THE MARKET INTEGRATION OF ENERGY – CLIMATE CHANGE PACKAGE

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Improved energy efficiency has the potential to make the most decisive contribution to achieving sustainability, competitiveness, and security of electricity supply. On 19 October 2006, the Commission adopted the Energy Efficiency Action Plan, containing measures that would put the EU well on the path to achieving a key goal of reducing its global primary energy use by 20% by 2020. If successful, this would mean that by 2020 the EU would use approximately 13% less energy than in 2006, saving €100 billion and around 780 millions tones of CO2 each year. The first is to improve electricity efficiency on both the supply and demand side by developing more efficient power generation technologies and by improving efficiency in all kinds of applications. The benefits of both existing and new technologies, on both the demand and supply side, must be exploited through practical take-up.

Keywords: energy efficiency, renewable resources, demonstrative program, citizen attitude.

1. Introduction

Market integration of energy- climate change package involves two aspects: willingness of electricity companies to improve energy efficiency and reduce CO2 emissions through the implementation of real, innovative projects based on energy renewable sources and on carbon capture and storage, and, on the other hand, the public awareness increasing concerning the role of energy saving. The authors' contribution is the integration of these two aspects by presenting the results obtained within the Energy Wisdom Programme and some aspects concerning the EU citizen attitudes on issues related to EU Energy Policy.

2. Energy efficiency

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On 19 October 2006, the Commission adopted the Energy Efficiency Action Plan, containing measures that would put the EU well on the path to achieving a key goal of reducing its global primary energy use by 20% by 2020. If successful, this would mean that by 2020 the EU would use approximately 13% less energy than in 2006, saving € 100 billion and around 780 millions tones of CO2 each year[1]. Improved energy efficiency has the potential to make the most decisive contribution to achieving sustainability, competitiveness, and security of supply.

The Energy Wisdom Programme is a partner of the Sustainable Energy Europe Campaign 2005-2008, representing a voluntary initiative which demonstrates how electricity companies are improving energy efficiency and reducing CO2 emissions through the implementation of real, innovative projects. The main concept of the Programme is to compare the real levels of greenhouse gases GHG emissions from a scenario "With Project" against a "Without Project" scenario that represents what would have been the levels of GHG emissions had the project not been implemented [2]. Some examples of CO_2 reduction obtained by different energy efficient projects are presented.

2.1. Natural gas-fired power plant

A natural gas Combined Cycle Power Plant (CCGT), with an installed capacity of 484.6 MW situated near the city of Komotini, in the region of Thrace, Northeastern Greece was commissioned in 2001. For the estimation of CO2 emissions reductions in 2003, the following calculation was made: The CO_2 emissions factor for a CCGT unit is: 2050 t CO_2/MNm^3 of natural gas burned. Fuel burned = 495,000 kNm3 of gas. Emissions with project = 2050 x 495,000 = 1015 kt CO_2 Emissions without project: CO_2 coefficient = 1301 kton/TWh. TWh generated in the power plant = 2.432 TWh. Emissions without project = 2.432 x 1301 = 3164 kt CO_2. Emissions Reductions = 3164 - 1015 = 2149 kt CO_2 [3].

2.2.New lignite-fired unit

RWE has decided to build a high-efficient lignite fired twin power plant in Germany. The net efficiency will exceed 43%; RWE will invest €2.2 billion. RWE intends to replace old lignite-fired units by high efficient state-of-the-art twin power plants. Technical specification of the new twin unit: capacity: 2.100 MW; expected generation: 16 TWh/year; efficiency: > 43%; specific emissions: 0.93 kg CO_2/kWh. Technical specification of the units which will be replaced by the new twin unit: efficiency: 31%; specific emissions: 1.29 kg CO_2/kWh . Calculation methodology: CO_2 savings: 5.8 Mt/year = 16 TWh/year x (1.29 – 0.93) kg CO_2/kWh[4].

2.3.Combined heat and power

Electrabel and several large oil and chemical companies in the harbour of Antwerp signed partnership agreements to build CHP generation units on the premises of these companies. Each CHP is individually designed in response to the local requirement for heat. The gas turbine driven CHPs typically consists of 42 MW units .and provide steam to the industrial partner and electricity to the network or to the partner. The CHPs are fuelled with natural gas. They create 15% less harmful emissions than producing heat and electricity separately. A quality cogeneration unit of 42 MW saves up to 15 million cubic metres of natural gas and avoids emissions of 30 ktCO_2 annually[5].

