CARBON TRUST

Energy efficiency in agriculture

Sector guide

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Preface

Reducing energy use makes perfect business sense; it saves money, enhances reputation and helps everyone in the fight against climate change.

The Carbon Trust provides simple, effective advice to help business take action to reduce carbon emissions; the easiest way to do this is to use energy more efficiently.

This overview of opportunities to implement energy savings opportunities and measures for energy efficiency within the agricultural and horticultural sector is aimed at businesses looking to invest in measures that will enact energy savings and reduce carbon emissions.

Contents

Introduction

Who is this publication for?

This guide aims to outline energy savings opportunities that are applicable to anyone in the agriculture sector. A number of opportunities that are low or no-cost are highlighted, while also offering advice for those wishing to make a more significant investment in their operations to increase efficiency and enact energy savings. The guide focuses on potential savings in a farming operation's electricity consumption and use of fuels for heating which are a considerable cost to the agricultural industry. The first section of the guide outlines energy savings opportunities that are applicable to all agricultural practices, while the subsequent sections give sector specific energy savings opportunities. The key features of this guide will outline:

- Energy management
- Sector-specific energy savings opportunities
- Methods for improving performance

The benefits of implementing energy savings opportunities are multi-faceted and can lead to a number of positive results for an agricultural business, including:

- Reduced costs and increased profitability - a 20% cut in energy costs can represent the same bottom line benefit as a 5% increase in sales
- Improved internal environment in a production facility
- Improved crop quality
- Compliance with crop assurance schemes
- Increased sales to customers who are increasingly concerned with the environmental credentials of the products they buy
- Increased sales to produce buyers who are increasingly concerned with the environmental credentials of the products they buy

Energy consumption in the agricultural sector

The context for managing energy consumption

Although energy costs may seem insignificant to the overall costs of an agricultural business, reducing these costs can lead to a competitive advantage and as a result increased profitability. As shown in Figure 1, energy consumption still has significant associated costs across the agricultural sector as a whole.

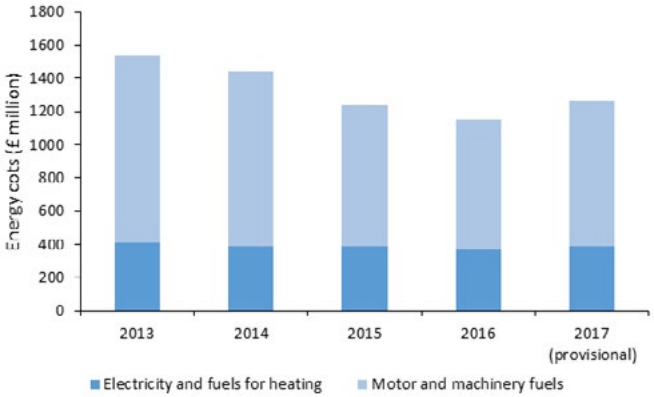


Figure 1: Cost of energy consumption in the agricultural sector in the UK. Source: DEFRA[1]

With increasing focus placed on the agricultural sector's contribution to greenhouse emissions and climate change (agriculture is estimated to contribute approximately 13%[2] of global greenhouse gas emissions), farmers and stakeholders such as supermarkets are increasingly placing importance on reducing the environmental impact of their operations and operations in their supply chains.

Understanding the key areas of energy consumption

The key areas of energy consumption in agricultural businesses can vary significantly by activity (as outlined in Table 1 below). Pig, poultry, beef, dairy, arable and horticulture all have different energy use profiles, however a number of common themes exist between these different farming sectors.

Areas of major energy consumption

Lighting, heating, ventilation, air circulation and refrigeration equipment are generally the biggest energy consumers and therefore offer the opportunity for significant savings to be realised. In addition, animal feeding systems and waste removal can have a significant energy footprint. The major areas of energy consumption by farming sector are outlined in Table 1.

