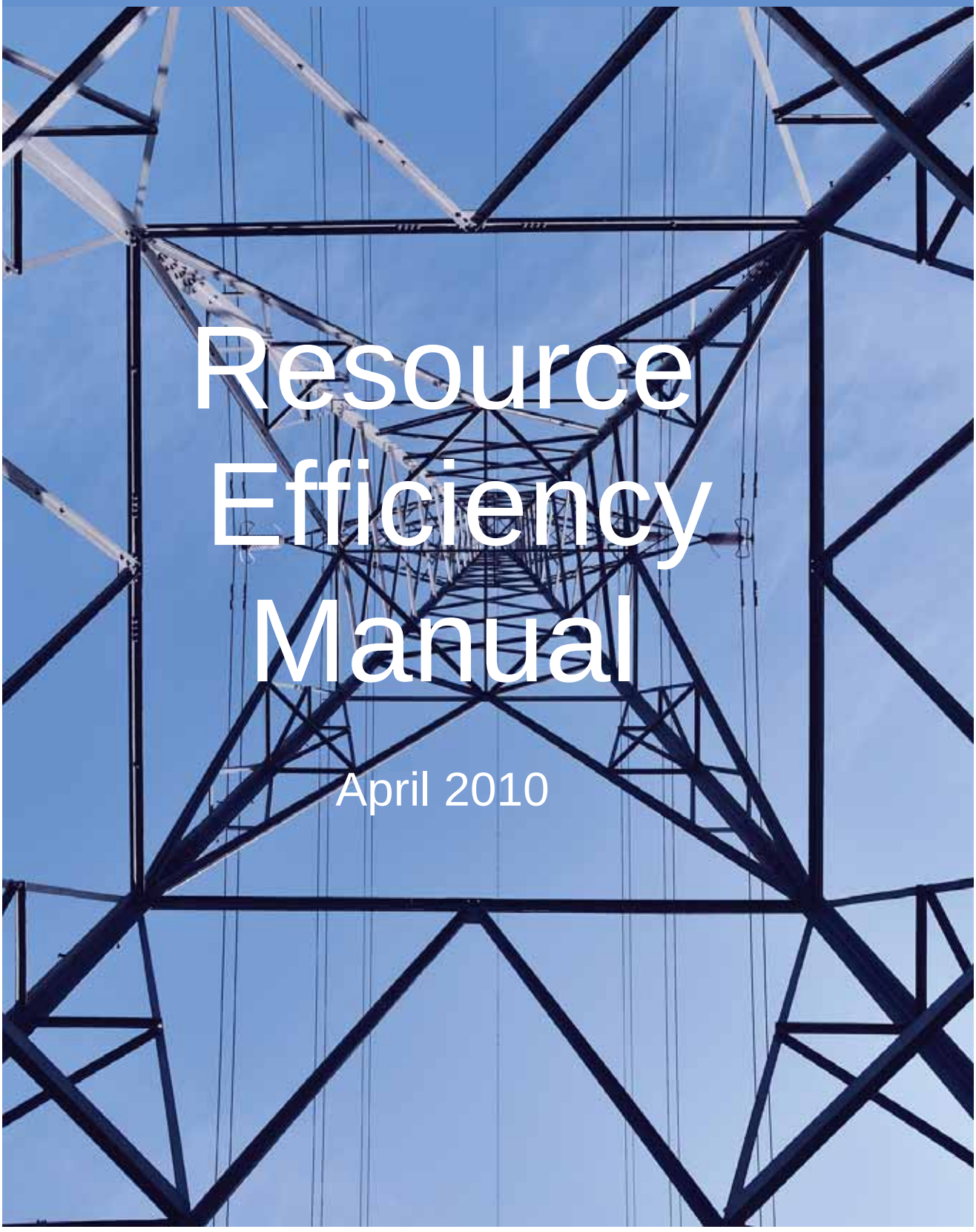
ENWORKS



Resource Efficiency Manual

April 2010

Contents

Module 1 – Energy

This module introduces methods and cost saving options when using energy on site. It attempts to address several key issues in energy management. Namely:

- How to ensure the best energy prices are obtained.
- How to monitor energy on site.
- How to control energy use.
- The options available for energy reduction.

1.1 Learning objectives

As a result of this module, delegates should:

- Understand the billing of energy and be aware of purchasing options.
- Be able to monitor energy use and wastages in order to understand how energy is used on their site.
- Be familiar with cost reduction options such as maintenance/housekeeping, controls and other specific energy saving areas.

1.2 Why focus on energy?

All companies use some form of energy whether gas, electricity or fuel. Therefore, energy often forms one of the key costs for companies. According to information from the Carbon Trust, most businesses can reduce their energy bills by 20%. £12 billion of energy is wasted in the UK every year.

1.3 Energy billing and purchasing

1.3.1 Energy purchase

Various factors influence energy costs incurred by end-users:

The energy competitive market

The electricity and gas markets in the U.K. have been deregulated since 1998. This means that any company can buy its gas and electricity from the supplier of its choice and tender for the most

competitive prices. The deregulation of the market should progressively apply to the whole of the European Union, offering an even greater choice of suppliers. At the same time, the broadening of energy supply to a vast market may impact on energy prices nationally. For instance, gas prices rose in the U.K. in 2000 due to the opening of a new gas line between the U.K. and Continental Europe, where gas prices were higher.

The energy suppliers' costs

Electricity suppliers have to cover major costs of power supply, i.e. generation, transmission, distribution and supply. Gas suppliers must recover costs in terms of production, transportation and supply.

Electricity generation from renewable sources, such as wind farms, is generally more expensive than electricity produced from fossil fuel, as some renewable sources are still at a development stage and have a limited capacity.

The Government's policy

The climate change levy was introduced on 1 April 2001 to tax all energy use from non-renewable sources. The introduction of Feed-In-Tariffs from April 2010 and the Renewable Heat Incentive from April 2011, mean that microgeneration of electricity and heat at business premises is becoming much more cost effective.

The energy user profile

Prices will also vary depending on:

- How much energy your company uses.
- How well energy is used. For example, this considers the energy users' requirements and their ability to use energy off peak.
- For how long the energy supply is required.

Although energy users cannot always control all the factors influencing energy costs, checking that current energy purchase is in line with the company's consumption and ensuring energy contract negotiation takes place at the end of each contract is the first step in ensuring the lowest energy prices.

Before you decide to negotiate your energy contracts and possibly change suppliers, it is recommended that you ensure control over your current energy supply.

Read your energy meters and ensure that actual consumption figures are provided to the energy suppliers. Using estimates can lead to your company being grossly under or over-charged for its energy use.

Check your energy bills for accuracy. Energy suppliers do make mistakes in their invoices, which could lead to over-charges or retrospective charges.

1.4 Energy contract negotiation

In order to successfully negotiate your energy contract, you will need to know your actual energy usage pattern and competitively tender for the best prices. When preparing to tender for a new contract, make sure you have enough time to:

- Gather energy data about your company.
- Send requests for quotes and analyse replies. Most energy suppliers will take between 1 to 3 weeks to send you a quotation back.
- Ensure that formal notice of termination of the current contract is given in good time. This can be between one to three months typically. It is important that you check existing contract terms.

Electricity

When tendering for your electricity contract, you will need to gather the following data:

- Company name and full site address (including postcode).
- Current supplier name.
- Meter reference number.
    - MPAN number – for sites with an electrical load below 100 kW. This is your Metering Point Administration Number, also referred to as the Supply Number. It is a unique site reference number, which gives the electricity suppliers access to the Public Electricity Supplier Registration System (PRS). This system is a database operated by the electricity suppliers, supporting data collection and aggregation for managing the competitive market.

<table>
<tr><td rowspan="2">S</td><td>08</td><td>123</td><td>456</td></tr>
<tr><td>23</td><td>6789</td><td>0123</td><td>456</td></tr>
</table>

    - Code 5-meter number – for sites with an electrical load between 100 kW and 1MW.

- Code 3-meter number – for sites with an electrical load of over 1 MW.

- Current tariff – this is your pre-published charge schedule. It is available to all sites consuming less than 10 MW. The tariffs offered will reflect the electricity purchase costs associated with the company's profile such as peak/off-peak/weekend operation, maximum demand and power factor. Therefore, it is important that a company intending to negotiate a new contract monitors its electricity consumption closely, to ensure it can obtain the most appropriate profile and tariff. See section 1.2.3. for further details on tariff components.

- Annual consumption, split into night and day consumptions if appropriate.

Gas

When tendering for your gas contract, you will need to gather the following data:

- Company name and full site address (including postcode).
- The 'M' identification number – this is a unique number allocated by Transco to meter points. It enables the identification and verification of meter data in Transco central database.
- Annual consumption.

Recommendations

- If you anticipate changes in your energy consumption patterns, whether in terms of quantity or time of use, past data may not be adequate to negotiate the best tariffs. You should then try to estimate future consumption and likely patterns of use, before requesting quotations.

- Beware of contract lengths and termination clauses. With gas, the longer the contract, the cheaper the price, however, some contracts may be difficult to terminate or re-negotiate and you may have to stick to a high price for a long time, while market prices go down.

- Beware of which months are covered by the 18-month contracts. With an 18-month contract period, you will either have 2 summers or 2 winters included. You should decide whether this is working to your advantage. This will depend on when you are likely to use more energy. It could be winter, because of heating requirements. You could also have a production profile that varies with seasonal patterns; for example, summer months may be the busiest.

1.4.1 Understanding electricity tariffs

Electricity tariffs consist of various charges, which reflect the different features of the electricity supply. It is essential to understand those charges in order to identify the best tariff for your company and to be able to control related costs.

Electricity tariffs include all or some of the following components:

- *Time of day tariffs*. These reflect the variation of energy demand with the time of supply. They are usually split between day and night tariffs and expressed in p/kWh (pence per kilowatt hour) or p/unit (pence per unit).

If you use more than 15% of total electricity usage in the off-peak period, you should consider a day/night tariff.

The night rate usually applies for a period of 7 consecutive hours, from midnight to 7 am for instance. The day rate applies for the remaining 17 hours.

- *Maximum demand*. This is the maximum rate of consumption of electricity or highest instantaneous demand recorded at a site. It is measured in kW or kVA (kilovolt amperes). A maximum demand charge will be incurred usually in winter months (typically November to February), reflecting the higher costs of providing power then.

Example:

A company with a maximum demand of 95 kW.

Maximum demand charge:

- £4.94/kW/month from November until February (inclusive).

The company will incur a maximum demand cost of £469.30 per month or £1,877.20 per year.

- *Availability*. This is also referred to as “supply capacity” or “authorised maximum demand”. It is the reservation of “space” for maximum demand requirements and is measured in kVA. The availability should be agreed in advance with the electricity supplier. It might be reviewed, however, to reflect the actual maximum demand recorded for any month in the previous 12 month period. Typically, availability should be set no higher than 10% above maximum demand.

Example:

A company with an availability of 275 kVA.

The availability charge is £1.180/kVA or £324.5/month.

The company will incur an annual availability charge of £3,894.

- *Power factor*. This measures the ratio of kW and kVA maximum demands, and reflects the ability of a company to convert the energy supplied into useful electricity. The power factor is a key indicator of how efficient your company is at using electricity. It appears, on the bill, as a number between 0 and 1 or a percentage between 0% and 100%. If a company is using its electricity efficiently then the number will be close to 1 or 100%. Low power factors can be corrected with capacitors.

- *Reactive power*. This is the element of the energy supplied that is not used by the company and is directly related to the power factor. Reactive power charges are a penalty for having a low power factor.

Electricity tariffs can be very complicated, with different rates applying at different times of the day and year. It is crucial that you get clear information from your electricity supplier regarding tariff structures.

1.5 Monitoring

Once you have ensured that your company benefits from the best energy prices, it is necessary to monitor energy data in order to understand where and how energy is used, how much it is really costing and where cost savings can be made. This will also help to ensure that low energy prices can be maintained or re-negotiated.

Monitoring should gather useful data in order to get a better understanding of energy use and facilitate decision-making on energy issues.

The collection of data can be overwhelming and it is important that you decide what should be monitored before starting any monitoring process. Monitoring should focus on the highest costs. If your company uses very little gas, it is not appropriate to spend time monitoring gas use in any great detail. On the other hand, intensive energy users may want to consider sub-metering devices in order to reach a greater degree of accuracy and detail in the analysis of their energy use. The level of monitoring and the data monitored must be appropriate and effective for your company.

A critical feature of monitoring is to understand what drives energy consumption. This can be roughly split into three categories – hours, production and weather. Guidance on energy monitoring against those three variables is detailed below.

Monitoring over time

The simplest method is to monitor the company utility invoices over time to identify consumption patterns and any possible anomalies.

Figure 1 shows an example of gas consumption monitoring on a monthly basis. The data is obtained from monthly invoices.

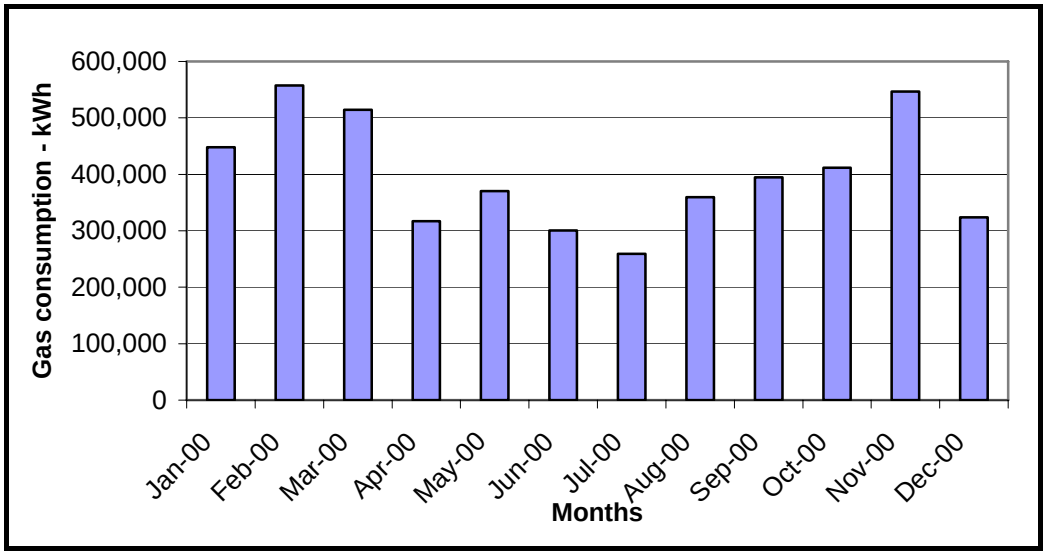


Figure 1. Monitoring of monthly gas consumption over time

Monitoring consumption over time offers a first opportunity to identify possible energy issues and can also be used as a basis to forecast future gas consumption. However, data interpretation remains limited, as the data cannot be related to other variables at this stage.

Figure 2 shows the same gas data as in Figure 1, but represented in comparison with gas data for 1999.

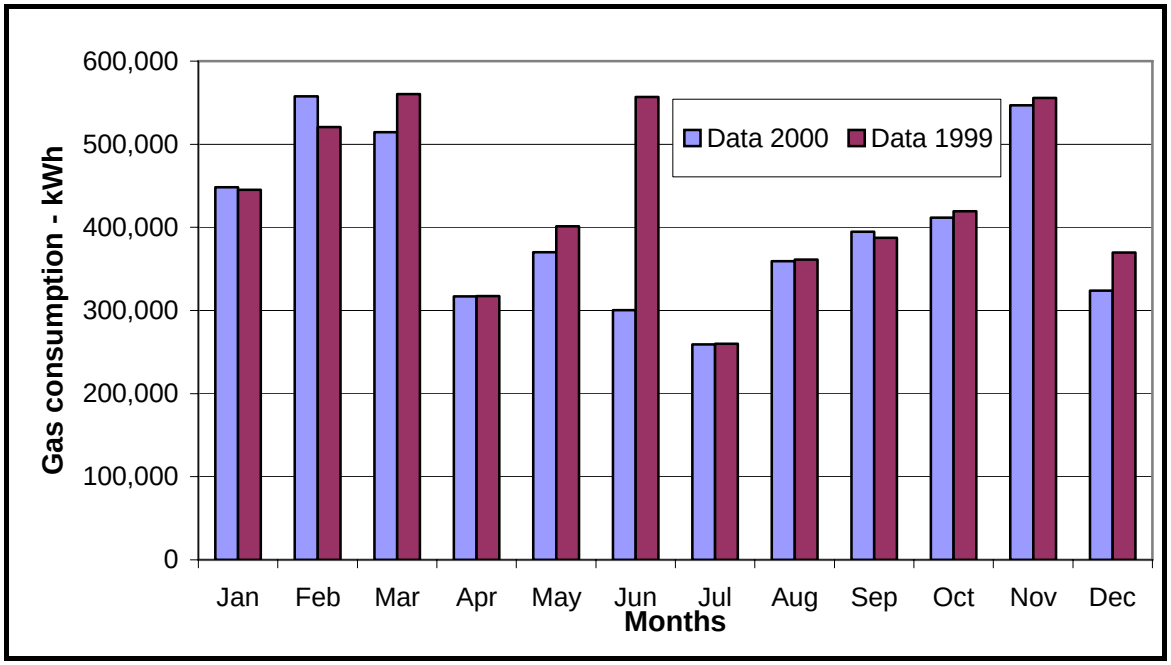


Figure 2. Monitoring of gas consumption in comparison with previous use

The above figure shows that there was little variation in gas consumption from 1999 to 2000, except for the month of June, where gas use was much higher in 1999 than in 2000. This graph shows how energy use varies from one year to another. This type of monitoring may highlight potential anomalies such as the difference in consumption in June. However, more data would be required to understand clearly why there was such a change in energy consumption in June.

Monitoring over time can equally be applied to electricity use or any other form of energy.

Half hour data

Companies with an electricity consumption of over 100 kW have access to half hourly profiles of their electricity use. This data is provided by the electricity company free of charge and can be requested on disk or via email.

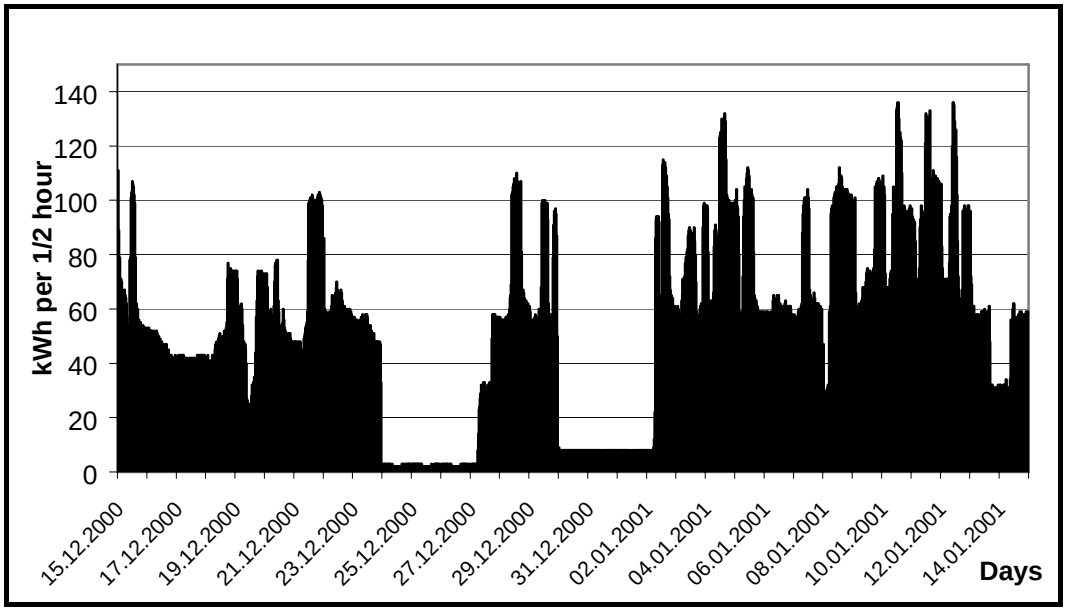


Figure 3. Half-hourly electricity profile over one month

Figure 3 represents half-hourly electricity use over one month. The graph enables checks on electricity consumption against operational times. This may help to check that there is no electricity use at weekends, or over periods when the factory does not operate, Christmas and New Year breaks for instance.

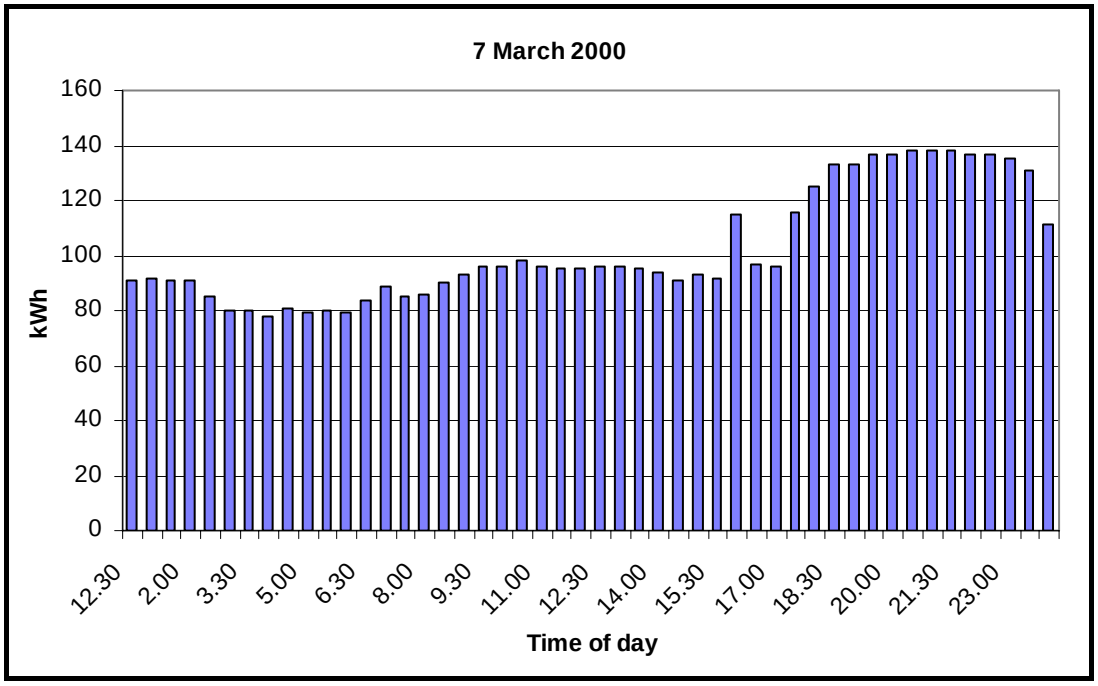


Figure 4. Half-hourly data over one day

Figure 4 shows another representation of half-hourly data over just one day. The figure shows that over a particular day, the company constantly uses above 70 kWh every half hour.

