How does a cogeneration unit work

Efficient and highly effective combined production of electricity and heat (cogeneration) can utilize more than 90% of the fuel supplied, converting it efficiently into electricity and heat.

Traditional electricity and heat production in the Czech Republic is mostly separate. Electricity is typically generated in coal or nuclear power plants, where a large amount of heat is produced as a by-product but is not utilized and is released into the environment. As a result, electricity generation requires significantly more fuel than combined production.

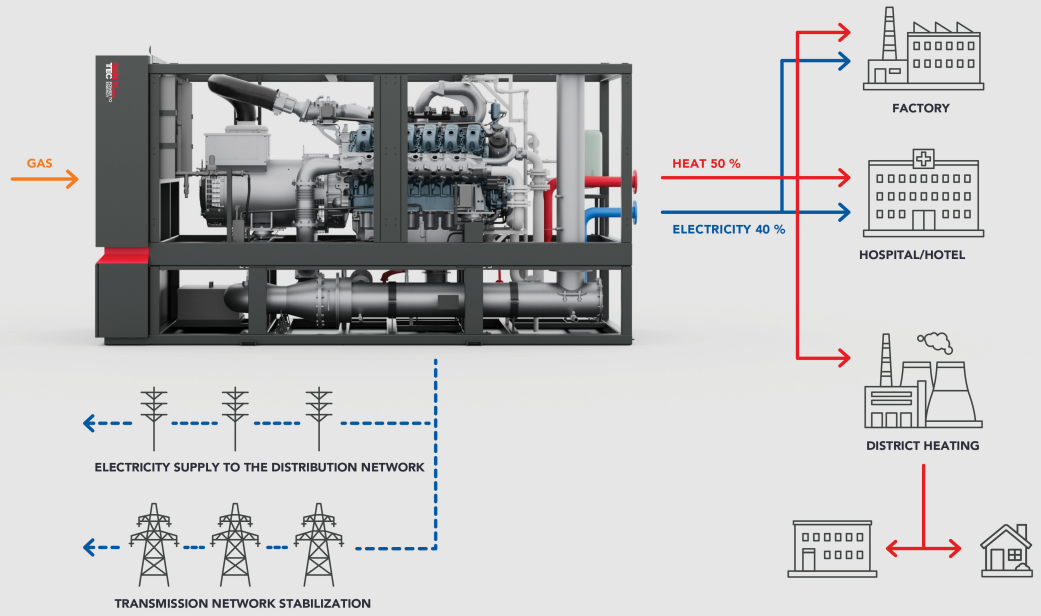
Combined heat and power production, compared to conventional energy generation, is able to use this heat effectively and convert it into heat for district heating systems and domestic hot water supply, with lower fuel input requirements.
Cogeneration is one of the highly efficient and environmentally acceptable ways of producing electricity, based on the effective utilization of heat generated during electricity production.