Table 1: Areas of energy consumption by farming activity

Farming activity	Major areas of energy consumption
Horticulture	- Heating of greenhouses
Pigs	- Waste and manure management - Feeding systems - Maintenance of environmental conditions for stock rearing
Poultry	- Maintenance of environmental conditions for stock rearing
Beef	- Feed delivery to cattle
Dairy	- Milk production process - Water heating - Lighting and pumping - Cooling and refrigeration of milk
Arable	- Milk production process - Water heating - Lighting and pumping

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/741062/AUK-2017-18sep18.pdf

[2] https://www.wri.org/blog/2014/05/everything-you-need-know-about-agricultural-emissions

Assessing your energy consumption

The first steps to identifying areas of high consumption

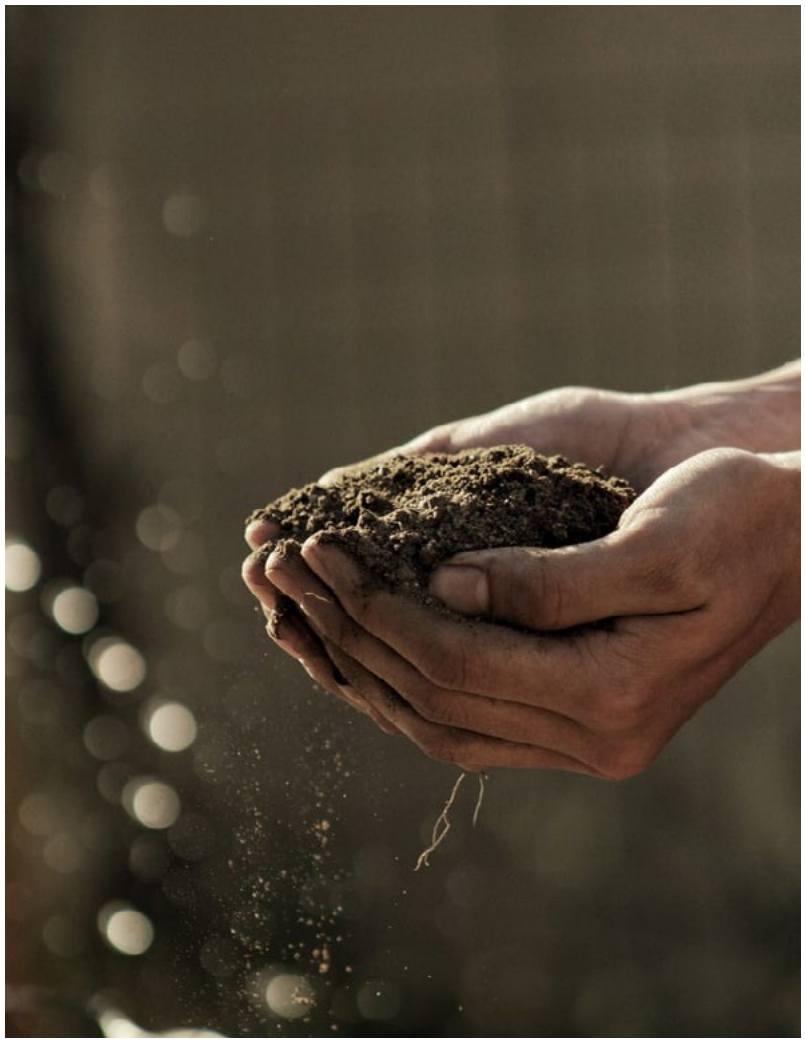
For farmers to identify areas of high energy consumption, they must first benchmark their energy usage. This involves collecting information on the amount of energy used by your activities and attempting to identify areas of high consumption. Your energy consumption can be compared against industry averages or similar farms to indicate the energy performance of your farming operation.

Monitoring energy usage

Implementing a regular review of your energy usage is the best place to start if you intend to monitor your energy usage. Without detailed energy use data, it is difficult to form an accurate picture of the energy usage within your business.

To do this, in addition to monitoring your billing, it is prudent to implement a meter reading schedule within your business. Utility bills can often be based upon estimated or irregular readings, and therefore may not be corrected for a number of months.

A schedule for meter reading should be based upon the frequency with which you receive your utility billing (e.g. monthly, quarterly). If you are billed on a monthly basis then you should take weekly readings, and if billed quarterly you should take at least monthly



readings. Record these readings, and note any differences in production from business as usual, extremes in weather or any factors that are likely to affect your energy bills. This will allow you to understand fluctuations in your energy usage and identify opportunities for energy savings.

Low cost/free opportunities for energy savings

There are a number of potential free or very low cost opportunities to improve the energy efficiency of your operation

Switching off

When not in use, all energy consuming equipment should be turned off. This requires engagement with staff in order to implement consistently. Alternatively, time switches or adjusting the building control systems can significantly reduce energy usage without costing any money.

Maintenance

As part of regular maintenance, small measures can be implemented in order to enact energy savings. For instance; maintenance of boilers and other machinery, keeping components clean, and checking of seals are all potential measures that could easily lead to energy savings as part of a regular maintenance schedule.