Analysis of half-hourly data can also help determine when night rates should apply to the best advantage of the company. Figure 4 shows for instance that there is high electricity consumption between 18.30 and midnight. If this is a regular pattern, it is in the company's interest to try and negotiate a night tariff covering this period, this may not always be granted by the electricity supplier.

Energy monitoring over time can be used to:

- Ensure your company is on the best tariff – including day and night rates, maximum demand and availability charges.
- Identify possible anomalies.
- Anticipate future energy requirements and budget energy costs.

1.5.1 Energy monitoring against production

To take energy monitoring a step further production records are required.

Such monitoring will help the company in determining:

- The amount of energy use per product output. This information can then be used as a performance indicator for benchmarking purposes.

- The amount of energy not linked to production. This is the non-productive element of energy expenditure, which is used by operations such as equipment start-up, warm-up and running losses, lighting and space heating.

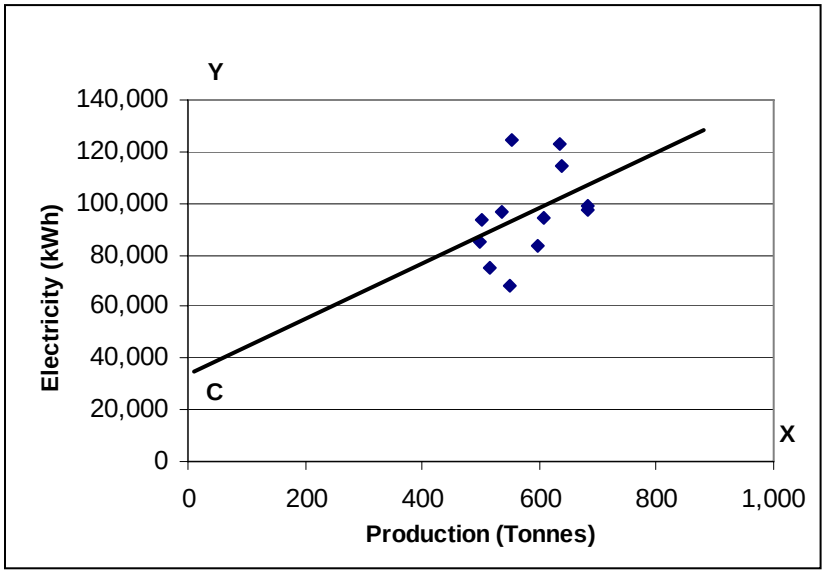


Figure 5. Example of electricity consumption versus production output

Figure 5 takes electrical consumption data, but this time compares monthly consumption against production output, measured in tonnes. By plotting a best-fit line through all of the points plotted on figure 5, it is possible to create a benchmark line by which to compare subsequent monthly figures.

The equation for the best fit line is Y = M X + C, where:

- Y = Amount of electricity (kWh/month).
- X = Production output (tonnes/month).
- C = Energy that would be required if production was reduced to zero.
- M = Amount of energy required to process each additional unit of production.

In the case of Figure 5, the equation of the line is:

- Y = 96,155 kWh/month (on average).
- X = 583 tonnes/month (on average).
- C = 33602 kWh.
- Therefore M = 107.3 kWh/tonne.
- The scatter of the points away from the best-fit line indicates the variation in energy per unit of production.
- From this chart it is also possible to calculate the proportion of energy that does not relate to production by dividing the energy that is unrelated to production (C) by the average monthly energy usage.

Therefore, the proportion of energy not related to production is:

$$\frac{33602\ \text{kWh}}{96155\ \text{kWh}} * 100\% = 35\%$$

35% of the electrical energy consumed by the company each month is not directly related to production. This is a figure in excess of £15,000/annum or £1,300/month for a business with an annual electricity bill of about £45,000.

Recommendations

- Use data on energy per output as a performance indicator. Monitor variation over time. Can you identify best practice?

- Tackle the non-productive component of electrical expenditure.

1.5.2 Degree day analysis

A degree day (°D) is a quantitative index of variations in outside temperatures to enable building designers and users to relate a building's energy consumption to the weather, and allow energy saving measures within the building to be monitored.

In some buildings heating can account for a large proportion of the fuel bill but consumption varies widely with the seasons. Variations in weather can make it difficult to make accurate monthly comparisons. The degree day method enables allowances to be made for variations in ambient temperature. Degree day calculations are also useful for exposing abnormal seasonal patterns of consumption.

- The base temperature used to calculate degree days in the UK is 15.5^{o}C. This is the temperature at which most UK buildings can heat themselves without the need for supplementary heating, due to solar heating of the building fabric, body heat of occupants, heat from equipment such as computers, etc.

- Degree days are defined as the difference between this baseline and the actual outdoor temperature, multiplied by the number of days. The larger the monthly figure, the colder the month, and the greater the need for space heating. Degree days are measured in 18 locations across the UK (see the Government's Action Energy website for details).

- Typically, the relationship between fuel for heating and the number of degree days is a linear one, as shown in Figure 6, which plots gas consumption for 1999 against degree days. Any deviations should be investigated.

- Targets for improvement can then be set using these revised charts as benchmarking diagrams.

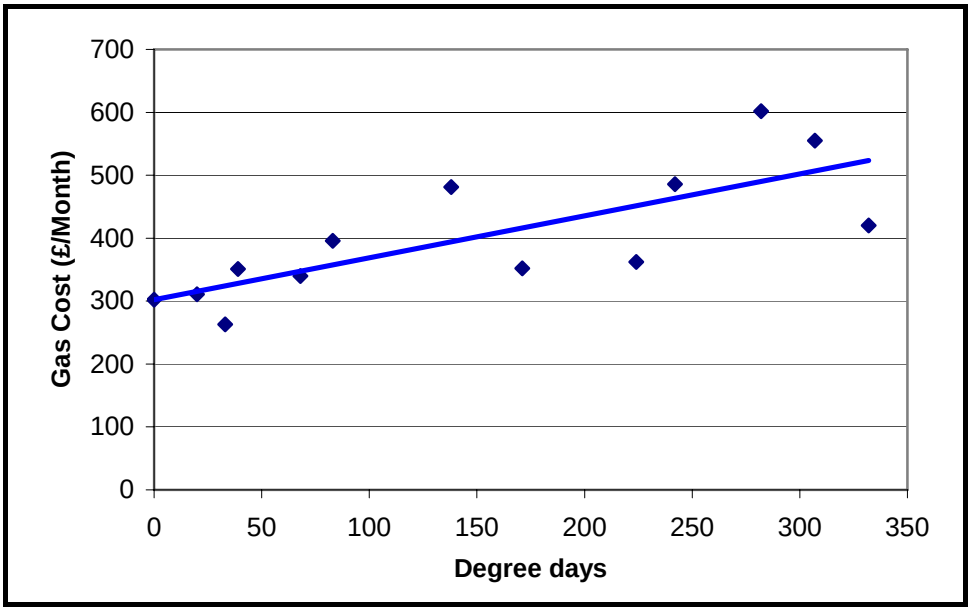


Figure 6. Example of degree days (1999)

1.6 Specific areas for energy reduction

There are numerous publications providing detailed information on specific areas of energy use, as well as advice available – see the reference list at the end of this section and section 6 on 'Services and Support'. Listed below are a few key areas to consider when implementing energy saving initiatives.

1.6.1 Low and no cost solutions

Awareness raising

Make people responsible

You will need to make everybody aware of energy use in your company and make people responsible. The Resource Efficiency Management Manual provides more information about raising awareness and resources that are available to help you.

Tackle myths

There will be barriers to overcome in order to get everybody interested in saving energy. One type of barrier is the existence of myths on energy use.

- *"Leaving the lights on is more economical than switching them off".*

Old fluorescent tubes used a lot of energy when being switched on, but modern fluorescent tubes (for the past 20 years!) do not have this problem and should be switched off when not in use. A modern fluorescent tube uses over 500 times more energy if left on for 15 minutes than the energy needed to switch it off and on again. The energy cost saved by switching off the lights recovers the cost associated with the shortening of the lamp life within a few minutes. Therefore, it is always cost effective to switch lights off.

- *"Leaving equipment such as compressors, machine tools and other motors on is more economical than switching them on and off all the time".*

The starting current for an induction motor can be six or seven times the normal full load current. However, motors left on when no actual work is being done can still use up to 50% of the full load current. Equipment monitoring will help to assess exactly how much energy is used at start-up and when idling. This will help to establish motor starting and switching off options. *More information on motors is given below and in the Action Energy Good Practice Programme Guide 2 ("Energy Savings with Electric Motors and Drives").*

- *"Office equipment such as computers use hardly any electricity".*

Leaving a PC and its peripherals to run all night and at weekends can increase its energy use by 300%. A typical PC left on 24 hours per day can use at least £60 of energy per year. Turned off at night and weekends the same unit will only use £15 of energy per year. Although office equipment may not be your most intensive energy equipment on site, cost savings can be made by ensuring equipment is switched off when not in use.

Case Study 1

Energy efficiency

Wild Manufacturing are a presswork company employing 180 people. Energy was key cost to the company and also their main environmental impact. They set up an Energy Team who started a monitoring programme to gather useful data. A reduction target of '10% of utilities in the first' was set.

To meet this target they first initiated an awareness raising campaign, focusing on common sense housekeeping issues. They started a check and repair procedure for the compressors, fitted light sensors to areas that were not used continuously.

They then focused attention on drafts and sealed all gaps around windows and doors. Traffic doors were kept shut as much as possible. To maintain commitment and staff awareness consumption data was published on a regular basis.

Achievements in the first year:

- Electricity costs were reduced by 13%
- The cost of gas was reduced by 7%
- Throughout the organisation staff awareness of resource efficiency issues was greatly improved. This has helped the company to make year on year savings.

Good housekeeping

Look for unnecessary and poorly controlled energy use. Auditing techniques such as walk rounds will help to identify unnecessary energy uses. Good housekeeping will help to tackle basic energy wastages.

Create a checklist

Creating a checklist of critical equipment and controls to check on a regular basis will help to make individuals responsible about energy use.

Examples of checklists include:

- Space and water heating checks – looking at room and hot water temperatures, time switches and thermostat settings.

- End of day/shift checks – an employee should make checks on equipment and lighting and ensure everything has been turned off when no longer needed.

Establish a maintenance programme

Maintenance is needed to keep equipment in an good condition, but must be cost effective. While breakdown of machinery may result in costly losses in production, it must also be borne in mind that stopping machinery for maintenance can also cause a loss of production.

When establishing a maintenance programme, the company should decide what equipment requires more attention and at what frequency. A logbook on breakdowns will help identify the machinery that is most critical to the company's operations. In some cases, it may not be practical or economical to include some equipment in a scheduled routine, although safety inspections will still need to be carried out.

The use of a computer-supported database may help in setting up a record system and scheduling maintenance programmes.

The maintenance programme should also be used to decide where it is practical and cost effective to upgrade to more energy efficient equipment. For instance, lighting can be changed to high efficiency lighting; motors can be upgraded to higher efficiency motors. Improvements must be considered on a case-by-case basis.

1.6.2 Equipment controls

All equipment, which uses energy, should be controlled. Controls have two basic functions, switching equipment between on and off and varying equipment performance, such as speed or heating levels. Controls should ensure that outputs such as lighting, heating and motive power are provided in the right amount, in the right place and for the required time.

Controls do not have to be new or sophisticated to work, but somebody must know how they operate and be responsible for checking that they are used adequately. It is recommended that switches be well positioned when installed, and labelled.

There are a variety of control devices available and only some of the most common are listed below.

Heating controls

Heating systems can benefit from the following controls:

- Time controls such as time switches or optimisers.

- Temperature controls such as compensators, room temperature thermostats and thermostatic radiator valves.
- Heating source controls such as boiler firing controls and boiler sequence controls.

Heating controls can be as sophisticated as a 7-day electronic time switch permitting different settings for each day, ensuring that the heating can be controlled to cover different daily schedules. Some devices can also divide the heating system into zones, with time and temperature controls ensuring that heat is provided when and where it is needed. *Fuel Efficiency Booklet 10 on "Controls and Energy Savings", produced by Action Energy provides more details on heating system controls and building energy management systems.*

Lighting controls

When considering lighting control arrangements, you should ensure that occupancy patterns and behaviours are well understood.

The types of lighting controls available include:

- Time controls such as time delay.
- Occupancy controls such as infrared sensors.
- Daylight controls such as photocells.

Variable Speed Drives (VSDs)

An inverter or variable speed drive (VSD) are two of the names given to a piece of equipment which controls the speed at which an induction motor runs.

VSD's should be considered whenever it is necessary to change the speed of a standard three-phase motor during operation. By slowing down the motors, VSD's allow for a reduction in energy consumption.

One of the main uses for VSD's is for the control of pumps and fans, in order to regulate air or liquid flows.

More information on VSD's is available in the Action Energy Good Practice Guide 2: Energy Savings with Electric Motors and Drives (see Appendix).

1.6.3 Motors

Motors are major energy users, consuming an estimated two-thirds of electrical energy used by industry. Even modest efficiency gains can therefore deliver substantial savings.

It is recommended that you generate an inventory of the motors used by your company. The inventory should include the sizes and main uses of the motors. As with all areas of resource efficiency, efforts must be focused on the most wasteful areas and it is recommended that efforts are focused on the energy intensive motors.

Savings of up to 20% across your site can be obtained by a number of simple procedures. When focusing on motors, it is recommended that the following questions should be considered:

- Is the equipment still needed?
- Can it be switched off?
- Can the motor load be reduced? For instance, there may be losses due to pipe-work or ducting which could be minimised and therefore increase the efficiency of the equipment being driven by the motor.
- Is it the most efficient motor for the job? For instance the company should avoid using greatly oversized motors.
- Can it be slowed down? In fan applications, a small reduction in speed can produce cost savings.

Action Energy Good Practice Guide 2 provides more detailed guidance.

1.6.4 Compressed air

Compressed air can represent a significant cost, with one unit of compressed air requiring ten equivalent units of electricity to generate it. A hole the size of a pinprick in an air line can cost up to £120 per year, with a common leakage rate of 30 – 40% this can result in significant costs.

To reduce the running costs of air compressors and avoid losses, follow some simple procedures.

- Conduct a programme of leak detection and repair, with employees encouraged to identify and report leaks as they occur. This will contribute to improving the efficiency of the compressed air system.

- The easiest and cheapest way to reduce the cost of compressed air is to monitor its operating times, and ensure that it is not operating when not required i.e. weekends and nights.
- A good way of establishing the significance of leaks in the absence of suitable measuring devices is to undertake a “no-load” test.

    - Firstly, close down all air operated equipment.
    - Then start the compressor and operate to full line pressure, when it will be off-load. Air leaks will cause the pressure to fall and the compressor will come on-load again.
    - Over a number of cycles make a note of average on-load time (T) and average off-load time (t).
    - Total leakage (litres/sec) = (Q x T) / (T + t), where: Q = air capacity of the compressor (litres/sec).

See Action Energy Good Practice Guide 126 (Compressing Air Costs) for more details.

1.6.5 Buildings

The building fabric can significantly influences a company’s energy use. Buildings can lose heat through fabric transmission and air leakage, and can also influence the amount of daylight and ventilation coming through. It is therefore important that building considerations are taken into account when trying to improve energy efficiency.

Air leakage

The largest source of air leakage usually comes from goods doors. Options for improvement include portioning, rapid closing doors, plastic strip curtains, air curtains and pneumatic seals.

Fabric transmission

Heat loss can be reduced through improved insulation. There are many different types of insulation material and systems available, with different thermal performances, handling properties, fire safety and other characteristics. The choice of insulation will also be dependent on practical limitations of what can be applied on a building and economic constraints when the return on insulation costs in terms of fuel savings becomes unacceptably low.

Daylight / ventilation

Insulation and air proofing must be balanced with requirements for ventilation and daylight. It is best to rely on natural ventilation and daylight whenever possible.

1.6.6 Purchasing energy efficient equipment

Good purchasing means value for money. When purchasing equipment you should take into account both capital and running costs.

Life cycle costing and payback periods

Consider energy use and other related costs such as maintenance when investing in new equipment.

Investments should take the likely lifespan of the equipment into account. Figure 7 shows an example with a heating boiler. Option (a) illustrates the capital versus energy costs for a £2,000 boiler with energy costs of £15,000 over a 10 years lifespan, option (b) shows the same chart for a cheaper boiler worth £1,000 but with energy costs of £20,000 over 10 years.

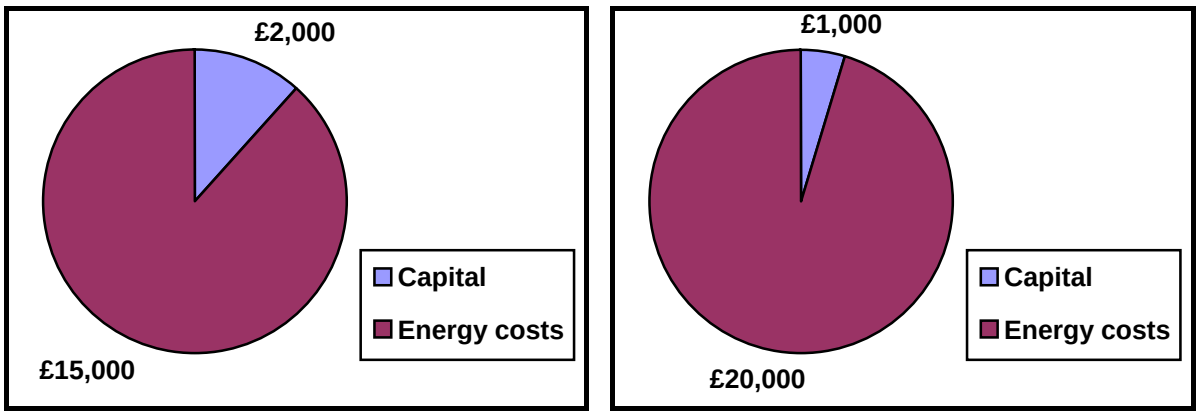


Figure 7. Capital versus energy costs

Although the initial investment may seem important, it may be worth spending more in order to save more in the medium and long term.

Payback periods should be calculated prior to investment and monitored once the equipment has been installed and is up and running. Figure 8 illustrates a simple payback calculation.

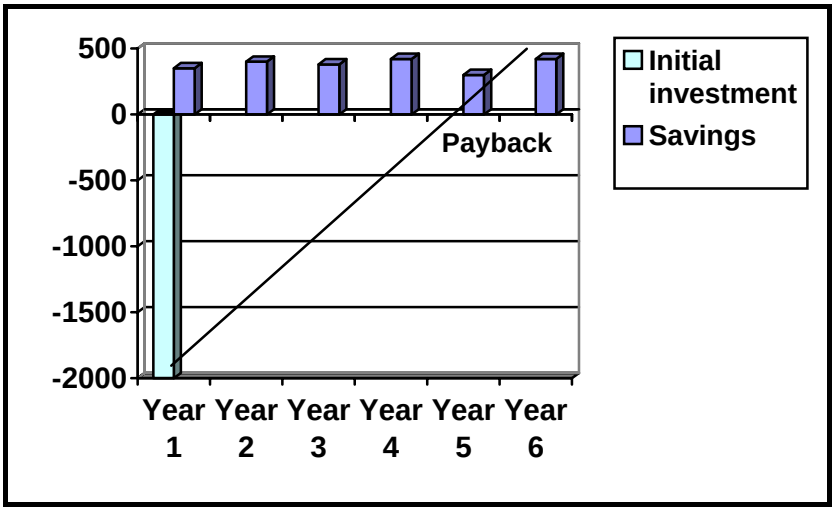


Figure 8. Simple payback calculation (excluding equipment depreciation)

Equipment selection

When selecting energy efficient equipment, it is recommended that you obtain several quotations from potential suppliers stating the equipment cost as well as anticipated running costs. You should also take care to include the cost of installation of appropriate controls.

Grants and tax breaks

You may be able to benefit from grants or tax breaks on energy efficient equipment purchases, such as the Enhanced Capital Allowance (ECA) scheme introduced for energy efficient technologies in April 2001. The current approved list of energy efficient equipment that qualifies for ECA's contains the following:

- Air-to Air energy Recovery Devices
- Automatic Monitoring & Targeting Equipment
- Boiler Equipment
- Combined Heating and Power Systems
- Compact Heat Exchangers
- Compressed Air Systems
- Heat Pumps
- HVAC Equipment
- Lighting
- Motors and Drives
- Pipework Insulation
- Refrigeration Equipment
- Solar Thermal Systems
- Uninterruptible Power Supplies

For a complete list and further information about eligibility and claiming ECA's visit their website www.eca.gov.uk. It is worth checking that funding is available prior to placing an order, as financial support can rarely be accessed retrospectively.

Module 2 – Packaging

2.1 Learning objectives

As a result of this module, delegates should:

- Understand the steps involved in packaging management.
- Become familiar with options for reducing, re-using, and recycling packaging.

2.2 Why focus on packaging?

Packaging can be defined as “All products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of any goods” Producer Responsibility Obligations (see up to date Packaging Waste Regulations). Packaging waste is a major contributor to the waste stream and to the problem of litter, as most packaging ends up as waste. For example, over 60% of the total waste plastic in Europe arises from packaging.

