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W23 – Examples of Energy Reduction in Action

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Introduction

- What are the ‘Top 10’ energy reduction technologies
- Where do Renewables fit into the pecking order of low carbon solutions

Introduction

The aims of the seminar are to discuss the top 10 energy reduction technologies and how and where renewables fit into the pecking order of low carbon solutions.

Unfortunately, it is difficult to prepare a definitive list of the most effective technologies as their impact will very from site to site. Therefore, the aim of the presentation is to discuss those technologies that being most commonly installed and to identify a number of issues that should be considered or may affect the overall impact of the individual technologies.

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Overview of Technology Use

Overall impact of technologies will depend on a number of factors;
Energy Use, Processes, Sector, Environmental Control etc

Overview of Technology use

The overall impact of different technologies on a sites utility consumption and carbon emissions will depend on a number of factors.

A range of technologies that positively impact one site may not be feasible at another.

The suitability of certain technology will depend greatly on the energy usage on site and the energy split in terms of fuel and electricity. Another factor will be the processes undertaken on site. For example, if there are large process and heating loads technologies based around improving the efficiency of the heating systems may be more relevant than Variable speed drive applications for instance.

Certain technologies will also be more relevant across certain sectors. For example, in a typical pharma production building up to 40% of energy is used by the HVAC plant and therefore VSD's, BMS and improving the efficiency of the boiler and chiller systems may provide the best opportunities to reduce energy, whereas, environmental control & lighting technologies may provide the best opportunities in an office environment.

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Low or no cost opportunities

Low or no cost opportunities can have a big impact on site energy usage.

- Good Housekeeping
- Pipework Insulation
- Steam & Compressed air leaks
- Temperature Control
- BEMS Optimisation

Low or no cost opportunities

Of course, there may be low or no cost opportunities that can contribute to reducing emissions. The level of savings that can be made through these measures will depend on the quality of Energy Management Practices on site, where the savings will be greater at sites with poor Energy management Practices.

Good housekeeping can help reduce energy consumption across buildings and industry. Examples include turning off lights when not required in buildings, turning off equipment and reporting compressed air leaks in industry.

However, these types of measures only tend to provide benefits in the short term as any campaign tends to lose focus after the initial success.

Other opportunities include insulating pipework and repairing steam and compressed air leaks. Quick wins can also be gained from creating a heating and cooling policy which will help avoid over heating and simultaneous heating and cooling.

BMS optimisation can provide significant gains through improved plant control and from ensuring that the building environment is optimally controlled.

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10 – Combined Heat & Power (CHP)

CHP is now commercially available from 4 kW. The process involves burning fuel to generate electricity and heat which can be used in form of steam or LTHW.

- Only a good option if you can utilise the all / majority of heat generated
- Reduces both cost and CO2 emissions if sized correctly

10 – Combined Heat & Power

CHP is now commercially available from 4 kW (1kW for Micro CHP). The process involves burning fuel to generate electricity. The waste heat from the unit can be used in the form of steam and LTHW and warm air if required.

Sterling Engine technology is most commonly used in Micro CHP (<4 kW) which is ideal for domestic properties as it has a heat to power ration of approximately 25:1. Gas reciprocating engines are commonly used for an electrical output of up to 3MW and have an electrical efficiency of between 40-45%. Gas turbines become commercially feasible for loads over 3MW and have an electrical efficiency of approximately 30-33%.

CHP becomes a good option if you can utilise all or the majority of the heat generated and consideration should be given to this when sizing CHP units.

Small scale applications include Leisure centres and care homes whereas large applications include pharma, chemical sites and hospitals.

When sized correctly a CHP plant will help reduce both cost and CO2 emissions.

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9 – Efficient Heating & Cooling Technologies

The use of efficient heating and cooling technologies can help reduce the overall energy use of the building.

- Condensing boiler (95 % eff) vs. Conventional Boiler (80% eff)
- Variable Speed chiller (COP = 6) vs. Standard Chiller (COP = 4)

9 – Efficient Heating and Cooling Technologies

The use of efficient heating and cooling technologies can help reduce the overall use of energy.

Improvements in heating and cooling technologies have improved the efficiencies of systems from approximately 80% for a conventional LTHW boiler to 95% efficiency for the modern condensing boiler.

