Position Paper

Combined Heat & Power (CHP)

Papermaking is intrinsically energy intensive, using electricity to drive the paper machine and heat to dry the paper from 99% water content to 6-7% in a few seconds. UK papermakers have already halved the amount of fossil carbon emitted per tonne of production (since 1990, the Kyoto Protocol baseline) and continue to invest in energy efficiency projects driving even more decarbonisation.

The UK paper sector has an aggregate annual turnover of £12 billion, with 62,000 direct and a further 100,000 indirect employees. Notwithstanding the existing 46 paper mills, the UK imports more than half of the paper it uses, but exports more than half of the paper collected to be recycled in other countries where the jobs and economic benefits are realised. If the Government is serious about rebalancing the economy and delivering green jobs in left-behind parts of the UK, then adding value to the 5m tonnes of unrecycled paper by increasing UK papermaking would make a significant contribution to this agenda.

But such investment in new and existing sites can only be secured if the UK ensures companies can access competitively priced energy through the transition to a net-zero economy.

Historically the installation of CHP has been supported through various incentives and (for biomass) revenue support. These support schemes have been steadily withdrawn, with support for new projects now essentially limited to CCL taxation exemption.

For the future, the joint BEIS/Paper Sector 2050 Decarbonisation Plan currently identifies CHP as one of the key technologies to help decarbonise papermaking in the UK, either powered by gas or biomass. It was expected that enhanced Government support would be offered to further roll-out CHP across the sector and support the replacement of older CHP plant reaching the end of its operational life. This support has not materialised.

The two UK mills making virgin pulp already use UK sourced forest residues and wood-based wastes to power modern biomass fired CHP; with these low-grade and otherwise waste materials generally acknowledged to be eminently suitable for high-efficiency energy use in CHP. Such use should continue to be supported where suitable sustainably sourced feedstock is available.

For other sites (where the raw material is predominantly recycled fibre, and sustainable biomass-based materials for energy generation are not readily available) gas-fired CHP is acknowledged as Best Available Technology (BAT) by the regulatory agencies across the UK and, via the sector technical BREF, across Europe.

Additional to on-site economic benefits, modern CHP is designed to be operationally flexible with a role to support the electricity grid in times of stress by flexing its operation; CHP assets in place already fulfil this role. Not adding new plant and progressively closing old plant, loses this flexibility and increases the overall demand on the grid, requiring yet more investment in both baseline generation and flexible back-up. Additionally, an electrified papermaking industry would require substantial reinforcement and investment to the grid to allow the increased electricity supply to reach industrial users. Such costs are often neglected when developing decarbonisation policies.

In this discussion paper we highlight that electrifying the existing paper industry would be hugely expensive and would add extra inflexible baseload demand to a network already struggling with managing fluctuating supplies of renewable electricity.

We also argue that energy intensive paper mills with modern CHP powered by decarbonised gas or sustainable biomass should have an important role in ensuring security of supply by providing the back-up required by intermittent renewables. Sites with CHP can increase their take from the grid in times of renewable excess by turning their generation plant down; while reducing their demand and supplying into the grid in times of shortage.

A continued role for industrial CHP

CPI believes that industrial CHP fired by gas (progressively decarbonised by blending biogas and hydrogen into the supply) or sustainable biomass has a role to play in decarbonising the UK in the short to medium term while alternative technologies develop and become cost competitive. Existing plant already plays an important role in supporting the operation of the grid, and by not adding to overall grid demand necessitated if industrial operators were to be driven to swap away from auto-generation.

The Government decision not to provide further incentives to invest in such plant, and indeed to

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withdraw some of those policies that have benefited the industry in recent years, is misguided and should be reviewed. CHP technology is recognised as the Best Available Technology, and economic alternatives are not currently available – the choice facing UK sites is between an expensive energy supply and an even more expensive one.

There is a risk that papermaking company decision makers – nearly all headquartered outside the UK – decide to stop investing in their UK assets and reduce or cease their UK manufacturing because of the high costs of energy in this country. CHP is one of the ways this risk is currently mitigated.

Decarbonising the electricity supply

The justification not to further support gas-CHP rests on the assumption that the electricity transmission and distribution system in the UK will continue on its rapid decarbonisation pathway. It follows that at some point, co-generating heat and electricity from natural gas will no longer save carbon compared with using grid electricity. The implication is that sites currently using gas-CHP will be expected to swap from auto-generation to grid supplied electricity and either gas or electric heat boilers. However, this assumption seems take no account of the national strategy to decarbonise the gas supply, by blending biogas and hydrogen, that would push back the point at which CHP would become carbon positive. Assuming this time-point is pushed back, and with a progressively decarbonised gas supply, then new CHP investment should be supported.

