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PERSPECTIVES OF A CCS BASED ELECTRICITY GENERATION IN EUROPE CONSIDERING DIFFERENT CO_2 INFRASTRUCTURE OPTIONS

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MOTIVATION AND TARGET

In the long term, the future of the electricity supply in Europe is influenced by the climate protection target of the European Union, which aims at limiting the global warming to 2° C. For the achievement of the target both energy policy measures and a plenty of competing technologies can be applied. The contribution of power plants with carbon capture and storage (CCS) to the cost effective achievement of the climate target is determined by their CO_2 avoidance costs. Besides economic and technical development of CCS power plant technologies (Pre combustion, Post combustion and Oxyfuel), CO_2 avoidance costs are influenced by the costs and potentials for CO_2 transport and storage, which differ among European countries.

The study aims at analysing the perspectives of CCS power plant types (Oxyfuel or IGCC) in the European electricity generation sector under a European climate policy regime and to assess the impact of different CO_2 infrastructure options. Additional to the domestic storage of CO_2 enhanced infrastructure options are analysed, like the trans-boundary CO_2 transport for a cross-national cooperation for CO_2 storage and the establishment of a centralised CO_2 infrastructure in the North Sea for the use of large CO_2 aquifer storages (e. g. the Utsira formation)[1].

METHODOLOGY

The analysis is based on the Pan-European TIMES energy system model (short: TIMES PanEU), which is a model of 30 regions containing all countries of EU-27 as well as Switzerland, Norway and Iceland. The objective function of the model is the minimisation of the total discounted system costs over the time horizon of 2000 to 2050. TIMES PanEU covers on country level all sectors connected to energy supply and demand like for example the supply of resources, the public and industrial generation of electricity and heat and the sectors industry, commercial, households and transport. The model contains a comprehensive technology database including all technologies necessary for the assessment of the development of the energy system over the model horizon. In TIMES PanEU regional particularities are considered, e. g. country specific power plant decommissioning curves, potentials for the conversion of renewable energy as well as regional detailed cost potential curves for CO_2 transport and storage. [1]

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[1] The analysis is based on the results of the European research project “Analysis of potentials and costs of storage of CO_2 in the Utsira aquifer in the North Sea“, which was accomplished within the framework of the Fossil Energy Coalition (FENCO ERA-NET)

For the regionalisation of CO_2 transport and storage European power plant sites (>600 MW) and possible storages are analysed. In Europe up to 450 Mt CO_2 can be transported and stored at costs below 5 €$_{2000}$/tCO_2 and further 600 Mt CO_2 at costs below 8 €$_{2000}$/tCO_2. Saline aquifers represent the most important storage option with about 80 % of which 40 % are located offshore. Regarding emission sources, large coal based power plant site, like Jaenschwalde (Germany), Drax (UK) and Belchatow (Poland) profit from economies of scale for CO_2 transport, if they are equipped with CCS technology. [2]

RESULTS

Under a European wide climate policy regime following the 2°C target, the electricity supply sector faces comparably moderate CO_2 avoidance costs and contributes considerably to the achievement of the climate target. CCS power plants account for significant quantities of CO_2 captured in the countries of the EU-27 (0.5 Gt in 2030 and 1.1 Gt in 2050). Correspondingly, the installed capacity of CCS power plants in the EU-27 amounts to 80 GW in 2030 and 400 GW in 2050. The share of CCS power plants of total electricity generation increases from 13 % in 2030 to about 35 % in 2050 in the EU-27. Thereby trans-boundary trade of CO_2 can contribute to an effective use of storage capacities

For the neighbouring countries of the North Sea the connection to a central pipeline network and the use of the Utsira formation represent a cost effective option, if domestic storage capacities are limited (e.g. in the Netherlands) or the costs of domestic transport and storage increase to costs for the use of Utsira, like the case of the power plant site Longannet in the northern part of the UK. According to the domestic availability of CO_2 storages in the neighbouring countries of the North Sea, up to 0.3 Gt CO_2 in 2050 can be transported and stored in the Utsira formation. For German power plants located nearby the Dutch border, like in the Rhine-Ruhr-Area, CO_2 transport to the Netherlands and storage abroad represents a valuable option compared to domestic storage. For instance for the countries of the North Sea region, trans-boundary transport of CO_2 leads to additional capture quantities of up to 40 Mt CO_2 annually.

CONCLUSION

Based on the energy system analysis it can be concluded, that CCS power plants are a cost effective technology option for the achievement of the European long-term climate targets, contributing to a maximum of about 35 % of total electricity generation in 2050 in the EU-27. Enhanced CO_2 infrastructure, like the use of large aquifers in the North Sea via a centralised pipeline network (up to 0.3 Gt) are a valuable option, if domestic storages in the European countries are limited.

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