Danish participation in the project "Analysis of potentials and costs of storage of CO2 in the Utsira aquifer in the North Sea - StorageUtsira

Final report

Grohnheit, Poul Erik

Publication date:
2010

Document Version
Publisher's PDF, also known as Version of record

Final Report

ForskEL Project Number: 2008-1-10266.

Danish participation in the project "Analysis of potentials and costs of storage of CO2 in the Utsira aquifer in the North Sea - StorageUtsira"

Risø DTU, Systems Analysis Division

Frederiksborgvej 399, SYS-110, P.O. Box 49, 4000 Roskilde.

CVR nr.: 30060946

Poul Erik Grohnheit, 17 May 2010

Introduction

The project is aimed at funding the Danish participation in the project "Analysis of potentials and costs of storage of CO2 in the Utsira aquifer in the North Sea – StorageUtsira" within FENCO-ERA, which is an EU network for national R&D activities in 13 countries in the field of fossil energy conversion and CO2 capture and storage.

The StorageUtsira project has studied the possibilities of CO2 storage into the Utsira formation and analysed carbon capture, transport and storage of CO2 from countries in the North Sea region into the formation. The following partners have been involved in the project:

- Institute for Energy Technology, NO (coordinator)
- University College London, UK
- Utrecht University, NL
- University of Stuttgart, DE
- Risø DTU, DK

The project have used the Pan European TIMES (PET) model and national MARKAL/TIMES models for the United Kingdom, the Netherlands, Germany, Denmark and Norway. Input data to the national models and a common regional model, covering all five countries were harmonised including cost and performance of fossil fuel based power plants. Analyses were carried out on both national level and regional (North European) level, and the model results were compared to study the advantages of a common European CO2 infrastructure in contrast with national infrastructures.

The potential capacity to store CO2 in the Utsira formation is very large. Thus, it is expected that the Utsira formation could be used as a CO2 reservoir for at least 20-30 years for several European countries. Therefore, the possibility of storing CO2 at Utsira needs to be assessed taking into account national CO2 reduction targets, temporal, and spatial aspects (e.g. availability and location of local sinks and CO2 sources over time).

Data sources

The main source for estimates on storage capacities was the database developed within the GETSCO and GeoCapacity projects. Data and maps for storage potentials and point sources in Denmark were received from GEUS. These estimates are subject to significant uncertainty, which follows from a set

of conservative estimates in the final report from GeoCapacity. For Denmark the conservative estimate is about one-fifth of the theoretical potential.

Final results and Conclusions

The future role of the Norwegian Utsira formation as a storage location for CO2 from North European countries depend on the actual properties of the formation, mitigation strategies, future energy costs, development of CCS technologies, public acceptance and political barriers.

The main limitation for the Utsira formation is the maximum annual injection rate for CO2. This is a stronger limitation than the total storage capacity. The literature show simulating results of CO2 injection up to 150 Mt per year in Utsira distributed over many wells and water production from the formation is necessary to reduce the pressure build up. Under stringent mitigation targets the requirement of annual CO2 capture can exceed 150 Mt per year in the North European countries. To obtain a better understanding of the limitation of the Utsira formation as a possible storage location for North European CO2, further research on the injection rate capacity is required.

The European CO2 reduction commitment is vital for the implementation of CCS technologies towards 2050 and the importance of CO2 storage in the Utsira formation. All national models (United Kingdom, the Netherlands, Germany, Norway and Denmark) have considerable differences in the CCS implementation dependent on the emission reduction targets. National models have been analysed with both 20% and 80% emission reduction on the EU27+ in 2050. For example in Germany the amount of CO2 captured in 2050 is 22 Mt/y with a 20 % emission reduction and 238 Mt/y with an 80 % emission reduction.

When comparing the modelling results from national and regional level, we find that modelling with different geographic scale have an impact on the results. This is a result of different input, e.g. the regional model cover international aviation and the national models only cover domestic aviation. The national models have also a higher level of detail on demand changes, technologies, taxes and policies, thus generates a range of difference in sectors, resources and measures to meet CO2 targets.

With a tight climate target storage of CO2 in the Utsira formation can be a cost effective option for North Europe. With an 80 % emission reduction target in 2050 up to 1.4 Gt CO2 will be captured annually in EU27+ in 2050 and the use of costly storages and long transport distances will be necessary. Under this condition the Utsira formation can be competitive and it represents a valuable CO2 storage option. According to the European model results CO2 transport to Utsira from outside Norway comes mainly from the UK (60 to 75 Mt/y in and 2050) and from the Netherlands (20 to 50 Mt/y in 2040 and 2050).

The United Kingdom profits from the comparably short transport distance to Utsira and the Netherlands utilise the Utsira formation due to limited domestic low cost storages. In Germany and Denmark the availability of domestic onshore saline aquifers determines the competitiveness of CO2 storage in Utsira. If these aquifers are not usable, Utsira gains a competitive storage option.

