Energy status report: GB potato storage

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Contents

Terms of Reference

This review covers the present state of the UK energy market in terms of its effect on the energy costs of post harvest equipment operation in the UK potato production industry. It identifies the changing value of energy in relation to returns for the potato crop. The main uses of energy in the sector are listed and the most promising areas of energy saving covered. Recommendations for further work to improve energy efficiency are given. Major equipment suppliers have been contacted and asked their views of this subject area. A list of companies in question appears in Appendix 1 including any feedback or help they have given.

Summary and Conclusion

By the end of 2006 most growers will have seen electricity price increases of between 30 and 60% compared with 18 months previously.

As corresponding potato prices have not changed significantly over this period then the price increase represents a reduction in the margin of the crop.

The impact on individual growers will depend on their particular reliance on energy. Producers carrying out more post harvest operations and storing for longer will see the greatest net cost increase. As such, the range of increases in electricity prices will represent between 30p to £3.39 per tonne, with an ‘average’ producer (refrigerated store and typical loading and unloading facilities), paying about £2.00/t extra.

Long term energy cost trends are hard to determine. Future energy markets show a slightly falling trend for the next three years. However increasing interest in environmental issues and climate change are likely to result in pressure from Government either in the form of taxation or targets to reduce energy usage.

There is a considerable amount of energy-saving technology which can be used at various stages in the post harvest handling and storage of potatoes. Most of this technology is well established. However the benefits it has to offer are not well understood in the industry because of a lack of published assessment work.

Newer technology also has something to offer in the way of energy-saving especially in the areas of control and monitoring, but further work needs to be carried out to match the technologies to the industry’s requirements and evaluate the applications and benefits. Also the wider impacts on crop quality need to be assessed.

Background

Importance of energy costs to potato businesses

Energy is a significant cost in the production and presentation to market of the UK potato crop. The two main areas of use are for field operations (land preparation, planting, chemical/fertiliser application and harvesting) and for post harvesting processes (grading, cleaning, drying, cooling, and lighting). This report covers energy use for post harvest operations.

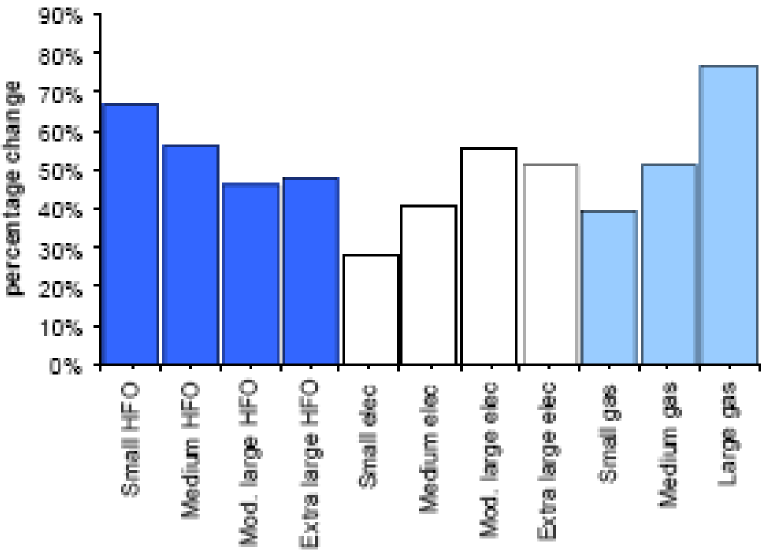
Two issues have combined to increase the proportional cost of energy for these operations.

Firstly, the drive for a refined high quality product, free from chemicals and available all the year round, has meant that the use of energy intensive operations has increased. For example, more energy is now used in refrigeration, washing, grading and packing than was formerly the case.

Secondly, energy costs have risen. Rises have been particularly rapid in the last 12 months. The increases in the cost of gas and oil have impacted on the cost of electricity as these fuels are extensively used for generation.

Recent trends

The following graph illustrates the cost increases in heavy fuel, gas and electricity in the last year.



Percentage price movements between quarter 4 2004 and quarter 4 2005 for heavy fuel oil (HFO), electricity and gas, by size of consumer.

Note that, in the gas and electricity market, larger users appear to have experienced higher percentage price rises than users of smaller quantities. However, because the large power contract market is affected quicker than the smaller users market, growers with lower consumption levels will soon find that their price increases will catch-up with those that have been experienced by larger users.

