Fresh pair of

Most plants might benefit from an energy audit, but many could also do with a review of operations, aimed at improving everything from efficiency to product quality. Dr Tom Shelley reports

Significant improvements to plant operations and equally significant energy savings can be achieved, with minimal investment – provided they are understood by competent plant engineers, with open minds. How much is 'significant'? Neil Wilson, senior utilities manager at Danfoss, reckons 10 to 15% energy cost savings are common – but not from harnessing technology alone. For him and others, what matters is a plant audit, followed by action based on the data recorded, the detail of plant engineering and an awareness of what might now be done better.

Visiting a 40-year-old grain handling and animal feed processing plant recently, near Canterbury in Kent, with other SOE members, the common sense of Wilson's approach became clear. Variable speed drives, high efficiency motors and modern sensors, supplied by top quality, blue chip manufacturers, were all in evidence. Also, sophisticated control systems that allowed the simultaneous production of up to three recipes, from up to 15 ingredients.

However, Colin Beesty, manager of WL Duffields (the animal feed plant section of the site), conceded that energy remains one of this plant's biggest costs, not least because materials are still elevated to the tops of silos and allowed to fall no fewer than four times during the course of production.

Plainly, if the plant were to be built today, there would almost certainly be only one elevation and one progression from the top of the plant to the bottom. However, since it is not feasible to rebuild the entire plant, sections most able to benefit from substantial improvements are being replaced. For example, a £400,000 Spanish manufactured bagging plant is currently being erected, with the expectation of considerably more efficient operations.

Returning to Danfoss' Wilson, he explains that his team typically goes into a plant and, following initial investigations, offers guarantees of deliverables on a 'no cure, no pay' basis. For him, getting this right is about examining the detailed design and engineering of the plant, part of which is achieved by installing data monitoring equipment and undertaking some analysis "to transform the data into information" – using his team's skills to determine where to look and how to respond.

Steamy solution

By way of example, he suggests that, if a pasteuriser were consuming too much steam, it would be Danfoss' task to find out why. Perhaps a valve might be malfunctioning and too much water overflowing. But his point is that a management information system, such as his organisation would install, would establish whether there was a problem and identify the probable causes. Cost of the software is typically £12,000 to £13,000, which, he contends, can be very quickly recouped.

A similar approach is offered by Siemens, which focuses on electrical energy consumption. Mark Danzenbaker, product manager for Siemens' Gridpoint energy management system, explains that data loggers can provide a detailed picture of currents, voltages, power factors and power quality around a plant. Analysis then flags up elevated loads for entire sites, particular processes, machines or

circuits – pinpointing areas with developing faults or helping managers to plan load shedding.

"Payback is definitely under two years," says Danzenbaker, adding that the package is provided as a service, with one of its 3612 systems costing around £8,500 to install, plus £300 to £500 per year. Two years is probably a cautious assessment: Siemens' leaflet, Top 10 energy saving tips, puts metering at the top of its list and claims paybacks of one to three months. Importantly, it suggests there is no need to meter everything. "Don't meter what you can't control, but focus on the big ticket items, such as heating, process equipment, air conditioning and lighting," say the authors.

Nigel Orchard, managing director of Pilot Systems, and chairman of the Energy Services and Technology Association Monitoring Group, agrees. He makes the point that smart metering (fiscal metering with remote communications) has been mandated by government, to be rolled out in less than 10 years, precisely because of the energy savings it enables. He suggests trials demonstrate that just having information on energy consumption in different parts of a plant can save 5% on energy, but adds that making good use of the data can move that up to 30%.

Although there are smart metering systems for home use, for small plants and for very large plants, Orchard anticipates that large plants will be the big winners. Systems of the future, he says, will enable plant managers to switch energy suppliers on a half hourly basis, to take advantage of best prices. Already, plant managers can elect to use independent metering companies. That may seem strange, given that meters supplied by energy suppliers usually come free. However, independent firms normally supply smart meters. Also, as Orchard observes: "Users tend to do more with their energy data when they know they are paying for it."

Left centre: Colin Beesty, manager of WL Duffields, says that, while energy remains one of this plant's biggest costs, rebuild is not a sensible option

Heat metering

But while electricity and gas are fairly easy to meter, what if the problem is monitoring heat, as transmitted by hot water circuits? Kamstrup UK is one company offering instrumentation to measure temperatures in hot water flow and return pipes, and computing heat by monitoring volume flows, using ultrasonic flowmeters. As the company's Stephen Oakman says, if pipes are inadequately insulated, significant heat (or cold) energy may well be lost in transmission. Measuring just how much points plant engineers in the direction of simple solutions.

In a similar vein, Micronics Flow Meters supplies clamp-on ultrasonic meters for heat flow monitoring. Instruments are available to operate with data logging facilities, and information can be uploaded or permanently connected to so-called automatic monitoring and targeting (aM&T) systems. Users include Luton Borough Council, Network Rail, Kings College and the Ricoh Arena.

