Reducing Energy Costs - The First Steps

The “Climate Change Levy” will increase the cost of electricity by 0.43p/kWh and the base energy generation costs are rising throughout the world. Energy costs are always somebody else’s problem and the plastics processing industry generally regards the energy as an overhead and as a fixed cost. This is untrue and energy is both a variable and a controllable cost. Most processors could easily reduce energy costs (without large investments) and increase profits through simple good energy management practice. This series aims to show you how to reduce energy usage and increase your profits.

“Energy is a variable and a controllable cost”

The vital questions

Before you can start to reduce your energy costs you need to understand where, when why and how much energy you are using. This information provides the benchmarks and signposts for improvement.

- **Where you are using energy?**

The main electrical energy users are motors and drives, heaters, cooling systems and lighting systems. A simple site energy distribution map will show where energy is being used. If you are using a single meter it may be cost effective to use sub-meters to get further information on the areas of high energy use. Sub metering allows you to start to calculate the cost of energy for each operation and to identify areas of high energy usage - a key factor in reducing energy costs. A first step is to produce an energy map of your site to locate areas for monitoring and improvement.

- **When you are using energy?**

The time at which you are using energy is important and demand plotted versus time will give invaluable information on how to reduce the energy costs (see below). Data for such plots should be available from your supply company. Look for unusual peak variations from day to day and energy use when there is no production. A demand graph also helps you to find the ‘base load’. This is the load used for heating, lighting, compressors and pumps when you have no production at all.

The first in a series of energy efficiency worksheets by Dr. Robin Kent for the EEBPP to help the plastics industry reduce costs through efficient use of energy.

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Another way to find the base load is to record the meter readings (in kWh) and production volumes (in kg) at the end of each shift. Plot the amount of polymer processed against the energy consumption. From the graph, the energy use at zero production gives an idea of the ‘base load’. Reducing the base load is a sure way to make savings.

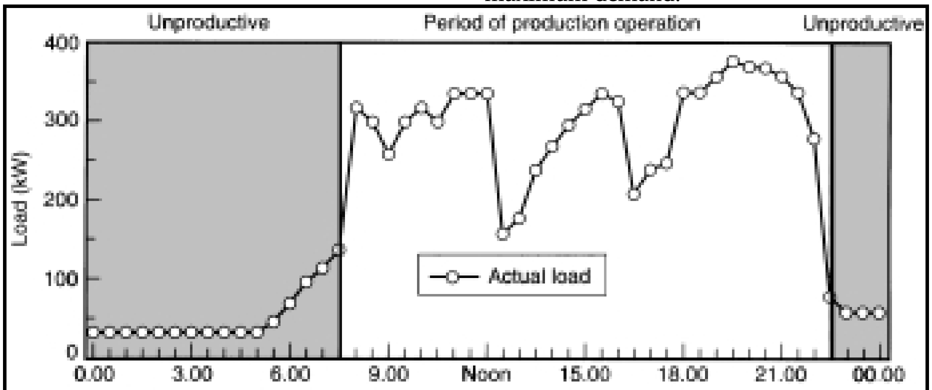
- **Why you are using energy?**

Ideally energy should be used only to produce good product and the most important energy benchmark is the energy used to process good product (in kWh/kg). This is called the specific energy consumption (SEC) and can be found from the slope of the graph produced to find the base load. It can be compared to the industry averages to provide targets for energy reduction.

Is energy being used to keep machines idling when they could be turned off? Are heaters running that are not being used? Are compressors running just to pump air out of leaks? Finding out why you are using energy will reveal a wide range of possible steps for reducing energy use.

- **How much energy you are using?**

Electricity charges are based on a combination of factors (see right) and an initial survey will reveal areas for potential savings, sometimes actions as simple as changing the tariff can reduce costs at no cost! ‘Peak demand lopping’ can be very effective to reduce short peaks in the maximum demand.



Typical Site Energy Usage over Time

Get free advice and help

Energy management will save money and make you more competitive. Start your energy management programme today and reap the benefits of improved profits by cost effective investment and management.

The Government Energy Efficiency Best Practice Programme (EEBPP) provides free resources for energy management and cost reduction in plastics processing. An initial handbook “Energy in Plastics Processing - a practical guide” (GPG292) gives essential information on how to start reducing your energy costs and signposts further free information.

Get the information, save the money and become more competitive!

Key tips for reducing the cost of electricity

Maximum Power Requirement is the maximum current a site can draw at the supply voltage. Reduce the cost by:

- Staggering start-ups.
- Matching the MPR to the requirements.
- Getting the MPR right for new premises to avoid costly charges.
- Negotiating an annually based MD instead of an MPR charge.

Maximum Demand is the current drawn at the supply voltage averaged over half an hour. Reduce the cost by:

- Staggering start-ups.
- Giving machinery time to stabilise before starting up new processes.

Power Factor is a measure of the phase shift created by machinery. Lightly loaded machinery tends to have a high phase shift, and a low power factor. Improve the power factor by running electric motors efficiently to get power factors close to 1.

Load Factor is a measure of the hours per day that the user draws from the supply. Reduce the cost by:

- Running for greater than a single shift.
- Carrying out some operations outside the main shift pattern e.g. regrinding.

Use less energy. See future Worksheets in this series.

