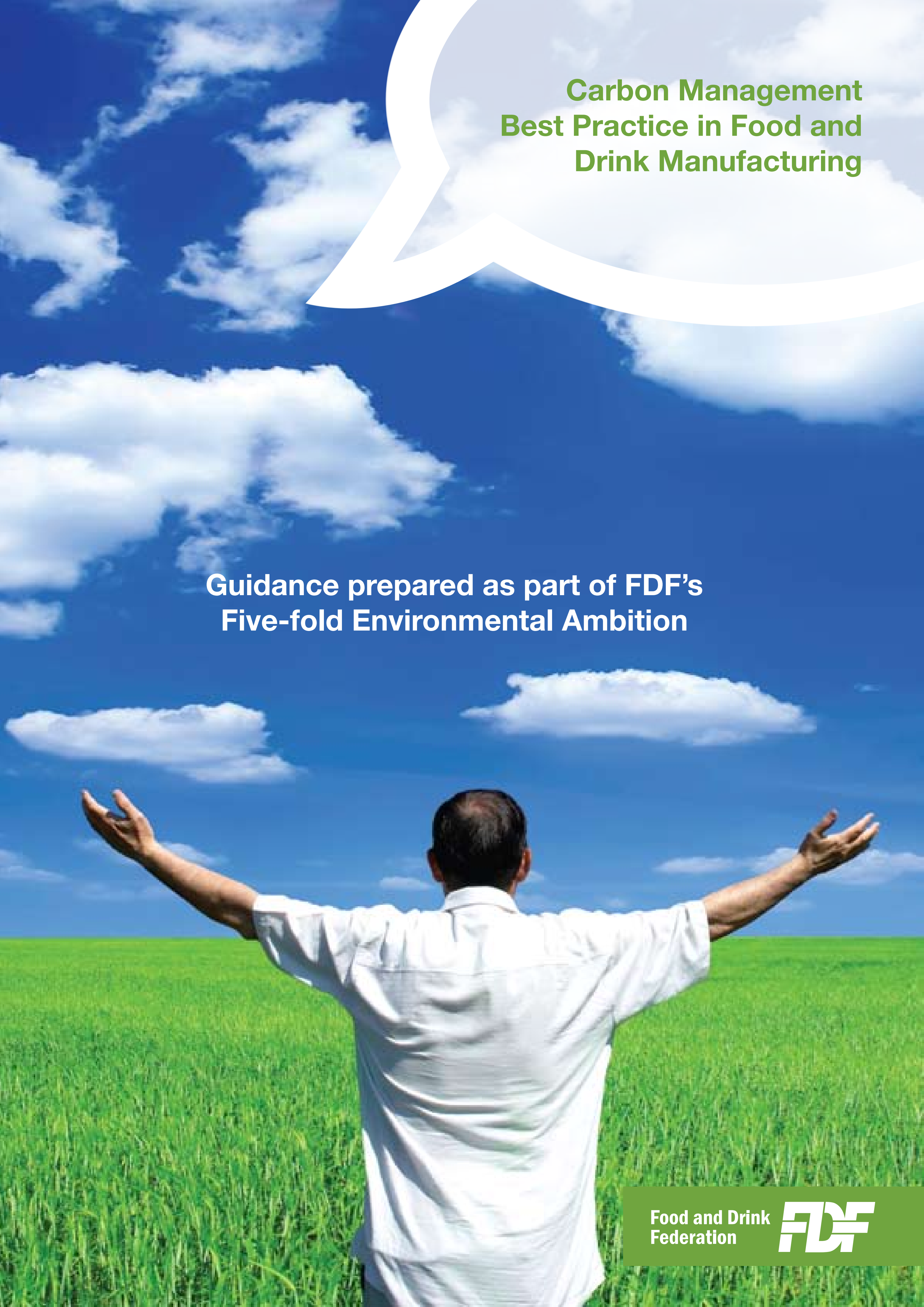
Carbon Management Best Practice in Food and Drink Manufacturing



Guidance prepared as part of FDF's Five-fold Environmental Ambition

Food and Drink Federation
FDF

Introduction

This short guide is designed to help food and drink manufacturers understand the importance of Carbon Management and to provide practical advice on ways of reducing CO_2 emissions. From our sector's perspective, these primarily arise from the burning of fossil fuels, upon which we depend for generating energy and raising steam.

The guide has been commissioned by the Food and Drink Federation (FDF) in the context of our Five-fold Environmental Ambition launched in October 2007 to make a real difference to the environment.

One element of our ambition is to show leadership nationally and internationally by achieving a 20% absolute reduction in CO_2 emissions by 2010 compared to 1990 and aspiring to a 30% reduction by 2020. This reflects:

- FDF's acknowledgement that climate change is arguably the biggest single challenge facing mankind and the planet.
- that the main cause of climate change is the release of greenhouse gases, such as CO_2, into the atmosphere.
- that the food chain represents a significant proportion of the UK's emissions of greenhouse gases.

