Avonmouth Power Generation Project

new £4m CHP plant saves cash & the environment

by
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Bristol Sewage Treatment Works, located at Avonmouth, on the Bristol Channel is Wessex Water's largest STW site, serving a population equivalent of over one million people. Principal sludge treatment process on site is digestion, and the methane produced has been running Combined Heat & Power (CHP) plant there since the construction of the site in the 1960s. For many years of its operation the site was not served by a mains electricity supply, and relied entirely on its own power and heat generation from the digester biogas. Expansion has occurred over the years and the site is now served by a 7.2 MVA connection at 33KV.

Avonmouth: Removal of 390KW Allen Sets & retention of 1100KW set (foreground) *(courtesy Wessex Water Engineering Services).*

The generation station on site has grown with the works expansion, with the initial four 390KW Allen engine dual fuel (biogas and diesel) sets from the 1960s being augmented with three larger 1100KW Allen sets in the early 1970s.

These engines have given great service over the years, in terms of electricity generation consumed on site and exported, heat for the digestion process and as a standby power source to maintain works consent during main supply outages.

Whilst part of the engines would have lasted virtually indefinitely, the decision was taken in late 2000 to replace the engines with new spark ignited engines capably of running on either biogas or natural gas. The principal factors behind the decision included:

* cost of maintenance of existing sets;
* difficulty in obtaining spare parts;
* decreasing plant availability;
* greater efficiency of new gas engines;
* requirement for increased levels of standby generation capacity on site;
* government financial incentives for green generation.

Work undertaken

The work was advertised in the OJEC and *Finning (UK) Ltd* were successful in tendering for the work under a G/90 design and construct contract. Scope of the work included for the supply, installation and commissioning of:

Five 1150KW *Caterpillar 3516* generating sets in acoustic enclosures, heat recovery equipment, gas train boosting and mixing, switchgear, control system and a standby 2MW biogas fired boiler.

The latter was procured to ensure that sufficient heat was always available for the digestion process during strip-out of the existing equipment.

The project was valued at just under £4 million.

For operational security the strip-out was carried out in two phases, to ensure that there was always at least some standby availability and that the biogas production was not wasted. The first phase involved the removal of the four oldest engines and the installation of three of the five new engines, whilst allowing the three larger Allen engines to remain operational. This caused a certain amount of difficulty for the contractor, as maintaining the running of half of the station proved extremely challenging at times. By taking great care only one unplanned shut down occurred during the whole contract.

The second phase strip-out started after a short period of test running of the first three new engines, and was much more straight forward, ending with the commissioning of the remaining two engines and all five engines as an integrated system.

Operational issues.
The new engines were designed for firing on biogas, natural gas or a combination of the two. Blending of the gases is automatic, with the engine control system adjusting the fuel/blend air mix as required. This allows the company to generate the maximum possible electricity from the engines, as there is not sufficient biogas to run all of the engines or to provide full standby cover. The other factors in the decision to blend gases were the dilution effect on H_2S and siloxane contaminants in the biogas, and the security of being able to run in the event of serious biogas production shortfalls, or problems with the digesters, gas holder or biogas feed.

The successful running of engines in this fashion is in its infancy, and *Finning* were able to bring their valuable experiences on the recent Lowestoft scheme for Anglian Water to the project as well as their general industry experience gained with Thames.

Gas contaminants, particularly siloxanes were a factor that caused some concern. This had not previously been an issue on the old engines but has quite an effect on spark ignition engines.The levels experienced at Avonmouth were intially very high, mostly due to the industrial wastes received at the adjacent licenced waste disposal centre. It became necessary to cease imports of certain trade wastes containing high levels of detergent wastes to reduce the siloxane levels.

High H_2S levels were also measured in the biogas, often up to 1500 p.p.m. To avoid damage to the engines the control system was set up to blend in natural gas on detection of high H_2S, thus causing dilution to safer levels.

Renewable obligation certificates -Premiums for "Green Energy"
The scheme has been registered for CHPQA from ETSU, and as such is eligible for Enhanced Capital Allowances on the capital purchase costs. The "Green" electricity generated from the biogas element is eligible for Renewable Obligations Certificates (ROCs), worth in the order of 4.5p per kWh regardless of day or night generation. Due to the firing on mixed fuels it has been necessary to install extensive gas, heat and electricity metering to auditably establish the "useful heat" consumed by the digestion process, the actual amount of biogas consumed and thus the true amount of generation eligible for ROCs. The generation consumed on site also offsets the Climate Change Levy (CCL) that would have been

Avonmouth: New Caterpillar 3516 1150 KW output inside acoustic enclosure *(Wessex Water Engineering Services).*

incurred on imported electricity. The value of the generation in terms of all of these factors and the virtually free biogas fuel is in the order of £1m per year.

Conclusion

The project is a winner in terms of sustainability, profitability, provision of standby electricity to the works and heat to the digestion process. Payback of the scheme is just under four years and the viability of other similar, smaller, schemes within the Wessex Water region is currently being investigated.

The project would have been technically more straightforward and shorter in duration if Wessex Water had been in a position to either hand over the generation station in its entirety to the contractor, or if new facilities had been built in a different location to the existing generating station. Carrying out the work in two distinct phases increased contract costs, but these were partially offset by the value of the generation achieved during the construction period.

On a smaller installation it would have been possible to hire in standby generation or temporary CHP/boiler plant to eliminate the need for phasing, but the size and criticality of the site precluded the company from doing so in this instance. ■

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