Energy efficiency on farm
– a practical guide
Introduction

When was the last time you looked at your farm’s energy costs?
The aim of this fact sheet is to help farmers gain a greater understanding of what their actual energy costs are and to identify potential savings and ways of using energy more efficiently in the future.

The cost of supplying power to a dairy farm is significant and, like any other farm input cost, this should be reviewed to see if savings can be made. This is even more pressing due to the recent fluctuations in the cost of electricity and gas. It is expected that prices will increase over time due to the diminishing global resources and the reduction of production capability within the UK over the next 10 to 20 years. In addition, concern about climate change means that pressure from customers and the government to reduce CO₂ emissions is unlikely to abate.

The first step is to be able to measure the energy that is actually being used on your farm. The biggest source of energy will almost always be electricity but gas and fuels such as oil and diesel should also be reviewed.
Measuring energy consumption

It is important to know how much energy you use both in terms of cost and quantity. With the highly variable energy prices of late it can be far too easy to ‘blame’ high costs on the price paid. But there might also be an underlying increase in total energy use that could otherwise go unnoticed.

• **Step 1** – Collate data from utility bills and fuel invoices to establish how much your business is spending on each type of fuel over a period – ideally 12 months with a monthly or quarterly breakdown. Beware of consumption data from invoices based on estimated meter readings or stocking up on diesel when prices are low. Both of these can give a false impression of when you use energy.

• **Step 2** – Take regular meter readings and monitor stock levels to give more detailed information and enable any variation in consumption to be quickly identified – once a month is a good starting point, once a week is much better.

Any significant change in consumption should be investigated as it may be a result of a problem with equipment. For example, the malfunction of a time switch or thermostat on a water heater could cause the heater to turn on during the daytime when electricity is more expensive or to continually heat water when it is not required. Early detection could prevent unnecessary costs and avoid plant breakdown.

• Reading your meter regularly will also help you to compare current consumption with previous figures, so that you can quickly assess the impact of new equipment or procedures, changes in production or even the weather.

• Once you are familiar with your energy consumption data you can then use this information to help you compare your business with other similar operations. Benchmarking tools such as MilkBench+ allow you to compare your costs and business performance with other similar dairy farms. You can establish if the amount of energy you are using is ‘normal’ in comparison and set targets for improvement.

• Farmer discussion or buying groups are also a useful forum to get together and share this information. To make a true comparison it is best to relate energy consumption to the level of production or unit of output on your farm eg, kWh (kilowatt hours) per cow or per 1,000 litres of milk.

• Having measured your energy consumption and analysed the data for the different types of energy you can then consider how to make savings.
Managing energy consumption

There are three key elements to this process:
1. The price you are paying for the energy you use
2. Finding out where the energy is used
3. Identifying how to use less

The price you pay
Consider:
• Your supplier – are you getting the best in terms of price and service?
• In the case of electricity – are you on the most appropriate tariff for your type of business?

Choosing an electricity supplier
There are many companies to choose from and it is worth at least looking to see what is on offer. Letting your existing contract with a supplier ‘roll over’ for an extra year is never the right thing to do.

If you are thinking of changing to another electricity supplier you will need to check if you are tied into a contract with your current supplier. Many companies offer contracts for periods of one to five years and breaking this contract can incur a penalty charge which needs to be taken into account in the overall cost/benefit analysis.

Many electricity contracts require you to give written notice at least three months before they end to say that you do not want to automatically renew. This ‘notice to terminate’ letter should also be sent by registered delivery so that, if necessary, you can prove it was sent and when. By doing this you are telling your existing supplier that you are serious about getting a good deal and will leave them if they don’t make you a good offer.

All electricity suppliers have to adhere to rules set by the industry regulator Ofgem. If you are struggling to resolve a problem the independent industry watchdog Consumer Direct can be useful. Visit www.consumerdirect.gov.uk/EnergySupplyandPost or call 08454 04 05 06.

