CCS in the European Electricity Supply System – assessment of national conditions to meet common EU targets (*Energy Procedia*, Elsevier, 2010).

Authors: M. Odenberger, J. Kjärstad, F. Johnsson

Abstract. This paper investigates the role of CO_2 capture and storage (CCS) technologies as part of a portfolio for reducing CO_2 emissions from the European electricity supply system until the year 2050. The EU Commission, gives targets on greenhouse gas emissions for the entire energy system and for the electricity generation system CO_2 emissions are regulated by means of the European Emission Trading Scheme (EU-ETS). Yet, the ability of different EU Member States and regions to facilitate and to benefit from CCS will most likely depend on local conditions in terms of current energy mix, fuel supply chains and distance to suitable storage locations. Thus, the aim with this study is to estimate the contribution from CCS and where such systems should be built. The analysis is based on modelling a scenario, with the aid of a technoeconomic model which is regionalized down to Member State level, finding cost-efficient investment strategies within the electricity supply system until 2050. The modelling is carried out for EU-27 at a member state level with differentiated assumptions on costs and availability of different electricity generation technologies. Special emphasis is put on the transition from the present system to a system which meets stringent CO_2 reduction targets, considering timing of new investments and technology choices. Thus, the existing capital stock (power plants) is included in the model through application of a detailed database, the Chalmers Energy Infrastructure Database, providing information on present and planned power plants (e.g. fuel type, capacity and age structure) down to block level. Assuming technical lifetimes for power plants in the database gives residual capacities remaining over the period studied, which together with new investments have to meet projected electricity demand. The scenario investigated estimates development under the current policy regime inflicted on the European power sector, such as integrated markets for electricity, CO_2 emission targets and trade with emission allowances, a joint European effort to meet targets for renewables as well as indicative targets of implementing efficiency measures to limit growth in electricity demand.
The scenario presented here assumes emission reductions within the electricity sector of 85% by 2050, compared to 1990 emission levels. The results show that in order to meet these goals, significant changes are required in the current infrastructures of the electricity-supply system. The challenge is not due to a lack of technologies – these are available at costs which should not be prohibitive for society and which, indeed, are expected from the EU Emission Trading Scheme (ETS) – but due to the large investment ramp-up required and to fuel-market implications as well as the institutional and logistical challenges (permitting procedures, matching CO_2 sources with sinks and establishing CO_2 transportation systems in-between). In addition, it can be seen that efficiency measures to reduce electricity demand are of great importance to reduce the strain in capacity ramp-up of CCS and renewables. Common targets on CO_2 emission

reductions point to differentiated strategy between member states. Thus, regions which currently have high carbon intensity and are located near suitable storage sites will benefit most from CCS implementation, whereas other regions have large potentials for renewable electricity generation (e.g. coastal areas with high expectations in annual average load hours for wind power). For this reason, this paper provides a European overview of how the aggregate system can evolve under the given assumptions as well as corresponding development in member states which should require building up a large CCS infrastructure.