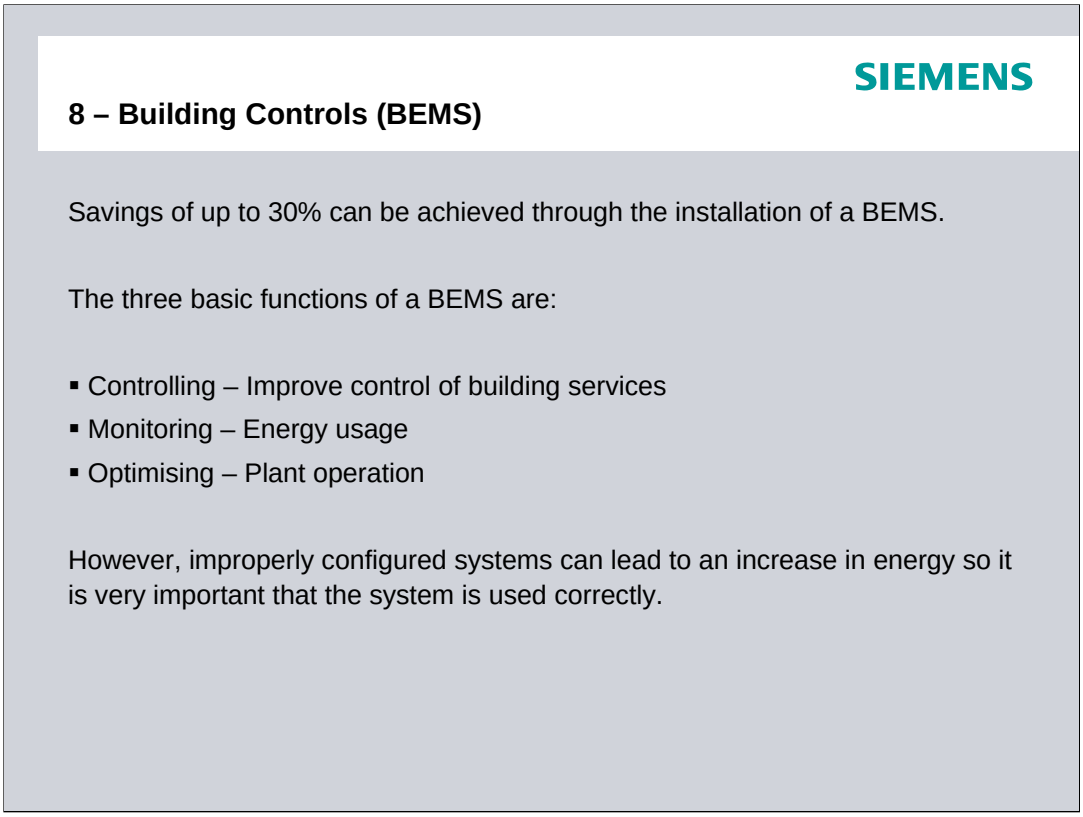
In regards to steam system improvements, system efficiencies can be improved through evaluating burner and boiler controls, flash heat recovery, flue gas heat recovery and reducing distribution losses.

The development of refridgeration compressor technology has led to significant improvements in performance. The coefficient of performance is the ratio of useful work out to work in or terms of a chiller system the number of kW cooling units for every kW of electricity used.

The COP of a chiller with a variable speed drive compressor can be as high as 6 whereas the COP of a standard chiller may have a COP of 3.

However, the efficiency of the chilled water distribution system can greatly affect the overall system COP. Therefore, sites should focus on both the generation and distribution of chilled water to help reduce costs.

The integration of these systems should be considered against other technologies to determine the most efficient solution for the building.



8 – Building Controls (BMS)

Savings of up to 30% can be achieved through the installation of a building energy management system.

The three basic functions of BEMS systems are:

Controlling – to improve the control of building services

This can include heating and cooling systems, lighting and fire and security systems.

One of the main benefits of controlling the plant is that a BEMS system can be used to integrate all of the plant to eliminate the conflict of separate systems.

Monitoring – A BEMS can help you monitor energy usage across the building which can be used to identify any anomalies in consumption and therefore reduce wastage to a minimum.

Optimising – A BMS system can be used to optimise systems to ensure they are operating as efficiently as possible to maintain the environment within the building.

However, a BEMS system is not a fit and forget solution as improperly configured systems may lead to an increase in energy if the conditions of use within the building change.

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7 – Supply Voltage Optimisation

Optimises your supply voltage from UK average 240V to 225-220V (depending on systems on site)

- Savings up to 8% can be achieved through the optimisation.
  - does not provide saving benefit on all equipment across the site (VSD, HF lighting, AC motors)

- Lower benefits can also be achieved for low / no cost through
  - tapping down transformers
  - replacing old transformers

7 – Supply Voltage Optimisation

The average supply voltage in the UK is approximately 240V. Voltage optimisation equipment allows sites to micro manage their own supply and can be used to provide the optimum voltage your electrical equipment needs which maybe between 220 – 225 V.

The reduction in supply voltage may provide savings of up to 8% and provide other benefits such as improving power factor and reducing reactive power.

However, care must be taken when evaluating this technology as the benefits will vary depending upon the equipment installed on site.

For instance, a number of loads are voltage dependant such as the majority of lighting , motors, electric heating and electronic equipment. Reducing the voltage to certain types of lamps and fittings will provide energy savings but also reduce the light output. There will be no savings or reduction in light output from reducing the voltage supplied to LED and high frequency lamps.

In addition to LED & high frequency lighting, reducing the voltage will not provide any benefits to motors fitted with variable speed drives or uncontrolled electric heating.

