

EN20 Combined Heat and Power (CHP)

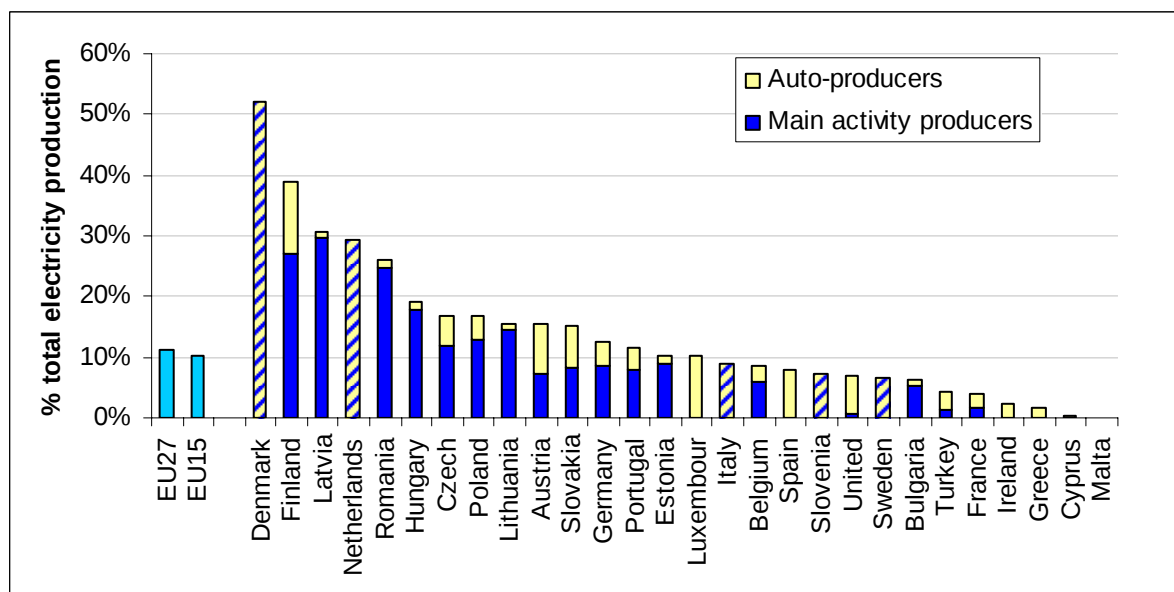
Key message

The share of electricity produced from combined heat and power (CHP) in the EU-15 slightly increased between 2000 and 2005 to 10.2 %. Strong policy support to promote the technology in many Member States was counteracted by the effect of increasing gas prices and relatively low electricity prices, which reduced the competitiveness of gas-fired CHP-plants. More initiatives will be needed to reach the EU-15 indicative target of 18 % of CHP electricity in gross electricity production by 2010. In the new Member States the share of CHP is more than 1.6 times that in the EU-15

Rationale

CHP or “cogeneration” implies that heat and electricity are produced simultaneously in one process. Use of combined heat and power can help to improve the overall efficiency of electricity and heat production as these plants combine electricity production technologies with heat recovery equipment. Increasing the conversion efficiency of power generation through the use of CHP thus helps to reduce the environmental impact of power generation. The Sixth Community Environment Action Programme contains the aim of doubling the overall share of CHP in the EU-15 to 18% of total gross electricity production.

Fig. 1: Share of combined heat and power in gross electricity production in 2005



Data source: Eurostat

Note: The share is defined as the proportion of CHP electricity production (from both private and public utilities) in total electricity production. However, it should be noted that not all electricity production from a CHP ‘plant’ may be considered as CHP production as the plant may consist of different types of units (such as heat only, or flexible units where the power-to-heat ratio may be adjusted). The method for data collection by Eurostat on CHP was revised in an earlier version of the factsheet to account for this (as it had previously tended to overestimate the share of electricity generation from CHP) and is described in more detail in the metadata section. Therefore the current share is not directly comparable to the 18 % target outlined in 1997 by the European Commission (COM (97) 514 final).

Division in auto-producers and main activity producers is unknown for Denmark, Netherlands, Italy, Slovenia and Sweden.