Next month: The Initial Site Survey

The rewards

Energy efficiency measures can improve your profits significantly for minimum effort and costs. For a plastics company with a turnover of £10 million per year and a net profit of 10% then the profit will be £1 million. The average electricity bill will be approximately £200,000 (between 1 and 3% of turnover). Simple no-cost or low-cost energy reduction practices can reduce this by a minimum of 10% (and up to 20%) and increase profits by at least 2%. This is the equivalent of adding sales of £200,000 to turnover and is a worthwhile investment by any standards.

"Low cost energy efficiency measures can improve profits significantly "

Worksheet 1 of this series gave details of the information needed to understand energy usage. This sheet shows how to carry out an initial site energy survey - the starting point for all improvement plans.

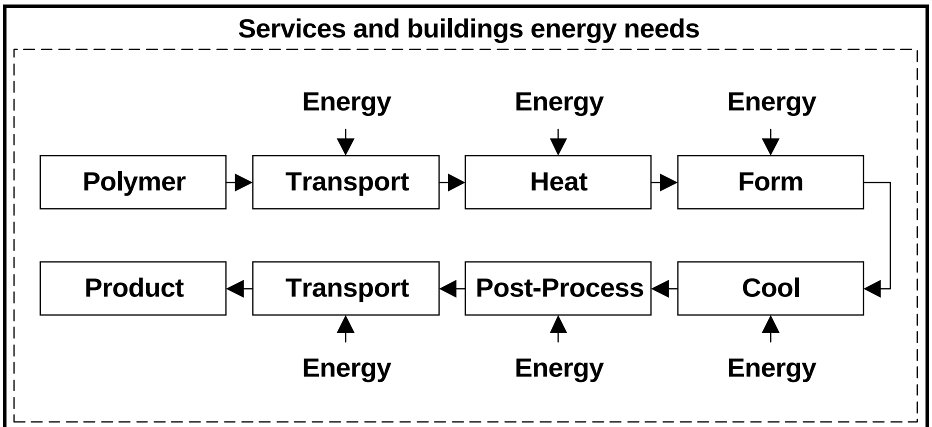
The initial site energy survey

The objective of the initial energy survey is to gain an overview of the general site energy use. It is a walk around the site with an energy manager's hat on. This will identify some rapid no-cost or low-cost improvements that can be made to save money.

The survey should be carried out as soon as possible - if energy is being wasted now, it is costing money now. The diagram shows the main areas of energy use in plastics processing. Use this as a guide during your walk-around to look for areas of high or unnecessary energy usage.

How do you do a site survey?

Take an unannounced walk around the site at around mid-shift. If there is no night shift it can also be profitable to take a walk around the factory when there is no production being carried out.



Energy uses in plastics processing

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The questions to ask (and answer)

- Which areas have the largest electrical load? (look for the largest machines, they will most likely also have the largest motors and create the largest load, when they are used).
- Is the thermal insulation, if present, on all the machines in good condition? If there is no insulation then why not?
- Look for signs of machines that are not in production but have motors or ancillary equipment running (e.g. conveyors, pumps, granulators, fans, machine heaters).
- Are there any good reasons why machines need to be kept idling to be ready for the next production run?
- Which motors are left running when not doing productive work?
- Why are the motors the size they are and would a smaller motor be more efficient?
- Which cooling water pumps (and chillers) and vacuum pumps are still running?
- Is the airflow from fans being throttled back with dampers and could variable speed drives be used instead?
- Look for areas of energy use where no productive work is being carried out and yet machines are running and using energy.
- Look for water, air or steam leaks.
- Where can you hear steam and compressed air leaks? The hissing noise you hear from leaks is costing real money. If there is no production being carried out then why is the compressed air system still running?
- Is compressed air being used for expensive applications where other cheaper methods can be used? e.g. cleaning or drying.
- Does the compressed air pressure need to be so high, or the vacuum so low?
- Is the lighting dirty, broken?
- What are the good, simple maintenance measures that can be adopted to reduce energy use?
- Are 'accepted' practices wasting energy? Can they be modified at no cost at all?
- Are there clear setting instructions for all machines and products and are they implemented when a machine is set up?

Turning the survey into energy savings

A site energy survey is useless unless action is taken as a result of the findings. Use the survey to estimate the excess energy usage of the site and arrange for an electrician to measure the factory electrical load and calculate the costs involved. Use the survey to identify operating practices that cost money and need to be changed. The results of the survey should be sent to the Managing Director and Production Director with full recommendations and costs for carrying them out.

Raising energy awareness

The cost savings possible from energy efficiency will only be achieved if there is a management commitment to actually carry out the work necessary and save the money. This is best ensured by having an energy policy that is as much a part of the overall company operations as the quality policy. The energy policy should ideally be part of a broader company environmental policy and, at the very least, should be formally adopted with top-level management commitment. The policy should be the responsibility of a designated Energy Manager who has clear responsibility for energy matters. There needs to be regular formal and informal communication with major users who are held accountable for their energy usage which should be monitored and targeted. The quantified savings from the implemented energy policy should be promoted within the company and used to create a favourable climate for investment treatment of other energy saving programmes.

Energy efficiency is a competitive advantage in any market and an initial site survey is the start of gaining the advantage for your company.

Next month: Injection Moulding

The third in a series of energy efficiency worksheets by Dr. Robin Kent for the EEBPP to help the plastics industry reduce costs through efficient use of energy.

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Injection Moulding

Over 90% of the energy costs in injection moulding are accounted for by electricity. This makes electricity purchasing very important for moulders and costs can be significantly reduced by good purchasing and operational controls. Only 5 to 10% of the total energy used in the process is actually input to the polymer, the other 90 to 95% is used simply to operate the machine and large savings can be made.