As an example voltage optimisation was considered against upgrading lighting and motor controls in a leisure centre. The lighting and motors accounted for 64% of the total average load.

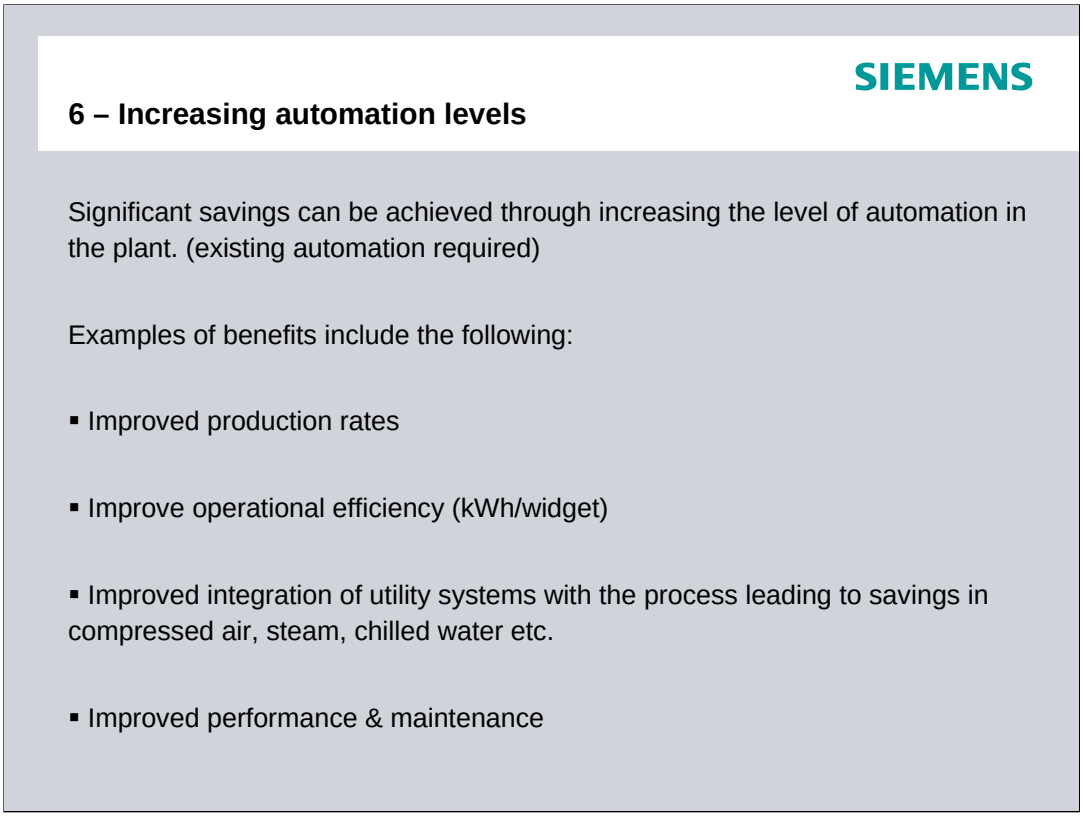
The payback for installing voltage optimisation equipment was 5.3 years for an initial outlay of £26,000 whereas upgrading the lighting and motor controls provided a payback of 1 year for an initial outlay of £32,000.

Obviously, if voltage optimisation was carried out first followed by the lighting and motors controls the savings from the voltage optimisation equipment would be significantly reduced.

In regards to VO savings on motors. Single phase motors rated at 230V and three phase motors rated at 380V will operate with inefficiencies at higher voltages, however there is no additional benefit for supplying voltages below this.

Based upon this, the technology should only be considered and installed as part of an energy reduction plan where the impacts of other energy saving technologies are taken into account.

Other methods of reducing voltage include changing the tap settings on transformers, replacing transformers with different winding ratios and installing controlled voltage transformers.



6 – Increasing automation levels

Significant savings can be achieved through increasing the level of automation across the plant.

In most cases a level of automation will already exist in manufacturing plants. Systems include Win CC, PVS7 and other SCADA systems.

Examples of the benefits from increasing the levels of automation include:

Increased production rates

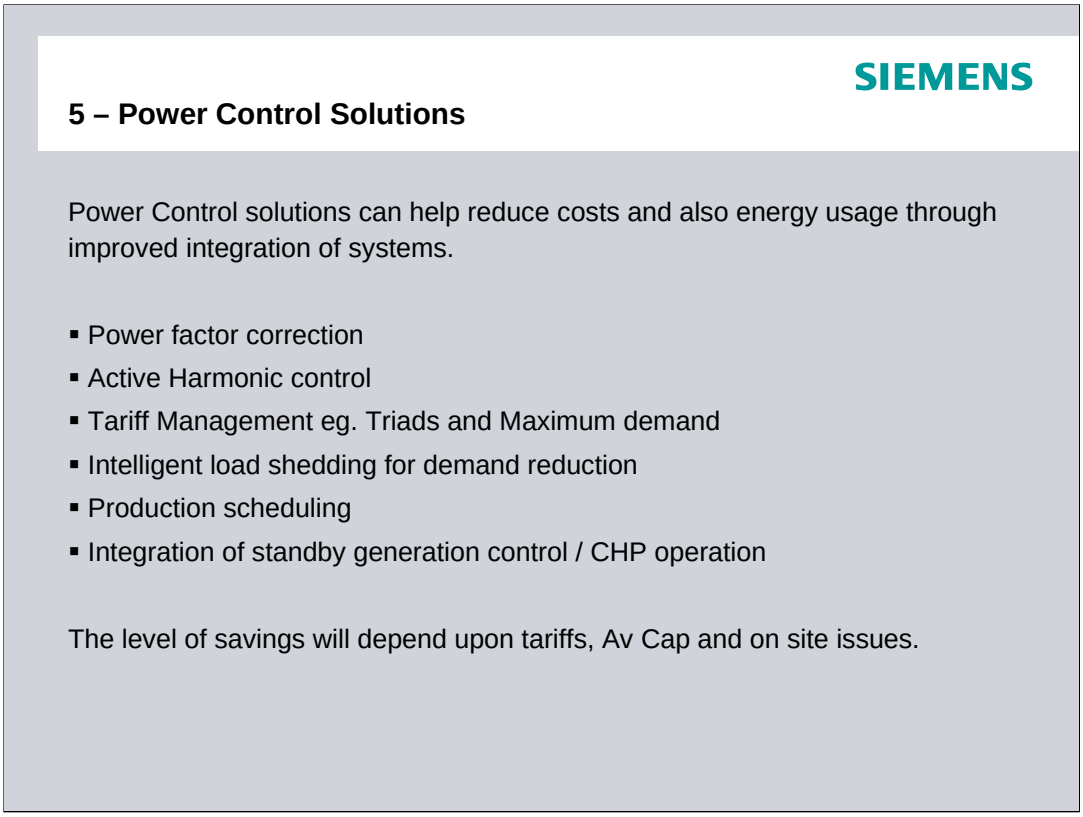
Improved operational efficiency (kWh / widget)

Increased yields

Improved integration of utility systems, which may lead to savings in compressed air, steam and chilled water.

Improved performance and maintenance.

Examples of improved performance and maintenance of major plant will be discussed in the following presentation.



5 – Power control solutions

Power control solutions can help reduce costs and also energy usage through the improved integration of power systems.

A range of products can help deliver the following benefits:

Improved power factor

Active harmonic control

Tariff management eg. Triad & maximum demand

Intelligent load shedding for demand reduction

Production scheduling

Integration of standby generation control / CHP operation

The level of savings will vary from site to site and will depend up on the tariff, available capacity charges and on site power quality issues.

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4 – High Efficiency Motors

The energy cost to run a motor can be greater than the initial capital cost to purchase the motor in 2 weeks.

- Over 20 years period energy cost > 500 x capital cost
- All new motors supplied after 16.06.2011 will be IE2 HEMs
- Siemens motors up to 7.8% more efficient than CEMAP min standards for IE1
- Simple payback for new motors < 18 months (retrofit)
- < 6 months comparing new motors

4 – High Efficiency motors

The installation of high efficiency motors can provide sites with a good opportunity to reduce both base and process electricity loads.

For example: A 75 kW motor running continuously will cost more than £1 million to operate over its life time. Also the energy costs to run a motor may exceed the capital cost of the motor in just 2 weeks.

New legislation states that all new asynchronous motors supplied after 16th June 2011 will be IE2 motors. For those of you who may not be aware IE2 is to replace the EFF1 rating.

In regards to Siemens offerings, Siemens IE2 motors are up to 7.8% more efficient than CEMAP minimum standards for IE1 (the old EFF2).

In terms of return on investment, retrofitting a HEM may provide a payback of less than 18 months, whereas the payback will be more like 3-6 months when comparing a HEM to a standard motor when a motor is being replaced or newly installed.

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3 – Variable Speed Drives

Variable speed drives can be used in all variable volume applications to reduce the speed of the motor and save energy.

With energy recovery and process optimized closed loop speed control savings of up to 70% are achievable.

Examples of use:

- Chiller and air compressors
- Pumps
- Ventilation fans
- Conveyor belts
- etc

3 – Variable Speed Drives

Variable speed drives also known as Variable Frequency drives or inverters can be used in all variable volume or flow applications to reduce the speed of the motor and save energy.

Currently, only 10% of all motors are fitted with VSDs and potential to fit VSDs to a further 10%. Therefore, there is huge potential to cut emissions from the use of all motors.

Following the cube law, reducing the speed of a motor by 20% will reduce the energy consumed by 50%. Savings of up to 70% can be achieved using regenerative drives or by using closed loop speed control.