Across the board increases averaging 60% might well result by the end of 2006.

Contract price increases in regions

The following table gives comparative electricity prices offered for two year contracts for small/medium users in November 2004 and May 2006 from one major electricity supplier.

Area	Nov 2004 p/kWh			May 2006 p/kWh (% increase)		
	Standard	**Day**	**Night**	**Standard**	**Day**	**Night**
Eastern	5.60	5.73	3.11	8.08 (44%)	8.16 (42%)	5.54 (78%)
East Mids	5.78	5.79	2.98	7.73 (33%)	7.97 (37%)	4.49 (51%)
Mersey/Nth Wales	6.32	6.79	3.13	8.67 (37%)	8.99 (32%)	5.83 (86%)
Midlands	6.62	7.28	2.83	7.92 (20%)	8.18 (12%)	5.45 (92%)
North East	7.51	7.98	2.93	8.5 (13%)	8.59 (8%)	5.47 (36%)
North West	5.97	6.56	2.91	8.25 (38%)	8.5 (30%)	5.45 (37%)
Scotland (North)	7.30	7.96	3.66	10.33 (42%)	10.49 (32%)	6.43 (75%)
Scotland (South)	7.10	8.43	3.08	8.55 (20%)	10.15 (20%)	6.24 (102%)
South East	5.78	6.22	2.88	7.97 (38%)	8.14 (31%)	4.88 (69%)
Southern Area	6.30	6.28	2.98	8.78 (39%)	9.09 (45%)	4.77 (60%)
South Wales	6.29	6.59	3.07	8.81 (40%)	9.58 (45%)	5.62 (63%)
South West	5.60	5.73	3.11	8.72 (26%)	9.62 (31%)	4.93 (51%)
Yorks and Nth Lincs	5.78	5.79	2.98	7.77 (22%)	8.03 (30%)	5.43 (87%)
UK Average	**6.45**	**6.86**	**3.06**	**8.47 (31%)**	**8.88 (30%)**	**5.43 (77%)**

Note that as these prices have been supplied by one supply company they can only be regarded as indicative of those offered for each area.

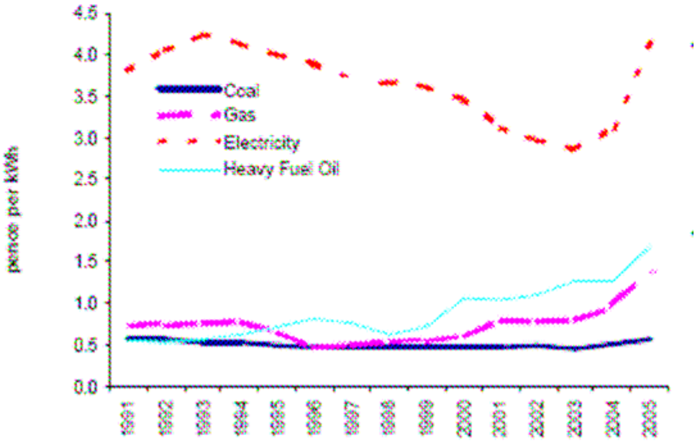
Two main things are immediately evident looking at these figures. Firstly, there is a tremendous variation in regional prices, and the price increases that each region has seen. Also there appears to be significantly higher increases in off-peak prices across the board; the effect of which is to close the differential between on-peak and off-peak prices. This trend seems to be fairly universal with other companies producing similar increases.

The variation in regional price increases is not quite as easy to explain. It may have something to do with the supply company's changing marketing emphasis or possibly some underlying energy distribution cost factor driven by the location of the various types of power plant in the UK.

