and encourages them to stay longer?

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 • Rold Skov Sawmill achieves large savings and better product quality through energy optimisation of drying rooms

The Rold Skov Sawmill cuts up trees for the construction and packaging industries. After cutting the wood, it has to be dried in drying rooms requiring high energy consumption. To reduce energy consumption, the company invested in comprehensive energy optimisation, and at the same time improved product quality.

The energy optimisation project consisted of the following sub projects:

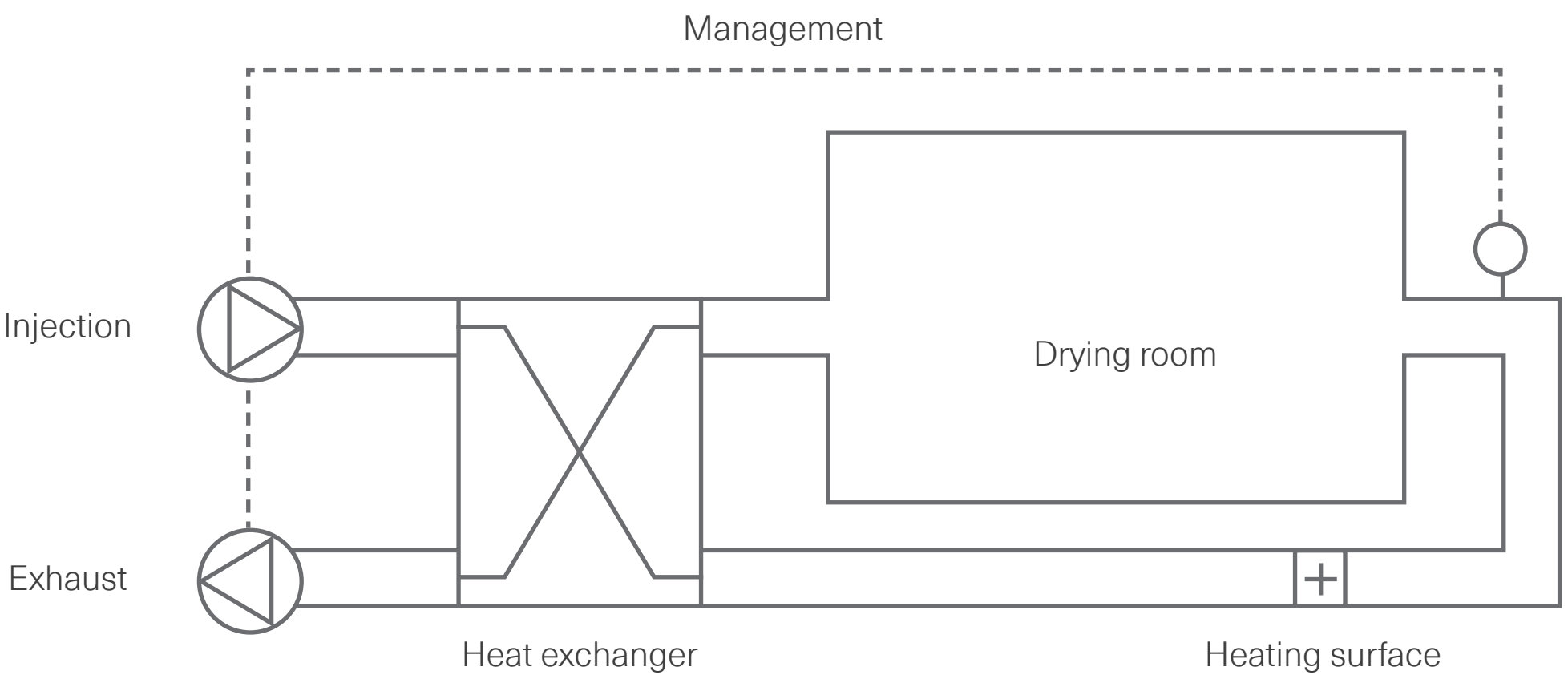
- Extensive re-insulation and sealing to reduce heat loss from the drying rooms.
- Heat recovery of ventilation air.
- Installation of frequency converters to adjust the speed of fans and manage the volume of air.
- Replacement of ventilation demand control. Temperature and humidity meters were installed in the drying rooms, and in combination with speed control, these can be used to adjust the volume of fresh air.
- Definition of drying process key indicators for benchmarking and ongoing optimisation.