We hope that by explaining where CO_2 emissions occur in the sector and providing "top tips" for reducing them, we will help food and drink manufacturers to play their full part in tackling climate change. The planet and future generations depend upon it.

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FDF Energy Manager

Guide Contents

FDF's Five-Fold Environmental Ambition

The Food and Drink Federation (FDF) committed, on behalf of its members, to making a significant contribution to improving the environment by targeting priorities where they can make the biggest difference. Working collectively, our 'Five-fold Environmental Ambition' is to:

- achieve a 20% absolute reduction in CO_2 emissions by 2010 compared to 1990[1] and to show leadership nationally and internationally by aspiring to a 30% reduction by 2020
- send zero food and packaging waste to landfill from 2015
- make a significant contribution to WRAP's work to achieve an absolute reduction (340,000 tonnes) in the level of packaging reaching households by 2010 compared to 2005 and provide more advice to consumers on how best to recycle or otherwise recover used packaging
- achieve significant reductions in water use[2] and contribute to an industry-wide absolute target[3] to reduce water use by 20% by 2020 compared to 2007
- embed environmental standards in their transport practices, including contracts with hauliers as they fall for renewal, to achieve fewer and friendlier food transport miles and contribute to an absolute target for the food chain to reduce its environmental and social impacts by 20% by 2012 compared to 2002[4].

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1 Proposed in the Food Industry Sustainability Strategy published by Defra in 2006
2 Water use outside of that embedded in products themselves
3 Proposed in the Food Industry Sustainability Strategy published by Defra in 2006
4 Proposed in the Food Industry Sustainability Strategy published by Defra in 2006

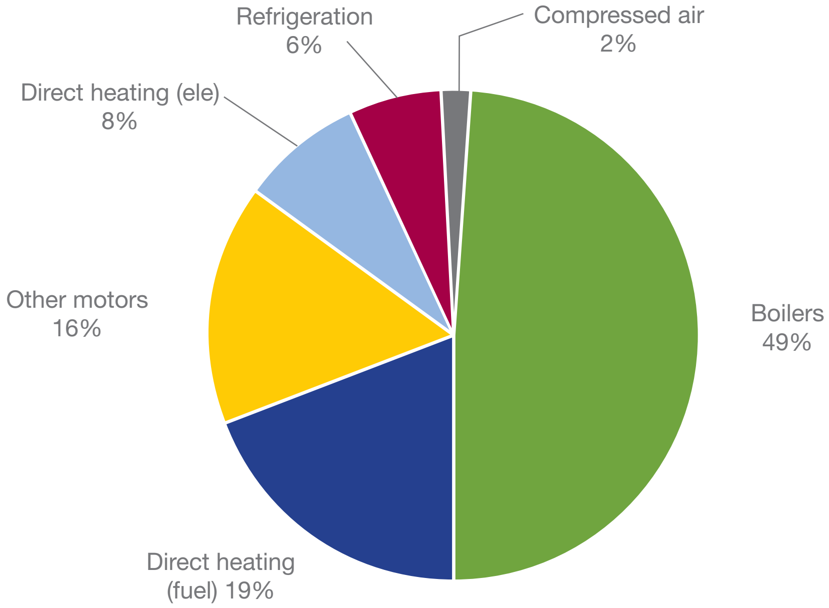
Greenhouse Gas Emissions from Food & Drink Manufacturing

Energy Related Emissions

The main sources of Green House Gas (GHG) emissions from food and drink manufacturing sites relates to the use of energy:

- The burning of fossil fuels such as oil and gas lead to "direct" CO_2 emissions at the factory. The key uses of fossil fuel are for steam boilers and other heating systems such as ovens and driers.
- The use of grid electricity leads to "indirect" CO_2 emissions at the power station producing the electricity. The key uses of electricity include refrigeration, compressed air, pumps, fans and processing / packaging equipment.
- All transport of raw materials, finished goods and your staff also gives rise to emissions from vehicles.

For all the food and drink factories in the FDF Climate Change Agreement, the overall split of emissions between fossil fuels and grid electricity is approximately equal. However, different sub-sectors of the industry have very varied emissions profiles. Some processes, such as food canning and baking are very heat intensive, whereas others like frozen foods and flour milling use much more electricity. The graph below shows the average breakdown of emissions for the whole industry:



Here are a few examples of how this average breakdown can change:

a. Food canning, is very steam intensive – the boilers use 70% of energy.
b. Baking requires large ovens using 60% of energy.
c. Frozen and chilled foods have large refrigeration loads using 60% of energy.
d. Flour milling plants have large electrical loads using 80% of energy.