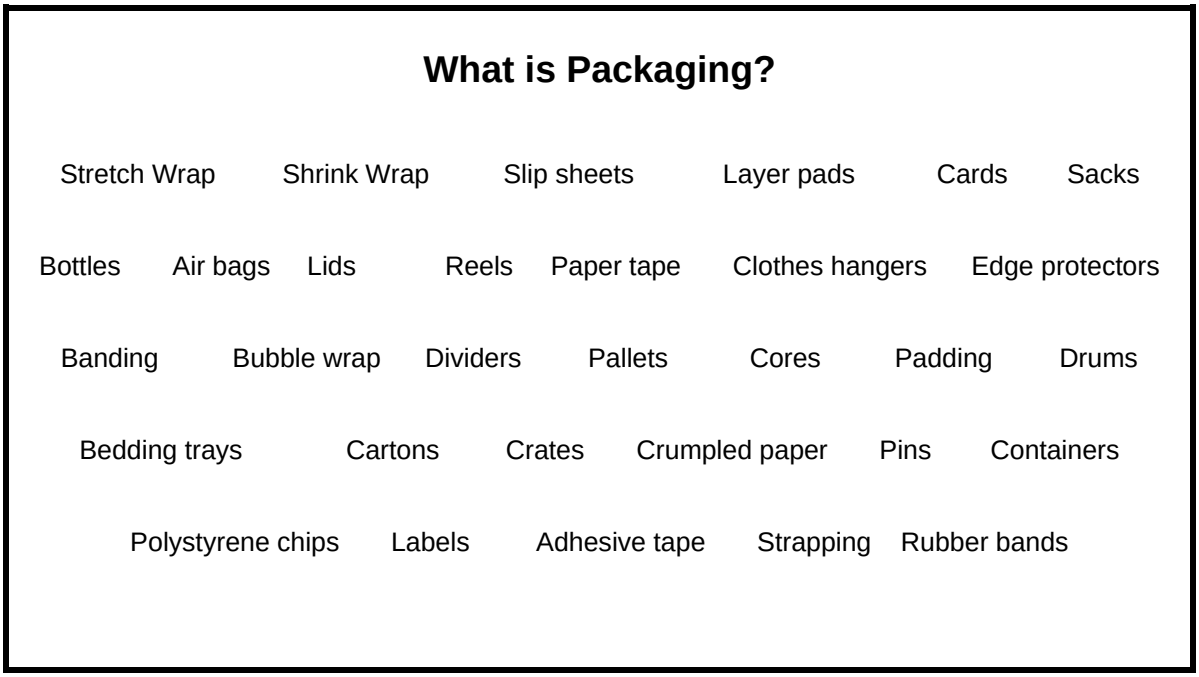


Figure 9. Some examples of packaging materials

Businesses contribute to the packaging waste stream by supplying goods surrounded/protected by packaging. This eventually has to be discarded by the end-users. Businesses also receive packaging, which they have to dispose of.

It is possible to recycle, compost or recover energy from most types of packaging waste. There are also areas where packaging waste can be reduced through avoidance or re-use. Companies can contribute to reducing the amount of packaging waste going to landfill, whilst simultaneously reducing costs.

This module presents ways in which your company can reduce packaging waste and its associated costs.

2.3 Packaging management

2.3.1 Why manage packaging?

Packaging plays a fundamental role in the distribution, protection, handling, storage and marketing of goods. Packaging management can therefore be defined as a systematic approach that allows the most efficient use of packaging and packaging materials in order to reduce costs and material wastage, without compromising product distribution, protection, handling, storage and marketing. Packaging management can benefit companies by:

Reducing direct packaging costs

Packaging management will directly tackle your purchasing costs.

Reducing indirect packaging costs

As with other areas of waste, there are many hidden costs associated with packaging. These include the cost of damaged goods due to poor packaging, waste disposal from backdoor packaging, labour, waste storage and compliance with the legislation.

Helping to comply with legislation

Companies handling large amounts of waste have an obligation under the Producer Responsibility Obligations (see up to date Packaging Waste Regulations) to recycle and recover a certain percentage of packaging. The Regulations, demanded by the EU Packaging Directive, not only have cost implications, but can also leave companies open to prosecution where they do not know how much packaging they actually use. Packaging management will help to quantify how much packaging is being used, determine whether a company is obligated in the first place, and identify recycling and recovery options. Where a company is close to, or just above, the 50 tonnes threshold, packaging management can be used to ensure that the company remains (or falls) below the legislative obligations.

The Packaging Regulations set targets for recovery and recycling of packaging waste to be met by obligated businesses each year so that the UK can meet EU Directive targets by the specified deadline.

The Packaging (Essential Requirements) Regulations (see up to date) contain specific requirements relating to the manufacturing and composition of packaging. Packaging must be manufactured so that the packaging volume and weight is limited to the minimum adequate amount. In addition, packaging must be designed and produced to permit its re-use or recycling, and to minimise its environmental impact when disposed of. The use of noxious and other hazardous substances and materials in packaging materials must be minimised to avoid emissions or leaching when the materials are incinerated or landfilled.

Potential problems associated with packaging management

Packaging may be more difficult to deal with than other waste issues as it can interact with other aspects of business and have far-reaching implications, particularly in terms of distribution and marketing.

- A change in packaging could affect a product life cycle, from storage to disposal. For instance, a reduction in packaging strength may affect the storage life of the products.

- The packaging and marketing of goods can be tightly inter-related, particularly in the consumer markets. It may be difficult to make any packaging changes due to marketing value of the current packaging. For example a Coke bottle is easily recognisable by its shape. There may be more effective ways of packaging Coke but they will not have the same marketing impact as the traditional Coke bottle.

2.3.2 How do we manage our packaging?

Similar to other areas of waste, packaging can be managed through a step-by-step approach. At each step, however, there are considerations specific to packaging management that need to be taken into account.

Step 1 - Obtain management support

To convince senior management of the benefits and need for packaging management, companies may need to include the Sales/Marketing Director, Distribution Manager, Storage/Warehouse Manager, Despatch Manager, and all other key people who will be directly affected by packaging management.

Step 2 - Establish a team and appoint a co-ordinator

The resource efficiency team and coordinator can be used to investigate packaging management. They should ensure that people who have a direct impact on packaging use are consulted. Think about including warehouse workers and customer sales administrators, as they may have different/strong views on packaging requirements. Sales staff may have already received comments from customers regarding packaging issues. Alternatively, you may want to set up a separate packaging efficiency team, including key representatives.

Step 3 - Collate the required information

An initial packaging review should be carried out, identifying the types of packaging bought, received, used and discarded - and where. Process flows are a good way of mapping packaging in a company. They will help in understanding how packaging moves through your site.

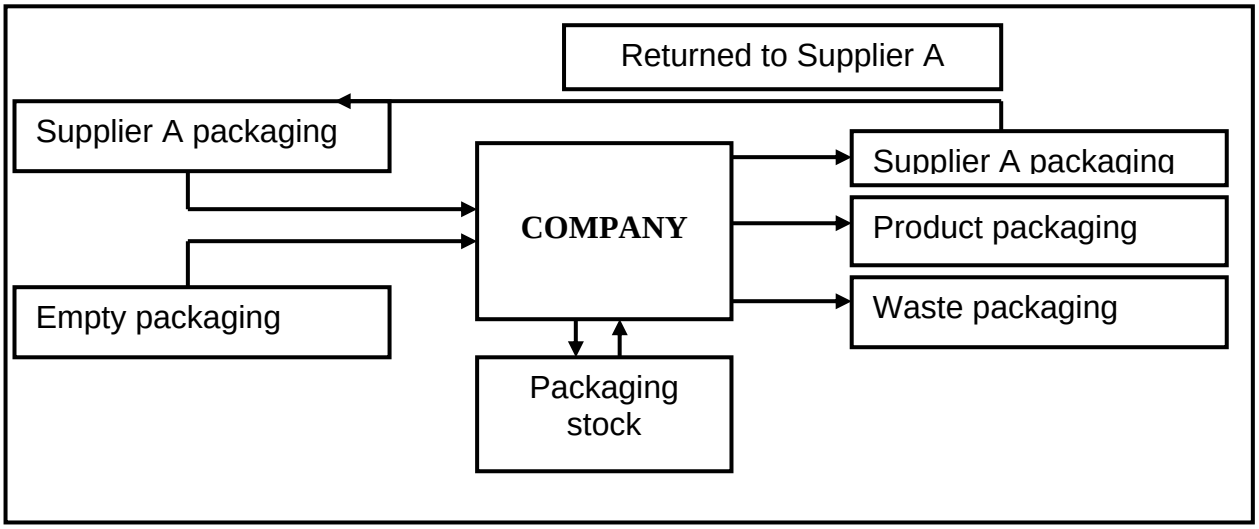


Figure 10. Packaging mapping exercise

This mapping exercise may immediately identify areas of unnecessary waste and opportunities for improvements.

After having identified packaging flows within a company, packaging use and waste should be quantified. This will help in focusing the company's efforts on the highest packaging costs (in terms of value and waste costs).

Step 4 - Data analysis

The data collected in Step 3 may have to be further manipulated to identify opportunities. One method is to use visual representations, i.e. charts and diagrams.

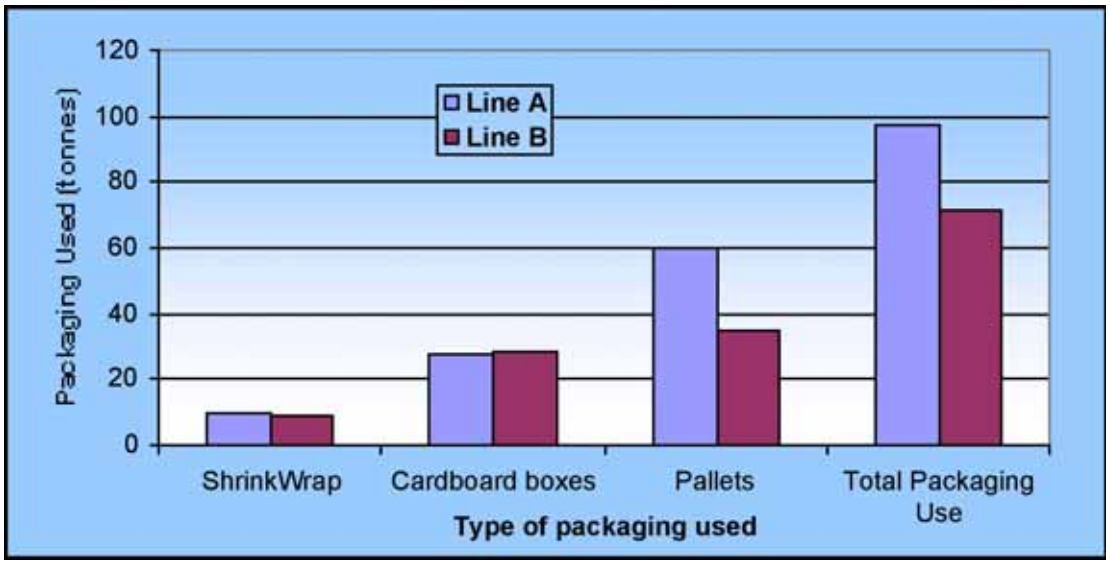


Figure 11. Packaging use per production line

The comparison of packaging use per type of products, or production line, may help to identify best practice. Figure 3 shows that production Line A uses more pallets than Line B, although approximately the same amount of boxes and shrinkwrap are used. The company may want to investigate the reasons for the need for more pallets with Line A. Could it be that more pallets are damaged during handling on this line?

Step 5 - Consider options for improvement

Improvement options will start to emerge as part of the data analysis process. Brainstorming techniques should also be used to generate ideas and solutions to packaging waste issues.

As with other areas of resource efficiency, packaging improvements should aim to raise packaging management options up the waste hierarchy.

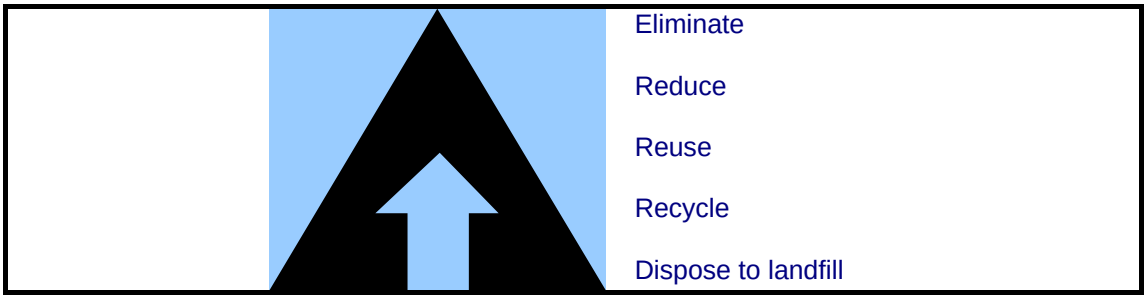


Figure 12. Packaging waste minimisation hierarchy

Reduction, re-use and recycling options should all be considered when tackling packaging waste.

When considering changes in how you manage and use your packaging, communication with customers and other interested parties, such as transport and distribution contractors, is paramount as these changes may also affect their working practices. Consultation is also likely to be required to ensure that customers and suppliers do not raise any objections to the packaging changes proposed.

Once decisions have been made regarding proposed changes to existing packaging systems, a packaging management action plan should be developed including the stages when consultation and/or trials will take place.

Step 6 - Review progress regularly

As with other resource efficiency initiatives, packaging changes should be monitored. A review of the packaging improvements should ensure that the cost savings identified/anticipated are achieved and that there are no problems arising from the packaging changes. For instance, a decrease in packaging thickness may lead to an increase in damaged goods, more returns from customers and higher transport costs. It is essential that any new issue is identified at an early stage. Packaging achievements – i.e. reductions in volumes/cost and any technological changes - should be fed back to employees, and other stakeholders where appropriate.

2.4 How do you reduce your packaging?

Eliminating or reducing packaging at source is at the top of the packaging management hierarchy. Methods to achieve this can vary from a slight change in packaging specification to a complete re-design of packaging, or a re-think of working practices.

2.4.1 The ‘bulk option’

Consider whether there are any products or raw materials, which can be delivered in bulk, as this may eliminate the need for packaging altogether. For example, liquids can be delivered via tanker or pipeline to bulk storage facilities if required in sufficient quantities. Powders can also be delivered in bulk, for example, directly to hoppers where the material is required for processing. Bulk delivery is a very efficient method of reducing packaging costs, and has the spin-off benefit of reducing raw material waste.

2.4.2 Packaging design

When investigating ways of optimising packaging design to reduce waste, it is essential that the packaging remains fit for purpose (taking into account the protection, handling, storage, distribution and marketing of goods).

Design

You will need to investigate ways to optimise the design of your packaging without increasing product damage or waste. This means matching the level of packaging to the level of protection required. Making the best use of your packaging design may involve: specific fitness for purpose requirements; minimising the amount of packaging material used; designing containers for effective cleaning or maintenance; and maximising the contents of a delivery container/lorry and the amount of goods per pallet through improving space efficiency. Technical computer database programmes (such as Computer-Aided Design - CAD) may assist in optimising the design of the packaging.

Example: Redesigning a cardboard box so that it eliminates the use of filler materials into the packaging can result in savings.

Envirowise provide a Design Track service that could be used to focus on packaging design. For more information visit the website at www.envirowise.gov.uk

Materials

Changing packaging materials can also assist in reducing your packaging. Again, it is best to choose materials and packaging types to combine fitness for purpose with minimum environmental impact. For example, changing from using cardboard boxes to using shrink-wrap provides the same level of protection, but constitutes only 30% of the weight. Some plastic wrapping materials are stronger than others in terms of the puncture and stretch tolerance. Machine applied stretch-wrap appears to offer more effective, uniformed protection than manually applied wrap.

PLASTIC DRUMS AND CONTAINERS

These are lighter, rust-free, and more re-usable, recyclable and chemically resistant than steel drums.

INTERMEDIATE BULK CONTAINERS (IBC'S)

These sit neatly on standard pallets and are space efficient in terms of storage and transport due to their near-cubical shaped container.

CORRUGATED DRUMS

These are best used for dry fluidic materials that tend not to fit well into cubical or rectangular shaped containers. They are lighter and more re-usable and recyclable than steel drums and are space efficient whilst in transit.

Figure 13. Benefits of choosing various packaging materials

2.4.3 Changing packaging specifications

Changing packaging specifications can result in reduced costs. For example, reducing the weight of packaging will improve the fuel consumption of delivery operations. Consider whether there are any materials used that can be substituted for lighter, more durable materials, or whether the weight or thickness of existing materials can be reduced. For example, can wooden packaging be replaced by lighter, more durable plastic packaging? Or can a lower grade shrink-wrap be substituted without compromising product quality? Another possibility could be to use a plastic liner to protect the primary packaging, e.g. steel drums, from contamination. When selecting or designing new packaging, choose the cheapest materials and the minimum thickness that will:

- Satisfy your specifications.
- Give you an acceptable service lifetime.

Trials should be conducted when changing material grades in packaging, to assess any impacts on product handling or protection.

Example

A toiletries manufacturer substituted a more lightweight shrink–wrap resulting in reduced consumption of 24 tonnes/year and associated cost savings of around £27,000/year.

2.4.4 Changing working practices

Improving the methods used to handle your product can result in both cost and time savings. For example eliminating a layer of packaging where it is considered unnecessary will inevitably save money for the company, for example, corrugated board trays commonly used for collation packing.

Alternative handling of products may further reduce the need of packaging. For example, using pipes rather than drums or IBC's to transport fluids or powder, or using a conveyor belt for transporting cardboard boxes rather than forklift trucks may reduce the packaging requirements for delicate objects.

Just-in-time delivery

Delivering goods 'just-in-time' will not only increase your storage space, but the product will spend less time in the warehouse. Products are also less likely to get contaminated, or suffer damage, thus minimising the amount and specification of packaging required. For example, such delivery minimises the need for compression strength when it comes to stacking products. This type of delivery will also enhance the company's reputation as products spend less time taking up valuable storage space.

2.5 Recycling your packaging

Recycling packaging involves collecting and selling suitable materials for recycling, usually by a third party. Recycling of packaging should be considered once other options such as elimination and re-use have been explored.

2.5.1 Identification

Firstly, materials suitable for recycling must be identified. Packaging wastes commonly recycled include cardboard, plastic, wood and metals. When considering which materials are suitable for recycling, quantity of material available, level of contamination, and the market demands for such materials must be assessed.

2.5.2 Segregation

Implementation of this approach requires the separation and identification of materials. Separating materials makes recycling easier. A mixture of packaging materials can complicate matters and may prevent recycling. Using single material types will facilitate recycling, for example, one polymer type rather than mixed polymers. The whole package including the labels should also be of the

same material or instead be easily removed by using low-tack adhesives or label pouches. Sorting of mixed waste is generally perceived to be uneconomic. It is also difficult to recycle composite packaging.

2.5.3 Recycling schemes

Separation and careful storage of materials in sealed and clearly labelled skips will avoid materials becoming contaminated or mixed up with other materials. Separation of waste materials from chemical drums reduces disposal costs and may change the status of the material from special waste to ordinary waste.

The identification of materials used in packaging is crucial so that materials can be easily detached from the mixed waste streams. There is a harmonising EU labelling system currently in development, which should be adopted when introduced. In most instances colour coded containers around the shop floor are used to allow for the easy separation of materials. These containers are usually situated near the waste-producing processes.

Recycling merchants

Suitable outlets may purchase and use your waste materials, providing you with a source of revenue and a reduction in disposal costs. The use of a front end loader (FEL) skip may be suitable to remove your waste material, this is more efficient as it can be emptied directly into a waste collection compactor vehicle, and is less expensive than to have whole skips removed and replaced. A compactor may reduce your waste by 20% of its original volume; this will reduce disposal costs as fewer collections are made.

Further investigation is required if your waste volume is sufficient to purchase an energy plant, incinerator, or a compactor. There may be other companies in the locality who can assist with this option. It is wise to consult a specialist party who can assess the validity of the idea, of any available financial support and the appropriate regulations. Where there are close relationships established between smaller companies in a local area a jointly owned compactor or incinerator can prove viable.

2.6 Re-using your packaging

Packaging re-use is becoming an important aspect to packaging management and is prevalent in both the industry and retail sector in the UK. For example, such systems may consist of re-using pallets, using drum slip sheets and push-pull systems, plastic boxes, metal crates with wheels, and lastly, separators, layer pads and interlocking collars.

2.6.1 Closed loop systems

Closed loop systems provide the most economic and environmentally responsible conditions for packaging re-use. These systems allow items to flow between sites easily in either direction without interruption and can sometimes be returned to the source of the process. Certain types of primary packaging, e.g. textile yarn cones, can be re-used within a closed-loop system. Re-usable packaging is less suitable where clients or suppliers are overseas and closed-loop systems are harder to close due to prohibitive transport costs. Reusable packaging may also be less suitable where small quantities of product are delivered to a high number of customers.

There are some considerations needed before implementing this type of approach. Usually nominal one-trip packaging is resilient enough to survive several trips. On-site inspections can be executed for wear and tear occurrences of such products. If damage is higher than normal, then re-use is probably not appropriate.

The decision to re-use packaging will depend on several factors:

- The purpose of your packaging and the level of the packaging required.
- The materials that are suitable for the task.
- The importance of the design.

2.6.2 Re-use of packaging on-site or by a third party

Packaging may be suitable for re-use either on-site or by a third party. For example, corrugated and plastic transit cases can be doubled up for in-store display cases. Cardboard boxes and plastic bags can be used for fillers or to transport the product around the site, or for storage of waste materials. Re-usable packaging may be useful to third parties such as non-profit scrap stores, schools, environmental business organisations and resource efficiency clubs. If this approach is to be adopted, the Duty of Care regulations must be adhered to.

If simple, standard containers are selected for packaging needs, then the potential for re-use on-site is improved. If appropriate, containers should be designed to stack or collapse, as this will reduce the requirements for on-site storage space. Easily interchangeable labelling and identification features will facilitate the on-site re-use of containers.

