CO_2 Reduction Possibilities by CHP

A recent study prepared by the Committee for Ecology of Euroheat & Power shows, that if the EU-wide target of an 18 % CHP share of electricity generation is met by 2010, the European Union can avoid 380,7 million tons of CO_2 emissions per year. In an interview with the editorial board of this magazine Hans Hof, Chairman of the Committee shows how reliable these figures are and how they can promote the further growth of combined heat and power.

Hans Hof
Chairman of the Committee for Ecology of Euroheat & Power

EHP: *Hans Hof, what was the main reason to carry out the study »CO_2 Reduction by Combined Heat and Power in the European Union«?*

H. Hof: The Study is a joint effort of the members of the Committee for Ecology of Euroheat & Power. It was carried out at the suggestion of the General Secretary of Euroheat & Power. There was an overall need for the examination of the possibilities of CO_2 reductions by CHP. Especially because of the Kyoto agreements CO_2 reductions became a very important issue in the last 5 years. Although there is the general awareness that CHP is an important option to reach the Kyoto targets, it was never calculated and investigated how far CHP can contribute to CO_2 reduction. So the most important question was: what is the contribution of CHP and district heating in regard to the Kyoto agreements. Beside this there were four main reasons: First, we wanted to give a clear signal to the politicians at European level and to give a distinct basis for the discussions about the possible CO_2 reductions by CHP. Furthermore, we want to be an important partner in these discussions with politicians. This is in line with the general role of Euroheat & Power of becoming a more lobbying Association for combined heat and power and district heating at European level. Second, there was a general ambiguity about what role CHP can play in the market in respect to the Kyoto Protocol. There exist some estimations about this subject with very differing figures. These figures could not be a reliable basis for a high level discussion. Third, we wanted to have a computer model with which it is possible to calculate the CO_2 reductions by CHP. Until now there has been no tool for this kind of calculation. Finally, we wanted to promote the environment-friendly product combined heat and power. Although there was already the awareness that CHP is environment friendly, it was not very obvious in regard to the CO_2 reductions. Thus we wanted to make this more manifest to promote the environment-friendly product CHP.

EHP: *How reliable are the presented figures and what is the main difference between your methodology and that used in other studies?*

H. Hof: The study is based on theoretical exercises and we have to rely on theoretical examinations. This is the only way to determine CO_2 reductions because they could not be measured. In fact, they have to be calculated by means of comparisons with alternative situations. We have been working on this study for more than 3 years. In this period we had numerous discussions with experts and conducted many crosschecks to verify that we have the right information and reliable figures. There are some other studies, which only focus on the figures at EU level. But we found out that it is very important to first determine the necessary figures at country level. Only on the basis of these figures it is reasonable to carry out the calculations at EU level in a second step. We also discussed how the main findings would be influenced by the modification of the four most essential parameters. These are the definition of CHP electricity, the fuel mix assumed in 2010, the potential for technological progress up to 2010 and the improved efficiency of separate heating units replaced by CHP in 2010. For these parameters a sensitivity analysis was performed to show the possible over and underestimation. Furthermore, we took into account that there is a technological improvement for CHP units and for the electricity only power plants. This was not considered in other studies. We also took into account all types of CHP such as local CHP and district heating CHP, which is also not the case in other studies. Finally we had a very detailed set of data available for the calculation. This means that the figures in the report are based on a consistent methodology and a coherent set of data. All the assumptions are clearly documented in the computer model and it is a complete transparent system.

EHP: *Your figures and the figures from Eurostat differ significantly. What feedback did you get from Eurostat to obtain a more reliable and detailed CHP statistic?*

H. Hof: To calculate the CO_2 savings by CHP it is very important to apply a unique definition of CHP electricity. This was one of the main discussion items in the project. Until now Eurostat has had no unique CHP definition and it had to rely on figures provided on a voluntary basis by the member states. However, these figures are based on 15 different national CHP definitions. Some countries, for example, consider the entire electrical output of a CHP plant as CHP electricity, independent of the actual proportion of output in CHP mode and in condensing mode. However, the latter should not be considered as

CHP electricity. This highlights the necessity to introduce a technically correct CHP definition. There are two main differences between the approach of Eurostat and Euroheat. One is the definition of CHP and there is also a difference in the definition of local CHP and district heating CHP. It emerged that Eurostat did not use the same definitions for local CHP and district heating CHP. This could lead to a double counting or an under-estimation of the CHP electricity. We have discussed this with Eurostat and it agreed that the situation could be improved. There was also a good co-operation with Eurostat in terms of the energy efficiency set of data. We concluded that Eurostat has better energy efficiency data for local CHP and Euroheat & Power has better data for the district heating sector. So we were able to join efforts on this subject to improve the reliability of both sets of data. This means that Euroheat & Power accepted the local CHP data and Eurostat seems to accept the statistical data for the district heating sector gathered for years by Euroheat & Power. After the publication of our report Eurostat carried out its own CO_2 calculation with roughly the same results.

EHP: *Do you expect a unique standard definition of CHP electricity in the future in Europe?*

H. Hof: Yes, I think this will be possible in the long term. But there is not much time left. For a good energy policy at European level it is necessary to have comparable and reliable figures which are based on a unique definition of CHP electricity. For example, if you use the Protermo method, which is based on the pure CHP electricity, there is 8.3 % CHP electricity in 1997 at EU level. Eurostat however calculates 11.7 %. This shows that there is a significant definition problem, which is a main obstacle for the promotion of CHP.

