European CHP Directive
The definition of harmonised efficiency reference values for the separate production of heat and power

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1. BACKGROUND

CHP, in industrial, district-heating and individual building applications, is a powerful technology to convert fuels in the most efficient way into electricity and useful heat, helping to meet energy demand with reduced primary energy consumption and less CO₂ emissions in Europe.

The final legal text of the European CHP Directive¹ left the following three regulatory areas to implement the Directive unresolved:

- The detailed specifications for determining what is a CHP plant and what are the CHP products (the "Annex II problem");
- The reference cases for comparing the conversion efficiency of CHP with that of the separate production of heat and power (the "Annex III problem"); and
- The guidelines for Member States on how to undertake a study on their national CHP potentials (the "Annex IV problem").

The single most important issue in this list is the definition of harmonised reference values for the efficiency of the separate production of heat in boilers and of power in thermal power plants. A CHP installation will only be recognised as being "high-efficiency" if the calculation method proposed in the Directive leads to the result that this installation reduces primary energy use by at least 10% when compared to the set reference scenario (CHP units small than 1 MWₑ qualify if they achieve any primary energy saving). This means, the higher the reference efficiency values agreed by the Regulatory Committee, the smaller the amount of CHP qualifying as high-efficiency.

Further to Article 14 of the Directive, a Regulatory Committee is in charge of regulating this issue (as well as the other two issues). This Committee is composed of Member State representatives and will be chaired by the Commission. It will meet for the first time on 3 March 2005 and the process is likely to take between 6 months and one year to complete.

2. THE IMPORTANCE OF REFERENCE VALUES

The setting of efficiency reference values for separate production and the resulting qualification of CHP installations as high-efficiency or not will have extremely important implications for the future of CHP in Europe.

It can be assumed that non-qualifying CHP existing units will lose their eligibility under national support mechanisms, whilst new projects not meeting the 10%-criterion will not proceed to development, although in the real world they are likely to reduce primary energy consumption and CO₂ emissions.

The reference values established under the CHP Directive are likely to be applied in the implementation of a range of other European Directives, including the Emissions

Trading, Energy Performance of Buildings, and the forthcoming Energy Services Directive. Each of these Directives is potentially supportive of CHP, but this effect will be reduced or may even turn negative if the Regulatory Committee for the CHP Directive defines excessively strict efficiency reference values.

The outcomes of the Regulatory Committee process will also set an important precedent for CHP-related policies at Member State level. Many national governments will seek inspiration from the European CHP Directive when defining the methods to evaluate the quality of CHP and the mechanisms to support the development of CHP within their countries.

The definition of efficiency values for the separate production of heat and electricity is only to some extent a matter of scientific insight. There is also an important element of plausibility, arbitrariness and thus of political choice.

There is no single "exact" or "correct" definition of efficiency reference values for the separate generation of heat and power for the purpose of the CHP Directive. Because of the complex and constantly changing generation park on the one hand and the nature of electricity and heat markets on the other hand, it is impossible to say which generation, and thus which primary energy consumption and CO₂ emissions, a specific CHP plant is replacing.

The definition of efficiency reference values is therefore to some extent of an arbitrary and hypothetical nature, reflecting an agreement between the organisations involved in the decision-making process in the Regulatory Committee. The result must provide a plausible basis for a fair and accurate comparison of CHP installations with an assumed separate heat and power generation and supply system.

The Regulatory Committee has much discretion in interpreting the requirements of the Directive and thus an important responsibility in defining accurate and plausible reference values.

Some fundamental requirements and considerations for the definition of reference values have already been formulated in the CHP Directive. However, the precise definitions and comparisons for these references are for the decision of the Committee. For instance, the Committee may decide to apply additional criteria, which have not been included into the Directive at all, to enhance the plausibility and accuracy of the comparison between the performance of CHP installations with that of separate production.
3. KEY CRITERIA AND CONSIDERATIONS

In the light of the previous observations and of discussions within a "CHP Directive Task Force" of COGEN Europe, the following aspects should be taken into account for the definition of the efficiency reference values for separate production:

3.1 Harmonisation

According to Article 4 the CHP Directive, efficiency reference values must be harmonised across the EU.

