ECG089

Energy Consumption Guide

Energy Use in Pig Farming

CARBON TRUST

Making business sense of climate change

Contents

1 Introduction

Pig farmers use energy in both intensive and extensive rearing systems in order to achieve their production goals. The main uses of energy are for building services, animal feeding systems and waste removal. Energy also plays an important part in animal welfare and environmental protection, most notably in waste management and emissions control.

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. Any alterations should take full account of the pigs' environmental requirements and welfare. It is often the case that improvements in control systems and insulation will enhance the pigs' environment.

2 Background to this Guide

This guide presents benchmark data on 'typical' and 'good practice' levels of energy consumption for pig farms in the UK.

Benchmarks are valuable because they allow producers to compare their performance with other similar businesses. In addition, they also provide two other useful functions:

1. They allow routine assessments to be made that show progress against a benchmark. Such appraisals are not restricted to year-on-year evaluations as they can be carried out quarterly, monthly or even weekly to track progress.
2. Opportunity assessments can be carried out. For example, if a facility is to be modified or upgraded, the effect of the change can be determined.

Throughout this guide, the benchmarks and information are based on methods and techniques that minimise energy consumption whilst maintaining pig performance at an economically acceptable level.

Pig farming in the UK is a complex and diverse business with a variety of facilities being used for each stage of production. To produce guidelines for all production system combinations would be an extremely time consuming and difficult task. Therefore, in order to give realistic guidelines, production has been broken down into several key areas to illustrate typical performance with benchmarks. These production areas are:

- Farrowing accommodation
- Weaning accommodation
- Finisher accommodation
- Feeding system
- Waste handling.

3 Measuring energy efficiency

Energy use benchmarks relate energy use to numbers of pigs produced or kilogram (kg) of pig meat. In this way, businesses of dissimilar size or output can easily be compared.

Energy benchmarks are therefore a measure of energy use intensity, the most common units being kWh/pig and energy use per liveweight produced (kWh/kg).

The data used in this guide was obtained under the auspices of a Carbon Trust funded project from many sources including FEC Services Ltd and the National Pig Association (NPA). The data was collected and analysed to provide energy savings information, measures and benchmarks.

4 Establishing the facts and planning actions

4.1 Taking stock of the current situation

Before a business can make use of energy benchmarks, it must carry out a simple assessment to establish energy use. This involves collecting information on the amount of energy used and calculating the energy intensity (total energy use for the previous year divided by total animal production).

4.2 Comparing performance

Once the energy intensity has been calculated, performance can be compared with the appropriate benchmark. Having done this comparison, you may wish to take one of the following courses of action:

- If the figure is more than **typical**, urgent action is required to reduce energy consumption. Some measures are suggested in Section 5
- If the figure is between **typical** and **good practice** then action is still needed to improve performance
- If performance is in line with **good practice**, there is still scope for improvement although the need to make changes is less urgent.

Use the figures in Table 1 to benchmark your energy use.

Production stage	Energy range per pig produced		Main influence
	Typical	Good practice	
Farrowing	8kWh	4kWh	Use of box creeps with thermostatic control gives the lowest running cost. Under-floor heating pads are generally more energy efficient than infra-red bulbs
Weaning	9kWh	3kWh	Major issues are the insulation of buildings (or kennels) and most importantly, the control of ventilation
Finishing (fan ventilated)	10kWh	6kWh	Efficient fan selection, good design of inlets and outlets and system cleaning are the key points to minimising energy use
Feeding system	3kWh	1kWh	Dry feeding systems use a small amount of energy for conveying. Wet feeding is generally more energy intensive because of the need to mix pump feed and pressurise pipework
Waste management (slurry systems)	6kWh	2kWh	Selection of high efficiency pumps, aerators and separators

Table 1 *Benchmark figures for energy use*

Heated floor pads are particularly economical for open creeps

4.3 Identifying energy efficiency measures

Section 5 contains information on measures that can help make energy efficiency improvements. These methods can be used on an existing farm or at the design stage for new or refurbished facilities.

The savings figures quoted can be applied to the calculated energy intensity to determine the likely effectiveness of using the techniques described.

5 Energy saving measures

5.1 Energy management approach

Establishing an energy action plan is the essential foundation for the reduction of energy waste in any business. The plan should consider all of the information available to the company and should have the backing of senior management.

GPG323: 'Energy saving guide for agriculture and horticulture' gives detailed information on how to set up an energy action plan.
Visit www.thecarbontrust.co.uk/energy or call the help line on 0800 58 57 94 for further information.

