Carbon Trust
Making business sense of climate change

Industrial Energy Efficiency Accelerator

Guide to the animal feed milling sector

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1. Executive summary

One way for industry to achieve significant CO_2 reductions is to improve energy efficiency in sector-specific manufacturing processes. The Carbon Trust has been working with a number of industry sectors, as part of its Industrial Energy Efficiency Accelerator (IEEA), to identify where savings can be made in each one. This novel approach aims to deliver quick and substantial reductions in industrial process emissions, by accelerating innovation in process control and the uptake of low carbon technologies.

The animal feed industry in the UK produces over 18 million tonnes (Mt) of product per year at approximately 130 sites. Products include a broad range of feedstuffs for all types of animal, including agricultural, pets, fish, horses and exotic animals. Annual energy consumption for the sector is approaching two terawatt hours (TWh) and carbon emissions are approximately 620,000 tonnes of CO_2 (tCO_2).

The Carbon Trust worked with the animal feed sector in 2008 and 2009 to understand energy use in the manufacturing process and identify possible ways to improve efficiency. The investigation focused on pelleted compound feed for agricultural animals, as this manufacturing process is used by most of the sector and accounts for the majority of carbon emissions.

The detailed data collected from submetering of the animal feed manufacturing process highlighted a number of opportunities to significantly reduce carbon emissions within the sector. These fall into three broad themes:

- innovation in process control
- product strategy innovation
- innovative equipment

The animal feed sector could take a more strategic approach to carbon reduction, engaging with both customers and suppliers, in order to position itself to take advantage of the low carbon economy.

This report discusses in detail the opportunities for energy efficiency and carbon reduction. It also presents data that has been gathered as evidence to justify investment in these opportunities.

2. Background to the Industrial Energy Efficiency Accelerator

Industry is responsible for 25% of the UK's total CO_2 emissions[1]. Experience at the Carbon Trust supports the view of the Committee on Climate Change, which indicated that savings of 4-6MtCO_2 (up to 4% of current UK emissions) should be realistically achievable in industry with appropriate interventions.

We believe that CO_2 savings far beyond those set in current policy targets are possible by working more directly with organisations to clarify the opportunities. The impact of policy can also be accelerated and increased if industry sectors are helped to understand their energy use and how to make significant changes in a short time frame, rather than gradually reduce their emissions over time. What's more, direct intervention can help embed a culture of innovation and good energy management, resulting in a greater long-term impact.

Significant CO_2 reductions in industry are possible by working with those medium-sized industry sectors that are outside of the EU ETS scheme but are affected by either Climate Change Agreements (CCAs) or the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme. These industries are moderately energy intensive and, in total, account for 84MtCO_2 emissions per year [2].

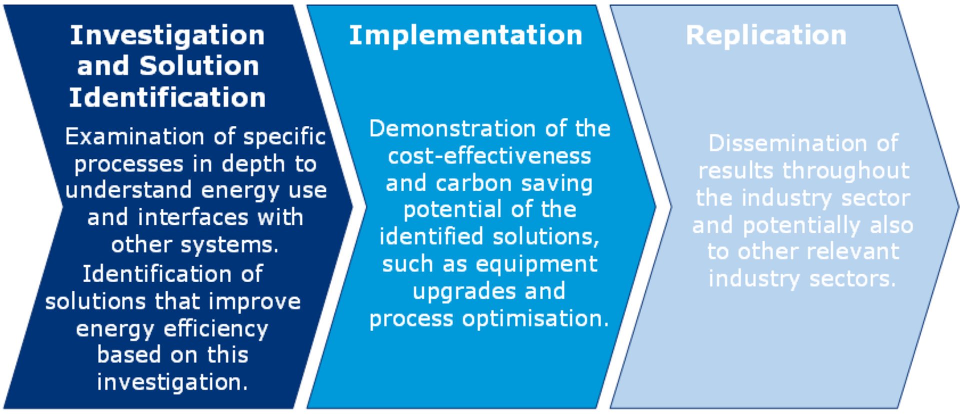
The Carbon Trust currently works with industry by supporting companies to reduce their carbon emissions. The approach is applied across a range of industries but does not offer detailed advice on sector-specific manufacturing processes. More energy intensive industries frequently cite the fact that survey recommendations do not address the bulk of their energy use as a reason for not implementing them. Between 50-90% of a site's energy consumption could typically be used by a sector-specific manufacturing process.

In addition, the Carbon Trust Applied Research Scheme has supported the development of a number of industry-related technologies. This scheme is offered in response to applications for support, rather than targeting specific technologies.

Recognising the challenge of reducing CO_2 emissions from industry, and the carbon reduction potential of sector-specific manufacturing processes, we looked at how we could best engage with industry to significantly increase the rate of carbon reduction beyond that delivered by carbon surveys. As a result, we developed the IEEA approach, which was launched as a pilot in 2008.

The IEEA approach focuses on identifying and addressing the reasons why opportunities to reduce emissions in industrial processes are not put into action. This is a three-stage process:

[1] Committee on Climate Change Report, December 2008.
[2] Source: DECC CRC Presentation, Westminster Energy Forum, January 2009



In 2008/09 we undertook the investigation and solution identification stage with three pilot industry sectors: animal feed milling, asphalt manufacture and plastic bottle blow moulding. This report details the results and key findings from the investigation work for the animal feed milling sector.

3. Background to animal feed sector

The animal feed industry in the UK produces over 18Mt of product per year at approximately 130 sites. Annual energy consumption for the sector is approaching 2TWh and carbon emissions are approximately 620,000tCO_2.[3] Electricity makes up 28% of energy used, while the remainder includes gas, fuel oil, gas oil, kerosene, coal and liquid petroleum gas (LPG).

The sector is represented by the Agricultural Industries Confederation (AIC) and over 95% of the industry is covered by the AIC Climate Change Agreement (CCA).

What they manufacture

The animal feed sector is made up of producers of a broad range of feedstuffs for all types of animal, including agricultural, pets, fish, horses and exotic. The main classifications of agricultural animal feeds are:

- ruminant (beef and dairy)
- sheep
- pigs
- poultry (broilers and layers).

These can be further subdivided by product type:

Roughages
Fibrous ingredients suitable for ruminants, e.g. hay and grass.

Compound feeds
A number of different ingredients (including major minerals, trace elements, vitamins and other additives) mixed and blended in appropriate proportions, to provide properly balanced diets for all types of stock at every stage of growth and development. Compound feeds may be produced in the form of:

- meals – an unbound mix of ingredients
- pellets
  - pellets (2-4mm)
  - nuts (5-8mm)
  - rolls (10+mm)
- crumbs – for very young poultry, even small pellets may be too large. Crumbs are often used to provide a nutritionally balanced diet for such animals. Crumbs are produced by breaking pellets into smaller pieces in a crumber.

Protein concentrates
Products specially designed for further mixing before feeding, at an inclusion rate of 5% or more, with planned proportions of cereals and other feeding stuffs added either on the farm or by a feeding stuffs compounder.

[3] Enviros. CCA data for the period October 2006 to September 2007.

Coarse mixes
A number of different ingredients of different physical form, e.g. rolled, flaked and cracked, mixed together with protein concentrate pellets.
Straights
Single feeding stuffs of animal or vegetable origin, which may or may not have undergone some form of processing, e.g. wheat, barley, flaked maize, fish meal.

Additives
Substances added to a compound or a protein concentrate in the course of manufacture for some specific purpose other than as a direct source of nutrient, e.g. drugs.

Supplements
Technical products for use at less than 5% of total ration in which they are included, and designed to supply planned proportions of vitamins, trace mineral, one or more non-nutrient additives and other special ingredients.

Different products are produced for different animals, as well as for different stages of growth and development. The majority of sites manufacture pelleted compound feeds for agricultural animals, so this project has focused on that process.

How they manufacture

The animal feed milling process consists of a number of stages. A simplified diagram of the main stages common to all mills producing pelleted compound feeds is given in figure 1.

Mixing is done in batches of two, three, four or five tonnes depending on the site. Apart from this and the intake/loading of materials, process operations are continuous.