To implement this approach it is best to:

- Investigate whether this approach is cost effective. If it is considered viable, there are several factors that need to be taken into consideration. For example, providing more protection at points of vulnerability to damage (e.g. corners) may make the packaging more resilient, or plastic pallets can be used which are stronger and last longer than wooden ones. Staples may also need to be removed from some types of packaging before it can be re-used.
- Other factors to be assessed are the logistics for the collection and return of containers, cleaning and refurbishment facilities, and requirements for container tracking systems.
- Before embarking on changes, you must gain consent or approval from your customers and other interested parties. This must be done at the early stages of the development process. Customers should be pre-warned if the packaging is likely to appear unattractive due to wear and tear. Insufficient communication to interested parties may damage your company's image. Are your customers willing to return the packaging when requested to by the supplier? This will depend upon their ability to store packaging prior to collection.
- The next step is to decide whether to manage the scheme yourself, employ a third party specialist company, or persuade a supplier or customer to begin the scheme.
- A balanced judgement is needed throughout the process in order to assess the costs and benefits of various options and compare this to your current arrangements.

2.6.3 Re-using third party packaging

Packaging that is re-used is exempt from the packaging regulations after its first use, thus reducing your duties and cost of compliance. Types of packaging particularly suitable for re-use include pallets, IBCs and drums. Suppliers of third party packaging can be easily sourced, for example, through the Yellow Pages or by contacting ENWORKS. Suppliers of leased packaging, such as pallets, will manage stocks for an additional administration fee, collecting and returning supplies from customers. Second hand packaging will be considerably cheaper than new packaging but issues of quality need to be considered. Some customers may not accept second hand packaging, unless it meets strict specifications, such as size, weight and even colour.

One potential problem with sourcing third party packaging is labelling, for example, packaging cannot be used which bears the logo or details of another company.

Providing none of the issues outlined in the section pose a potential problem, the re-use of third party packaging is an economically viable and environmentally preferable option.

Module 3 – Solid Waste

3.1 Waste management

Nine million tonnes of solid waste are produced in the North West each year, placing great pressure on our dwindling landfill capacity. Although incineration currently complies with regulatory guidelines, emissions from incinerators may have longer term health effects and are not a trouble-free solution to the waste problem. It is therefore important for business to practice resource efficiency in its management of solid waste.

Once other options for resource efficiency have been explored, for example, elimination or reduction at source, there is inevitably some waste left over, which ends up in the skip. By managing this waste effectively, costs will be minimised and legislative compliance improved. Sometimes, options for reducing waste still further can be hidden in poor skip management. Skip management is an important part of resource efficiency and environmental management, although there may be better options in terms of the waste hierarchy. This section will discuss in more detail the different options identified in the waste hierarchy and then, as a last resort, how skip waste can be managed effectively to improve efficiency.

3.2 Learning objectives

As a result of this module, delegates should be able to:

- Understand the concept and importance of the waste hierarchy as part of resource efficiency.
- Understand techniques to improve waste management.
- Produce a prioritised action plan to gain control over waste disposal.

3.3 The waste hierarchy

The concept of resource efficiency is based on the waste hierarchy, illustrated below. Resource efficiency relies on the movement of waste from one end of the hierarchy to the other, i.e. from landfill to elimination. The preferred option for waste disposal is always that which is highest in the waste hierarchy.

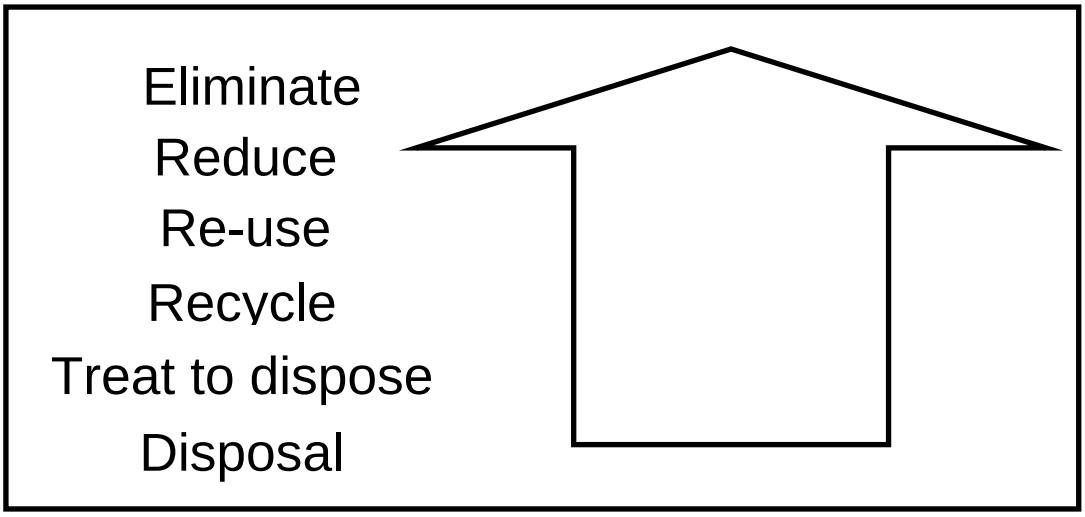


Figure 14: The Waste Hierarchy

When reviewing waste management, and considering how costs can be reduced, the waste hierarchy should always be considered. Waste management is an important part of resource efficiency, although there are better options to consider, for example, reduction of waste at source or elimination. For companies that have not undergone an in-depth resource efficiency programme, then it is likely that significant improvements can be made through improving solid waste management.

3.4 How much is waste disposal costing you?

Before examining alternative options for waste disposal, it is important to calculate the current costs, remembering the cost of waste disposal alone does not include the value of materials. The cost of alternative options can then be compared with current arrangements, and any savings recorded. Simply shopping around for the best prices, and choosing a reputable waste contractor can achieve significant savings in waste disposal costs. It may be possible to make changes simply by restructuring the current agreement, or making arrangements to segregate and recycle materials rather than dispose of waste to landfill.

The cost of waste disposal is generally made up of the following components:

- *Tonnage related charge*. This will vary depending upon the type of waste, for example, whether it is hazardous or not.
- *Skip hire charge*. Most waste disposal contractors charge a daily or weekly hire rate for skips or other waste containers, which varies depending upon the size of the container.

- *Transport/lift charge*. Waste disposal contractors usually charge for transport costs each time the skip is collected (known as lifts).
- *Landfill tax*. This is currently charged at a rate of £2 per tonne for inert waste and £14 per tonne for general waste.
- *Special waste consignment note fee*. A fee of £15 is charged on movements of special waste, payable to the Environment Agency.

Waste contractors have different charge structures, for example, the tonnage related charge may be included in the lift charge, or the landfill tax component may be included in the tonnage related charge. However, all of the components described above will be combined in some form. It may be beneficial for some companies to change to a different charging structure for waste disposal.

Annual cost of waste disposal =
Annual cost of skip hire + (Annual number of lifts x Cost of lift) + Cost of landfill tax

3.5 Waste management and legislation

As part of an on-going review of waste management, it is essential that regular checks are made to ensure the company is complying with all related environmental legislation. In the UK, the primary pieces of legislation applicable to waste disposal are:

- Environmental Protection Act 1990
- Duty of Care Regulations (see up to date)
- Hazardous Waste Regulations (see up to date)
- Environment Act 1995
- The Finance Act and Landfill Tax Regulations (see up to date)
- EU Landfill Directive (see up to date)
- Environmental Permitting Regulations (see up to date)

Under the Duty of Care, transfer notes are required for all wastes and must be kept for at least two years from the date of transfer. For special wastes, consignment notes must be completed and kept for at least three years from the date of transfer. The company should ensure that all waste carriers used are registered and obtain a copy of the waste carriers licence, or registration number and date of expiry.

The landfill tax is currently charged at a rate of £48 per tonne on general waste, and £2.50 per tonne on inert waste, and will increase by £8 a year until 2013. Therefore, it is prudent to ensure that inert materials (e.g. sand, rubble etc.) are segregated from general waste and stored in a separate skip in order to avoid paying the full rate of landfill tax.

It is also important to check that waste is being stored safely on site, for example, that waste storage areas are tidy and clearly signed. A build up of large amounts of waste on site may mean the company is affected by waste management licensing. It is also likely to present risks to health & safety and the environment.

3.6 What wastes do you generate?

3.6.1 Skip audit

The first step towards effective waste management is to identify the types and quantities of waste currently disposed of into the skips (or other containers for hazardous waste). This can be achieved by carrying out a simple skip audit, first determining the number, type and location of all waste containers, and identifying the contents of the skips on a number of days over a 2 or 3-week period. A skip audit can take the form of a simple checklist and is not a time-consuming task.

Wherever possible, wastes should be divided into subtypes; for example, plastic could be split up as polythene, PVC or polypropylene.

Part of a skip audit should also involve a check on housekeeping practices, for example, are any wastes being stored or disposed of on other parts of the site? It is also important to check the general tidiness and suitability of current waste disposal areas. This will help with compliance with duty of care legislation.

3.6.2 Should the waste be in the skip in the first place?

Once you've identified the type of wastes present in your skips, the next step is to determine whether there is anything in the skips that simply should not be there. For example:

- Are any raw materials or products being disposed of into the skip unnecessarily?

- Perhaps wastes that are not even coming from your business are being put into your skips. This will be costing you money to dispose of and may be putting your company in breech of the law.

- Try to identify how each of these unexpected wastes has got into the skip. Potential sources could include:
    - Contractors wastes

- Waste from other businesses
- Waste from members of the public

Remember, the company will be paying to dispose of this additional waste. If anything is found in the skips that should not be there, decide on what action needs to be taken to ensure this source is removed. Perhaps a procedure or practice within the company needs to be changed, or training needs to be given to ensure that employees are aware of the appropriate disposal routes. If the source of the additional waste is elsewhere, then improving the security of the waste disposal area, or locking skips at night should solve the problem.

3.7 Cost savings through waste management

A simple way to reduce the cost of waste to your business is to identify whether the company is paying too much for the disposal of its wastes. There are a number of ways in which a company can reduce the cost of its waste collection:

- Ensure skips are full when they leave the site. The transport component of the waste disposal bill will be based on the number of skips, not the tonnage of waste in individual skips. It is better to arrange to phone the waste disposal company when skips are full, rather than arrange a regular weekly or fortnightly collection. Such arrangements will require prior agreement from the waste contractor.

- Consider whether the size of the skip is appropriate for requirements. A smaller skip will reduce the daily rental charge, whereas a larger skip will reduce the number of collections required.

- Investigate whether it is appropriate to use a baler or compactor to reduce the volume of waste, and hence reduce waste disposal costs. Bear in mind the capital cost of such equipment, and associated running and maintenance costs.

3.8 Can your waste be segregated?

After the results from the skip audits have been compiled, you should have a good understanding of the types of waste disposed of to skips, and hopefully removed anything that should not be there. The next step is to consider whether any of these wastes can be segregated. If wastes are mixed then problems are created:

The segregation of wastes enables easier re-use and recycling, and may also reduce the costs of waste disposal.

The potential for segregating waste will be dependent upon the availability of storage space. Space saving storage containers and skips divided into sections for segregating wastes are available, and some can even be located underground if space is limited.

When determining the suitability of different waste types for segregation, it must be ensured that sufficient quantities of waste are produced, and that there is a viable outlet for the segregated material, for example, a local reprocessor.

It should be noted that hazardous wastes should always be segregated from general waste. If hazardous wastes are mixed with general wastes, then the whole collection will be classed as hazardous, and will attract a premium rate for disposal. Mixing hazardous and non-hazardous wastes is also a potential risk to waste disposal staff and can lead to breaches of the legislation.

Case Study 2

Improved segregation of wastes

At Schloetters Co. Ltd., a variety of raw materials are delivered in 20 litre metal cans. These are unfortunately designed in such a way that it is impossible to completely empty them, often leaving up to 5% of the chemicals still inside the can. To overcome this problem a metal stand was designed to hold the can over a bucket. The cans were then punctured through the base with a spike and allowed to drain.

3.9 Are wastes suitable for re-use?

Before considering whether materials can be recycled, first consider whether any wastes are suitable for re-use.

Some product and packaging wastes such as paper, card, plastics and textiles may be useful to organisations such as schools and charity groups. If wastes are transferred to such organisations, their status should still be checked even if they are exempt from the requirements for a waste carriers licence. Packaging can sometimes be re-used by other companies.

Items such as office furniture and fittings, and electronic equipment such as computers and mobile phones may be suitable for donation to schools or charitable organisations. If the equipment is damaged, or requires upgrading before use, then there are a number of companies specialising in the refurbishment of such equipment, some of which have charitable status. If you are disposing of items that may be suitable for refurbishment, ENWORKS can provide advice and lists of appropriate organisations.

Case Study 3

Wastes as a raw material for other companies

LEAR Corporation in Pendle produce internal panelling for the automotive industry. Felt is manufactured as part of their process. To produce this, a variety of cotton and acrylic wastes from another manufacturer are shredded and reduced to a specific fibre length before being bonded.

Cavalier Carpets in Blackburn, participated in a resource efficiency project. Part of the manufacturing process involves the shearing of woven carpets to produce a uniform tuft length. Approximately 125 tonnes per annum of waste fluff resulting from this process was originally sent to landfill. This is now taken away to be used as a filler in cardboard manufacture. The company have saved £4,500 p.a.

3.10 Are wastes suitable for recycling?

Many wastes are suitable for recycling, an option which is preferable to landfill according to the waste hierarchy. Whether a particular material is suitable for recycling will depend on the quantity produced, level of contamination and market demand for that material. Materials, which are commonly recycled, include:

- Cardboard and paper
- Plastics, particularly non-composites
- Toner cartridges
- Wood
- Textiles
- Glass
- Metals
- Aluminium and steel drinks cans
- Solvents
- Packaging (cardboard boxes, wooded pallets, steel drums etc)

This list is not exhaustive, and other materials may also be suitable for recycling. It is also necessary on occasion, to treat the waste prior to recycling e.g. by baling and compacting. Recyclers are likely to ask for more details of the material, in particular, whether it is contaminated with labels or tape, whether the material is baled and how much is produced.

Companies can support charities through recycling, for example, by donating printer and toner cartridges. ENWORKS can provide assistance with sourcing suitable recycling companies.

The viability of collecting materials for recycling will be dependant upon the proximity of the recycler to the source of the material. There are environmental impacts associated with the transport of materials for recycling which must be taken into account. It should be noted that materials sent for recycling are classified as waste, and as such, the Duty of Care legislation (see up to date) must be adhered to.

3.11 Waste recovery

Valuable resources can be recovered through processes such as energy from waste, anaerobic digestion and composting. Once other options such as re-use and recycling have been exhausted, then the waste recovery techniques described in this section can be assessed for their suitability. If useful energy can be extracted from waste, then waste recovery techniques are preferable to landfill.

Composting is the natural process of controlled decomposition of organic materials such as green waste and food scraps. It is an excellent way of recycling biodegradable waste and reducing the amount sent to landfill. The compost produced can be sold to garden centres or other suitable outlets providing strict guidelines on the composition are adhered to. Composting is a relativity rapid process, taking about 4-6 weeks to reach a stabilised material, which can be sold as a viable product. Composting waste removes a large part of the organic bio-waste, which would otherwise go to landfill, helping to remove problems caused by landfill gas and leachate.

Anaerobic digestion (AD) involves a complex biological treatment of waste materials in an enclosed controlled reactor. The process mimics and speeds up that which occurs in a landfill site. The main product of AD is a biogas rich in methane, which can be harnessed as a source of energy, and a soil improver that can be used to enhance the condition of poor soil. The process has been used as a method of handling certain wastes including sewage sludge for many years. As a treatment for organic solid waste it is relatively new, although more than 115 plants are now in operation or are under construction worldwide.

Energy from waste is the process of recovering energy through incinerating waste once other recycling options have been exhausted. This process can either be carried out at large municipal solid waste plants, or on a smaller scale at individual companies. If energy from waste equipment is installed at a business, the electricity can be used on site. Modern equipment with ‘combined heat and power’ facilities simultaneously produces both useful electricity and heat. Exhaust gases from this process are usually passed through a scrubber or electrostatic precipitator in order to remove particulates and acid gases. Suppliers of equipment will be able to advise on capacity and suitability for specific types of wastes. Wastes that have a high calorific value and are particularly suitable for converting into energy include oil, wood, textiles and plastics.

(Note: There may be a need to get a licence or exemption from the Environment Agency for some types of recovery process).

3.12 The way forward

To develop an action plan for improving waste management, the following stages should be considered.

1. Determine which wastes are disposed of into the skips by periodically carrying out simple skip audits.
2. Investigate whether any wastes are being disposed of into the skips that should not be there. Identify the likely source of this waste and take appropriate remedial action.
3. Look at the feasibility of segregating wastes based on storage requirements and market demand for that particular material. Segregating waste is likely to underpin most improvement options.
4. Determine which alternative disposal options are suitable, bearing in mind cost and legal compliance issues. The main options to consider at this stage, i.e. once waste has been reduced as far as possible, are re-use and recovery (for example energy from waste), recycling and treatment. Compare the cost of these alternatives with the current arrangements.

Module 4 – Water

4.1 Learning Objectives

This module introduces methods and cost saving options when using water on site. It attempts to address several key issues. Namely:

- How to monitor water on site.
- How to control water use.
- Options available for reducing water use.

As a result of this module, delegates should:

- Understand the billing of water and be aware of purchasing options.
- Be able to monitor water use and wastages.
- Be familiar with cost reduction options such as controls, maintenance/housekeeping and specific water saving devices.

4.2 Why focus on water?

Water has traditionally been considered a cheap resource, which governments have a duty to supply. However, the amount of water available (even in a wet country like the UK) is not unlimited, and the cost of treating wastewater is expensive. The intensity of water use in this country can be inferred from the high figures given for various manufacturing sectors in Table 1.

Industry	**Water use per unit of activity**
Electroplating, galvanising	10-50 litres PER m^{-2} surface area
Tanning	74-88 m^3 PER tonne
Fruit processing	4-7 m^3 PER tonne
Textile processing	80-600 m^3 PER tonne
Brewing	8-13 litres PER tonne
Steel making	4-200 m^3 PER tonne
Paper making	5-30 m^3 PER tonne
Poultry processing	30-35 m^3 PER 1000 chickens

Table 1. Typical water use by industrial activities
(Source: Enterprise and the Environment, Open University, 1998.)

Because of manufacturing and the high population density, the UK is in fact classified as a “low” water availability country in world classifications – with South Africa. Excessive water use by industry also has an adverse effect on the environment, for example through pollution and by lowering the water table in wetlands.

Charges for water consumption and for the discharge of effluent have risen steeply in recent years, as water companies seek to recover the “true” costs of the services they provide. Water is a resource for which a manufacturer has to pay twice: first to purchase it from the water company and then for its disposal as effluent. Efficient water use is therefore an important component of business success. Manage it or it is money down the drain.

As a rule-of-thumb, for sites that have not previously tried to save water, reductions of 20% in water and effluent bills are usually achievable at little or no cost. As much as 40%, or more, might be achievable if projects with paybacks of up to two years are included (see Case study 1).

Case Study 4

Hanson Brick

Hanson Brick is the UK’s leading manufacturer of quality facing bricks. The ‘soft mud’ brickmaking process used at its Tilmanstone works in Kent required large quantities of water in order to wash the used sand from the brick moulds.

To reduce water consumption, Hanson installed a new recycling system, supplied by VisionInvest. The new process separates the water from the sand, ensuring that both the water and the sand can be reused.

Installing the new system reduced daily water consumption by 71%, an annual saving of 300,000 m^3, and sand consumption was reduced by 700 tonnes per year. Financial savings are estimated at £40,000 per year, which meant that the initial investment was paid back in just over two years.

Source: Envirowise, Resource Efficiency: A Management Guide (2001).

4.3 Water management – billing and purchasing

In order to gain control over water use, businesses should first ensure that they are charged correctly for their water use and discharges.

Charging schemes and tariffs[1] will vary from one water provider to another. However, businesses will usually be charged for their water consumption, wastewater, surface water and also trade effluents in some instances. Each of these charges is looked into in more detail below.

At the moment water can only be bought from your local water provider, unless your site uses more than 180,000 m^3 per year. The Government is looking at introducing competition in the water industry, which would mean that customers would be able to choose their water suppliers in a similar way as they choose their energy suppliers (see up to date regulations).

Ofwat (the Office of Water Services) is the economic regulator of the water industry in England and Wales and is responsible for making sure that the water and sewerage companies provide a good-quality, efficient service at a fair price. It is a government department led by the Director General of Water Services (the Director).

The Director has a duty to facilitate competition between suppliers and potential suppliers, ensuring that a framework exists in which competition can develop. After the Government announced proposals for developing competition in the water industry in March 2001, Ofwat have concluded that the market for water and sewerage services in England and Wales is not ready for the introduction of competition for domestic and small business customers.

4.3.1 Water consumption

The water company will usually require that all business premises are fitted with a water meter, where practicable.

Depending on water consumption patterns, businesses will be invoiced on a quarterly or monthly basis.

Water consumption is charged per cubic metre. The volume of water supplied is calculated from the change in the meter reading. When the water company is not able to take an actual meter reading, it may estimate consumption on the basis of past use.

[1] The information provided in this section is based on the schemes and tariffs operated by United Utilities, the local water company in the North West.

A company is billed a fixed rate charged based on the size of the meter so it is important to ensure that you have been fitted with the correct sized meter.

Depending on how much water a company uses, it will have a choice of tariffs, as described below. Please note the figures given are for 2003/2004.

Intensive water users

Businesses using more than 180,000 cubic metres of water annually may benefit by paying under an "industrial" tariff. Charges would include:

- A charge of 56.2p per cubic metre of water used.
- A standing charge per annum per meter based on the meter size.
- An additional fixed charge of £35,978 per annum per site.

Medium water users

Businesses using between 50,000 and 180,000 cubic metres of water per annum may benefit from the middle user tariff:

- A charge of 72.6p per cubic metre of water used.
- A standing charge per annum per meter based on the meter size.
- A fixed charge of £6,400 per annum per site.

Standard tariff

The standard tariff is applied automatically to all companies, unless they choose the industrial or middle user tariffs.

The standard tariff is made up of 2 charges only:

- A charge of 85.4p per m^3 of water used.
- A standing charge per annum per meter based on the meter size.