Other Types of GHG Emission: Whilst energy related CO_2 is usually the dominant GHG emission, other food factory emissions can come from sources such as leaking refrigerants; methane from effluent treatment; and process CO_2 from fermentation.

Greenhouse Gas Emissions from the Food Chain

Food and Drink Manufacturing: The largest emissions of GHGs related to food production and consumption do not come from food manufacturing plants, which only represent about 10% of emissions from the food chain.

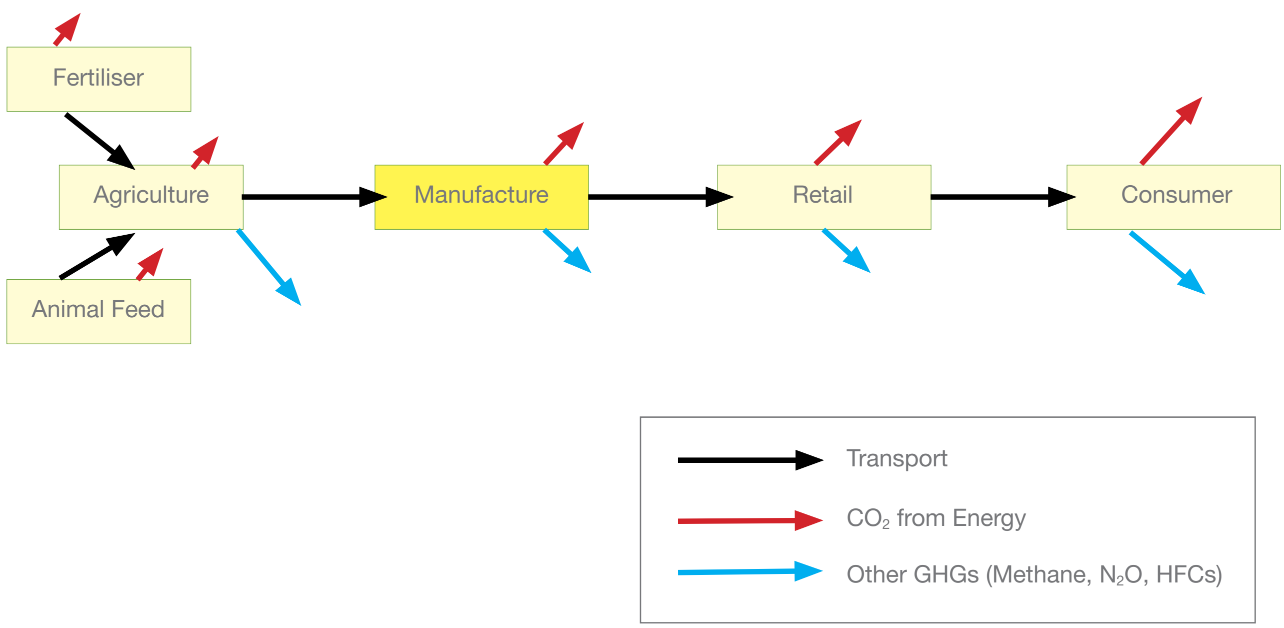
Agriculture: About 50% of GHG emissions come from agriculture. Most of this is not energy related. Key emissions include methane from livestock and N_2O which is emitted from fertilisers in the soil. The animal feed and fertiliser also factories that supply the agricultural sector are also big energy users.

Retail: The retail and catering sectors are also significant representing about 15% of emissions. Most of these emissions relate to energy use, including a significant refrigeration requirement. Refrigeration systems using HFC refrigerants often have a large GHG emission because of refrigerant leakage.

Domestic: Storage and cooking of food in domestic dwellings is also significant, representing about 15% of emissions.

Transport: The energy use in transport between different stages of the food chain represents a further 10% of emissions. There is increasing concern about 'food miles' especially if these involve food transported by air. However, long distance transport is not necessarily bad in terms of CO_2 emissions – for example the extra transport energy importing vegetables from Africa might be less than the glass house heating required to grow the same crop in the UK.

Waste: Any waste food put into land fill will create emissions of methane. This can represent a significant proportion of food chain emissions. It has been estimated that between 20% and 30% of food sold in the UK is wasted.



Carbon Footprints

Many food companies are measuring their carbon footprints and publishing information about carbon emissions, for example in Annual Reports. There are a number of different types of carbon footprint, based on the "system boundary" included in the footprint. For example:

a. **Corporate footprint:** The carbon footprint of a food manufacturing company might represent the direct emissions from the companies operations including energy use, transport, waste, refrigerant leakage etc.

b. **Product footprint:** This includes all the food chain emissions of a particular product including agriculture and retail as well as manufacturing. Product footprints can also include the domestic emissions.

