RESOURCE USE IN THE BRITISH BEEF AND LAMB PROCESSING SECTOR

Energy

Factsheet 4

Increases in energy costs coupled with Government initiatives to reduce consumption to meet climate change and greenhouse gas emissions (GHG) targets pose an increasing challenge for companies.

Energy costs for many meat plants represent the fourth highest operational cost (after the cost of raw materials, waste disposal and labour), and are seen as one of the key factors that determine competitive advantage. Survey work has shown that managing energy use is still in its infancy in much of the meat industry. Energy costs have increased because plants have increased their level of processing, yet few companies have the means of breaking down where the most energy is used throughout the plant (e.g. very few have sub-metering at point of use).

Legislation

The Climate Change Levy (CCL), an energy tax on non-domestic intensive users, was introduced in the UK in April 2001. Its aim was to increase energy efficiency and reduce carbon emissions. By signing Carbon Change Agreements (CCAs), over 200 large abattoirs, cutting and retail plants were able to get an 80% reduction on the levy provided they agreed to improvement targets for energy efficiency and carbon emissions. **However from April 2011, the levy discount will reduce to 65%.**

In 2008, the UK Climate Change Act introduced a legally binding target of a cut in GHG emissions from production across all sectors of the economy (of 80% against 1990 levels by 2050). To assist in achieving this aggressive target, the Carbon Reduction Commitment was introduced in 2010. This scheme is aimed at less intensive but still significant energy users.

Organisations with more than 25% of their emissions covered by Climate Change Agreement, and emissions covered by the EU Energy Trading Scheme and by a Climate Change Agreement, are exempt from the CRC.

Currently the Department of Energy and Climate Change are consulting on the CCL. The decision with relevant legislation is expected in the Finance Bill 2011.

Carbon Footprinting

The amount of carbon produced per kilowatt is dependent on the source of energy used. Energy produced using natural gas produces less carbon than oil, which currently produces less than electricity sourced from the grid, while certain types of renewable energy are carbon free.

Energy Usage

Recent survey work has shown that typically 50–80% of energy used in an abattoir/cutting plant is provided by electricity (with the other 20–50% coming from thermal energy). Electricity is usually used for refrigeration and compressed air, as well as for ventilation, lighting, powering the operating equipment in the slaughter, boning and by-product processing areas, e.g. saws, hoists, conveyors, packing machines, and electrical stimulation. Electricity is also used by abattoirs for on-site rendering plants. The tallow from these could have been used to generate thermal energy, however, in all cases was actually sold on the open market. Gas and oil are primarily used to provide heat and hot water for the factories (e.g.for scalding, knife sterilisation, cleaning process areas and machinery, by product processing and heating). A small minority of plants are solely reliant on electricity for all forms of energy.

Cattle and sheep abattoirs tend to need significantly less hot water than pig plants. A pig abattoir could have 80% of its energy in the form of thermal energy (e.g. heating scalding tanks, raising steam, singeing), whereas in comparison cattle and lamb abattoirs tend to require about 30–50% thermal energy.

Sheep processing generally uses less than pigs or cattle principally because:

- Less bulky animal therefore less energy is required for chilling
- Sheep meat is not normally aged for too long
- The stomachs are not normally processed so less hot water is used
- Many sheep companies ship a lot of their product out as whole carcases rather than deboning and vacuum packing

The survey information showed that it takes on average about 775 kWh of energy to produce a tonne of beef and 685 kWh per tonne of sheep meat (based on the energy used for slaughtering, cutting and retail packing), although the energy per tonne varied considerably depending upon the type of processes within the plant. At 'slaughter only' abattoirs for example, the electricity average per head was measured at 50 kWh (with a range of 16 to 67) and the total energy use averaged 96 kWh per tonne (range 47 to 189).

None of the companies interviewed in this survey used renewable energy such as solar, water or wind power,

Energy Usage *(cont'd)*

although some were considering these options. Renewable energy produces no carbon and if excess energy is generated, and could be sold to the national grid, carbon credits could be gained.

Investigating and developing opportunities to install renewable energy generators, including anaerobic digestion, is currently not on the radar of most plants. This is a growing area with the government giving incentives to establish new sources of energy. This is currently an opportunity that will be extremely important if the CRC scheme really takes off and, if not viable on an individual plant basis, the meat industry could start partnering up with some of their suppliers, customers and effluent companies and start processing their wastes.