The investment

The total project cost was DKK 3 million (EUR 400,000) and around 1,000 internal hours. This results in a simple payback period after subsidies of 5 years.

The result

Energy savings of 3.5 GWh of biofuel and 0.5 GWh of electricity were achieved. Overall, this results in annual financial savings of DKK 600,000 (EUR 80,000). In addition, the many initiatives have improved product quality, primarily because of more accurate management of heat consumption and ventilation in the drying rooms.



Design of new drying rooms with cross exchange and demand control. The drying rooms also have recycling, but this is not included on the chart.

CASE • Heat pump for evaporation and drying process saves Arla Foods DKK 5 million every year

Arla Foods in Videbæk, Jutland, produces milk powder, and the process includes a spray drying facility that allowed utilization of waste heat by installing a hybrid heat pump. The heat is utilized to preheat injection air for one of the spray towers. Heat from the hybrid heat pump can raise the injection air temperature to 63 °C, and this reduces the temperature increase subsequently required from steam.

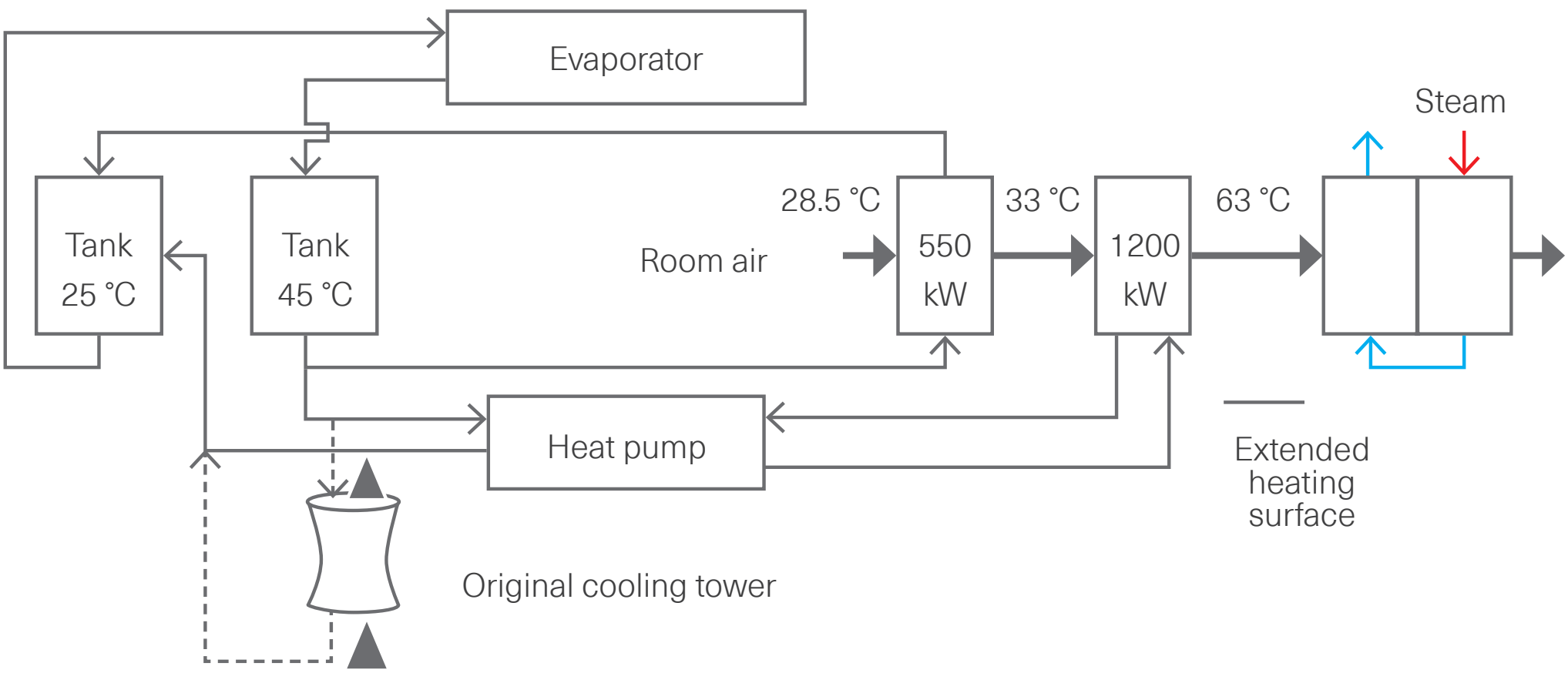
Initial heating of injection air from 28.5 °C to 33 °C is based directly on waste heat in a heat exchanger. Subsequently, the air is heated to 63 °C by a heat pump that further utilizes waste heat from the evaporator. Overall, the injection air only has to be heated by steam from 63 °C to 225 °C, whereas previously, it had to be heated from 28.5 °C.