Typical applications of use include:

Chiller and air compressors

Pumps

Ventilation fans

Conveyor belts

Crane systems etc.

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3 – Variable Speed drives – Case Study

Pharmaceutical: VSD's installed into production building in the following areas

- **Installed VSDs to main HVAC systems to reduce air change rates**
- **LTHW circulation pumps**
- **HTF circulation pumps**

- **Project Cost: £200K**
- **Project Savings: £102K**
- **Payback < 2 years**
- **693 tCO2/annum**

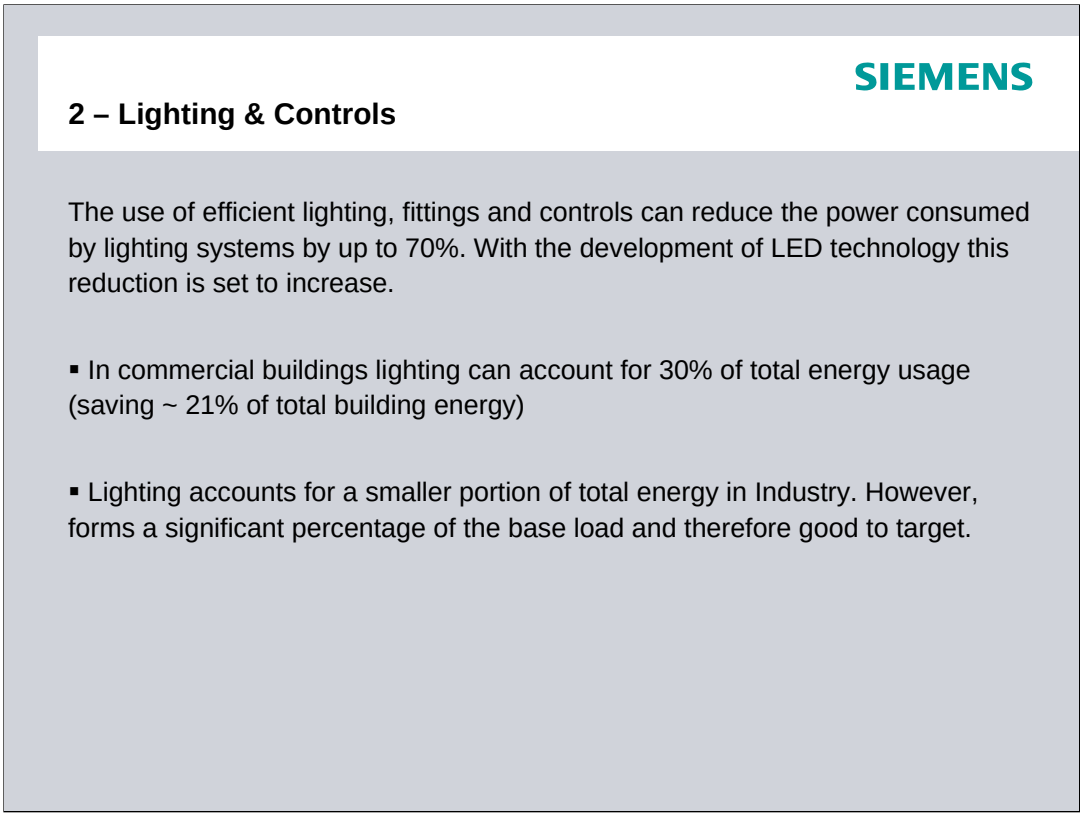
3 - Variable Speed drive Case Study

An example of the use of VSDs can be seen on this slide. VSDs were installed into a pharma production building on the main HVAC systems to improve the control of the ventilation rates. Drives were also fitted to the LTHW circulation pumps and the Heat Transfer fluid pumps.

The total project costs including installation were £200K giving savings of £102K and a payback of less than 2 years.

The total CO2 savings were 693 tonnes per annum.

In this particular example, a high percentage of the cost was for piping modification to the LTHW & HTF systems. Shorter paybacks in the region of 3-6 months are not uncommon in less complex applications.



2 – Lighting & Controls

The use of efficient lighting, fittings and controls can reduce the power consumed by lighting systems by up to 70%. With the development of LED technology the savings will become greater.

In commercial buildings lighting can account for 30% of the total usage therefore a 70% reduction would represent a saving of 21% of the total building energy.

Lighting accounts for a smaller portion of the total energy in Industry. However, lighting forms a significant percentage of the base load and is therefore a good area to target along with process optimization.

Each lighting application is different and unfortunately there is not one solution that fits all. An assessment of the lux levels for new lighting schemes and the suitability of different types of lighting needs to be undertaken in most circumstances. The selection of controls should also be appropriate for the environment that they are fitted.

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2 – Lighting & Controls – Case Study

Automotive Industry:

- Replaced 1,200 lamps and fittings (Metal Halide & Fluorescent)
- Installed daylight / PIR controls where suitable

- Project Cost: £109,000
- Project savings: £122,000 p/a
- Payback: 10.5 months
- 669 tCO2/annum

2 – Lighting Controls – Case Study

This case study shows the project details for a lighting replacement programme carried out in the automotive industry.