Long term changes

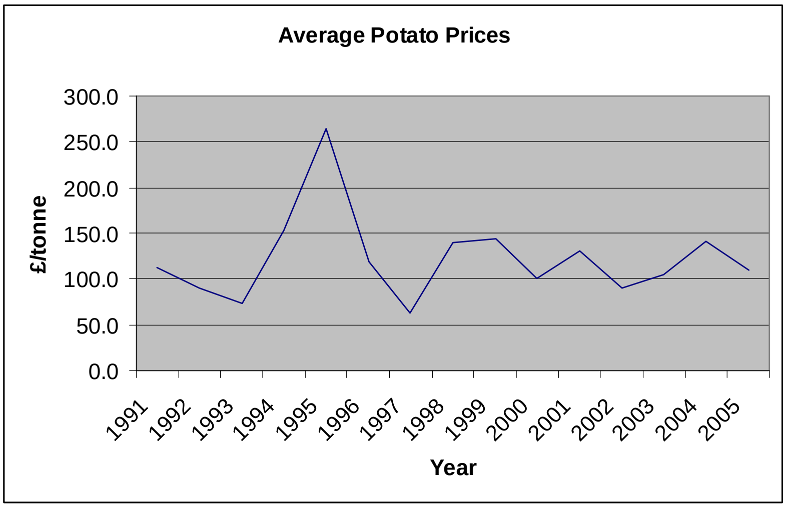
Looking at a 15 year historical perspective it's clear that most fuel prices stand at a record high. Both gas and oil have shown a steady increase since 1999, with a sharper increase in more recent months. It's worth noting that the increase in electricity prices is a very recent phenomenon. Prices for electricity had in fact fallen steadily from 1993 up to the beginning of 2004. The recent price increases have therefore come as a shock to many buyers.

Ref. Quarterly Energy Prices – March 2006 published by DTI.



Fuel prices for manufacturing industry, in cash terms 1991 to 2005

To fully assess the impact of energy price increases on business profitability, historical potato prices must also be examined. The adjacent graph indicates that, although prices have shown some volatility, the long term average price has not changed dramatically. Consequently, taking into account both energy prices and potato prices, energy now represents a larger proportion of revenue per tonne than it did 10 years ago.



The future

As far as the short term future is concerned, it is expected that further price increases will filter though over the next few months.

In the longer term fuel prices will be affected by:

- Political and environmental issues - particularly cross border conflicts and attitudes to global warming.
- Supply issues – the availability of resources.

Political and environmental issues

Political influences are always difficult to determine and are clearly a function of transient issues and longer term strategic plans.

With the UK now sourcing most of its energy from non indigenous sources, suppliers are considerably more exposed to the possibility of disruption caused by disputes and conflicts. Oil and gas are particularly vulnerable and by implication, electricity is affected.

Political attitudes to global warming are likely to impact on energy taxation. We already have the Climate Change Levy (CCL) which is applied to none oil-based fuels. CCL does not represent a large tax burden at present – in the order of 5% for most fuels – but this could change in the future. Compare CCL with road fuel tax for instance where taxation accounts for over 60% of costs. Should it be perceived by Government that non-road fuels are such that they warrant taxation at such a level, then costs could obviously go much higher. As more information becomes available on the nature and progress of global warming it seems probable that energy taxation will tend to increase.

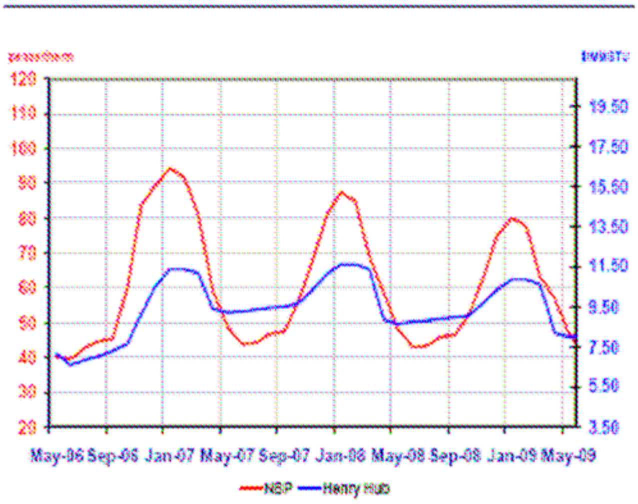
A strategic move towards more renewable energy systems is also pushing up energy prices. In 2002 the Government imposed a **renewable obligation** which sets targets for electricity suppliers on the amount of renewable based generation which should be available and penalties if these targets are not met. The target for 2005/6 is 5.5%. This rises to 15.4% by 2015/16. Since renewable generation is inherently more expensive than conventional systems in the shorter term, the effect has been to increase the price of electricity. This incremental increase in renewable generation and the knock-on effect on cost is expected to continue. (ref. http://www.dti.gov.uk/energy/energy-sources/renewables/policy/renewables-obligation/what-is-renewables-obligation/page15633.html)

Supply issues

An improving European supply infrastructure for gas is reflected in future prices which show a steady fall for the next three years. The adjacent graph shows the future gas prices available at the moment. Some volatility will occur with system outages and any particularly cold periods but generally the indication is for steadily falling prices.