Equipment selection

Careful selection of equipment to ensure it is robust enough to deal with the environment it operates in is important during the procurement process. It is also important to test whether they will be able to meet the demands of the system they are being placed into. Correct sizing of equipment (e.g. motors) should be achieved in order to optimise energy efficiency. This should be aided by a rigorous maintenance system (as above) and can ensure longer life and more efficient functioning of equipment. This can be particularly important in agricultural operations due to the range of weather conditions that are encountered where machinery is used outside.

Procurement of equipment should not be entirely based on upfront cost, because choosing more energy efficient equipment can, over the whole equipment lifetime, be more beneficial to the farming operation overall. Life cycle costing evaluation takes into account likely annual fuel costs which will be lower if more efficient equipment is procured.

Utilise control systems

Control systems are a powerful tool for assessing energy usage. Temperature sensors on building environmental systems should be regularly checked for accuracy - this can be done using a reference thermometer. Many modern control systems can store data on temperature and ventilation which can be used to inform energy usage. Utilising control systems effectively to manage conditions can increase energy efficiency without compromising animal welfare. For further detail of acceptable welfare conditions, see links from DEFRA[3,4].

Raise awareness

Raising awareness about the benefits of energy efficiency among employees is a key driver of efficiency. Awareness campaigns[5] and engaging with staff can have a significant impact on energy usage within an agricultural organisation.

[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69368/pb7949-cattle-code-030407.pdf
[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/694013/meat-chicken-code-march2018.pdf
[5] https://www.carbontrust.com/media/13089/ctg056_creating_an_awareness_campaign.pdf

Heating

Heating is often a high energy consuming area

Heating is a key part of maintaining many functioning agricultural facilities. Heating can have the greatest impact on an operation (dependent on activity), which gives significant opportunity for energy savings.

Ensure temperature controls match requirements

Check that operating system hours match when heating is required, consider automating (with regular review) the process to take human error out of the equation. Recommended temperatures (for human work) include:

- Stores: 10-12°C
- Heavy work: 11-14°C
- Workshops and light work: 16-19°C
- Sedentary work: 19-21°C

Ensure control systems (e.g. thermostats) are located in areas that are not affected by draughts or sunlight. There are also a number of guidelines for the safe rearing of livestock that are housed inside which DEFRA provide[6,7].

Upgrading controls

Upgrading heating controls can quickly repay the capital outlay because old, inefficient time controls can have a negative effect on energy efficiency. Compensators automatically regulate heating based on the weather, while optimum start controllers learn how quickly a building reaches optimum temperatures and switches on as necessary. This can pay back in two years.

Maintain boilers and pipework

Check pipework for leaks and adhere to a regular servicing schedule for your boiler. This can deliver as much as 10% on annual heating costs.

Consider radiant heating

In buildings with high ceilings, significant energy losses can occur. Radiant heaters can provide more energy efficient heating through radiant heat transfer, allowing heat to be directly targeted at a specific section without requiring the surrounding areas in large buildings to be heated.

[6] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69368/pb7949-cattle-code-030407.pdf

[7] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/694013/meat-chicken-code-march2018.pdf

Ventilation and air circulation

Often an underappreciated area for significant energy savings

Ventilation accounts for on average 14% of energy bills across the sector. Identifying and implementing energy savings opportunities in ventilation systems can therefore have a significant impact with an energy reduction of up to 20% possible.

Natural ventilation and free cooling

Windows and doors may be able to provide levels of natural ventilation, which would allow fans to be switched off or powered down. When planning greater use of natural ventilation, wider implications such as security and impact on heating demand should be considered.

Regular system maintenance

Effectiveness of ventilation systems can fall by up to 60% if not properly maintained, causing increased running costs and risk of breakdown. Regular cleaning of ventilation ducts can remove debris and harmful pathogens that multiply in air ducts and continuously expose animals and staff to diseases or cause respiratory problems, such as Aspergillosis.

Variable speed drives

In most settings within the sector, ventilation and air circulation fans do not need to operate continuously at full capacity. Variable speed drives allow the output speed to match the requirements, leading to energy savings.

Interlocked control for ventilation

Automatic control utilising time switches, occupancy sensors or controls can reduce operating time of fans.

Improve air flow through ducts and air inlets/ outlets

Ensure internal surfaces of ducting are smooth. Air inlet and outlets can be built in to improve ventilation efficiency by 20%.