The standing charge is for the use of the mains water pipes supplying the company.

Recommendations

- Check that a water meter is fitted on site and that it is the correct size. This is the only way to ensure accurate billing of your company's water use.

- Provide actual meter readings to your water provider. Avoid invoices based on estimates, as this may lead to your company being overcharged or having to pay high retrospective charges at a later date.
- Check that you are on the correct tariff for your water consumption. Calculate your company's annual water usage and check that you are using the best tariff for your site's consumption.
- Record meter readings for water use to ensure that you are charged for the appropriate volume of water use.

Case Study 5

J W Lees & Co Ltd

J W Lees & Co (Brewers) Ltd based in North Manchester use a large volume of water in their process. As costs associated with water constituted one of their major expenditures they focused their resource efficiency efforts on reducing water consumption as a priority.

Following a water audit and regular monitoring, a number of leaks were identified. The company invested in new piping systems at a cost of £400, which resulted in immediate savings of £13,000 per annum.

The monitoring system enabled JW Lees & Co to identify unexpected changes in consumption and therefore take action. If the company had not known how much water was normally used in production they would have lost £13,000 per annum.

4.3.2 Sewerage and waste water disposal charges

Water providers also charge businesses for disposing of water. This covers water that has been used on site as part of processes or for domestic purposes and rainwater, which is drained off site through gutters and sewers.

United Utilities calculate sewerage and waste water costs on the following basis:

- A charge of 55.9p per m^3 based upon the volume of water registered on the meter. The water company assumes that most of the water supplied is returned to the sewers.

- A charge of 38.9p per £ of the business' charging value. The charging value is based on the business' rateable value. The water company assumes that the higher the rateable value, the bigger the site and therefore the more surface water is drained off to sewers.

Cost reduction opportunities

- If more than 10% of the water supplied is not returned to the sewer (e.g. if it is used in products or evaporated through processes) the water company may give a discount on the volumetric charges payable.
- If the company can prove that no surface water from the property drains to a public sewer (e.g. if surface water runs off into a stream), a reduction in wastewater standing charges of up to 50% may be available. To obtain a reduction in the wastewater charges an accurate diagram of the property along with the appropriate claim form should be sent to the water company. The water company will then decide the reduction in charges.
- If a company has a significant grassed area, it may also benefit from a discount on water sewage as part of the rainwater is not discharged to sewers but absorbed by the grassed land.

Recommendations

- Identify all water uses on site and assess whether any of the supplied water is not disposed of to the drainage system. Does water go to a local watercourse / grassed area?
- If so, contact United Utilities to discuss possible discounts[2].

4.3.3 Trade effluents

Trade effluent is defined as "any liquid either with or without particles of matter in suspension in the liquid, which is wholly or in part produced in the course of any trade or industry carried on at the trade premises", but does not include domestic sewage.

By law, businesses must seek consent from the water company or the Environment Agency to discharge effluents to sewers or controlled waters, such as rivers. The holder of a discharge consent must comply with the requirements/conditions stated in the consent.

It is the company's responsibility to obtain a consent. Discharge to public sewer or controlled waters without a consent is a criminal offence.

[2] Contact United Utilities at www.united utilities.com

Discharge to sewers

Where the premises are connected directly or indirectly to the public sewer, trade effluent charges are payable in addition to sewerage charges.

The charge is based on a standard unit charge per cubic metre (m^3) of trade effluent discharged to a public sewer. The standard unit cost is fixed by the utility company. Water providers usually charge for trade effluents discharged to sewers on the basis of the Mogden Formula. This formula attempts to link charges for a particular customer to the cost of treating the effluent.

The formula includes charges for:

- The reception and conveyance of effluent.
- Primary treatment based on effluent volume.
- Effluent chemical oxygen demand.
- Effluent suspended solids.

The volume of trade effluent will either be separately measured, or assessed from the volume of water supplied. Where it is assessed, an allowance is made for the water not returned to sewer, and for domestic sewage. The latter will be assessed on a per capita basis of 50 litres per employee per day (or 60 litres per employee per day where canteen facilities are available).

Discharge to controlled waters

There is an annual charge for all consents to discharge to controlled waters.
This charge is made up of four factors:

- Maximum daily volume discharge.
- Contents.
- Receiving waters.
- Annual charge fixed by the regulators (the Environment Agency).

Recommendations

- Check whether your site requires a discharge consent or not.
- If your site operates under a discharge consent, check that the terms of the consent are met.
- Ensure that trade effluents are discharged separately to domestic sewers and/or rainwater, otherwise the cost of trade effluents will be based on the total volume discharged.

4.4 Water monitoring

Before beginning a water saving campaign, water and effluent costs should be looked at to make sure it is worth taking action. Information about typical water consumption, in various sectors, has been collated by many trade associations. Further information is available in the Environmental Performance Guides, available from Envirowise.

The first step to evaluating the water efficiency of your company is by a water use mapping exercise.

4.4.1 Water use mapping

By using simple mapping techniques, using a site plan for instance, with labelled pipework, it will be easier to identify where water is being used and discharged.

A walk around the site will help to identify areas where water is being wasted, such as leaks and incorrectly set valves, or unnecessary or excessive use. Wastage points should be added to the water use map. For example, in one mapping exercise, a forgotten tap at a brewery was found to be discharging fresh water direct to drain 24 hours per day all year round. In another, a tap was left running continuously to cool the employees' tea-break milk - costing the company £1,000 per year.

Taking photographs of the points at which water is discharged or used, may also help in building a comprehensive map of water uses.

When producing a waste map, water use should be discussed with all relevant departments and people.

Initially, a waste map of the whole process or facility should be produced, identifying the major areas where wastewater may be generated. The next step is to produce waste maps for individual processes. This allows for a more detailed resource efficiency programme.

Think about where water is used on your site. Table 2 below gives examples of where water can be used.

What do you use water for?	Examples of water uses
The main processes	***Processing*** To dilute materials, mix, heat/cool, separate raw materials and products. Steam raising for processing
The ancillary processes	***Cooling*** To reduce heat from rotary machinery, temperature from process materials and condense vapours. Cleaning During maintenance of equipment, hygiene and product quality.
Emergency situations	Treating spills, leaks and drips During abnormal events
Domestic purposes	***Sanitary*** Used for drinking, washing and flushing toilets. Heating system As part of the boiler system

Table 2. Examples of water uses

Once information has been gathered on water uses, you can build a map for the whole company or specific processes. Figure 16 below shows an example of a water use map for a boiler system.

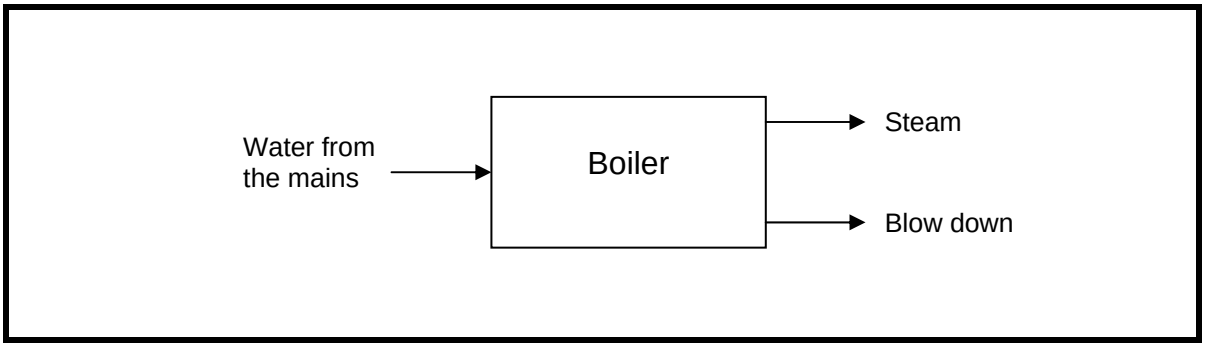


Figure 16. Example of a water use map for a boiler system

4.4.2 Water quantification and costing

After identifying the areas of water use and wastage, a monetary figure should be given for the water inputs and outputs. At this stage it may only be an estimate. This will help in identifying water issues that should be addressed by the company.

Water balance

The first stage of a quantitative approach to water management is a water balance, where the quantities of water entering and leaving the site are measured and compared. Drawing up a water balance helps to identify all water uses and calculate their cost, which would otherwise be difficult to estimate.

A water balance states that the amount of water entering a site equals the amount of water leaving the site. If the components that comprise a site's water balance can be quantified, then waste is easily identified. Account may need to be taken of water leaving the site in the product or by evaporation during drying processes, and also of rainfall reaching the effluent disposal system.

The following diagram shows a simplified water balance for a factory.

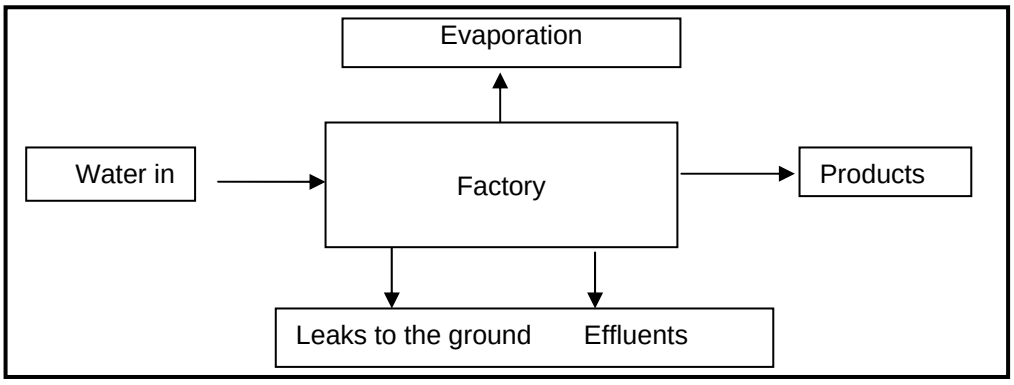


Figure 17. Example of a site water balance

Measuring the flow of water

In order to cost water use on site, the company should find out how much water is being consumed and how much effluent is being generated for each process.

The flow of water can be measured by simple and effective methods such as:

- Reading existing meters.
- Using a bucket and a stopwatch.

- Comparing an existing measurement system with known information e.g. manufacturer's information, product specifications.

More complex methods include:

- The use of flow meters and in-situ recording equipment.

Recommendation

Often, a single water meter will serve a whole site, which means that the data on water use are aggregated and difficult to interpret. Individual meters for process areas can be installed inexpensively and provide more useful information.

For example, installing a £300 water meter in the beer tank room at a brewery helped in identifying significant water losses, saving £650 per week when remedial measures were adopted.

Case Study 6

The true cost of one cubic metre of water

Flow rates of water of 1 m^3/hour are approximately equivalent to the flow of a garden hose, or filling a standard 9 litre (2 gallon) bucket in half a minute. According to a 1996 study of water costs in different parts of the U.K., conducted by Envirowise, this seemingly small flow rate translated into costs of between:

- 48 pence and £1.34 every hour; or
- £12 and £32 every day; or
- £80 and £225 every week; or
- £4,205 and £11,740 every year.

(Source: Envirowise Good Practice Guide 67: 'Cost Effective Water Saving Devices and Practices').

The true cost of water use

Recognising the true cost of water in the same way as other waste disposal costs will help to identify savings and understand inefficient use of water.

The additional (hidden) costs associated with water may include:

- Waste water and trade effluent disposal costs.
- Pumping costs. Distributing water on the site incurs a pumping cost. The electricity used by the pumps will depend on the flow rate required, the distribution pressure and the pumping efficiency.
- Treatment costs may occur prior to use or discharge of water. For instance, the company may need a settlement tank prior to disposing of water to sewers.
- Maintenance costs associated with pumps, pipework, flow meters and water treatment devices. These costs may include ancillary materials, such as oil, chemicals and also labour costs.
- Loss of valuable raw materials in wastewater. These include raw materials, products and treatment/cleaning substances.

4.4.3 Monitoring water costs

It is recommended that priority water issues are closely monitored over time and against production.

In order to monitor significant water costs, the company should establish performance indicators relevant to its main water issues. These may include water consumed in cubic metres per unit of production and trade effluent costs per production unit.

Once performance indicators have been defined, the company should introduce monitoring procedures to ensure that data is collected and made available for making decisions.

Monitoring over time

Regular surveys are essential to monitor water and effluent systems effectively.

Below is an example of how water monitoring over time can help in identifying costs and solutions for cost savings. During a resource efficiency audit of a local manufacturing company, an increase in trade effluent charges was identified in spite of the fact that the volume of trade effluent remained the same (Figure 18).

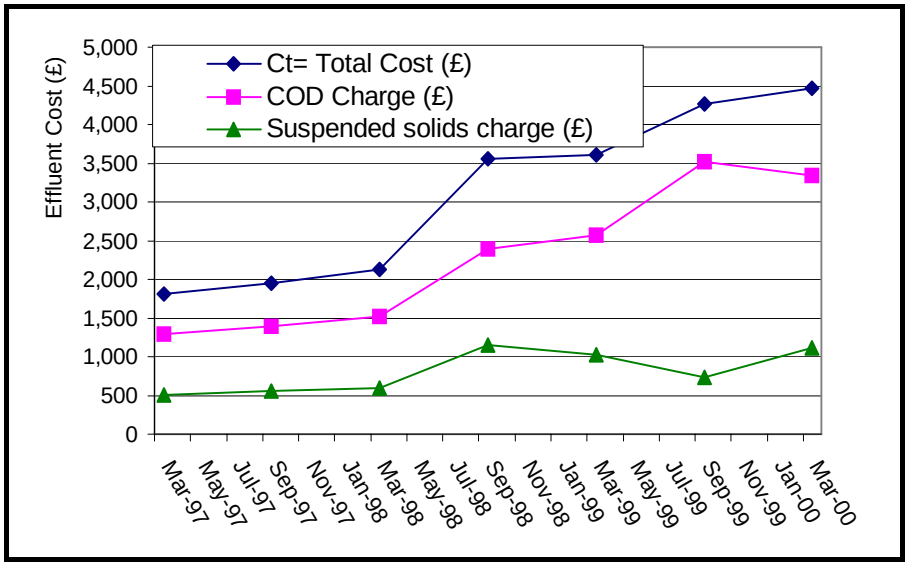


Figure 18. Trade effluent costs, with a constant increase over the past two years despite no increase in effluent volume

Monitoring of trade effluents allowed for an analysis of the situation and it was clear that an increase in the amount of suspended solids and chemical oxygen demand (COD) were the reasons for the increase in the trade effluent charges (Figure 19). Without monitoring, the company could not have identified the reason for the increase in costs.

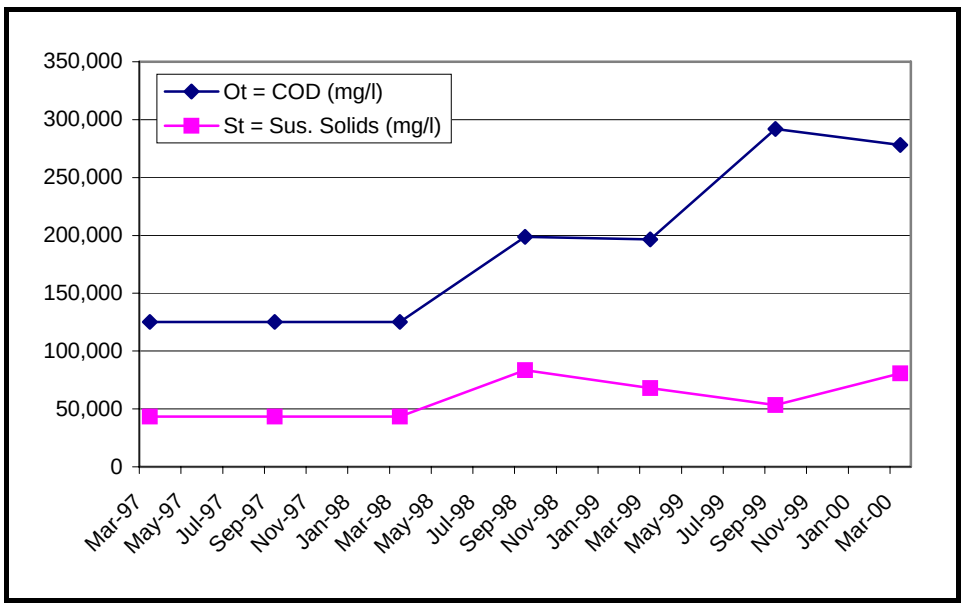


Figure 19. Comparison of suspended solids with chemical oxygen demand (COD) (mg/l)

The results show a small increase in the amount of suspended solids and considerable increase in the chemical oxygen demand.

Monitoring against production

If your site uses water as part of a production process, it is recommended that water use be monitored against production figures. This will help to highlight best practice as well as anomalies in consumption. Figure 20 shows an example of water monitoring against production.

If it is not possible to sub-meter the water use going into the production process, you should try to estimate water use for domestic purposes and deduct this from the total water use. As long as occupancy does not vary drastically, domestic water consumption should remain fairly constant.

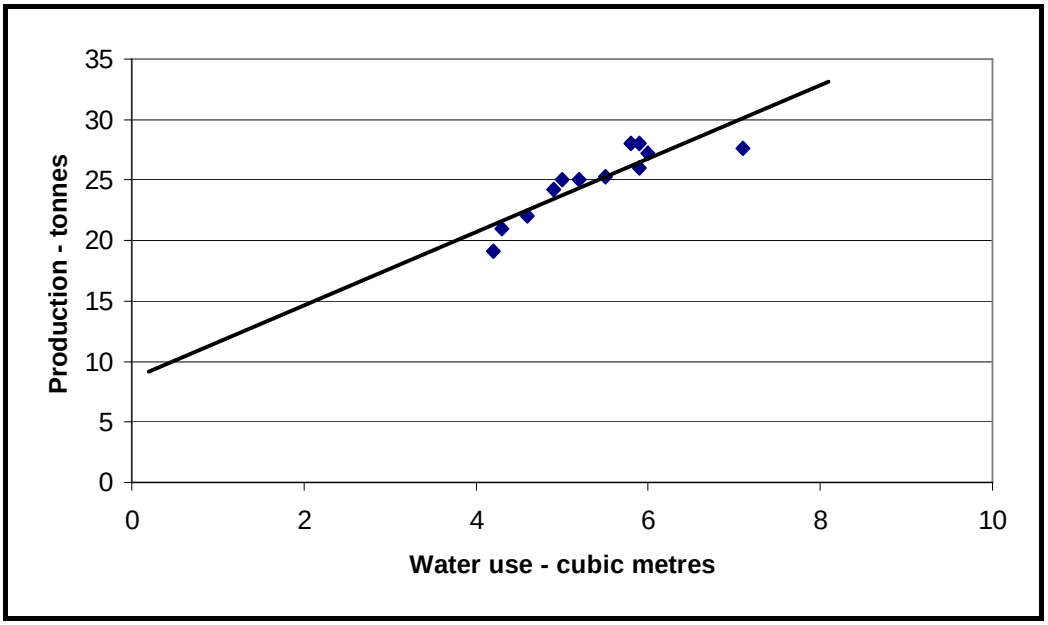


Figure 20. Water use against production

4.5 Options for water cost reduction

Water mapping and monitoring may already have identified no cost and low cost measures to save water. Equipment may have to be installed in some instances.

4.5.1 Awareness raising options

Over-use

Part of water wastages are due to poor control of water use, such as taps left running or poor practices in the use of water for cleaning and rinsing. Such waste can be tackled by raising employees' awareness and setting control procedures to check that water controls are in place and are used.

For instance, when using water for rinsing, the company should ensure that bottles, cans, churns and other vessels are fully emptied of contents before washing. Water spillages can be reduced by keeping water levels in rinsing and washing tanks to a minimum.

You should also review your water usage in order to check that there are no unnecessary water uses.

Leaks

Leaks are probably the most common unnecessary use of water in businesses. Typically leaks will arise from:

- Damaged pipes, connections, flanges and fittings.
- Worn valves.
- Flooded floats on water tanks or cistern valves.
- Corroded pipework and tanks.

The rapid detection and repair of a single leak can justify metering and monitoring costs. Carry out regular leakage tests on concealed piping and check for overflowing tanks, worn tap washers and other defects of the system.

Maintenance

Establishing a maintenance programme for particularly sensitive equipment will help to tackle water leaks.

Recommendations

- Raise employees' awareness about the cost of water and ways to minimise its consumption.
- Set up control measures and procedures.
- Set up a maintenance programme.

4.5.2 Water saving devices and practices – industrial uses

There are a number of devices, that can be used to control and reduce water use and costs. The main options to consider are listed below.

Water control / reduction

- Make sure overflows are controlled, most overflows are drained without being measured.
- The use of simple level sensors and on/off control systems for pumps and shut-off valves should ensure that overflows are controlled.
- Pipe restrictions may be possible where a steady flow of water is not required.

Water recycling

- Try to recycle water where possible. For instance in:
    - Water cooling. The water may be pumped to a condenser/heat exchanger and cooled for re-use.
    - Rinsing. Water can be collected, diluted with fresh water and recycled.
    - Re-use steam by condensation.
- Use reject water (grey water) for secondary purposes – water from some processes is still usable for cooling purposes, floor cleaning and yard washing.

Use of alternative water supplies

- As water becomes more expensive, the use of alternative sources may prove economically viable. Rainwater, boreholes, rivers and canals are all potential sources of ‘greywaters’, which can be used in some systems where potable water may currently be in use.
- The mechanical issues associated with use of alternative water supplies, such as the installation of pumps and pipework, are relatively simple. However, the chemistry issues can be very complex and it is important to consider these carefully before any changes are made, in order to avoid damage to your system.

Reducing contaminant levels

By reducing the level of contaminants in trade effluents, you may be able to save on trade effluent costs and also re-use water in some of your processes.

There are various treatment technologies available to reduce contaminant levels in water. These include filtration, clarification/sedimentation, centrifugation and flotation systems.

You should bear in mind, however, that treating water will give rise to sludge and other deposits which will have to be disposed of. Treatment technologies will also require capital investments and create operating costs such as energy and maintenance costs.

