SUCCESS STORY:

Pellets move the dairy back to nature

INVESTMENT CASE
Title:
Wood Pellet Fired
Dairy Steam Boiler
Year (commissioned):
2015
Location:
Sundsvall, Sweden

Stakeholders:
1. Site manager, Arla Sundsvall
2. Site process and maintenance manager, Arla Sundsvall
3. Senior Technical Dairy Expert, Arla Foods
4. Division manager, Arla Foods

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Arla Food's dairy in Sundsvall, Sweden, invested in a 1 000 kW wood pellet fired steam boiler to replace its old oil fired boilers. The dairy's main product is consumption milk, including cream and buttermilk, in total about 40 000 metric tons/year. Steam is mainly used for process heating (pasteurization) and for heating hot water for disinfection / cleaning-in-place. The dairy also has a heating water system for comfort heating and pre-heating of cleaning water, which in part has steam as heat source.

The dairy use about 700 ton/a wood pellet (3 200 MWh/a), saving more than 900 ton/a CO_2. The total investment cost was 6,9 MSEK of which the new boiler including all peripheral equipment was 5,6 MSEK. The straight payback is 3-3,5 years.

Why?
When Arla Foods took over a bankruptcy dairy and restarted the operation in 2012, it turned out to be one of the last industries in the city Sundsvall using fossil heating oil. For Arla Foods with "Closer to Nature" as slogan and a strong relationship to its owners, 12 700 milk farmers, this was not consistent.

An energy mapping conducted as part of the restart pointed out the old oil-fired boilers and the coming phase out of the fossil fuel tax reduction the industry still enjoyed. Oil would become more expensive within a few years.

Among the available options, a new wood pellet fired boiler was found to be the most attractive. Wood pellets made of residuals from a local wood industry was available. It was easy to find a good location for the pellet storage silo and it was possible to install a new boiler without any change or stop in the dairy operation.

The new wood pellet boiler system includes a boiler with a rotating roaster combustion chamber, a new chimney, stack gas cleaning and a wood pellet storage. At the time of the investment, an existing steam accumulator was fitted with extra insulation, another was decommissioned to give space for the new boiler and other retrofitting was made.

The investment and its technology

Arla Food's dairy in Sundsvall, Sweden, invested in a 1 000 kW wood pellet fired steam boiler to replace its old oil-boilers. Sundsvall is a coastal town on the Swedish east

Fuel type:
- Wood pellet

Feedstock origin:
- Domestic silviculture residuals from thinning, tops, branches etc
- Domestic forestry by-products/ residuals: bark, wet wood chips, etc
- Domestic wood manufacture by-products / residuals: dry chips, shavings, dust

Conversion system:
- Boiler combustion, e.g. stand-alone boiler plant including co-firing and combined heat and power

Co-fire:
- Heat generator (i e boiler) is 100 percent biomass-fired.

Heating system heat sources:
- Biomass is the only heat source in system
- Heat generator is part of a system with heat pumps

Comments:
- The site has two heat distribution systems, a steam system and a heating water system. Steam is used for dairy processes, while the latter is used for pre-heating cleaning water and for comfort heating.
- The pellet fired boiler provides all steam. There is an oil fired back-up boiler.
- The heating water system uses a heat pump as base heat source and steam (pellet boiler) as the secondary peak-load source.

The new wood pellet boiler system includes a boiler with a rotating roaster combustion chamber, a new chimney, stack gas cleaning and a wood pellet storage.

coast, 380 km drive north of Stockholm. It has cold climate. The dairy's main product is consumption milk, including cream and buttermilk, some 40 000 metric tons/year. The dairy used about 700 ton wood pellets (3 200 MWh) year 2016. Year 2014, before the replacement, it used 340 m^3 oil (3 500 MWh) in old inefficient boilers and 400 MWh district heating. The fuel change saves more than 900 ton/year CO_2.

Economy:
The total cost of investment including reinvestments in boiler room steam equipment was 6,9 MSEK. The annual fuel cost was about 1,2 MSEK lower 2016 compared with year 2014, but this does not include saved district heating costs. District heating was mainly used cold days, it had a reasonable energy price, but was associated with a high annual fee, about 0,5 MSEK/year. If district heating savings are included, the total energy cost savings will be close to 2 MSEK. Service and maintenance costs are higher than for oil. Arla's technical staff spends 1 hour/day checking the boiler, and sweeps the boiler every 6 weeks, in total 200-400 hours per year for maintenance. About 50-100 kSEK/year in direct costs.

Technology:
The wood pellet boiler system includes a boiler with integrated pellet burner, flue gas cleaning, a new chimney, wood pellet storage and full automation. The boiler tubes

Relation to Sustainable Development Goals:

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Contribution of the investment:

- By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.

Ensure sustainable consumption and production patterns

Contribution of the investment:

- Promote wood pellet production.

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Contribution of the investment:

- Purchases pellets produced with by-products (not primary wood) from a sustainable silviculture origin.

and pellet burner are designed to be self-cleaning to minimise the number of stops. Currently there are about nine annual stops for sweepings are made. A large steam accumulator tank was removed to give place for a new boiler room, another pre-existing accumulator was fitted with extra insulation and there was some other steam system retrofits was made at the time of investment.

Boiler: VEÅ UNIVEX P16PD H-16, fire tube boiler, 16 bar / 204°C.

Wood pellet burner: Jan Fire, Jet 1 MW, rotating roaster combustion chamber

Storage Silo: MIWA, 80 m^3, 13 meter tall, 3 meter wide, partly outdoors, partly in basement.

