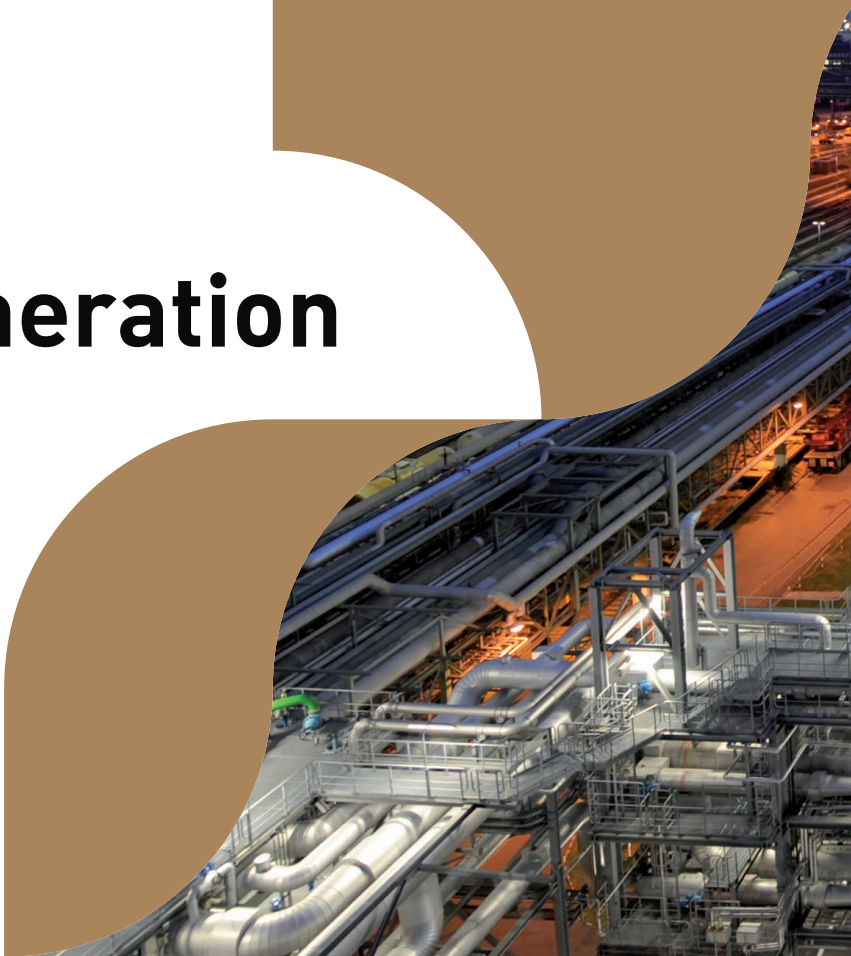
Cogeneration



BASF's cogeneration plant,
Ludwigshafen Verbund site, Germany

Source: BASF SE

Cogeneration (Combined Heat and Power or CHP) is the simultaneous production of electricity and heat, both of which are used. In conventional power plants, heat is not recovered when generating power, while in cogeneration plants the heat is put to effective use to provide comfort (space heating and hot water) or services (high temperature heat and steam) for homes, public buildings, businesses and industry. **Trigeneration means that the plants can also produce cooling in addition to heat and electricity.** Heating and cooling accounts for around half of the EU's energy use, hence the importance of saving energy in these sectors by boosting energy efficiency.

Cogeneration optimizes the energy supply to all types of consumers, with the following benefits for both users and society at large:

- Increased efficiency of energy conversion and use. **Cogeneration is the most effective and efficient form of power generation.**

- Lower emissions into the environment, in particular of CO_2, the main greenhouse gas. Cogeneration is a vital part of the EU's carbon reduction policies.

- Large cost savings, providing additional competitiveness for industrial and commercial users, and offering affordable heat for domestic users.

- An opportunity to move towards more decentralized forms of electricity generation, where plants are designed to meet the needs of local consumers, providing high efficiency, avoiding transmission losses and increasing and supporting the grids by providing balancing and ancillary services through electricity markets. This will particularly be the case if natural gas is the energy carrier.

- **Improved local and general security of supply:** local generation, through cogeneration, can reduce the risk of consumers being left without supplies of electricity and/or heating. In addition, the reduced need for fuel resulting from cogeneration reduces import dependency, thus helping to tackle the key challenge of ensuring a secure energy supply in Europe.

