COGEN Europe Position Paper: Micro-CHP delivering energy savings in the framework of Energy Efficiency Directive

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Executive Summary

The Energy Efficiency Directive 2012/27/EU (hereafter called EED) – which must be implemented in EU Member States by 5 June 2014 – has significantly improved the European legislative landscape for CHP, with positive implications for micro-CHP technologies[1]. This European Directive gives Member States the opportunity to assess current legislation and develop an appropriate policy structure that is supportive of micro-CHP technologies. Stimulating the market with the tools established in the EED will help to realise the significant potential for energy savings and CO_2 emission reductions that micro-CHP holds.

There are opportunities under many EED articles to revise and improve legislation impacting the micro-CHP market, so that the sector can make a full contribution to the energy savings target. The advantages of greater deployment for micro-CHP with respect to the EED include:

- Micro-CHP has the potential to deliver significant primary energy savings until 2020 and beyond. To fully realise this potential, **Member States are encouraged to include micro-CHP in the Comprehensive Assessment required under Article 14**.
- Micro-CHP technologies with a higher heat-to-power ratio can deliver significant primary energy savings cost-effectively in existing buildings, when reducing heat demand to low levels could prove technically and/or economically difficult. Fuel cell micro-CHP, which compared to other micro-CHP technologies has a very high power-to-heat ratio, accompanies the evolution of new build towards low-energy buildings, while also playing a role in the existing building stock. Therefore these technologies can foster **improvements in the energy performance of the building sector, in the spirit of Articles 4, 5 and 6**.
- Micro-CHP is a best-in-class technology that energy suppliers can roll out both to save energy among end users and to ensure customer satisfaction (through enhanced service quality and by empowering consumers to produce their own energy), while **meeting their energy saving obligations under Article 7.**
- Based on the identified potential, micro-CHP can also be promoted as part of small energy consumers' efficiency programmes or energy audit schemes for SMEs, as described in Articles 8 and 12 respectively.
- Micro-CHP should be given a more prominent role due to its contribution to the integrated smart energy system of the future. **On-site generation of electricity combined with generation and storage of heat should be rewarded** commensurate to the services offered to the energy system. Micro-CHP units can contribute to balancing the supply and demand of electricity, while fostering the integration of a higher share of renewable energy sources into the energy mix. **To facilitate this, Member States should take on board the measures featured in Article 15, particularly by introducing a simplified 'install and inform' procedure for micro-CHP.**

[1] Micro-CHP, also known as micro combined heat and power or micro-cogeneration, is defined in the EED as a cogeneration unit simultaneously producing process heat and electricity, with a maximum capacity below 50 kWe.

1) Introduction

With the ability to attain overall efficiencies above 85%, micro-CHP units meet the demand for heating, space heating and/or hot water[2], while providing electricity to replace or supplement the grid supply. As per the micro-CHP definition featured in the EED, micro-CHP can be applied in private dwellings, public and commercial buildings to supply a range of heat usages. The reduction in primary energy usage results in GHG emission reductions and the mode of operation of the micro-CHP unit can support the grid integration of variable renewables.

The large majority of commercially available micro-CHP technologies are based on Stirling engine, Organic Rankine Cycle (ORC) or Internal Combustion Engine (ICE) technologies, characterised by high heat-to-power ratios. This makes them most suitable for installation in existing buildings. Newer technologies based on fuel cells are just being launched onto the market, with the largest field trial in Europe, ene.field[3], currently underway. The most highly-efficient fuel cell micro-CHP technologies can be operated according to electricity demand when installed in new low-energy buildings.

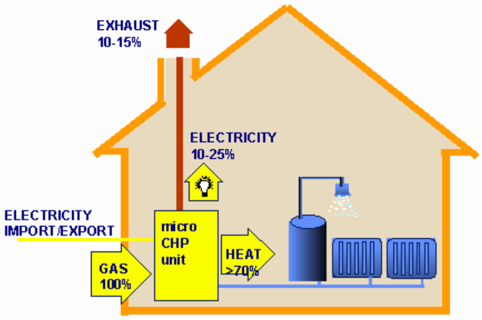

Figure 1 Micro-CHP system scheme

Micro-CHP products have recently entered European markets, receiving a positive response from end users. Field studies and modelling indicate that micro-CHP technologies can achieve savings ranging from 15-25% of primary energy and 25-35% CO_2 emissions compared to a gas-based boiler and conventional power plant reference baseline[4]. This translates into cost savings for end users derived from auto-consumed electricity produced on-site, which coincides in most cases with peak demand periods. Expert forecasts indicate that a total installed micro-CHP stock of 700,000 units would be reached by 2020[5], which will significantly contribute to achieving the EU's 2020 climate and energy targets.

This briefing paper outlines the opportunities offered by micro-CHP technologies in delivering additional energy savings in line with the Energy Efficiency Directive's (EED) objectives, contributing towards the indicative energy-efficiency targets set by the Member States under the EED.