With much of the electricity power generation being tied to the cost of gas it is expected that electricity costs will be heavily influenced by gas costs. (Ref. Total Gas Ltd market intelligence monthly bulletin).

Figure 1. UK (red), US (blue) Forward Curve Comparison



Conclusions on energy price issues

The impact on individual growers will depend on their particular reliance on energy. Producers carrying out more post harvest operations and storing for longer will see the greatest net cost increase.

Examination of typical energy usage and changing market conditions imply that electricity price increases will represent between 30p to £3.39 per tonne, with an 'average' producer (refrigerated store and typical loading and unloading facilities), paying about £2.00/t extra as a result of the current round of energy price inflation.

Long term energy cost trends are hard to determine. Future energy markets show a slightly falling trend for the next three years. However increasing interest in environmental issues and climate change are likely to result in pressure from Government either in the form of taxation or targets to reduce energy usage.

Energy Use in Post Harvest Handling and Storage

Energy – increasing use

Since the intensive production of potatoes began the use of energy in post harvest applications has increased. The need to store potatoes longer and to maintain quality without the use of chemicals has led to the more widespread use of energy intensive processes.

The following list covers most of the energy based post harvest applications in current use today. On some farms most of these techniques will be in use. On others only one of two will apply. The market driven quality end of production will tend to use more of these techniques than the part of the industry which is concerned with bulk ware supplies through merchants.

Applications	Energy technology	Range of energy use
Loading	Conveyor motors, fork lift	0.2 to 1.0kWh/tonne
Grading for quality control, dirt removal and sizing	Conveyor motors, dust extraction lighting	1.0 to 2.0kWh/tonne
Drying	Electric fans, refrigeration, heat	2.0 to 5.0kWh/tonne
Washing	Conveyor/brush motors, pumps	1.0 to 3.0kwh/tonne
Short/medium term storage	Ventilation fans, recirculation fans, louvres, lighting, humidification	10 to 20kWh/tonne
Long term storage	Refrigeration, recirculation fans, lighting, humidification	50 to 100kWh/tonne
Chemical Application	Fans	0.2 to 0.5kWh/tonne
Outloading	Conveyor motors, fork lift, packing	0.2 to 1.5 kWh/tonne

Depending on end use and what processes the potato requires before leaving the farm, post harvest processes can account from between 12 and 135kWh per tonne – at current electricity costs this might be between £1 and £12 per tonne.

One important factor which is clear from a quick examination of these figures is that the energy used for cooling during storage – whether using ambient or refrigerated air - eclipses all other uses. Therefore it is these uses that are most important when considering the impact of energy prices and the scope for making savings. This is where the ‘big wins’ are likely to be made.

Energy Saving Technologies/Techniques

This section of the report deals with generic energy-saving technologies which could be used to reduce costs in post harvest and storage processes. Each technology is described briefly and its relevance to post harvest operations discussed. An attempt has been made to score the importance of each technology. The score takes into account a number of factors including:

- payback time.
- ease of application.
- the impact on total energy spend on the business.

Finally, a suggestion is included as to what work might be done to bring the technology close to the marketplace. In some cases simply marketing the benefits to growers is all that is required. In other cases it may be necessary to carry out research, development or demonstration work to investigate and develop the application further and to maximise the appropriate application of the technique. The information included in this area has been derived from knowledge of relevant energy efficiency techniques and applications in the potato and other industries. Contributions have also been included from equipment suppliers who have had first-hand experience of successful energy-saving technology applications.