A high degree of harmonisation is paramount to prevent distortions in the treatment of CHP within the internal market for electricity as well as within the emerging markets for energy efficiency and greenhouse gases. It also increases certainty for investors and it can rule out discriminatory treatment of CHP through national policies.

Climatic variations and electricity grid losses are the two parameters that have to be based on national data whereas all other data should be harmonised.

3.2 Fuel neutrality

Article 4 and Annex III (f) of the CHP Directive determine that efficiency reference values must be determined on fuel categories corresponding to the fuels used by the CHP plant.

The list of fuels should include, but may not be limited to: natural gas, hard coal, lignite, peat, heavy fuel oil, light oil, biomass, biogas, bio-liquid, industrial waste fuels, municipal waste and hydrogen.

Where a CHP plant burns more than one fuel the references should be apportioned in the same ratio as the fuels consumed, based on the energy content of each fuel.

3.3 Best Available Technology, but real-life conditions

According to Annex III (f) of the CHP Directive, each CHP unit should be compared against the best available and economically justifiable technology for the separate production of heat and electricity.

This does, however, not mean that a CHP unit should be compared with the one single most efficient power plant and boiler in Europe, or that laboratory efficiency values of power plants and boilers should be applied.

Instead, the Directive makes it clear that the efficiency values for best available technology need to reflect

- the available technology in the year of construction of the CHP plant;
- the types of heat and power production which CHP will substitute;
- the impact of real-life operational conditions on reference efficiencies;
- the impact of climatic conditions.

The final efficiency reference value is thus to be based on best available technology, but corrected for the influence of climatic conditions as well as of the age, size and other installation characteristics, and the real-life operational conditions of the CHP unit.
3.4 Year of construction
To take into account the year of construction it will be necessary to defined clearly what "year of construction" should actually mean: Date of commissioning? Date of full commercial operation? Date of investment?

To simplify the overall approach it would be possible to have fixed reference values for a five-year period, say, for example, between 1995 and 2000.

It is paramount that reference values for a particular age of plant are not revised periodically but remain fixed so as to provide investors with a stable regulatory framework.

3.5 Substitution Principle
The reference scenario should also reflect the types of heat and power production, which CHP will substitute. This means comparing apples with apples.

The size of power plants and heating appliances, which CHP will substitute, is an important factor for the reference efficiencies.

For instance, whilst a 600 MW<sub>e</sub> coal-fired power plant operating 7500 hours per year may come close to 45% efficiency, a 100 MW<sub>e</sub> installation will only achieve 40%. Combined Cycle Gas Turbines operated 7500 hours vary between 49% and more than 56% annual operation efficiency, depending on whether the capacity of the plant is less than 50 or more than 350 MW<sub>e</sub>\(^2\).

CHP may also supply a heat demand where several boilers have been used before. If these boilers do not run at full output thus peak efficiency of boilers is an inappropriate reference. Where small boilers are replaced by larger boilers, as in the case of network growth of District Heating, then the efficiency of the smaller boilers must set the reference.

The grade of heat supplied by the CHP must also be considered to determine the reference efficiency for the boiler plant. A boiler supplying hot water will have a higher efficiency than one supplying process steam.

3.6 Operational efficiencies under real-life conditions
The real-life operational efficiencies of thermal power plants and boilers can also differ significantly from suppliers' claims, depending on the number of hours they operate per year and load conditions.

Efficiency reference values must therefore reflect measured annual operational data from power plants and boilers that have been operating for one complete year. It is important to consider a load range, which corresponds to the load range of CHP plants, i.e. it is inappropriate to take only base-load operation into account.

