Brighter prospects for CHP in Europe

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The prospects for the development of CHP in Europe have started to improve, albeit from a low base, argues Klaus Traube. New micro-technology, rising electricity prices, the CHP Directive and the approach of emissions trading have all contributed to a brighter medium-term outlook. The ability of decentralized CHP to improve energy security is also important.

In 1997 the European Commission presented a report on a common strategy for the promotion of cogeneration (CHP), emphasizing that CHP is one of the few technologies that could, in the short term, render an important contribution to enhance energy efficiency in the European Union (EU). However, noting that its potential was widely underused, the report underlined the need to remove the barriers which prevented the adequate exploitation of the potential for CHP in most of the Member States. These barriers had caused a decrease of the CHP share in the electricity generation of the EU since the 1970s. The Commission proposed a policy with the aim of doubling this share, from then 9% to 18% by 2010.

The European Council approved the report but the proposed strategy was not implemented. Since then, the share of CHP electricity in the EU has continued to stagnate, or decrease even further, due to the decline of wholesale electricity prices in the first years after liberalization of the electricity market.

More recent developments seem to indicate that the conditions for CHP in Europe have now started to improve. Wholesale electricity prices have been rising again. The European Parliament and the Council passed the long-awaited Directive on the promotion of cogeneration in January 2004 (see *COSPP* March-April 04). Next year, emissions trading will start in the EU. Will the development of CHP finally reach point that reflects its benefits? We cannot know now, but in this article will examine the parameters that will influence the further development of CHP in the short and medium terms – driving forces and barriers, benefits and technical potential.

BARRIERS TO CHP DEVELOPMENT

The barriers to CHP development result primarily from a conflict of interests in the electricity sector. Since plants have to be located close to centres of heat demand, CHP production is necessarily decentralized and thus reduces the demand for electricity produced in large, centralized power plants which are predominantly operated by the major public utilities. Historically, many of these utilities have applied strategies to prevent investment in CHP plants, which they considered as competitors in the electricity market. But there were also exceptions to this rule. Indeed, the differing strategies of dominant utilities towards potential CHP competition were mainly responsible for the enormous differences in the development of CHP within the EU. Whereas the share of CHP electricity has reached about 50% in Denmark and the Netherlands and 35% in Finland, it remains below 10% in most of the 15 established members of the EU and below 3% in France.

The removal of such barriers may result in a rapid development of CHP, as has been demonstrated by the Netherlands and Finland. In the Netherlands, the electrical generating capacity of installed CHP plants almost tripled in the decade 1987–97 as a result of a political decision to actively develop CHP and to reorganize the electricity industry accordingly. In Finland, the production of CHP electricity doubled in the industrial sector and tripled in the district heating sector during the period 1983–97. This was a result, not of political intervention, but of a changing strategy within the electricity industry. The then dominant utility, Imatran Voima, decided in 1983 to co-operate with industry and municipalities in the development of CHP. Since then, it has expanded its electrical capacity by only installing decentralized CHP plants instead of large central power stations.

At the onset of liberalization, it was argued that barriers to CHP might disappear since CHP operators could sell surplus power, or buy additional and reserve power, on the market instead of being forced to contract with the local electricity monopoly. But, in practice, only a few large CHP operators profit from these opportunities and the attitude towards CHP of most of the large utilities did not change much. Due to pressure from Member States, the new CHP Directive does not oblige them to actively support CHP. The Parliament had proposed to establish a target of at least an 18% CHP share in the total electricity output of each Member State to be achieved by 2012. But the final version of the Directive does not mention targets – in contrast to the Directive on electricity from renewable energy sources of September 2001.

The German act on CHP support of April 2002 is also a result of the conflict between political goals and vested anti-CHP interests. The German government had decided in 2001 to actively support CHP expansion as the most important contribution to its programme of reducing greenhouse gas emissions. But, due to intervention by the dominant utilities, the resulting act does not support the installation of new CHP plants; it merely supports modernization of old CHP plants on condition that their heat output is not increased.

DRIVING FORCES

Market-driven CHP investments depend largely on the conditions for access to public electricity grids (purchase of additional and reserve power, feed-in of surplus power) and for the supply of natural gas, the most important fuel for new CHP plants. These conditions depend to a large extent on specific CHP-related strategies of large public utilities and on energy taxation policies. Politics may influence CHP market conditions directly by taxation policies and indirectly by regulating access to the grids. Thus politics play a major role in CHP development.