Technology	Energy monitoring/management/benchmarking
Importance score(1-10)	10
Description	Energy monitoring can be anything from the regular and organised reading and recording of utility meters on site, to the installation of energy data logging equipment and the automatic interpretation of this data to take into account operational conditions and weather, with benchmarking against other sites or equipment and exception alarms to notify unusually high energy use.
Application	Energy monitoring can be applied to whole sites, individual buildings and individual pieces of equipment within a building.
Rationale	Energy monitoring is a key factor in successfully managing the energy use of any business or part of a business. It is a relatively cheap thing to undertake but without it, it is virtually impossible to make rational decisions about how to save energy and what techniques to use. In the majority of cases farmers rely on little more than that of their utility metering equipment to give them feedback on how much energy they are using. What's more, they rely on infrequent and often estimated utility bills. Good energy monitoring allows a farmer to: • identify high energy using equipment and times. • spot where problems might be occurring. • make rational investment decisions on energy-saving equipment. • compare other buildings, techniques or sites.
What needs to be done	At its simplest, promoting the benefits of reading utility meters, and recording and comparing data is required. An industry benchmarking system, spreadsheet or Web-based tool to simplify recording and give useful feedback would be a good start. There has been significant recent progress on low-cost data logging and remote access data acquisition either using store control equipment or utility metering. Again this needs promoting to the industry. A demonstration project might be used in this area.

Technology	Building improvements – insulation and sealing
Importance score (1-10)	6
Description	Technologies include thermal insulation, sealing products, insulating doors, low emissivity surface coatings.
Application	Ambient and refrigerated stores.
Rationale	Clearly the greatest energy requirement for stores is for cooling and most of this is required to counteract high external temperatures. There are a variety of products on the market which will improve the thermal characteristics of stores. Some products are high cost like a thermal insulation board. Others are relatively cheap, for instance sealing products for structures and around doors. There are a number of novel products including low emissivity paints and reflective films. Opinions from the supply industry and circumstantial evidence would seem to indicate that high air leakage is one of the primary causes of high energy costs in storage.
What needs to be done	Growers have difficulty making objective decisions about what building improvement products to use because of the lack of specific performance data as applied to their own stores. They may also lack comprehensive information about all the techniques available to them. Information systems about the availability of products and ways in which they can assess their own stores are required including software to calculate costs and paybacks. 'Which' type guides could be produced looking at generic products, their application and viability. Some work on air leakage characteristics of certain building types and the effect on running costs would be useful. The value of spray-on insulation and the various types of door seals would be useful information.

Technology	Advanced control techniques for cold stores
Importance score (1-10)	10
Description	Control which integrates information from temperature sensing equipment, equipment operational sensors, weather data, electricity tariff times, and can produce historical reports on the equipment operation and building conditions.
Application	Ambient and refrigerated cold stores.
Rationale	Good control is an essential component in providing good crop conditions at the lowest energy cost. Compared with many capital investment options, control is generally quite cheap to integrate into an existing store. Facilities like remote diagnostics, multipoint temperature monitoring, and the ability to define refrigeration equipment operation to coincide with periods of cheap electricity availability all go towards reducing energy use and controlling costs. Redwood Refrigeration Ltd have kindly supplied data based on 19 stores which they have monitored remotely using their 'Barn Report' system. Average energy use per tonne across the sites was been 57kWh/tonne. Without tariff control most stores average about 25% consumption during the cheap night tariff rate. With active tariff control night rate usage averages more than 50%. Savings at current tariff prices will be about 60p/tonne.
What needs to be done	Information needs to be collated about the advantages of advanced store control. Some surveys which relate the control system to running costs will reveal the degree of savings that are on offer.

Technology	Variable speed drives on fans/pumps
Importance score(1-10)	5
Description	Electronic variable speed drive equipment based on the inverter control. This equipment produces a variable speed alternating current which allows electric motors to operate at a range of speeds without instability.
Application	Fans, conveying equipment, pumps, compressors.
Rationale	Electric motors are generally single speed devices. The fall in price of power electronics now means that it is possible to apply a variable speed AC voltage to a motor and effectively operate it at any output speed. The main advantage of this is that the output of the device which the motor is connected to e.g. a pump a fan or a conveyor, can be operated at optimum speed and energy input. This means that, what in the past has been regarded as a fixed parameter may be changed depending on external factors. A good example of this is with store ventilation where traditional ventilation rates are defined as fixed figures. By linking fan speed and output to exact requirements, large amounts of energy can be saved. Generally, power consumption of many fans and pumps falls in proportion to the cube of the speed. Therefore small reductions in speed can deliver quite high energy savings.
What needs to be done	The underlying rules for control of devices like fans need to be re-examined. For example, ventilation rates need to be a redefined in terms of exacts crop requirement at certain stages of storage – air throughputs can be reduced as cooling requirement falls. Trials and demonstrations which determine optimum control techniques and demonstrate potential savings need to be carried out.