1. Indicator assessment

The share of electricity from combined heat and power in total gross electricity production in the EU-27 was 11.1% in 2005. It was significantly higher in the new Member States (16.5%) than in the pre-2004 EU-15, where it was 10.2%. In 2002, the shares were 9.9%, 15.4% and 9.2%, respectively.

In recent years, CHP has suffered from adverse market conditions in many EU-15 Member States. The problems encountered by CHP include: increasing natural gas prices that have reduced the cost competitiveness of CHP (the preferred fuel for new CHP plants is natural gas), falling electricity prices resulting from market liberalisation and increased competition (although these have now started to rise again), barriers to accessing national electricity grids to sell surplus electricity, and relatively high start-up costs. Until the external costs of energy are internalised in its price, cogeneration may require government support such as by providing investment support or giving tax exemptions (EC, 2005).

To date the uncertain and changing regulatory environment in many Member States as the electricity sector is liberalised, coupled with a lack of coordinated support policies for CHP, has led to an increased perception of risk and undermined confidence. Further support mechanisms will therefore be needed in the future in order to alleviate this situation. The CHP Directive on the promotion of high-efficiency cogeneration (2004/8/EC) is expected to start having an effect from 2006; it encourages Member States to promote CHP up-take and help to overcome the current barriers hindering progress. It does not set targets, but instead requires Member States to carry out analyses of their potential for high efficiency cogeneration.

A number of EU Member States have introduced laws or other support mechanisms to promote new CHP. Such measures include:

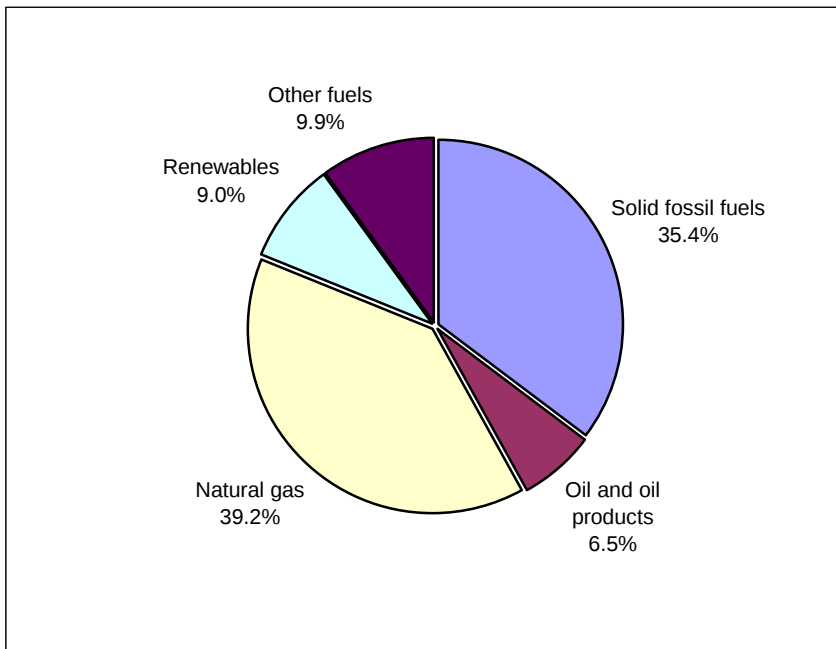
- Legal provisions prescribing a mandatory CHP oriented energy audit in the case of new installations or major reconstructions above a given capacity (e.g. 5 MW in the Czech Republic);
- Statutory duty to connect particular types of CHP to the grid and purchase their electricity (Germany, 2002), provisions obliging the utilities to provide CHP access to the networks, adopted in many new Member States;
- Fiscal measures to provide support to CHP, such as:
 - o capital grants (United Kingdom),
 - o preferential feed-in tariffs for CHP plants (Czech Republic and Hungary) or guaranteed minimum feed-in price for electricity produced by CHP plants operated by public utilities (Germany, 2000¹),
 - o tax incentives: exemptions from or lower rates of taxation (United Kingdom), exemption from income tax for the operation of CHP up to a defined capacity limit (Czech Republic and Slovakia) or lower level of value added tax (VAT) applied to district heating (Czech Republic). The recent decision by the EU to allow for lower VAT-rates for combined heat and power production may help to further promote CHP (Council of the European Union, 2006).

