Cheap as CHPs

Kingston Hospital's combined heat and power plant provides an excellent insight into just how much energy and money can be saved with so little. Brian Tinham reports

Combined heat and power (CHP) isn't only about CCGT (combined cycle gas turbine) installations that generate hundreds of megawatts. Especially in these times of expensive energy and environmental awareness, all of us need to be considering much more modest CHP plants. Why? Because they're typically more than twice as efficient as conventional generation, in terms of converting fossil fuels into energy.

Top of the list should be those involving gas, diesel, petrol, gasoil or kerosene-powered reciprocating engines for electricity, with exhaust gases either used to preheat feed water to twinned boilers, and/or to heat domestic water etc, via heat exchangers.

That sounds like idealism and, yes, I know, managers will tell you it's not a perfect world, so it can't be done here. Reasons cited range from 'the boiler plant can't be written off yet', to 'we can't afford it', 'there isn't space', and 'it wouldn't be economically viable on our size of plant'. But the truth is that modern CHP plants can be very small and, with current funding, surprisingly affordable. Even if your plant is as little as 10 years old, the efficiency and emissions improvements alone from conversion to CHP – or, at the very least, a plant upgrade (see panel opposite) – can make a project very worthwhile.

Which is why it's so interesting to look at a smallish boiler house refurbishment project, recently brought into full operation at Kingston Hospital, that went the CHP route. The new plant comprises a 1.4MWe 20-cylinder, gas-fired GE Jenbacher engine in combination with a gas- and oil-fired Wellman Robey Loos 9.59 tonne waste-recovery boiler, two additional Wellman Robey 8 tonne steam-raising boilers (again, dual fuel) in duty/standby, a 330kW absorption chiller, heat exchangers and high and low voltage switchboard. That's now providing heating, cooling and the lion's share of hospital electricity under a 15-year PFI (private finance initiative) backed contract with facilities and energy management company Dalkia.

You're looking at an investment of £2.9 million that included stripping out three existing boilers, which had reached the end of their operational life (there was no on-site generation, other than standby plant), all the civils, professional asbestos removal, provision of temporary boilers, and design, installation and commissioning of all new plant – as well as subsequent operation and maintenance.

Pointers

- Combined heat and power plants are more than twice as efficient as conventional generation, in terms of converting fossil fuels into energy
- Even if your plant is as little as 10 years old, the efficiency and emissions improvements alone from conversion to CHP are significant
- PFIs (private finance initiatives) take the pain out of capital investment
- PFIs also encourage better plant engineering practice and lower opex

Note that, under the PFI, there was zero capital outlay for the hospital trust and using CHP also enabled the hospital to claim Climate Change Levy exemption. What's more, the resulting plant has cut greenhouse gas emissions by an estimated 4,000 tonnes per year. Total cost savings for the hospital are around £245,000 per year. In short, the benefits – environmental and financial – are very significant, and there's now a guaranteed secure and stable future energy supply to this 632-bed hospital.

So much for the top-line stuff: let's look at some of the engineering detail. Dalkia project manager Derry Carr explains that heat recovery from the engine is primarily from its exhaust to the waste recovery boiler, but also includes lower-grade heat. "We've installed heat exchangers on the oil and jacket coolers. In the summer, they drive the absorption chiller to provide air conditioning, or to preheat the domestic hot water system. Then in winter, when the chiller is mothballed, that heat goes to three plant rooms, preheating the existing calorifiers for hospital heating."

Belt and braces

As for instrumentation and control, that was all bespoked, although installed by Dalkia engineers, but it's worth observing the company's approach here. Critical pressure, level and temperature monitoring are provided not only digitally to the site SCADA (supervisory control and data acquisition) system in its adjoining control room, but also via conventional plant-mounted dial gauges. Why? Because not only does that ensure operational flexibility, but it also improves security of supply.