Technology	High efficiency motors
Importance score(1–10)	3
Description	Modern motor designs are inherently more efficient than older types.
Application	All applications where electric motors are used.
Rationale	Although the improvement in efficiency provided by new motor designs is small, the marginal extra cost of these devices is often justified when running times are extended. This becomes especially important when motors fail and their replacement or rewinding is being considered. In the case of rewinding motors, a small reduction in efficiency results from the rewind and affects the economic viability of this option compared with buying a new motor. Few users are aware of the economic consequences of rewinds/new motor purchase. Whether a high efficiency motor is viable or not depends on the additional purchase cost, efficiency differences and operational time of the application.
What needs to be done	Information which explains the benefits of high efficiency motors and in what situations they can be used economically should be made available to growers.

Technology	High efficiency lighting
Importance score(1-10)	3
Description	
Application	Within storage buildings, over packing and the grading lines, outside buildings.
Rationale	Although lighting is not a massive cost to most producers, lighting equipment has a long service life and represents a steady background energy use. A new generation of lighting equipment using gas discharge tubes with electronic ballast will produce good-quality lighting at a fraction of the cost of lighting with tungsten filament based equipment. The economics are such that it is rarely worth installing a replacement lighting system on energy cost grounds alone. However, where old lighting has failed or where new lighting has to be installed for a new facility then the marginal cost of the high efficiency option is invariably worth it.
What needs to be done	Information which explains the benefits of high efficiency lighting and in what situations they can be used economically should be made available to growers.

Technology	High efficiency fans and duct design
Importance score(1–10)	6
Description	Newer designs of fans and duct which are aerodynamically more efficient.
Application	For all ventilation components in storage.
Rationale	Fans are a large consumer of energy in storage. It is often not appreciated that fans of the same energy rating can deliver significantly different outputs. The reasons for this lie in different impeller, motor and casing designs. Also inlet and outlet ducting configuration has a significant effect on efficiency.
What needs to be done	Information in this area is not easy to assimilate. Manufacturers' information comes in many different forms and very often it is not easily applied to potato store applications. A review of the performance of equipment needs to be carried out and some work on the efficiency of equipment working in potato store systems is required.

Technology	Cooling techniques optimisation
Importance score (1–10)	6
Description	Mixed refrigeration/ambient cooling. Refinements in the refrigeration techniques.
Application	Crop cooling and storage.
Rationale	Ambient and refrigeration cooling both have a place in crop storage. The integration of the two techniques is used in a number of systems, but little is known about the energy consequences of this type of approach and other benefits and problems. Also, there are a number of newer techniques in refrigeration which can improve the coefficient of performance of the equipment providing more cooling for less power. Techniques include better defrost control, variable speed condenser fans, electronic expansion valves, variable speed compressors. This is a highly technical area and requires some detailed engineering evaluation in cooperation with manufacturers and installers of potato storage equipment.
What needs to be done	A detailed engineering review looking at the various options which are available for cooling performance optimisation.

Summary of energy saving technologies & potential

Description of measures	Potential energy reduction (%)	Kwh /p per tonne saving	Value to industry	Cost category	Comments	Further work required
Energy monitoring /management/benchmarking	10% overall	10kWh / 68p	17GWh £1.44m	Low	Energy monitoring is a factor in successfully managing energy use. Monitoring over number of sites could feed in to an industry benchmarking system	Requires promotion, education, software tools and a benchmarking website. Possible demonstration project.
Building improvements	Up to 20%	15kWh/ 128p	34GWh £2.9m	Medium to high	Some established products like thermal installation and draught proofing. Other more novel products like low emissivity surface coatings, heat reflective films	More comprehensive information required on products available and paybacks. Evaluation of the financial benefits of specific techniques like sealing.
Advanced control techniques	10%	7.5kWh/ 63p	17GWh £1.44m	Medium	High quality control, integrating information on store environment and energy performance. Cheap tariff period targeting for system operation can be used	Benefits need to be evaluated and demonstrated
Variable speed drives on fans /pumps/compressors	30%	6kWh/ 51p	11GWh £0.92m	Medium to high	Applicable to a wide range of ventilation and pumping applications. Concentrate on high load factor applications like ventilation in stores.	Research required to give recommendations on issues like optimum airflows at different stages of storage and methods of control.
High efficiency motors	3%	0.3kWh/ 3p	1.1GWh £0.09m	Medium	Widely applicable but only economically viable for high load factor equipment or when equipment is being changed or repaired	Information program required to inform users of the benefits
High efficiency lighting	30%	0.5kWh 4p	1.8GWh £0.15m	Medium	Lighting technology is constantly developing with lower energy light sources and better control systems	Information program required to inform users of the benefits
High efficiency fans and duct designs	30%	4kWh / 34p	14GWh £1.2M	High	High efficiency equipment is available but benefits are not well understood by installers or users.	Review work required to assess the benefits of available systems and report this to installers and producers
Cooling technique optimisation	20%	15kWh / 128p	34.GWh £2.9m	High	Mixed ambient/refrigeration systems, and novel techniques in refrigeration technology need to be evaluated	Technical review of these areas needs to be carried out. Some form evaluation of real systems would be required.