4.5.3 Water saving devices and practices – commercial/domestic uses

If your main water use is for domestic purposes there are various devices, which you may want to consider, in order to reduce water consumption.

Toilets

- Flush controls. Passive infrared (PIR) sensors can be fitted to reduce the flushing frequency in men's toilets.
- Cistern volume adjusters or cistern bags are cheap and simple devices, which reduce the volume used for each flush of a toilet.
- Waterless men's urinals may be another option. They use chemicals instead of water to maintain hygiene.

Sinks

- Fit automatic supply shut-off taps, such as percussion or push taps.

Showers

- Fit flow restrictors on showers.

4.5.4 Purchase of water saving equipment/technology

In order to assess a water saving option, it is recommended that you estimate equipment and implementation costs as well as water savings expected. Where possible, work on the basis of the true cost of the waste water.

Project costs may include:

- Design and project management.
- Purchase of equipment.
- Equipment installation and commissioning.
- Disruption of normal work during installation.

The equipment will also have operating costs once installed, such as:

- Employee training.
- Energy use and maintenance (including ancillaries).
- Disposal of wastes from treatment processes.
- Monitoring and reporting.

When evaluating potential water saving opportunities, calculate current costs and compare them with the expected costs and savings. Where equipment purchase is involved, it is recommended that you obtain quotations for the equipment costs and estimated water savings from the suppliers. Once water saving actions have been implemented, do not forget to carry on monitoring your water use in order to record the savings made.

Module 5 – Materials

This module is concerned with purchasing materials that have a lesser environmental impact than their equivalents whilst providing the same functionality, and with life-cycle assessment and supply chain management.

5.1 Learning objectives

As a result of this module, delegates should:

- Understand the business benefits of considering the environmental impacts of materials when making purchasing decisions.
- Be familiar with the general principals of life-cycle assessment.
- Appreciate how environmental purchasing forms part of the wider issues of supply chain management and continuous improvement.

5.2 Purchasing materials

Environmental purchasing can help business by reducing corporate exposure to environmental risk, improving the security of key supplies, and driving environmental improvements along the supply chain. Although the benefits of environmental purchasing have to be weighed against costs and other commercial pressures, the environment can no longer be ignored in purchasing practices.

The products manufactured, or services delivered, by a business obviously define the types of materials used, however, there are usually choices available as to the specific products or services that are utilised. This means that companies must make purchasing decisions and so have the opportunity to include environmental criteria in that decision-making process.

Environmental purchasing is about specifying products and services that provide the desired functionality with a reduced environmental impact when compared to alternatives. Amongst other things they:

- Provide value for money.
- Are energy and resource efficient.
- Use the minimum of virgin materials.
- Make maximum use of recycled materials.
- Produce minimal pollution.

- Are durable, easily upgraded and repairable.
- Are re-usable, with available markets and infrastructure for recycling the product at the end of its life.
- Are supported by additional information to demonstrate why they are environmentally preferable.

5.2.1 Why is environmental purchasing an important business issue?

In today's economic, social and political climate, businesses are being driven to address environmental issues in a formal and structured manner. The driving forces behind these changes, some of which are detailed below, all have implications for an organisation's financial position and are therefore major influences on the adoption of improved environmental management practices, including environmental purchasing.

Legislative pressure

The Government's commitment to sustainable development is reflected in a large quantity of environmental legislation and fiscal policy seeking to drive environmental improvement and to impose limits on pollution and waste. For example (see up to date):

- The Climate Change Levy.
- The Landfill Tax.
- The Producer Responsibility Obligations (Packaging Waste) Regulations.
- The Packaging (Essential Requirements) Regulations.
- The Waste Electrical and Electronic Equipment Directive.
- The End-of-life Vehicles Directive.
- The Climate Change Act

These initiatives are putting pressure on individual businesses to improve resource efficiency but are also having a direct effect on supply chains, as they affect the market for products and therefore the context in which purchasing is carried out. Environmental purchasing provides business with a means to avoid or reduce the burden placed on them by these initiatives and to secure their future in a time of increasing environmental legislation.

Stakeholder pressure

The impact of corporate activity on the local and global environments is of growing concern to customers and the general public. Investors are also beginning to take account of the environmental performance of companies as a good environmental record shows good management control of risks. Thus, stakeholder pressure for improved environmental performance (including environmental purchasing) has risen significantly.

In response to this stakeholder pressure, and to pressure from competitors, many organisations have adopted formal environmental management systems (EMSs), e.g. ISO 14001, EMAS and BS 8555, which can be certified by an external body. As well as focusing on the direct environmental impacts of the activities of a business and providing a structured approach to controlling those impacts, formal systems like these also require a business to look at its impacts 'beyond the factory gate' – i.e. the impact of the goods or services that the business uses or produces. These are known as 'upstream' and 'downstream' impacts.

Supply chain pressures

Large businesses at the top of supply chains have achieved much in terms of environmental management improvements and are now transferring pressure to their suppliers - the smaller businesses with which they deal. The electronic and automotive sectors have been particularly demanding when setting environmental standards. For example, suppliers to General Motors have been advised of the requirement to achieve ISO 14001 and have been set deadlines for meeting that requirement. Other sectors may not have such stringent requirements for demonstrating environmental responsibility but are, nonetheless, expecting their supply chain to achieve and demonstrate significant improvements in environmental performance in order to retain or gain contracts.

Government policy

The UK government's sustainable development strategy contains four broad objectives:

- Social progress that recognises the needs of everyone.
- Effective protection of the environment.
- Prudent use of natural resources.
- Maintenance of high and stable levels of economic growth and employment.

All four of these objectives have a connection with the environmental performance of business and with purchasing, as purchasing activities influence the quantities and types of resources consumed, and have a direct bearing on economic growth and employment. Also, the criteria used when sourcing products or choosing suppliers affects the potential for reducing environmental damage and making social progress in the supply chain.

European policy

Initiatives at the EU level are a key driver of environmental improvement. The EU has, for example, initiated an Integrated Product Policy (IPP) as a way to reduce the environmental impacts of products by looking for cost-effective measures that can be taken at all stages in a product's life-cycle. The EU has also proposed product taxes, banned certain types of material and instituted an eco-labelling scheme.

5.2.2 The business benefits of environmental purchasing

Although introducing environmental considerations into purchasing can add complexity to the decision-making process, it can also deliver a number of benefits. The drivers for environmental considerations becoming integrated into purchasing are discussed below:

To increase profits by reducing waste and improving resource efficiency

The purpose of a purchasing policy is to deliver value for money and ensure that money is not wasted. Effective purchasing processes can make a significant contribution to reducing waste in an organisation. Where the amount of waste generated is large and waste management costs are high, there is likely to be substantial scope to improve purchasing practice, thereby improving environmental performance and reducing costs.

To enhance company image and avoid negative publicity

Businesses can come under pressure from customers or other businesses in the supply chain to improve their environmental performance. Failure to make the necessary improvements may result in the loss of a particular supply contract or, at worst, the failure of the business.

To demonstrate corporate responsibility

Environmental purchasing demonstrates to a wide audience that the business is engaged with the wider consequences of its operations and activities. It indicates that the business is looking at the 'upstream' consequences of its activities, as well as the 'downstream' consequences through examining the impact that both manufacture and use of a product has on the environment.

To secure the supply of goods and services and minimise business risk

New environmental regulations, such as the banning of certain hazardous substances, can have an impact on the security of the supply of vital goods and services. For example, in the chemicals industry, the EU REACH legislation (Registration, Evaluation and Authorisation of Chemicals system) bans a variety of chemicals currently in production. A company can therefore be exposed to business risks through the operations of its suppliers – for example, where the supplier is in breach of environmental regulations. Purchasers need to be aware of the potential implications for supply in such circumstances, in time to source alternative materials or to ensure that existing suppliers can continue to meet their needs.

To provide cost savings and added value

The inferior quality of some early examples of 'greener' products led many to believe that value for money could not be achieved through 'greener' purchasing. However, the quality of such products

has improved, and cost savings can now be achieved by sourcing materials with reduced environmental impact that add value to the business through improved environmental performance.

To create markets for new products and services

Purchasing can add value by helping to stimulate markets for goods and services with reduced environmental impact, particularly through joint working and by encouraging suppliers to aim for continuous improvement across a range of issues, including environmental performance. The result is better quality products from better performing suppliers.

Purchasers with significant buying power, but also smaller companies, can encourage suppliers to invest in new technologies, and develop new products with higher environmental specifications. They can also stimulate markets for:

- Recycled products or those with a high recycled material content.
- New services delivering an equivalent function to the products they replace but at a lower environmental cost.

An example of the power of larger purchasers to influence suppliers is found within public sector procurement. Government agencies in many parts of the world now address the environmental impacts of their purchasing activities, and thereby attempt to stimulate the economy in them.

Encouraging producers to place more environmentally-sound products on the market is known in the UK as Market Transformation. An example of a 'market transformation' measure is the government's Waste and Resources Action Programme (WRAP), whose aim is to create markets for recycled materials. More information on WRAP can be found on their website at www.wrap.org.uk

Case Study 7

Working with suppliers

A vehicle manufacturer's collaborative work with a supplier of sub-assemblies led to reductions in the weight, complexity and material content of that sub-assembly.
Development prompted by the search for cost-reduction led to:

- Energy savings for the supplier and the vehicle user.
- Reduced demand for materials.
- A sub-assembly design that facilitates refurbishment.

Not only did these changes reduce the impact on the environment but also resulted in cost savings for both companies.

Case Study 8

B&Q

In 1990, when a journalist asked Bill Whiting, now the chief executive, how much tropical timber B&Q stocks, he was unable to answer the question, and realised that not knowing really meant not caring. Realising that B&Q had a responsibility as a major retailer to address the environmental impacts it has, Whiting appointed an environmental specialist, Alan Knight, and now B&Q hold their suppliers accountable for ensuring that all of its wood products are from sustainable forestry certified sources. The result has been an enormous marketing success for B&Q. Their policy is to 'continue to build our customers' trust that all our wood and paper products come either from proven, well managed forests or recycled material, thereby continuing to grow sales and build pride for our entire supply chain'.

B&Q now has a well-established system of working with suppliers to reduce the environmental impacts of key product groups, such as wallcoverings, bathroom accessories, paints and garden supplies. In consultation with its suppliers, the company reviews the life-cycle factors of the key products that it stocks, to identify the most important issues for each group and set targets to stimulate improvements in environmental performance. In the case of wallcoverings, for example, the issues identified were the use of pulp certified by the Forestry Stewardship Council (FSC), recycled paper, chlorine bleach, solvent based inks and packaging. All the targets set so far have been achieved and the company has now gained third-party certification that its wallcoverings come from well-managed forestry.

According to Alan Knight, 'Done well, greener purchasing means being a better informed buyer by knowing more about where your products are made and how. It means being more creative and influencing relationships with your suppliers. It results in driving more product innovation and even cost reductions. Ultimately, it means handling products that make you and your colleagues proud'.

5.2.3 Creating an environmental purchasing policy

Creating a new policy is a sensible starting point for an environmental purchasing strategy. This is often developed as part of an overall environmental policy.

The environmental purchasing policy should give priority to the main activity of your company, and purchases that cause the most environmental impact, rather than peripheral activities. For example, a chemical manufacturer should be concerned primarily with the sourcing of feedstocks rather than office paper.

Ideally, an environmental purchasing policy should include commitments to the following:

- Comply with all relevant legislation.
- Encourage suppliers to investigate and introduce processes and products with minimised environmental impact.
- Ensure that environmental credentials are considered in the supplier appraisal process.
- Ensure that, where appropriate, environmental performance criteria are considered in the awarding of contracts.
- Specify, wherever possible and reasonably practicable, the use of materials and products with less environmental impact than comparable materials and products.
- Ensure that consideration is given to inclusion, within all specifications, of a facility for potential suppliers to submit prices for environmentally preferable alternatives.
- Ensure that appropriate consideration is given to the costs and benefits of environmentally preferable alternatives.

Buying Green Energy

Green energy comes from renewable resources. This includes power generated by wind, solar, geothermal, small hydro-electric, wave and biomass sources. By combining effective energy efficiency measures with purchasing all, or a proportion of, your energy supply from renewable sources, you can reduce the environmental impact of your energy usage and support the renewable power industry at the same time. Green energy is also exempt from the Climate Change Levy.

Renewable energy is pooled along with electricity generated by other sources into the national grid. Signing up to a ‘green tariff’ does not guarantee that the electricity supplied to your site comes directly from a renewable source, but it does require the demand for ‘green’ electricity within the grid to be matched by an equivalent supply, which means developing new green energy sources.

Further information on buying green energy is available on the Environment Agency website (http://www.environment-agency.gov.uk/netregs)

5.2.4 Identifying environmentally preferable alternatives

For smaller companies, with limited resources available, the task of identifying environmentally preferable alternatives for materials and services can seem difficult. However, modern society has witnessed an explosion in materials technology, and often a change in materials can actually prove cost-effective. For example, the switch to lightweight materials in the transportation/automotive sector (such as plastics and aluminium alloys) has reduced the amount of fuel used in transportation, and hence the operating cost for that activity.

Quite often it turns out that there is more than one way of satisfying an identified need, and that alternative options can be significantly different from the current solution. Provision of a service rather than a product may meet the same need and prove more economically beneficial.

One way to identify suppliers with good environmental performance is to look for formal environmental accreditations, such as ISO 14001, BS 8555 or eco-labels for particular goods, such as the German Blue Angel label (see Environmental Labels). The Department of the Environment, Food and Rural Affairs (DEFRA) is the main source of information on environmental purchasing in the UK, and can be contacted at http://www.defra.gov.uk/.

Environmental Labels

The EU eco-labelling scheme

The EU flower eco-label scheme considers the whole life-cycle of a product, so has the value of defining 'greener' across a number of criteria. A product bearing an eco-label of this sort can be expected to have better environmental properties itself and to be produced in a less polluting plant than its unlabelled equivalent. The scheme can be applied to any products other than food, drink or pharmaceuticals and certain medical devices.

Other multi-attribute labels

A number of OECD countries, such as Austria, Canada, France and Germany, run multi-attribute schemes similar to the EU eco-labelling scheme. Most schemes enjoy government support. The German Blue Angel scheme has been established for over twenty years and is one of the best known. The Scandinavian Nordic Swan eco-label provides criteria for 24 product groups. In the US, there is no government-run or government-sanctioned eco-labelling programme, but there are two privately run programmes.

Single-issue, single criteria labels

There are a number of eco-labelling schemes that focus on one issue or one stage of a product's life-cycle. Energy labels are used widely on electrical equipment such as computers and domestic appliances. The European scheme for energy labelling of white goods provides one example of a mandatory eco-labelling scheme. In these schemes energy efficiency labels must be displayed at the retail outlet on household appliances such as fridges, freezers, washing machines, dryers and lightbulbs. The labels have information regarding the energy efficiency of the product by ranking them from A (the best) to G (the worst).

Single-issue, multi-criteria labels

These labels are also concerned with only one issue, or one stage of a product's life-cycle, but take into account a number of factors related to that issue. The Forest Stewardship Council (FSC) label for sustainable timber use is one of the best-known schemes of this type. Following the lead of the FSC, a similar scheme has been set up by the Marine Stewardship Council, Unilever and the WWF with the mission of promoting sustainable fisheries.

Further information on a range of labelling schemes is available on the Environment Agency site at www.environment-agency.gov.uk/netregs

5.2.5 Stages involved in environmental purchasing

There are a number of stages involved in the process of purchasing and therefore a number of points at which environmental considerations can be incorporated. Figure 21 below provides a schematic view of some of the processes involved, as viewed from a supply chain management perspective. Some sample questions to consider at each stage of this process are given below.

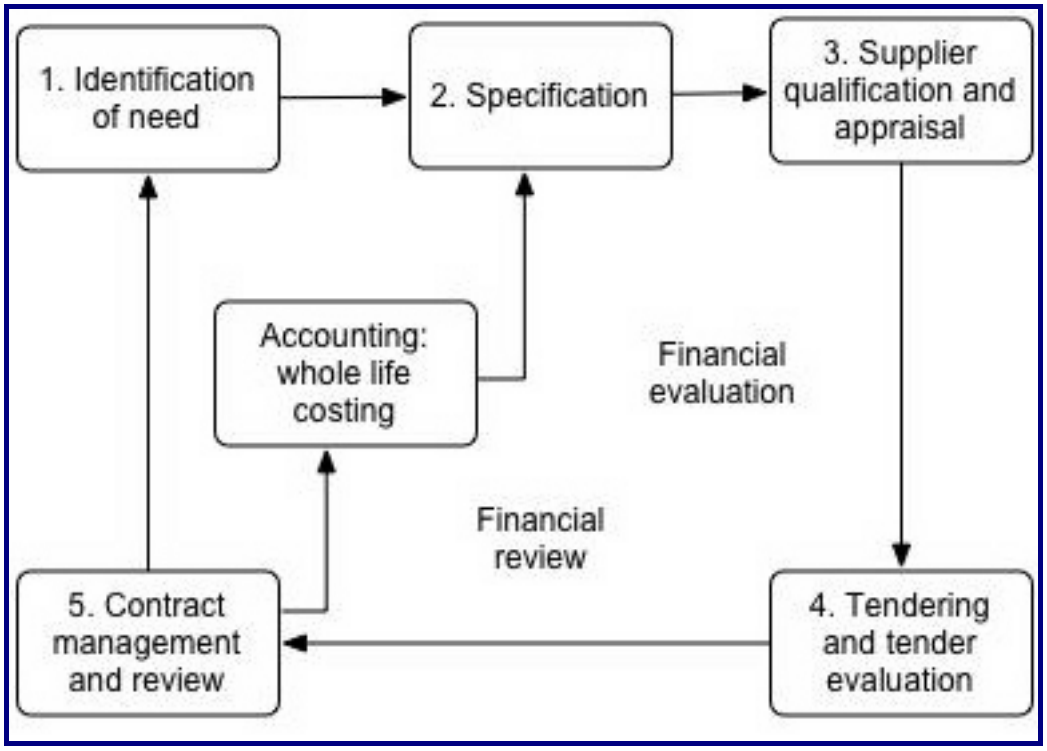


Figure 21. Aspects of supply chain management. Source: Environmental Purchasing in Practice. IEMA, 2002

1. Identification of need

The following points should be considered:

Do we really need this product? Only buy what you really need and consider whether you could mend or repair existing equipment or use products more efficiently.

Do we need it to this specification? Some products can be made from a lower specification material that uses fewer resources without compromising quality.

Can we use a product that contains re-used or recycled materials? This helps to stimulate the economy in recycled or re-usable materials and reduces the overall impact of the product.

Can the product be purchased locally? This reduces transport costs and is good for the economy of your area.

Is it possible to arrange for a 'point of need' delivery system? Arranging for delivery of materials as and when required reduces the need for storage and possible wastage of the product in storage.

Is the product heavily packaged? Can the packaging be reduced, re-used or recycled?

Which product is cheaper over its whole life? Look for the lowest whole-life cost, not just the lowest capital cost.

Can the product be re-used or recycled once obsolete? Will the manufacturer or retailer take the product back?

Will the product require special disposal arrangements? For example, water-based paints are safer and cheaper to dispose of than solvent-based products.

Can your suppliers adapt to your requirements by improving the environmental performance of their product? Initiate dialogue with your suppliers and communicate any specific performance requirements you may have.

Would the purchase of a service be more resource efficient than the purchase of a product? Many purchases are made on the basis of what has been purchased in the past. Effective environmental purchasing requires that 'repeat purchases' should be challenged.

2. The specification

One of the most effective ways of reducing environmental impacts through purchasing is to focus on the specification of materials, in collaboration with suppliers and the end user. By changing specifications you can:

- Manage out wastes such as packaging.
- Reduce the amount of hazardous material in products.
- Improve product quality.
- Increase the recycled material content of products.

Some companies have found that they can improve resource efficiency by relaxing specifications where this is feasible, or allowing the supplier to offer an alternative solution. For example, when a firm buys treatment chemicals for boiler feed water, what the business really wants is clean water for the boiler, not the chemicals themselves.

'Value for money' is not always 'the lowest price'. Relatively expensive products may last longer and create less waste, leading to overall savings. Consider whether the cheapest product is in fact the most economic when the entire life-cycle of that product is taken into consideration, i.e. direct and indirect running costs, administration costs and costs of disposal.

3. Supplier qualification and appraisal

Most organisations use a set of criteria to ensure that suppliers meet their standards. A simple approach to environmental purchasing is to integrate environmental considerations into these criteria.

Supplier appraisal forms are a useful way of evaluating suppliers, but suppliers should not be overwhelmed by unduly sophisticated or technical questions concerning environmental performance in such forms.

Supplier qualification and appraisal: Examples of typical questions

Does your organisation have a named officer responsible for environmental management? If 'yes', please provide the person's name, position and qualifications.	Yes/No
Does your organisation have an Environmental Policy? If yes, please enclose a copy.	Yes/No
Does your organisation have in place an Environmental Management System?	Yes/No
If 'Yes', do you have any objection to this being inspected?	Yes/No
Does your organisation hold either of the following certifications?	Yes/No
• BS 8555 • ISO 14001	Yes/No
Has your organisation compiled a register of environmental legislation relating to your business operations?	Yes/No
If 'Yes', do you have any objection to this being inspected?	Yes/No
Has your organisation compiled a register of environmental aspects / impacts?	Yes/No
If 'Yes', do you have any objection to this being inspected?	Yes/No
Do you have an environmental action plan in place to reduce your adverse impact on the environment?	Yes/No
If 'Yes', do you have any objection to this being inspected?	Yes/No
On a separate sheet, outline the specific environmental impacts associated with your product/service and what steps are being taken to minimise them?	

4. Tendering and tender evaluation

Organisations can incorporate their own environmental priorities into tenders for goods and services. This helps to make environmental purchasing an integral part of business operations, particularly where environmental criteria are used alongside traditional purchasing criteria such as quality, delivery and fitness for purpose.

Many companies apply weightings to the different criteria in tenders to aid evaluation of competing bids. It is therefore possible for environmental factors to be given a higher weighting for products where there is a high degree of environmental risk.