5.2 High priority / low cost measures

In general, it is best to initially implement low cost and no-cost measures which require little or no capital expenditure. In many cases, these measures give the best rewards as significant savings can often be made quickly and for little effort and expenditure.

Examples of low cost actions are as follows:

5.2.1 Monitor energy use

This is the basis of good energy management. Without detailed energy use data, it is impossible to get a complete and accurate picture of how energy is used in the business.

Do not rely on utility bills alone as these can often be based on irregular or estimated meter readings. Take regular meter readings and record these in a systematic manner. Make this part of your usual routine to ensure you obtain frequent and accurate information.

If you are billed on a monthly basis then take readings at least weekly; likewise if you are billed quarterly, then take readings at least every month. Relate the information collected to production levels and external influences like the weather. Tracking progress in this way will give an early warning of any unexpected changes in consumption which could be indicative of faulty equipment, altered controls or other problem. Correcting the problem will lead to energy savings.

5.2.2 Carry out maintenance and repairs

Simple repairs are often overlooked but they are an essential part of reducing wasted energy. Dust and corrosion are major problems for heaters, ventilation components and controllers. Equipment should be selected carefully to ensure that it is capable of enduring an aggressive environment. Cleaning of all components should be carried out as part of the 'end of batch' cleaning programme. This should include inspection of duct interiors, inlet baffles, fans and heater reflectors.

5.2.3 Check the accuracy of controls

Temperature sensors on building environmental systems should be regularly checked for accuracy. Use a reference thermometer to check readings and when inaccuracies are found, take immediate action.

5.2.4 Use information from your control system

Many modern controllers have the facility to store temperatures and ventilation settings. These can be downloaded at a later date to show how ventilation and heating systems have performed. Linking this information to energy use can reveal areas of wastage caused by incorrect setting of controls.

5.3 Medium and long term actions

5.3.1 Improve building insulation

Good insulation is important in all pig housing systems. Where heating is being used, insulation cuts heat loss and costs. In unheated finishing accommodation, insulation also prevents excessive temperature rises from solar gain.

Current recommendations are for an insulation level of better than $0.4W/m^2/^\circ C$ (60mm polyurethane).

Insulation in older buildings and structures is often based on fibre-wool type materials. Compression and slipping of this material can mean that insulation levels and coverage decrease over time.

Best results can be achieved using composite panels containing solid polyurethane insulation. These panels can be bought with plastic coated steel cladding for durability and cleanliness. They can also be used as effective structural components – especially useful in kennel construction.

5.3.2 Use enclosed creeps

Open creep areas have substantial heat losses so it is advisable to use boxed creeps. Boxing a creep provides a controllable environment for the piglets and allows better regulation of the thermal environment.

Enclosed creeps vary in construction from fully sealed and insulated boxes with pop-holes protected by strip plastic curtains, to crude, open sided areas with un-insulated lids. The better the construction, the more heating energy can be contained and therefore, the more effective controls will be in maintaining the correct temperature at lowest energy input. An ideal construction will be well sealed and insulated.

5.3.3 Improve controls

Good controls are a prerequisite for maintaining the right temperature in buildings and minimising the use of energy. For creep heating, use either fully variable manual dimmers or thermostatic controls.

Covered creeps with thermostatic control give lowest running costs

Where heating is used in the building (e.g. for weaning accommodation), it is critical that the minimum winter ventilation rate is controlled accurately. If the level is too high then heating costs will increase dramatically. Too low a level will produce foul air conditions.

5.3.4 Use efficient fans and ducts

It is important to recognise that fans vary significantly in their efficiency. Take particular note of the rated air throughput of the fan at the operational pressure it requires, together with the energy rating. Fan efficiency is stated in airflow per unit energy (e.g. m^3/h per W).

When buying fans, consider the 'lifetime' cost. This means taking into account the energy cost of the fan over its operation life as well as its initial capital cost.

Because of the sustained operation of fans in a typical finishing building for instance, a single fan will consume its own value in energy in about 18 months. So spending, say, 10% more in capital terms to secure a 10% energy saving will pay back in around the same time – a very good return on investment.

Most manufacturers produce performance characteristics measured to ISO5801 part 1, which can be used in selection of the most efficient unit.

The following characteristics should be noted when considering the efficiency of fans:

- Fan efficiency generally increases with impeller diameter
- Belt driven fans are generally more efficient than fans with direct drives
- Fans fitted with proprietary 'bell-mouths' to smooth the passage of the air will be 10% more efficient than fans fitted into a basic circular diaphragm
- Fitting 'cones' to outlet fans will increase efficiency by 10-15%.

Ventilation inlet and outlet ducting should be sized adequately. The internal surfaces should be smooth and clean with slow bends.