The investment

The total investment was DKK 12.5 million (approx. EUR 1.7 million). After energy subsidies, this results in a simple payback period of 1.6 years.

The result

Savings on natural gas after installing the hybrid heat pump have been calculated at 16,400 MWh. The heat pump electricity consumption less previous consumption for cooling towers and other equipment is 1,406 MWh. This results in total energy savings of around 15,000 MWh.



Schematic diagram of heat recovery system for utilization of waste heat from evaporators to preheat air for spray drying facilities.

How to save energy on evaporation, drying and distillation facilities

- 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, can you reduce drying, evaporation and distillation to a minimum? Or can you optimise other parameters to achieve energy optimal operations?

2. **System efficiency:** For example, can you achieve better heat recovery between the individual steps in the process? Or could you benefit from investing in new and better technology for this purpose?

3. **Optimisation of operations:** For example, can you plan your production and operations so as to minimise start-up and close-down times and reduce periods spent on cleaning and standby?

Adjust to demand

In general, the easiest and most inexpensive way to achieve savings is to monitor your systems and optimise operations, and to become absolutely clear about the basis for the operation of your systems.

However, overall, the largest savings can be achieved by fundamentally optimising the efficiency of your systems, for example through increased heat recovery in or between the individual processes or by installing entirely new technology.

CASE • **Solae Denmark A/S**

Solae Denmark A/S produces soya protein products for the food industry. The business analysed the possibility of reducing the drying need of the process and found that a higher water content did not reduce the quality of the product and had no impact on drying operations.

Additional earnings and savings amounted to around DKK 300,000 (EUR 40,000) per year.

Simple payback period after subsidies: 2.8 years

How to get started
– and achieve the best results

Use this approach to make sure you consider all relevant aspects of your systems and your needs. 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. Identify the original design basis

- For what purpose and capacity were the systems originally designed?
- What process parameters were the systems originally set up to meet?
- What was the original energy balance in the systems?

2. Analyse your current needs and existing operations

- What characterises the existing operations? Where have there been significant changes?
- Are there any significant variations in products and process parameters?
- Is there an energy balance and an overview of the current energy consumption of the systems?
- Is there a risk that operators are running the systems at reduced efficiencies?

3. Assess your system efficiency

- What is the current system efficiency
  - Relative to the original design?
  - Relative to Best Available Technology (BAT)?
- What is the current efficiency of the heat recovery systems?
  - Are there heat exchangers with high temperature differences?
- How efficient are electric motors, drives, pumps, vacuum pumps, etc.?
- Can heat pumps be integrated into the process (MVR, high-pressure hybrid heat pumps, etc.)?
- Can waste heat be used for other heating purposes in the business?

4. Optimise your system operating parameters

- Can you operate the systems more accurately or according to new process parameters?
- Can you optimise recycling or reflux etc. to increase efficiency?
- Are the procedures for starting up, closing down, cleaning, etc. optimal from an energy efficiency perspective?

5. Optimise your system maintenance procedures

- Do you have fixed routines for maintenance, cleaning, etc.?
- Is there any risk of false air intrusion, leaks or soiling of heating surfaces, etc.?

6. Define your key operating indicators

- Can you define an operating target for system efficiency and energy consumption?
- Can monitoring and reporting of important process parameters increase focus on energy consumption?
- Can you set an energy target per batch or continuously for each product?

Learn more

You will find six remaining feature articles in this series:

- **Energy management and employee involvement**
- **Ventilation and extraction systems**
- **Cooling, compressed air and vacuum systems**
- **Kilns and melting processes**
- **Evaporation, drying and distillation**
- **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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Photos: Scanpix and KAM