Farm Carbon Cutting Toolkit

Energy Efficiency to reduce costs and minimise Greenhouse Gas emissions

The energy security issues we face as farmers are a massive threat to our businesses and call for greater resilience for each farm in how we approach energy.

Ofgem forecast price rises of 30% by 2020, which will impact our business more than most others. Energy resilience involves adapting to a changing, energy constrained world and planning for a future where energy supplies are running out and prices rising. This means coping on the farm with supply shocks, pressure to reduce consumption and increasing self-sufficiency by generating energy on-site.

Strategies for energy resilience

There are several critical energy demands on farms, from being able to jump in the tractor for land work, to critical machinery and heating or cooling equipment. Noting all the critical areas of energy use the farm is dependent on will help plan for the future and anticipate and combat risks.

'Embodied energy' is a major part of any farm's overall energy use and therefore should be considered as part of planning a strategy – fertilisers and chemicals, buildings, and imported materials contain significant amounts of energy used in their manufacture and distribution. This therefore creates a reliance on energy from other sources and reduces on-farm energy resilience, so need to be taken into consideration. Can you source some supplies more locally, or switch to lower embodied energy alternatives?

So the first stage in any energy resilience strategy is to map existing energy demand and identify the largest and most critical elements of this. What can you not afford to be without power to in order to keep the heart of the farm running? Energy use can be identified by regularly checking meter readings and analysing energy bills.

Once energy use is identified, you can start to plan responses to cope with shocks such as price rises or interruptions to power supplies.

The next stages are vital- ensuring that energy use is first reduced, and then used more efficiently. Simple steps can reduce energy use by as much as 15% for example, which reduces dependence on unsustainable energy supplies and therefore improves on-farm resilience. A number of straight forward, on-farm measures to reduce energy use are outlined below.

The final part of any energy resilience strategy is considering on-farm renewable energy options, such as solar panels and biomass boilers. Renewable energy systems such as Combined Heat and Power (CHP) plants can ensure certain critical infrastructure continues to receive power in the event of a power cut, and generate alternative sources of income. Renewable energy should only be considered after energy saving and efficiency steps have been taken. Some of the government-backed payments for renewable energy now require minimum levels of energy efficiency.

Energy consumption

On typical farms

The highest energy consumption on typical farms varies by type of enterprise. Machinery supporting milk cooling comprises the greatest element of energy use in dairy farming (25%), followed by milking production and lighting (17%), with crop storage and cultivation the greatest consumers of energy on arable farms. On livestock farms forage production and silage are the most energy intense activities.

On pig farms, heating, followed by ventilation and lighting comprise the largest sources of energy consumption. Poultry farms use the majority of their energy on lighting, feeder machinery and ventilation.

Reducing energy use and increasing energy efficiency

Reducing energy use was once about simply switching lights and equipment off. While that is still vitally important, new technology and other advances mean there are myriad steps every farmer can take to save energy. See below for some measures any farm can take, and read on for more specialised advice by farm type.

Steps any farm can take:

While there are sophisticated steps you can take to use energy more efficiently, the first step should always be to save energy, so consider installing motion sensors in offices and different 'zones' in large spaces like storage sheds, so you're only using lighting when required. You don't need to light a whole space if you're only using one part of it. Depending on the farming sector, reducing lighting can save 15% of typical energy use.

- Turn off non-critical devices, rather than leaving them on standby – machinery and appliances can use up to 90% of their full energy demand while on standby.
- All machinery should be kept regularly maintained and operating on the appropriate settings.
- Farmhouse and office hot water only needs to be heated once in the morning for about an hour. The hot water cylinder should keep the water hot providing it is well-enough insulated. If you have a separate hot water cylinder, the hot water heating programme does not need to be set to match the central heating programme, a common misconception.
- Heating programmes should be optimised to switch on only when required - heating an empty building (even at a low temperature to maintain a 'constant heat') is wasted energy, and money.
- All exposed hot water pipes (pipework you can see coming from or to boilers, machinery and heaters) should be lagged with insulating material available cheaply from most hardware stores - even this simple and easy to install measure will instantly save energy and money.
- Install modern energy saving and LED lights - although they have a higher up-front cost they use only around 10% of the energy of traditional incandescent light bulbs, saving money in the longer term.
- Where cooling systems or mechanical ventilation are used, consider whether natural air or ventilation could do the same job.
- Similarly, close windows and doors when air conditioning or central heating is being used (though leave some source of ventilation open) – this will increase the efficiency and save energy
- Where machinery requires them, such as in processing units, switch off fans and pumps whenever not in use.