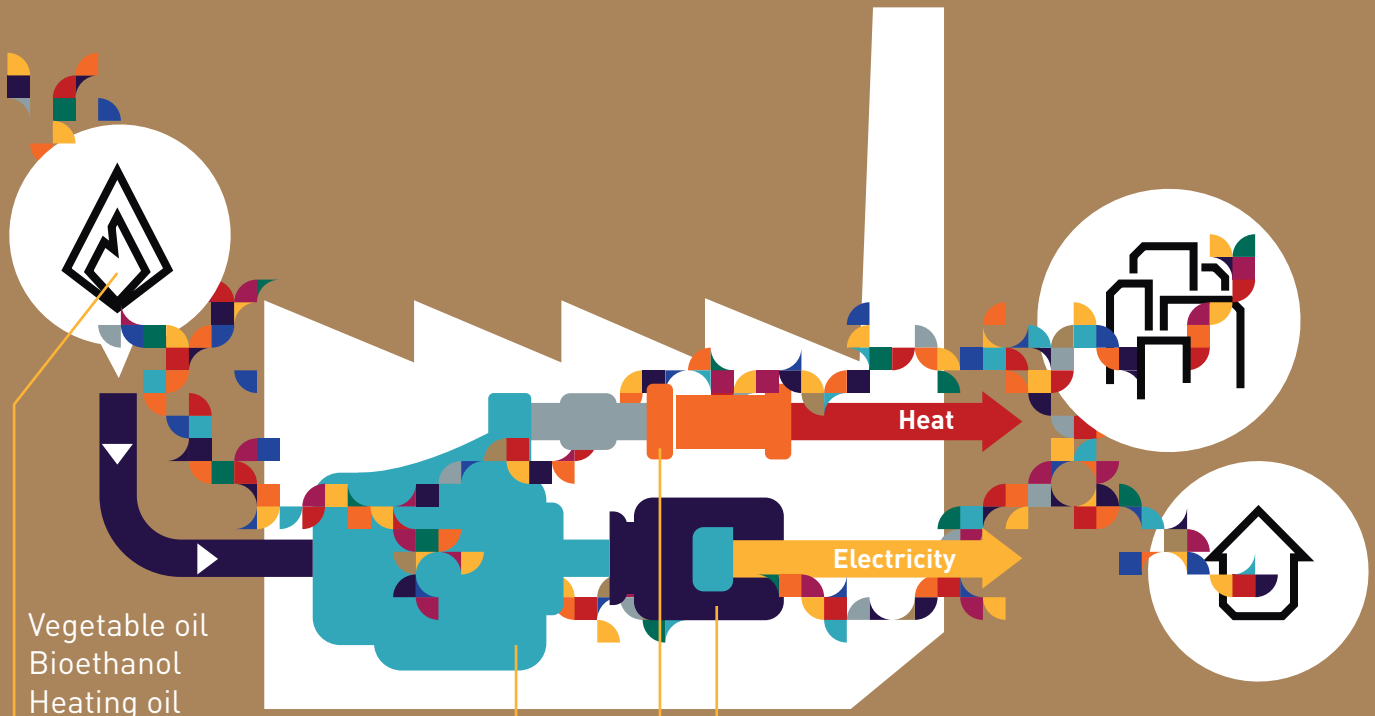
- An opportunity to increase the diversity of generation plants and provide competition in generation: cogeneration provides one of the most important vehicles for promoting efficient distributed energy solutions.

- Increased employment: numerous studies have concluded that the development of CHP systems is a generator of jobs.

DID YOU KNOW?

The world's first power plant, built at Pearl Street in New York City by Thomas Edison in 1882, was a CHP design. While the steam engines provided grid electricity, Edison made use of the thermal by-product by distributing steam to local manufacturers, and heating nearby buildings in the Manhattan area.

COGENERATION PLANT



1. **15%** of the EU's heat (850 TWh) and **10.5%** of its electricity today comes from high efficiency CHP.

2. In Europe, **Latvia** has the greatest share of cogeneration in total electricity generation (47.5%) followed by **Denmark** (44.3%).

3. The efficiency of a cogeneration installation can exceed **90%**.

4. Cogeneration offers energy savings ranging between **15-40%** when compared to the separate supply of electricity and heat from conventional power stations and boilers.