EHP: *Besides the most realistic scenario, the thermal scenario, you took into account two further scenarios, which are not very realistic. Can you describe these two scenarios and what was the reason to extend the study to these examinations?*

H. Hof: We wanted to be sure that we do not overestimate the CO_2 reduction of CHP because there are different situations like the fuel mixes in the different European countries. This is the main reason why we carried out three scenarios, which cover the whole spectrum of scenario possibilities. In contrast to the thermal scenario, the average scenario assumes that electricity generated in CHP plants replaces electricity produced in the average mix of power plants. This assumes that CHP electricity must compete with electricity generated by hydro and nuclear power plants. This is important, for example, for France with a high share of nuclear power and Sweden with a high proportion of hydropower. This scenario would be more relevant for these countries. The Combined Cycle Gas Technology Scenario was included because there have been discussions that electricity produced in high efficient combined cycle power plants would have a better CO_2 reduction potential than CHP. This Scenario assumes that CHP has to compete with high efficient combined cycle power plants in condensing mode. But even in this case CHP would save a substantial amount of CO_2 emissions. With these three scenarios we covered the whole spectrum of possibilities and give a wide range of interpretation of the CO_2 reduction possibilities. But it shows that in all scenarios CHP contributes to CO_2 reductions.

EHP: *You did not undertake any economic considerations. Where do you think the money could come from to achieve these targets?*

H. Hof: The main objective of the report is the assessment of the CO_2 reduction possibilities by CHP without economic considerations. We only calculated how many CO_2 savings

CO_2 savings by Combined Heat & Power in the European Union

If the EU target of 18 % CHP share of electricity generation is met by 2010, the European Union will avoid 380.7 million tons CO_2 emissions per year, according to the most realistic scenario (thermal scenario) of the report »CO_2 reductions by Combined Heat & Power in the European Union« which was prepared by the Committee for Ecology of Euroheat & Power. Subtracting the 186.4 million tons per year CO_2 emissions already avoided by CHP in 1997, the additional CO_2 savings by CHP would be 194,3 million tons per year. This corresponds to 57,8 % of the Kyoto CO_2 reduction targets of the EU which is currently estimated to be 336 million tons per year for all EU-15 countries together.

The **Thermal Scenario** assumes that electricity generated in CHP plants replaces electricity produced in the average fossil fuel-fired power plant of the different EU countries. This is the most realistic scenario. Generally, the electricity generated by CHP plants has a medium marginal cost. In liberalised electricity markets, therefore, CHP electricity tends to replace other power plants with a medium marginal cost, operating at the medium load of electricity supply. In most EU countries, these are fossil-fuelled power plants. The scenario takes into account the expected switch towards more gas and biomass both in CHP and in electricity-only power plants.

The **Average Scenario** assumes that electricity generated in CHP plants replaces electricity produced in the average mix of power plants of the different countries. This is very unrealistic because it can not be assumed that CHP electricity will replace substantial amounts of electricity generated in nuclear plants, because the latter have very low marginal costs. Furthermore it is not expected that in countries with a high share of hydropower with marginal costs close to zero CHP electricity will replace a significant amount of hydropower. As such a scenario is sometimes taken as a reference in policy debates, it has also been analysed. In the average scenario CHP avoided 107,5 million tons per year CO_2 emissions in 1997. If the 18 % target is reached in 2010, further 118,5 million tons per year CO_2 savings would be achieved. In total CHP would then avoid 226.0 million tons per year CO_2.

The **CCGT Scenario** assumes that 18 % electricity generated in CHP plants will replace only electricity produced in Combined Cycle Gas Technology plants. This scenario does not correspond to a realistic assumption concerning the relative position of CCGT and CHP in the electricity market of 2010. CCGT and CHP are no alternatives. In fact, CCGT plants can be operated as CHP plants, adding the advantages of the CCGT technology to the benefits of utilising the heat, which is still wasted when CCGT plants generate only electricity. Currently, CCGT plants in electricity-only mode can achieve at most 56 to 58 % of energy efficiency, whereas CCGT-CHP plants can achieve 90 to 95 %. The CCGT Scenario is considered in the study because it has been put forward as an argument against the need for promoting CHP. Obviously, the CCGT Scenario is the »toughest« comparison for CHP, as far as it regards the potential to reduce CO_2 emissions. Nevertheless, it shows that even in this case CHP growth would lead to a substantial CO_2 emissions reduction, due to the fact that CHP does not only replace power production but also separate heating systems.

should not increase CHP as far. But preliminary analyses indicate that CHP is the CO_2 reduction option, which is somewhat more expensive than non-CHP electricity but it is much cheaper than renewable electricity. It can be concluded that in the long term we will see a certain mixture of cost-efficient CHP electricity and more expensive renewable electricity. The main task will be to find an optimum mix of these potentials.

EHP: *From your point of view, do you think the 18 % target can be achieved?*

H. Hof: I think the 18 % target is very ambitious. This target was issued in 1997. Until that time the European institutions did not implement very specific sets of measures to reach this target. So with every year without specific measures it would be more difficult to reach the result. In 1997, we had 8 % CHP share and now there is 9 or 10 %. This means that in the next 8 years we have to double the CHP share. Against this background the target will probably not be attainable. In any case, the 18 % share will not be achievable without substantial efforts and clear incentives to support the increase of CHP. It can be concluded that the heat market is not the bottleneck in this situation because this market is big enough for an appropriate increase. The main problem is the overcapacity in the European electricity market. However, as we can see in the Netherlands, it is generally possible to achieve a substantial increase of CHP. Within 10 years the CHP share was increased from 20 % to 40 %. But it was only possible with enormous efforts from all players in the market. Against this background I think the growth of CHP electricity in the coming years will be very moderate and it will be very difficult to achieve even this.

EHP: *Hans Hof, thank you for the discussion.* ■