A total of 1,200 lamps and fittings which were a mixture of Metal Halide and Fluorescent lamps were replaced with new fittings, lamps and controls where relevant.

The total project cost was £109K with £122K savings which provided a project payback of 10.5 months.

The CO2 savings were 669 tonnes per annum.

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1 – AMR / aM&T (+ effective implementation prog)

Critical part of any Energy Management Programme:

- aM&T enables sites to continuously improve performance through
  - reduced wastage
  - identification of inefficiencies compared to design
  - identify capital improvement projects
  - benchmark process lines
  - set reduction targets
  - reporting
  - target specific plant

1 – AMR / aM&T (+ effective implementation program)

This is a critical part of any Energy Management Programme and enables sites to continuously improve performance through:

Reduced wastage

Identification of inefficiencies compared to design

Identifying capital improvement projects

Benchmarking process lines

Setting reduction targets

Reporting

Targeting of specific plant

aM&T is recognised as best practice and forms part of the Energy Management systems BS EN 16001.

The guidelines require businesses to set energy use targets, assign staff to manage energy use and promote energy saving measures, establish monitoring systems and organise an internal audit programme to ensure targets are met and regularly review the effectiveness of the Energy Management system.

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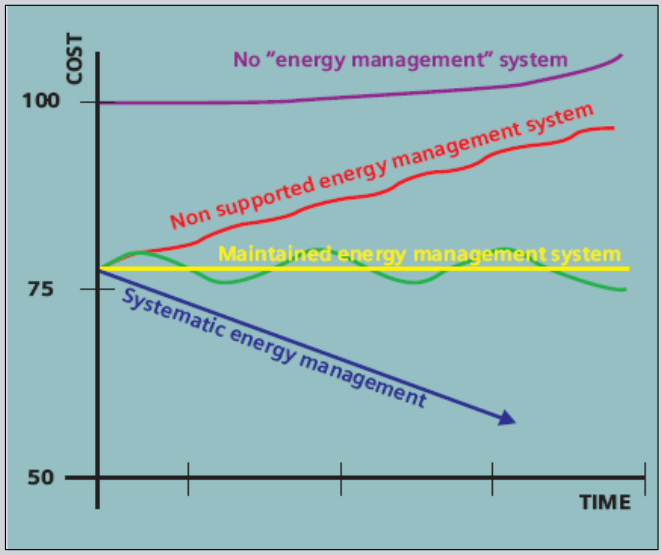
Benefits Of A Systematic Cost Reduction Strategy



"Our experience is that piecemeal measures cannot deliver the energy and cost reductions required by industry and commerce"

- A systematic energy strategy provides the most successful method of energy, carbon and cost reduction.

Benefits of a systematic cost reduction strategy

The chart shows that a systematic energy strategy provides the most successful method of energy, carbon and cost reduction and will provide the best results over time.

Typical savings from maintaining Energy management standards and systems on site are 10% which are generally lower cost using existing skills. Savings in the region of 20% are expected to follow using an 'invest and save approach' which requires higher capital, new skills but provides longer term benefits.

Further benefits will be achieved through better design and asset management and investing in renewable technologies.

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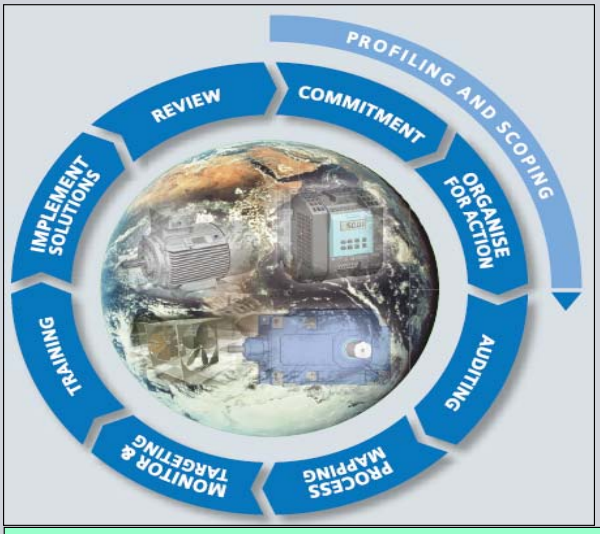
Best Practice Utility & Cost Reduction Strategy



- A systematic approach delivers maximum cost reduction.
- This process forms the basis of a long term continuous improvement programme.
- Simplifies environmental compliance issues
- Maximises contribution to "carbon" reduction targets

"Cost Reductions achieved through a systematic approach are typically **4 x greater** than compared to 'ad hoc' stand alone measures"

Best Practice Utility & Cost Reduction Strategy

The Siemens approach on customers sites can be seen here.