Key Aspects of Carbon Management

Objectives of a Carbon Management Programme:

To take steps to reduce emissions of greenhouse gases from within your own organisation and to influence the reduction of emissions up and down your supply chain.

Drivers:

There are a number of compelling drivers to carry out Carbon Management:

- Cost savings: the high price of energy makes reduction of energy use a win-win measure for the environment and your bottom line.
- Regulations: there is increasing regulatory pressure to ensure reductions in CO_2 emissions e.g. Climate Change Agreements, EU Emissions Trading Scheme, Carbon Reduction Commitment, F Gas Regulation etc.
- Stakeholder pressure: your customers and your shareholders are showing increasing interest in the efforts you are making to reduce emissions.

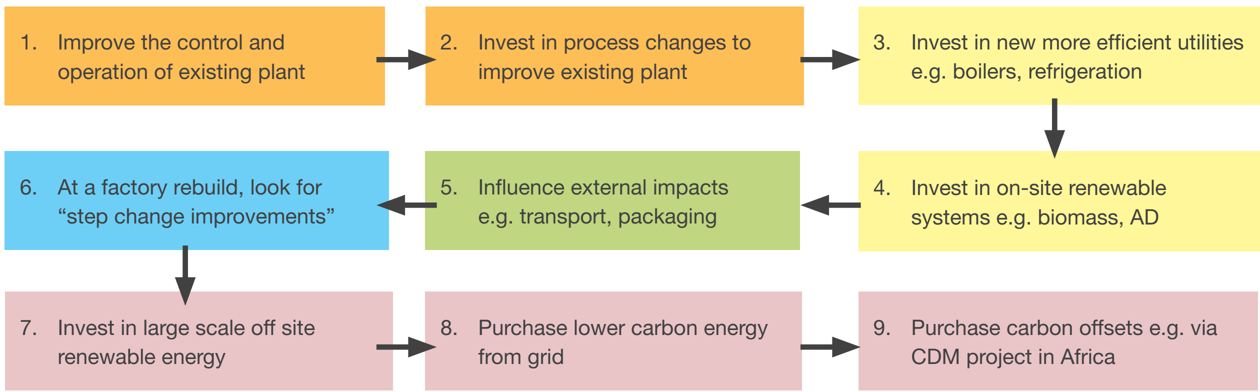
Designing an Effective Programme:

The approach to Carbon Management must be carefully tailored to your own company circumstances. Firstly, you must understand the level of emissions within your organisation and find cost effective ways of reducing them. Then it may be appropriate to look at your external impact, e.g. raw material supplies, packaging and the transport and use of your finished products. The various drivers should be taken into account to develop your business case for a vigorous emission reduction programme.

Step 1	Step 2	Step 3	Step 4	Step 5
Evaluate Business Case	Develop Strategic Objectives	Identify Opportunities	Develop and Implementation Plan	Manage Implementation

Five Step Carbon Management Process

Use the Carbon Reduction Hierarchy: The long term UK Government policy on climate change is now clear: massive cuts in emissions will be required over the next 25 years. These will come from a variety of technologies, some of which are more cost effective than others. The best combination of technologies will be company specific, but the route taken will often be as follows:



Top Tips for Reducing Energy Use and CO_2 Emissions

There are hundreds of cost effective ways to reduce energy consumption in food and drink manufacturing plants – providing both financial benefits and a reduction in CO_2 emissions. Addressing energy efficiency is almost always the most important first step in a Carbon Management programme.

On the next few pages of this guide we provide the 'top 10 tips' related to the major energy using systems in food and drink factories i.e.

- boilers and steam systems
- direct heating systems such as ovens and driers
- refrigeration and cooling systems
- compressed air
- pumps and fans.

Some general rules apply to all energy saving initiatives:

Rule 1: Get a good energy balance for the whole site. This tells you which bits of equipment are using the most energy and helps you focus attention in the areas with greatest potential for saving.

Rule 2: Assess and criticise the process requirements. It is important to understand what the manufacturing process actually needs in terms of energy inputs – this is often much lower than your energy bill because of inherent inefficiencies in the system! For example, if compressed air is used to blow water off of a product you should ask (a) do I need air at all (compressed air is a very expensive 'energy source;), (b) do I need so much air and, (c) do I need air at such a high pressure? In many situations you can reduce the basic requirements for compressed air, steam, cooling etc.

Rule 3: Be ready to challenge historical practices. It is not uncommon to find processes run in an inefficient way because "that is how we have always done it". You should challenge this to try and improve efficiency – don't forget that energy costs 2 or 3 times as much as it did a few years ago, so old rules of thumb may no longer apply.