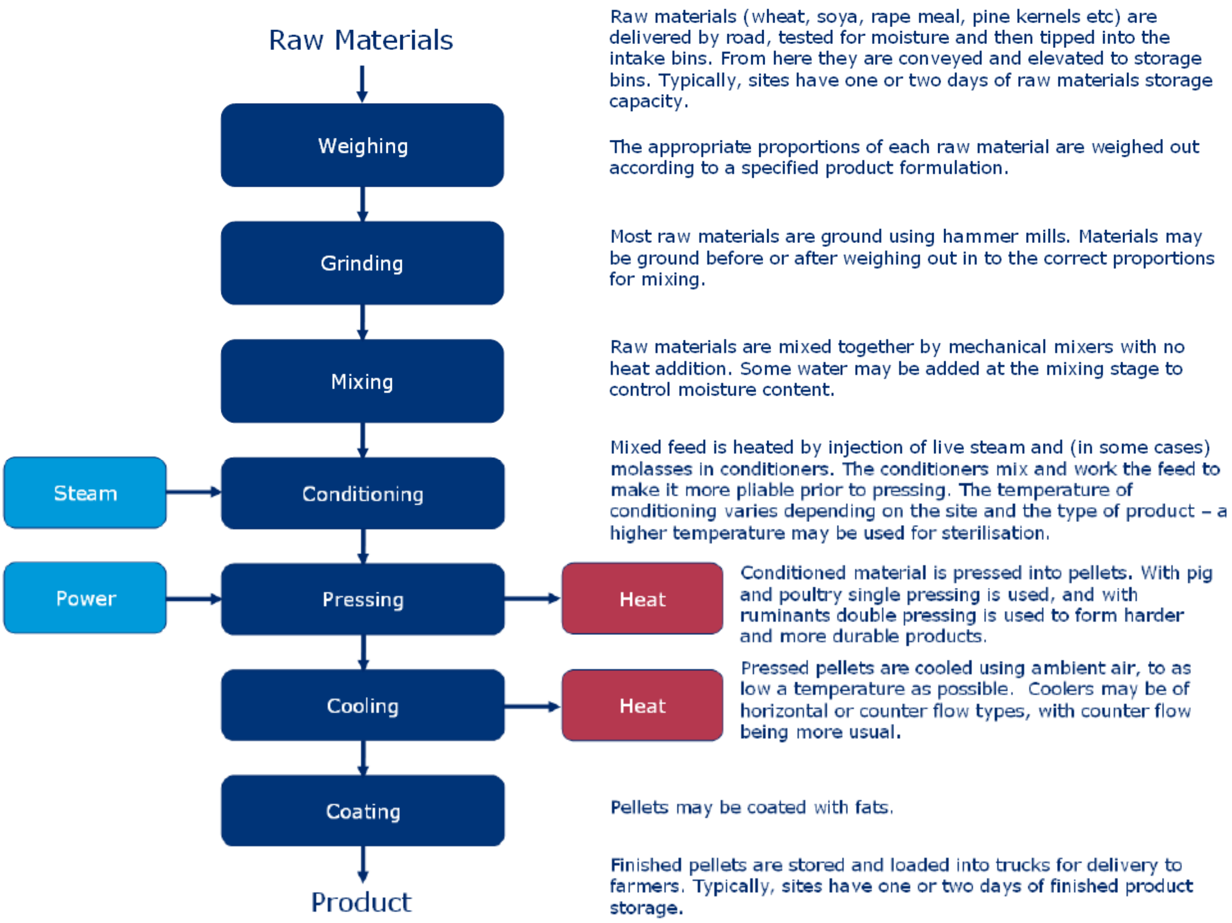


Figure 1: **Flow diagram showing the main stages of pelleted animal feed production and the major energy demands.**

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Business drivers

As in all businesses, animal feed producers are influenced in their decisions by a number of key drivers. Figure 2 illustrates some of the most important business drivers in this sector.

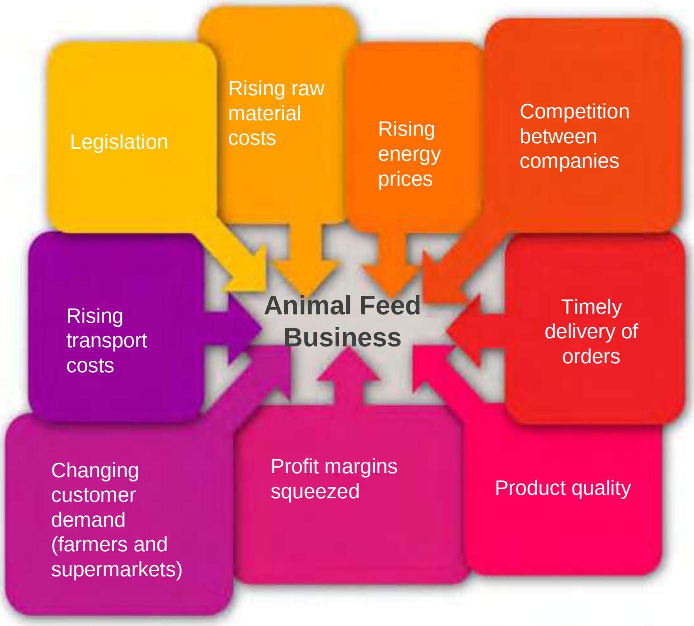

Figure 2: Key business drivers for the animal feed sector

Customer demands

The immediate customers of the animal feed mills are usually farmers. However, supermarkets (and to some extent consumers) have recently begun to influence producers.

In the short-term, the demands of farmers dictate to a large extent which products are produced and when. Order lead times at feed mills are typically one to two days, meaning that there is relatively little flexibility around scheduling different products. Batch sizes can be small, resulting in frequent changes in process operations, which reduces energy efficiency. In addition, there is little flexibility to allow for machine downtime.

In the longer-term, changes in the demands on agriculture from supermarkets have a knock-on affect on feed producers. For example, pressure from supermarkets to keep the cost of meat and milk low has put pressure on agriculture to increase the efficiency of food production. This has meant that animal feed companies have had to supply products that deliver the nutrients required to produce higher yields. Another example would be the rise in the popularity of organic food, which has meant that animal feed companies now include organic lines in their product range.

On the ruminant side of the industry, production is very seasonal. Most feed is produced from September to May when cows are housed indoors. During this time, feed mills are stretched, whereas in summer they are under-used.

Animal feed producers argue that they have limited scope to influence customer demands, as they generally need to provide what the customer wants when it is demanded, in order to maintain market share in a competitive environment. However, anecdotal evidence from some companies suggests that, in areas where competition is less intense, they may in fact be able to influence their customers to a certain extent.

Legislation

Production of animal feed is highly regulated. Animal feed legislation covers:

- additives (vitamins, colourants, flavourings, binders, and so on) authorised for use in animal feed
- maximum levels of various contaminants (e.g. arsenic, lead, dioxins and certain pesticides)
- certain ingredients that may not be used in feed
- the nutritional claims that can be made for certain feeds
- the names and descriptions which must be applied to various feed materials
- the information to be provided on feed labels.

In addition to legislation, the production of feeds in the UK is covered by the Universal Feeds Assurance Scheme (UFAS) code of practice. This is an independently audited trade assurance scheme, managed by the AIC, which embraces all applicable national and EU legislation as well as Hazard Analysis and Critical Control Points (HACCP). While the majority of larger feed producers are UFAS accredited, there remains a number of small producers that are not.

Animal feed mills producing over 300 tonnes per day fall within the remit of the Integrated Pollution Prevention and Control (IPPC) directive, which controls environmental emissions to air, land and water.

Over 95% of the industry is covered by the AIC CCA, allowing these sites to receive up to an 80% discount from the Climate Change Levy (CCL) in return for meeting energy efficiency targets. The sector negotiates these targets with Defra through the AIC. Historically, the targets have been achieved relatively easily – largely because under-used mills have been closed and activities at the remaining sites have intensified. It will be more expensive and more difficult to achieve the tighter targets in the future.

Competition

At present there is overcapacity in the UK animal feed sector, so companies are in competition for farmers' business. Feed producers argue that farmers are relatively free to shop around for the right product at the right price. Although certain companies are more prevalent in particular regions, there remains strong competition between the companies at a national level. Companies compete not on price, but by trying to differentiate their products from those of competitors. For a particular type of animal at a particular stage of development, there may be literally hundreds of different products on offer.

Raw materials cost

Raw materials, such as grains and oils, account for around 80% of the finished product cost. Raw materials are generally bought on the world market, so fluctuations in price impact directly on animal feed companies.

Product formulations are drawn up to deliver the required nutritional package at the least raw material cost. For example, if the price of wheat goes up relative to maize, then the proportion of wheat in a product may be reduced and the proportion of maize increased.

Energy costs are relatively small in relation to the cost of a product. Energy is not generally taken into account in formulations.

Transport costs

The transport costs associated with animal feed are significant. Raw materials are transported by road from ports or storage terminals to the mills, and finished products are transported by road from mills to customers. In recent years, mills have been rationalised. Those situated far from their end market have been closed and the production consolidated into those closer by.

Product quality

As well as nutritional quality, there are a number of important measures of product quality used in the animal feed industry. They are:

- moisture content – feed products must not contain greater than 14% moisture
- hardness – cows feed better on solid pellets, and so customers' prefer harder pellets that do not disintegrate on transport
- durability – pellets must be able to withstand handling, transportation and storage without breaking up. Samples of finished product are tested for durability using a Holman testing machine, which simulates the disturbance that pellets experience during transport and storage.

Maintaining product quality is extremely important, as batches that do not meet the required standard may be rejected. Most mills closely monitor their production for quality assurance.

Profit margins

The rising costs of raw materials, energy and transport, as well as the pressure to keep prices low, mean that profit margins are increasingly squeezed. This has emphasised the need for operational efficiency. Mills are now highly automated and staff numbers are kept to a minimum.

Energy costs

Energy costs have increased markedly over recent years. This has brought energy efficiency up the agenda for animal feed companies and many have engaged with the Carbon Trust through energy surveys and taken measures to improve their energy efficiency.

A typical mill producing 250,000 tonnes of feed per year would be likely to spend £750,000 a year on energy. The average electrical demand would be 850kW and the heat demand 8,000kW. The cost of energy per tonne of product would be around £3, compared with a typical product cost of £200/tonne. The bulk of the product cost results from the cost of the raw materials.

Energy consumption and energy reduction drivers are described in more detail in the following sections of this report.

Energy consumption

Energy is a small proportion of product cost but represents a major variable or operational cost for animal feed mills and is becoming an increasingly high priority for the sector.