A profile and scoping phase which shows the customers commitment to the approach is followed by auditing, process mapping and M&T phases where all energy is accounted for, following this the process is benchmarked and compared against good practice benchmark figures. All of this data is used to identify opportunities to reduce energy on site and improve the efficiency of the process.

A complete review of the systems which leads to continuous improvement follows training and the implementation of the opportunities found during the first cycle of the approach.

The cost savings achieved through a systematic approach are typically 4 x greater when compared to 'ad hoc' stand alone measures.

Siemens has the expertise to deliver these services, if this of interest then my contact details can be found on the final slide.

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"Top 10" Technologies By "Payback"?

	Technology	Return on Investment
1.	AMR / aM&T (+ effective implementation programme)	1 to 3 months?
2.	Lighting & Controls	1 to 12 months?
3.	Variable speed drives (VSDs)	3 to 12 months?
4.	High Efficiency Electric Motors	3 to 12 months?
5.	Power control solutions	1.5 to 4 years?
6.	Increase automation levels	1.5 to 4 years?
7.	Supply voltage optimisation	1.5 to 4 years?
8.	Building controls (BEMS)	2 to 5 years?
9.	Efficient heating & cooling technologies	2 to 5 years?
10.	Combined Heat & Power	3 to 7 years?

Notes
i) Excluding employee awareness / change management type programmes
ii) Excludes mechanical / process type improvements
iii) Paybacks based on direct energy reduction – extensive associated benefits also accrue

"Top 10" Technologies by Payback

The chart below shows the Top 10 technologies by typical payback. As discussed earlier not all technologies will be relevant on all sites and it is therefore best to carry out a systematic approach to identify all opportunities on site.

The main factors effecting the payback for the different technologies are the site tariffs and age and size of plant.

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Renewables – How do they fit in

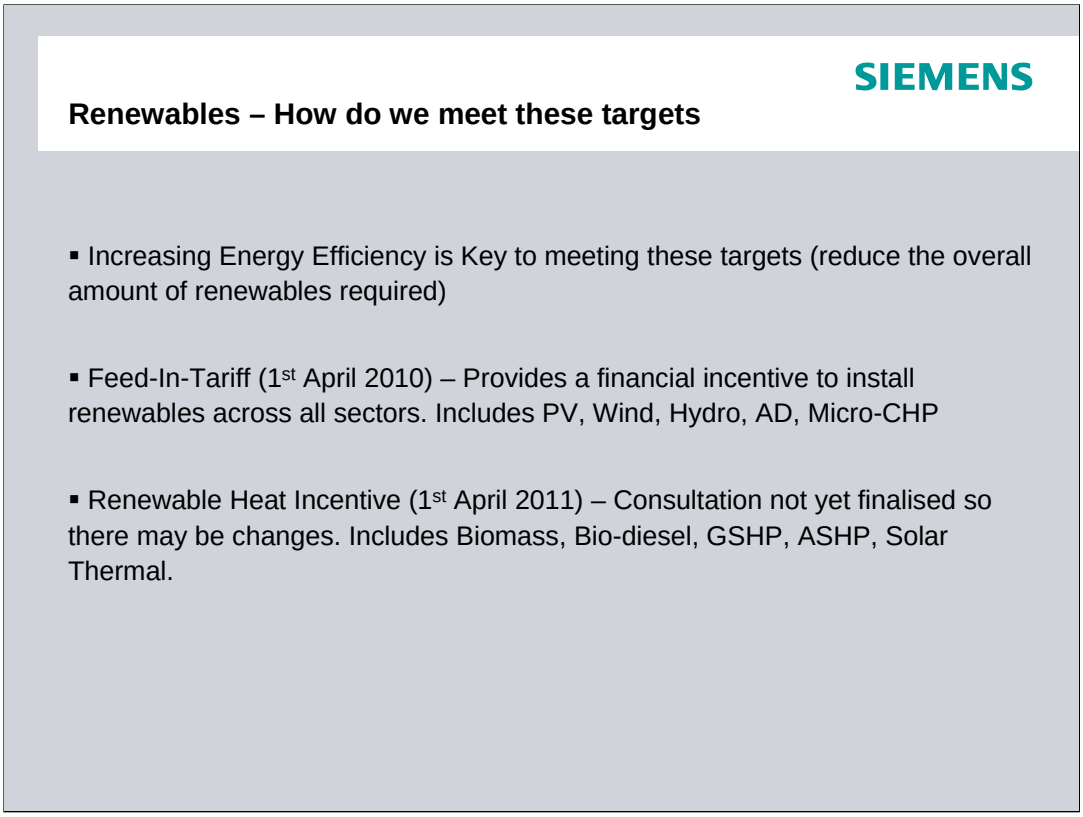
UK – Renewable energy target of 15% by 2020 (1.3% in 2005)

In order to meet this target (which includes transport and fuel) it is estimated that at least 32% of electricity will need to come from renewable sources.