5. Contract management and contract review

Organisations seeking to drive improvements in their supply chain need to ensure that environmental considerations are integrated into the contract management and review process.

Where organisations engage in long-term commercial relationships with suppliers, it is important to convey the message that the environment is a priority for the customer. This may encourage suppliers to bring forward innovative solutions to environmental problems.

Many initiatives involve a certain amount of joint working, where suppliers can collaborate in meeting objectives defined by their major customers. Joint improvement targets typically involve:

- Reducing packaging weight and volumes.
- Introducing re-usable and returnable packaging.
- Reducing hazardous material content of products.
- Improving delivery scheduling to reduce impacts from transportation.

Accounting: whole life costing

The accounting system of a company often needs to show some flexibility to accommodate an environmental purchasing policy. Short payback periods and environmental purchasing can be hard to reconcile. However, providing incentives to budget holders through more flexible accounting practices often makes good business sense.

To justify such changes in accounting practice, it is important for whole-life costing exercises to be fed back to budget holders and decision makers, and that they understand their implications.

5.3 Life-cycle assessment (LCA)

Life-cycle assessment (LCA) considers the environmental impacts of a product from its design to its disposal. It takes into account each step in the life of the product, from 'cradle to grave' including: raw material extraction, manufacturing, packaging, transport, storage, utilisation and disposal. In the context of LCA, an 'environmentally preferable product' is a product that has the minimum of environmental impacts throughout its lifespan, compared with other products or services serving the same purpose.

Addressing the impact of a product or service throughout its entire life-cycle can deliver a number of environmental benefits. These include the following:

- Increased resource efficiency.
- Reduced use of hazardous materials.
- Reduced pollution and waste.
- Reduced impact of distribution.
- Facilitation of re-use and recycling.
- Reduced impact of disposal.

The overall business benefits from this include:

- Increased resource efficiency.
- Improved quality.
- Optimised functionality and service life.
- Improved marketability.
- Increased competitiveness.

5.3.1 The stages of life-cycle assessment

There are a number of stages involved in carrying out a life-cycle assessment. These are addressed below:

Goal and scope definition

As the name implies, at this stage of an LCA, decisions need to be made concerning the purpose of the exercise and what it is going to cover. For example, an LCA could assess a single product or compare similar products that differ in design or manufacturing processes. The environmental

issues that are of particular concern to your company, or stakeholders, may influence the decisions you make about the goal and scope of your LCA.

Inventory analysis

This stage involves gathering data on the environmental burdens associated with each stage in the life-cycle of the product in question. An inventory may be produced, listing how much energy and other resources are used, and how much solid, liquid or gaseous waste is generated during each of these stages.

To aid data interpretation and comparison, LCA relates each of these environmental burdens to the same functional unit, e.g. 1 kg of final product. Obtaining inventory data can be a time consuming task, which is why it is common practice for companies to share LCAs or use established LCA computer tools (see the LCA sourcebook: A European Business Guide to Life-Cycle Assessment, 1993).

Impact assessment

At this stage, to facilitate interpretation of a large number of environmental burdens, burdens with the same environmental impact are grouped together in a process called classification. For example, greenhouse gases would be grouped together, and their total global warming potential calculated.

Interpretation

The results of the previous stages of LCA are used to identify changes in the product or productive system that will reduce the total environmental load.

Case Study 9

Proctor & Gamble

Using LCA to generate cost savings Procter and Gamble has been using LCA successfully for some years to reduce the cost and quantity of raw materials purchased and waste disposed. Interest in LCA crystallised when the company set challenging resource efficiency targets for its operations – one of these was to reduce waste at all its sites by 15% per unit of production.

In three years, waste was reduced by 50%. The benefits to the company for one year alone included a reduction in waste disposal costs of over £2 million, and a reduction in raw material purchases of an estimated £5 million. In five years, Proctor and Gamble saved nearly £50 million across its operations by using LCA to identify resource efficiency opportunities.

LCA can be a laborious, expensive exercise, making it a daunting process for small to medium-sized businesses. However, it can be an important management tool in any resource efficiency programme.

Methodologies have been developed to 'streamline' the LCA process. These are based on the principle that elements within an LCA can be omitted or ignored without impairing the overall result. This approach is likely to be the most practical for smaller businesses.

For example, a lightbulb manufacturer could adopt a streamlined LCA having identified from EU Eco-label published work that the most significant life-cycle stage for a light bulb is the in-use phase. Manufacture and disposal can be reasonably omitted on the basis that 90% or more of the environmental impacts resulting from the manufacture, use and disposal of a light bulb occur during use and are attributable to the electricity consumed.

How the customer uses a product may be every bit as important for its environmental impact as how the product is made or disposed of. In the case of dishwashers, a study conducted for the EC showed that the most significant environmental impacts occur during use, due to electricity consumption, water consumption and detergent use, rather than during manufacture and disposal. In such a case, a focus on clear instructions can be as important as clever technology.

The key barriers to carrying out an effective and useful LCA are detailed below with corresponding solutions:

Lack of time and resources

- Simplify boundaries of the study.
- Use checklists.

Lack of expertise

- Look at case studies.
- Use external agencies such as ENWORKS and Envirowise.

Lack of data

- Search the Internet.
- Use generic LCA data.

5.3.3 Changes based on a life cycle assessment

The reason for carrying out a life cycle assessment is to improve the efficiency of the production process, therefore reducing resource consumption and making cost savings. Some examples of changes that might be made in the light of an LCA are given below:

Input material changes

These could include substituting a material that provides the required function but results in a reduced environmental impact. Examples are the replacement of chlorinated organic solvents by non-chlorinated or aqueous media in cleaning operations or paints, or the replacement of chemical biocides by hydrogen peroxide, which decomposes to leave no residues. In such situations, the whole life-cycle of the material must be considered to ensure that one environmental problem is not simply being exchanged for another at a different stage.

Technological changes

These could include improving process control – redesigning a process to improve heat recovery or to avoid dilution of process streams, or improving waste segregation – implementing a process to treat a specific waste is likely to be more effective and less expensive than treatment of a mixed waste stream. ‘Concentrate and contain’ waste rather than ‘dilute and disperse’ it.

Operating practice changes

These could include changing or implementing operational controls in the form of procedures or training to prevent unnecessary releases, such as leaks, or to re-use materials, such as solvents. Waste should be avoided at source rather than cleaned up after its production.

Product changes

These could include alterations made to the final product to reduce waste generation and other environmental impacts arising elsewhere in the life-cycle. This will be covered in more detail in the next section on cleaner product design.

5.3.4 Cleaner product design

Ultimately, conducting an LCA may identify a need to redesign the product in order to improve resource efficiency and reduce the environmental impact of the product. This involves a process known as cleaner product design.

Cleaner product design involves satisfying your customers' requirements (and optimising the product or service delivered to them) whilst using the minimum amount of resources and creating the minimum amount of environmental impact over the product's life cycle.

5.3.5 The business case for cleaner product design

As well as being beneficial to the environment, there are real savings to be made from greater efficiency in product design. The potential benefits of cleaner design include:

- Lower production costs.
- Improved product function and quality.
- Increased market share.
- Improved environmental performance, which facilitates compliance with accreditations such as ISO 14001.
- Improved relationships with customers and suppliers.
- Continued compliance with legislation.
- Easier disassembly and increased potential for recycling.
- Longer product design life.

5.3.6 Key considerations in cleaner product design

The environmental performance of your product can be improved by taking into account key considerations at the various stages of the product's life-cycle, listed below. These considerations can help you identify design priorities and to focus on areas that will reduce both costs and environmental impact.

Raw materials

Use materials with less environmental impact. Create a list of the materials used in your products and identify the environmental impacts associated with them. Specifying materials that have a reduced environmental impact during their production, e.g. using less energy or causing less pollution, will reduce the product's environmental impact and could also reduce the need for expensive controls during production. Using renewable materials and recycled materials instead of virgin materials will reduce resource depletion and create opportunities and markets for using waste, thus diverting it from landfill disposal. Using fewer hazardous materials, or reducing the amount used, can reduce the environmental impacts and costs associated with disposal.

Use less material. Reducing the amount of material used to make the product will reduce resource use, the transportation of material and the amount of waste when the product is eventually discarded.

Manufacture

Reduce the impact of the manufacturing process. How is the product manufactured? Is it an energy intensive process? Does it produce a lot of waste? Designing the product so that the manufacturing process uses less material, energy, water and other resources will reduce the adverse environmental impacts of production and increase your efficiency.

Distribution

Reduce the impacts of distribution. Reducing the weight and volume of packaging and designing the product's transport and storage to use less energy and to produce less waste and pollution will reduce both environmental impacts and the cost of the final product. Using robust packaging that can be re-used may also bring cost and environmental benefits.

Use

Use fewer resources. Designing the product so that its use and maintenance requires less materials, consumables, energy and other resources will reduce the adverse impacts of the product and the cost of using the product, e.g. electricity and water consumption.

Cause less pollution and waste. Designing the product so that it causes less pollution and produces fewer emissions and less waste will reduce its environmental impact during use.

Optimise the efficiency and service life of the product. Optimising the efficiency with which a product performs its purpose reduces the need for additional products or resources to achieve the same task. Giving the product a longer service life will require fewer products to be manufactured, thus reducing the pollution associated with a product's production, delivery and disposal.

End-of-life

At the end of its 'first' life, your product (or parts of it) may be re-used, remanufactured, recycled, destroyed in an incinerator to recover energy or disposed of to landfill.

Make re-use and recycling easier. Re-using, remanufacturing and/or recycling all or part of the product can significantly reduce raw material use and divert material away from limited landfill space. Design decisions can ensure that these options are achievable.

Reduce the environmental impact of disposal. Where re-use or recycling is not possible, the product will be disposed of. Landfilling the product uses limited landfill capacity and, depending on the material content, poses potential toxicity problems to land, watercourses and groundwater, e.g. through chlorinated solvents in landfill leachate. Incineration with energy recovery provides an alternative disposal option for the product, which may have a reduced environmental impact. The product can be designed to minimise its impacts at end-of-life.

5.3.7 Implementing a cleaner product design programme

Implementing a cleaner product design programme involves the following stages.

1. Organisational aspects

Appoint an internal Champion for cleaner design. Senior management commitment and financial support is essential.

2. Researching your product

The aim of product research is to understand which aspects of the product cause the greatest environmental impacts in order to identify how these may be addressed. Information is required for the key considerations listed above. Identify the main issues for each stage in the product's life, the quantity per unit product and the opportunities for improvement. Use trade associations, libraries and consultants as information sources.

A complete life-cycle assessment may not be required, but a streamlined approach, as discussed earlier is frequently useful. Dismantle your product to see how easy it would be to recycle. This is frequently useful to identify the key areas on which you should concentrate.

3. Identifying cleaner design priorities

It is essential to prioritise cleaner design priorities otherwise the exercise can become unnecessarily complicated. When deciding which ideas to take forward, consider:

- The scope for environmental gain.
- Compliance with existing and future legislation - for example, legislation that increasingly places responsibility for disposal upon the producer is likely to come into effect over the next few years.
- The scope for direct and indirect cost savings.
- The customer and supply chain relationship – for example, increased satisfaction or closer working.
- The work involved and the likely costs of implementing the change.

4. Designing the cleaner product

This should aim to meet the priorities identified at the information gathering and analysis stages, using principles such as material substitution and resource efficiency, and incorporating design features to facilitate recycling (for example, labelling components that can be recycled).

5. Design review

Feedback from the production and sales departments throughout the design process is vital to confirm the manufacturability and marketability of your cleaner products. This feedback may lead to modifications and contribute ideas for further cleaner design initiatives. It provides the impetus to begin the cleaner design cycle again to achieve continual improvement.

Case Study 10

Crawford Hansford & Kimber Ltd: Keeping ahead of the legislation

This SME manufactures electronic sub-assemblies for industry. They identified the WEEE directive as a driver for change as it would potentially increase the running costs of the business. They adopted a proactive approach using cleaner design as a method of increasing product recyclability and reducing unit costs. The new design:

- Reduced use of lead solder by 80%
- Reduced the number of screws and fittings used
- Created additional markets for cleaner products
- Reduced costs and the environmental impact of production

Case Study 11

Cleaner product design

Varian Medical Systems UK Ltd implemented cleaner design techniques to reduce the environmental impact of its products at all stages of their life-cycle, i.e. design, development, production, operation, disassembly, recycling and final disposal. Design for value maximisation was applied first to the collimator unit of a radiotherapy simulator. They identified three drivers for cleaner design:

To maintain competitive advantage

To avoid excessive costs from proposed European take-back legislation

To satisfy corporate policies

The benefits of cleaner design include:

Lower production costs

Reduced environmental impact of products

A positive marketing feature

Improved product quality; and

Easier disassembly and increased recyclability

Implementation included: the appointment of a co-ordinator, training for selected staff and the setting up of cross-functional working groups. These groups assisted the project development team by examining specific issues associated with finishing, fastening, connectors and labelling. Integration of cleaner design into the organisational culture of the company proved crucial to the success of the initiative.

Re-designing their products along cleaner design principles led to cost savings of £162,000/year, achieved at a cost of £24,620. There was a 65% reduction in the number of components used, a 29% reduction in the number of fasteners, and a 27% reduction in assembly time. The cleaner design included a switch to water-based paints.

5.4 Supply chain management

5.4.1 Purchasing as part of the wider supply chain

Supply chain management is about improving the way your company finds the raw components it needs to make a product or service, manufactures that product or service and delivers it to customers. Supply Chain Management has two measurable objectives:

- Increased revenues (via time to market or improved product availability).
- Reduced costs (via reduced inventory and better procurement).

A key consideration is building up relationships with customers as well as suppliers.

Effective supply chain management solidifies business links and leads to greater understanding and awareness throughout the supply chain.

5.4.2 Environmental purchasing, supply chain management and EMSs

Supply chain management, life-cycle assessment, environmental purchasing and resource efficiency all fit into an environmental management system structure. Effective management of material inputs into your company facilitates compliance with the demands of ISO 14001 and environmental regulations.

For environmental purchasing to be fully effective, the link needs to be made with environmental management systems. This can be done most effectively in the assessment of significant environmental aspects. The assessment of brought-in goods and services should consider the potential environmental impacts of suppliers' and service providers' actions and processes, and it should also consider the environmental impacts associated with the products themselves and their constituent materials.

Compliance with environmental legislation and standards affecting products and product life-cycles should be identified by the organisation's management system procedures. Where compliance with legislation or standards requires some form of supply chain management, the EMS programme should include such activity.

Module 6 – Air Emissions

Emissions of chemical compounds into the atmosphere are responsible for causing many environmental and health problems. The sources and effects of these emissions are varied and complex modern industry must reduce its contribution to atmospheric pollution in order to reduce the negative effects it can have. There is considerable evidence that this reduction can be achieved at no-cost and low-cost in many cases, and that it can result in major cost savings to the industry concerned.

6.1 Learning objectives

This module introduces the emission and management of atmospheric pollution from industry. As a result of this module, delegates should understand:

- The major atmospheric pollutants emitted by industry and vehicles, and their associated environmental effects.
- The legislation applicable to emissions from industrial processes.
- The management techniques available to reduce emissions from solvents, resulting in cost savings and improved environmental performance.
- The management techniques available to improve the efficiency of transport and distribution, again reducing environmental impact and generating cost savings.

6.2 The business case for emissions reduction

There are several reasons why businesses should strive to eliminate, reduce and manage their airborne emissions:

Environmental protection

Urban air pollution, acid rain, contamination by toxic chemicals (some of them persistent and transported over long distances), depletion of the ozone layer and changes in the global climate system are all important environmental threats linked to the emission of pollution to atmosphere. Businesses must recognise their contribution to these issues and respond by gaining management control of emissions to air. This control must cover chemicals such as chlorofluorocarbons (CFCs) that are produced for industrial use but are released unintentionally into the atmosphere by faulty equipment, goods or practices; and chemicals as sulphur dioxide (SO_2) and carbon monoxide (CO) that are unavoidable by-products of burning fossil fuels.

Economic benefit

Control of emissions, for example, through energy efficiency, solvent management and transport management, saves money rather than being an additional expense. Good environmental practice is part of good business practice.

Reputation

Demonstrating social and environmental responsibility can enhance corporate image and make good business sense. It will pay dividends both in terms of attracting public consumers, and securing trade with business customers who are increasingly concerned with ensuring that their supply chain is environmentally responsible. Efficient emissions management can enable companies to prove to key stakeholders that they are aware of their impact on the environment and are working to reduce them.

Government policy

Atmospheric pollution in England and Wales is regulated by legislative controls and economic instruments, and reflects the development of government policy and law from a localised, piecemeal response to pollution incidents, to a planned and integrated response to local, national and global threats to air quality. Taking a proactive approach to emissions management can help business to ensure compliance with current legislation and provide the time to ensure compliance with future more stringent controls, keeping you a step ahead of the regulators.

Health and safety

Emissions to atmosphere from industry can impact directly on the local community around the businesses (be that commercial or residential), but also on the employees of the business in their working environments. Due to the potentially serious nature of these impacts, emissions are very tightly controlled not only by environmental legislation, but also by health and safety legislation. Managing emissions to air effectively will therefore reduce a business's liability under this legislation, and demonstrate a real commitment to the protection of the health of employees.

6.3 Atmospheric pollutants – an overview

Pollutants can be usefully and simply classified into two types, those with a local or regional impact, and those with a global impact.

6.3.1 Local and regional pollutants

Sulphur gases

The main sulphur gas pollutant is sulphur dioxide (SO_2); it is produced during the burning of fossil fuels and comes from natural sources such as volcanoes and the burning of vegetation. The main source of emissions in the UK is fossil fuel power stations (66% of the total in 1993) but industrial processes also constitute a significant contribution. SO_2 causes acid rain and is one of the components of smog (smoke and fog). The devastating effects of smog (for example in the 'Great Smog' in London in 1952 when around 4000 people died) led to the building of higher stacks to try and disperse pollution higher into the atmosphere. Since 1970 here has been an overall decrease in sulphur dioxide emissions in the UK by some 50%, but it is still an important source of pollution. In summary, sulphur dioxide:

- Is damaging to human health (causing respiratory problems).
- Damages ecosystems (especially lakes) by making the soil and water more acidic.
- Wears away buildings – especially those constructed with limestone.

Nitrogen gases

These pollutants include ammonia (NH_3), nitric oxide (NO), nitrogen dioxide (NO_2), and nitrous oxide (N_20). Nitrogen gases are also responsible for acid rain, and are involved in the formation of secondary pollutants such as ground-level ozone. The major sources of NOx in the UK in 1999 were road transport (44%), power stations (21%) and industry (including iron and steel refineries) (12%). In summary, nitrogen pollution:

- Is damaging to human health.
- Is sometimes beneficial for ecosystems (since it is an inadvertent fertilizer), but is often 'too much of a good thing', leading to damage to lakes and forests by over-fertilisation.

Hydrocarbons

These are a chemically diverse group of air pollutants ranging from methane (CH_4) to complex compounds such as polycyclic aromatic hydrocarbons (PAHs). They are primarily produced during the burning of fossil fuels.

Volatile organic carbons (VOCs) – such as benzene – fall within this category of pollutants. They are liquid at room temperature but readily evaporate to cause atmospheric pollution. Paints, varnishes, and wax all contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing, and hobby products. The ability of organic chemicals to cause health effects varies greatly from those that are highly toxic, to those with no known health effects. Health effects associated with VOCs

include eye, nose, and throat irritation; headaches, loss of coordination, nausea; and damage to the liver, kidneys, and central nervous system. Although there has been an overall decline in the total levels of atmospheric pollutants in the UK over recent years, the levels of VOCs emitted are still high.

Particulates

These are a growing source of concern. Evidence is emerging that particles with a diameter of less than 2.5 µm ($PM_{2.5}$) affect human health significantly by penetrating deeply into the lungs, settling in areas where the body's natural clearance mechanism can't remove them. The constituents in small particulates also tend to be more chemically active and may be acidic as well and therefore more damaging. Diesel engines are a key source of particulate emissions.

6.3.2 Pollutants with a global impact

CFCs

Ozone depletion is caused when chemicals such as CFCs rise into the stratosphere. In contrast to ground level ozone, the stratospheric ozone layer is vital to life as it filters out damaging UV radiation that is readily absorbed by our DNA and can cause cancers. The international community has addressed the serious problem of ozone depletion by banning the use of CFCs.

Greenhouse gases

These are gases in the atmosphere such as water vapour and carbon dioxide (CO_2) that allow short-wave solar radiation through the atmosphere, but absorb thermal (long-wave) radiation emitted from clouds and the earth's surface, thereby preventing the radiation from escaping back into space. The result is a build-up of the Earth's temperature – like the build-up of heat in a greenhouse, where the glass also allows solar radiation to enter the greenhouse but retains the heat.

The greenhouse effect is a natural phenomenon, however, fossil fuel combustion, agriculture and the burning of forests world-wide is causing an 'enhanced greenhouse effect' through increased emissions of gases such as carbon dioxide, nitrous oxides and CFCs.

Given the great risk that climate change and other air pollution presents, there is an increasing amount of legislation in place to ensure that businesses manage their emissions effectively and reduce emissions of CO_2 and other greenhouse gases as far as is practicable.

6.4 Solvent management

Solvents are used as dispersants, viscosity modifiers (for example in lubrication of machinery), cleaning agents and chemical reactants. Typical solvent compounds include:

- Hydrocarbons (hexane, toluene, xylene).
- Alcohols (ethanol, isopropanol).
- Ketones.

6.4.1 Why manage solvents?

Economics

There are good business reasons for careful solvents management. As solvents are expensive (£500 - £2000 / tonne), improving their management can greatly reduce losses and wastage and therefore generate cost savings. Health benefits and improvements to the working environment can also be gained from reducing emissions within the workplace. These can be achieved through improved housekeeping and leak prevention measures and may beneficially affect the productivity and profitability of business. Reducing emissions may also improve your company's image as good solvent management is an indicator of good overall management. A responsible public profile can be beneficial to the bottom line by attracting new business.