2.4. Efficiency improvements in a nuclear power plant

Loviisa Nuclear Power Plant – Finland comprises of two units with pressurised water reactors of VVER-440 type. The total generation capacity of the plant was originally 930 MWe (gross) and 890 MWe (net). After upgrading the corresponding figures are 1,020 MWe (gross) and 976 MWe (net). The project consisted of modernisation and power upgrading of the plant with a total increase of about 100 MWe in the electrical output of the plant. Due to the project, the thermal power of the two reactors has been upgraded by about 9% to 1,500 MW compared with the original level of 1,375 MW. Example for 2004: Additional electricity generated by the project 1040 GWh, CO_2 emission from a coal-fired power plant (efficiency 40%) 0.834 ktCO_2/GWh, emissions without project = emissions reductions = 1040 x 0.834 = 870 ktCO_2. The total amount of 6.2 MtCO_2 has been avoided during 1996-2004[6].

2.5.Efficiency improvements in a lignite-fired power plant

The process of modernization in BOT Turów Power Plant has been designed to meet the requirements of the continuous production and financing, with special regard to the environmental impact at each modernization stage. For combustion of lignite, fluidised bed technology was implemented. All CO_2 reduction efforts focused primarily on enhancing the generation efficiency and optimising the combustion systems. 2004, the overall generation efficiency of the modernized units was approx. 41%, being improved by around 20% compared to that in 1994.

For the estimation of CO_2 emissions reductions, the following calculation was made for 2003: Emissions with project: CO_2 emissions factor = 0,88 tCO_2/MWh, total energy production = 11,216,501 MWh. Fuel burned in 2003 = 13,819.97 kt of coal. Emissions with project = 0,88 x 11,216,501 = 9,834.72 kt CO_2.Emissions without project: Calculated using MWh generated by project and kt CO_2/MWh on remainder of company's lignite-fired power stations. Company CO_2 emission factor before project in 1994: 1,1 t/MWh. MWh generated in the power plant in 2003 = 11,216,501 MWh. Emissions without project = 1,1 x 11,216,501 = 12,389.17 kt of CO_2. Emissions reductions in 2003: 12,389.17 – 9,834.72 = 2,554.45 kt CO_2[7].

2.6.Efficiency improvements in a hydro power plant

In run-off river power plants the upstream water level is usually manually controlled. This kind of control leads to a deviation of the water level from the optimal level and to a decrease of production. By means of fuzzy logic control an additional production of 3.5 GWh/year can be gained without further measures. A new and innovative fuzzy logic control has been installed in 2001 in the power plant of Melk, a river power plant at the Danube with a rated output of 187 MW and a mean annual production of 1221.6 GWh. In the meantime, the fuzzy logic control has also been implemented in the power stations of Wallsee (Danube, 210 MW; 1318.8 GWh/year) and Ybbs (Danube, 236.5 MW; 1335.9 GWh/year). The energy saving of the project is calculated in such a way that the distribution curves of manually and fuzzy logic control (frequency of occurrence versus difference of water level to maximum water level) are compared. Due to the fact the Verbund group owns hydro power plants as well as thermal power plants, the additional production of the project would be generated in thermal power if the project would not have been realized. The specific emissions of the thermal power plants of Verbund vary between 0.89 and 0.96 kt CO_2/GWh depending on the fuel mixture. Therefore the specific emissions of the thermal power plants were multiplied with the annual additional production yielding GHG reductions of 3140 t (2003) and 3180 t (2004)[8].

3.Renewable energy

The Commission proposes in its Renewable Energy Roadmap a binding target of increasing the level of renewable energy in the EU's overall mix from less than 7% today to 20% by 2020. This will require a massive growth in all three renewable energy sectors: electricity, biofuels and heating and cooling. The investment cost of renewable energy plant in 2005 and projected for 2030/2050 is represented in the figure 1.

The joint EURELECTRIC/VGB/RECS conference Renewable Energy in the Internal Energy Market – The way forward – April 2007 set the scene for the future, looking towards a true European market in renewable electricity (RES-E)[2].

