The role of micro-CHP in future energy sector

A focus on energy efficiency and emission reduction

The European Turbine Network (ETN) and COGEN Europe welcome the European Commission's initiative to clarify and prioritise the actions and research needs within the updated SET-Plan and matching them to the pillars of the Energy Union. We appreciate the opportunity to participate in the dedicated stakeholder's consultation on the "Issue Paper No. 5: *Develop new materials and technologies for, and the market uptake of, energy efficiency solutions for buildings*", where we would like to stress the importance of micro-CHP in the future energy sector, with a particular focus on micro gas turbines. ETN and COGEN Europe therefore jointly submits this input paper in order to help shape research and innovation activities in this area.

Our contribution focus on the section 7 of the Issue Paper "Concrete ideas for cooperation based on the Integrated Roadmap", where the EC identified "Efficient and smart cogeneration (CHP) for buildings (e.g. micro and small scale CHP)"and "innovative heating and cooling systems" as relevant technologies and solutions.

Micro-CHP in buildings

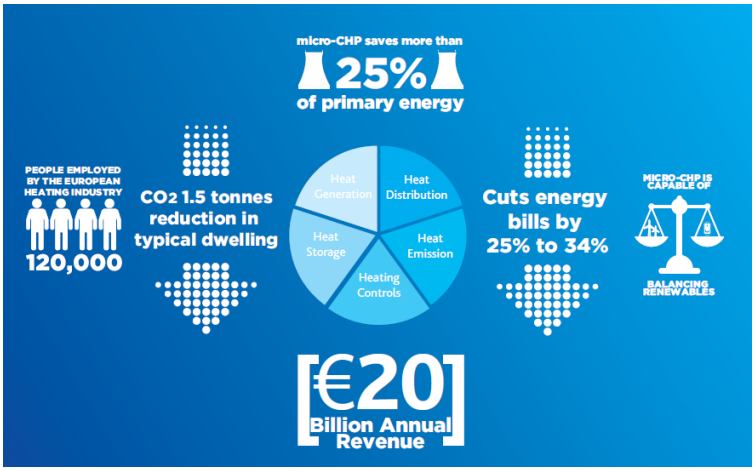
With the ability to attain overall efficiencies above 90%, micro-CHP units meet the demand for heating, space heating and/or hot water (and potentially cooling) in buildings, while providing electricity to replace or supplement the grid supply. Depending on the regulatory arrangements in place the electricity produced by micro-CHPs could be sold to the local supply network, partnering with intermittent renewables to balance supply and demand and provide further services to the grid. The heat generated could be used on-site (maybe in combination with gas fired boilers) and/or supplied to other homes nearby through district heating infrastructure. Micro-CHP systems can also provide cooling through the use of absorption chillers that utilize heat as their energy source (i.e., Combined Cooling, Heat and Power (CCHP)). In this way, end-users from different sectors (including multi-family buildings, commercial, and industrial applications) become partners sharing responsibility for a greener and more sustainable energy supply. A micro-CHP system is also a controllable Distributed Generation (DG) solution that can empower consumers by enabling them to produce their own electricity and heat, taking control of their energy bills (i.e. becoming active participants in the energy market). Also, as viability of carbon capture and storage (CCS) solution for decarbonisation targets remains in doubt, micro-CHPs can play a leading role in this regard at the domestic level.

A micro-CHP system can be based on several types of technologies, including engines (both Stirling and Internal Combustion Engine), gas and steam turbines and fuel cells. Micro-CHP systems deliver important benefits to energy consumers as well as the wider energy system, in line with EU reaching its energy and climate objectives:

- Savings on total energy costs for the end-user (as a function of electricity and heat savings),
- Improved efficiency of fuel use (better fuel utilization factor) (at least 25%[1]),
- High level of fuel flexibility,

[1] Compared to importing electricity from the grid and using boilers to generate heat

- Reduced emissions (up to 33%[2]),
- Independence and security of power supply,
- Improving the energy performance of buildings,
- Supporting the electricity grid & helping the integration of intermittent renewables



Micro gas turbine based CHP

Micro gas turbines (MGT) used in cogenerative applications have proved to be a promising technical solution for distributed combined production of electricity and heat, especially due to their size and volume, high efficiency, maintenance cost, reliability, operational flexibility, controllability, noise and vibration, and last but not least pollution and environmental impact. Since the heat exchanger, integrated in a MGT technology solution, does not usually form part of the MGT cooling system, the unit is extremely flexible with regards to higher water temperatures.
MGT-based CHP produces electricity and heat fueled by natural gas and achieves an overall efficiency of 80-90% (electrical efficiency of more than 30% with the heat exchanger).