Political support for CHP is based on its benefits. And the extent of political support is influenced by public recognition of these benefits and by the efforts of interested lobbyists. Except for countries with a highly-developed CHP sector, the lobbying power of the CHP related industry – manufacturers and operators – is weak compared to that of the large power industry. This situation may lead to a half-hearted support for CHP, as in the case of the new CHP Directive. The Directive will deliver some support to CHP, but to a rather limited extent because it does not oblige Member States to implement such support.

The forthcoming emission trading scheme should, according to its theory, deliver economic advantages for energy-efficient technologies such as CHP because they reduce emissions. However, within the framework of the new Directive on emissions trading, CHP may suffer disadvantages because of the fact that the reduction of energy consumption due to CHP does not occur in the CHP plant itself, but outside its boundaries. During negotiation of the Directive, proposals to clarify how to deal with this particular CHP situation were turned down. Thus it is up to each Member State whether or not to repair this inconsistency. The outcome again depends on political processes. Decisions on the allocation mode of emission allowances for power plants, including CHP, are still pending in most of the Member States. It seems probable that emission trading will, eventually, be beneficial for CHP in most, but not in all of them.

BENEFITS OF DECENTRALIZED CHP

It is widely recognized that CHP reduces energy consumption compared to the separate generation of heat and power. Thus, CHP contributes to:

- reducing emissions, in particular of greenhouse gases
- securing energy supply by reducing energy imports
- conserving energy resources.

These are the benefits listed in the CHP Directive to justify promotion of CHP as an EU priority.

However, there are other, less well-recognized yet important, benefits related to the decentralization of power generation associated with CHP. Obviously, CHP offers opportunities for independent power producers, including new market entrants. This opportunity for diversification of power production should be politically welcomed to counteract the marked tendencies of an oligopolistic concentration in the energy sector. Diversification of market actors could be a valuable by-product of CHP development.

Decentralizing power production by CHP development also causes important beneficial effects on the electrical grid system. CHP production occurs near to the sites where heat and power is consumed. This holds for any size of CHP plant, from units of several hundred megawatt electrical capacity serving large industrial sites, as well as for micro-CHP plants serving individual houses. The amount of surplus electricity fed into the public grid is usually quite limited and will normally be consumed locally rather than being transmitted to distant areas. Thus, CHP production relieves the load on electrical transmission systems. This effect has important economic consequences and enhances protection against blackouts.

The series of power blackouts which occurred last year in the relatively highly-developed European and North American electricity systems, has drawn public attention to the vulnerability of electricity supply systems. The blackouts demonstrated that investments in the electrical grid had been neglected due to the economic pressure caused by liberalization of the electricity market. It appears that costly improvements are needed. The current EU programme to increase the capacity of European transnational grid systems will also promote improvements to grids. But is this an adequate answer to the vulnerability of the electrical system? Does development of a common electricity market require transmission of electricity from Portugal to Finland?

The growth of decentralized power production will reduce demands on electrical transmission systems, thus reducing their vulnerability. In addition large-scale blackouts may be caused not only involuntarily but also by sabotage. Protection against blackouts caused by acts of terrorism will be enhanced by reduced demands on transmission systems, not by increasing their capacity in order to increase international electricity trading.

The grid-relieving quality of CHP also has important economic consequences. In public electricity systems, the grid normally requires higher capital investment than the corresponding generating capacity. Development of decentralized CHP production constitutes an alternative to costly reinforcement of electrical grids. Indeed, investments in CHP may replace investment in electrical grids. If the development of public electrical systems were rationally optimized as a whole, new CHP plants would be credited with the expenditure in grid reinforcement spared due to the grid-relieving quality of CHP. Taking this credit into account would radically change the competitive situation of CHP investments. However, under the prevailing market situation, this credit is not transferred to the potential CHP investor, who does not operate the grid. The effects on the grid are therefore irrelevant for his decision on CHP investment. It remains a challenge, therefore, to establish a process of decisions on investments based on optimization of the entire public electricity system, comprising both grid and generating capacity.