Notes on table. The saving figures are broad estimates with percentages relating to the technique in question. So for instance 20% lighting energy reduction pertains to lighting alone. Also where a particular technique is mentioned like refrigeration the percentage reduction and the energy/cost per tonne relates to a site using that particular technique. The cumulative savings from some of the techniques are not mathematically additive, as some improvements may make others less effective, For instance, advanced control techniques will go some way to providing the savings detailed in energy management/benchmarking. For the purposes of these calculations it has been assumed that 2m tonnes of stores use refrigeration and 1.6m tonnes are cooled with ambient air.

Secondary Technologies and Renewable Energy

The technologies discussed so far are those which would be fairly easy to apply and which use off-the-shelf technology.

In the process of examining what can be done to improve energy efficiency its worth have a quick look at some ideas which may be at the margin on feasibility but might be considered in the longer term.

Implication of changes in store atmosphere on energy use

Controlled atmosphere (or modified atmosphere) has been explored in other work but not in the context of energy saving. Where air exchange rates can be reduced or storage temperatures can be increased there would be a consequential reduction in energy use for cooling. If physiological and quality requirements can be satisfied, there may be some potential in looking at this area.

Renewable energy systems based on wind/solar power

Renewable technologies work most economically when the load factor of the application they are supplying is high. Potato storage does not fit naturally in this particular area but nevertheless, it does have the advantage of not being as time critical as some other applications. That is to say, the thermal inertia of the store is such that cooling can be delivered in sporadic bursts without leading to undue risk to the crop. It is possible to envisage systems which rely on wind and solar energy for instance to provide energy for cooling without being too sensitive to the erratic availability of these energy sources.

Heat recovery

One of the by-products of refrigerative cooling is the rejected heat. In some applications it is possible to use this heat to displace energy derived from other fuels. Again, there is no obvious natural use for recovered energy from the potato store cooling system. However, in some situations, it may be feasible to use recovered heat for offices, workshops or domestic dwellings.

Alternative refrigeration technologies

All refrigerated potato stores currently use conventional compression cycle refrigeration. Refrigeration accounts for an increasing amount of energy use in all our lives. For example, the increasing use of air conditioning now means that electricity demand on a hot summer day can be as high as that on a cold winter day. As a result considerable effort is being put into developing novel, more efficient refrigeration technologies that may be applicable to potato storage. A review of developments in this area and their applicability to potato storage may produce some useful results.

Appendix

Survey of equipment suppliers

A group of equipment suppliers were emailed with the following communication to get their option on energy use in the Potato Industry.

> FEC Services have been commissioned by BPC to do a short review of the importance of energy in potato storage and the effect of recent energy price rises on the cost of storage. I'm writing to get any thoughts and comments you have in the area so they might be included in the report.
>
> Part of the study is to review how the improvement in fixed equipment can help to reduce energy inputs. Clearly, efficient equipment is central to reducing energy costs but its importance is not always given enough attention by growers.
>
> You may feel that the storage equipment industry needs help, either in the development, monitoring or demonstration of techniques, so that these can be brought to the market with greater effect.
>
> There are many areas which could be considered: control, energy and environmental monitoring, variable speed motor drives, building issues (structure, insulation, sealing, finish), air handling systems, fan design, ambient/refrigerative cooling, drying systems, novel refrigeration techniques, low energy motors, humidification all have an impact on energy use.
>
> If you can find time to consider these issues and send me your thoughts and opinions, I will be pleased to include them in the report. I'm also interested in techniques which your own company has implemented and which you believe is having an impact on energy efficiency in storage.
>
> This project will be concluded very quickly and will have an important influence on future BPC work in this area, so I hope you can see that your input could bring some real benefits.
>
> I look forward to hearing from you.