Evaporative cooling

Evaporative cooling is an energy efficient climate control method for hot/dry climates that uses the natural temperature reducing properties of water. Even though they have topographical restrictions as to where the can be applied, they still they provide a much cheaper and environmental friendly alternative to conventional air-conditioning units

Lighting

Lighting can account for up to 4% of energy bills across the agriculture sector, and therefore having the most efficient approach to lighting usage and equipment can lead to energy savings.

Staff awareness

Encourage staff to take ownership and switch off lights when not needed. In addition labelling of light switches for their specific function and awareness posters to switch off when not in use can reduce unnecessary lighting usage.

LED lighting

Replace 'conventional' tungsten or compact fluorescent light bulbs with LEDs to decrease energy usage from lighting and provide better quality of light.

Sensors

Install occupancy sensors to ensure that lighting is only used when required. This is particularly effective for areas that are intermittently used. This can lead to a saving of 30-50% on lighting energy costs. In addition, day-light sensors can be used to dim or switch off lighting when natural daylight is sufficient. This is particularly applicable in outdoor settings. This can lead to payback in less than a year, and when combined with time switches can lead to significant savings.

Refrigeration

Refrigeration is a necessity in some sections of the agricultural industry, namely dairy farming where its implementation can comprise a significant proportion of energy costs.

Clean condensers

Allow for good airflow by keeping condensers clean, if blocked they can increase consumption by 20%.

Fit PVC curtains

Either fitting strip curtains or upgrading to self-closing doors can significantly reduce temperature loss or gain from controlled-temperature rooms.

Operate at peak efficiency

Ensure refrigerators are full but not overloaded, keep away from heat sources and ensure that chiller doors remain shut at all times. All of these measures can enact a significant energy saving.

Avoid overcooling

Increase temperature thermostats where possible to improve energy efficiency and avoid over cooling, without compromising product or process quality. Energy consumption can be reduced by 2-4% if the cooling temperature is increased by 1°C.

Building fabric and insulation

Agricultural and horticultural buildings vary widely in terms of build quality, build type, age and function. Identify the opportunities for improving the energy efficiency of your buildings.

Improving building fabric

Improving building fabric can have a number of positive effects on your buildings, including:

- Better temperature control through lower ventilation and heating costs
- Improved productivity through providing a better working environment for staff
- Lower expenditure - less heating and ventilation required
- Investments in energy efficiency can improve the value of a building

Check for damp

Damp can cause significant damage and reduce the insulation properties of a building. Checking for damp in areas likely to be affected (e.g. under gutters, leaky roof tiles etc.) allows for early identification of problems and so a reduction in costs.

Install draught proofing

Gaps of larger than a 1p coin on its side should be fitted with draught strips to reduce energy loss. Cold draughts of air can also have a negative impact on animal welfare, as it can increase aggression between animals. In addition, draughts can lead to increased feed costs, as animals need to use more energy to maintain their body temperature (thermoregulate).

Insulation

25% of a building's heat can escape via an uninsulated roof. Insulation in building components should be made up of extruded polystyrene or equivalent.

Establish a housekeeping schedule

Compiling a checklist to assess areas where energy can be lost, and checking against this on a regular basis, will highlight any inefficiencies in the system.

Innovation

Opportunities to generate your own electricity

If significant capital is available, there are a number of potential opportunities that agricultural organisations could look into implementing in order to reduce their energy costs. This can include looking at options to generate electricity on their land. When coupled with the energy efficiency measures outlined previously, a farmer willing to make these investments can reduce their energy costs and carbon emissions significantly.

Wind

Where a farm has a significant area of land under its control, the potential for either a single turbine or the commissioning of a wind farm can have significant benefits for your operation. Wind turbines can be sited in your existing fields without materially impacting on the use of the land. Wind turbines can provide a farming operation with all of their electricity needs, while larger installations can bring income by selling electricity to the grid.

Solar

Establishing solar panels can be beneficial for a farming operation. Those with large sheds and farm buildings (e.g. poultry/dairy) can take the opportunity to install solar panels which could supply electricity for the majority of a farming operation (and also the home). This requires significant capital investment, but payback can be seen in 7-10 years for a modestly sized installation. In addition some farmers are installing solar panels in their fields to build 'solar farms' which can create energy to be sold back to the electricity grid.

Micro-hydropower

In upland areas or farms with rivers/streams, constructing a run-of-the-river micro hydropower installation can generate a significant amount of the energy needed for the agricultural operation. Subject to planning and other potential hurdles, a micro-hydropower scheme can generate a significant amount of energy.