"Good practice is inexpensive and reduces all costs – not just energy costs"

Moulding machines

As with most machines, the initial cost of a moulder will be less than the cost of energy used during its lifetime. The energy cost will be even more for machines that are not energy efficient. Although it may cost more initially, energy efficiency will save money in the long term, a factor that is becoming more important in markets where customers expect decreasing prices through the lifetime of a product.

- **Tip -** Use 'whole life costing' for new machines and include the energy costs.
- **Tip -** Contact machinery suppliers for information on additional equipment to reduce energy consumption.
- **Tip -** New generation machines often have improved energy efficiency and can reduce product costs by over 3%.

Getting the right machine for the job is vital and the machine should be closely matched to the product.

- **Tip -** Using large machines for small products is inherently wasteful. Are all jobs on the appropriate machines?
- **Tip -** Total efficiency decreases as the operating conditions move further away from the design conditions.

Electric motors account for 60% of the electricity used in moulders and the moulding cycle causes intermittent, variable loads with Power Factor values in the region of 0.7. PF correction equipment can increase the PF to greater than 0.95 with a payback of less than one year.

- **Tip -** Improving the PF is cost effective and simple with excellent payback.
- **Tip -** Motors are most efficient near the design load. Oversized motors at part load are less efficient than small motors at full load. Check all motor sizes.

Controlling the start-up sequence of machines can reduce energy costs with no other effect. Starting multiple machines at the same time will increase the Maximum Demand and the energy cost.

- **Tip -** Fit a warning device to the MD meter to sound when the load approaches the allowable limit.
- **Tip -** Plan and control the start-up sequence

Machines use energy even when idling, the amount varies with the machine to but can range from 52% up to 97.5% of the full moulding consumption. An idling machine is not 'free'.

- **Tip -** Idle periods of between 20 to 45 minutes may make it cheaper to switch off and restart.
- **Tip -** Are barrel heaters and cooling fans left on between runs?
- **Tip -** Is cooling water circulating through idle tooling?
- **Tip -** Is compressed air supplied to idle machines?

'All-electric' machines are an energy efficient moulding solution and can both reduce energy use and make computer control easier and more direct. On conventional machines the hydraulic systems provide peak power for a very short time and the hydraulic system is overrated for most of the time.

- **Tip -** The use of accumulators for rapid hydraulic energy release can significantly reduce the hydraulic system size.

Heat transfer to the barrel is improved by pre-seating the heating element to the barrel and by using flexible metal bearing compounds.

- **Tip -** Thermal efficiency can also be improved by barrel insulation. This has a rapid payback (generally under one year) and improves other areas such as Health and Safety and fluctuations due to air currents.

Preventative maintenance such as de-aeration of the oil system and maintenance of the controls will reduce energy costs.

- **Tip -** Monitor the energy use to identify deterioration of the machine.
- **Tip -** Increased maintenance can lead to significant energy savings.

Moulds

Product cooling time is generally more than 50% of the cycle time. Efficient cooling can greatly reduce cycle times and energy usage - a double benefit.

- **Tip -** Is cooling water at the maximum temperature and minimum quality, how efficiently is it treated and distributed?
- **Tip -** Air in the cooling system reduces the cooling effectiveness. Degassed and pressurised systems can reduce cycle times and energy usage.

Excessive tool change times will waste energy if the machine is idling. Rapid set up of tooling reduces energy and improves overall factory effectiveness.

- **Tip -** Are tool changes planned into production schedules? Are they quick?

Ancillaries and services

Ancillaries use energy in electric motors and consumption of utilities. For highly automated production the total ancillary energy demand can be comparable to the machine energy demand. The main opportunities are minimising the demand for utilities. Motors are generally small and run intermittently and it is often not cost effective to retrofit more efficient motors or controls.

- **Tip -** Specifying energy efficiency during design of handling and ancillaries will give rapid payback on any additional costs involved.
- **Tip -** Check that handling systems can be set to operate 'on-demand' only.
- **Tip -** Match utilities to the demand.

Granulation and scrap recovery uses large amounts of energy and can will raise energy bills considerably.

- **Tip -** Carry out granulation at night.

Heat recovered from hydraulic systems and chiller units through heat exchangers can be used to provide space heating for offices and other areas with pay back times of 6 months..

- **Tip -** Look for opportunities to recover heat and reuse energy.

Management controls

Tweaking of machines by operators causes more lost time and energy than almost any other cause.

- **Tip -** Optimising the machine settings reduces the electrical energy needed. Get machines set right, record the settings and do not change them unless absolutely necessary.
- **Tip -** Use Statistical Process Control to control machine settings and performance.

The goal

Management is really at the heart of energy efficiency, without good management, neither energy efficiency nor any other change in operating practices will be effective. Energy efficient injection moulding is simply good moulding practice. It is inexpensive and reduces all costs – not just energy costs. Start working on energy efficiency today and reduce your costs to become a world class energy efficient moulder.

Next month: Extrusion

The fourth in a series of energy efficiency worksheets by Dr. Robin Kent for the EEBPP to help the plastics industry reduce costs through efficient use of energy.

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Extrusion

Extrusion is not only a final forming process for products but is also an intermediate process for other processing techniques such as injection moulding, blow moulding and film blowing. The efficient operation of extrusion screws is therefore essential to much of the plastics processing industry. The process is highly dependent on electricity and most of the energy used is directly related to machine operation. For profile extrusion the energy used to drive the extruder itself is 50% of the total and the remaining energy is used for items such as ancillaries and utilities. Industry surveys show that a typical company should be able to reduce energy usage by 10% without major capital outlay.