To get a quote all you normally need is:
• The 16 digit MPAN number (quoted on your bill within a grid that starts with a large bold “S”).
• Your last electricity bill and ideally bills for the last 12 months so that your annual consumption can be calculated.

Your prospective supplier will then give you a quote based on the same tariff that you are currently on.

When considering the quoted price you need to take account of:
• The unit charge and the fixed or standing charge.
• Some companies offer deals with no fixed charges but usually charge a higher price for the first few 100kWh. This is sometimes referred to as the ‘primary block’.
• Payment method – most suppliers still accept payment by cheque but they often offer additional discounts if you pay by direct debit. Some companies only accept payment by direct debit.
• Beware of deals which deduct a fixed amount from your account each month. With these, if energy use changes, it is easy to get behind (or too far in front) with payments.
• Group discounts – if you belong to an organisation with several other farmer members check if they have negotiated a special deal with a supplier offering a group discount or some benefit to all group members.
• Dual fuel deals – if you buy both gas and electricity from the same supplier they will probably give you an extra discount.
• Additional benefits – some suppliers may not offer the cheapest price but offer additional benefits such as discounts on other services eg, telephone. The value of this is subject to individual circumstances.
• Look at the terms and conditions of your contract and penalty clauses should you wish to exit the contract early.

Finally – as soon as you sign up with a new supplier check the date by which you have to send in your ‘notice to terminate’ letter and put it in your diary.

Choosing the right tariff
Equally, if not more important than your electricity supplier, is your choice of tariff. Electricity suppliers offer a range of tariffs and you need to ensure you are on the best one for your business.

The most suitable tariff for a dairy farm is normally one which includes a cheap rate period during the night – typically 00:00 to 07:00. The price during this period can be as much as half the price of daytime electricity and it is well worth adding time switches so that all your water is heated at this time. If ice is used for milk cooling, time switches should also be used to encourage your refrigeration system to operate at this time. These tariffs are sometimes referred to as Economy 7 (E7), day/night or 2-rate tariffs.

There are also tariffs that offer mid-price electricity during the evening and all day on weekends. However, these only tend to be worthwhile for farms that milk three times each day.

An E7 type tariff does charge a higher unit price for electricity consumed during the daytime compared to a tariff where you pay the same price no matter what time of day it is. As a guide, you need to use at least 15% of your total kWh during the cheap rate period to be saving money. Most dairy farms will achieve this simply by ensuring that all hot water is heated during this period. Some dairy farms can use as much as 50% of their electricity during the cheap rate period.

You do not need to change supplier to change tariff. If you want to change tariff a new electricity meter may need to be installed. There is normally no charge for this and it can be arranged through your existing electricity supplier.

Energy Brokers
There are many companies who specialise in finding the best gas and electricity deals for businesses and they will do the leg work to obtain quotes on your behalf. For many, this fact alone makes the use of these companies an attractive prospect. In addition, such companies often have access to more competitive prices than single users are able to get directly.

Consultants obviously have to make a charge for their services. This can be either as a fee paid directly to them by you or by a commission they are paid by the electricity supplier. Beware of the commission based approach; it can sometimes restrict the deals that they offer you but at least it is ‘no win, no fee’.
Where does the energy go?

Once you are happy that you are paying a fair and competitive price for the energy you use you can focus on how you utilise this energy.

Studies have shown that electricity usage on a sample of dairy farms can vary between 200 kWh and 400 kWh (kilowatt hours) per cow, per annum, so there is significant potential for savings to be made. Milk cooling, water heating and the vacuum pump each account for 25-30% of total electricity consumption with the remainder being used by lighting, heating and ventilation. Water heating and milk cooling offer the greatest potential for saving and should be reviewed first.

