EN20 Combined Heat and Power (CHP)

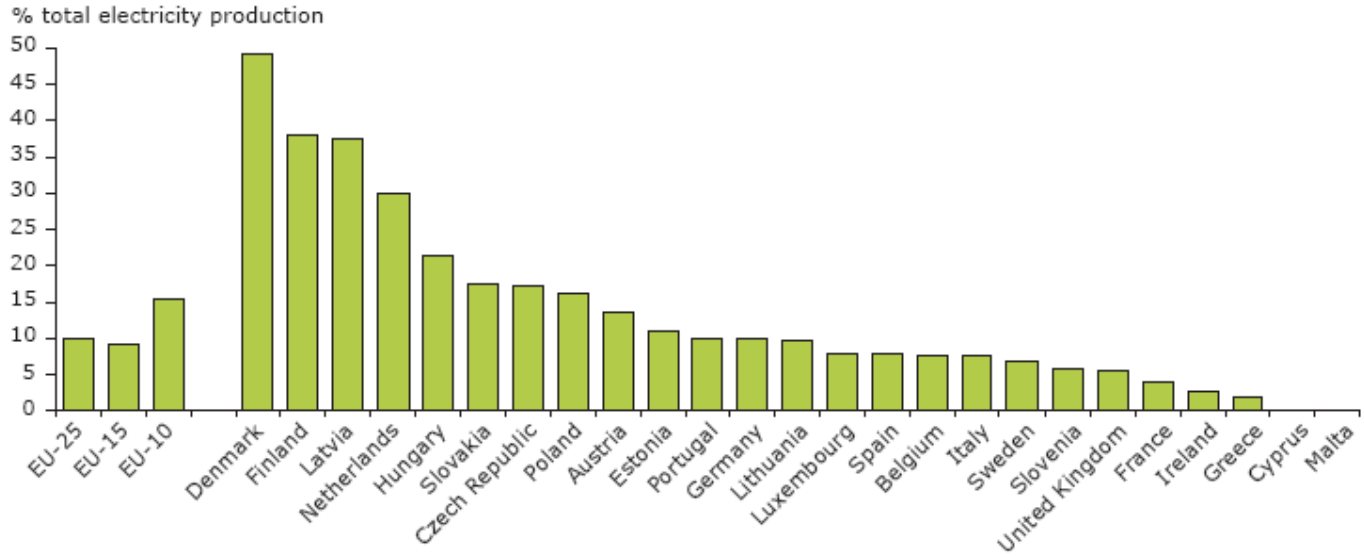
Key message

The share of electricity produced from combined heat and power (CHP) remained almost constant at 9.2 %, in the EU-15 between 2000 and 2002. 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 1.7 times that in the EU-15.

Rationale

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 as a whole to 18 % of total gross electricity production.

Fig. 1: Share of combined heat and power in gross electricity production in 2002



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 the previous 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).

1. Indicator assessment

The share of electricity from combined heat and power in total gross electricity production in the EU-25 was 9.9 % in 2002. It was significantly higher in the new Member States (15.4 %) than in the pre-2004 EU-15, where it was 9.2 %. Compared to 2000, this meant a reduction of around 0.8 percentage points (EU-15). The visible decline in production between 2000 and 2002 is partly due to the fact that the methodology used to calculate the CHP production changed in 2000 and subsequently altered for a second time in 2002. For the 2000 data, Eurostat adopted a new methodology to calculate the share of CHP in gross electricity production, designed to better identify electricity production from combined heat and power. This revision has resulted in lower figures for some countries. However, despite these changes in the calculation methods, it would appear that the EU-15 is far from being on track to meet the indicative target to double the share of CHP electricity in gross electricity production between 1994 and 2010 (COM(1997) 514 – final). When calculated according to the old Eurostat methodology, this required an increase of CHP electricity from 9 % in 1994 to 18 % in 2010.

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) and falling electricity prices resulting from market liberalisation and increased competition, although these have now started to rise again. 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 also 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 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:
    - capital grants (United Kingdom),
    - 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, 2000[1]),
    - 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 gas[2] 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.