"Extrusion is a key forming process and is integral to many other processes"

The extruder

The initial cost of energy efficient extruders may be higher but they will give rapid returns on the extra investment. Options such as high efficiency AC motors and Variable Speed Drives have good payback for both new purchases and when replacing motors and drives.
Whatever the age of the machine, it is essential to get the right extruder for the job and the screw diameter and design should be checked to make sure they are right for the polymer and product.

- **Tip -** Using large extruders for small profiles is wasteful.
- **Tip -** Total efficiency (including energy efficiency) is best operating at the design conditions.
- **Tip -** Set the extruder to run at its most efficient speed (usually maximum design speed) and control the screw speed to give an extrusion rate as close to the maximum as possible and still produce good product.

Motors run most efficiently close to their design output - a large motor at part load is less efficient than a small one at full load.

- **Tip -** Size and control the electric motor to match the torque needed by the screw.

Optimising the extruder speed maximises the heat from mechanical work and minimises the amount of electrical energy needed. Provided the downstream equipment does not limit the output, the energy consumption can decrease by nearly 50% by doubling the rotational speed of the extruder.
Accurate temperature control is needed for good extrusion - excess temperatures are wasted energy. The polymer needs to be kept close to the optimum processing temperature.

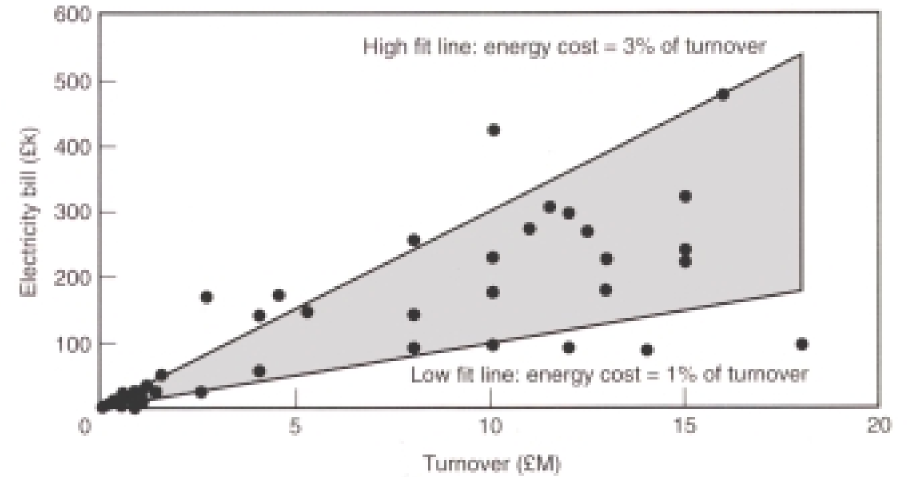
- **Tip -** Barrel insulation has a payback of under 1 year and also reduces Health and Safety issues and air current fluctuations.
- **Tip -** Check the controls to make sure that the heating and cooling are working efficiently together.

Standby' operation can use significant amounts of energy in utilities through barrel heaters, cooling water, calibration vacuum and lights.

- **Tip -** Find the minimum 'standby' settings and set an operator routine to always leave machines in this condition.
- **Tip -** Can you turn off barrel heaters and cooling fans between runs?
- **Tip -** Can you turn off cooling water on idle machines?

Energy use can be used as a diagnostic tool to identify deterioration of the machine condition and the need for maintenance

- **Tip -** Increasing the frequency of maintenance involves effort and cost but can lead to significant energy savings.



The cost of energy to extrusion companies

The ancillaries

The main opportunities for energy saving in ancillaries are in minimising the demand for utilities, such as vacuum and compressed air. The electric motor drives are generally small so replacement with efficient motors is only likely to be cost effective when motors fail. Specifying energy efficient features at the design stage will give rapid paybacks on any additional costs.
The first step is to get the extruder right - if the extruder is at the optimum conditions the need for downstream cooling and calibration will be minimised. For utilities the approach should be to 'minimise the demand and then optimise the supply'.

- **Tip -** Find the maximum acceptable extrudate temperature after cooling and set the maximum cooling water temperature to achieve this.
- **Tip -** Check that cooling water is not circulating through idle calibrators.
- **Tip -** Check that cooling water is treated, chilled and distributed efficiently.
- **Tip -** Check that compressed air is not supplied to idle machines.
- **Tip -** Check that compressed air is generated and distributed efficiently at the minimum pressure needed by the process.
- **Tip -** Check that the vacuum supply is the minimum needed and that it is generated and distributed efficiently.
- **Tip -** Check that the vacuum supply is switched off when it is not needed.
- **Tip -** If replacing electrical motors then match the size to the actual demand and fit energy efficient motors.

Management

'Tweaking' of machines by setters and operators causes more lost time and energy than any other cause.

- **Tip -** Get the machines set right, record the settings and do not change them unless absolutely necessary.

Increased maintenance involves additional effort and costs but can lead to significant energy savings.

- **Tip -** Set up a total productive maintenance (TPM) programme to keep all machines and systems in top condition.

Energy efficiency will save you money – start an energy management programme today and reap the benefits of improved profits by cost effective investment and management.