In most cases new equipment is more energy efficient than old equipment but the capital cost of replacement can be prohibitive and must be taken into account. When reviewing any piece of equipment you will need to:

- Understand the current cost
- Look at alternatives
- Determine the investment needed for replacement
- Calculate the payback period to establish if the investment is viable
- Do not underestimate the effect of energy price inflation on the payback period
How to reduce water heating costs

Insulate everything
Trials carried out by Farm Energy showed that an uninsulated water heater can lose 50% of the heat you have paid for within 17 hours. This compares to just 5% for a well insulated heater. If you have an uninsulated water heater the best option is to bite the bullet and replace it with a pre-insulated tank. Simply fitting a glass fibre jacket is a cheap option but is still far from ideal. The guidelines for insulation are 50mm polyurethane foam or 85mm of glass fibre.

All pipe work, including joints, should also be well insulated (minimum 12mm) and the heater should be placed as close as possible to the point of use to minimise the length of pipe work required and the potential for heat loss.

Maximise the use of cheap rate electricity
Make sure that all your water heaters have a time switch fitted and check them regularly to make sure they are in step with the time switch on your electricity meter. This is especially important if the power has been off for even a few hours.

If any water heater has to be refilled and heated during the daytime, such as for the afternoon parlour wash, consider buying a second water heater that can be heated up during E7. Providing the tank is well insulated it will only need a short ‘boost’ before use in the afternoon. In this situation the cost of an extra water heater will normally be repaid within three years.

Heat recovery units (HRU)
A HRU is connected into the refrigeration system of your bulk tank and uses the waste heat that is normally thrown away to pre-heat water before it enters your water heater. As a HRU has to be connected into the refrigeration system it is a specialist job and best done when other refrigeration work is needed to save on costs. Depending on the size and number of compressors a HRU can cost from £1,500 to £2,500. However, they can reduce water heating costs by as much as 50%.

Additional key points to remember are:
- Make sure that the way the HRU works does not increase the amount of higher cost day time electricity used.
- Whatever happens you need water at the right temperature (85°C) at the right time. Do not let a HRU compromise this.

To help you to calculate your own water heating costs each time you heat 227 litres (50gal) of water to 85°C you will use 21kWh of electricity. Simply multiply this by the price you pay for electricity to work out what it costs and therefore what you could save.

Milk cooling
The two main types of milk cooling are ‘Direct Expansion’ or indirect via an ‘Ice Bank’.

Direct expansion
The evaporator plates of the refrigeration equipment are attached directly to the surface of the tank. This is an efficient way of delivering cooling but the equipment can only run when there is milk in the tank that requires cooling. Therefore the ability to maximise the use of cheaper rate night electricity is dictated by the time that you milk.
Ice bank
The milk is cooled by chilled water from ice banks which can either be in a separate ‘box’ or built into the base of your bulk tank. As there is an extra step in the cooling process ice based systems are less efficient than direct expansion in terms of litres of milk cooled per kWh of electricity. However, ice based systems win this back because they can use cheaper night rate electricity to make ice even if the milk does not need to be cooled at that moment in time.

Overall an ice bank tank will normally cost less to run than a direct expansion tank. However, it can often be difficult to justify the capital cost of adding an ice builder to a direct expansion tank for all but the biggest of dairy farms.

For any existing milk cooling system:
• Regular servicing is vital to ensure efficient operation and will reduce the chance of a breakdown.
• Make sure that the condenser is free from any dirt/debris so that it can reject heat as easily as possible.
• Make sure that cold air has an easy path into the condenser and the warm air leaving it can get away just as easily.
• Consider pre-cooling – see below.

Mains / borehole water – Pre-cooling
This is where milk is passed through a plate heat exchanger (PHE) using mains or borehole water to cool the milk before it enters the bulk tank. The water takes heat from the milk and becomes warm itself. This warm water is then available for use elsewhere. It terms of overall cost it is important that this water is utilised otherwise any cost savings from pre-cooling will be offset by the additional costs of the water (unless water is from a spring or bore hole).

At the very least you should expect a pre-cooler to reduce the temperature of milk by 10˚C. It is possible to achieve as much as 20˚C of cooling with a large PHE and higher water flow rates. As a guide the ratio of water used to milk cooled ranges from 1:1 to 2:1.