Renewables – How do they fit in

The UK has set itself a renewable energy target of 15% by 2010. In 2005 the level was only 1.3%. In 2009, the level reached 6%, however this is set to fall due to a lengthy cold and wind less space and helps highlight the fact that wind energy can not be used in isolation for meeting the countries electricity needs.

In order to meet this target which includes transport and fuel it is estimated that at least 32% of electricity will need to come from renewable sources.



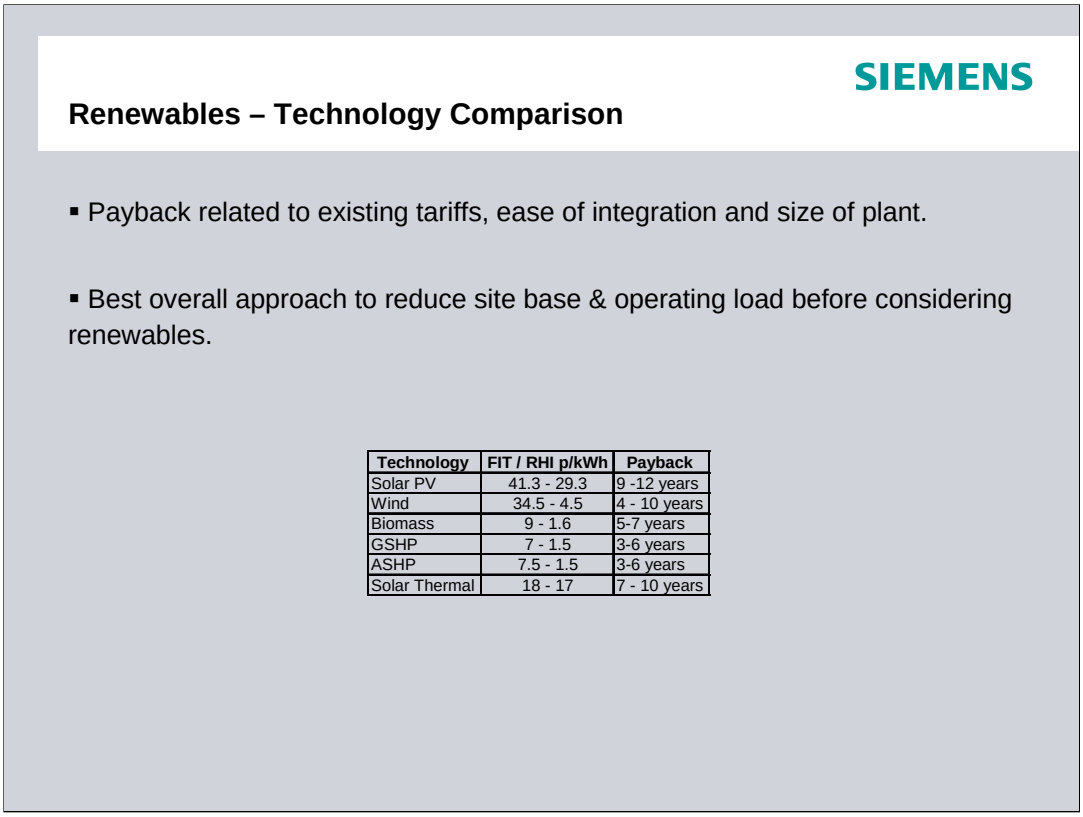
Renewables – How do we meet these targets

Increasing Energy Efficiency is key to meeting these targets as it will reduce the overall capacity of renewables required.

In order to increase the effectiveness of renewables to companies and individuals the Feed-In-Tariff provides a financial incentive to install renewables which generate electricity and covers Photo-Voltaics, Wind, Hydro, Anaerobic digestion and Micro CHP. The scheme went live on 1st April 2010 and will provide the incentive for qualifying projects for between 10 – 25 years depending on the technology.

The renewable heat incentive is due to start on 1st April 2011 and covers biomass, biodiesel, GSHP, ASHP and solar thermal. However the consultation for the RHI has not yet been finalised so there may be some changes over the next year.

The scheme will provide the incentive for eligible technologies for the next 10 – 23 years.



Renewables – Technology Comparison

The chart below shows the incentives and paybacks for installing renewables. The level of incentive depends on the size of the equipment being installed.

Before considering renewables the best approach is to reduce the sites base and production loads using the systematic approach as it is important that renewables are optimally sized to give the best financial return.

For example, the best approach for Biomass boilers is to size the boiler to meet the heat base load as Biomass boilers do not operate efficiently at low or part load. A similar approach should also be considered for GSHP and ASHP.

Overall, renewables will be more financially attractive in new builds for a number of reasons including:

Not having to write off the asset value of any equipment it replaces.

Reduced planning requirements

Spacial constraints of retrofitting equipment

In summary, it is predicted that energy prices will increase by 60% by 2016. Therefore, there is no better time for companies to invest in its plant to reduce both energy and costs and gain a real competitive edge over companies within their sector.

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Thank You

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