Next month: Blow Moulding

The fifth in a series of energy efficiency worksheets by Dr. Robin Kent for the EEBPP to help the plastics industry reduce costs through efficient use of energy.

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Extrusion Blow Moulding

For blow moulding, the Specific Energy Consumption (the energy used to process a kg of polymer) varies from 'typical' values of 1.5 - 2.0 kWh/kg up to 'high' values of greater than 3.0 kWh/kg. If your factory SEC is greater than 2.0 kWh/kg there are some real savings to be made from energy efficiency and experience shows that energy savings of 5 to 10% can be made through simple low cost measures. For a company with a turnover of £5 million this means saving £10,000 to £20,000 per year for minimal expense. With rising energy prices and the Climate Change Levy, energy inefficient firms will be at a considerable commercial disadvantage.

"Failing to control energy costs will affect your wallet"

Machine

The major component of energy use is the extruder area which typically uses 40% of the total energy (see previous Worksheet on extrusion. As with other processes, energy efficient machines have lower long-term operating costs than standard machines will pay back any extra investment.

The use of all-electric machines is an energy efficient option for blow moulding because these machines remove the energy losses at the electro-hydraulic interface and can reduce energy costs.

Whatever type of machine is used, good process parameter control gives efficient operation and can give huge savings.

- **Tip:** Use just enough energy to complete each process stage. Look for opportunities to reduce heating time, cooling time and other cycle stages to save energy.
- **Tip:** Process controller improvements make it worthwhile investigating upgrades. Controlled, accurate and minimised wall thickness and parison length, will improve energy efficiency and materials usage.

Blow moulding machines use only small amounts of externally applied heat (most is generated mechanically) but heat transfer from barrel heaters can be maximised and evenly distributed by good seating to the barrel and the use of a conductive metal compounds. The energy used will be reduced and controlled by barrel insulation jackets - these also improve Health and Safety, reduce start-up times and generally have a pay-back of less than 1 year.

- **Tip:** Set the polymer at the minimum temperature it actually needs.
- **Tip:** Turn off barrel heaters and cooling fans between runs.

Parison weights are often up to 40% more than the weight of the final product. Any trimmed materials (tops and tails) can be recycled and recovered but the energy used is lost forever. Large tops and tails cost real money even if the material is recycled.

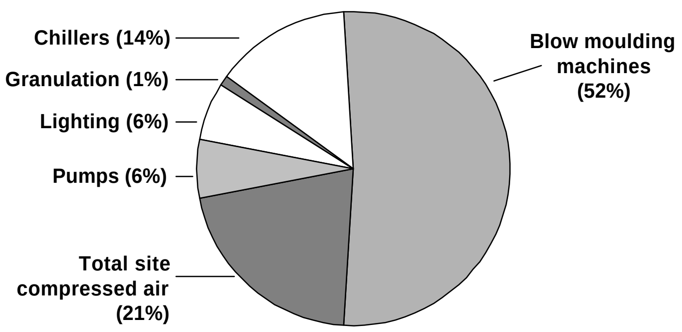
- **Tip:** Improved control of the parison and final product size will improve energy and process efficiency.
- **Tip:** The amount regranulated varies from under 10% to nearly 80%. You can improve in this area.

Regranulation should be done off-line (at night) to minimise energy costs, but first minimise tops and tail production - reduce and then recycle.

When a machine is not producing for a short time it is not practical to shut down the extruder but shutting down the hydraulic systems can give considerable energy savings.

Start-up procedures can be set to bring the energy demands online at the best possible time i.e. heaters until stabilised, hydraulics and finally the extruder drive. Similarly shutdown procedures can be developed to switch off the energy intensive areas of the machine.

- **Tip:** Develop start-up and shut-down procedures to save energy and time.



Electricity use in a typical blow moulding factory

Ancillaries

Parison forming must be complete before the outside surface chills and stops surface texture formation. The compressed air pressure for blowing should be just sufficient to form the parison before chilling but it can then be reduced to hold the parison against the mould surface.

- **Tip:** Excessive air pressures for blowing or holding wastes energy.

Most of the heat put in during the melting stage must be removed before the product is released from the die. Product cooling time is about 50% of the cycle time and minimisation of the melt temperature will save energy in heating and cooling as well as reducing the cycle time.

- **Tip:** Setters may raise temperatures or increase cooling times to get a job running - Check the settings.

The chiller system uses large amounts of energy and the process efficiency affects both time taken and energy used. Water has a better cooling efficiency than air and bubbles in the cooling water will decrease the efficiency of the cooling.

- **Tip:** Seal, degas and pressurise the water cooling system.

Cooling is most efficient with good contact between the parison and mould and this should be kept by the air feed during cooling.

Hydraulic systems for mould closing should be matched to the demand (blowing pressure x projected area) to reduce the energy needed and the hydraulic oil should be de-aerated on a regular basis to improve the efficiency of the hydraulic system. The hydraulic fluid should also be kept at a steady temperature to improve the process control and prolong the life of the oil.

- **Tip:** Some companies use chilled water from mould cooling to cool the hydraulic oil. This may make the hydraulic oil too cool and give rapid viscosity changes and control and quality problems. Check the temperature.

General Tip

The real secret to reducing energy costs is not in the technical aspects of any process - it is in the management attitude. A desire to reduce costs through energy management and an effective implementation and monitoring programme will produce the results and the commercial benefits.

Next month: Motors and drives

The sixth in a series of energy efficiency worksheets by Dr. Robin Kent for the EEBPP to help the plastics industry reduce costs through efficient use of energy.