The capital cost of a pre-cooler is around £800 plus installation. As long as the water can be reused the cost of a PHE will be repaid within three years on most dairy farms.

Vacuum pump
The size of a vacuum pump is generally dictated by the demand of the washing process. This means that for most of its operating time (during milking) it is far too big.

The speed of certain types of vacuum pump can be automatically reduced while milking using a variable speed drive (VSD). Energy savings of 30-60% are claimed. However, the cost of a VSD means that even savings of this level rarely justify the replacement of an existing, reliable unit.

To ensure your vacuum pump is as energy efficient and reliable as possible there is no substitute for good maintenance.

Heating, lighting, and general energy usage
Although these are not the main power users, they are still significant and savings can be made.

Heating
Milking parlours are very difficult to heat due to their open design. In general, radiant heating systems are more efficient than space heating systems.
Lighting – Parlour
Good lighting in the parlour is vital as the herdsman needs to be able to see clearly to perform the milking routine and to inspect the herd. The colour of the light is also important; this is why fluorescent fittings are preferred to the more efficient (but yellow) high pressure sodium fittings. In some modern, more open parlours metal halide fittings mounted high up in the roof can be used but they tend to cast too many shadows in more typical parlours that have a lot of overhead pipes.

When specifying a new installation or replacing fluorescent lights that have failed always ask for T5 tubes with electronic ballasts. They cost a little more but this is quickly repaid by the energy saving. They also have the added benefit of longer tube life and improved starting in cold conditions.

Most farm environments are dusty and/or damp. To prevent the premature failure of light fittings in particular, IP65 fittings (dust and damp proof) should be specified. Many of these are made from polycarbonate which also helps to comply with the various assurance schemes and dairy regulations.

Lighting – Cattle buildings and outside buildings
If lights are left on all night to help with security or so that cows can see to move around, high pressure sodium lights are the best option. They are very efficient and the bulbs last for a long time. A 70W sodium fitting will give as much light as a 300W tungsten halogen floodlight.

Their only drawbacks are that they take two minutes to reach full output and the light they produce is quite yellow. They also need a reasonable mounting height so that the light from them can spread adequately.

Tungsten halogen floodlights are very inefficient and ‘cheap and cheerful’ but they still have a place where high light levels are only required for a short time each day or where movement sensors are used to turn them on.

How much does ‘X’ cost to run?
Although not 100% accurate the following is a simple way to calculate what any piece of equipment costs to run.

- Find its rated power consumption – this is normally stated next to the model number or serial number. It may be quoted as W or kW
- How many hours does it run each day?

\[ \text{kWh consumed} = \text{rated power consumption in kW} \times \text{hours run} \]

Note - To convert W into kW divide by 1,000

Cost = price per unit (kWh) \times \text{kWh consumed}

Beware - using this method to calculate the running cost of motors subject to a highly variable load such as a feed milling unit can be misleading. It will tend to significantly over estimate the actual running cost.
Summary – tips for energy saving

• Record the amount of electricity being used on farm, ideally every week.
• Compare energy use to your output and to previous consumption. Any large variations should be investigated immediately.
• Check that your bills relate to actual consumption and not estimated data. Successive estimated bills can lead to a significant over or under payment.
• Compare what your current supplier is charging you with what other suppliers are offering.
• Make sure that you send your notice to terminate letter in time.
• Familiarise yourself with the electricity usage on your farm. Note the major pieces of electrical equipment and the time they are in operation.
• Wherever possible use cheaper night time electricity, especially for water heating.
• Insulate the water heater and all pipe work.
• Consider using a heat recovery unit.
• Install a plate cooler.
• Make sure the condenser on your refrigeration system is clean.
• Switch off any equipment and lighting whenever possible and ensure everyone is aware of the focus to save energy.
• If you are due to replace equipment always ask for an energy efficient option. The slightly higher cost is all that the energy savings have to repay and this will often be repaid very quickly.