5. **60%** of all bioenergy electricity is produced by cogeneration.

6. Renewable fuels to cogeneration have more than doubled between 2005 and 2015 from **9% to 21%**.

7. As a flexible and dispatchable technology, cogeneration helps integrate more intermittent renewables on the grid.

Today, cogeneration already saves Europe around 200 million tons of CO_2 per year.

8. **70 million Europeans** use district heating; half of its heat is supplied by cogeneration today.

9. Around **100,000 Europeans** self-generate electricity and heat in Europe with on-site CHP, in homes, businesses and industry.

10. Cogeneration could generate **20%** of the EU's electricity efficiently with a range of increasingly renewable fuels.

Sources: Eurostat, COGEN Europe, Euroheat & Power, CODE2.

1. Take an integrated approach to the energy transition.

To engage consumers, policy should take a comprehensive perspective and break the silos between energy conversion, transmission, distribution and consumption, as well as harness synergies between different energy carriers (electricity, gas, heat), fostering consumer choice between different sustainable energy solutions. Taking an integrated approach to energy and climate policy, for example in setting objectives, energy planning, implementation and reporting, is particularly important for customers to reap the full benefits of cogeneration.

2. Allow investors and consumers to achieve real efficiency improvements.

Acknowledging the potential for demand reduction, supply side efficiency opportunities are equally important for achieving the energy efficiency objectives across the entire economy and can deliver significant savings in a more systematic way. Policy signals need to reflect when and how heat and electricity can be used and produced most efficiently. A robust and transparent methodology capturing these principles (within the Primary Energy Factor) will allow consumers to take informed decisions to achieve real efficiency gains.

3. Apply cogeneration to thermal generation for both conventional and bioenergy fuels.

Applying cogeneration to thermal power-only and heat-only generation technologies is key to achieve immediate energy savings and CO_2 reductions, helping to meet intermediary and long-term climate and energy efficiency goals cost-effectively. This means implementing the comprehensive assessments for heating and cooling in the Energy Efficiency Directive (EED). The incentive to promote biomass use in cogeneration plants in the latest Renewable Energy Directive (RED) review, in the EU Clean Energy Package, is a step in the right direction.

4. Enable innovation policy to boost cogeneration as part of new energy market designs.

There is significant potential for innovation in how cogeneration can be optimized to address the emerging needs of a decarbonised, high renewable energy system in the future. The policy framework for energy innovation should prioritize these aspects.

5. Unlock all available flexibility opportunities on the energy market.

Including demand response, heat and/or electricity storage, balancing services, aggregation of both demand and supply, the capability to provide grid support and ancillary services by cogeneration should be better recognised and rewarded. This will be achieved by facilitating the connection to the grid of cogeneration embedded in the local economy. In addition, the structure of the electricity tariffs should be based on the use-of-the-system, taking into consideration system costs avoided by having cogeneration installed.

Tim Rotheray

Board Member of COGEN Europe

How big is the European market for cogeneration?

Heat represents today more than 40% of energy consumption in Europe. There is a general need of security of heat supply in industry and there is an increasing need for energy independence, as homes and business will want to produce their own clean and affordable power and heat. The potential for expansion of the CHP market is very large. There is at least room for a doubling in the capacity of CHP across Europe, depending on the already existing installed capacity at Member State level. High efficiency cogeneration produces today 15% of the heat and 10.5% of the electricity generated in Europe. The EU-funded CODE2 project showed that the cost-effective potential for cogeneration in 2030 amounted to 20% of the total electricity and 25% of the heat expected to be produced in Europe.

Will cogeneration be phased out by 2050 as a transition technology?

Most commentators would say that this is unlikely. We may need more thermal capacity by 2050. If we need heat to make power, then we should not waste heat but capture and use it – whatever the heat source. By 2050, our energy system will have changed dramatically with almost entirely decarbonized electricity and significant share of renewables in the grid, the system will be smarter and more interactive between producers and users. Those users will need efficient and reliable heat and power. Cogeneration is reliable, can be used on demand and cuts energy waste. In a decarbonized energy system, with lower carbon energy inputs (sun, wind, low carbon gasses or biomass) we want to ensure we are not wasting any. If we want to ensure that consumers get a good deal from decarbonizing our energy then we must cut energy waste. That is why cogeneration has a strong role now, and will grow in the future.