Rule 4: Look critically at energy distribution systems. After you have minimised process requirements then you should review the way energy is distributed. This might include steam, refrigeration, compressed air etc. If the system is oversized or poorly maintained then the standing losses (e.g. heat loss or leakage) can be very high. Try and avoid 'lowest common denominator' distribution systems where loads with different requirements are lumped together on one system. For example some compressed air users need air at 8 bar and some need only 2 bar. It is very common, and very wasteful, to have a single air systems at, say, 10 bar, so it can serve all loads.

Rule 5: Maximise the efficiency of major utility systems. Having dealt with process loads and distribution then look at the utility plant such as boilers, compressors etc. There are many cost effective measures that can be undertaken to improve the efficiency of these systems.

Rule 6: Try and avoid high base loads. Many electrical devices such as pumps, fans, mixers, lights etc. are either on or off. They use the same amount of energy irrespective of the plant throughput. Careful use of improved controls, especially with variable speed drives, can help reduce consumption of many motor driven systems.

1. Top Tips for Boilers and Steam Systems

Background:

Steam is often the most convenient heat source in food and drink manufacturing and it is used for a wide variety of heating applications. Boilers producing between 2,000 and 20,000 kg/h of steam are very common in the industry, often operating at a pressure of about 10 bar(g). Common uses of steam include water heating and boiling, cooking, drying, evaporation and cleaning processes.

Saving potential:

If an old boiler system is replaced with a state of the art efficient system it is not uncommon to achieve in excess of 25% energy savings. For existing boiler systems it is often possible to save between 10% and 20%.

Top tips:

1. **Minimise the load.** Can the heat load be reduced e.g. by better control, change of operating temperature; process heat recovery; improved process equipment, better insulation. Avoid using steam for space heating as this is usually very inefficient compared to direct fired heating.
2. **Rationalise and improve the distribution network.** Many steam systems lose a lot of heat from over-sized and poorly insulated distribution networks. Ensure the pipe runs are as short as possible and well insulated. Avoid having small heat loads a long way from the boiler house – these might be better on a direct fired local heater. Shut off sections of pipework when not in use. Ensure good condensate trapping and removal. Repair leaking valves, steam traps and flanges.
3. **Avoid over-sized boilers.** Standing losses are very high if the boiler is too big for the job. Have a small boiler available for low load conditions e.g. at night or at weekends.
4. **Fit good burners and burner controls.** Ensure that you are running the boiler as well as possible with good combustion efficiency. Good burners and good control (e.g. with oxygen trim) are essential if this is to be achieved under all load conditions.
5. **Fit heat recovery systems.** An economiser and blowdown heat recovery system can cost effectively improve efficiency, especially for gas boilers.
6. **Use gas rather than oil.** In terms of CO_2 emissions, gas is a far better fuel, so avoid using oil if you have gas available.

Best practice guidance:

Various guides from Carbon Trust including:

- GPG 369 Energy efficient operation of boilers
- GPG 381 Energy efficient boilers and heat distribution systems
- ECG 066 and 067 Steam generation and distribution costs

Support organisations:

Carbon Trust: www.carbontrust.co.uk

Combustion Engineering Association: www.cea.org.uk

2. Top Tips for Direct Fired Process Heating

Background:

Direct heating, usually with gas, is used for applications such as baking ovens, fryers, dryers and water heaters.

Saving potential:

Some older systems such as ovens are quite inefficient. Savings of 20% to 30% can often be achieved on new ovens and savings of 10% to 20% may be possible through improvements to existing systems.

Top tips:

1. **Use direct heating in place of steam where appropriate.** Steam systems can suffer high losses, especially at part load. Direct fired gas heaters can avoid these losses e.g. for water heating and for space heating. Small steam loads at the end of a long steam main should be replaced with gas heaters when this is practical.
2. **Improve the burners on ovens.** Many gas fired baking ovens have numerous burners, often with a very crude design. Improved burners allow much better control of the gas/air mixture leading to significant improvement in combustion efficiency.
3. **Ensure the heater control system is optimised.** Even with good burners some direct fired systems are badly controlled. Ensure temperature settings are as low as possible and that combustion air volume is not too high.
4. **Switch systems of whenever possible.** An advantage of a direct fired system is that standing losses can be avoided when heat is not required. Ensure the system is switched off when there is no process demand.
5. **Use heat recovery to preheat combustion air.** The flue gas temperature of direct fired systems is often quite high. Energy can be saved by fitting heat recovery to re-use some of the flue gas heat to preheat combustion air or, in some circumstances, to heat the product or to heat water.
6. **Use gas rather than oil.** In terms of CO_2 emissions, gas is a far better fuel, so avoid using oil if you have gas available.