In general, plant engineers can install energy monitoring equipment themselves or may prefer to go for a solution. Darryl Mattocks, director of Enistic, suggests that, while other firms sell metering systems, his offers a full service. Enistic, he says, installs equipment that either reports back to the plant manager or to one of the company's 'energy coaches' in Worminghall, who can then offer advice. Equipment can be based on fiscal meters, monitoring up to 20 parameters, or instrumented

Siemens' top ten energy saving tips

1	Metering	*Payback: one to three months*
2	Lighting	*Payback: one to 12 months*
3	High efficiency motors and variable speed drives	*Payback: three to 12 months*
4	Building controls	*Payback: three months to four years*
5	Intelligent lighting controls	*Payback: one to four years*
6	Increased factory or process automation	*Payback: one to four years*
7	Power controls	*Payback: one to four years*
8	Supply voltage optimisation	*Payback: one to four years*
9	Efficient heating and cooling technologies	*Payback: two to five years*
10	Combined heat and power	*Payback: two to seven years*

Condition monitoring

If you need help in prioritising energy saving and/or performance enhancing initiatives related to problematic plant and equipment, but can't justify the expense of condition monitoring systems, there is another way. Much can be done to detect developing faults by walking around a plant, using an infrared camera and looking for hot spots.

These devices typically cost around £5,000, but Steve Carey, technical support and sales at Speedy, observes that, for many would-be users, hiring is a more sensible option than buying the equipment.

"This also allows engineers to have a ready access to the most innovative thermographic models on the market, as and when they become available," he declares.

distribution boards, or plug-in meters to monitor individual circuits and machines.

Communications are by Zigbee Pro wireless and, should distances between units be great, individual monitoring units can also daisy chain data. Cost of a typical plant starter system is about £3,000, according to Mattocks, who says that the firm's biggest project cost £15,000. Reference sites include Honda, Bradford and Bingley, and the World Wide Fund. Mattocks says the system has also been installed at several industrial plants.

Meanwhile, if the issue is improving the efficiency of chilled distribution or HVAC, Matthew Brumwell, director of ThermOzone, reckons that its plant refurbishment service, dubbed Re-Chill, "usually gives 25% to 30% energy savings". He says that engineering generally starts by replacing old reciprocating compressors with screw types. These are inherently more energy efficient and reduce the number of friction-inducing moving parts from around 40 to four.

Beyond that, Brumwell suggests that new coils and fins usually improve performance, while new 'drop in gases', to replace R22, only require minimal modifications. He also says that, because of advances in electronic control, installing advanced controllers – in this company's case, from California-based MCS – as well as variable speed drives on fans, will make a worthwhile difference.

These approaches are widely applicable. EcoCooling, for example, recently completed a project for the University of Cambridge mechanical engineering department that has cut energy consumption for cooling its data centre by 90%. Its system replaced conventional direct expansion refrigeration equipment, operating with a power usage effectiveness (PUE) of 1.6. Measurements taken by the department indicated that the system was operating at a coefficient of performance (COP) of 2, meaning it was taking 50% of the load to cool the servers.

The replacement scheme harnesses six evaporative coolers and has a design capacity of 150kW. The equipment discharges cooled air directly into the cold aisle, while hot air from the servers is ducted through the plant room and discharged through roof vents. On implementation, the IT load increased from 70 to 100kW, but the cooling energy drain is now only about 5% of the IT load. The university department confirms that it is currently running at a PUE of less than 1.1 and the cooling system operates at a COP of 20.

All that said, if your plant is on top of its game, in terms of process and ancillary equipment energy consumption, how about lighting – Siemens' number two in its top 10 list? Siemens reckons that typical paybacks for lighting projects range from just one to 12 months, so what makes most sense?

The most efficient industrial lamps now available are based on LEDs. However, before you rush out to buy some, Jim McMahon of Ecotronic reckons that big savings can be achieved simply by installing passive infrared switches (to turn lights off when people are not around), as well as sensors that detect when daylight reaches more than 125% of artificial light intensity. He also states that 45% energy savings are available by changing from 400W high-mounted sodium lamps to modern fluorescent tubes in luminaries equipped with suitably shaped, highly polished, aluminium reflectors. Recent implementations include Airbus Operations UK, at Filton, Bristol, and SCA Hygiene Products UK.

Nevertheless, LEDs are undoubtedly the future, as costs come down, while energy prices rise. Thorworld Industries recently launched 12W LEDs for its standard Plus Dock lights, as an alternative to 80W bulbs. Light intensity, at more than 1,000 Lumens, is the same, but lifespan is 50,000h – at least 10 times the life of halogens. Ledeco Lights, based in Camberley, Surrey, offers retrofit LED lighting systems. It makes the point that, if reduced maintenance costs are included, replacement of a 5ft fluorescent tube, used 24/7, with a 5ft Goodlight LED tube, pays back in just four months. PE