Three obvious issues arise if industrial CHP is lost – the added demand on the electricity system (just as other sectors (such as transport) are also being driven to electrify); the fact that UK manufacturing industry already suffers the most expensive grid-supplied electricity in Europe[1] and the grid losing a dispersed network of local generation plant it already calls on to ensure stability in the grid supply of electricity in times of stress.

Adding demand to the grid

Some analysis to illustrate the impact of electrifying the 46 UK paper mills by switching from on-site CHP and boilers to grid supplied electricity (based on 2019 figures):

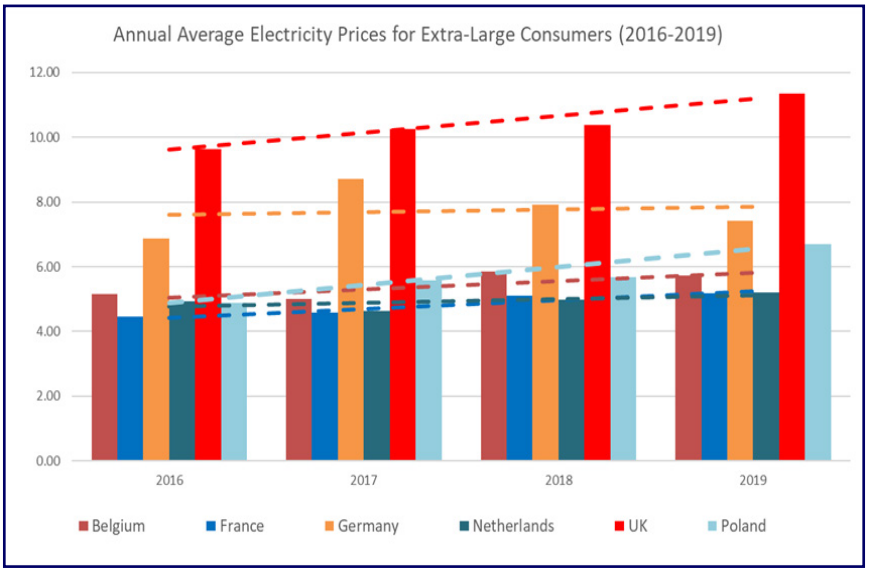
Sector use of fuel in CHP is around 9TWh pa (5.5TWh gas, 3.5TWh biomass), providing 1.6TWh of onsite electricity (from 4.2TWh of the input fuel) and 4.8TWh of heat. An additional 3.2TWh of gas is used in non-CHP mills.

To convert to grid supplied electricity then an additional supply of 1.6TWh would be needed to replace CHP generated electricity; an additional supply of 4.8TWh to replace the CHP heat; and an additional supply of 3.2TWh to replace gas boilers. Plus the 1.6TWh of existing grid supplied electricity that could be reduced by additional investment into on-site generation would still need to be supplied from the grid.

So to supply an electrified UK papermaking industry, the grid would be required to supply 11.2TWh of low carbon electricity – or a seven-fold increase on current imports. Assuming new generation operating at 100% load factor, this would require 1,278MW of new capacity.

Assuming this new generation would be supplied by off-shore wind (currently the preferred technology) and a load factor of 38% (source DUKES) then an installed capacity of around 3,200MW would be required. While the installations costs for new offshore wind farms has fallen, the estimate cost for the proposed Hornsea 3 array (2,400MW) is still quoted as £5 billion to £8 billion (source – funding statement by developer in the application documents for the Development Consent Order) – indicating an investment cost in the region of £7.5 billion to £12 billionto provide one and a half such sites to supply an electrified paper industry.

As well as this direct investment cost, off-shore wind cannot guarantee to supply electricity when needed - critical for continuous process manufacturing such as papermaking. Power cuts, and increasingly fluctuating voltage cause crash-shuts on machines that result in costly and time-consuming incidents.



Source – Energy Intensive Users' Group (EIUG)

This requirement for guaranteed power supply when needed, means either expensive storage or conventional back-up generation is required. The cost of this storage and back-up is additional to the capital investment cost.

The existing CHP fleet already

provides this role, while modernised and new plant on industrial sites can provide a larger pool of support – required as intermittent renewable increase their generation role, so replacing traditional baseload fossil-fired plant.