The specific energy consumption (SEC) for most sites in the animal feed sector falls within a relatively narrow range, with 85kWh/tonne being broadly average. The distribution of SEC is shown in Figure 3, below.

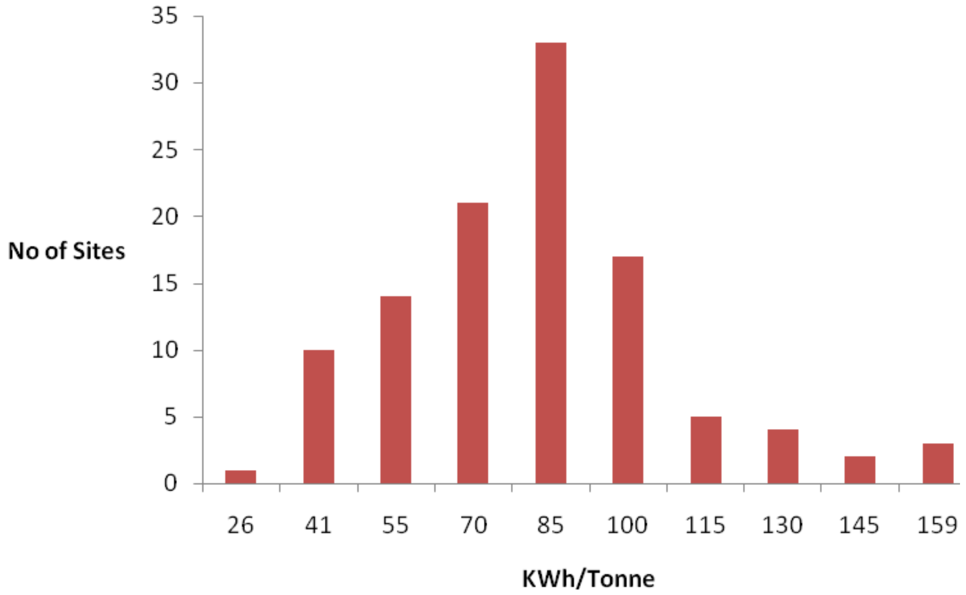

Figure 3: Frequency distribution of specific energy consumption for the animal feed sector (2006-2007)

The variation in SEC can be explained in two ways.

First, investigation of the outliers shows that SEC deviates considerably from 85kWh/tonne in sites which produce something other than pelleted compound feeds for agricultural animals. For example, many of the sites with very high SEC were energy intensive fish food producers, while sites with very low SEC were producing coarse blends of meals, which do not require pelleting. This is illustrated in Figure 4.

Second, for the 80% of sites producing pellets for agricultural animals, the variability in SEC is explained by a number of factors:

- intensity of production
- batch size
- product type
- product quality
- efficiency of equipment
- operations management

This report discusses opportunities to improve energy efficiency in these areas.

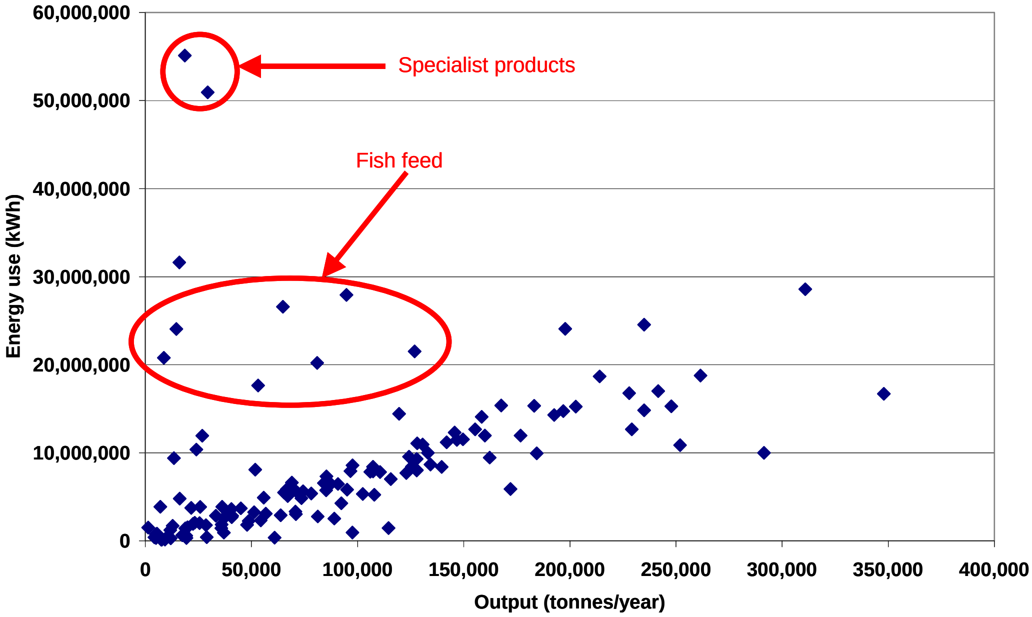

Figure 4: Relationship between energy use and product output for the animal feed sector (2006-2007)

Energy management practices within the sector are, in general, fairly basic. Most companies do not have a formal energy policy, a dedicated energy manager or formal channels for communicating energy efficiency to staff. Equipment is frequently replaced through the second hand market, with little focus on energy efficiency. Before this work there was virtually no energy submetering in place within the sector, and it remains unusual.

Over recent years, all the major companies in the sector have rationalised their milling operations, closing many smaller mills and increasing production of the larger mills by running for longer hours. This has increased the efficiency of feed production and it is clear from our analysis that those mills operating close to capacity tend to be more energy efficient.

Energy reduction drivers

A number of factors are driving moves towards energy efficiency in the animal feed sector. These are illustrated in Figure 5 below. Many of the drivers which influence business decisions also have a bearing on energy efficiency.

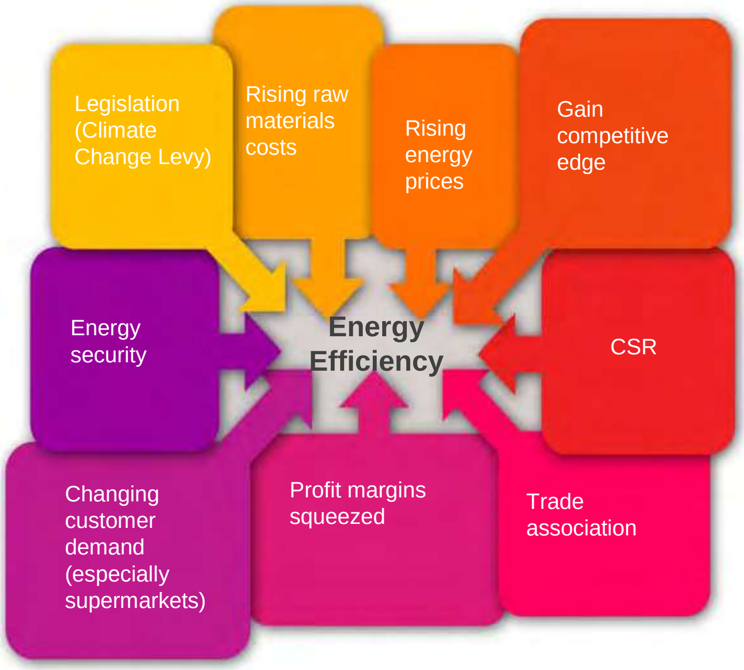

Figure 5: Key energy efficiency drivers for the sector

Energy costs

Energy costs are by far the most significant driver for energy efficiency improvements on animal feed mills. Energy makes up only 1% to 2% of the cost of a product but represents up to 30% of a mill's variable costs. Electricity and gas prices have increased very significantly over recent years, as shown in the figures below.

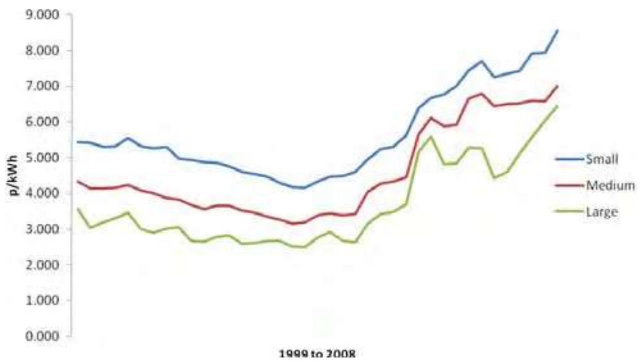

Figure 6: Electricity prices 1999-2008 for small, medium and large industrial consumers[4]

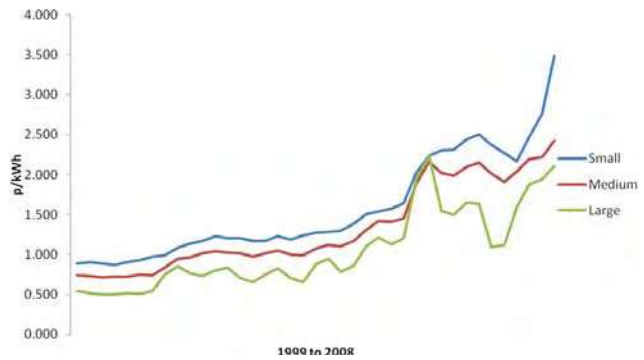

Figure 7: Gas prices 1999-2008 for small, medium and large industrial consumers

[4] BERR Energy Trends Quarterly

Climate Change Agreement

Over 95% of the industry is covered by the AIC CCA. But it's questionable how significant the CCA is as a direct driver for energy efficiency at a site level, because the targets apply to the whole sector rather than individual companies. Also, the cost of carbon, as measured by the CCL, is relatively low in comparison with the value of energy.