The first stage in managing and improving energy use is in implementing an environmental management system (EMS), such as adopting ISO 14001, as detailed in factsheet 1. This is globally recognised and enables a business to manage its environmental activities in a comprehensive, systematic, planned and documented manner in order to reduce its environmental impact. The plan focuses on energy (electricity, gas, oil, diesel and petrol), water and effluent, and also airbourne pollutants, including bad smells and noise. See factsheet 1.

The Carbon Trust believes that most companies could cut up to 20% of their energy costs be employing some easy 'low cost/no cost' measures.

Managing Energy Use from Thermal Sources

The majority of plants used gas, liquid petroleum gas (LPG) or oil to generate the space heating, hot water and steam production throughout the plant, so an obvious target is to ensure that boilers and related equipment and pipework are operating as efficiently as possible. The most common issues seen in many plants regarding boiler usage were regarding water loss, where:

- Excess water used by boilers will mean a waste of energy, as well as excess use of chemicals
- Water used in boilers is often pre-treated – softened and/or had anti-scale chemicals added to it in ion exchange columns, however, every stage of treatment increases the value of the water and therefore the cost of its loss (e.g. treated water can cost 3 or 4 times that of potable water and steam 10 times)

There are several ways to reduce water loss which will save energy and chemical additives costs, as well as water, for example:

- Maximising the amount of boiler condensate recovered from cooling of steam, as it does not require pre-treatment and will retain much of its heat
- Using sub-metering on the hot well that tops up boiler water to monitor the volume of top-up water used, showing the influence of condensate recovery

How much is this boiler condensate costing per annum?

- Regenerate the ion exchange columns only when it is required. Control systems are available to manage water consumption, based on conductivity monitoring. This reduces the amount of regeneration chemicals, energy and water that are wasted during the stabilisation period
- Boiler blowdown is conducted to remove total dissolved solids (TDS) that build-up in the system. Blowdown is often conducted manually using timers, however this can be very wasteful. A conductivity meter can be used to ensure blowdown only occurs when necessary, as it will determine the concentration of TDS. Automatic blowdown control systems that use conductivity measurements are usually set to a conductivity equivalent of a TDS of 3000-3500 mg/litre. Typical treated water has a TDS concentration of 275 mg/litre

Fitting a combined heat and power (CHP) boiler is the most efficient method. A lot of plants had steam plants rather than boiler plants. Steam plants generate water temperatures in excess of 100°C which then need to be cooled depending on the temperature required for the individual operations. They are normally the heaviest consumers of gas or oil.

Managing Energy Use from Thermal Sources *(cont'd)*

As well as reducing the amount of wasted hot water, other strategies include improving insulation, heat recovery and better maintenance.

Some key strategies are listed below:

- improving insulation on heating or cooling systems and pipework
- insulating and covering scald tanks and knife sterilisers to prevent heat loss

Knife steriliser, twin-walled to improve insulation and fitted element to heat water and visual temperature gauge

- maintaining a leak-free compressed air system
- implementing switch-off programs and installing sensors to turn-off or power-down lights and equipment when not in use. Equipment left on stand-by can use over 50% of its powered up energy
- maintaining optimal combustion efficiencies on boilers
- eliminating steam leaks
- maintaining and regularly changing filters to ensure they do not become blocked
- running central heating and air conditioning at optimum temperature

Managing Energy from Electricity

Up to 70% of the electricity used by many meat plants, especially abattoirs, is accounted for by their refrigeration systems. The most common issues seen in many abattoirs concerning refrigeration were:

- lack of remote monitoring systems
- undersized chillers for throughput meant that carcases were packed too closely and took longer than expected to reach 7°C
- poorly set-up evaporators which required maintenance. Some were iced up which also reduced air velocity and chilling performance
- doors being left open for extended periods especially during loading. It is estimated that the electrical energy costs approximately £250 per year for every hour a chill room door is left open
- using external filtered air in the cutting and packing rooms when external temperatures are low enough
- refrigeration equipment (condensers) located badly, in full sunlight, hot roof spaces etc. This means that it takes more energy for them to reject the heat. Some were located so they sucked in the hot air rejected by its neighbour
- condenser coils caked with dirt

There are other simple housekeeping tips that can be used to reduce electricity consumption in all parts of the plant and offices:

- implementing switch-off programs and installing sensors to turn-off or power-down lights and equipment when not in use
- improving maintenance to maximise energy efficiency of equipment

When designing a plant it is important to take into account heat generated by the equipment and opportunities to recycle both heat and water within the factory.