- You can reduce your energy use by making sure you have enough insulation and that drafts are minimised. The recommended insulation for loft spaces and equivalent office ceilings, is at least 270mm in depth.
- Many simple to install low cost measures are available for domestic and office environments, such as draught-excluding strips, which can be bought in any hardware or DIY store. For larger on-farm buildings, bespoke solutions exist.
- Ventilation systems should be regularly cleaned and maintained to avoid inefficient operating conditions.
- Make sure vehicles are regularly serviced and tyre pressures are correct – check the manual to make sure they are at the right level. Ensure appropriate vehicle loadings and remove unnecessary vehicle racks to reduce drag and save fuel. See the Buildings & Operations section for more on in-field efficiency.

Monitoring energy usage

Track your usage using energy monitors and accurate record keeping. Wireless energy monitors are now widely available and easy to install, and provide information on how much energy you are using, and how much it is costing, in real time and over specific periods, for example by week or month. If there are unexplained changes this may be due to machinery malfunctioning and allows for an 'early warning' to take steps to respond. This allows energy use to be tracked and compared, illustrates the effect energy saving measures are having and gives better control over and awareness of, costs. You can buy monitors and meters online at: http://jdmetering.co.uk/smart-meters.html, and at similar sites.

Efficiency on Dairy farms

Overview

Research suggests energy use on dairy farms is associated with cooling milk, the milking processes and lighting.

Installing variable speed milk and vacuum pumps, and heat recovery systems offer the greatest potential energy savings – farmers report energy savings of over 60%.

Heat exchangers and variable speed pumps help cool milk to the necessary temperature and reduce energy costs. For example heat exchangers will transfer the heat from freshly extracted milk to another liquid before entry in the bulk tank – this process can save 60% of energy costs. Variable speed milk pumps cool the liquid by an extra 15-20 degrees.

Low rate irrigation rather than tractors can be used for dirty water, which will save considerable amounts of energy.

Energy, noise and maintenance costs are all reduced by using variable speed vacuum pumps. These operate at different levels in response to capacity requirements, not at a constant rate as with conventional pumps, therefore reducing wear and tear and energy used.

Read more in the Dairy Co factsheet on energy efficiency for dairy farms

Areas to consider

Variable speed motors

Can have a range of applications, most commonly as vacuum pumps, but can also be applied to milk pumps, irrigation and ventilation systems.

Variable speed vacuum pumps

Current vacuum pumps operate at a constant speed to provide the vacuum requirements for milking. Variable speed vacuum pumps are designed to meet capacity required when it is needed. The addition of a variable speed driver pump eliminates the need for a conventional regulator because less energy is delivered to the motor and operating speeds are reduced.

By maintaining a constant vacuum level and only producing necessary amounts of air flow, energy cost savings of up to 60% can be made. The noise level is also greatly reduced allowing for a gentler parlour environment. There are also reduced maintenance costs and less wear, leading to an extended life compared with a conventional oil vane pump.

Milk cooling

Cooling milk accounts for the highest energy cost associated with the milking process. Milk needs to be cooled from its harvested temperature of 35 - 37 degrees, to three degrees to maintain high milk quality and low bacterial counts. There are various options to help cool the milk, including heat exchangers and variable speed milk pumps.

Heat exchangers

Used for pre cooling raw milk, transferring the heat from the milk to an intermediary cooling fluid (usually water). Installing a heat exchanger to pre-cool the milk prior to entry to the bulk tank can reduce energy consumption by 60%.

Variable speed milk pumps

The use of a variable speed milk pump allows the milk to be pumped through the plate cooler at a more consistent speed, allowing the plate coolers to operate more efficiently and resulting in greater milk cooling. It also allows more heat to be extracted by the plate cooler, and reduces the energy demand on the bulk tank. Milk can be cooled by an extra 15-20 degrees by installing a variable speed milk pump.

Heat recovery units

During the process of cooling milk, heat is rejected from the condenser coil of the refrigeration system. It is possible to recover this by passing the hot refrigeration gas through a heat exchange system which is immersed in water. A water temperature of over 50 degrees C can be achieved by using this technique.