Energy security

Although it is not yet having a significant impact, some of the larger animal feed companies see energy security as a driver for energy efficiency. This has led them to investigate opportunities such as distributed generation, combined heat and power (CHP) and biomass.

Raw materials cost

As described earlier, raw materials account for around 80% of the finished product cost. Recent increases in the price of raw materials have meant that companies are looking ever more closely at where efficiencies can be made. As staffing levels have already been rationalised considerably, energy has become a key focus area.

Corporate and social responsibility

The major animal feed producers value company image and brand value. The sustainability agenda in general, and carbon reduction in particular, are increasingly discussed at board level. A number of companies are also beginning to see carbon reduction as a means of differentiating themselves from the competition in terms of the corporate and social responsibility agenda.

Competition

It is widely recognised within the sector that reducing operational costs through energy efficiency is one way of gaining a competitive edge.

Changing customer demand

Consumers and major retailers are starting to demand information on embedded carbon in consumer goods. This is driving farmers to reduce the carbon footprint of animal products. For example, Cadbury has advised the dairy farmers who supply its milk on carbon saving tactics. The advice includes recommendations regarding types of animal feed. Consumer demand is likely to become an increasingly significant factor over time.

Trade association

The AIC negotiates the CCA with Defra and provides a forum for the industry to discuss environmental issues. This gives it an important position in driving the carbon reduction agenda within the industry.

Investment in energy efficiency

When considering making a capital investment, animal feed companies go through a process of prioritisation and building an internal business case. The details of this process vary from one company to another and tend to be more rigorously structured in larger companies than smaller ones. The following describes a typical process for a larger company:

- Annual mill improvement plan - drawn up by the group manager and the site management team. This is based on a review of the mill's performance over the past year and the perceived future requirements. It includes issues relating to:
    - technical
    - health and safety
    - environmental
    - feed safety
    - commercial
    - personnel and management
    - energy efficiency.
- Priority actions – drawn up from a review of the mill improvement plans with senior management.
- Investment proposal reports – giving the reasons and justification for each investment including:
    - legal compliance
    - return on investment
    - commercial advantage.
- Capital proposal form – signed off at board level.

The required payback period for an investment can vary from two to 10 years depending on the type and size of the investment and other mitigating factors.

For small companies the decision-making process is often less structured than that described above. However, it will usually be based on the same principles, i.e. prioritisation of investments and calculation of paybacks.

4. Key findings

Feed milling is energy intensive and the energy use in mills is also highly variable. The energy bill for a typical mill is approximately £750,000 per year, at current energy prices. The breakdown of energy costs is shown in Figure 8.

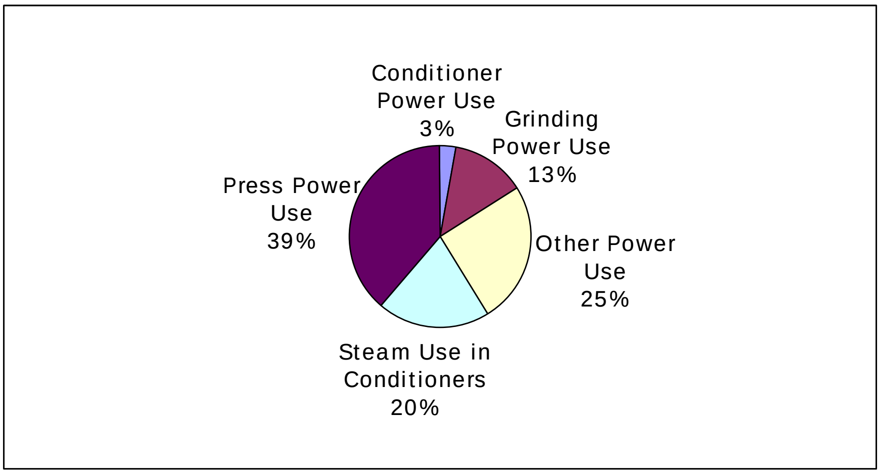

Figure 8: Relative energy costs for a typical feed mill

The majority of the power is used in the presses. This accounts for around 40% of overall energy costs. The press lines also include the conditioners, which use both power and heat in the form of steam. There is an operational trade off between increased steam and reduced press electricity. There is also an energy saving trade off: the heat generated by the raising of steam represents about 20% of site energy costs but about 50% of absolute energy use and carbon emissions generated.

'Other power use' includes:

- conveyors
- elevators and screws for handling materials
- the mixers used to blend the raw materials
- the coolers which use ambient air to cool the pellets after pressing
- air compressors providing air for instrumentation and controls
- other relatively small process and utility equipment.

The press line electricity use is affected by a number of factors both within and outside the control of the operations and management staff. These include the type of product produced, the composition of the products, the rate of processing the batch size and the decisions made by the operator.

Product type and raw materials

The impact of the type of product on energy use is shown in Figure 9. For example, turkey feed is generally more energy intensive to manufacture than broiler feed at any one site. The data for this chart was captured at a single site, although the same relationships were evident at all sites metered.

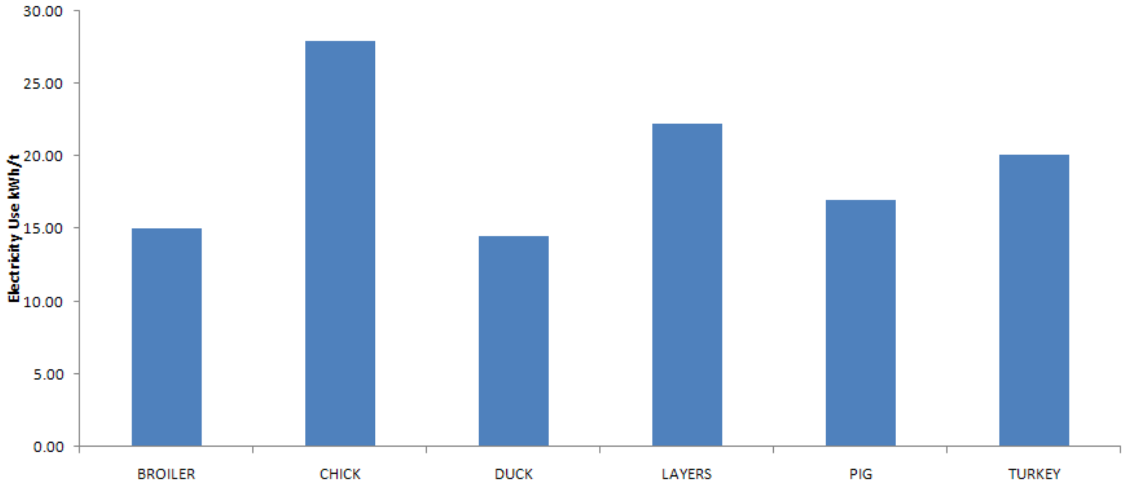

Figure 9: Variation in electricity use with product type – certain poultry products

Different product types consume different amounts of energy in the manufacturing stage, as each contains different raw materials. Figure 10 shows the impact of wheat content on press electricity use. Wheat is known to be relatively easy to press, and a 20% increase in wheat content from 40% to 60% reduces press power use by 15%. By understanding the fundamental causes of how presses use energy, manufacturers can adjust formulations to achieve energy efficiency improvements. Currently, formulations are largely driven by the cost of raw materials as well as the need to achieve the required nutritional quality, but energy efficiency could become another significant factor.

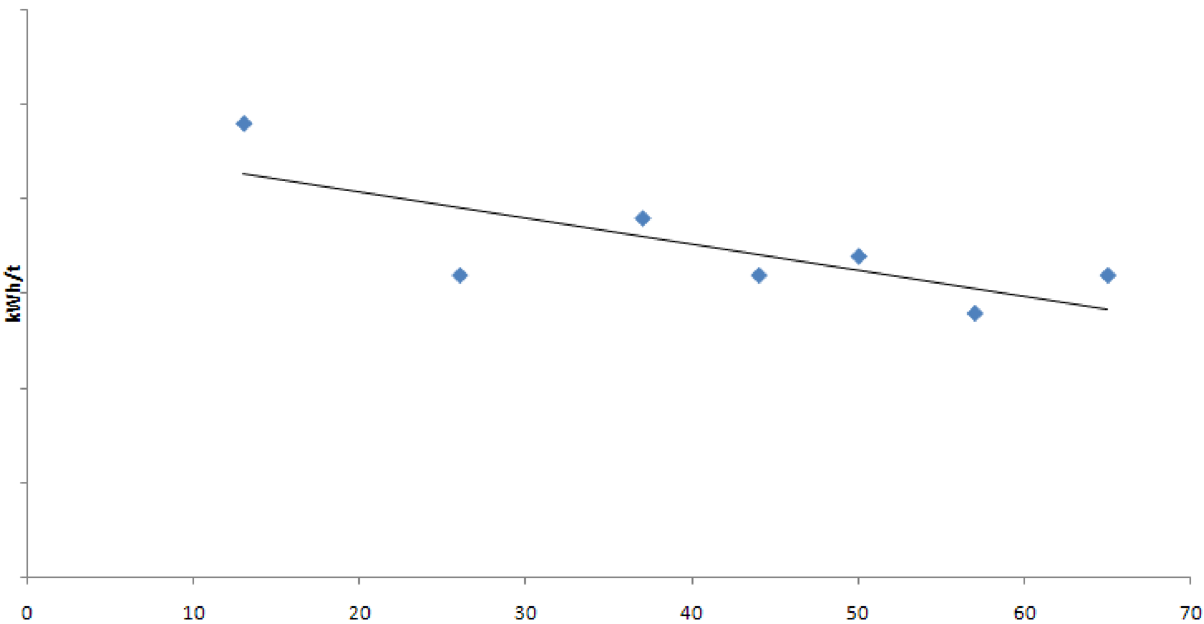

Figure 10: Impact of wheat content (%) on electricity use in poultry pressing

These findings were found to be true for ruminant as well as poultry mills. Figure 11 shows the impact of different ruminant product types (described by their recipe code numbers, e.g. 1051, 1061, etc) on electricity consumption.