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[2] And potentially cooling.

[3] Ene.field is funded by the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative. It will deploy up to 1,000 residential fuel-cell Combined Heat and Power (micro-CHP) installations across 12 key Member States. More information can be found here: http://enefield.eu/

[4] This estimate is based on the Carbon Trust study from March 2011, a Gaz de France presentation from 2008 and industry estimates from 2014.

[5] According to preliminary CODE2 modelling results. CODE2 is an ongoing project co-funded by the Intelligent Energy Europe Programme of the European Union.

2) Micro-CHP delivering energy savings in buildings (Articles 4, 5 and 6)

Member States are required to establish a long-term strategy for renovating the national buildings stock (Art. 4), ensure annual renovation rates of 3% in public bodies' buildings (Art. 5), and encourage public procurement of products with high energy-efficiency performance (Art. 6).

Micro-CHP technologies that have a high heat-to-power ratio are designed to meet all or most of a building's heat load, while producing electricity as a by-product. As the existing building stock faces significant challenges in reducing its heat demand dramatically when compared to new buildings, micro-CHP is an energy-efficient and a cost-effective solution in the toolbox of possible measures to meeting both customers' needs and legislative requirements. This makes micro-CHP technologies, which can achieve overall efficiencies of up to 105% (Net Calorific Value), particularly suited to delivering energy savings in the existing building stock as required by Articles 4, 5 and 6.

3) Micro-CHP enabling energy suppliers to save energy at end-user level (Article 7)

Article 7 requires Member States to introduce an energy efficiency obligation scheme over the period 2014-2020 in order to achieve end-use energy savings equivalent to an annual 1.5% reduction in the energy sales of energy distributors and retailers. As a genuine end-use technology, micro-CHP can be employed to meet this obligation, as shown in the below best practice example from France.

Best practice from France: Micro-CHP eligible under the Energy Efficiency Certificates Scheme

Since January 2011, micro-CHPs have been eligible for the French energy-saving certificate (aka White Certificate), and a calculation methodology has been developed to allocate certificates (i.e. BAR TH 44 template for micro-CHP Stirling engines). Micro-CHP technologies are also taken into account in the calculation methodologies of the latest building code (*réglementation thermique*/RT 2012). In addition, the installation of a micro-CHP is an alternative to the renewable energy requirement for buildings of 5 kWh/m^2 per year (in addition, individuals who install micro-CHP can also benefit from a tax exemption).

Micro-CHP technologies can be part of energy suppliers' toolbox of products and services in order to comply with the requirement to save energy at the end-user level in Article 7, while also ensuring customer satisfaction and establishing further business opportunities. Power and gas suppliers around Europe are already successfully undertaking new business models that involve micro-CHP manufacturers and energy suppliers. Through these new business models, small consumers are empowered to efficiently produce their own energy.

Member States should make use of this opportunity under Article 7 in order to ensure that the energy saving potential of micro-CHP technologies is realised.

4) Micro-CHP empowering consumers to save energy (Article 12)

Small-scale, sustainable technologies like micro-CHP are set to play an important role in attaining the "prosumer"[6]-centred energy system of the future. Micro-CHP is considered the next generation solution for space heating and is recognised for its flexible power production capabilities.

Micro-CHP is promoted as part of energy-efficiency programmes for small energy consumers in Belgium, the UK and Germany, as recommended in Article 12 (see best practice box below). These best practice examples should be replicated in other countries as well.

Best practice from Germany: Micro-CHP Incentive Programme and Feed-in Premium

As part of its Energiewende strategy, Germany has been promoting micro-CHP as one of the technologies to deliver energy savings in the residential and commercial sectors. Under the CHP law, micro-CHP technologies are also eligible for a CHP bonus, which is offered on top of the market price for electricity. In addition, to encourage consumers to opt for efficient micro-CHP technologies, when deciding to change the house boiler or when increasing the energy efficiency of an office building, purchasing a micro-CHP below 20 kWe makes the owner eligible for a grant of between €1425 and €3325, depending on the size of the unit.

[6] The term "prosumer" is broadly defined as an energy user who consumes energy and can also generate energy.

5) Micro-CHP enabling efficiency in heating and cooling (Article 14)

Article 14 requires Member States to assess the cost-effective potential to develop energy efficiency in heating and cooling and to introduce policies that take into account the identified potential to apply high-efficiency cogeneration at the local and regional levels.

In the **Comprehensive Assessments (CAs) to be submitted to the European Commission by 31 December 2015, Member States must identify the heating and cooling demand that can be met by high-efficiency CHP, including residential micro-CHP**. The CA must also include a description of strategies, policies and measures to be adopted up to 2020 and 2030 in order to realise the identified potential.