Clean fans and use smooth inlet bell mouths to improve efficiency

5.3.5 Efficient lighting

Prolonged periods of use mean that fluorescent lighting will afford the most efficient solutions in most cases. As two different levels of lighting are generally required (depending on whether the stockman is present in the room or not), lighting can be split into two circuits:

- For high level lighting, strip fluorescent lamps with T8 tubes and electronic control gear will give the best energy efficiency and most even light distribution
- For low level lighting in smaller rooms, a small number of compact fluorescent lamps is a good solution. An alternative would be to use strip fluorescent lamps with dimmable ballasts to allow the lights to be turned down during stock lighting periods.

Lighting control is generally confined to manual switching. Typical lighting costs are detailed in Table 2.

Lighting type	Efficiency characteristics	Energy use (kWh/pig)
Tungsten bulbs	Cheap but very inefficient Can be dimmed for dual stockman/stock use	2 to 4
Compact fluorescent bulbs	Often used as a direct replacement for tungsten lights but cannot be dimmed	0.4 to 0.8
Fluorescent strip lighting	Choose T8 (1¼ inch) tubes rather than T12 (1½ inch) tubes as these are more efficient Fittings with electronic control gear should be considered as they give a 20% energy saving over conventional wire wound ballasts and extend lamp life by 50% Electronic types are available with dimmable facilities allowing dual use for stockman/stock	0.4 to 0.8

***Table 2** Typical energy use for lighting*

5.3.6 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 specifying or upgrading motors on feed or waste handling systems.

With wet feeding and slurry pumping systems, select pumps that give the best flow/energy characteristics. Pumps which are used to service a variable demand should be linked to Variable Speed Drives (VSDs). These drives enable the output speed of the pumps to match the volumes and pressures required at different times of the operational cycle. Savings of between 30-50% can be expected in pump running costs when using VSDs.

With aeration, it is important to choose a technique with a high specific oxygen transfer rate per unit of energy input (kg O_2/kWh). This should be checked with the manufacturer of the system.

6 Appendix Main energy uses – detailed breakdown

6.1 Farrowing heating

About a third of the energy used on pig breeding units is for farrowing (creep) heating.

Creep heating systems come in a number of forms and designs. The basic types are:

- **Radiant electrical** – either using a bright-emitter lamp (pig lamp) or a dull emitter (black-bar/black-panel)
- **Gas radiant** – using small, direct acting radiant heaters normally running on liquid petroleum gas (LPG)
- **Underfloor heating** – either by direct cables laid in the floor or by hot water pipes fed from a boiler.

Energy use is influenced by the control system, the type of heating chosen and whether creeps are boxed or open.

Benchmark energy use for creep heating is as follows:

	Open creep electric / gas radiant		Boxed creep electric radiant		Underfloor	
	Typical	Good practice	Typical	Good practice	Typical	Good practice
Average annual usage (kWh/pig)	8.4	5.0	6.0	4.0	5.0	3.0

Measure	Low/medium/high cost	Payback period
Careful control of heater output	No cost	Immediate
Clean heaters and ensure they fit well into creep lids	Low	2-3 months
Seal boxed creeps and fit pophole curtains	Medium	1-2 years
Install boxed creeps	High	2-3 years
Install thermostatic controls ideally with temperature profiling	High	3-5 years
Choose higher efficiency heating type	High	3-5 years

