Passionate about energy

It's too easy to be swayed by popular initiatives and yesterday's headlines. To work well, energy-saving projects require hard-nosed engineering reappraisal. Brian Tinham reports

Every engineer knows that energy saving is good. It's almost invariably linked with worthwhile emissions savings and there are attractive financial returns. Also, installing new equipment, instrumentation and/or controls usually solves what are often annoying maintenance and/or operations headaches, as well as resulting in cleaner plant and better working environments.

But how big are the savings and how rapid the paybacks? Are you confident of demonstrating a business case? For that matter, do you know which initiatives work best? Do you understand all the opportunities and the implications of each? Even if you do, when you look beyond the headline projects, you may be surprised at the potential.

So first, let's put figures on some of the more conventional options. For a typical steam plant equipped with four boilers, for example, heating plant manufacturer Fulton estimates the cost per boiler fitted with its ECA burners at £2,300, yielding an annual running cost saving, again per boiler, of £2,750. That's a payback of less than one year.

Burner and boiler maker Energy Technology & Control estimates similar returns from electronic combustion controls using zirconia analysers – listing improvements as up to 5% better utilisation from boiler sequence control, 10% waste avoidance from increased turndown, 1% efficiency improvement from precise and repeatable control, 3.5% efficiency improvement from oxygen trim, 10% waste avoidance from its setback option and 80% electricity improvement by using variable speed drive (VSD) control on the air fan.

But beyond the obvious, GP Burners in Swindon has helped agricultural engineering firm Syngenta's research centre at Jealott's Hill to achieve a 26% energy saving by converting 12 Wellman Robey boilers, ranging in size from 250 kW to 2,400 kW, to full modulation from low and high firing. Other energy-saving measures included using inverters to control pumps, taking control of lighting during occupancy and challenging the running of large energy-consuming plant, such as compressors.

Moving on to steam distribution, steam trap surveys on sizeable plant regularly surprise users – often providing paybacks within four to six months, mostly due to rectifying failures on fixed orifice devices. But again, that's not all. Concrete blocks manufacturer Tarmac Topblock, for instance, says it's saving £100,000 per year since installing a Spirax Sarco engineered heat recovery system at its Alfreton factory. Instead of venting process steam to atmosphere, it is now pre-heating the site's boiler feed water – with a storage tank providing the buffer to handle demand variability.

Then again, there's more to energy saving than VSDs and high-efficiency motors. Fenland Laundries says it is saving £10,000 per year in its clean room operation by controlling power, rather than voltage, to vary speed on 96 fans. The company went for a Eurotherm 2500 controller that's now optimising sequence control of 48 single phase in and out inverters, thus also automating clean room pressure management. Payback here will be about one year. Remembering the huge estate of smaller drive applications out there, this is an area well worth investigation.

Meanwhile, engineering services firm Deritend makes the point that, if you're thinking about high efficiency motors, why not check drive trains, and size and type of driven plant first? It cites one food and beverage user with a conveyor, driven by a standard motor and 1.5kW helical worm gearbox, giving 59% overall efficiency. Replacing that with a

Right: Oke Anosike at Huntingdon-baed Cellbond – evaporative cooling is amazing
Below: Ferrybridge power station – looking at retrofitting Doosan Babcock technology

Paul Dronsfield, Creative Edge

Flender helical bevel gearbox and an EFF1 motor took it up to 81%, providing £375 saving. As for pumps, the company highlights the fact that, while changing to high-efficiency motors will yield 1–5% energy savings, analysing the pump application can provide 30%, since so many have been incorrectly specified. Swapping pumps isn't cheap, but those are predicted average total life savings when pump and impeller performance curves are re-assessed. Replacing throttling mechanisms with VSDs can then make for another 50% energy-saving improvement, dependent on the application.

Help is at hand

So these are well worth doing. And bear in mind that capital investment here is attractive now, not just because of the recent sharp rises in energy prices, but also the government-backed ECA (enhanced capital allowance) scheme – operated by Defra, The Carbon Trust and the Inland Revenue – which enables businesses to claim 100% of their capital allowances in the year of purchase for ETL (energy technology list) accredited equipment. And there's The Carbon Trust's own 'amazing' interest-free energy efficiency loans for SMEs.

Or so we thought. Beware though: there is some doubt over the latter. Maxsys, for example, which offers a money-back guaranteed 5% energy saving on gas and oil fired plant with its Fuel+ magnetic fuel pre-treatment equipment, reports prospective users being denied acceptance on the scheme. In one case, The Carbon Trust was "unable to find a suitably qualified independent technical expert to validate the energy-saving claims". That despite successful verification by ABB and reference installations at Ford, Mondi, the NHS, Union Papertech, Dow Chemical, Ciba Speciality Chemicals, Michelin, Scott Bader, GM and Toray Plastics. Worryingly, sources are speculating that innovative technology is being used as a smoke screen for budget problems.

That said, let's look in more detail at a few of the more novel options, taking evaporative cooling first, only because it appears to offer so much for factory, warehouse and even office cooling – and at a tiny fraction of the cost of air conditioning plant. Alan Beresford, managing director of supplier EcoCooling, claims that running costs are less than 10% of the equivalent air conditioners, they're 75% less expensive to install, and they show a 90% saving on carbon footprint. For a technology that's been around – albeit in a less developed form – in the Middle East for years, it seems astounding that it's only now starting to catch on in the UK.

