SQUIRE PATTON BOGGS

Energy Opportunities in the Chemicals Sector

The Use of CHP Plants in the Chemicals Sector

Combined heat and power (CHP), also known as co-generation, is the concurrent generation of electricity and useful heat from a single fuel source close to its point of use. It is a highly efficient technology for the chemicals industry due to its capacity to deliver economic and emissions savings; users of CHP plants typically save around 20% of their energy costs and CHP can reduce carbon emission by up to 30% compared to separate means of conventional generation via a boiler and power station. CHP plants consist of a prime mover (turbine engine), an electricity generator, a heat recovery steam generator (HRSG) and a control system.

The main fuel type used in the UK chemical sector is natural gas[1] and as such, gas turbines are used for these CHP plants. Gas-fired generation remains a popular option in OECD countries, because of its relatively low capital cost, short construction time, high degree of efficiency and operational flexibility, all in all leading to lower energy production costs. The burden of energy costs has been described by the European Chemical Industry Council (CEFIC) as "the European industry's Achilles' heel, especially compared to the oil and gas-rich Middle East, and more recently to the United States, riding on a shale gas boom." The investment costs for natural gas-fired generating technologies can vary widely depending on the country where the technology is deployed. For example, according to the International Energy Agency's 2016 report on projected costs of generating electricity, in the UK, the highest investment cost (in 2015 figures) was estimated at 521 USD/kWe, whilst in the US it was estimated at 1194 USD/kWe. China (a non-OECD country), on the other hand, stood at 646 USD/kWe.

As the demand for process heat in the chemicals industry is high, the use of CHP plants is common. CHP systems can also be designed to make use of fuels or waste heat provided by chemical processes themselves, in turn using this to generate more electricity and steam. CHP plants are, of course, commonly used outside of the chemicals industry. However, in contrast to plants used in a non-industrial context (for example, district heating networks for heating buildings), cogeneration plants in the chemicals industry can be operated to almost full capacity all year round[2], reaching efficiencies of more than 80%.

These high efficiencies also deliver energy as well as operating and maintenance cost advantages. In addition, as the energy source in CHP systems shifts from electricity to gas by burning the gas to generate power and process heat, CHP plants can take advantage of the widening gap between gas and electricity costs (particularly relevant in the UK market) – the wider the gap, the faster the cost savings are achievable. That is impressive by itself but hardly ground breaking. There are several additional, less obvious market opportunities open to the industry from use of any excess capacity available from such CHP plants. CHP plant operators, who have first satisfied their own required demand and have assessed for themselves the commercial rationale in doing so, can look at oversizing (i.e. generating more than the site's local process requirements) to engage in and take advantage of the following market opportunities.

Market Opportunities

Entering excess available capacity into the Capacity Market (CM) scheme.

The aim of the CM scheme is to encourage sufficient capacity to be pledged to "prevent the lights going out" by providing backup for more intermittent and inflexible low-carbon generation sources (typically from renewables). Successful applicants receive a CM agreement for a specific obligation and price per MW of electricity supplied. In return, they receive monthly CM payments set through an annual auction process. CHP plants, which are either embedded generators (i.e. those who are directly connected to the low voltage Distribution Network) or those connected to the Transmission Network, can participate. Embedded generation can provide a net demand reduction to the Transmission Network by increasing their own generation production which, in turn, will reduce the net demand on the Transmission Network; these generators can bid their demand-reduction capacity into the CM auction.

Transmission Network connected generation can pledge to deliver a pre-contracted amount of capacity (which can be up to the level of their Transmission Entry Capacity (TEC) set out in their Grid Connection Agreement) four hours from receiving a CM Warning from the System Operator (i.e. National Grid) of a system stress event. The CM Warning will state the percentage of the capacity provider's obligation (set out in the provider's CM agreement) that it is required to deliver and the 30-minute settlement period in which the delivery must take place. Failure to deliver the contracted capacity will result in penalties. Additional payments are given for over-delivery, but only if other capacity market participants fail to respond.

1 Finning presentation "Combined Heat and Power (CHP) in the Chemicals Industry, available at http://www.finning.com/content/dam/finning/en_gb/Documents/Industries/ElectricPower/ElectricPowerBrochures/Finning_CHP_Guide_Chemicals.pdf, accessed 27 March 2017.