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Motors and Drives

Approximately 2/3 of the energy costs in polymer processing are the result of electric motor usage. Yet motors are often neglected when considering energy usage. The motors in the main processing equipment such as injection moulders and extruders are obvious but the majority of motors are 'hidden' in other equipment such as compressors, pumps and fans. When the energy cost of running a motor for 1000 hours can exceed the purchase cost and when the 'whole life costs' are often over 100 times the purchase cost then failing to take action with all motors in a factory is expensive!

"The energy cost of a motor can exceed the purchase cost in just 1000 hours of use"

The motor management policy

The greater importance of running costs over the initial purchase price means that companies need to change the way they look at motors. Decisions need to be made on the 'whole life cost' where all purchase, maintenance, repair and operating costs are considered. The changes with the development of Variable Speed Drives (VSD) and High Efficiency Motors (HEM) mean that, in order to reduce costs, companies must develop and implement a motor management policy for the purchase and operation of motors. This policy should include guidelines on:

- repair and replacement based on lifetime costing.
- the specification of HEMs for all new purchases.

When new motors are required, the benefits of opting for HEMs are obvious. However, the failure of an existing motor raises the question of whether the motor should be repaired or replaced. Repairing a failed motor may appear to be a cost-effective action but repair can reduce energy efficiency by up to 1% and may not be the most economical long term action. A motor management policy can provide the rules for making the best financial decision.

Motor sizing

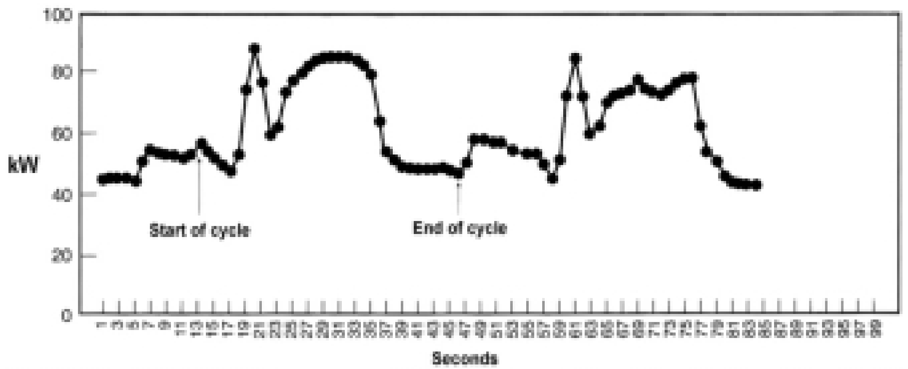
Motors are most efficient when their load equals, or is slightly greater than, the rated capacity. Motors can even be overloaded for short periods provided that there is a later lower load to allow cooling. If machines larger than needed are purchased or used then the motor will not reach the design load and will never run at optimum efficiency. Oversized motors are inefficient and equipment needs to be carefully matched with demand. Even 'steady' loads from extruders, fans, compressors and pumps will fluctuate slightly and the basic operating load rarely matches a standard motor.

The demand graph (below) shows the instantaneous energy demand during an injection moulding cycle and illustrates the wide variations in load demand from a typical injection moulding machine.

- **Tip** - It is strongly recommended that expert advice on motor sizing is sought to reduce costs.
- **Tip -** Where motors can be accurately predicted to run at less than 33% of the rated output it is possible to reconfigure the motor from Delta to Star connection. This simple low-cost action can produce savings of up to 10%.
- **Tip -** Devices, such as Variable Speed Drives (see below) will allow motors to run at the required speed to save energy.

High efficiency motors

The cost premium for High Efficiency Motors (HEMs) is small and easily offset by the energy cost savings that result form their use. HEMs achieve efficiency levels of up to 3% more than conventional motors and have a peak efficiency at 75% of load, thus reducing both energy costs and oversizing problems. A 3% efficiency gain may not sound much, but a £500 motor uses approximately £50,000 in energy over a 10 year life will be and a 3% saving is £1500 - this is equivalent to 3 free motors.



Instantaneous energy use of an injection moulding machine

"The life cost of a motor is often over 100 times the purchase cost"

Variable speed drives

The speed of an AC motor is fixed by the number of poles and the supply frequency. As a result, the hydraulic pumps in many processing machines are driven at a constant speed, even though the demand varies considerably during the cycle. The flow demand changes from the hydraulic pump are controlled by a relief valve and re-circulation of the hydraulic fluid. . Another way of meeting the varying demands is to fit a variable speed drive (VSD) to the motor. A VSD allows the speed of an AC motor to be varied and the pump output can be matched to the variable demand. The demand graph shown would have considerably fewer peaks and troughs were a VSD to be used on the machine. The application of VSDs can significantly reduce energy costs. Other VSD benefits are:

- Reduced demand on the hydraulic system means that the hydraulic oil runs at a lower temperature and requires less cooling - an additional cost saving measure.
- Reduced noise.
- Lower maintenance costs.
- Better all-round performance.

VSDs can also be applied to fans, water pumps and air compressors where the load varies considerably. For constant loads, the use of a correctly sized motor is the best option.

Despite this the varying loads and the difficulty of matching the output to the need will inevitably lead to some energy losses

Next steps

- Contact the EEBPP to get information on motors (GPG2) and motor management policies (GIL 56).
- Analyse the existing motors using 'Quickstart' from the EEBPP.
- Start to save real money by choosing the best motors and systems for your company.