Flue gas cleaning: Multi cyclone JM-250

Other: Fully automatic system: fuel feeder, ash removal system, sweeping, etc

Replacing:

The wood pellet boiler replaced two old oil boilers (one of them is kept as back-up). The boiler also replaced district heating as the secondary heat source for the heating water system (comfort heat and pre-heating of cleaning-water). A heat pump using waste heat from the refrigeration system is the primary heat source for heating water. District heating was replaced for economic reasons.

Factors behind the decision

When Arla Foods took over a bankruptcy dairy and restarted the operation in 2012, it was one of the last industries in Sundsvall using fossil fuels. Arla Food has "Closer to Nature" as slogan and a strong relationship to its owners, 12 700 milk farmers. Being one of the last industries using oil wasn't consistent with neither its' slogan nor its' environmental strategy "from cow to consumer".

An energy mapping was made as part of the restart putting its finger on the old oil-fired boilers and pin-pointing the coming phase out of the fossil fuel tax reduction the industry still enjoyed. Oil would become very expensive within a few years.

At the same time, the two oil-fired boilers were old (commissioned in 1960's) and one of them was oversized due to change in production and process equipment during its more than 50 years of operation.

A reliable heat source:

Wood pellets are produced from wood industry residuals, which gives a steady supply from many sites within Sweden. There is a large local manufacturer of wood pellets close to the dairy. Additionally, the pellet price is less volatile than the oil price and pellet fired hot water boilers in the 1 MW range has been used in small district heating systems for many years. On the downside, the number of small industrial steam boilers is limited and Arla has no previous experience of wood pellet steam boilers in this size. (Arla's dairy in Jönköping, Sweden, has invested in a wood pellet fired high-temp hot water boiler).

Alternatives:

Several alternatives were investigated. Gas boilers were ruled out, since there is no natural gas network in Sundsvall. Retrofiting one of the oil boilers to LPG was investigated but retrofitting a 50 year old boiler and still not be CO_2 free didn't fly with Arla's policy.

It was investigated to replace the steam distribution

Replicability potential:

- High local replicability
- High regional replicability
- High national replicability
- Medium international replicability

Comment:

Simple and proven technology: Using a globally available biofuel makes it easy to replicate at all scales, everywhere. On international level not all industries have access to a local wood pellet market.

Scale-up potential:

- Medium local potential
- Medium regional potential
- Medium national potential
- Medium international potential

Comment:

Simple and proven technology: Using a globally traded biofuel makes it easy to replicate at all scales, but for large boilers cheaper and more difficult bio fuels (wet wood chips) are often more competitive.

Connection to policy case:

- Carbone dioxide taxation and the greening of Swedish district heating.

with a new heating water distribution system at high temperature (110° C) with an electric boiler as heat source, but this included big intervention in process equipment and in the building. Otherwise, electrical boilers are used at several dairies, the power price is currently low and the CO_2 footprint is reasonable low within the Nordic power system.

A description of the underlying policy framework: The CO_2- tax on heating fuels has been decided by the Swedish government in a broad coalition including all major political parties. It is based on the long term national environmental goals, including reduced climate change and its sub target to become independent of fossil fuels for heating by 2020.

The tax has existed since the early 1990's, first as a fee and from mid-90's as an excise tax. The industry has had a tax reduction, but lately it has been removed in several steps to be completely gone by 2018. For year 2017 the industry pays a tax of 2 237 SEK/m^3 oil (216 SEK/MWh or about 1100 SEK/kg CO_2 emission).

Lessons learned

Wood pellet boilers are much more demanding to operate than oil-fired ones. The boiler needs to be looked after every day. A few days a week one needs to weigh the pellets and adjust the feeding and every 6 weeks the boiler needs to be swept. To do all this your organization must have staff working 0.5-1 hour/day plus the time needed for regular sweeping. In total it requires about 200-400 hours a year.

There have been a number of technical issues with fans and mechanical breakdowns during the first year of operation. Because of this, it has taken a long time to trim and tweak all parameters, and it has caused a lot of grey hairs(!). For the last three months (end of winter and beginning of summer 2107) the boiler has run smoothly without any complications. The lesson is: Make sure the supplier is obligated to do all maintenance, trimming and tweaking, until the boiler works as promised and before the final payment is done.

Success factors

1) CO_2-tax on all heating fuels makes wood pellet an economically sound alternative
2) It goes hand in hand with Arla Foods' slogan "Closer to Nature" and complies with Arlas' Environmental goal to reduce CO_2 with 25% between 2005 and 2020.
3) Access to wood pellet
   a. Made locally (short transport)
   b. From wood industry residual/waste
   c. Originating from sustainable silviculture
   d. Grown on ground with low heavy metal content

Constraints

Maintenance: Need an organization with capacity (time) to operate the boiler
Space: Pellets are less energy dense than oil. They need more space for storage than oil. (On other hand pellets is neither explosive, liquid nor poisonous, which are / can be positive for choice of location).
Environmental permit: Wood boilers' stack gas emissions are different from oil and gas boilers, it has much more particles (PM10). May need extra filter to get a permit.
Load characteristics: The boiler (with a rotating roaster combustion chamber) is much slower in ramping up capacity than oil and gas boilers. It needs a large steam accumulator and some trimming to work or other technology must be used (i.e. powder burner). Correct sizing is also more important compared to oil fired boilers.

Web sites:
www.ri.se
www.arlafoods.com
www.energimyndigheten.se/en/
www.iea.org/tcp/
www.ieabioenergy.com

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