The price development of oil, natural gas and coal influences the role of CCS in the energy system. At a stringent emission target CCS is inter alia in competition with renewable and nuclear technology. Higher fossil fuel prices are in favour of the renewable technologies and lower energy prices is favour for the CCS technologies. Model results from the United Kingdom show that there is a competition between nuclear power and CCS technologies. When the energy prices increase, the power production

from coal-based CCS decrease and the nuclear power increase. Thus, the future role of the Utsira formation can depend on the political acceptance of future nuclear power in Europe. The utilisation of CCS technologies in a country will also be influenced by the national electricity supply options and the opportunity for cross-boundary CO2 transport.

For the CO2 transport to Utsira three different network layouts have been analysed. The analysis showed that electricity generation structure of the neighbouring countries of the North Sea is not influenced by the type of network but rather by climate policies. Different CO2 infrastructure layouts for the North Sea region primary affect the transported quantities of CO2 from the Netherlands to Utsira. The different infrastructures options have little impact on the CO2 storage from the other North Sea countries.

The deployment of a trans-boundary CO2 offshore pipeline will require an active participation and commitment from the national governments. It is a relative new topic and many organisational aspects are still unclear. A CO2 transportation network needs governmental support, suitable domestic and international legislation and a financial plan.

Main conclusions for Denmark

So far, there has been very little interest in CCS in Denmark. The technology is not a part of public policy, and the Government has not expressed any official standpoint on the use of CCS in Denmark. On the other hand, both the electricity industry and geologists from the Geological Survey of Denmark and Greenland (GEUS) have been active in international research on both capture and storage.

A very significant additional constraint for CCS in Denmark is the planned development of wind power, which currently covers some 20 % of the annual electricity demand, but is planned to increase to 50 % of the annual electricity demand by 2025. This will further reduce the need for base-load thermal electricity generation.

For the model analysis in the StorageUtsira project it means that the potential for CCS is becoming increasingly constrained. To model these constraints, it means that the Pan European TIMES model, which has a structure that is harmonised to meet the requirements for 30 European countries, must be calibrated in further details for give a proper representation of the constrained potential for Denmark.

It is unlikely that Denmark will need the CO2 storage capacity in Utsira within the time-horizon of the study. However, in co-operation with other countries around the North Sea the Danish potential for carbon storage may contribute to the build up of the long-distance CO2 transport infrastructure.

Disssemination and further model development

The partners have submitted contributions to conferences to be held during 2010 in the fields of CCS, energy modelling and energy economics.

The Danish country report and the common final report will be distributed to Danish institutions that have been active within the FENCO ERA network.

A Danish version of the Pan European TIMES model, which was developed as a part of this project and previous EU-projects will be used by the DTU Climate Centre, and data and results from the model will be made available for other energy models for Denmark and North Europe, e.g. Balmorel.

Common final report

Fidje, A, Espegren K, Wangen M, Seljom P, Strachan N, Blesl M, Kober T, Grohnheit P, Lüthje M, Hoefnagels R, Ramírez A, Wu Z, van den Broek M. “Analysis of potentials and costs of storage of CO2 in the Utsira aquifer in the North Sea – Final Report for the FENCO ERA-NET project”, April 2010.

Country report – Denmark

Grohnheit P, “Analysis and potentials and costs of storage of CO2 in the Utsira aquifer in the North Sea, Country report – Denmark”, Risø DTU, March 2010.

Other project reports

Wangen M, “WP1: Physical possibilities and constrains for CO2 storage in the Utsira Formation”, Institute for Energy Technology, IFE/KR/F 2009/152, September 2009

Hoefnagels R, Ramirez A, “Analysis of potentials and costs of storage CO2 in the Utsira aquifer in the North Sea, WP2: Assessment and harmonization of CCS related economic and physical performance parameters of the MARKAL and TIMES models”, Copernicus Institute, January 2010

Strachan N, “Analysis of potentials and costs of storage CO2 in the Utsira aquifer in the North Sea, Country report – United Kingdom”, University College London, October 2009

Hoefnagels R, Ramirez A , Broek M, “Analysis of potentials and costs of storage CO2 in the Utsira aquifer in the North Sea, Country report – The Netherlands “, Copernicus Institute, November 2009

Kober T, Blesl M: “Analysis and potentials and costs of storage of CO2 in the Utsira aquifer in the North Sea, Country report – Germany”, University of Stuttgart, February 2010

Seljom P, “Analysis and potentials and costs of storage of CO2 in the Utsira aquifer in the North Sea, Country report – Norway”, IFE, November 2009

Kober T, Blesl M: “Analysis and potentials and costs of storage of CO2 in the Utsira aquifer in the North Sea, WP4 Report – Regional analysis at North Sea Level”, University of Stuttgart, March 2010

Wu Z, Ramirez A, “Analysis and potentials and costs of storage of CO2 in the Utsira formation, Possibilities, Synergies and Conflicts for Building a Common CO2 Pipeline in the North Sea, Final Report WP5”, Copernicus Institute, NWS-E-2010-17, April 2010