Next month: Compressed Air

Compressed Air

Compressed air is a convenient and often essential utility, but it is very expensive to produce. In fact, most of the energy used to compress air is turned into heat and then lost. At the point of use, compressed air costs more than ten times the equivalent quantity of electrical power i.e., an equivalent cost of around 50p/kWh. At this price, it should never be wasted and only be used when necessary. Air also needs to be treated to remove moisture, oil and dirt and the higher the quality required, the greater the energy consumed by the treatment system.

"Compressed air is an expensive resource. Minimise the demand and then optimise the supply."

The chart below shows the cost of compressor ownership over ten years. In a typical 24 hour day, five and half day week, a 100 kW motor will use energy worth around £30,000 per year, assuming the cost of electricity to be £0.045/unit. At these cost levels, an energy efficient system is highly cost effective, even if it costs slightly more to install.
The cost of compressed air makes it an expensive resource and the way to achieve the best savings is to minimise the demand and then to optimise the supply. Up to 30% savings can be made by inexpensive good housekeeping measures such as making end users aware of the cost of generating compressed air and enlisting their help in reporting leaks.

Minimise demand

Reduce leakage

A significant amount of energy is wasted through leakage. Typically, leak rates are up to 40% - i.e. 40% of the generating power is wasted in feeding leaks. A 3 mm hole in a system at 7 bar will leak about 11 litres/sec and costs £1,000 per year. In a system with numerous leaks, this cost will multiply rapidly!

The seventh in a series of energy efficiency worksheets by Dr. Robin Kent for the EEBPP to help the plastics industry reduce costs through efficient use of energy.

Environment and Energy Helpline 0800 585 794

BEST PRACTICE PROGRAMME ENERGY EFFICIENCY

Simple leak surveys and maintenance can produce dramatic cost reductions and in some cases, leak reporting and repair has enabled companies to shut down some compressors for all or most of their operating time.

- **Tip -** Simple and repeated walk-round surveys, with leaks tagged and repaired as soon as possible, will significantly reduce leakage rates.
- **Tip -** Isolate redundant pipework, this is often a source of leakage.
- **Tip -** Measure losses due to leakage and target reductions.

Reduce usage

Compressed air is often misused because everyone assumes it's cheap. Check every application to see whether it is essential or simply convenient.

- **Tip -** Stop the use of compressed air for ventilation or cooling - fans are cheaper and more effective.
- **Tip -** Fit high efficiency air nozzles - payback can be as short as four months.
- **Tip -** Consider the use of electric tools instead of compressed air tools.
- **Tip -** Do not use compressed air for conveying granules or products.

Optimise the supply

Reduce generation costs

The higher the compressed air pressure, the more expensive it is to provide the air. Twice the pressure means four times the energy cost. The real needs may be lower than you are supplying. In some cases the machine rating is for a 7 bar supply but pressure reducers are fitted inside the machine. What are your real needs?

- **Tip -** Check that compressed air is not being generated at a higher pressure than required.
- **Tip -** Switch off compressors during non-productive hours. They are often only feeding leaks or creating them.
- **Tip -** Check that compressors are not idling when not needed - they can draw up to 40% of full power when idling.
- **Tip -** Position air inlets outside if possible - it is easier to compress cold air.
- **Tip -** If there is a machine or area that requires compressed air longer than the rest, consider zoning or a dedicated compressor so that others can be switched off.
- **Tip -** Investigate electronic sequencing to minimise compressors going on and off-load.
- **Tip -** Maintain the system - missing a maintenance check increase costs.

Improve distribution

The longer the compressed air pipeline, the greater the pressure loss over the pipeline and the greater the cost of the system.

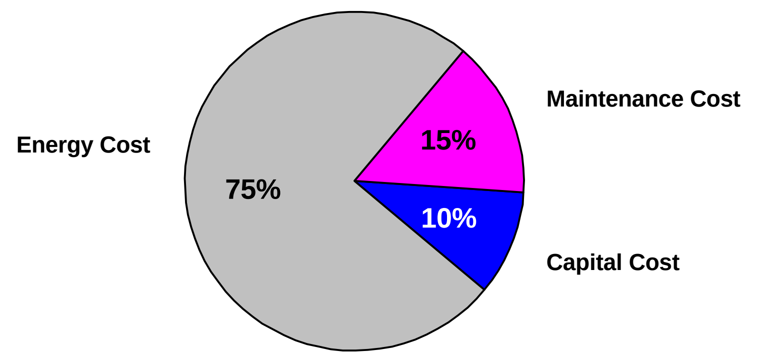
- **Tip -** Make sure that pipework is not undersized, this causes resistance to air flow and pressure drops.
- **Tip -** Use a ring main arrangement in each building - air can converge from two directions. This reduces the pressure drop and makes changes to the system easier.
- **Tip -** Avoid sharp corners and elbows in pipework as these cause turbulence and hence pressure drops.

Reduce treatment costs

- **Tip -** Treat the bulk of air to the minimum quality necessary, e.g. 40-micron filters are usually sufficient. Specifying 5 micron will increase filter purchase cost, replacement frequency, and pressure drop.
- **Tip -** Test filters regularly to make sure pressure drop does not exceed 0.4 bar - if the pressure drop is higher than 0.4 bar, replace the filters, since the cost of power to overcome this drop is usually greater than the cost of a filter.
- **Tip -** Manual condensate traps are often left open and act as leaks. Consider fitting electronic traps to replace these.