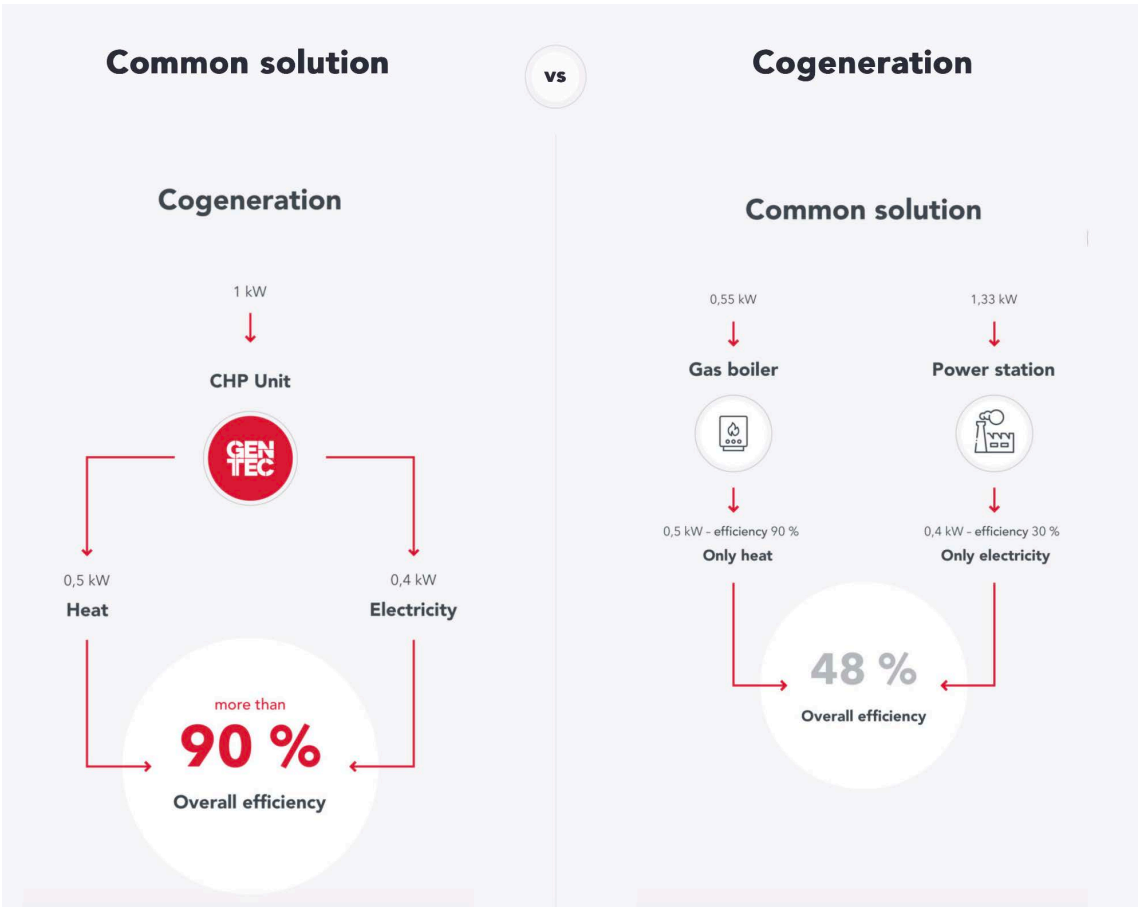
In addition, by generating electricity directly at the point of consumption, further losses associated with transmission and distribution are eliminated, which has a positive impact on the environment.

Gas cogeneration units (CHP) in bullet points:

- sustainability
- decarbonization
- one of the pillars of modern energy systems
- important part of the energy mix
- energy stability
- decentralization of energy sources
- energy flexibility
- high efficiency and effectiveness
- provision of ancillary (balancing) services
- modernization of district heating systems

How CHP works?





Main advantages of cogeneration units

Competitiveness

In the Czech Republic, conditions for renewable energy sources (RES) are not particularly favorable. However, district heating systems (DHS) are traditionally well developed. Approximately 1.7 million households, representing more than 4 million people (around 40% of the population), are connected to district heating systems.

Heating plants equipped with gas boilers and cogeneration units can therefore act as important players in the flexible energy market. They can generate electricity when RES production is low and consume it when RES production is high. This can become a competitive advantage for the Czech Republic in the international energy market, as flexibility is a highly demanded and well-valued service in Europe today.

Flexibility

Gas-fired cogeneration units are, after batteries, one of the most flexible energy sources. They can start from zero to full output in up to two minutes and do so several times a day, helping to stabilize the transmission grid.

Such resources are essential due to the intermittent nature of renewable energy sources and the gradual phase-out of coal-fired power plants. When operated in aggregated units, they also utilize digitalization and artificial intelligence. This enables both large and small cogeneration units to play a key role as providers of flexibility services, balancing renewable energy generation. This is strongly demanded, for example, by the Czech transmission system operator ČEPS.

High efficiency

Gas cogeneration units achieve overall efficiency of more than 90%. Because they are located close to heat consumers, thermal energy is not wasted, unlike in large coal-fired (some with efficiency below 40%) and combined-cycle power plants.
This results in fuel savings of 20–30% compared to separate electricity and heat production in gas power plants and boilers, making operation more economical and less sensitive to rising carbon allowance prices.

Decentralization

Cogeneration units produce energy at the point of consumption, eliminating transmission losses. They consist of a large number of small and medium-sized installations with capacities of 1–20 MWe. This allows a wider range of market participants, including citizens, to benefit from their construction and operation.

Speed of construction

Due to their smaller size, project development is not time-consuming. Preparation, design, and permitting typically take 6–9 months, followed by 6–18 months of construction. Even larger projects in the tens of MW range can therefore be completed within approximately 2.5 years. In comparison, combined-cycle gas power plants typically take 6–9 years to complete.