Best practice guidance:

Various guides from Carbon Trust including:

- GPG 252 Burners and their controls
- GPG 309 Reducing energy costs in industrial bakeries
- GPG 141 Waste heat recovery in the process industries
- GPG 185 Spray drying

Support organisations:

Carbon Trust: www.carbontrust.co.uk

Combustion Engineering Association: www.cea.org.uk

3. Top Tips for Refrigeration Systems

Background:

Refrigeration systems often represent the largest use of electricity in food and drink factories, for example in breweries, chilled and frozen food factories and chocolate factories. Most refrigeration is used either at 'chill' product temperatures between 1 and 5ºC or at frozen temperatures between -15 and -25ºC. As well as the main compressors, refrigeration plants also use a lot of energy for pumps and fans.

Saving potential:

If an old refrigeration system is replaced with a state of the art efficient system it is not uncommon to achieve in excess of 40% savings. For existing refrigeration systems it is often possible to save between 15% and 25%.

Top tips:

1. **Minimise the load.** It is often possible to significantly reduce the cooling load. Process loads can be reduced by pre-cooling with air or cooling tower water. Auxiliary heat loads can be reduced by better control of pumps, fans and lights. For cold stores the load can be reduced by improved operation of cold store doors.
2. **Minimise the 'temperature lift' of your refrigeration systems.** This is the temperature difference between the evaporating temperature and the condensing temperature. Refrigeration efficiency is very sensitive to temperature lift. A 1ºC drop in lift can save between 2% and 4%. There are many ways of reducing temperature lift e.g. larger heat exchangers, removal of condenser fouling, removal of frost from evaporators etc.
3. **Avoid putting loads of different temperature on the same plant.** It is common to use a single coolant to serve many loads. Whilst this is convenient it can lead to major inefficiencies because the warmer load is being cooled at a much lower temperature than necessary.
4. **Minimise any head pressure control settings.** Most plants have a minimum condensing pressure setting to avoid certain types of problem that can occur during cool ambient conditions. This setting is often much too high – in winter time this means that a refrigeration plant can use as much energy as in summer. This very wasteful. Floating head pressure allows much more efficient operation in winter.
5. **Pumps and fans are very costly.** Pumps used to circulate secondary refrigerant (e.g. chilled water or glycol) and fans used to circulate cold air are paid for twice – once to run the device and again to remove the heat they create. Good fan and pump control using variable speed drives is usually very cost effective.

Best practice guidance:

Various guides from Carbon Trust including:

- GPGs 277, 278, 279, 280 and 283
- Outputs from FDF Refrigeration Efficiency Networks project including Guides on Purchasing Efficient Plant, Operational Efficiency Improvements, R22 phase out and the F Gas Regulation (from www.fdf.org.uk).

Support organisations:

Carbon Trust: www.carbontrust.co.uk

Institute of Refrigeration: www.ior.org.uk

F-Gas Support: www.defra.gov.uk/fgas

4. Top Tips for Compressed Air Systems

Background:

Compressed air is used for a range of activities such as control (e.g. valve actuation), conveying and dewatering (usually using devices such as 'air knives'). Many food factories have a single air distribution system operating at about 10 bar(g) that serves numerous loads throughout the factory.

Saving potential:

It should be recognised that compressed air is an extremely expensive form of energy and should be avoided wherever possible. In many cases air operated devices can be replaced by alternative systems. This could lead to savings in excess of 50%. Where air is still required, investments in existing systems can often save in excess of 20%.

Top tips:

Avoid using compressed air. Always ensure that air is the only option before you use it. In many cases air operated devices are used because "we have always used air". Valve actuators can often be operated electrically instead of pneumatically. Mechanical conveyors use much less energy than pneumatic conveyors. Mechanical shaking screens can be used for dewatering instead of jets of compressed air.

Avoid running loads with different pressure levels on the same system. Some loads need high pressure air (e.g. valve actuators may need 8 bar(g). Other loads such as conveyors need high volumes of low pressure air, say at 2 bar(g). If these are run on the same system all the air must be compressed to a high pressure. Use a local low pressure blower for the conveyor.

Rationalise and improve the distribution network. Leakage from compressed air systems is notoriously high. It is not uncommon for leaks to represent 50% of the load! Invest in a good quality distribution system that does not suffer from leaks. Avoid unnecessarily long pipe runs. Use timer operated valves to isolate any parts of the system in a factory area that is not operating all the time – then you prevent leaks out of normal operating hours.

Control the compressors for high efficiency. The quantity of air needed can vary enormously over the course of a day. It is important that the compressed air system is designed to operate efficiently at both high and low load levels. This may require compressors of different sizes to be properly sequenced.

Best practice guidance:

Various guides from Carbon Trust including:

- GPG 385 Energy efficient compressed air systems
- GPG 238 Heat recovery from Air Compressors
- ECG 40, 41 and 42 Compressing Air Costs

Support organisations:

Carbon Trust: www.carbontrust.co.uk

British Compressed Air Society: www.bcas.org.uk

5. Top Tips for Other Electrical Loads Including Pumps and Fans

Background:

There are numerous other electrical devices in food and drink factories including pumps, fans, mixers, lighting, specialist process machinery, packaging equipment etc.