The German Electricity Industry Association noted that installed wind power in Germany has reached over 20,000MW, which, though a generally positive development, makes balancing the grid more difficult, exacerbated by the fact that wind fed into the grid is paid at the set feed-in tariff – therefore electricity generated is fed into the grid regardless of its load, and other plant must be disconnected to prevent overload. This would improve if wind was properly integrated in the market, based on a harmonised European RES-E certificate trading system, and thus subject to normal balancing between generation input and withdrawal to maintain grid stability. Energy storage could assist in managing wind integration, e.g. electric vehicles charging when wind input is high and supplying back to the grid when there is a shortfall in production[2]. Some examples of CO_2 reduction obtained by different renewable energy projects are presented.

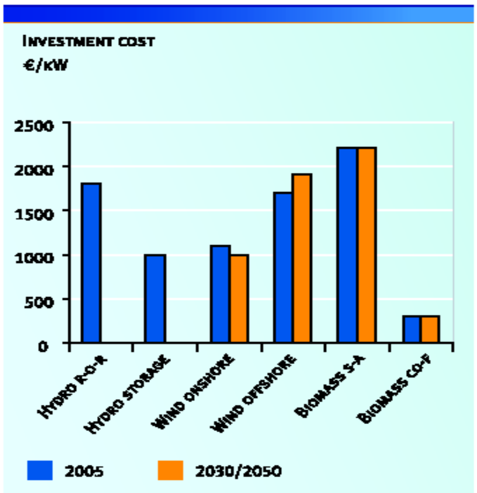

Fig.1. The investment cost of renewable energy plant in 2005 and projected for 2030/2050

3.1.Solar energy

The 1 MW photovoltaic project in the Nieuwland suburb of Amersfoort has been integrated in a residential area. Photovoltaic solar panels were installed on the roofs of 500 houses and several utility buildings. The surface area of more than 12,000 m2 solar panels is producing 1.35 MW. The most relevant environmental benefit is the avoidance of CO_2 emissions. The CO_2 emissions with the project are zero, as solar power generation is a CO_2-free energy source. The reduction by ENECO solar stations in 2003 (1,4 GWh x 430g/kWh) was 0.604 ktCO_2 and in 2004 (1.5 GWh x 430g/kWh) 0.641 ktCO_2[9].

3.2.Wind energy

EDP launched its wind farm programme in 1994. The total avoided CO_2 emissions was: 105.6 ktCO_2 in 2003 and 197.1 ktCO_2 in 2004. The fossil fuel/energy savings were calculated by converting the electricity production of the wind power plants into GJ (ktoe), using the average net heat ratio of the company's thermal power plants each year (9404.2 GJ/GWh in 2003 and 9381.4 GJ/ GWh in 2004). The results were an energy saving of 28.8 ktoe (2003) and 53.1 ktoe (2004)[10].

3.3.Hydro power plant

This project comprises all the new hydro power capacity, including small and large hydropower installations, as installed or repowered by Iberdrola in Spain from 1991 to 2004. CO_2 emissions with project are zero, as hydro power generation is a GHG-free energy source. CO_2 emissions without project were calculated from the total annual hydro based electricity production corresponding to the new installed and repowered capacity of installations put into service since 1991 and the CO_2 annual average specific emissions (tCO_2/GWh) of the remaining Iberdrola's thermal electricity generation mix (coal + oil/gas + gas - fired power plants, including CCGTs). In 2003, CO_2 emissions reductions were equal to Emissions without project - Emissions with projects = 1521.07 GWh x 714.55 t CO_2/GWh = 1,086.88 kt CO_2. In 2003, Iberdrola's hydro generation avoided the consumption of 640.4 kt of coal with an equivalent saving of 309.1 ktoe[11].

3.4. Fuel switching: from coal to biomass

Two major power stations in the South of the Netherlands have been adapted to allow co- firing of biomass on a large scale: the 1245 MWe base-load pulverised coal "Amer" power plant at Geertruidenberg; and the 1280 MWe load following gas and oil fired "Claus" power plant at Maasbracht. At the end of 2004, a total capacity of 396 MWe was suitable for biomass.

The CO_2 reductions have been estimated on the basis of the avoided CO_2 emissions for the same amount of electricity production using the directly displaced fossil fuel in the power station involved[12].