Despite these measures, there remain substantial differences in the level of combined heat and power across the EU-15. Countries with a high market penetration of CHP electricity include Denmark, Finland, Latvia and the Netherlands. In Denmark CHP has received strong government policy support, providing tax incentives and subsidies, and growth has been seen mainly in public supply as a result of investments in district heating infrastructure. Government support was also an important factor in the Netherlands, combined with widespread availability of natural gas, the favoured fuel for CHP. The high level of CHP production in Finland and Latvia reflects the cold climate, which leads to a significant need for heat as well as electricity. In contrast to the process of energy market liberalisation in many other countries, the strong demand for both outputs coupled with a well developed district heating network, has actually helped to stimulate investment in CHP as opposed to hindering its expansion. Poor infrastructure for natural gas² and less demand for heat, in particular in Greece and to a lesser extent Ireland and Portugal, has historically hindered CHP development and the share of CHP electricity remains low in these countries. Combined Heat/Cooling-Power Conversion may help to overcome the problem of surplus heat production in summertime and in warmer countries such as Greece and Portugal.

(1) This measure was taken to help reverse the rapid decline in CHP due to the liberalisation of the electricity market over this period. The law was subsequently updated in 2002.

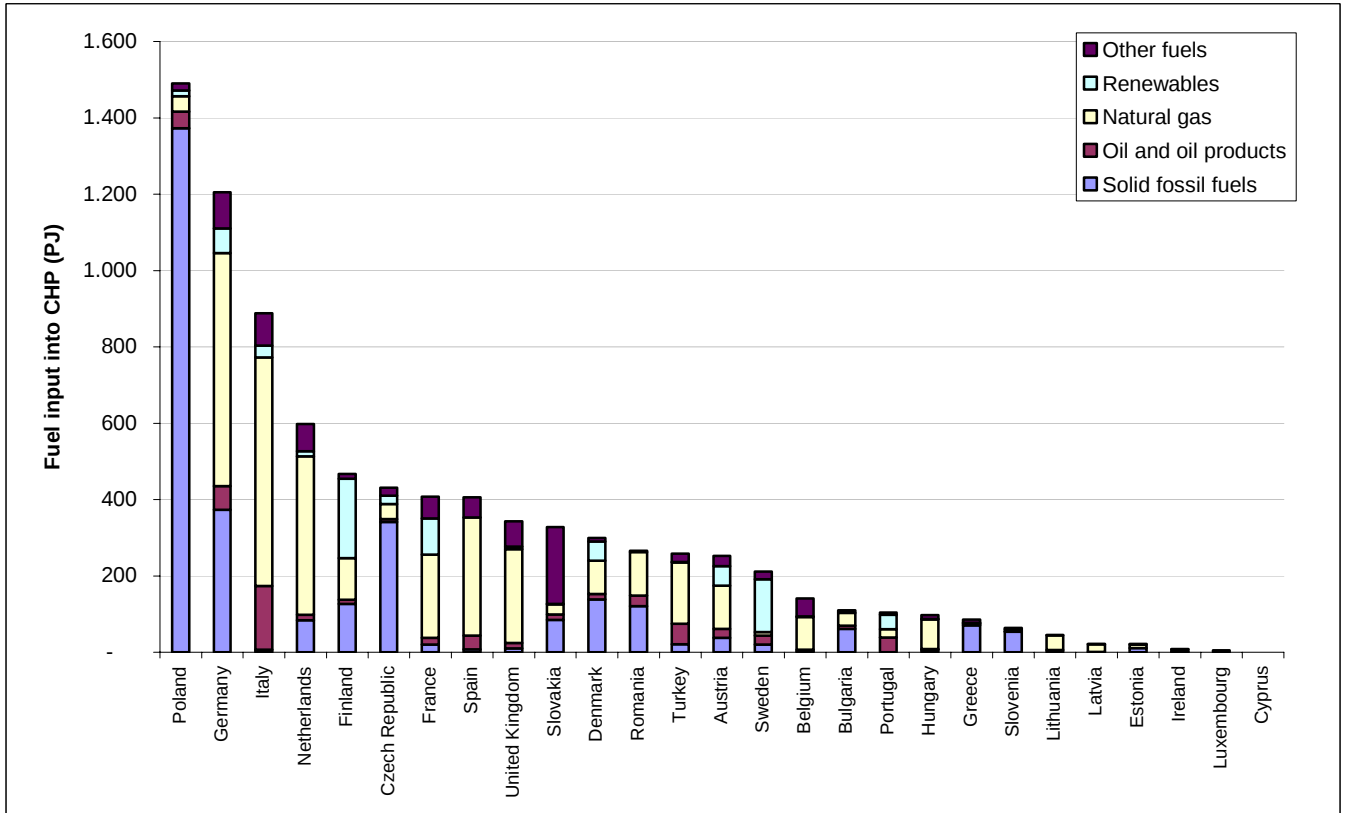
(2) Natural gas is the favoured fuel for combined heat and power.