Next steps

Compressed air is not free and processors can save at least 30% of the costs of compressed air by simple management systems and maintenance. Start now by contacting the Environment and Energy Helpline for the full set of free information on how to reduce your costs.



Whole life costs for compressors (10 year life cycle)

Next month: Buildings.

The eighth in a series of energy efficiency worksheets by Dr. Robin Kent for the EEBPP to help the plastics industry reduce costs through efficient use of energy.

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BEST PRACTICE PROGRAMME
ENERGY EFFICIENCY

Buildings

Previous Worksheets have concentrated on process related energy use. The buildings related energy use is often seen as secondary but it actually represents an average of 17% of the total energy costs. The buildings related energy is an easy area to make energy savings because any changes do not impact on production. In most cases a simple site survey can reduce costs considerably.

"Building energy costs are a significant percentage of the total energy costs."

For the plastics processing industry, recent years have seen vast improvements in factory buildings and working conditions. This upgrading of conditions has produced significant improvements in all-round site efficiency, and this has resulted in a general reduction in the usage of energy. However, large opportunities still remain for energy savings in areas such as lighting, space heating and general hot water supplies.

Many processes generate excess heat (which should be reduced if you have followed the tips in this series) and it is worth investigating if this can be used for other purposes, such as space heating on colder days.

- **Tip -** Processes that involve vaporising solvents will require 'Local Exhaust Ventilation'. Processes that only generate heat have options for general or local ventilation or preferably energy recycling through a heat exchanger.

Building audit tips

The starting point to reduce building energy use is an audit of the buildings and systems. The following tips can serve as a basis for the initial audit:

Existing buildings

- **Tip -** Reducing heating load is the top priority, so prevent unnecessary heat loss by making buildings as air tight as possible. Draught proofing doors and windows is cheap but effective.
- **Tip -** Automatic fast-acting roller shutters save energy on external access doors used with forklifts and other mechanised access.
- **Tip -** High ceilings increase your heating costs. Investigate the use of false ceilings, or destratification fans to blow hot air from the roof space down to the working area.
- **Tip -** Restrict the areas to be heated by using partitions or local systems to control the key areas. Don't ventilate or heat the whole building space for a few small areas.
- Tip - Do not heat areas where you have windows or outside doors open.
- **Tip -** Do not heat lightly occupied stores or warehouses when you are only trying to prevent excessive dampness.
- **Tip -** Insulate supply pipes to radiators.
- **Tip -** Install tamperproof thermostats and controllers to prevent s tampering with them. For larger sites, Building Energy Management Systems control energy costs without relying on staff.

"Improving building energy efficiency also improves staff comfort and work output"

New buildings/refurbishment

- **Tip -** Request GPG304 - *The Purchaser's Guide to Energy-Efficient Buildings for Industry* from the Helpline and look for energy efficient designs with passive solar heating, passive ventilation, added thermal mass, and natural lighting systems.
- **Tip -** Review building insulation and fabric meet the current best practice.
- **Tip -** Double glazing can both reduce heat loss and improve comfort. Modern low-e glass and systems are even more effective than standard double glazing.
- **Tip -** Condensing boilers are the best option for new or replacement small hot water systems.

Lighting

Although it is only a relatively small part of the overall energy usage, lighting systems offer easily demonstrable opportunities to save energy. Pay attention to areas with:

- High or continuous lighting levels and no or low occupancy. Use occupancy sensors or time switches.
- Fluorescent tubes at high levels without reflectors. The use of reflectors increases light levels which may mean that the number of fittings can be reduced.

In lighting, simple measures can save money easily and a well designed lighting system can be a permanent energy saving feature. Examples and information on improved lighting methods is available in Best Practice Reports from the Helpline.

- **Tip -** Many major lamp manufacturers also offer advice and contract consultancy on lighting. Use the help that is available for free to save energy.
- **Tip -** Replacing normal tungsten bulbs with compact fluorescent (CF) lighting saves money in the long-term. Although they cost more, CF bulbs use only 25% of the energy of tungsten bulbs and last about ten times longer. The reduced maintenance costs, especially for lights in high fitments, can easily fund the extra purchase costs.
- **Tip -** High frequency tri-phosphor T8 tubes should always be installed when replacing or refurbishing existing older systems where good colour is needed. For areas where colour is not critical, high pressure sodium lighting is an option Research shows that lighting switched on in the morning will rarely be switched off until the evening - whatever the changes in light levels in the intervening period.
- **Tip -** Use natural daylight where possible and keep skylights clean to reduce the amount of artificial lighting needed.

ECG018 'Energy Efficiency in Industrial Buildings and Sites' presents the results of a survey conducted across all UK industry. The figures below give the **average** annual delivered energy use and cost. The main figures represent an average working day of 2.3 eight hour shifts and the figures in brackets give the values per eight hour shift worked.

	kWh/m^2	£/m^2	% total kWh	% total cost
Process	532 (231)	26.60 (11.56)	61.0	82.9
Buildings	340 (148)	5.48 (2.38)	39.0	17.1
Of the buildings energy use, the space heating element was over 50%:				
Space Heating	288 (125)	2.88 (1.25)	33.0	9.0

The buildings energy use values from the sample ranged from 300 (130) to 550 (239) kWh/m^2. Calculate your annual buildings energy use per m^2 per shift, and compare it to the sample range above.

Next month: The start of a new series from Envirowise on Waste Minimisation - 'How to reduce waste and add 10% to your profits'.