Biofuel

Biogas is a type of biofuel that is naturally produced from the decomposition of organic material, such as animal waste, in anaerobic conditions. With the application of a anaerobic digester, a farm can reduce the expense of treating animal wastes by reducing their overall quantity, and the reduce the carbon emissions associated with the remaining wastes. In addition, purchased energy costs can be reduced by using the biogas produced to generate electricity for use on the farm, and any excess exported to the grid.

Case Study

Through the Carbon Trust's Green Business Fund, a range of agricultural and horticultural SMEs have been offered advice for the most effective ways to improve their energy efficiency through a range of different measures. Some examples include:

Savings opportunities identified

A grain storage firm in the UK

Opportunity	Likely saving
Energy Management	£8,500
Change to Natural Gas from LPG	£35,500
Lighting upgrade	£8,100
TOTAL SAVING	£52,100

A horticultural nursery in the UK

Opportunity	Likely saving
Energy Management	£300
Fitting a Combined Heat and Power (CHP) system	£12,900
Lighting upgrade	£17,000
TOTAL SAVING	£30,200

The Carbon Trust has identified approximately £250,000 worth of savings opportunities for companies in the agricultural and horticultural sector.

Carbon Trust Guides – Find other Carbon Trust Guides on our website and for heat pumps in particular:

- Heating, ventilation and air conditioning (HVAC)
- Refrigeration
- Lighting

Case Study

The Carbon Trust have also supported companies with Implementation Advice, identifying savings opportunities and helping with tender processes to select a suitable supplier to install an energy saving project. Some examples of the Implementation advice offered to SMEs include:

A chicken farm in NW England

Opportunity	Average annual cost saving
LED lighting installation	£12,500

A farm and grain store in SW England

Opportunity	Average annual cost saving
Grain store fans and sensors	£2,750

A vegetable farm in NW England

Opportunity	Average annual cost saving
Fitting compressors	£2,600

The Carbon Trust has supported many agricultural companies with identifying energy savings and implementing projects. Through the Green Business Directory, Carbon Trust Accredited Suppliers have been independently assessed by the Carbon Trust and met or exceeded criteria designed to examine their capability and proven track record of delivering thoughtful, well-designed energy efficient and renewable energy systems. As part of the robust assessment process, the Carbon Trust takes into consideration case studies and feedback from client references regarding suppliers' performance.

Visit the

Green Business Directory

Sector-specific advice

Pigs

Sector	Energy saving opportunity	Explanation
Heating	Install creep heating	35% of energy used on pig farms is used for creep heating. Fitting insulated creep boxes with thermostatically controlled heating can enact savings, provide a better environment and extend the life of heat lamps
	Install under floor heating	These are more efficient than infrared bulbs
Ventilation & air circulation	Specify high-spec fan equipment	Ventilation directly affects feed intake and mortality for animals
	Winter ventilation	Ensure minimum winter ventilation rate is accurately controlled
	System maintenance	Dirty fans and ducts can reduce ventilation by as much as 40%
	Flexible system	Design systems to suit changing demands of pigs as they grow (e.g. higher demand when finishing rather than weaning)
	Auto control natural ventilationv	Automatically control ventilation to pigs to improve their environment and wellbeing with little energy cost
Lighting	LED lighting	Fitting LED lighting can significantly reduce energy use and increase lighting quality
Building fabric and insulation	Use boxed creeps	Boxed creeps are far more efficient than open creeps in terms of heat loss as they allow for better control of the environment

Sector-specific advice

Horticulture

Sector	Energy saving opportunity	Explanation
Heating	Use thermal screens	Thermal screens can reduce heat loss from a greenhouse by up to 30%
	Fixed screens	Can be placed above crops in early development
	Movable screens	Can be opened and closed as necessary to make the best of available heat and light
	Clean glass	Ensures most amount of heat and light reaches crop
Ventilation & air circulation	Ceiling circulation fans	Reduce amount of excess heat above crop
Lighting	Replace reflectors	After 4-5 years of operation reflectors should be re-anodised or replaced
Building fabric and insulation	Pipe insulation	Pipes can freeze in cold weather, and so energy is required to prevent this
	Reduce air leakage	Ensuring greenhouses are well sealed heating costs can be reduced by 25%
	Protect against high winds	Use windbreaks or landscaping can provide a fuel saving of 10%