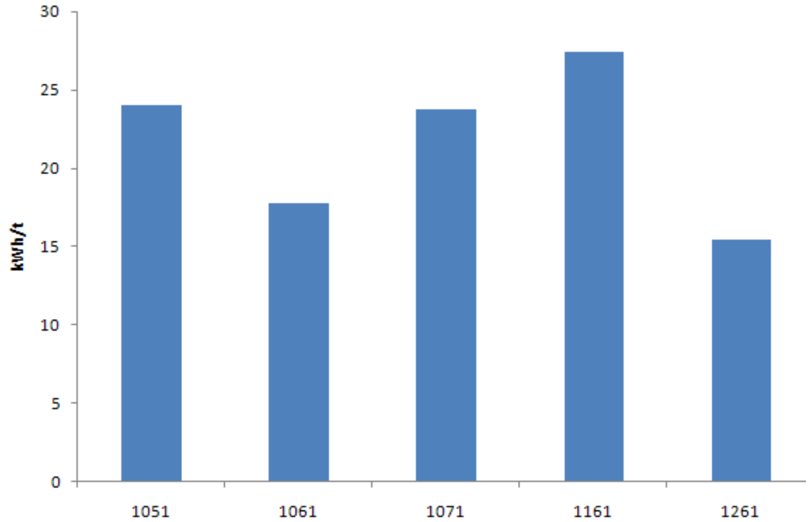

Figure 11: Variation in electricity use with product type – ruminants

Additives

Additives in the animal feed (including molasses) also significantly affect the press energy use. Certain additives are marketed as reducing press energy use. At current energy prices, these are relatively expensive, adding around 90p per tonne to the cost of a product, compared with a power cost of around £2 per tonne of product (for a ruminant mill). The potential for additives to reduce energy use needs to be better understood to evaluate cost-effectiveness.

Rate of processing

Analysis of the data for single product types on repeated runs at each site showed that the rate of processing affects the amount of energy consumed to manufacture the product. A higher rate of processing leads to lower electricity use. This is a general pattern, illustrated in Figure 12.

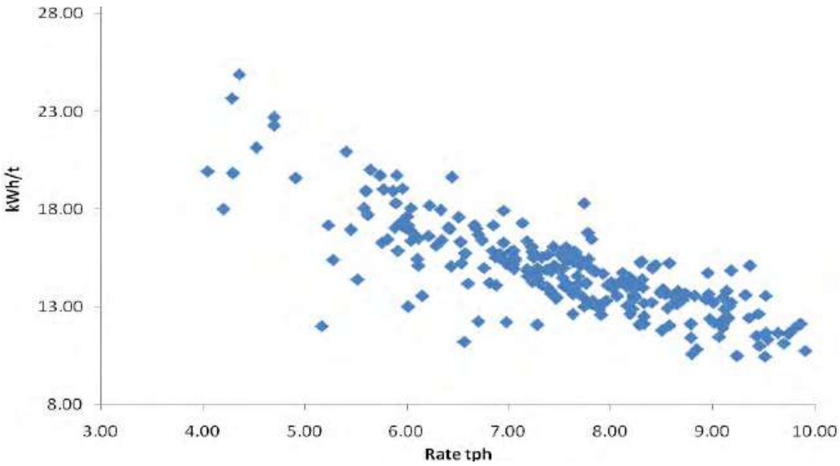

Figure 12: Variation in electricity use with rate for single poultry product

The rate of processing is influenced to some extent by the batch size, since the press is generally started at a low rate and then ramped up. On shorter runs the average rate is therefore less than on larger runs. This is illustrated in Figure 13.

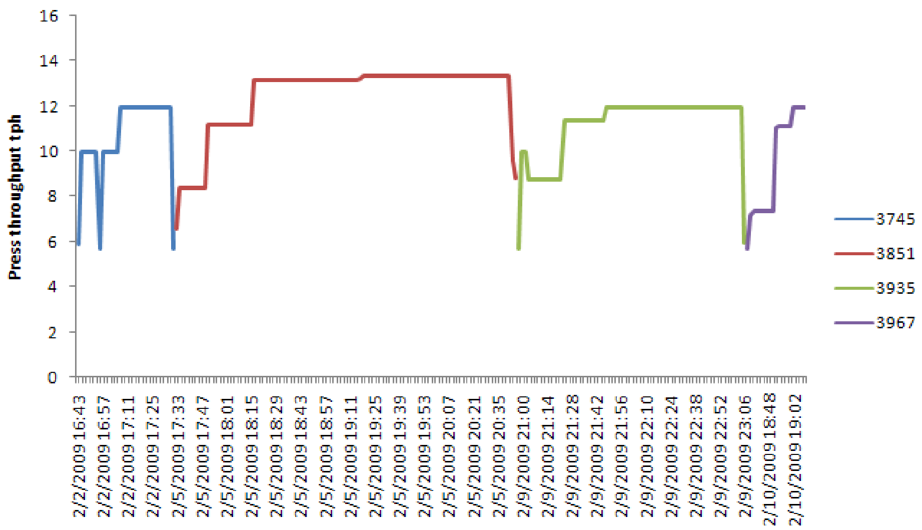

Figure 13: Typical press rate profiles

Length of product runs and batch sizes are partly driven by customer demand as product storage space is typically quite limited at feed mills. However, there is also a case for improved scheduling of production to reduce energy consumption. Limiting the range of product options for customers and installing additional storage capacity are ways for animal feed milling companies to achieve this.

Use of steam in conditioning

Steam is used to condition the feed before pressing. Increasing the amount of steam used decreases the amount of electricity needed. This is illustrated in Figure 14.

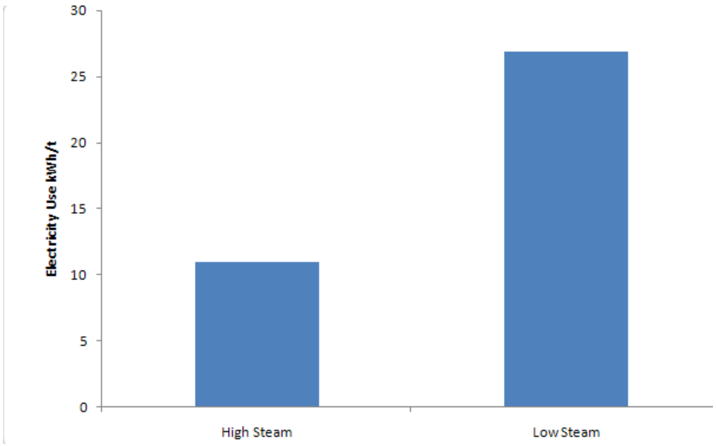

Figure 14: Impact of steam on press line energy use

Optimising the use of steam can reduce the electricity required for pressing by as much as 20%. The optimum level of steam varies depending on the relative costs of steam and power. Only certain conditioners allow the increased volumes of steam and conditioning times that are necessary to reduce overall energy use.

Equipment idling

Equipment in animal feed mills, particularly presses and grinders, is often left idling for longer than necessary. Figure 15 shows press power use in a particular mill (the colours represent different motors on the press line). Periods of idling are clearly identified as times of low, but not zero, power.

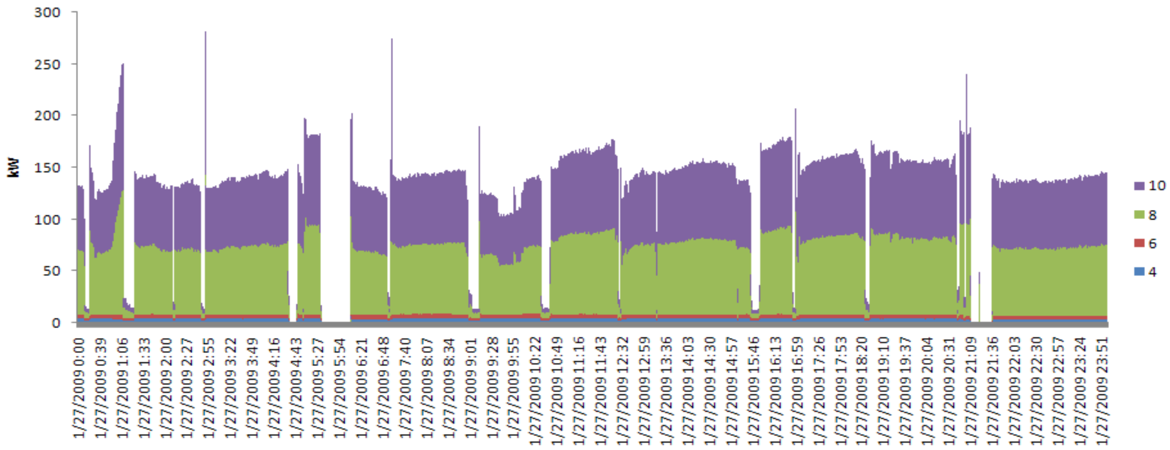

Figure 15: Press power use at Mill A, showing periods of idling

Figure 16 shows a further mill with even greater periods of idling where power use is not zero.