The e-mail was sent to the following companies:
Crop Systems, Pirie Systems, Redwood Refrigeration, Bradley Refrigeration, Farm Electronics, Welvent, Cornerstone Systems

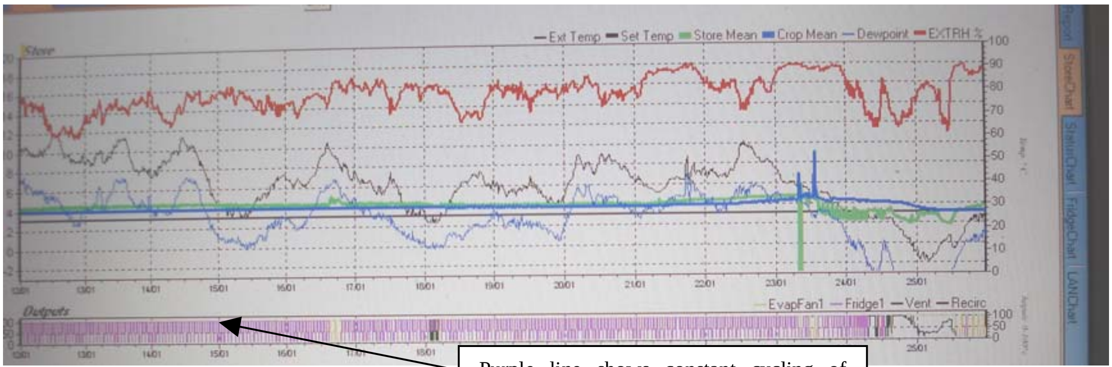
To date replies have been received from 2 companies – Redwood and Crop Systems.
Below is an extract from the reply from Crop Systems

> …..Our company has been pushing inverter control of fans for all applications of store control for several years, our competition have been fighting against this.
>
> We have electronic controls to run Inverter speed control based on all mechanical functions, we have very high levels of energy saving protocols to avoid unnecessary

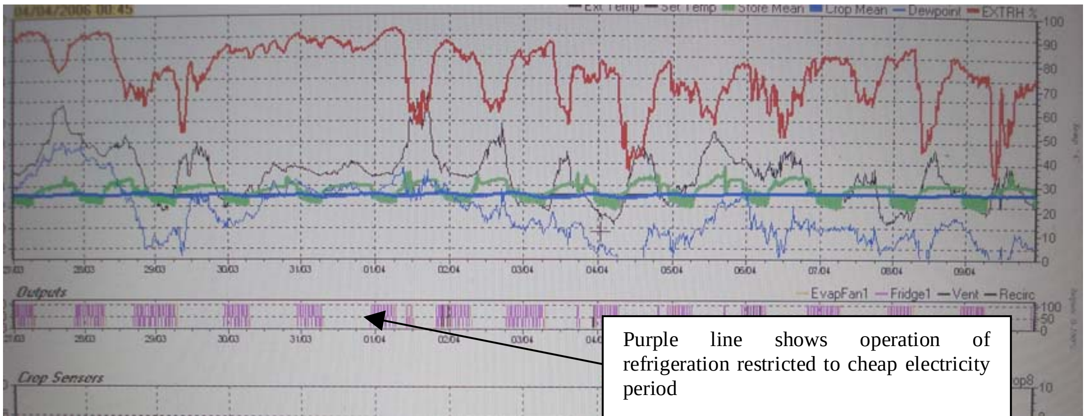
use of energy, we predict adiabatic cooling for use with our Evaporative cooling cells.

We have a consultancy side to the company which identifies store problems, we see huge amounts of energy wastage outside of energy usage, sometimes in excess of 35%.

Redwood made 2 particular comments. When asked about the 3 most important building related issues they said "Air leakage, Air leakage and Air leakage". They also illustrated the value of good monitoring and tariff control – see screen shots below from their Barn-report software.



Purple line shows constant cycling of refrigeration without tariff control



Purple line shows operation of refrigeration restricted to cheap electricity period