Sector-specific advice

Dairy

Sector	Energy saving opportunity	Explanation
Heating	Consider radiant heating	As most milking parlours are uninsulated and draughty, radiant heating is more efficient than space heating
Refrigeration	Use plate coolers	Cooling milk and heating water accounts for 66% of energy use on dairy farms. Pre-cooling milk can halve cooling costs
Building fabric and insulation	Pipe insulation	Pipes can freeze in cold weather, and so energy is required to prevent this
Heating (Dairy)	Continuous rather than batch pasteurisation	As the heating and cooling demands for pasteurisation are high, continuous pasteurisation reduces the considerable energy use (up to 14%) when no milk is throughput
Dairy	Reduce head pressure in homogenisation	Upgrading head to more efficient pressure design (180 bar to 120 bar) reduces electricity by 33%
	Variable Speed Drives	Fitting variable speed drives to a farm's milking machine operation can reduce a machine's energy use by 60% and payback in 7 years

Poultry

Sector	Energy saving opportunity	Explanation
Ventilation & air circulation	Specify high-spec fan equipment	Ventilation directly affects feed intake and mortality for animals
	System maintenance	Dirty fans and ducts can reduce ventilaztion by as much as 40%

Sector-specific advice

Arable & crop storage

Sector	Energy saving opportunity	Explanation
Ventilation & air circulation	Store management	Stores should be loaded/unloaded to achieve good airflow and consistent drying
Lighting	Shatterproof covers	Fit shatterproof covers to all lamps to comply with crop assurance
Building fabric and insulation	Check doors, louvres and air mixing boxes for sealing and leakage	Refrigeration can condensate drains and other service entries can also be a source of leakage which is a significant contributor to heat gain
Other	Make most of weather	Use drying facilities when it is warmest as this is the most efficient time to do so
	Humidity based controls	Check calibration of sensors at least annually to maintain optimum performance

Your next steps

See if your agricultural operation could be reducing emissions and saving money by implementing energy efficiency measures

Step 1: Evaluate your energy usage

Identify areas of high energy consumption within your operations.

Step 2: Identify your opportunities

Build the business case for implementing any energy savings opportunities, considering likely payback and other effects including those on staff. A number of opportunities may be low or no cost.

Step 3: Prioritise your actions

Try and implement measures that will reduce the most significant areas of your energy consumption, first looking for low or no cost opportunities and then scaling up to those that would require more capital input if the likely savings and paybacks are favourable.

Step 4: Seek specialist help

It may be possible to implement some energy saving measures straight away but others may require specialist assistance. Discuss the more complex or expensive options with a qualified expert.

Step 5: Implement your action plan

It may be possible to implement some energy saving measures in-house, but others may require specialist help. Discuss the more complex or expensive options with a qualified technician.

Step 6: Continue to manage your office's energy use

Enforce good energy management behaviours and switch-off procedures to ensure that your business operates efficiently and that savings are maintained in the future.

For further information, the following organisations and Carbon Trust guides may be useful

Carbon Trust Guides – Find other Carbon Trust Guides on our website and for heat pumps in particular:

- Heating, ventilation and air conditioning (HVAC)
- Refrigeration
- Lighting
- Electric and smart vehicles
- Energy storage

Go online to get more

The Carbon Trust provides a range of tools, services and information to help you implement energy and carbon saving measures, no matter what your level of experience.

Website – Visit us at www.carbontrust.com for our full range of advice and services.

www.carbontrust.com

Tools, guides and reports – We have a library of publications detailing energy saving techniques for a range of sectors and technologies.

www.carbontrust.com/resources

Events and workshops – We offer a variety of events, workshops and webinars ranging from a high level introductions to our services through, to technical energy efficiency training.

www.carbontrust.com/events

Our client case studies – Our case studies show that it's often easier and less expensive than you might think to bring about real change.

www.carbontrust.com/our-clients

The Carbon Trust Green Business Fund – is an energy efficiency support service for small and medium-sized companies in England, Wales and Scotland. It provides support through tools, guides and webinars for SMEs.

www.carbontrust.com/greenbusinessfund

*Subject to terms and conditions.

The Carbon Trust is an independent company with a mission to accelerate the move to a sustainable, low-carbon economy. The Carbon Trust:

- **advises businesses, governments and the public sector on opportunities in a sustainable, low-carbon world;**
- **measures and certifies the environmental footprint of organisations, products and services;**
- **helps develop and deploy low-carbon technologies and solutions, from energy efficiency to renewable power**

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