Supporting grid stability and partnering with intermitted RES

Micro-CHP can play an important role in supporting renewables and meeting the challenges of the modern electricity grid. The technology is able to support renewables[3] at the system level in Europe and can realise multiple benefits as a form of demand response, enabling householders and SMEs to change their electricity production and demand to suit grid conditions[4]. There is also evidence that micro-CHP technologies can be connected together and controlled remotely as part of virtual power plants, supporting the grid and avoiding further grid and infrastructure investments [5].

The economic viability of micro-CHP is, first and foremost, dependent upon the efficiency and size of the unit being appropriate for the building. In this application, it is necessary to consider the time profile of the energy consumptions requirements, in terms of heat/power ratio. An extremely important characteristic in energy consumption, is represented not only by their averaged amount, but also by the irregularity degree with which they are requested during a reference time period (day, week, etc.). Indeed, the presence of strong irregularity in energy consumption could lead to an

[2] According to models ran by Delta-ee, micro-CHPs technologies can reduce CO2 emissions by 17%-33% in a typical German family home compared to covering energy needs by an advanced condensing boiler and electricity from the grid. Retrieved from: http://bit.ly/1PmrmMc
[3] Some renewable energy sources are described by the European network operators group (ENTSO-E) as "inflexible and highly variable".[3]
[4] Ecuity. The role of micro-CHP in a smart energy world. Retrieved from http://www.ecuity.com/wp-content/uploads/2013/03/The-role-of-micro-CHP-in-a-smart-energy-world.pdf
[5] LichtBlick Virtual Power Plant Concept which integrates RES, micro-CHP, electric vehicles and the smart grid: http://www.lichtblick.de/docs/default-source/infomaterial/spiegel_virtual-power-plants_engl.pdf?sfvrsn=2

higher energy cost, and thus to an higher difficulty in identifying the reason of energy waste. A MGT CHP system, is very flexible in terms of the ratio of heat to electricity production, hence being more adaptable to different users' needs.

Global energy efficiency of micro-gas turbines is high if compared with other technologies, due to the use of waste heat for cogeneration; moreover, their compactness and high power-to-weight ratio make MGT suitable for small installation in real-estate and retail environment.

GHG Emissions

Micro-CHP, in general, has the potential to reduce CO_2 emissions and reduces primary energy consumption compared to a conventional boiler with electricity drawn from the grid. Depending on different scenarios, micro-CHPs can save about 240-300 PJ (1 PJ is 31.6*106 m3 NG) primary energy per year (this is roughly 0.5-0.6% of the total energy used in the EU-27 in 2010). Based on that, greenhouse gasses can be reduced by 13-14 [Mton of CO2-eq/year] by using micro-CHP systems instead of gas boilers (this is equivalent to about 0.3% of the total EU-27 GHG emissions in 2010). Depending on the technology used, electrical efficiency of a micro-CHP unit ranges from 20% (for Rankine cycle and Stirling engine) up to about 60% (for solid oxide fuel cell). In terms of thermal efficiency, it can reach between 40% and 80% for different types of technologies.

A recent study from Delta – ee[6] shows that buildings account for 36% of CO_2 emissions in the EU. In this context, the MGT technology has been identified as one of the most suitable technology to lower GHG emissions. The use of clean fuel, such as natural gas, and the nature of the combustion allow MGTs to reach very low values polluting emissions. Within MGT combustors, the chemical energy conversion of fuel into thermal power is much more controlled than other comparable technologies; the combustion chamber design is optimized for the control of NOx formation and emissions are one order of magnitude lower than in other combustion engines. The reduced temperatures of premixed flames inhibit the formation of nitrogen oxides while the excess of air instead restricts unburnt CO. Currently MGTs are inherently clean and do not require the use of abatement systems on the exhaust gas.

[6] http://www.cogeneurope.eu/medialibrary/2015/05/19/d6648069/miro-CHP%20study_merged.pdf