Fig. 2a: Fuel input to CHP plants in the EU-27 in 2005



Data source: Eurostat

Fig. 2b: Fuel input to CHP plants in EU-27 countries in 2005



Data source: Eurostat

Note: No data available for Malta

Although the increase in the share of CHP in electricity production has been limited, the amount of electricity production from CHP increased during 1994 to 2005 in the majority of EU-15 countries, particularly in France, the United Kingdom and Spain. Among the EU-15, Germany currently has the highest absolute production of CHP-electricity (78 TWh in 2005).

The use of renewable energies (biomass) in combined heat and power provides the opportunity to further improve its environmental performance, and increase progress towards targets for renewable electricity production (see EN30). However, as shown in Figure 2 renewables provided only 9% of the fuel input in CHP plants in the EU-27 in 2005. Natural gas accounted for more than half of the fuel input in EU-15 (12% in the new Member States), while solid fossil fuels such as coal and lignite provided 74% of the fuel input in the new Member States (17% in EU-15).

For a long time, the statistical system did not permit the correct assessment of CHP production at European level. EU Directive 2004/8/EC on the promotion of cogeneration then obliged Member States to submit statistics on CHP to the Commission (Eurostat). However, Eurostat had already started collecting CHP statistics at the beginning of the 1990s (in the course of pilot projects). Since then, a common methodology for CHP data collection has been developed and assistance given to Member States in setting up the required statistical reporting system (Eurostat, 2007). The overall efficiency of a CHP unit is used as a measure to determine whether electricity generation is fully CHP or not. If overall efficiency is above a threshold set at 75% (85% for steam condensing extraction turbines and combined-cycle units), all the electricity generated is considered to be CHP electricity. On the other hand, if the overall efficiency is below the threshold, the amount of CHP electricity (E_{CHP}) is calculated by multiplying the produced CHP heat by the power to heat ratio. These power to heat ratios are the actual ratios. If these actual ratios are unknown, default values can be used for several types of CHP. For several types of CHP (like: Stirling, fuel cell or organic Rankine cycles) countries can determine their own default values. These values shall be published and notified to the Commission.

2. Indicator rationale

2.1 Environmental context

Combined heat and power is one means of increasing the efficiency of electricity generation as it makes use of the heat that is otherwise lost in conventional thermal power plants. The combined efficiency of heat and electricity production from CHP schemes is therefore usually higher than that from heat and electricity produced independently. A typical efficiency value for CHP is approximately 85 % for the combined heat and electricity generation, compared to a typical efficiency value for conventional thermal electricity-only plant of 35–45 % and for heat only boilers of up to 90 % (ADEME, 1999). CHP plants are often located close to where the heat can be consumed, limiting transmission and distribution losses.

Increasing the conversion efficiency of power generation through the use of CHP helps to reduce the environmental impact of power generation. Additional environmental benefits can be realised if the scheme uses low emission fuels such as natural gas or biomass as opposed to coal or oil. Meeting the indicative EU-15 target of doubling the share of CHP in gross electricity production from 1994 to 2010 could lead to avoided CO₂ emissions of over 65 Mt CO₂/year by 2010.