For instance, the annual operation efficiency of a 300 MW coal-fired power plant drops from 42% to 37.6% if its annual hours of operation decrease from 7500 to 2500. For a Combined Cycle Gas Turbine of more than 350 MW capacity, the corresponding efficiency decline is from 55% to 50.6%\(^2\).

Power plant data must include all system losses, normal operation cycle variations and maintenance and shall not be corrected to standard (ISO) conditions. Boiler plant data must reflect factors such as condensate return, flow and return temperatures, as well as cycling and part-load conditions from boiler over-sizing.

3.7 Climatic Conditions

Climatic conditions, notably the ambient temperature, humidity and altitude range widely across Europe, and this affects the performance of some CHP technologies and reference power plant technologies.

A simple approach should be included to take into account the impact of climatic conditions across Europe. For instance, electronic geographical and meteorological maps of Europe could be used to determine the average weather conditions and the altitude at the location of each individual CHP plant. These conditions could then be factored in to correct the efficiency reference values.

3.8 Avoided Grid Losses

Finally, the CHP Directive did not specifically mention avoided grid losses. However, taking them into account is a fundamental condition to determine the operational use under realistic conditions of thermal power plants as stipulated in Article 4 of the Directive.

Because CHP generates electricity near the point of use, the avoided losses from not using or minimising the use of the electricity networks must be accounted for in comparison to larger/centralised electricity production. Typically, a large CHP plant connected at high voltage would avoid around 2.5% network losses, whilst a CHP plant in a house connected at low voltage would avoid network losses of at least 10%.

Electricity grid systems, both transmission and distribution show considerable variation across Europe, thus it will be necessary using a simple and workable method to correct for national circumstances. The French approach to this issue is very useful in this context. It defines a standard grid loss for each voltage level of the French system. Depending on the voltage level a CHP unit is connected to it is thus easy to determine the total avoided grid losses of the unit. A similar system of default grid losses should be established for each EU Member State.
4. MAKING THE SYSTEM USER-FRIENDLY: TOWARDS A EUROPEAN REFERENCE EFFICIENCY SOFTWARE

Based on the considerations outlined so far, COGEN Europe proposes the development of a comprehensive calculation model to determine harmonised efficiency references for each existing or planned CHP plant in Europe. This model should calculate the appropriate reference efficiency for each installation on the basis of its characteristics on the one hand and the expected characteristics of the separate production, which it replaces. This calculation should take into account the CHP plant’s:

- year of construction of the CHP installation;
- geographical location and thus the climatic conditions;
- size;
- fuel used;
- operational regime;
- heat grade of the thermal output;
- the power plant and boiler which it replaces; and
- the voltage level of its electrical interconnection and thus the resulting avoided grid losses.

In order to make the process of calculating the reference values as user-friendly as possible, it would be useful to develop a computer programme that simplifies and standardises the calculation method.

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COGEN Europe is Europe’s umbrella organisation representing national cogeneration associations, equipment suppliers, users and all other cogeneration stakeholders. The association promotes the wider use of cogeneration for a more sustainable energy future in Europe. COGEN Europe is fuel-neutral, technology-neutral and independent from any particular commercial organisation. It is backed by key players in the cogeneration industry including gas and electricity companies, ESCOs, equipment suppliers, consultancies, national promotion organisations, financial and other service companies.

Cogeneration is the most efficient way of generating heat and electricity from any fuel, far better than their separate production in power plants and boilers. About 13 per cent of electricity are currently cogenerated in the EU, but there is a potential to grow this share to more than 20 per cent, saving an additional 250 million tonnes of CO₂ per year\(^1\). More cogeneration would not only cut down Europe’s fuel consumption and CO₂ emissions. It would also improve the reliability of energy supply, avoid important investments in new electricity networks, create jobs in high-tech and high value-added sectors, and strengthen European competitiveness and leadership in energy efficiency technologies.