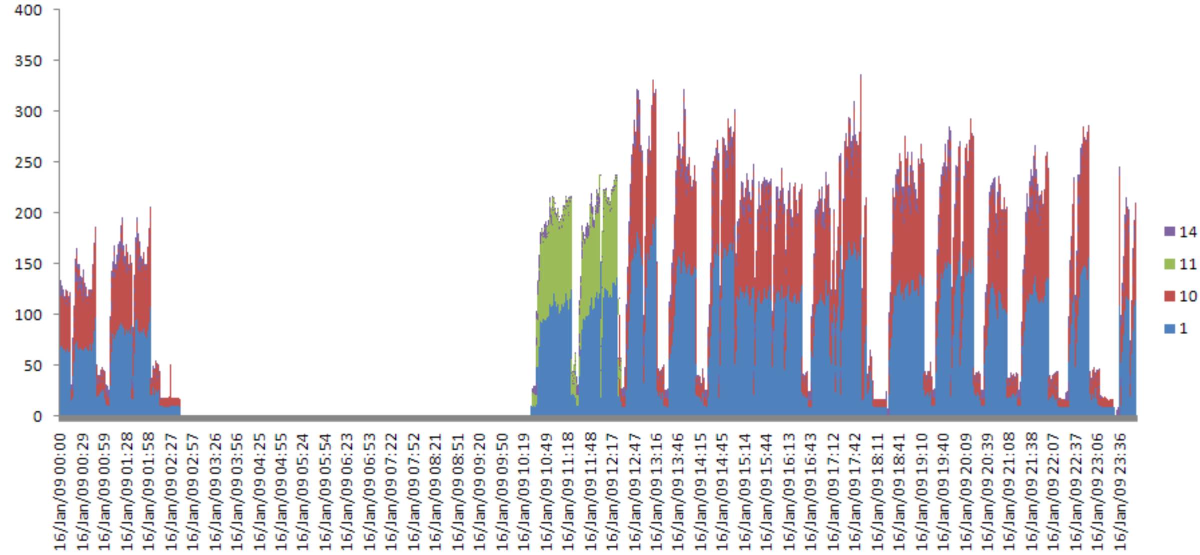

Figure 16: Press power use at Mill B, showing more significant periods of idling

There is sometimes a need for low level power use on the press line in order to flush or clean-out the line between different products. This ensures that the raw materials from different products do not contaminate each other. This should not be confused with the excessive periods of idling illustrated in Figures 15 and 16.

Idling is also a problem for grinding and mixing equipment. A typical profile of grinder power use is shown in Figure 17. Grinder speed is varied according to product type. For example, wheat feed is more difficult to grind than soya.

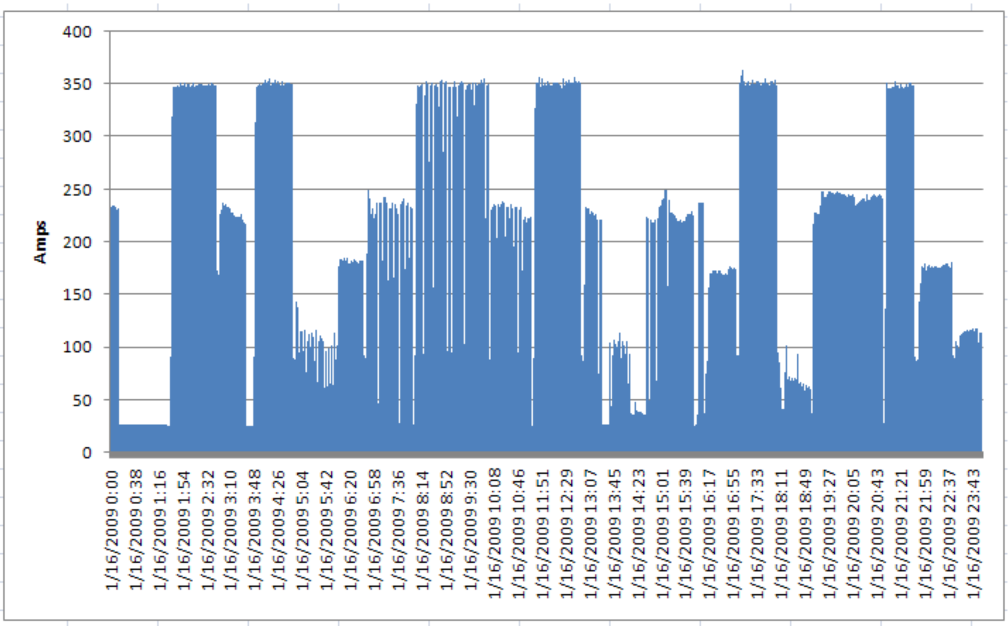

Figure 17: Grinder power use, showing periods of idling

Operator best practice

Operators play an important role in setting the process operating parameters that influence energy use. For example, more cautious operators may reduce the processing rate in order to avoid the risk of blockages in the press. The impact of different operating practices is illustrated in Figure 18. There is a clear case for operating staff to share best practice as this will significantly reduce overall energy consumption.

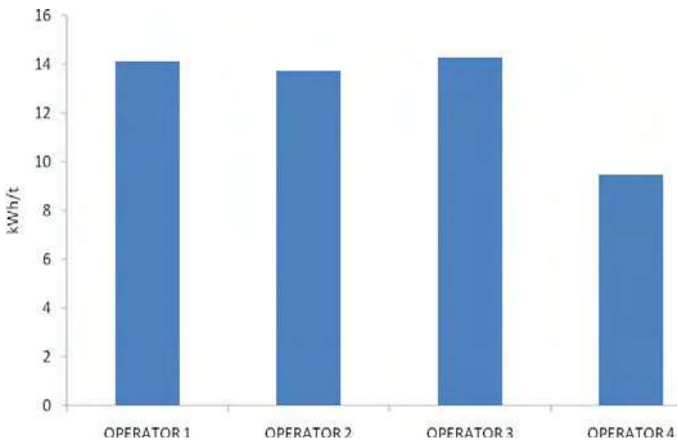

Figure 18: Impact of operating practices on press electricity use at one site

New equipment

Very little new equipment is used in the animal feed industry but different presses, conditioners and grinders have been shown to have a marginal impact on overall energy consumption. Some mills use a Boa pre-conditioner to reduce overall press line energy use. There is currently insufficient data to be able to compare press lines with and without a Boa pre-conditioner.

Low profit margins have led to a lack of investment in new plants, equipment and R&D in general. The newest mill in the UK was built in 1998, equipment is often bought secondhand and there is effectively no R&D into equipment taking place in the UK. Most equipment is from overseas manufacturers.

Product quality

The quality parameters of the finished animal feed product (for example, the moisture, hardness or durability) influence how much energy is consumed in manufacture.

Figure 19 shows how much moisture the feed typically contains after the final cooler. The target moisture content is 14% but there is clearly variability. A final moisture content below target suggests that more energy than necessary is being wasted in drying the product.

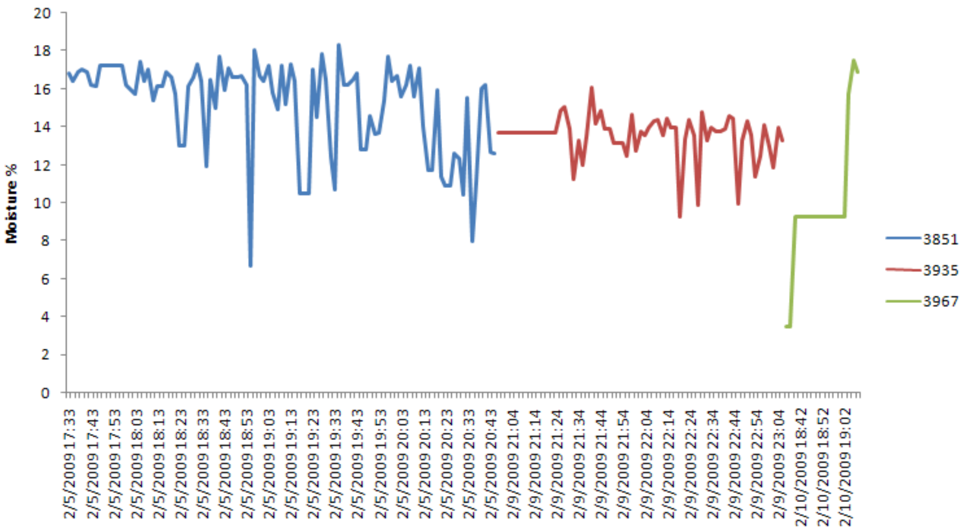

Figure 19: Typical product moisture profiles

Process optimisation

Data monitoring has shown that, in general, motors on animal feed sites are operating for long periods at low loads. This is confirmed by low power factors. There is scope for animal feed companies to install more efficient motors and motor controllers as this will reduce energy losses.