CHP in industrial processes has a large potential for achieving energy-efficiency and CO₂-emission reductions. A typical example: of the four refineries in the port of Rotterdam (the Netherlands) two use CHP for production of steam, the other two not. When the other two would also use CHP for steam-production, this would result in an expansion of production from refineries with app. 500 MW. Technically, a further expansion to app. 1200 MW would be possible if all refineries would use CHP for heat-production as well. If this 1200 MW would replace production of electricity by coal-fired power plants, this equals a net reduction of app. 5 Mton CO₂ (CE Delft, 2008).

2.2 Policy context

Regarding the large potential of CHP for CO₂-emission reductions, increasing the share of CHP must be seen in the context of reducing greenhouse gas emissions and helping the EU to meet its commitment under the Kyoto Protocol of the United Nations Framework Convention on Climate Change. CHP is also identified as an important contribution to reducing the Union's energy demand and increasing efficiency.

The Commission's cogeneration strategy of 1997 did set an overall indicative target of doubling the share of electricity production from cogeneration to 18 % by 2010. This was endorsed by the Member States in the form of a Council Resolution in December 1997. The indicative target was taken up in the Communication on CHP (COM(97)514 final) providing for an analysis of the barriers and strategies for its realisation and is also contained in the Sixth Community Environment Action Programme (Decision No 1600/2002/EC).

A more recent Directive on the promotion of high-efficiency cogeneration based on a useful heat demand in the internal energy market (2004/8/EC) concentrates on providing a framework for the promotion of CHP in order to overcome still existing barriers, to advance its penetration in the liberalised energy markets and to help mobilise unused potentials. The Directive defines high-efficiency cogeneration as cogeneration providing at least 10 % energy savings compared to separate production. It does not include specific targets, but rather requires Member States to carry out analyses of their potential for high efficiency



cogeneration. Once the potential in each Member State has been assessed and reported to the Commission, each one is obliged by the Directive to make substantial progress towards meeting this potential. In the Action Plan for Energy Efficiency (COM (2006) 545 final) the Commission set a target for 20% energy-savings by 2020 and proposed 10 priority actions for achieving that target. As part of this Action Plan an amendment of the Directive (2004/8/EC) is prepared. This aims at an increase of CHP and overcoming still existing barriers. Key-elements are harmonisation and certification, investigation of potentials and setting minimum-standards for efficiency.

A key-element in the package of legislative proposals of the Commission regarding energy use and climate change of January 2008 is improvement of the EU Emissions Trading Scheme (COM(2008)16). This could be a driver towards increasing CHP as all thermal electricity generating plants greater than 20 MW are part of the EU ETS. As the caps on emissions will result substantial prices for CO₂-emissions, the EU-ETS will probably result in a drive towards higher efficiencies of power generation. This might also be a stimulation for the use of CHP.

References

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CE Delft (2008) unpublished results

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http://europa.eu.int/comm/energy/efficiency/doc/2005_06_green_paper_text_en.pdf

COM (2006) 545 final – Action Plan for Energy Efficiency: Realising the Potential

COM(2008) 16 Proposal for a Directive amending Directive 2003/87/EC (EU ETS)

COM (97) 514 final Communication from the Commission on a Community strategy to promote combined heat and power (CHP) and to dismantle barriers to its development.

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Eurostat (2007) Panorama of Energy, 2007 edition

Future Cogen (2001): The Future of CHP in the European Market – The European Cogeneration Study, ESD Ltd, COGEN.

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Meta data

Technical information

1. Data source: Eurostat <http://ec.europa.eu/comm/eurostat/>

2. Description of data/Indicator definition:

The share of combined heat and power (CHP) electricity production is the ratio between the electricity produced from combined heat and power plants (based upon the consideration of individual units within the plants) and the gross electricity production calculated for a calendar year. The former is expressed as a percentage of the latter. It measures the contribution of electricity produced from CHP to total electricity production. However, there are several important qualifications as not all the electricity and (useful) heat produced in CHP plants can be considered CHP production. This is explained in section 6 of the metadata.