Reinforcing and support the grid
An increasing component of electricity bills is the cost of the distribution and supply system. As well as the costs for national distribution, few if any of the existing supply links into paper mills are currently sized to be able to cope with a switch to 100% electricity use. Upgrading these links would be hugely expensive at site level.

A dispersed network of local generation plant
An additional benefit of having a significant number of industrial generators around the country is that they connect to the distribution networks at local level. This mean they feed into the local distribution network when required by local conditions, so reducing the quantity of electricity required to be supplied by the transmission system to that local network. This also has the benefit that less physical reinforcement of the transmission system (to supply that local network) is required, with associated investment and operating cost savings for the system operator.

During the Covid-19 crisis with depressed electricity demand, sector CHP plant has operated flexibly – indeed a UK paper mill was the largest responder to one of the emergency response schemes with a 30MW swing offering based on flexible operation of the CHP.

Considerations
The important issues to consider are:

1. How rapid will this grid decarbonisation be?

2. Even if the average grid carbon factor reduces rapidly, what is the marginal generation technology going to be?

3. If bio-methane and renewable hydrogen are blended into natural gas supply, this will reduce the carbon intensity of natural gas and will push back the point in time at which average CHP generation becomes less carbon-efficient than average grid supply. New CHP plant should be 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 in that the system does not need to invest in the capacity that would otherwise be needed if CHP did not exist. If industrial CHP is allowed to wither and die, electricity network capacity will have to be enhanced at (typically) huge cost.

6. CHP provides a further significant benefit in that flexible plant allows sites to take electricity from the grid in times of excess supply, and reduced demand and supply electricity into the grid in times of shortage thus (a) reducing the total requirement for power generated at distance, (b) further reducing the required capacity of the network, and (c) providing local embedded generation making system operation more efficient.

Further Information

Further information is available from Steve Freeman, Director of Environmental and Energy Affairs, on 01793 889625 or email sfreeman@paper.org.uk.

Confederation of Paper Industries

- The Confederation of Paper Industries (CPI) is the leading trade association representing the UK's Paper-based Industries, comprising recovered paper merchants, paper and board manufacturers and converters, corrugated packaging producers, and makers of soft tissue papers.

- CPI represents an industry with an aggregate annual turnover of £12 billion, 62,000 employees, which supports a further 100,000 jobs in the wider economy.

- For facts on the UK's Paper-based Industries please visit: www.paper.org.uk.

[1] Source – BEIS Consultation into the operation of the Green Gas Levy (page 13)
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/919901/consultation-green-gas-levy.pdf

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Annex A – A continued role for CHP

Worked Example. CHP is a proven way of dramatically increasing energy efficiency at a consumer site using both heat and electricity.

Take a paper mill that requires 30 units of electricity and 55 units of heat in order to operate and which is connected to the natural gas and electricity networks.

1. Independent energy supplies:
If the heat is provided in the conventional way by a boiler, the best efficiency achievable with brand-new equipment is about 85%. Therefore 64.7 units of natural gas would be required to produce the required 55 units of heat.

If the electricity is imported from the grid, generated by a gas-fired power station (CCGT), the best efficiency that could be hoped for is close to 50% (and recall some gas generation is almost certainly required to support intermittent renewables). Furthermore, some 15% of the resulting electrical energy is wasted in transmission losses. Therefore in the most optimistic case, 70.6 units of gas would be required to generate the required 30 units of electricity.

The total energy consumption associated with the site's demand is therefore 135.3 units.

2. CHP energy supplies:
If one plant generates both heat and electricity from the input natural gas, efficiency savings are captured. A typical gas turbine CHP has an electrical efficiency of 30% and a heat efficiency of 55%. Therefore in order to co-generate 30 units of electricity and 55 units of heat, 100 units of natural gas are required.

3. Efficiency saving of CHP vs Independent Supplies:
In this conservative case, relying on boilers and grid supplied power (generated by CCGT still likely to be on the system for many years as the marginal generation technology) would use around a third more gas than industrial CHP. In reality, the figure is likely to be larger depending on the actual efficiency of gas CCGT (probably lower than 50%) and the configuration of the gas CHP (which can give overall efficiencies in excess of 90%).

4. Modern flexible CHP:
CHP is a vital part of a distributed generation network supporting renewable generation on the grid. Modern plant can be designed as a flexible asset with regard to electricity export and import and as a balancing plant for steam. Indeed, modern gas turbines can run part-load or be turned off depending on signals from the grid.