A reduction in investments in electrical grids, improved protection against blackouts and enhanced competition in the electricity market are valuable benefits associated with the decentralized nature of CHP. These benefits are not as well-known as those associated with energy efficiency, and awareness of them has to be promoted for the sake of getting the political support necessary to remove the barriers to CHP. The same barriers that have been erected because CHP enhances competition in the electricity market.

MARKET POTENTIAL

The potential scale of CHP development depends on the size of the heat demand accessible for supply by CHP plants. It is often argued that the potential for CHP is limited due to scarcity of adequate heat demand. This claim is generally substantiated by focusing on large district heating systems, whose further expansion may be inhibited by penetration of natural gas supplies into housing areas. But gas may also fuel CHP installations. The introduction of internal combustion engines and small gas turbines as CHP generators made a large variety of heat demands accessible to gas-fired CHP. On this basis, various market studies carried out in the 1990s concluded that, in Europe, CHP plants could generate 40% to 50% of the total electricity demand. In fact, this level has already been exceeded in Denmark and the Netherlands.

This market potential for CHP may even be increased by the development of micro-CHP technology. Internal combustion engines supplying CHP at electrical capacities of only a few kilowatts are already on the market. Quite a number of manufacturers are engaged in the development of fuel cells or Stirling engines with electrical capacities down to one kilowatt. They aim at replacing conventional gas heating systems for individual houses. Market surveys have suggested annual sales of many millions of micro-CHP generators. Such prospects may come true if a real technological breakthrough is achieved, making micro-CHP devices as simple, reliable and cheap as current conventional gas heating devices.

The medium-term potential for CHP penetration may be enlarged by the development of micro-CHP. However, will the expansion of power production from renewable energy sources (RES) restrict the potential for CHP?

Both CHP and RES production reduces consumption of fossil fuels and thus avoid emissions. In the energy supply sector, their development is by far the most important contribution to climate protection and conservation of resources. Furthermore, except for large hydro plants and offshore wind-parks, RES power in general is decentralized production that also, like CHP, relieves the load on electrical transmission systems.

RES power based of biomass, geothermal and solar thermal energy should be produced in combination with production of useful heat; that is in CHP plants. In this sector, expansion of RES will not restrict the potential for CHP. However, RES power generated by photovoltaic, wind and hydropower constitutes an area of power production obviously not accessible to CHP.

The concentration of large hydropower capacity has already limited the use of CHP. In Norway, for example, where almost 100% of electricity is generated by hydropower, CHP does not exist. In principle, the further expansion of power generated by photovoltaic, wind and hydro power may limit the potential for CHP. But there is little potential for expansion of hydropower from rivers in Europe; exploitation of wave and tidal power is still far away; and photovoltaic power will not contribute an important proportion of power generation in the short and medium term since considerable development effort is still required to cut down it's high cost. Thus, in the medium term, the potential for CHP could only be restricted by the expansion of wind power capacity. Until now, this has been a real problem only in Denmark, where the share of both CHP and wind power in the total power generation is higher than anywhere else.

In the long term, energy supply will have to be based predominantly on RES. But in the short and medium terms, the potential to replace conventional power will be higher for fossil-fuelled CHP than for RES. CHP capacity may be developed rather rapidly once adequate market conditions are established – as demonstrated by the examples of Finland and the Netherlands. Eventually, the infrastructure now installed for fossil-fuelled CHP may, at least partly, be converted to CHP based on biomass, geothermal energy or, in southern areas, solar thermal plants.

CONCLUSIONS

The expansion of renewables-sourced power in the wind, photovoltaic and hydro power sectors may substantially diminish the potential for CHP in the long term, but not in the short and medium terms. The technical potential for CHP development is huge compared to the current market penetration in most countries. In Europe, the state of the current power plant fleet is now favourable for penetration of CHP. After a long period of overcapacity in most of Europe, existing plants are now degrading due to ageing. In some countries, the phasing out of nuclear power is also planned. Therefore, a large proportion of the European power plant capacity has to be replaced in the period 2010–20. Decisions to be made on the allocation of emissions for power plants in the European emission trading system will exert an important influence on the choices for the next generation of power plants. It seems probable that CHP will benefit from emission trading in most, but not all, of Europe.

The rising trend in electricity prices is also favourable for CHP but this effect is partly offset by high prices for natural gas. The CHP Directive will create not much support, but some. All in all, the prospects for future CHP development in Europe seem to be brighter than in the recent past.

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