Combined Heat & Power

confederation of paper industries

DISCUSSION PAPER

Summary

Papermaking is a continuous, energy intensive process which uses electricity to power the paper machine (equipment such as drive motors, pumps and compressors) and heat (essentially steam or hot air) to dry the paper from a water content of more than 99% down to 6-7% in a few seconds.

This need for both heat and electricity means that combined heat & power technology (CHP) is a good fit for the sector. In the UK, 77% of paper is made at sites using either gas or biomass fuelled CHP, and this delivers major energy and carbon savings compared to the alternative of using grid-supplied electricity and stand-alone gas boilers (see Annex 1 for justification).

Grid-supplied electricity comes from a mix of sources and increasingly includes significant quantities of low-carbon renewables. However, marginal grid generation is still dominated by fossil fuel (gas), with sector CHP plant displacing marginal sources of grid supply (which are almost always closed or open cycle gas turbines following the closure of the final UK coal-fired power station). It's also worth noting that the target to decarbonise the UK electricity grid by 2030 still relies on significant amounts of gas generation retrofitted with carbon capture technology. So, CHP electricity does not generally displace low carbon sources with the existing grid set-up – and additionally on-site generation avoids transmission losses associated with grid-distributed power generation.

The joint BEIS/Paper Sector 2050 Decarbonisation Plan (in 2015) identified CHP as one of the key technologies to help deliver the plan, powered by gas or biomass, with policy support for the further roll-out CHP across the sector and when replacing older CHP plant reaching the end of its operational life. Accordingly the sector has continued to invest in CHP.

The two UK mills making virgin pulp already use UK sourced forest residues and wood-based wastes to power modern biomass fired CHP; these low-grade and otherwise waste materials are generally acknowledged to be eminently suitable for high-efficiency energy generation using CHP. Two other sites also include biomass-based wastes in their CHP input fuel. There is a general acceptance that such use should continue to be supported where appropriate feedstock is available.

For other sites (where the production feedstock is predominantly recycled fibre and biomass-based materials are not readily available), gas-fired CHP is still acknowledged as Best Available Technology (BAT) by the UK regulatory agencies and in the current sector technical BREF that guides regulatory permitting.

Combined Heat & Power

It follows that CPI continues to argue that industrial CHP fired by natural gas has a realistic role to play in decarbonising the UK in the short to medium term to cover the gap before alternative technologies develop and become cost-effective. A brand new, state-of-the art, gas-fired CHP can deliver significant carbon savings versus grid electricity from gas CCGT (which, together with OCGT, will be the marginal generation technology for some years to come). It follows that until gas is phased out of the generating mix completely, the use of high-efficiency gas-fired CHP at an industrial site (plus avoided transmission losses) will save carbon compared with the alternative of installing heat-only boilers and purchasing electricity from the grid.

The Government decision not to provide further incentives to invest in such plant, and indeed to consider the further withdrawal of some policies that have benefited the technology in recent years, is misguided and should be reviewed. CHP technology remains BAT and economic alternatives are not currently available for most sites – the

choice for many is between an expensive energy supply and an even more expensive one. Driving industry to replace gas-CHP with grid supplied electricity will actually increase carbon emissions while the marginal fuel for UK generation remains gas. If carbon capture becomes the way to decarbonise gas-generation, then the option to install such plant on industrial sites should be one considered.

There is also a risk that papermaking company decision makers – nearly all headquartered outside the UK – will decide to stop investing in their local assets and reduce or cease UK manufacturing because of the high costs of energy in this country compared to the cost elsewhere. CHP remains an obvious way to reduce this risk. Additionally, the EU (unlike the UK) has accepted that gas still has a role to play in supporting the energy transition, with this policy divergence having serious implications for UK industry.

Decarbonising the electricity supply

Government policy assumes that UK grid electricity will continue on its rapid decarbonisation pathway to deliver a decarbonised grid by 2030. Now that coal has been removed from the generation mix, natural gas is the major fossil fuel used to produce electricity with a key challenge being to stop, or decarbonise the use of natural gas. At some point before this, depending on how quickly natural gas generation is phased out, co-generating heat and electricity from natural gas will no longer produce electricity with a lower carbon content than that sourced from the grid.