Although the increase in CHP electricity production has been limited, the share of CHP in electricity production increased during 1994 to 2002 in almost all EU-15 countries. In absolute terms, the largest increases took place in France (+14 TWh), Spain

(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

(+10.8 TWh) and the United Kingdom (+8.9 TWh). In relative terms, Belgium and Ireland also showed a large increase, +153 % and +141 % respectively since 1994. Among the EU-15, Germany currently has the highest absolute production of CHP-electricity (23% of EU-15 total in 2002).

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, in 2002, renewable energies provided only 13 % of the fuel input in CHP plants in the EU-15 and 1 % in EU-10. Natural gas accounted for almost half of the fuel input in EU-15 (14 % in EU-10), while coal and lignite provided 61 % of the fuel input in the new Member States. According to baseline projections (EEA, 2005), future CHP production capacity will largely be based on natural gas combined cycle gas turbines and small gas turbines. These projections also show that the use of biomass is expected to emerge as a significant fuel for CHP over the period to 2030 only if future ambitious renewable energy targets were to be reached.

In the longer term, market penetration of CHP is expected to increase only slightly. PRIMES baseline projections show CHP electricity production for the EU-15 increasing from 10 % to 13 % over the period from 2000 to 2010 and to approximately 14 % in 2030, 19 % for the EU-25 (EEA, 2005). This is unlikely to be sufficient to meet the indicative target of doubling CHP electricity production between 1994 and 2010 (even allowing for some uncertainty caused by the changing definitions of CHP electricity). The share of CHP generation is not significantly higher under the Low Carbon Energy Pathway variant of the projections (EEA, 2005), indicating that a CO^2 permit price alone is not sufficient to support CHP.

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 electricity production in gross electricity production from 1994 to 2010 would lead to avoided CO_2 emissions of over 65 Mt CO_2/year by 2010.

2.2 Policy context

The EU strategy outlined in the Commission's cogeneration strategy of 1997 sets 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 is 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 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 mobilising 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 urges Member States to carry out analyses of their potential for high efficiency cogeneration.

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, as outlined in the green paper on energy efficiency (COM (2005)265 final) and the Directive (2002/91/EC) on the energy performance of buildings.

References

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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.

COM(2005) 265 final – Green Paper on energy efficiency, or doing more with less , European Commission http://europa.eu.int/comm/energy/efficiency/doc/2005_06_green_paper_text_en.pdf.
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Meta data

Technical information

1. Data source: Eurostat: statistics in focus 3/2006 - http://epp.eurostat.cec.eu.int/cache/ITY_OFFPUB/KS-NQ-06-003/EN/KS-NQ-06-003-EN.PDF
   European Commission, EEA (2005) (projected data) – baseline projections are consistent with European Commission (2004)

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.
   The PRIMES model was used by the EEA to analyse possible future developments of the European energy sector, including a baseline scenario without a permit price and the low carbon energy pathway (LCEP) scenario. It describes the least-cost response of the EU-25 energy system to the introduction of a carbon permit price that rises to EUR 65/t CO_2-equivalent by 2030.

3. Geographical coverage: EU-25 except Cyprus and Malta.

4. Temporal coverage:1994, 1996, 199 7, 1998, 2000, 2002, projections to 2030 in 5 year intervals.

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, all of which do not 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 (ECHP) 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: [(last year/base year) ^ (1/number of years) –1]*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.

   Indicator uncertainty (scenarios):
   Scenario analysis always includes many uncertainties and the results should thus be interpreted with care.
   - uncertainties related to future socioeconomic developments (e.g. GDP) and human choices;
   - uncertainties in the underlying statistical and empirical data (e.g. on future technology costs and performance);
   - uncertainties in the choice of indicators (representativeness);
   - uncertainties in the dynamic behaviour of systems and its translation into models;
   - uncertainties in future fuel costs and the impact on low carbon technologies.

   The LCEP scenario uses relatively optimistic assumptions on economic growth, compared with other scenarios. The same level of carbon prices as in the LCEP scenario would lead to higher CO2 emission reduction when simulated with other models (e.g. TIMER), which may partly result from the fact, that carbon capture and storage was not included in the PRIMES LCEP scenario.

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