At the majority of sites, voltage monitoring has confirmed that there is scope for voltage reduction and optimisation which will also reduce energy consumption.

Energy management

There are few dedicated energy managers in the animal feed sector and there is little specialist and independent support available. Most expertise rests with senior production and engineering managers.

Although mills capture and use extensive production information, little information is typically available at the unit process level to inform energy management decisions and measure performance improvement. Managers are generally aware of opportunities for energy reduction but lack the data to build a strong business case for change.

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5. Opportunities

Before the work undertaken as part of the IEEA, a number of animal feed sites had received surveys from the Carbon Trust and most were aware of conventional energy efficiency measures such as energy efficient motors, variable speed drives, efficient lighting, boiler plant optimisation and pipe lagging. It is clear that most sites could still benefit from fully implementing these measures. However, most of the energy use on animal feed sites is related to the production process, in which there are a number of additional opportunities identified through the Accelerator.

These opportunities fall into three broad categories:

- innovation in process control
- product strategy innovation
- innovative equipment

Innovation in process control

These opportunities tend to be cheaper to implement and have a shorter payback period than other types. They are also the most popular with the industry, partly for the same reasons but also because they are relatively straightforward to implement.

Active energy management

The animal feed sector could make significant energy savings by collecting, analysing and reporting comprehensive energy performance information. The information would help operators to identify causes of higher energy use such as low production rates, excessive plant idling, etc.

This opportunity applies to over 80% of animal feed sites in the UK and, if implemented at this level, could lead to savings for the whole sector of approximately 30,000tCO_2 per year.

Cost

The cost of implementing the required 'smart-metering' is approximately £30,000 per site. The ongoing management cost of analysing the data is approximately £15,000 per company per year. A payback period of less than one year is expected.

Barriers

It is always challenging for businesses to justify the initial cost of metering as the installation itself does not lead directly to savings. There is evidence of likely energy savings resulting from smart metering both in this report and also from the Carbon Trust Advanced Metering Accelerator (see the Carbon Trust publication CTC713). Carbon savings depend on appropriately skilled analysis of the energy data and improvements based on that analysis. The animal feed industry has limited skilled resources in terms of energy management and this can be a potential barrier to implementation.

Process optimisation

Once active energy management is in place, there is the opportunity for more advanced process optimisation. This includes optimising conditioning temperatures, steam flows, water additions and grinder sizes.

More sophisticated analysis and modelling is required in addition to the data made available through an active energy management programme.

This approach is possible for over 70% of animal feed sites in the UK and, if implemented at this level, could lead to savings for the whole sector of 20,000tCO_2 per year.

Cost

The cost estimate of implementing active energy management is based on bringing in expertise with appropriate analysis, modelling and energy management skills and is estimated to be £10,000 per site per year. The estimated payback period would be around one year.

Barriers

The barriers to implementation of this opportunity build upon those that exist for active energy management. Advanced process optimisation requires an even greater level of skill and experience in energy management, coupled with the time to analyse complex interrelationships in the data.

Production scheduling

Energy consumption could be significantly reduced by implementing longer production runs. This can be achieved through more effective planning and scheduling of production which in turn relies on management of customer orders and installing additional product storage capacity.

Over 80% of animal feed sites in the UK are suited to this approach. If implemented at this level, it could save the sector as a whole approximately 10,000tCO_2 per year.

Cost

The estimated cost of implementing this opportunity is around £50,000 per site. This mostly represents the capital required for additional storage. Some sites may also benefit from scheduling software tools. The payback period for this investment is around two years. This calculation is based on a 10% increase in production rate being achieved, which reduces energy costs by at least 5%.

Barriers

The most significant barrier to implementing this opportunity is the management of customer expectations. Under current practice, customers often require feed at very short notice and select from a wide range of products. Restricting both the product range and the required order lead time could lead to a loss of market share in a highly competitive market. The remaining market share is likely to be far more profitable for companies, but this is a difficult hurdle to overcome. The recommendation would be to make small changes incrementally.

Moisture control

Achieving a 0.5% improvement in moisture level (compared to target moisture content) reduces energy per tonne of product by approximately 1% and increases output by around 0.5%. The impact of moisture level on press energy use is complex and achieving estimated energy reductions relies on advanced moisture control systems.

Over 80% of animal feed sites in the UK can take advantage of this opportunity. If implemented at this level, it could save the sector as a whole approximately 5,000tCO_2 per year.

Cost

The required moisture control systems would cost approximately £30,000 per press line. The payback period would be less than one year because of the increase in output that becomes possible, as well as the energy reductions.

Barriers

The moisture control system is relatively expensive. Although the potential benefits are significant, they have not yet been independently tested and monitored in the UK. This makes it difficult for companies to justify the capital outlay.

Product strategy innovation

These opportunities tend to present greater commercial risks to the industry sector as they interface with customers and raw material suppliers. Although they can be low-cost, the sector does not currently consider them priority areas. There is a real opportunity for the first-mover in the sector to seize market share and build their reputation as a low carbon supplier by implementing these relatively significant energy saving opportunities.

Energy efficient formulations

There is an opportunity to choose product formulations that not only minimise raw material cost (as is currently common practice) but that also minimise the energy used in processing the raw materials. The industry could track the connection between formulations and their energy requirements through trials and monitoring and analysis of energy data. Once these correlations are quantified, this data can be incorporated into formulation systems that cost the least. Formulations should also use additives alongside other raw materials, where these are shown to reduce energy consumption cost-effectively.

This opportunity applies to over 80% of animal feed sites in the UK and, if implemented at this level, could save the sector as a whole approximately 30,000tCO_2 per year.

Cost

Implementing the required data gathering would cost approximately £30,000 per site. A payback of two years or less is likely.

Barriers

The barriers to this opportunity include the fact that the raw materials may vary in quality. For example, moisture content may vary, which would also impact on the energy needed for processing. There is also some scepticism in the industry that taking account of energy costs in formulations will lead to different formulation choices. This view is based on the belief that energy costs tend to be lower than raw material costs. This may be true for some formulations but there is unquantified evidence from operations managers that certain raw materials do impact significantly on energy use.

Low energy products

Energy can be saved by producing product types that require less energy, such as larger pellets, meal or single-pressed pellets.

There is limited opportunity to implement such changes because not all animals can accept all product types. For example, young poultry require crumbs, not pellets. It is estimated that this opportunity could be implemented at around 20 animal feed mills in the UK, saving around 20,000 tCO_2 per year.

Cost

This would cost a minimal amount to implement, with an immediate payback.

Barriers

The biggest challenge to implementing this opportunity is the need to influence customer product choices. This could be implemented incrementally through conversation with customers.

Innovative equipment

These opportunities tend to involve more significant capital outlay and therefore require a solid evidence base in order to build the business case for putting them into action. Due to the infrequent turnover of equipment in the industry, it will take longer to achieve significant penetration.

Energy efficient presses

Equipment suppliers to the animal feed industry are starting to look at developing more energy efficient equipment. Some are claiming potential energy savings of 25% per tonne of product processed. Current prototypes have not yet been integrated into milling lines in the UK and there is uncertainty around the size of the potential energy saving opportunity and potential impact on product quality.

This opportunity is applicable at around 50% of animal feed sites in the UK and, if implemented at this level, could save the sector as a whole approximately 10,000tCO_2 per year.

Cost

A new press machine costs £100,000 and the payback period is expected to be around four years.

Barriers

There is a very slow turnover of equipment in the animal feed sector. New technologies present a risk to product quality and output and need to be proven both to minimise this risk and also to demonstrate energy savings that justify the capital cost.

Multicrackers

Multicrackers are a particle size reduction technology used to tear or crack open the substrate instead of grinding it. The cracking action is achieved by two contra-revolving rows of discs. Multicrackers use significantly less energy than conventional systems and the technology is thought to be suitable for many types of substrate including cereals and seeds.

This opportunity could be applied at around 50% of animal feed sites in the UK and, if implemented at this level, could save the sector as whole approximately 10,000tCO_2 per year.

Cost

A 40-tonne per hour multicracker would cost around £120,000. The estimated energy saving opportunity indicates a payback period of around four years.

Barriers

The barriers to adopting multicrackers are similar to the problems with other high capital items of equipment. There is not enough performance-based data on multicrackers to prove that they improve energy efficiency without impacting on product quality or throughput to currently justify their adoption.

Figure 20 shows potential energy savings achievable by using a multicracker in place of either the roller or hammer mill.