Beresford says that his Breezair-based systems essentially draw warm air into buildings across wet cooling pipes to enable adiabatic cooling. He also says that, most of the year, they operate in ultra low cost ventilation mode, switching to cooling only in the summer months. What's more, he insists that Legionnaire's disease is not an issue, because the temperature of circulating water rarely exceeds the key 20°C point and his automatic controls ensure drainage when the system is switched off. "The control system varies the rate of ventilation, according to the internal temperature, bringing in

Energy savers

- Heat recovery from generators, compressors and steam raising
- Survey your steam trap operations and plant
- Instal new fuel and water conditioning equipment on boilers
- Fit modern burners and combustion controls
- Replace old motors with high-efficiency units
- Go for soft starts to take out idling motors
- Use variable speed drives on pumps, compressors and fans
- Check sizing of pumps, motors and compressors
- Look at technologies to replace traditional HVAC
- Check type of gearing and drive mechanisms
- Evaluate sensor and instrumentation accuracy

Above: EcoCooling in action at Cellbond in Huntingdon
Right: Doosan Babcock Posiflow furnace for coal-fired plant

evaporative cooling as early as possible to minimise energy consumption on the fans," he explains.

His claims are completely verifiable. Huntingdon-based composite structures manufacturer Cellbond, for example, installed a three-cooler EcoCooling system on its factory roof, with balanced extraction, and transformed its working environment – to the extent that the company is now looking at replacing its office air conditioning.

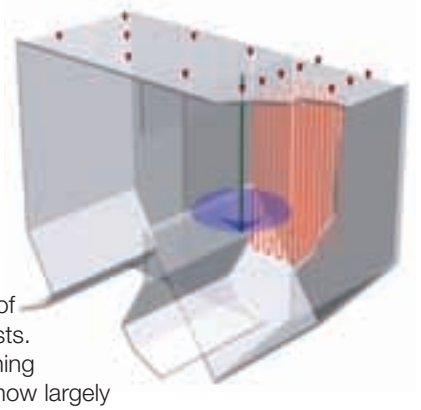
Cellbond project engineer Oke Anosike says: "The shop floor used to get up to 40°C in the summer: now you can have windows and doors open and the temperature stays at 22°C inside. It's amazing: the more air you exchange, the more efficient the system is."

What did it cost? "It was cheaper than air conditioning by a factor of four to one, with maintenance almost double that. Conventional AC would have cost about £80,000, but this was £22,500. Installation was pretty easy, too; we just had to work out where to position the extractor fans to get good air circulation."

Better heat transfer

Moving on to boiler technologies, even good old soot blowers have been getting a makeover. Not only are there effective alternatives to superheated steam cleaning, but automated controls now cover all the way from supercritical boilers, including tower units up to 1,200MW, down to smaller marine boilers and land-based units as small as 30MW – for example, on biomass operations such as Eggborough, Westfield, Ely, Thetford or Dundee.

Clyde Bergmann is among the leaders here, with closed loop boiler efficiency management controls that provide for cleaning, based on real-time mapping of the heat transfer surfaces, instead of overall back-end temperature measurements. Neil Inglis, sales director, reckons that on large coal-fired plant, improvements of 1% are easily achievable. "Imagine the fuel bill at Drax, Didcot or Longannet. A limited investment in automatic controls could save them millions of pounds. We've seen paybacks of just six weeks," he insists.



As for the new cleaning equipment, water has now largely replaced steam, and it covers a huge range of boiler plant sizes. For example, Clyde Bergmann installed shower-based cleaning on the Tyseley, Birmingham, waste-to-energy plant, and the next few months will see installation of its water cannon at "a major UK power station". Says Inglis: "These systems are directional, so, using our intelligent measurement, we can deploy better water or steam cleaning. That means we can improve efficiency on plants without a whole new mechanical installation. Equally, on new plant, we can deliver energy-efficient water cleaning that's far simpler to install, operate and maintain."

He agrees that there are more headline-grabbing improvements in the engineering around power plant mills, burning systems, water treatment etc, that can deliver bigger returns, but retorts: "Those need a massive investment for their big returns, whereas we're talking about delivering big returns for minimal investments." What about that cost? Inglis suggests that, for a land-based 650MW single boiler unit, they're likely to be £100,000–200,000, depending on choice of controls.

Incidentally, installation and commissioning are far simpler than on conventional plant – whereas a 650MW plant would need up to 50 steam soot blowers, around four to eight water cannons would do the job. So there are far fewer openings in the boiler wall, fewer services and no drain lines. PE

Coal-fired plant

Doosan Babcock has the technology to build large coal-fired plant capable of 47% thermodynamic efficiency (compared to today's 35% on UK plant) – and 45% by modifying existing plants of 300–1,000MW. Dr Mike Farley, director of technology policy, says that Ferrybridge and Longannet are among UK power stations currently looking at the technology.

"We can offer full guarantees because all of the elements have now been proven elsewhere in mainland Europe, China and America," he says. It's worth noting that the new approach takes supercritical steam up to 300bar and 600°C, meaning that the boilers and much, if not all, of the steam turbine plant have to be replaced. However, the controls and the rest of the plant need not be affected, and Farley emphasises that it's still only a small fraction of the cost of building new.

Part of the technology improvement involves Doosan's Posiflow furnace, which harnesses vertical, internally ribbed tubes to assist flow and ensure consistent outlet temperatures. Materials, too, have been upgraded with, for example, austenitic steel tubing for the boilers and ferritic alloy P92 modified 9% chrome for the pipework.

However, even this huge improvement in energy efficiency only equates to a 20% reduction in CO_2 emissions. Given the UK government's commitment to reductions of 26–32% by 2020, as outlined in its Energy Policy White Paper published in May, that's not enough. After all, its assumption is that up to 60% of that will come from power generation. Farley's answer is the promise of carbon capture. "The new plant design is carbon capture ready, whether the decision is to use post-combustion flue gas scrubbing, or oxy-fuel firing, with space for the plant in front of the boilers," he says. Interestingly, he believes there's potential for post-combustion carbon capture on CHP plants, possibly down to 100MW.