Socio-economic impact
Thanks to decentralized construction, many local companies of different sizes and sectors gain work opportunities. Revenues from electricity generation and flexibility services benefit a wide range of small and medium-sized entities, such as local heating plants, and indirectly also residents. Cogeneration units are manufactured in the Czech Republic, and their production and installation are linked to a significant number of jobs.

Stability of heat prices
The price of heat produced by cogeneration units is resilient to crises. The price of gas on the markets is closely correlated with electricity prices, and this has been confirmed long-term, including during past crises. When gas prices rise, electricity prices also increase, which in turn raises the revenue from cogeneration electricity production. This mechanism ensures stable heat prices produced by cogeneration units.

Low emissions
Thanks to their low emissions and high overall efficiency, gas cogeneration units comply with the European taxonomy and are therefore considered a sustainable energy source. Their emissions are significantly lower than those of coal-fired power plants. In the near future, the first cogeneration units capable of burning 100% hydrogen are expected to become available, which would produce zero emissions.

Strategic security
The conflict in Ukraine has highlighted the vulnerability of large centralized energy sources, which are easy targets. From a security perspective, decentralized gas cogeneration units are a better option, as they can operate in island or backup mode similarly to diesel generators. Local cogeneration can ensure the operation of critical infrastructure and supply both electricity and heat. Decentralized energy systems are inherently more resistant to cyber and physical attacks.

Independence
Cogeneration units enable companies to reduce dependence on the distribution grid through self-generation. Gas-fired cogeneration is not dependent on weather conditions, and its production can be planned very effectively. The price of heat produced by cogeneration is also less exposed to market fluctuations compared to gas boilers, electric boilers, and heat pumps.

The future belongs to cogeneration
If the Czech Republic is serious about energy self-sufficiency, independence, and security, it will not be able to rely solely on renewable sources and nuclear energy in the coming years. One more significant pillar of the energy mix will be needed: cogeneration.

Combined heat and power production (CHP) from natural gas should become the “third” fundamental pillar of the national energy system—alongside nuclear power and renewable sources such as solar, wind, and biomass.

One of the key advantages of cogeneration is its wide applicability, ranging from large industrial facilities to cities, small municipalities, and housing estates.

Cogeneration potential

The potential of cogeneration is enormous and it can significantly replace the current large-scale use of non-environmentally friendly coal in power plants and especially in district heating plants. The Czech government's policy statement assumes that coal combustion should end no later than 2033, although for economic reasons this may ultimately happen significantly earlier. Coal is becoming too expensive due to rising emission allowance prices, making it less economically viable for both power plants and heating plants.

Construction of new dispatchable sources

After the phase-out of coal, it will be necessary to build new controllable energy sources with a capacity of 5 to 6 gigawatts (GW), and according to some forecasts even up to 8 GW. Up to 3 GW could be covered by large combined-cycle gas power plants, and around 1 GW by small and large cogeneration units. Currently, about 500 megawatts (MW) of small cogeneration capacity is already installed in the Czech Republic.

National Climate and Energy Plan

The development of cogeneration is also included in the National Climate and Energy Plan and the State Energy Policy. These documents state a target of covering 60% of heat supply in district heating systems through combined heat and power generation by 2040.

Fuels: gas, biogas, biomethane, or hydrogen

In the coming years, natural gas is expected to be the primary fuel, but this may gradually shift toward cleaner alternatives. Cogeneration units can also use biogas, biomethane, or even hydrogen. The National Climate and Energy Plan foresees an almost complete transition to green fuels by 2050, with hydrogen expected to play a key role as a zero-emission energy carrier.

Aggregation of flexibility

Cogeneration complements renewable energy sources very well, particularly in district heating systems together with heat pumps and electric boilers. How does this work in practice? Heat pumps generate heat from cheap daytime solar electricity. During morning and evening peak demand, when photovoltaic production is low and electricity prices are higher, cogeneration supplies the required heat while also producing electricity to support the grid during peak load periods.This diversification of energy sources enables more stable prices, reduces the carbon footprint of heat production, and significantly lowers the risk of uncontrolled failure of district heating systems.

Sources:

https://www.cogen.cz/

https://gentec.cz/