WILL COMBINED HEAT AND POWER (CHP) STILL HAVE A ROLE IN THE NET ZERO ECONOMY?

Kevin Stephens, Principal Consultant, JRP Solutions Ltd asks: With de-carbonisation of the UK's grid electricity supply can Combined Heat and Power (CHP) still have a role in moving towards a Net Zero economy?

With increasing electricity prices and static, or even reducing gas prices there can be significant economic benefits from installing a new reciprocating engine CHP plant on a site that has a suitable and consistent heat load. However, the carbon reduction benefits may now be less clear cut.

Many existing CHP units are reaching the end of their planned or contracted service life or may need investment to comply with tighter NOx emission limits under the Medium Combustion Plant Directive. The economic benefits of re-lifing or replacing existing CHP plant can be very attractive, particularly if it provides an opportunity for efficiency improvements. But what would be the impact be on commitments to reduce carbon emissions?

Back in 2000, CHP was seen as a having an important role in reducing net CO2e emissions and the Government launched the CHP Quality Assurance (CHP QA) Scheme to promote and incentivise good quality CHP. The CHP QA website still states:

"The CHP Quality Assurance programme (CHPQA) is a government initiative providing a practical, determinate method for assessing all types and sizes of Combined Heat and Power (CHP) schemes throughout the UK. CHP, the simultaneous generation of heat and power in a single process, provides one of the most cost-effective approaches for making carbon savings and plays a crucial role in the UK Climate Change programme"

However, CO2 emissions from UK electricity have reduced from 0.48531 kg CO2e/kWh in 2010 to 0.25560 kg CO2e/kWh in 2019, whereas the emission factor for natural gas has remained at 0.18416 kg CO2e/kWh (UK Gov DBEIS). This reduction in grid emission factors diminishes the potential of CHP to reduce net CO2e emissions.

Conversely the economic case for CHP has improved dramatically due to a much greater increase in electricity prices compared to natural gas prices (the 'spark spread'). A site that paid 6.5 p/kWh for electricity and 2.0 p/kWh for gas in 2010 may be paying 10.5 p/kWh for electricity and 1.5 p/kWh for gas in 2020.

The difference between 2010 and 2020 for a typical 600 kWe reciprocating engine CHP unit is illustrated in fig 1..

Figure 1

Even a very efficient CHP unit with good utilisation can barely break even in CO2e emissions in 2020 compared to electricity supplied from the grid and heat from a boiler, whereas there would have been a significant CO2e benefit in 2010. On the other hand, the cost benefits of operating efficient CHP plants have improved dramatically over the last 10 years due to increased grid electricity prices and static, or even reducing, gas prices. This trend seems set to continue with increased decarbonisation of UK electricity supply and an excess of gas supply over demand which would secure the economic benefits of CHP but further challenge its role in a carbon reduction strategy.

Maximising CHP efficiency in terms of both electricity and heat delivery is essential in order to minimise CO2e emissions, and also to maximise return on investment.

Whereas electrical generation efficiency is more or less assured if CHP plant is well maintained, heat efficiency depends on the ability of a site to make beneficial use of heat available from CHP plant.

Under the CHP QA scheme heat efficiency is determined by the heat metered at the CHP boundary and it is possible to achieve a good CHP Quality Index as a result of heat supplied to inefficient systems or, for example sustaining heat distribution losses. In some cases, existing CHP installations have been over-sized on the basis of sustaining these losses.

The key to determining the optimum capacity, specification, and configuration for a proposed new or replacement CHP installation is a detailed analysis of hour by hour electricity and heat loads over a typical 12-month period including heat demands at the point of use as well as delivery.

A rigorous approach to quantifying, profiling and characterising heat load can often identify opportunities to reduce heat load through for example insulation, improved control, and measure to reduce heat sink temperatures enabling more efficient CHP heat delivery. Implementation of these opportunities may well reduce the optimum CHP capacity (and capital cost), and the overall holistic package of more efficient CHP and heat load reduction can provide an optimum whole site solution to reduce CO2e emissions and maximise energy cost savings and return on investment.

Of course, CHP should not be the only option considered when considering energy supply and demand reduction strategies to minimise carbon emissions and energy costs. A rigorous approach to quantifying, characterising, and reducing heat energy requirements should be used to assess alternative options which may include, for example, ground source or air source heat pumps, biomass combustion and solar thermal etc. Like CHP, the benefits of these alternative options will often be enhanced by measures to reduced heat demands and heat sink temperatures. A comprehensive option comparison considering carbon management, cost saving, return on investment and other client criteria can still show CHP to be the best solution for many applications.

In the longer term there may be more attractive solutions than CHP to minimising carbon emissions in the face of continuing de-carbonisation of the UK grid electricity and changing energy markets including the possible development of a hydrogen economy, this may bring about commercialisation of hydrogen fuel cells and other new technologies.

The asset life and typical service agreement for CHP plants is 10 to 15 years. Reduction and optimisation of heat loads to facilitate efficient CHP operation in the medium term can provide a good foundation for these newer technologies when it comes time to move away from CHP.

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