The water heating system needs to be carefully configured so that the heat recovery can deliver the maximum benefit without compromising the operation of the milk cooling system. Depending on the number of cows being milked, the water storage tank should be sized to provide enough hot water for one milking.

Tips for saving energy on dairy farms

- Record usage at various intervals
- Switch to a better tariff
- Use cheaper night time electricity where possible, especially for water heating
- Insulate water heaters and pipework to minimise losing heat you are paying for
- Consider investing in energy saving devices
- Switch off equipment and lights where appropriate
- Make staff aware of energy saving aspirations

Efficiency on Arable farms

The largest source of energy usage on arable farms is crop storage and drying. Transport and cultivation are also a considerable source and the inputs which go into growing crops comprise another large source. The 'embodied energy' found in fertilisers, especially ammonium and nitrate based fertilisers, can be very large, with around a tonne of oil used to manufacture each tonne of chemical fertiliser. Therefore reducing artificial fertiliser use will increase energy resilience and emissions.

Crop storage and drying

- Figures from ADAS show that conventional, high temperature dryers require 55 litres of oil per hectare of crop dried.
- Firstly, make sure all controls are set to the right setting, as inappropriate settings can waste up to 25% of the energy used. Humidity is key to crop storage and drying, having the right level could save up to 40% of your energy use due to drying.
- Cooling crops rather than drying them could save 10% in like for like comparisons of energy costs.
- Good maintenance, ventilation fans at the appropriate size, accurate moisture measurement and aeration together account for a good deal of energy use, so make sure these are all optimised
- Mixed flow driers save 50% of energy compared to conventional basic cross-flow driers. Adding recirculation to existing cross-flow driers can save up to 30% of energy usage.
- Make sure the dryer is operating at the right capacity, neither too heavily loaded, nor too lightly, which would require a second pass through the drying system.

Finally, make sure you are harvesting at the right time for drying – doing so can reduce the drying time, and therefore associated costs required, by three-quarters.

Minimising energy demands, things to consider

- Can minimum cultivation techniques be used?
- Have you considered growing energy crops?
- Have you considered changing to lower input crops?
- Is each cultivation operation really necessary?
- Do you avoid cultivating in adverse conditions?
- Have you reviewed equipment efficiency?
- Are tractor tyres the correct size and operating pressure?

Tractor efficiency

- Make sure that you use the right implement for the job (not the one that is the most fun to drive!)
- When purchasing new tractors, check their fuel efficiency and performance data
- Do regular maintenance (smoke is not good ....)

Check tyre pressures regularly and determine using manufacturers loading and inflation requirements, **and** ground conditions and compaction

Field Efficiency

- Maximising work rate and field efficiency can save large amounts of fuel
- Consider the use of precision farming and autosteer / GPS
- Wider implements will mean a reduced percentage overlap and reduced turning time (although not in small fields)

In cultivation terms, the largest single energy saving step possible is switching to a no-till or minimum-till approach – overall savings of 90% could be possible. This area is covered in more depth in the 'Buildings and operations' and 'Crops' sections.

Efficiency on Livestock Farms

Feed utilisation and sourcing

Forage production and waste management comprise the greatest sources of energy use in livestock farming.

If you mill your feed on the farm, use a disc rather than roller mill as this is considerably more efficient. Disc mills are newer, more efficient technology now available in the UK. Also check that moisture levels are at the right level (17-18%) as this reduces unnecessary drying.

Forage ensiling waste can be as much as 10%, reduce this as much as possible by ensuring appropriate storage conditions.

Nutrient management planning

For intensive operations, dirty water can be applied using low rate irrigation rather tractor, to save 60% of the energy costs. Divert all clean water from the slurry store in order to minimise slurry volumes and therefore slurry handling involving energy intensive machinery.

Ensure that you take account of nutrients in farm yard manure before applying bagged fertiliser which will reduce the energy needed to apply fertiliser and reduce losses to the farm bottom line and the environment.

Machinery and fuel use

- Ensure all vehicle tyres are kept at the correct pressure to save diesel
- Shut off engines when not in use rather than idling.
- Plan travel so as to combine jobs and minimise vehicle movements wherever possible.
- Install a fuel meter on the farm diesel tank to monitor fuel usage
- Service equipment regularly
- Consider soft start technology for electric motors.

Lighting

Use low energy or sodium lighting, especially in flood lighting. Keep all lighting covers and fittings clean and well maintained. Install timer switches and daylight / occupancy sensors in key lighting circuits, and in non-key circuits ensure that lights and other equipment is switched off when not in use.