Do smaller sources of energy like peat have an increasing role to play in cogeneration?

Cogeneration uses a range of fuels and can be an effective solution for rural and remote communities, such as with

the use of LPG or local bioenergy. However, it is important that whatever fuel is used it contributes to the European energy transition. We are seeing a decreasing role for coal in Europe and peat is likely to face a similar fate but whatever fuels we use in Europe, fossil or renewable, we should do so with minimum waste.

Increasing renewable fuels. Renewable cogeneration has doubled in the last 10 years. Sustainably sourced bioenergy fuels, in wastes sites and local production are very valuable. We should burn them carefully and extract as much energy value as we can. Increasing renewable cogeneration improves the use of bioenergy and reduces carbon emissions even further.

The share of renewable fuels used in cogeneration has increased from 9% to 21% [...] Cogeneration can be renewable and enable more renewables.

How can cogeneration continue to bring down its carbon emissions?

Today, cogeneration already saves more than 200 million tons of carbon per year. But industry is stepping up its efforts to do even better. The 2050 trajectory demands a great deal more work. There are three key areas for cogeneration reducing emissions:

Flexibility. Cogeneration plants can operate with increasing flexibility. Running at times of low wind and sun, thus displacing higher carbon coal and gas generation, but it can then slow and stop generation at times of abundant low carbon power. Flexible cogeneration is a key method for increasing the level of renewable generation on the power networks by managing renewable generation intermittency.

Decarbonized gas. In the longer term, there is likely to be a greater role for decarbonized gas. Europe's gas grid is a great energy store and we will need a lot of decarbonized energy storage if we are to achieve Europe's climate ambitions. Decarbonized gas will be hugely valuable, to address the flexibility and reliability challenge of electricity and heat supply.

COGEN EUROPE
The European Association for the Promotion of Cogeneration

PROMINENT
Netherlands

Prominent consists of 26 members with 36 sprawling, high-tech greenhouse facilities that supply 20% of the Netherlands vine tomatoes. To meet their on-site power, heating, CO_2 and artificial lighting needs, Prominent's members use combined heat and power (CHP) systems that produce a total of more than 150 megawatts (MW). A majority of this power (up to 131 MW) is supplied by 50 of GE's Jenbacher gas engine CHP systems. With GE's myPlant 2.0 Asset Performance Management solution, Prominent can increase the gas engine CHP performance and reliability on the 50 Jenbacher units installed at the high-tech greenhouse facilities. GE estimates that the industrial Internet will bring productivity gains of $8.6 trillion for industrial companies in the next 10 years – more than double the future value of the consumer Internet. We are moving from reactive to predictive data solutions.

STADTWERKE KIEL
Germany

A gas-fired thermal power plant with an efficiency of more than 90% will set new national standards. The order for 20 Jenbacher (J920) FleXtra Gas Engines with a total of 190 MW is the largest in Jenbacher company history. In replacing the existing coal-fired community power plant, the environmentally-sound energy solution will supply the region with district heating. Due to the high proportion of wind energy reliance in the regional network, the power plant must be able to supply full power to the local network at short notice to compensate for volatility of available wind in order to ensure network stability.

WINDSOR CASTLE
United Kingdom

Like its London sister, Buckingham Palace – the 11th century Windsor Castle is using cogeneration technology to help heat and provide power.

The 200kW decentralized energy system supplies hot water and electricity to the Royal Household and has been in operation for 11 years. The vast scale of the castle with its many banqueting halls and entertainment rooms means it is a prime site to reap the benefits that Combined Heat and Power Systems provide.

The cogeneration system was installed under a Discount Energy Scheme whereby the Castle simply purchases the electricity generated by the system at a discounted rate while incurring no capital costs for the project. With no initial payback period, the financial savings for the Royal Household are immediate.

The cogeneration system reduces the Castle's reliance on energy supplied from the grid and will achieve annual carbon dioxide savings of 418 tons, which is equivalent to the carbon that would be offset by a 343-acre forest.

(Left) Source: GE
(Middle) The new gas engine heating power plant is being built on Kiel's eastern shore.
Source: Stadwerke Kiel AG/ Luftbildservice Bernot
(Right) Windsor Castle. Source: John 'K'