The expectation is that, provided appropriate policies that increase the price of higher carbon fuels are put in place, sites currently using gas-CHP will be driven by economics to swap from auto-generation to grid-supplied electricity and separate heat boilers.

Three issues arise:

1. Can the UK generate or import the increased quantities of electricity required to electrify industry, at the same time as other sectors such as transport and domestic heating are also being driven to electrify?
2. Can grid connections be reinforced sufficiently to get this electricity to industrial users?
3. UK manufacturing industry already suffers from the most expensive grid-supplied electricity in Europe, and while Government has taken some actions, there's no sign that this position is about to fundamentally change.

Can sites operate on grid-supplied electricity and manage the operational cost to stay competitive?

Considerations

The important issues to consider are:

1. How rapid will grid decarbonisation be?
2. Even if the average grid carbon factor rapidly falls, what is the marginal generation technology going to be?
3. If bio-methane and renewable hydrogen are blended into natural gas (say at up to 20%) in the near and medium future, this will reduce the carbon intensity of natural gas in direct proportion and will push back the point in time at which average CHP generation becomes less carbon-efficient than marginal grid supply. New CHP plant is being designed for this new feedstock.
4. Can a UK paper mill move from CHP to grid electricity without reducing competitiveness to such a low level that future investment in the site is curtailed or stopped altogether?
5. CHP provides a huge benefit to the electricity network by reducing the demand from industry. If industrial CHP is allowed to wither and die earlier than necessary, electricity network capacity will have to be enhanced at (typically) huge cost.
6. CHP provides a further significant benefit because excess electricity can be spilled into the grid locally thus:
   - reducing the total requirement for power generated at distance
   - further reducing the required capacity of the network
   - avoiding transmission losses reinforcing the grid at times of system stress.

Annex – CHP Carbon Savings:

CHP is a proven way of increasing energy efficiency at a consumer site which uses both heat and electricity. Because of this, it will also deliver carbon savings compared with use of the same input fuel to (a) provide heat in boilers and (b) generate electricity centrally and distribute it to the site.

CPI holds data sourced from the CHPQA on the operation of CHP installations at UK paper mills. Numerical analysis (copy on request) **shows the carbon savings that electricity generation using gas-fired CHP plant delivers versus that generated in CCGT power stations. And this will remain the situation until gas is no longer the marginal fuel of production.***

1. Recent paper sector gas-fired CHP plant vs grid-supplied CCGT electricity:

   - Carbon content of CHP electricity = 229 gCO2e/kWh
   - Carbon content of CCGT electricity = 351 gCO2e/kWh (assuming 55% gross efficiency and after transmission losses)

   The CHP option delivers a 35% carbon saving. (comparing the CHP with electricity delivered at the grid-average carbon content).

2. Recent paper sector gas-fired CHP plant vs grid-supplied electricity at the average grid carbon content for 2023:

   - Carbon content of CHP electricity = 229 gCO2e/kWh
   - Carbon content of grid electricity = 225 gCO2e/kWh

   The CHP option delivers equivalent carbon savings.

In 2023, gas-fired CHP in the paper sector generated 1,190 GWh of electricity. This saved 145,000 tCO2e compared with sourcing this electricity from the grid (assuming that it had been generated in a CCGT). In fact, there was 101,700 GWh of gas-generated electricity produced in the UK in 2023 – 85 times the quantity generated in the paper sector. Since gas is currently the effective marginal generation fuel these carbon saving delivered by sector CHP can be regarded as genuine and not theoretical.

For current investment, new gas-fired CHP will still deliver significant savings versus gas CCGT (and even more versus gas OCGT) and these will be the marginal generation technologies for some years to come. Until gas is phased out of the generating mix completely, high-efficiency gas-fired CHP will still save carbon. If carbon capture equipment is deployed, then careful assessment is required to establish the most appropriate investment locations.

In 2023, 292.7 TWh of electricity was generated in the UK and 101.7 TWh of this was produced using natural gas - around 35% of the total. Source – Digest of UK Energy Statistics chapter 5

https://assets.publishing.service.gov.uk/media/66a7da1bce1fd0da7b592f0a/DUKES_2024_Chapter_5.pdf

CPI October 2024