Building maintenance

Improve building airflow to maximise natural ventilation and minimise drafts.

Efficiency on Pig farms

General pointers

Heating, followed by ventilation, feed production and slurry storage and lighting comprise the largest sources of energy use. Feed also contains a large amount of embodied energy as with fertiliser.

Adequate heating controls, the correct positioning of sensors and monitors and adequate maintenance and cleaning offer opportunities for energy saving and efficiencies in pig production. For example, outlet fans can be made up to 15% more efficient by adding cones.

Enclosing creeps will enable more accurate temperature control in each one, prevent heat loss and reduce heating demands.

Sufficient insulation and preventing draughts offer the potential to halve the energy consumed per pig during the production process. Newer materials offer greater energy savings as older insulation can wear out over time.

Fitting variable speed pumps to wet feed equipment which don't undergo uniform use or demand can save at least 30% in costs.

Read more from BPEX

Energy use can be minimised and costs reduced through sensible selection of system components, wise use of insulation and attention to design and operation of control systems. If you are making any alterations to improve energy efficiency, it is worth making sure that full account is taken of environmental requirements and animal welfare.

Taking stock of the current situation

- Compare your performance with industry benchmarks (or your own data from previous years)
- Assess current energy use
- Identify energy efficiency measures that will work with your business
- Establish an “energy action plan”

High priority / low cost measures

Implement these first as they require little or no expenditure. These often give the best rewards as savings can be made quickly and for little expenditure or effort.

Monitor energy use

- The basis of good energy management
- Regular meter readings, don’t just rely on utility bills

Carry out maintenance and repairs

- An essential part of reducing wasted energy

Check the accuracy of controls

- Check temperature sensors

Use information from control systems

- Link ventilation and temperature settings to energy data to see how the system is performing

Medium and long term actions

Improve building insulation

- Current recommendations are for an insulation level of better than 0.4W/m²/˚C (60 mm of polyurethane)
- Best results can be achieved using composite panels containing solid polyurethane insulation.

Use enclosed creeps

- Boxed creeps will reduce heat losses and provide a controllable environment for piglets, and better regulation of the thermal environment.

Improve controls

- Good controls are a pre-requisite for maintaining the right temperature in buildings and minimising the use of energy.
- If heating is used in building, it is critical that minimum winter ventilation rate is controlled accurately.

Use efficient fans and ducts

- Fans can vary significantly in efficiency
- Consider the lifetime cost when buying fans
- Fan efficiency generally increases with impeller diameter
- Belt driven fans are generally more efficient than fans with direct drives
- Fitting cones to outlets fans will increase efficiency by 10-15%

Efficient lighting

- Prolonged periods of use mean that fluorescent lighting will be the most efficient solution in most cases.
- High level lighting and strip fluorescent lamps with T8 tubes and electronic control gear will give the best energy efficiency
- For low level lighting, a small number of compact fluorescent lamps are a good solution.

Use high efficiency motors and variable speed drives on feed and waste handling systems

- High efficiency motors cost no more than standard motors and should be considered when upgrading motors.
- With wet feeding and slurry pumping systems, choose pumps that give the best flow to energy characteristics.
- Consider the use of variable speed drives where appropriate. Savings of between 30-50% can be expected in pump running costs when using VSDs.

Energy saving options for farrowing heating

- Careful control of heater output
- Clean heaters and ensure they fit well into creep lids
- Seal boxed creeps and fit pophole curtains
- Install boxed creeps

- Install thermostatic controls ideally with temperature profiling
- Choose higher efficiency heating type

Weaning accommodation ideas

- Closer setting of controls
- Seal buildings to stop draughts
- Clean fans and ducting regularly
- Install compact fluorescent lighting or high efficiency tubular fluorescent lighting
- Reconfigure ventilation to give better control of minimum level
- Update heating and ventilation controls
- Re-insulate buildings

Finishing accommodation

- Make sure controls are properly calibrated and set to the correct temperature
- Clean fans and ducting regularly
- Install compact fluorescent lighting or high efficiency tubular fluorescent lighting
- Improve the design of inlets and outlets to provide smoother air passage and lower air speeds

Efficiency on Poultry farms

General principles:

Feeding machines, ventilation, and lighting comprise the largest elements of energy use in typical poultry production.