There are opportunities to recover heat from the refrigeration system to pre-heat the water going into a boiler depending upon the location of the boilers and the chillers.

- recovering waste heat from effluent streams, vents, exhausts and compressors
- recovering evaporative energy in the rendering process using multi-effect evaporators

Additional savings can be made through purchasing more energy efficient equipment:

- bear in mind electricity costs over the life of a piece of equipment. Buying a cheaper machine which uses more electricity can be a false economy. A lot of equipment has the option of variable speed drives, metering controls and active management systems. This may cost more initially but payback is normally quick favouring more efficient equipment
- longer term it is becoming more economical to look at alternate forms of energy especially renewables such as wind and solar

Managing Energy from Electricity *(cont'd)*

Use your utility company. Electricity companies are among the few businesses who hope that you use less of their product. Most power companies are anxious to postpone construction of new power plants, so they actively encourage customers to use less power. Utility companies offer energy audits, tips, and other help for customers who want to reduce energy consumption. Call your energy provider or log onto their website to see what they have to offer.

- shop around. Investigate benchmark costs with a supply company. This will normally mean a new offer and reduced energy cost. Many companies did use an agent to do this for them

A typical energy management programme for refrigeration set up as part of an EMS would involve:

1 **Setting targets** – make sure that the programme has the full support of staff and management.

2 **Assess all refrigeration systems** – familiarise equipment and the main components, check the systems' components match the documentation (the more understanding there is of the operation of the plant the easier it is to identify potential savings).

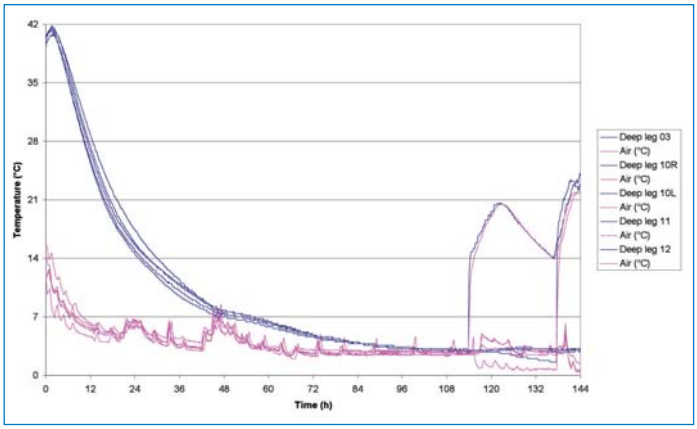
3 **Monitor electricity consumption** – electricity bills provide a basic record of overall kWh consumption, but sub-metering or energy loggers can measure energy consumption of individual refrigeration systems. Ensure the associated equipment, e.g. compressors, fans (evaporator and condenser), electric defrost heaters, lighting pumps, of each system are all measured. Relating energy consumption to throughput can highlight problem areas and also opportunities. Compressor drive motors tend to use the most energy, followed by fan motors.

4 **Measure the current process performance** – before making any changes check the chilling performance of each refrigeration system against its specification. A good starting point is the primary carcase chillers as they tend to have the highest energy consumption. Measure and record:

- air temperature and relative humidity in the chiller
- surface and deep leg temperatures for a range of carcases throughout the day
- air speed at several points throughout the chiller
- ambient air temperature
- weight of carcase throughput; measuring weight loss before and after chilling will show the evaporation and drip loss. Weight loss can increase if the cooling curves are extended

Recording data over a week gives more detail of how performance varies with production throughput and ambient temperature. By comparing current and previous performance measures, any adverse effects can be highlighted. Setting the chillers a degree lower than is necessary is money wasted.

Measuring carcase temperature



Graph measuring deep leg temperature drop over a few days

5 **Analyse baseline data** – examine the chilling performance and energy baseline data to determine how each system uses energy throughout the production cycle. Identify the key features of the energy

A typical energy management programme for refrigeration *(cont'd)*

consumption profiles, especially periods of high and low energy consumption and determine reasons for them. Track trends against throughput and look for unusual events. Check refrigerant levels – 15% lower than target will increase power requirement by 100%.

