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Edison Explains

Combined heat and power

What are the benefits of combined heat and power in an enviroment increasingly interested in distributed power?

How does combined heat and power generation work?

Cogeneration, or combined heat and power (CHP) plants, harnesses excess heat energy ejected by electricity generation as a by-product, funnelling the otherwise wasted thermal energy for various uses.

Industrial plants rank highly on CHP's client list, commonly in the form of chemical plants, oil refineries and pulp/paper mills, which require the large amounts of heat that CHP can provide cheaply. Local power plants can also deliver both heat and electricity to buildings and communities.

Cogeneration can help centralised power stations produce additional electricity with systems like combined cycle plants. Here, excess heat from primary power generation is recovered to boil water and drive a second set to steam turbines.

CHP also commonly provides distributed power systems that deliver heat and power to small communities, hospitals, care homes and large office buildings, for which a cheap and stable stream of both electricity and heat is critical.

What are the economic benefits of CHP facilities?

Only 38% of the chemical energy converted into electricity in centralised gas power plants finds its way to consumers. The rest is wasted in generation or transmission losses.

The World Bank claims that 8.2% of all energy output dissipates during transmission, mostly through the Joule effect, where energy is ejected as heat in transformers or power lines.

CHP facilities increase efficiency by capturing and repurposing heat during generation and reducing transmission burdens through decentralisation.

Given that CHP is mostly gas powered, savings are felt keenly in those countries where a considerable difference between gas and electricity prices (a 'spark gap'), is particularly prominent.

In Germany, Italy, the UK and the US, gas costs are on average five times less than energy, incentivising consumers to produce efficient electricity out of gas-powered CHP.

CHP can also offer a hedge against electricity price hikes and allow local CHP operators to sell unused electricity back into the grid, mitigating operating costs. However, regulations differ widely in this respect, which means that in some countries like France, CHP power reselling is popular, while in others like Germany, regulatory confusion weighs down implementation.

What are the benefits of a distributed power grid?

Decentralised power is a topic often discussed in the context of energy generation and implementation is now accelerating.

Increased interest in distributed power systems is partly attributed to the recent blackouts in Puerto Rico, where around half a million people remained without access to electricity four months after Hurricane Maria first hit the island.

The issues arising from centralised stations, which are based on the southern half of the island in the case of Puerto Rico, were made obvious by Hurricane Maria.

In addition, the sustained blackouts resulted from the stations being separated from urban hubs in the north by the island's mountainous centre, making it difficult to repair the damaged grid.

Another weakness of centralised grids is the need to keep large stations on standby at tremendous expense, in case of peaks in electricity demand.

Distributed systems can reduce these costs dramatically, given the flexibility of meeting electricity demand granted to smaller substations in a distributed system.

This does not account for distributed systems' ability for incremental expansion, mitigating the capital expended in building a

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Deployment of CHP systems is transitioning from simply being an economic mechanism for generating heat and power on the spot for operations such as old people's homes, to an integral part of smart power grids based on renewable generation sources. Anne Margaret Crow, TMT analyst

station likely to be underutilised for years as demand rises to meet the new supply.

This type of incremental expansion is increasingly critical, as countries look to replace antiquated power systems at reduced costs, including old coal-powered plants that no longer meet environmental regulations, or nuclear plants that are being phased out following the decline in popularity of nuclear power.

The most notable example is the US, where between 2013 and 2015, 14 nuclear power plants are slated to be shut down and 16GW of coal-powered capacity was brought offline for the year to November 2018.

Distributed systems also retain a desirable ability to mitigate intermittency issues, which plague the increasingly popular wind and solar sectors.

What place does CHP have in a renewable landscape?

CHP's renewable credentials are clearly established. For every one kWh of electricity the average gas power plant produces, it ejects 0.5kg of carbon dioxide, but generates around 1.5kWh of thermal waste. Although not all thermal waste is recoverable, using cogeneration to reduce energy loss mitigates the carbon burden of CO_2 plants.

Following on from this, biogas CHP is even more environmentally beneficial, powered by the products of landfills, sewage gases or syngas produced from consumer waste, and creating carbon-neutral power through recycled materials.

It is only more recently that CHP has been seen as a solution to renewables intermittency issues, a product of fluctuating solar and wind output in unfavourable weather conditions. The move may cement CHP's place in the renewable market as a backup to CO_2-heavy generators.

That said, batteries are likely to take some of this market, driven by what Morgan Stanley predicts will be a 42% decrease in price over the next few years. However, the long-term viability of either method of back-up generation has yet to be fully realised.

Hydrogen, as a renewable method of CHP power, has also seen some interest of late, especially given its potential for closed generation cycles. This means that surplus electricity generated from renewable sources can be used to produce hydrogen through electrolysis, which is then fed back into a CHP plant that has been modified to run off hydrogen.

For example, 2G Energy is providing a CHP system that will be fuelled by hydrogen produced by a power-to-gas-system at the port of Hassfurt, which uses surplus electricity generated by a nearby wind park for the electrolysis of the water. The CHP system will supply power to the city's electricity grid and heat to a neighbouring malt factory, school and kindergarten.

Which companies are involved in the CHP market?

The US Environmental Protection Agency lists 417 partners for combined heat and power. Siemens is one of the largest companies on the list and recently won a contract to modernise a 260MWh combined gas-fired power plant in the UK.

Veolia, a leader in environmental water, waste and energy management, is also active. The company recently delivered a CHP generator that will provide energy to 888 homes in London, cutting emissions by 556 tonnes of CO_2.

Following its recent struggles, General Electric sold its distributed power business, including CHP company GE Jenbacher, to Advent International for $3.25bn. Under the deal, Advent acquires the rights to Jenbacher engines and its manufacturing sites in Austria, Canada and the US.

Jenbacher has a particularly strong presence in Germany, where it retained 222,058kW of installed capacity in 2015. Jenbacher is followed by global CHP equipment providers Caterpillar (116,039kW) and 2G Energy (75,771kW) in the German market.