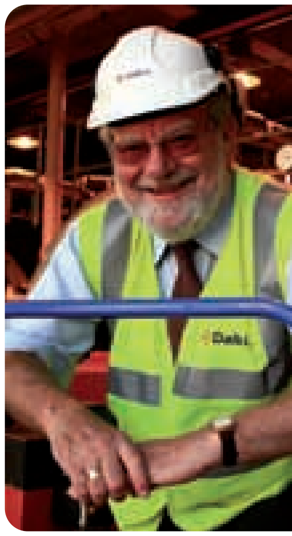
"Effectively this is unmanned plant, although we're contracted to be on-site for two hours each day for the PM5 level tests and so on," explains Carr. "But we put the dial gauges on, so we can monitor the boilers and the engine at all times, wherever we are, and be sure we're optimising our return. It also means we can run the plant without the SCADA system. I know the IT people will tell you SCADA failure is a once-in-30 years possibility, but the supply here is critical, and one of the good things about PFI is you can afford to invest in well-engineered plant for the long term."

Looking at site protection, all alarms from the SCADA system are fed back to Dalkia's facilities management call centre, so that, when the site is unmanned, mobile engineers can respond within the contracted one-hour period. Meanwhile, everything at the energy centre itself is fail-safe: fire or gas leaks, for example, will result in auto shut-down; if a boiler is locked out, the standby unit comes on stream automatically; and if the Jenbacher engine is lost, the boilers keep on running, while the hospital moves on to grid electricity supply. "There would be no loss of heating to the hospital in the time it takes for us to respond to a call-out," confirms Carr.

Returning to the C&I, steam monitoring is also digital and analogue, with meters on each of the boilers providing visible indication of efficiency. And it's much the same story with the gas meters – one for the engine and one for the overall plant – covering fuel usage. "We also have magnetic flowmeters to signal water make-up flow rates," comments Carr. "One shows the overall system condensate return rate, which is useful, for example, in indicating problems with the hospital calorifiers."

It's all pragmatic, best practice and it doesn't stop there. Carr points out that this plant has also been designed for ease of maintenance, with, for example, all-round platforms and stairs – as opposed to the standard single gantry and vertical ladder arrangements – providing safe and easy access for boiler operation. There's also inbuilt lifting equipment to aid plant removal and inspection. "Again, your capex is a little higher, but the opex and maintenance efficiencies are better – and you don't need to worry about installing scaffold towers, insisting on lanyards and the rest."

So how small can this kind of CHP go, yet remain viable? Carr says very small, explaining that Dalkia is currently working on plant for small residential units, harnessing micro CHP technology. "We're specifying a 43kW Toyota engine that will be equipped for exhaust and jacket heat recovery to heat domestic water supplies. The scope for CHP plants is massive. At the other extreme, the biggest job I was involved with was a 53MW CCGT plant." PE



Dalkia project manager Derry Carr: "It's all pragmatic, best practice plant and maintenance engineering"

Transforming efficiency on boiler plant

Even relatively new plant can be improved, in terms of energy efficiency and emissions savings. Derry Carr, Dalkia project manager, recommends a site survey and comments: "Nine times out of 10, you can make a huge difference simply by installing new burner technology. Sometimes replacement burners can bring, say, a 10 to 15-year-old boiler right up to that of a modern unit."

After that, it's about spending more money – and top of the list is retrofitting economisers. "That's considerably more expensive than first-fit, but it does return savings. Depending on the size of the boilers, you can expect 3–5% by installing the right systems."

But there are plenty of other options – for example, variable speed drives on the forced draft fans and on the water feed pumps so that they wind down, according to demand, instead of just running full-out, whatever the boiler load. And Carr also highly recommends automatic blowdown and ensuring decent control of the associated water treatment plant.

"When you blow down, you're blowing heat away, although again, you can invest in heat recovery from the blowdown through a flash vessel. But every one of these additions is adding space and cost, and there soon comes a point where you realise you're better off removing the old boilers and refitting new. For example, a new economiser on a 12 tonne boiler is up to £25,000, while new burners are around £18–20,000. New boiler plant can be in the region £70–100,000, but, with all the bells and whistles, can achieve efficiency improvements of between 15 and 20%, depending on loads and steam profiles."