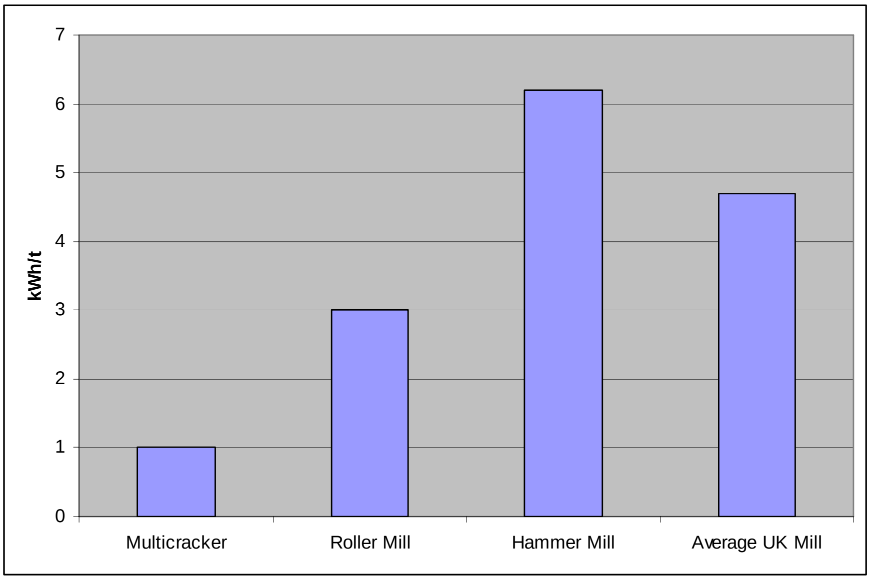

Figure 20: Comparison of energy consumption for different grinding technologies

Biomass heating and combined heat and power

The typical heat to power ratio for an animal feed mill is around 1:1, while at a large number of sites the ratio is even higher. This is illustrated in Figure 21. Heat to power ratios within these ranges indicate that the sector generally may be suited to CHP, either conventional or biomass based.

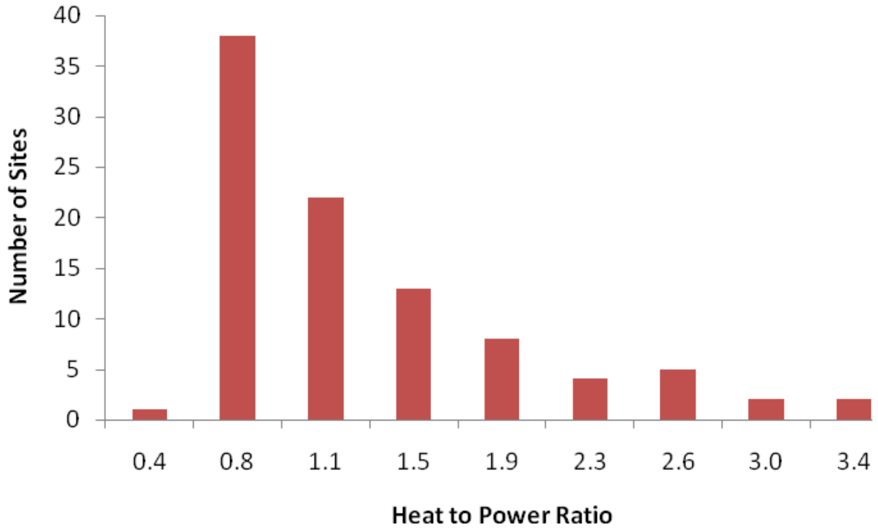

Figure 21: Frequency distribution of heat to power ratios for the sector (06/07 data)

Biomass pellets are of a similar form to animal feed pellets and could therefore be transported to animal feed mills in empty trucks returning from delivering products. This would also optimise use of transport.

This opportunity is applicable at approximately 30 animal feed sites in the UK. If implemented at each of these, it could save around 75,000tCO_2 per year.

Cost

A biomass CHP solution providing heat and power to a site, typically providing 1MW of heat and 200kW of power, would cost around £5 million to implement. The payback period would be approximately four to five years, taking advantage of existing government incentives.

Barriers

The significant capital cost is the greatest barrier to implementation of this opportunity. In addition, there are some uncertainties around the reliability of biomass supply.

Summary of opportunities

Figure 22 summarises the financial case for the major opportunities identified to reduce carbon emissions from animal feed manufacturing.

Opportunity	Cost per site	Payback	Sector CO2 saving
Low energy products	Minimal	Immediate	20,000t
Active energy management	£15,000	<1 year	30,000t
Process optimisation	£10,000	1 year	20,000t
Energy efficient formulations	£30,000	<2 years	30,000t
Production scheduling	£50,000	2 years	10,000t
Moisture control	£30,000	<1 year	5,000t
Energy efficient presses	£120,000	4 years	10,000t
Multicrackers	£100,000	4 years	10,000t
Biomass heating and CHP	£5 million	4-5 years	75,000t

Figure 22: Summary of opportunities

6. Next steps

The level of awareness of the need for energy saving in animal feed mills is quite good. Comparison with other industrial sectors suggests that the CCA, managed by the AIC on behalf of the animal feed sector, has acted as a driver for energy efficiency. However, companies could do more to engage staff and raise awareness of opportunities to improve energy efficiency. A culture of challenging accepted practices could be encouraged.

Install smart metering

Companies would benefit from detailed sub-metering of the manufacturing process at all sites. This would provide the information necessary for more efficient day-to-day operation of the process, as well as providing the evidence for justifying investment in more significant energy saving opportunities.

Think strategically

Senior management need to think strategically about the impact of the low carbon economy and how best to position their business to take advantage of this. Working more closely with customers to understand how their purchasing decisions may change in a low carbon economy, as well as trying to influence those decisions, would bring significant energy saving and financial benefits.

Get support

Companies should make sure that they are taking advantage of the available support and financial incentives to help them reduce energy and carbon emissions now. A variety of support is available to all sizes of business, for example through the Carbon Trust.

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7. Appendix – methodology

The purpose of the work undertaken in stage 1 of the IEEA with the animal feed sector, was:

- to examine the sector-specific manufacturing process in depth
- to understand energy use and interfaces with other systems
- to identify possible solutions to improve energy efficiency.

The investigation focused on pelleted compound feed for agricultural animals, as this manufacturing process is used by the majority of the sector and accounts for the bulk of carbon emissions.

More conventional energy saving opportunities, such as energy efficient motors, VSDs, efficient lighting, boiler plant optimisation and pipe lagging, are generally identified by the Carbon Trust's opportunities assessments. They were therefore not specifically investigated here, except where they form part of the larger process. Issues concerning road transport and ancillary process equipment such as conveyors, dust control, crumbers, etc were also excluded.

Nine sites representing five of the UK's leading animal feed producers participated in this study. Electricity submetering covering the key energy consuming items (grinders, conditioners and presses) was installed at five sites. In addition, a steam meter and a moisture meter were installed at one site. The sites were selected by the sector at a meeting of the AIC Animal Feed Environmental Steering Group, which included representatives from a large number of animal feed companies. The sites were chosen with the aim of achieving good coverage of the sector – in terms of the products produced, types of equipment used and size of mill – so that data collected was representative. Headline information on the participating sites is given in the table below. Collectively, the participating sites represented about 12% of UK production.

Site No.	Company	Site	Products	Fuel	Output (tonnes/year)
1	ABN	Northallerton	Poultry	Gas LPG	177,000
2	ABN	Enstone	Pig & Poultry	Oil	150,000
3*	ABN	Bury St Edmonds	Pig & Poultry	Gas	242,000
4	BOCM Pauls	Penrith	Ruminant	Oil	85,000
5*	BOCM Pauls	Newcastle-under-Lyme	Ruminant	Gas	158,000
6*	Carrs Billington	Lancaster	Ruminant	Gas	184,000
7	Carrs Billington	Carlisle	Ruminant	Gas Oil	116,000
8*	Noble Foods	Belle Eau Park (Nr Newark)	Poultry	Gas	252,000
9*	Davidsons	Shotts	Ruminant	Oil	134,000

* Submetered sites

The methodology used in this study included:

- initial information gathering phase to build relationships and understanding of the process and sector
- desk-based research into equipment and innovation
- analysis of historic process and energy data and new submetered data
- site visits and discussions with key industry contacts and site personnel
- workshops to identify and address barriers to deployment of opportunities.

Data from a number of sources has been used in this study.

- CCA data for electricity and fuel use by all sites in the sector – data for the period October 2006 to September 2007 was used to gain a sector level overview of energy use.
- Historical half-hourly electricity data and process data – a year's worth of data was requested from each of the nine host sites.
- Portable electricity meters were used on grinders and presses in order to allow early analysis of energy use while permanent meters were being procured and installed.
- Comprehensive electricity submetering covering the grinders, conditioners and presses was installed on five sites:
    - ABN – Bury St Edmunds
    - BOCM Pauls – Newcastle-under-Lyme
    - Carrs Billington – Lancaster
    - Noble Foods – Belle Eau Park
    - Davidsons – Shotts
- A steam meter was installed on the steam line at Carrs Billington, Lancaster, on one press line.
- A moisture meter was installed after the cooler at Carrs Billington, Lancaster, on one press line.

A significant amount of data on energy use was collected, including data on process operating conditions. This required analysis using advanced data analytics techniques not normally available to the industry. The analysis of patterns and trends in energy use represented new knowledge and/or quantified and proved existing understanding.

We held two workshops to discuss energy saving opportunities with the wider animal feed sector, as well as to identify and address key barriers to putting them into action. Representatives from 15 companies took part in the workshops, including site personnel, environmental managers, technical/engineering managers, senior managers, directors and suppliers.

8. Acknowledgements

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