It should also be noted that although the indicator focuses on CHP electricity the quantity of useful heat recovered is almost 2.5 times higher in energy terms.

3. Geographical coverage: EU-27.
4. Temporal coverage: 2005
5. Methodology and frequency of data collection: Data collected bi-annually.
Eurostat definitions for energy statistics <http://forum.europa.eu.int/irc/dsis/coded/info/data/coded/en/Theme9.htm>
Eurostat metadata for energy statistics http://europa.eu.int/estatref/info/sdds/en/sirene/energy_base.htm
6. Methodology of data manipulation:
The share of electricity produced from combined heat and power as a percentage of total national electricity production. The coding and specific components of the indicator are:
Numerator: Electricity production from combined heat and power plants. However, as mentioned in section 2 there are several important qualifications regarding the quantity of electricity that be considered to be from CHP production.
A power plant which is equipped with heat recovery facilities in connection with electricity generation is called a CHP plant. From the statistical point of view, the simplest approach is to consider all the electricity and useful heat produced in these plants as CHP production. However, there are special features in CHP production, which complicate the collection of the statistics. First, there can be several units in a power plant, not all of which have the possibility of recovering heat. Therefore, the collection of statistics has to be carried out on a unit basis. There might be some supplementary heating in addition to the CHP heat production. This supplementary heat can be produced for example in an extra boiler, completely separated from the CHP process and hence must be subtracted from the total heat generation of the plant. The fuel used to generate this heat also has to be subtracted from the total fuel consumed, when the CHP production is considered. There are also flexible units, where the produced heat to power ratio is adjustable. The flexible units can be operated in a fully CHP mode, or they may also be run without any heat recovery at all, depending on the current demand for heat and electricity. Variable heat loads are typical for district heating plants, whilst in industry the ratio between heat load and electricity generation is generally more stable.
Following a change in methodology the CHP component in electricity production is now calculated from the total production of CHP plants by considering the overall annual efficiency and the power-to-heat ratio of individual units within each plant to account for the above. Under certain conditions all the electricity produced in a CHP unit can be regarded as CHP production and in this case there is no need to separate the non-CHP component. In the past there was no unequivocal quantitative rule to define when this separation into CHP and non-CHP components should be done. Different interpretations of the old methodology were therefore possible. The methodology was strengthened for the survey for the year 2000; a threshold of 75 % for the overall efficiency was set as the criterion to select plants in which the CHP component of the electricity production has to be calculated. If the average annual efficiency is 75 % or higher, all the electricity produced in the plant is considered to come from CHP. If the efficiency is below that threshold, the CHP electricity (EHP) is calculated by multiplying the CHP heat production by the characteristic power-to-heat ratio of the plant.
Denominator: 6000 electrical energy 107000 total gross electricity generation.
Average annual rate of growth calculated using: $[(\text{last year}/\text{base year})^{(1/\text{number of years})} - 1] \times 100$
- Qualitative information
7. Strengths and weaknesses (at data level)
No historical data for new Member States. Changes in the methodology mean that historical time series are not consistent.
8. Reliability, accuracy, robustness, uncertainty (at data level):

Indicator uncertainty (historical data)
As mentioned in section 6 the method for data collection by Eurostat on combined heat and power has been revised in recent years. The primary change has been to account for the fact that not all of the electricity and (useful) heat produced in CHP plants can be considered CHP production. The methodology was strengthened for the survey for the year 2000 and again in 2002 and allows a clearer distinction between CHP and non-CHP electricity production and ensures more harmonised CHP statistics across the Member States. The effect of the methodology change on the reported CHP electricity production varies between the Member States. Some Member States were already reporting CHP statistics in which the condensing power, or the non-CHP production, was strictly separated from the gross production of CHP plants, whilst others were not. However, the overall effect has been to reduce the estimates of CHP electricity in the EU.
9. Overall scoring – historical data (1 = no major problems, 3 = major reservations):
Relevance: 1
Accuracy: 2 (for EU-15 data)
Comparability over time: 3
Comparability over space: 1