Table 3 *Energy saving measures for creep heating*

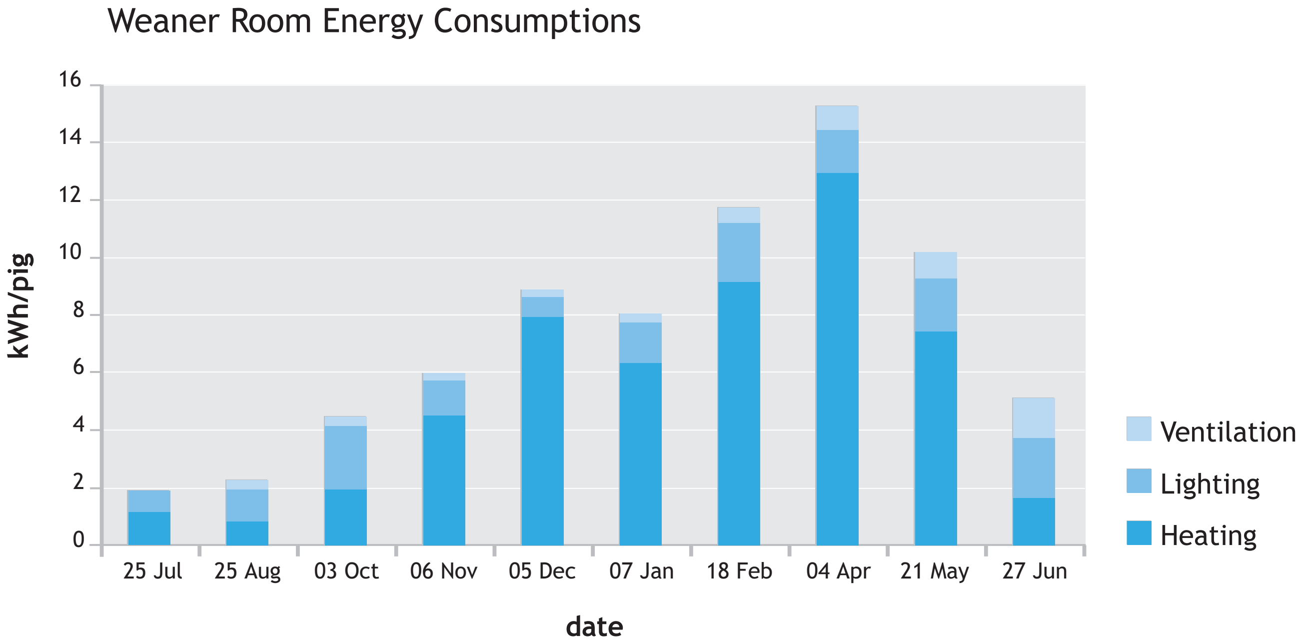
6.2 Weaning accommodation

Most weaner housing incorporates heating and ventilation and it is the heating that accounts for most of the energy use. The housing system for this stage of production can be categorised into two main types:

1. **Weaner rooms (flat-decks)** – where pigs are fully housed in a walk-in controlled environment room on an all-in, all-out basis
2. **Kennels** – where groups of pigs are housed in small batches in low level kennels, usually with solid floors and straw bedding.

Well constructed kennels can give good energy performance

6.2.1 Weaner rooms



Typical energy profiles for batches of pigs in a weaner room

The energy profile shown above was for a 26 m^2, 120 pig room with pigs housed from 3-7 weeks of age. Heating was from 4 x 1.5kW electric heaters and ventilation from 2 x 355mm fans.

This information should be regarded as an example of the 'typical' usage profile. Evidence shows quite a wide range of energy use from 6-17 kWh/pig, mainly due to variations in heating demand.

	Heating		Lighting		Ventilation	
	Typical	Good practice	Typical	Good practice	Typical	Good practice
Average annual usage (kWh/pig)	7.5	3.0	2.0	1.0	0.8	0.6

