UU Combined Heat & Power Installations

providing economic & environmental benefits

In March 2007, United Utilities unveiled a £37million plan to reduce its CO_2 emissions by eight per cent by 2012 - the equivalent of taking 9,000 cars off the road. A key element of this commitment is the development of its Combined Heat & Power (CHP) portfolio. The plan includes the use of CHP at a total of 23 sites, making United Utilities' North West operation the home to a quarter of the country's sewage-gas CHP facilities. Other components of the plan include a drive for greater energy efficiency and, following successful test rig trials, examining the potential for using biofuels to run the company's back-up electricity generators and also its fleet of more than 1600 vehicles.

Blackburn WwTW CHP Installation *courtesy MWH*

United Utilities employs digestion at many of its sites in the north west of England as a precursor to the safe recycling of sludge to agriculture. The other principal by-product of this process is a biogas consisting of approximately 60% methane.

Methane is a significant greenhouse gas but one that also has a high calorific value. Therefore, rather than release the biogas to atmosphere or flare it off, the company views it as a valuable natural resource and has, for a number of years, installed CHP engines or dual fuel boilers at these digestion sites.

In combusting the biogas, CHP engines produce both heat to maintain the sludge digestion process and electricity that can be used to supply power to the wastewater treatment works and, when a surplus arises - to the national grid. Therefore, as well as environmental benefits, there are commercial gains to be made, particularly following recent increases in the cost of electricity and the introduction of greater incentives for generation from renewable sources.

In developing its CHP capabilities, United Utilities has undertaken a detailed review of its sludge digestion sites to ensure that the maximum economic benefit is gained from the biogas being produced. This review has also been timely because of the development of more efficient gas engines since the installation of the original CHP plants in the early 1990's, many of which are nearing the end of their envisaged design life and some of which are adapted diesel units.

Biogas from the sludge digesters is first fed into a gas holder. From this it preferentially passes to the CHP engines where the combustion process generates both electricity and heat. When necessary, excess heat, not required to maintain the sludge digestion process or the site's heating needs, is either exported to adjacent third parties or, if this is not economic or viable, dumped to air.

Should the CHP engines be unavailable, due to maintenance for example, the biogas is instead fed to the dual fuel boilers to provide heat required to maintain the sludge digestion process. If biogas supplies are insufficient, the boilers can instead be run on a standby fossil fuel. If there is a surplus of biogas and the gas holder is full, excess biogas is flared off.

Implementation

Primarily by establishing the volumes of biogas produced at each site, comparing these to the capacity of the existing CHP engines (if present) and producing simple financial models, the review was able to prioritise the digestion sites at which new engines were to be installed.

Blackburn WwTW CHP installation *courtesy MWH*

Selected sites
Six sites were selected for the first phase installation programme. These are listed in Table 1 with relevant data for each site.

Table 1

Site	Current CHP engine Installation	Proposed CHP engine installation
Blackburn	none - boilers only	2 x Jenbacker 526kWe
Lancaster	1 x MAN 165kWe 1 x MAN 104kWe (both to be retained)	1 x Jenbacher 330kWe (additional to existing)
Crewe	(none - boilers only)	1 x MAN 342kWe 1 x MAN 190kWe
St Helens	(none - boilers only)	1 x MAN 342kWe 1 x MAN 190kWe
Macclesfield	(none - boilers only)	2 x MAN 190kWe
Bromborough	(none - boilers only)	1 x MAN 342kWe 1 x MAN 190kWe

With the objective of installing and commissioning the new CHP engines as quickly as possible, a procurement strategy was chosen whereby an initial outline design produced by a joint United Utilities and MWH team was then tendered by, and awarded to, a detailed design and installation contractor Nomenca, the engines themselves being provided 'free-issue' by United Utilities framework suppliers, Clarke Energy and Cogenco.

Design and installation
In awarding framework contracts for the supply of CHP engines, United Utilities had already identified that the new CHP engines should be containerised, a design that had already been succcessfully implemented at their Sandon Dock treatment works in Liverpool.This concept, to facilitate easy installation and removal, together with other requirements laid out in their CHP asset standard was used as the primary basis for design at each of the sites. The CHP engines themselves were selected to match the design capacity at each site and to meet identified company efficiency and legislative exhaust emissions targets.

The location for the new CHP engines at each of the sites was chosen from consideration of a number of different factors, not least of these being the availability of suitable space on already congested sites and the envisaged requirements of the local planning authorities.

Connections to, and interfaces with, the existing infrastructure were designed to minimise parasitic loads on the system, these arising from associated elements such as the booster pumps on the primary water circuits.

Exhaust stack heights and locations were designed on the basis of established good practice to mitigate the impact of emissions on local air quality, both within the wastewater treatment works and the wider surrounding environments. However, to further demonstrate their effectiveness and to ensure that local air quality standards are not breached, dispersion models are to be built for a number of the sites.

Health and Safety, operability and maintainability issues were also given the requisite priority, detailed HAZOPS and Access, Lifting and Maintainance Reviews being carried out for each site. One main issue was the hydrogen sulphide that is present in all sewage biogas. Although most sites had lower than average concentration,it was recognised that this could change over time. Suitable H_2S alarm systems were therefore installed within the containers

Commissioning
All of the new CHP installations are now operational. Further works are however required at the four PPC regulated sites in anticipation of the monitoring and reporting requirements required likely to be imposed by the Environment Agency as permit conditions.

Lessons learned
As with many contracts, especially those with an ambitious completion schedule, the interfaces between the various parties proved to be one of the most difficult aspects to manage. These were particularly complicated by the fact that the main installation contract had to be fully cognisant of the requirements of the kit framework contracts for engine supply that had been awarded earlier.

The requirement for early liaison with the regional electricity companies in respect of export to the national grid was understood at the earliest stages of the project. However, this did not prevent issues arising at the last moment.

Although not currently installed in the first phase CHP sites, it may well be necessary in future to provide a gas clean up system on the incoming biogas line. This would be designed to remove hydrogen sulphide, thereby directly minimising the emissions of sulphur dioxide in the engine exhaust gases and possibly reducing levels of siloxanes that speed up engine wear.

Future installations
The second phase of United Utilities CHP upgrade programme at existing sites with engines is now in full stride with five sites identified for installation and commissioning in 2007. ■

Note: *The Editor & Publishers wish to thank United Utilities and MWH for preparing the above article.*