Consumption can be reduced by ensuring correctly sized ducts and fans for ventilation systems, buildings are sufficiently insulated and heating and ventilation controls linked. Replace old fans as new fans are far more energy efficient.

Temperature controls are important as temperature demands vary based on bird age and weather conditions, mature birds require much less heat than young birds (22°C compared to around 30°C). Thermostats need to be in the correct locations to avoid overheating, so away from draughts or doors.

Reducing lighting where possible under regulations) and fitting new energy efficient fixtures and dimmers can reduce lighting costs considerably, one of the major costs for poultry farms.

- Clean fans and air ducts - dirt can reduce fan efficiency by 60%.
- Draught proof doors, windows, and ventilation louvres to stop heat escaping. Fit accurate heating and ventilation fans, use free heat from roof ridges which can be 10 degrees higher than at floor level.
- Ensure that air ducts allow the smooth passage of air - battens and obstructions can decrease efficiency by 20%.

- Specify as high performing ventilation equipment as possible.
- All fans and ducts should be included in the end of batch clean and filters should be replaced. Dirty ducts and fans can increase running costs by 60%.
- Ensure the minimum winter ventilation rate is controlled accurately where heating is used in a building. If the level is too high then heating costs will increase significantly, too low a level will produce foul air conditions.
- Replace tungsten lights with energy efficient alternatives such as fluorescent or sodium lamps to save 70% of lighting costs.

Solutions for saving energy

Building energy management systems

Building energy management systems are also available, which provides options for analysis of energy use on a regular basis for monitoring boiler lighting or fan running times, for switching off equipment, for zone control of heating and numerous other applications. Savings of between 10-30% of energy consumption are possible.

Boiler and space heating systems

Efficiency of oil and gas-fired boilers is extremely important. Regular servicing of boilers and cleaning of heat transfer surfaces is recommended potentially yielding savings of between 10-15%.

Insulation and air tighteners

The energy needed for heating and ventilation can be reduced by improving wall, roof and floor insulation. This will help to keep buildings, warm in winter and cool in summer. A balance needs to be struck between the levels of insulation and the density of birds otherwise overheating could occur in summer or excessive levels of ventilation will be required to maintain proper environmental conditions.

Temperature and ventilation controls

Multiple sensor controls for heating and ventilation provide greater accuracy and should be installed directly above the birds. Excessive ventilation in heated poultry production facilities during cold weather can dramatically increase heating energy and will have a big impact on heating running costs, sometimes by as much as 300%.

Lighting

Older incandescent and tungsten halogen lighting can be replaced with high frequency dimmable fittings, yielding savings of over 40%.

Variable speed drives on fans and pumps

Reducing the speed of a pump or fan by 20% using a variable speed drive could save 50% of the energy consumed. Water pumping and conveying systems can benefit from technology, especially when speed is linked to the flow and pressure requirements of the system.

Brooding curtains

Allow chicks to stay warm while restricting them to a smaller area of the house without the expense of heating the entire house. To perform efficiently they should form a tight seal along the ceiling, walls and floor.

Air circulation

By circulating pre warmed air into the poultry house, less heat and consequently less energy is needed to keep the birds warm. The effectiveness of ceiling inlets is linked to their placement the number of ventilation fans in use and the static pressure in the house.

Circulation fans

The hottest air in a poultry house is near the ceiling as air warmed by the birds rises upwards. Slow moving circulating fans should be used to push hot air back down to the floor, the more uniform the house temperature, the lower the heating costs.

Reducing energy use makes good business sense, it saves money, provides a competitive advantage, enhances farm reputation and plays a part in reducing carbon emissions and greenhouse gas emissions.

Source: Teagasc, Energy Use in Agriculture

Horticulture and Field Grown Vegetables:

There is significant embodied energy in artificial fertilisers, as with glasshouse and polytunnel crop production. Research has shown that fuel use in the growth of glasshouse crops can be reduced by 10-30% by sealing any air leakages and draughts. For example ensure all openings are properly flush when closed and that there are no cracked or broken panes, with sealant still in place around all panes in glasshouses.

Thermal screens which retain heat can be installed to cut down on energy loss and this can be highly effective. For smaller operations, plastic sheeting can be used as a cheaper alternative, though less effective.

For larger greenhouses, low power fans can be installed which circulate air effectively, ensuring a better balanced temperature through the space, which will ensure your heating systems do not overheat the space and waste energy.