Typical and good practice benchmarks for a weaner room

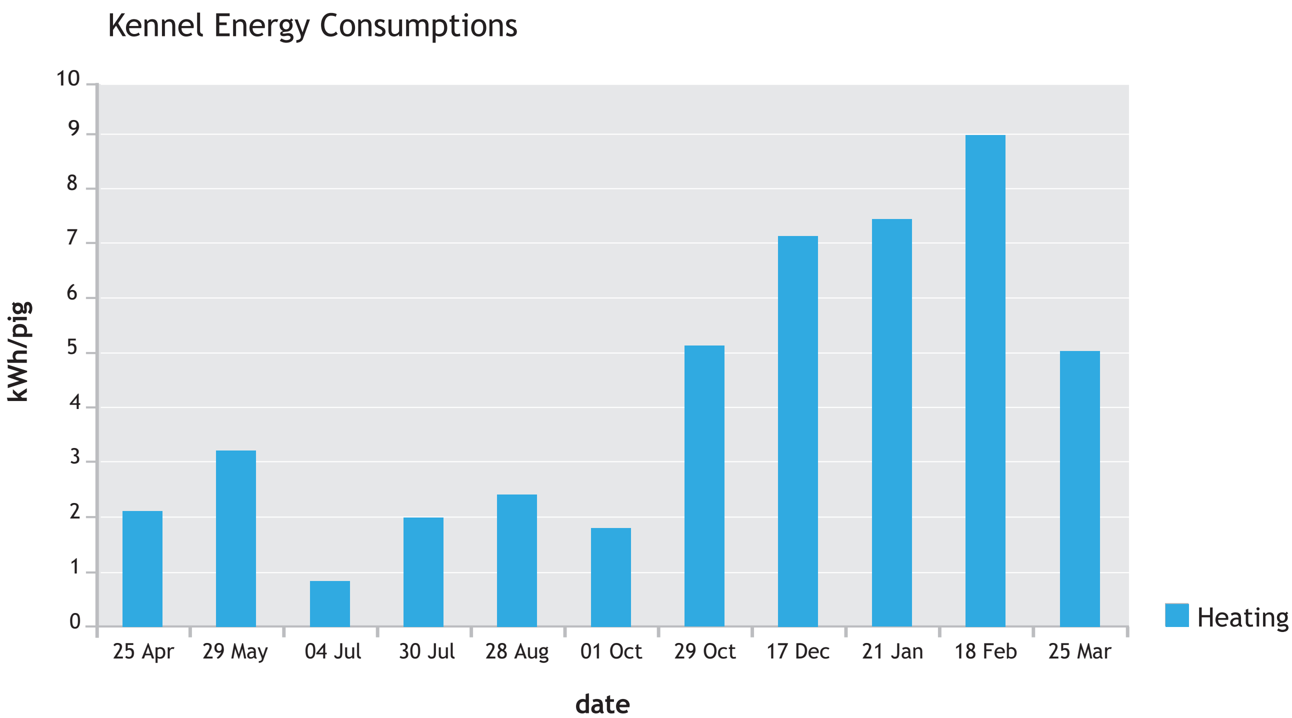
6.2.2 Kennels

The energy profile shown below was for a 4 m^2, 20 place kennel with pigs from 3-5 weeks of age. Heating was provided by 1kW underfloor heating elements. The kennels were fitted with automatically controlled natural ventilation (ACNV).

	Kennel Heating	
	Typical	Good practice
Average annual usage (kWh/pig)	6.5	3.0

Typical and good practice benchmarks for a kennel

ACNV uses little energy



Typical energy profiles for batches of pigs in a kennel

Measure	Low/medium/high cost	Payback period
Closer setting of controls	No cost	Immediate
Seal buildings to stop draughts	Low	Under 1 year
Clean fans and ducting regularly	Low	Under 1 year
Install compact fluorescent lighting or high efficiency tubular fluorescent lighting	Low-High	1-5 years
Reconfigure ventilation to give better control of minimum level	Medium	1-3 years
Update heating and ventilation controls	Medium	1-3 years
Re-insulate buildings	High	3-5 years

Table 4 *Suggestions for energy saving measures*

6.3 Finishing accommodation

Since the metabolic heat output of growing pigs increases with weight and their temperature requirement falls, ventilation systems in finishing buildings are of a higher capacity than those required in farrowing or weaning. Ventilation is therefore the major energy user at this stage of production and the careful choice of fans, the design of ducts and the maintenance of these systems is critical for efficient operation.

Lighting and feeding systems are the next most important users of energy.

Drastic reduction in energy use can be achieved by using natural ventilation or ACNV, but building temperature control may suffer leading to feed conversion increases. Also note that not all building designs lend themselves to conversion to these systems.

	Finishing building ventilation using fans	
	Typical	Good practice
Average annual usage (kWh/pig)	7.2	4.0

Typical and good practice benchmarks for finishing accommodation

Measure	Low/medium/high cost	Payback period
Make sure controls are properly calibrated and set to the correct temperature	No cost	Immediate
Clean fans and ducting regularly	Low	Under 1 year
Install compact fluorescent lighting or high efficiency tubular fluorescent lighting	Low-High	1-5 years
Improve the design of inlets and outlets to provide smoother air passage and lower air speeds	Medium	3-5 years
Update ventilation controls	Medium	3-5 years
Update ventilation to high efficiency low loss system	High	4-6 years
Re-insulate buildings to reduce solar gain	High	4-6 years

Table 5 *Suggestions for energy saving measures for finishing accommodation*

Further reading

GPG323: 'Energy saving guide for agriculture and horticulture'

GPG376: 'A strategic approach to energy and environmental management'

ECA Scheme

The Enhanced Capital Allowance (ECA) scheme aims to encourage business to reduce carbon emissions through providing an incentive to invest in energy-efficient technologies.

Carbon Trust Energy Surveys

Free professional and impartial advice to help you cut your energy bills.

An Energy Survey is a free, government-funded service that offers organisations the opportunity to identify and implement energy saving measures.

For further information on ECA's or surveys, contact the helpline on **0800 58 57 94** or visit the web site at **www.thecarbontrust.co.uk/energy**

Acknowledgements

The Carbon Trust gratefully acknowledges the support in production of this energy consumption guide from FEC Services Ltd and the National Pig Association (NPA).

Notes

Tel 0800 58 57 94

www.thecarbontrust.co.uk/energy

The Carbon Trust is funded by the Department for Environment, Food and Rural Affairs, the Scottish Executive, the National Assembly for Wales and Invest Northern Ireland.

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Registered in England and Wales Number 4190230.
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Ref: ECG089