Saving potential:

Improved operation and control of electrical systems can often save between 10% and 20% energy.

Top tips:

1. **First, look at systems moving fluids.** Moving fluids is often done very inefficiently. This includes refrigerants and compressed air – already dealt with in sections 3 and 4 of this guide. It also includes pumping of liquids and movement of low pressure air with fans e.g. ventilation systems, air extracts, evaporator fans etc. In almost all cases it is possible to (a) use a more efficient primary device (e.g. a better fan) and (b) apply variable speed control to improve part load performance.
2. **Pump and fan power influenced by a 'cube law'.** For most fan and pump systems the power consumed is proportional to the cube of the flow rate. By reducing flow a small amount from, say, 100% to 80% you will reduce power by 50%. Many fan and pump systems are designed 'conservatively' and are oversized for the application. A variable speed drive used to reduce flow a small amount will reduce power consumption significantly.
3. **Lighting systems can be improved.** There are many new types of light source that are much more efficient than those available 20 years ago. Light fittings can be improved to deliver more useful light. Light control systems can reduce power consumption when lower light levels will suffice. Good building design can maximise the use of natural daylight.
4. **Electricity metering is cheap – monitor performance.** Electrical devices are the easiest and cheapest to monitor accurately. All large drives should be fitted with a kWh meter so you can monitor and optimise performance.

Best practice guidance:

Various guides from Carbon Trust including:

- GPG 344 Variable speed driven pumps best practice guide
- GPG 383 Energy savings in fans and fan systems
- GPG 00_2 Guidance notes for reducing energy consumption of electric motors and drives

Support organisations:

Carbon Trust: www.carbontrust.co.uk

6. Top Tips for Energy Metering and Monitoring & Targeting

Background:

It is surprising how little energy sub-metering is fitted in food and drink factories. Without good sub-metering it is impossible to get the best performance out of a plant and to ensure that good performance is maintained over a long period of time. A monitoring and targeting (M&T) system makes use of metered data to help you improve performance. Some form of M&T should be used at all factories.

Saving potential:

A good metering system backed up by M&T can often save up to 10% energy through the identification of improved operation and maintenance .

Top tips:

1. **Fit sufficient meters.** Ensure that large plant items and systems are metered. Electricity is easy and cheap to meter – a rule of thumb is that it is worth metering any load that uses more than £10,000 of electricity. Steam flow is more expensive to meter, but should be measured leaving the boiler house and at large individual loads. Each boiler should have a gas meter and water meters are often a useful indication of heat requirements.
2. **Decide how and when to gather data.** It is vital to collect meter readings at regular intervals. Consider whether it is worth investing in automatic data collection – this will give you data easily at short logging intervals, but it is a large first cost. A manual system based on weekly logging is often a practical and effective starting point if the cost of automatic data collection is too high. A system based on monthly data collection is not good enough!
3. **Ensure you collect production data and other relevant information.** An M&T system is most effective when you compare energy use to 'influencing variables'. The most important of these are production figures from appropriate parts of your factory. Other important influencing variables include the weather (especially for factories with a lot of refrigeration), water usage (especially for cleaning systems) and the hours of operation. Production data is often most easily available on a weekly basis – which is why weekly energy data is so important.
4. **Carry out 'campaigns' into different factory systems.** The amount of data available from a good metering system can be a bit daunting. It is helpful to concentrate on small areas of the factory at a time, using the available data to understand best performance and to set targets for future operation.

Best practice guidance:

Various guides from Carbon Trust including:

- GPG 112 Monitoring and targeting in large companies
- GPG 125 Monitoring and targeting in small and medium sized companies
- GPG 215 Saving energy in industry with modern controls

Support organisations:

Carbon Trust: www.carbontrust.co.uk

Low Carbon Energy Supply Options

The 'Top Tips' sections of previous pages of this guide explain ways of reducing CO_2 emissions through better energy efficiency. This is usually the most cost effective first step in a carbon management programme. Once these opportunities have been dealt with the next step is to consider low carbon energy supply options. Conventional energy supplies are based on fossil fuels – these create CO_2 emissions. Alternative options can deliver heat and electricity with a low or zero CO_2 emission. In this section we discuss various alternative options that may be applicable to food and drink factories.

Biomass

Biomass is any recently grown vegetable material including wastes from crop production, forestry waste and specially grown woody materials. As these have absorbed CO_2 from the atmosphere during growth they are treated as 'zero carbon fuels'.