2 Horst-Heinrich Bieling "Chemical reaction – an energy-intensive industry finds the solution in CHP" 01.03.07, available at http://www.decentralized-energy.com/articles/print/volume-8/issue-2/features/chemical-reaction-an-energy-intensive-industry-finds-the-solution-in-chp.html, accessed 27 March 2017.

The CM scheme is particularly useful for CHP plants that are usually online for chemical production and, unlike plants only allocated to capacity response which have the burden of needing to be kept warm in case they are required, those involved in industrial energy production are able to readily respond within the time frame allocated. Out of 52 GW contracted in the December 2016 CM (T-4) auction for delivery in 2020/21 (which cleared at £22.50/kW/Year), 4.4 GW (representing around 8%) was awarded to CHP plants and autogeneration operators[3].

Trade excess capacity in the UK wholesale market.

In the UK wholesale market, CHP generators can choose to sell the excess capacity under a contract with suppliers and sell any (non-contracted) excess electricity that they can generate in a half-hour "Settlement Period" to the System Operator, setting the price that they wish to receive for that additional volume or set a price for reducing its generation.

CHP generators can also sell the excess capacity to a non-physical trader, who, in turn, will sell that capacity for a profit. This is an approach that many CHP plant operators adopt, but it has a number of implications that are less attractive than bidding excess capacity into the CM scheme, including the need for active management and spot price monitoring as well as the increased operating and maintenance cost from frequently fluctuating plant output that results from market price driven output.

For small-scale (<100 MW) embedded generators, entering into a PPA with suppliers selling the excess capacity along with embedded benefits.

Embedded benefits are payments, or saved/avoided expenditure, that can be earned by small-scale embedded generators connected to the distribution network and that do not need to use the Transmission Network or incur charges associated with such use. One of these charges (which is considered to be the most valuable embedded benefit) is the Transmission Network Use of System (TNUoS) charge. By ramping up generation at times of peak demand, known as Triad Periods, embedded generators can reduce a supplier's own TNUoS charge (as the supplier's demand off the Transmission Network is reduced in proportion to the amount of generation provided by the embedded generator) under a service commonly referred to as "Triad Avoidance". The value of this "embedded benefit" is, however, decreasing as Ofgem proposes to accept an industry proposal (WACM4) to reduce embedded payments from the current level of circa £45/ KW to around £2/KW. This window of opportunity is closing.

Storing the excess capacity via an on-site battery and entering a tender to provide the National Grid with Enhanced Frequency Response (EFR).

The installation of battery storage on-site can also enable the owner to provide EFR service to the National Grid to balance system frequency. EFR is defined by the National Grid Electricity Transmission as being a service that achieves 100% active power output at one second (or less) of registering a frequency deviation. This is a new service that is being developed to improve management of the system frequency pre-fault, i.e. to maintain the system frequency closer to 50 Hz under normal operation. One of the eight winners in the August 2016 EFR tender (the tender secured 201 MW of EFR at an average price of £9.44/MW of EFR/h), E.ON, has reportedly started work on its 10 MW lithium-ion battery, which will be part of the 30 MW Blackburn Meadows biomass CHP plant[4].

Chemicals site owners with suitable grid connections with excess capacity can also consider leasing part of their site to specialist battery storage developers. This is a rapidly growing part of the energy industry and suitable sites can be valuable, but there are issues to be considered such as rent structuring, short investment payback periods, rapid technology refresh and the potential to secure planning consents with unlimited duration.

Looking to the Future

With Britain's last coal-fired power plants due to come offline by 2025, almost half of the UK's nuclear capacity (15 reactors generating about 21% of UK electricity) reportedly to be retired (subject to life extension) also by 2025, and the first of some 19GWe of new generation plants not due to become operational until 2025 (ignoring the real potential for delay), coupled with the adverse impact from an increased proportion of the nation's energy needs being supplied from intermittent renewable sources, the market opportunities for CHP plant operators in the chemicals industry with excess capacity can only expand.

John Danahy and Rob Broom

3 Brendan Coyne, The Energist, "Capacity Market remains too low for new gas, but gigawatts of DSR, CHP and battery storage win contracts", available at http://theenergyst.com/capacity-market-remains-too-low-for-large-gas-but-gigawatts-of-dsr-chp-and-battery-storage-win-contracts/, accessed 10 April 17.

4 Ade Nes "E.ON has started work on a UK battery storage facility", available at https://www.theade.co.uk/news/reports/e.on-has-started-work-on-a-uk-battery-storage-facility, accessed 10 April 2017.

27013/06/17