6 **Increase the efficiency by improved compressor controls** – the compressors consume the most energy in a refrigeration plant. To save energy here, the evaporating temperature should be as high as possible and the condensing temperature as low as possible while still maintaining the required control temperature. Remember that for every 1ºC less between evaporating and condensing temperature there is a saving of 2–4% in energy costs as the compressor has less work to do. Seek advice from a good refrigeration contractor about reviewing and upgrading your system controls for more efficient operation including floating head pressure and electronic expansion valves.

7 **Optimise condenser fan coil units** – keep condenser coils and fins clean and free of debris. Blocked condensers increase the condensing temperature – a 1ºC increase will increase energy costs by 2–4%.

Condenser on the verge of failing

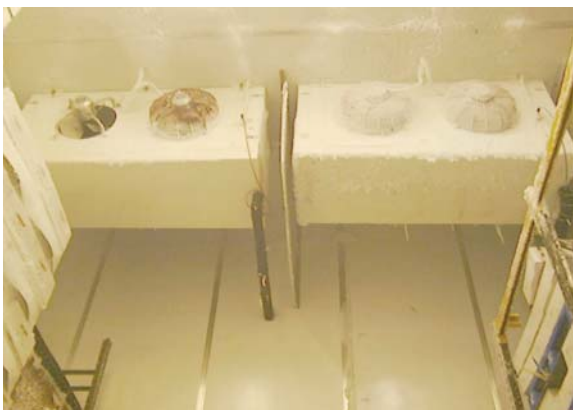
Condensers in direct sunlight, drawing hot air from its neighbour

Make sure that air entering the condenser units is as cold as possible (ideally shaded from direct sunlight on the north facing side of the building).

Upgrade to the most energy efficient fan motors and speed control systems.

When replacing condensers, consider installing units that are larger than standard designs. These may be more expensive to purchase but will improve refrigeration efficiency and save money in the long run. Very few companies use the reject hot air from the condenser to preheat water. This is 'free energy' and when installing new systems should be investigated especially if the boilers and condensers are sited close to each other.

8 **Optimise evaporator fan coil units** – evaporator fan motors consume a significant quantity of energy, especially if they run continuously at full speed. Save up to 70% of fan energy by replacing inefficient fixed speed motors with more efficient variable speed drives. These will reduce their speed when the heat has been removed. Regular checks to make sure that the coils and fins are clean, free from ice and not blocked to ensure efficient heat transfer. Check that the frequency and duration of defrosts are only enough to keep ice build up from affecting evaporator efficiency otherwise they will waste energy, add to the heat load and disturb the room temperature control and air distribution.



Regular checks to make sure that the coils and fins are clean

9 **Minimise door openings** – open or leaking doors waste energy. Ensure doors are easy to operate and educate staff to keep door openings to an absolute minimum. Keep strip curtains in good condition and consider investing in air curtains, vestibules or automatic door closing devices especially when freezer temperatures are involved.

A typical energy management programme for refrigeration *(cont'd)*

Strip curtains in poor condition

10 Check insulation – over time insulation deteriorates or becomes damaged. Poor insulation increases energy consumption as external heat is gained through small gaps in the walls, ceiling, doors and floor. Thermal imaging cameras can quickly identify areas that need attention. Check and replace any faulty insulation on cold refrigerant pipes between the evaporator and compressor (especially on larger suction line pipes). Also check that door seals are not damaged, allowing heat to leak in.

11 Fans – by using high efficiency electronically commutated motors (ECM) to replace evaporator fans, energy costs can be reduced by up to 50%. An abattoir with 10 kW of installed fan power costing over £9000 per year to run, reduced their fan speeds part way through chilling and changed to a more efficient electric drives/fan units. By doing this they made savings of over £2000 per year on electricity bills. Similarly 50% energy savings (approximately £900 per year) were made by converting evaporator fan motors in their primary chiller to high efficiency motors. However, the payback period was over two years due to the cost of the fans. Replacing units with more efficient ones when they fail is the most sensible option.

12 Air Socks – Fitting air sock diffusers to fans will benefit the refrigeration process if the chillers suffer from uneven chilling with hot and cold spots. The air socks deliver an even, low velocity, low temperature flow of air into the carcase chillers. Maintaining an even temperature and low airflow can sometimes help reduce evaporation and drip loss. However, air socks may increase energy usage and do need regular cleaning.

Air sock diffusers

13 Having completed steps 1 to 12 review energy usage. Calculate actual savings and monitor regularly to get annual savings. Publish savings so all departments are informed.

Agree an audit and maintenance schedule to ensure the plant maintains its optimum performance.