4. Carbon capture and storage

One of the most promising technology paths for the future is carbon capture and storage (CCS), in which the CO_2 from power plants would be captured at the plant and then transported and injected underground. This will require the development of new solutions. Underground storage of CO_2 seems to be one of the most attractive alternative. While many technologies used for CCS (gasification, capture technologies, etc) are already available, they have not yet been developed on an industrial scale. This represents a challenge not only for the industry and equipment manufacturers, but also for the public authorities.

A number of regulatory issues also await solution before full-scale deployment of CCS can happen. These include the treatment of CCS under the EU ETS and the regulatory and liability aspects of CO_2 storage. Public acceptance is also a major issue, which will require efforts from all involved parties.With the potential to produce power without releasing CO_2 into the atmosphere, CO_2 sequestration may become an important part of the post-Kyoto strategies of many countries. EURELECTRIC welcomes the European Commission's support for enabling CCS technology and promoting an economic framework for its early demonstration and commercial deployment [2].

The Commission's Communication on supporting early demonstration of sustainable power generation from fossil fuels envisages an EU structure - in the form of a European Industrial Initiative on CO_2 capture, transport and storage - to stimulate the demonstration of CCS technology. The Initiative would mainly play a coordinating role and provide a “marketable European identity”, as financing of demonstration projects will have to come from the industry or from Member State sources [1].

5. Eu citizens’ attitudes and perceptions on issues related to EU energy policy

The study on "Attitudes on issues related to EU Energy Policy" commissioned by the Directorate- General for Energy & Transport of the European Commission, carried out in February 2007 under the Flash Euro barometer framework and coordinated by The Gallup Organization, covering all 27 Member States of the European Union on a randomly selected sample of over 25,800 individuals of at least 15 years of age, was primarily designed to:

- Understand to what extent citizens link the way energy is produced and used to global climate change;
- Assess their perceptions regarding various possible actions in saving energy and thus combating climate change;
- Explore citizens' willingness to involve the EU in resolving these issues[13].

This study shows that sixty-two percent of EU citizens believe that the best way to tackle energy-related issues is through measures agreed on at the EU level as opposed to measures agreed on at a national level (an option selected by 32%).In 22 Member States, the majority prefer EU decision-making with regard to energy issues. Those preferring decision-making at the national level form the majority in some Eastern Member States: the Czech Republic, Bulgaria, Estonia, Latvia and Slovakia.EU citizens are quite certain that energy prices will increase significantly over the next decade. More than seven out of ten Europeans feel that they will need to change their energy consumption habits in the next decade, and that they will need to install energy-saving heating, lighting, cooling etc. equipment to keep up with rising prices and to comply with regulations[13].

Citizens believe that it is essential to have a real choice in the energy market (85%), and that environmental concerns also play a role in their preference for free competition. Currently, less than two in ten EU citizens say they do not pay attention to the energy consumption of household appliances they buy, while almost half of EU citizens reportedly pay a lot of attention to such concerns. When asked what actions citizens would most welcome from authorities in helping them cope with future energy challenges, they most often indicated monetary assistance to upgrade the energy-efficiency of their living space. It is also very clear that citizens expect their governments to intervene. The desired forms of intervention (e.g. tax incentives, funding research,) vary from Member State to Member State. The bottom line is that only 2% of citizens believe that their government should not do anything about this[13]. A significant majority of Europeans prefer that the EU coordinate decision making with regard to energy issues. Several policy initiatives of the EU also enjoy the support of the majority (and sometimes the overwhelming majority) of citizens. 83% of Europeans agree that the EU should set a minimum percentage of the energy used in each Member State that should come from renewable sources.

6. Conclusions

The next decades must see further progress towards a low-CO2 electricity generation mix through the pro-active use and development of all available options: hydropower, other renewable energy sources, nuclear energy, and clean fossil fuel technology including carbon capture and storage, as well as, energy efficiency increasing.

Due to the emission trading there is a growing interest in underground storage options for CO_2 in Europe now.

The benefits of both existing and new technologies, on both the demand and supply side, must be exploited through practical take-up.

The long-term nature of supply-side and of certain demand-side energy investments requires long term visibility for carbon pricing so as to facilitate the integration of climate change action into investments and business strategies.

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