Waste

Waste materials from each stage in the food chain e.g. agricultural waste, factory derived food waste, packaging, biodegradable domestic waste etc. are also considered as renewable and therefore classified as zero carbon fuel sources.

Generating Heat and Electricity from Biomass and Waste

In some cases food and drink companies have easy access to biomass and waste streams (e.g. you produce the waste in your own factory or your suppliers produce waste. Biomass and waste materials can be used to produce zero carbon energy. There are 2 basic options:

a. A biomass or waste burning system that can be used to produce heat or both heat and electricity.

b. An anaerobic digestion system that decomposes biomass or waste to form methane gas which is then burnt to produce heat or both heat and electricity.

This type of equipment is much more expensive to install than conventional gas fired boilers, but once it is built you have a zero carbon energy stream and you might have a low cost fuel source. Also you might make a saving on effluent treatment or waste disposal. On site biomass and waste systems can be amongst the most cost effective renewable energy options.

Combined Heat and Power (CHP)

At a conventional power station only about 35% of the energy content of the fuel ends up as electricity reaching a customer – the rest is lost as heat rejected in the power station cooling towers or as losses in the electricity distribution network. These losses can be avoided by building a CHP system.

A CHP plant consists of an electricity generator with a waste heat recovery system that supplies heat to the factory at which the CHP plant is located. The generator is usually one of 2 types:

a. A gas turbine – typically used for installations above 1 MW of electricity, although micro-turbines are available (50kW to 1MW). The gas turbine exhaust is used to raise steam or, in some cases, is directly used to supply heat to drying equipment.

b. A reciprocating engine – typically used for installations from 100kW through to 10MW. Most systems of this type produce heat in two forms – hot water from the water cooling system of the engine plus steam that is recovered from the exhaust of the engine.

The choice between gas turbines and reciprocating engines is partly based on size and also on the 'heat to power ratio' of the factory. For most efficient operation it is vital to make use of all the waste heat from a CHP system. Gas turbines generally have a heat to power ratio of about 2. This means that for each MW of electricity produced there is 2 MW of heat. A reciprocating engine CHP system has a heat to power ratio of about 1 – which implies it is better suited to sites with a relatively small heat demand. A key factor affecting the economics of CHP systems is the heat demand profile. Whilst any excess electricity can be exported to the grid, any excess heat must be thrown away. For this reason CHP systems are usually designed for the "base load" heat demand. It also means that CHP is likely to be most cost effective at factories with long hours of operation (preferably 24 hours per day) and with a steady base load heat demand. If there is a chilled water or refrigeration load on site and excess heat is available from a CHP plant, this can be utilised in an absorption chiller.

CHP systems are not usually 'zero carbon'. They can be if they use a waste or biomass fuel source, but in most cases CHP systems are run on natural gas which is a fossil fuel that emits CO_2. Because the losses of conventional power stations are avoided the electricity and heat produced by CHP systems has a significantly lower CO_2 content compared to conventional boilers plus grid electricity. CHP plants are relatively expensive to build but, when sized correctly, will have lower fuel costs than conventional systems.

Wind Power

Wind energy is a very cost effective option if built on a large scale. Modern wind turbines in the 250kW to 3 MW range can produce cheap electricity providing there is sufficient wind at the selected location. If you have available land in an area where (a) there is a good wind velocity profile and (b) you can get planning permission for a medium to large wind turbine then this could be an interesting option.

Smaller wind turbines are often less cost effective. There application is often to combine carbon reduction with engagement, as the turbine provides a visual statement of intent to reduce carbon emissions. This is especially true for turbines in the sub-100 kW range.

Getting Support and Further Information

Organisation	Web site	Comments
Carbon Trust	www.carbontrust.org.uk	Wide range of support on all energy and carbon management issues including funding for detailed studies and numerous technical support publications.
Combustion Engineering Association	www.cea.org.uk	Trade association able to provide information about boilers, steam systems and direct combustion systems.
Institute of Refrigeration	www.ior.org.uk	Professional body for refrigeration engineers. Can provide advice on many aspects of refrigeration system efficiency.
F-Gas Support	www.defra.gov.uk/fgas	Defra funded body providing advice about F Gas and Ozone Regulations. For food companies can provide useful help on R22 phase out and how to comply with the new F Gas Regulation .
WRAP (Waste & Resources Action Programme)	www.wrap.org.uk	WRAP helps individuals, businesses and local authorities to reduce waste and recycle more, making better use of resources and helping to tackle climate change.
Envirowise	www.envirowise.gov.uk	Envirowise offers UK businesses free, independent, confidential advice and support on practical ways to increase profits, minimise waste and reduce environmental impact.
British Compressed Air Society	www.bcas.org.uk	BCAS is a trade association that can provide helpful information on efficient compressed air systems.

Food and Drink Federation

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