As part of the CA, a territory-level cost benefit analysis (CBA) must be undertaken. For assessing the economic benefits of micro-CHP the following aspects are important:

- The benefits of micro-CHP lie in **primary energy savings in the conventional generating network**, the absence of grid losses and offsetting the need to build additional capacity and transmission lines.
- An additional benefit is micro-CHP's role in addressing fluctuating supply and demand. The valuable capability of micro-CHP to supply electricity during peak demand periods (i.e. due to the almost perfect match between peaking electricity and heat demand from households) should be considered in the CBA, given the increasing value of grid stability in the low carbon, high renewables electricity network.
- Scenarios in the CBA should also consider the **additional flexibility that micro-CHP can provide in a demand response market when coupled with heat storage or aggregated in Virtual Power Plants** (see best practice box below).
- **The CA should account for the different heat-to-power ratios of various types of micro-CHP technology in relation to the varying heat demand of existing and new buildings**. Micro-CHPs with higher heat-to-power ratios (e.g. Stirling engines and ICE-based micro-CHPs) may be more appropriate for existing buildings that have high heat demand. Additionally, fuel cell micro-CHP technologies can cater to new builds that have relatively lower heat demand, but could benefit from highly efficient on-site electricity production.
- The CA **should also consider micro-CHP for remote communities, which can be supplied with LPG[7],** and where the electricity benefit is even higher.
- The CA should also recognise that **the benefits of micro-CHP lie particularly in regions not served by district heating networks**.

[7] LPG stands for liquefied petroleum gas

6) Micro-CHP enabling an efficient and smart energy system (Article 15)

Micro-CHP technologies fit very well with the integrated and smart energy system vision of the future. As we witness a growing share of intermittent renewable electricity on the grid, power network stability is becoming increasingly valuable. Micro-CHP can complement renewable energy technologies like PV, wind and heat pumps for an increasingly decarbonised grid by operating during periods of the day/year characterised by high electricity demand.

In addition, micro-CHP operates for the most part during periods of peak electricity demand and at the lowest voltages on the electricity grid. This provides generation that follows the load curves for the system and reduces network strain, and therefore grid losses, by generating at the point of use in LV networks.

Best practice from Germany and Netherlands: Reaping the benefits of flexible and controllable micro-CHP

Several projects in the Netherlands and across Germany are employing micro-CHP as part of smart grid pilots to demonstrate the feasibility of a low-carbon, reliable and high renewables energy system. In Hoogkerk in 2010, 25 households were outfitted with several intelligent devices such as smart washing machines, heat pumps, solar panels and micro-CHPs. Linking devices and coordinating energy demand resulted in a lower peak in the grid and significantly reduced differences in supply and demand in the neighbourhood.

Virtual power plants (VPPs) – clusters of distributed electricity generation units controlled and operated by a central entity using integrated software systems – can also benefit from the flexibility of micro-CHPs. Several pilot projects are currently being undertaken in Germany and the Netherlands in order to test the technical and economic feasibility of virtual power plants (VPPs) aggregating either micro-CHP units exclusively or several complementing technologies, such as micro-CHP, heat pumps and wind turbines. One such project is the EnergieBlock, initiated in 2012 by Trianel, which connects 25 fuel cell micro-CHP units. The advantages of a VPP include efficient and flexible modulation of power generation up or down to meet peak loads and balance intermittent power from wind or solar.

Article 15 addresses energy efficiency in transformation, transmission and distribution, requiring Member States to facilitate grid connection and dispatch for high-efficiency CHP, promote demand response and simplify grid connection procedures for small and micro-CHP. Grid connection for micro-CHP appears to be one of the main barriers to faster uptake in many Member States. Nevertheless there is the best practice example of the UK, where grid connection is streamlined in the grid connection code for small installations like micro-CHP (see box below).

Best practice from the UK: "fit and inform" connection for Small-Scale Embedded Generation

The grid connection code ER G83/2 includes a simplified connection procedure ("fit and inform") for small-scale embedded generation of up to 16 A per phase. The connection procedure starts with installation by a certified installer. Once the unit is in place, the installer is obliged to notify the network operator within 28 days and submit to the network operator an information form with details about the unit. The connection is normally granted as soon as possible.

7) Micro-CHP: a relevant technology for SMEs (Article 8)

The versatility of micro-CHPs makes this technology appropriate for commercial use. SMEs can particularly benefit from micro-CHP, given the energy saving opportunities and the opportunity to ensure a reliable power supply.

Introducing micro-CHP as an option under the energy audit programmes for SMEs, recommended in Article 8, would diversify the array of technologies that small businesses could make use of. To support these efforts, the CODE2[8] project has developed a pre-feasibility tool for SMEs interested in installing micro-CHP (available here).

[8] The CODE2 project is co-funded by the European Commission (Intelligent Energy Europe – IEE) and will launch and structure an important market consultation for developing 27 National Cogeneration Roadmaps and one European Cogeneration Roadmap.