Environment

Emissions from solvents are a serious environmental concern. For example, many are harmful to human health (e.g. carcinogens) and many react photochemically to create low level ozone. Solvents in liquid form also constitute hazardous waste, the treatment and disposal of which is associated with further negative environmental impacts, and of course with financial costs to the business.

Legislative compliance

The use of solvents falls under the remit of a number of pieces of legislation including PPC, IPPC and the Solvent Emissions (England & Wales) Regulations (see up to date). Solvent management will help to ensure that you are aware of the volume of solvents you are using and the requirements of compliance with current and future legislation.

Reduction of solvent consumption through solvent management may mean that your processes no longer fall under the legislation. Therefore, saving you administration time and possibly avoiding the need for expensive abatement equipment.

6.4.2 Keeping track of your solvents

The solvent management process is a cyclical one that begins with an initial assessment to generate an awareness of the key issues. Quantities of solvents used must then be established, and staff and resources allocated to the project. An action plan to reduce the use of solvents should then be produced and, once the plan has been implemented, the final stage in the cycle is a review of the progress that has been made. The cycle then begins again.

This cyclic approach to solvents management is similar to the cyclical approach recommended for effective resource efficiency programmes, and the steps involved in solvent management should be incorporated in to a wider resource efficiency programme.

Step 1 – Gain commitment and establish consumption

As with all resource efficiency issues, the success of a solvent management programme is dependant on gaining commitment from management and all other employees. In order to gain commitment you will need to demonstrate that business benefits such as cost savings can be made through solvent management.

To establish the scale of savings that can be made you must gather the following information:

- Total quantity of solvents consumed each year.
- Total cost of solvents each year.

This process will be aided by developing a list of all the solvent-containing materials used on site. The list should include the solvent content and details of the supplier.

Step 2 – Solvent flow

The inputs, outputs and emissions from your processes must be identified and then quantified. Figure 22 below identifies a number of these.

Emissions can be in the form of captured emissions (i.e. those that are extracted through ducting to a vent or stack) or uncaptured/fugitive emissions (those that are released to atmosphere through windows, doors etc).

Inputs include all solvents purchased, both virgin and recovered, as well as those already present in coatings.

Outputs include solvents that that are disposed of off-site as well as those discharged to water. Also consider solvents that are recovered on-site and those that are left in the product.

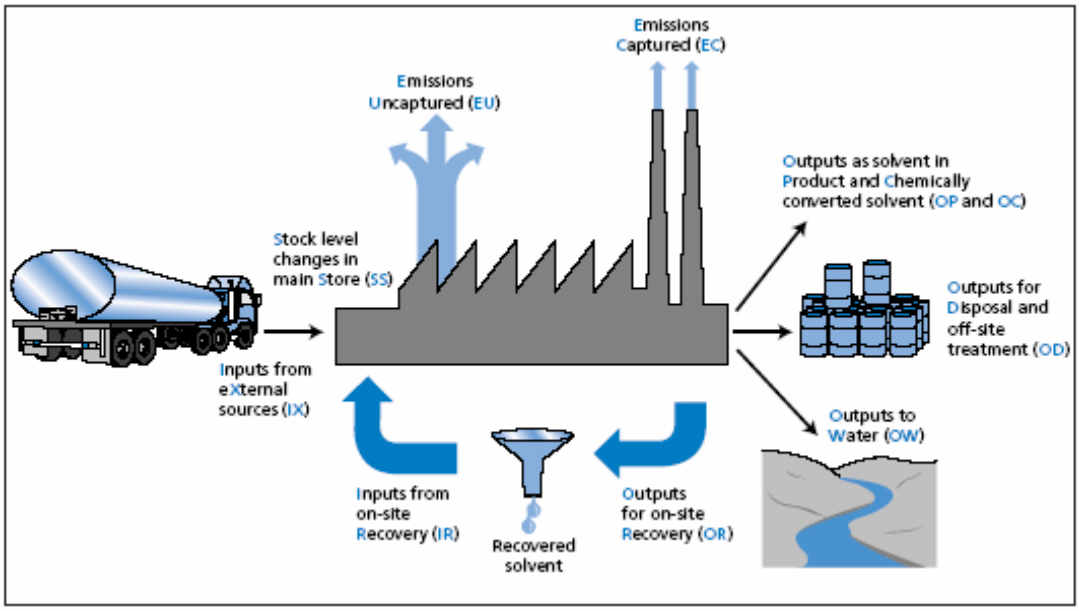


Figure 22. Solvent flow through a factory

Step 3 – Calculating emissions

Solvent emissions (E) can be calculated using the following equation:

E = I – O – S

Where:
E = the total amount of solvent emitted to the atmosphere by evaporation annually
I = the total amount of solvent purchased or re-used during the year
O = the total amount of solvent disposed of, sent for recovery, reacted during the year
S = the change in stock level compared with starting stock. This should include changes at the main store and in the process (i.e. in the machine reservoirs).

When calculating emissions or carrying out a mass balance exercise it is essential that the same units are used for each element. Note that mass balancing can also be usefully carried out for individual processes, using the same methods, in order to help identify processes where solvent use is excessive.

Step 4 – Calculate costs

Information on the cost of solvents should be easily accessed from financial accounts and purchasing. When assessing the cost of solvent losses you must consider the 'true cost of solvent waste' so include other elements such as disposal costs. This will be available from waste documentation from your waste removal company.

Once you have gathered together the financial information you then add that to the mass balance equation to calculate the cost of emissions to atmosphere in terms of lost solvent.

Solvent Emission Mass Balance

A company has two machines, each fitted with local air extraction and ventilation. Mixing of coatings is carried out manually in a central non-extracted, mixing bay. Machine washing is also manual. As part of a resource efficiency programme the company decided to examine its consumption and emission of solvents, as they were the most expensive raw material. The company did not recover any solvents on-site. Outputs of solvents were negligible (at approximately 1%).

During the previous financial year the company:

- Purchased 66.6 tonnes of virgin and recovered solvent
- Disposed of 8.25 tonnes in different residues
- Had stock levels 0.25 tonnes lower at the end of the year than at the start

The estimated total emissions to air (E) = 66.6 – 8.25 – (-0.25) (I – O – S) = 58.6 tonnes/year.

The cost of lost solvent is therefore the cost per tonne x 58.6. Remember, the 'true cost' of this inefficiency will be greater as it will include other items such as staff time and resources associated with the current practices that lead to the losses.

For more information about how to carry out a mass balance for solvent emissions and establish the cost, see the Envirowise Best Practice Guides GG114: *Reduce Costs by Tracking Solvents* and GG 13: *Cost-Effective Solvent Management.* Envirowise also produces a useful software package for carrying out an inventory of your solvents, which calculates the mass balance equations automatically.

Step 5 – Establish a solvent management team

Once the potential benefits of reducing solvent losses, and therefore the need for virgin solvents, have been identified the next step is to get people committed and involved in setting up a solvent management system.

It is important at this stage that the solvent management team are integrated with the overall resource efficiency team. The solvent management team must be represented at resource efficiency team meetings, and it is recommended that a manager is appointed to feed back to the resource efficiency team meetings. The role of the manager is to ensure progress is made in reducing solvent consumption and emissions.

The manager will require sufficient resources and full support from employees at all levels in order to meet her/his responsibilities. These responsibilities should be outlined in a file containing all documentation relevant to solvent management. This could include:

- Relevant policies and objectives & targets that may have been set by the company – for example: an environmental policy, a purchasing policy, ISO 14001 or resource efficiency objectives & targets.
- Complete records of solvent audits and monitoring programmes.
- Copies of relevant pieces of information relating to solvent use and disposal.

Step 6 – Implement savings initiatives

Generating savings does not always mean investing in new expensive equipment. The following two sections look at how to generate savings using low-cost and no-cost methods, as well as those that will require some investment.

6.4.3 Good housekeeping

Good housekeeping relating to solvent use and handling involves low-cost or no-cost practical measures that allow solvent consumption and VOC emissions to be minimised. Good housekeeping

can be applied throughout the manufacturing cycle, from delivery, storage, on-site delivery and handling, to process use, cleaning, waste recovery and disposal. Simple measures include:

Employee training and solvent awareness

To increase employee motivation you may consider awarding certificates of competence to employees demonstrating good practice, or linking bonuses to reduced consumption. Participation and co-operation from staff at all levels will increase if training and awareness raising initiatives are developed and implemented as part of normal business practices.

Optimising solvent delivery

For example, where possible, encourage suppliers to deliver solvents, and in particular coatings, in intermediate bulk containers (IBCs) rather than drums. By the nature of their design, less will be lost through evaporation and container residues.

Storage

Ensure that storage areas are well ventilated. Paint bulk tanks with light reflective paint to minimise heating and subsequent solvent evaporation. Provide impervious bunds and surfaces for all external storage areas. Fit ‘conservation valves’ for day-night breathing losses.

Distribution

Dispense canned and drummed solvents from a centralised store, keeping a record of the solvent type, quantity and process/department. This will allow a better check to be kept on usage, spillage and theft of solvents on site.

Processing

Always re-lid partly emptied drums or cans of solvent and, where practical, seal with adhesive tape to prevent vapour losses. When mixing solvents and coatings pour the least volatile material first and the most volatile last, thereby reducing losses.

Cleaning

Cleaning operations often use unnecessarily large quantities of solvent. For general surface/floor cleaning try using a detergent and warm water in isolation, or, for more difficult deposits, in conjunction with more mechanical measures such as scrapers or high-pressure jets. This will avoid the need for solvents. Follow a ‘clean as you go’ policy and remove deposits as soon as possible. A build-up of coating can become increasingly difficult to remove as time passes, therefore necessitating the use of solvents.

Maintenance

Consider establishing a preventive maintenance programme to visually check for leaking flanges, valves, welds, etc; pressure-test pipelines; and check for tightness of nuts and bolts.

Spray coatings

Big savings can be obtained using HVLP spray guns. HVLP guns have a transfer efficiency of 40-60%, compared to 20-30% for conventional spray guns.

Case Study 12

Savings through solvent management

- Clarks International, the shoe company, is saving over £270 000/year through good housekeeping and the substitution of water-based coatings/adhesives.
- ABT Products Ltd, a truck cabs company, is saving nearly £17 000/year through the use of high-efficiency spray guns and solvent recovery equipment.

For further details on good housekeeping, see the Envirowise Good Practice Booklets GG28: *Good Housekeeping Measures for Solvents*, and GG71: *Cost-Effective Reduction of Fugitive Solvent Emissions.*

6.4.4 Solvent recovery

There are limits to the amount of solvents that can be saved through good housekeeping. It may therefore be worthwhile investing in technology for solvent recapture and re-use. Techniques include:

- Adsorption. This is a batch process in which a solvent laden gas stream is passed through a suitable adsorption bed to remove the solvents from the stream.
- Condensation. This is based on a simple tube-and-fin heat exchanger.
- Cryogenic condensation. This technique uses liquid nitrogen.

For further information, see the Envirowise best practice booklets:

- GG12: *Solvent capture for recovery and re-use of solvent-laden gas streams*.
- GG100: *Solvent capture and recovery in practice: Industry examples*.

Case Study 13

Adsorption increases efficiency of solvent capture at D. H. Greaves Ltd.

The inks used for gravure printing at D. H. Greaves Ltd contain high levels of toluene. To prevent this solvent escaping to the atmosphere as it evaporates, the company practices solvent recovery, either re-using the recovered product or selling it to the ink manufacturer for re-use.

In 1996, the existing adsorption plant was replaced with a more modern unit, improving the efficiency of solvent capture by 20%, enhancing health and safety and environmental performance, and increasing annual revenue/cost savings from £700 000 to £800 000.

Case Study 14

Akzo Nobel

Akzo Nobel are a multinational company that use chloromethane (methyl chloride) in the manufacture of detergents and personal care items, as well as in products that are used in road construction and mineral processing.

The company monitor VOC emissions annually and then provide the data to the Environment Agency to comply with legislation and maintain the site's Integrated Pollution Control (IPC) authorisation. The release of chloromethane was identified as one of the most significant environmental aspects in the manufacturing process.

The company investigated the potential for cryogenic recovery of the chloromethane and invested £300,000 to purchase the necessary equipment. It is estimated that the new equipment will be able to recover virtually all the chloromethane released from the plant for re-use.

A saving of approximately £20,000/year will be made in raw material costs. Environmental benefits are the reduction in the required input of raw materials required in the process and the reduction in emissions discharged to the atmosphere.

6.5 Fleet management

It is estimated by the Department of Transport that by 2025 there will be 50% more cars on the road than in 1997 resulting in:

- More traffic jams.
- Reduced efficiency.
- Increasing impact on the environment.
- Increased disruption.

More than 10% of all cars running on UK roads are registered to companies, and these account for 20% of total UK car mileage. Another 40% of the UK car stock are former company cars, which means the purchase decisions of car fleet operators will heavily influence the composition of the UK's car stock and thereby the scale of environmental impacts.

6.5.1 Aims of fleet management

As the cost of transport and distribution increases, through direct means such as fuel and vehicle taxes, and indirect means such as the inefficiencies created by volumes of traffic, business must aim to manage their fleets efficiently for economic and environmental benefit. A fleet management programme or travel plan is a strategic package of initiatives designed to reduce vehicle use and improve the efficiency of necessary transport practices. Management control of fleets is becoming ever more necessary as such a programme enables a business to anticipate and adjust to tightening legislation whilst remaining mobile, achieving continual improvement and cutting costs.

6.5.2 Why consider fleet management?

Motor vehicles are a major source of atmospheric pollution. Petrol and diesel driven vehicles account for the following proportions of UK emissions (2003 figures):

- 98% (approximately) of benzene.
- 89% of carbon monoxide.
- 10% of carbon dioxide.
- 51% of lead.
- 36% of hydrocarbons.

Our continued reliance on road transport has effects on the environment at many levels. To tackle these effects, authorities need to reduce our reliance on cars and this is often attempted by increasing the cost of their use. For example, many inner cities are trying to encourage people to use alternative methods of transport by introducing disincentives to car use. These range from the introduction of congestion charging, low emission zones and escalating car park charges. All these policies will have a direct impact on the cost of running a fleet.

6.5.3 Initiating your fleet management programme

To implement a fleet management programme, a business will first need to understand it's current position. This is done by:

- Looking at journey patterns for business trips.
- Looking at the vehicles being operated.
- Recording business mileages.
- Recording fuel consumption.

Once this is done, the results should be analysed to identify areas where efficiency can be improved by evaluating alternative options.

6.5.4 Vehicle selection

The vehicle selection process is a vital component of good fleet management. As with any other task, it is important to select the right tool for the job and a company should be conscious of the vehicle specifications of it's fleet.

Relevant questions may include:

- What size/specification of vehicle is required?
- What fuel type is best? Petrol, Diesel, LPG/CNG, Electric, Hybrid (petrol/diesel and electric).
- Which specific model is most fuel-efficient / has the least CO_2 emissions?

6.5.5 Vehicle controls

It is necessary for a business to analyse its vehicle allocation policy so that, where possible, they can remove the option of a high pollution vehicle and in turn promote the use of low polluters.

Drivers of company vehicles should be made aware of the implications of CO_2 based taxation schemes.

It is essential that all vehicles are well serviced and maintained. Poorly maintained vehicles produce higher levels of harmful emissions, and are less fuel-efficient.

6.5.6 Travel reimbursement controls

Travel remuneration policies should be designed so as not to encourage driving extra miles, or be advantageous to those driving inefficient vehicles. A fleet management programme should provide guidance for journey methods, advising when to use a company vehicle or public transport, and when to make a hotel stopover.

Methods implemented should be aimed at reducing unnecessary mileage, and could include:

- Better journey planning (route planning software / internet).
- Better scheduling for customer visits / meetings.
- Increased use of telecommunications.
- Increased use of public transport / alternative travel methods.
- Car sharing.

6.5.7 Monitor mileage and fuel use

Accurate records should be made in order to identify and reduce redundant mileage and also to identify fraud. The utilisation of exception reporting can aid the identification of:

- Inefficient vehicles and groups of vehicles.
- Inefficient drivers and groups of drivers.
- Fraud.

6.5.8 Plan business trips

Business trips should be planned as far in advance as possible and when doing so, consideration should be given to the necessity of attending in person or whether it is possible to make use of telecommunications instead. If attendance in person is vital then fuel use may be minimised through careful selection of the venue for the meeting. If this is not possible, the time of the meeting should be looked at. At off-peak times, the roads are less congested and advantage can be taken of off-peak travel fares.

The diagram below can be used as a methodology to plan business trips so as to minimise unnecessary mileage.

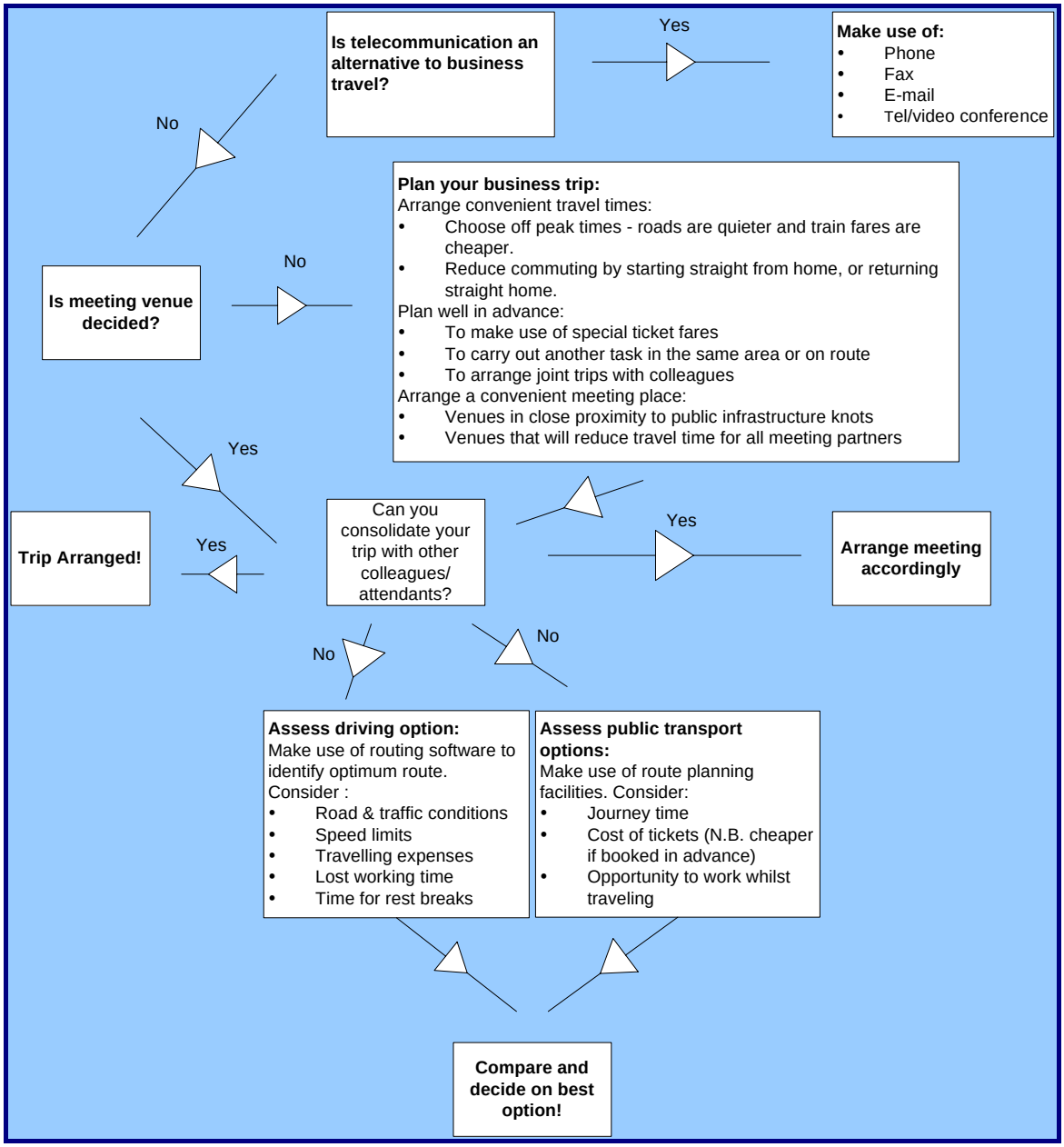


Figure 23. Travel planning flow diagram

6.5.9 How efficient is your fleet?

Once mileage and fuel efficiency data have been collected for your fleet, various performance indicators can be calculated.

The average mpg of vehicles in your fleet = $\frac{\text{Total mpg for fleet vehicles}}{\text{Total number of fleet vehicles}}$

How does your fleet compare with the national average of 35mpg?

The most efficient vehicles should be used for high mileage duties.

6.5.10 Driver education

A driver who is well educated about the correct and efficient methods of using a vehicle is much more beneficial to the environment and their company. Every driver thinks they drive well, but particular attention should be made to the following points:

- Smooth driving reduces fuel consumption by 10% in urban areas and 6% elsewhere.
- Correct gear selection can increase fuel efficiency by up to 25%.
- Tyre pressure should be checked regularly. A tyre that is under-inflated by as little as 2ps will lead to a reduction in fuel efficiency of at least 1%.
- Air conditioning can reduce fuel efficiency by as much as 10%.
- Journeys should be planned before departure. The AA estimates 20% of driving time on unfamiliar roads is spent getting lost!

6.5.11 Encourage other methods

Alternative methods of transport should always be considered. These include:

Car sharing. This is suitable for colleagues who commute into work from the same area and for colleagues attending meetings off-site, i.e. seminars and presentations. There have been proposals to implement special lanes for “car sharers”, enabling participators to avoid congestion.

Public Transport. This is an ideal method of avoiding congestion charges, beating one-way systems, and reducing the amount of pollution emitted to the atmosphere.

Cycling/Walking. These methods enable the user to bypass traffic jams, keep fit and benefit the environment.

The cost of inefficiency

- The annual cost of providing an employee parking space can be as much as the price of a season ticket for public transport use.
- Aggressive driving can increase fuel bills by a third.
- The fuel consumption of similar models of new cars can vary by over 25%.
- Strict monitoring alone can achieve fuel savings of at least 5%.