CSLF-P-2004-14D
13 August 2004

POLICY GROUP

A REPORT FROM THE
LEGAL, REGULATORY AND FINANCIAL ISSUES TASK FORCE

CONSIDERATIONS ON FINANCIAL ISSUES (ECONOMIC MODELLING) FOR CARBON DIOXIDE CAPTURE AND STORAGE PROJECTS

Note by the Secretariat

Barbara N. McKee
Tel: +1 301 903 3820
Fax: +1 301 903 1591
CSLFSecretariat@hq.doe.gov

Note by the Secretariat

Considerations on Financial Issues (Economic Modelling) for Carbon Dioxide Capture and Storage Projects
Report from the Legal, Regulatory and Financial Issues Taskforce

Background

The inaugural meeting of the CSLF in June 2003 established a Legal, Regulatory and Financial Issues Taskforce. The Taskforce was asked to consider financial issues and subsequently presented a brief paper to the Policy Group in Rome in January 2004.

The Policy Group agreed to hold a workshop to discuss the development of the modelling on economic implications of carbon dioxide capture and storage and develop a forward work plan. The United Kingdom was nominated to take the lead on this issue.

The attached report is a result of the discussions held at the workshop in London in July 2004.

Action Requested

The Policy Group is requested to approve the report from the Legal, Regulatory and Financial Issues Taskforce and agree to a future work program for the CSLF policy group on economic modelling issues. Upon approval by the Policy Group, it is requested that the report be presented to the Ministers to approve the recommended future work program on Economic Modelling Issues.

CONSIDERATIONS ON FINANCIAL ISSUES (ECONOMIC MODELLING) FOR CARBON DIOXIDE CAPTURE AND STORAGE PROJECTS

The economic attractiveness of carbon dioxide capture and storage is dependent on both project costs of storage and costs associated with a country's policy and regulatory environment. Understanding how these two elements interact within an economy will be important for countries that wish to develop climate change policies that allow for carbon sequestration to be an eligible and realistic mitigation option.

At the Rome meeting of the Carbon Sequestration Leadership Forum (CSLF) policy group in January 2004, it was agreed that the United Kingdom take the lead on economic modelling issues within the Legal Regulatory and Financial Taskforce.

On 16 July 2004, at the CSLF Legal, Regulatory and Financial Issues Workshop in London, the session on economic modelling was chaired by the UK's Department of Trade and Industry. The aims of the session were:

- To learn about national experiences and views on the energy-economic modelling of carbon dioxide capture and storage technologies.
- To consider the issues and uncertainties associated with the techno-economic data needed to represent carbon dioxide capture and storage technologies in energy-economic models.
- To identify what the CSLF should do to support and facilitate future modelling of carbon dioxide capture and storage technologies.

The agenda for the session was structure accordingly with sessions covering

(a) presentations of national experience and requirements for energy-economic modelling;

(b) presentations on the issues involved in establishing consistent techno-economic data; and

(c) a roundtable discussion on what information the CSLF required from energy-economic modelling of carbon dioxide capture and storage technologies and what actions it should take to ensure the necessary work was undertaken.

National Experience: Views on the Modelling of CCS Technologies

Three presentations of nation experience were received with a report from the CSLF Secretariat.

1. Modelling the cost of climate change abatement (Department of Trade and Industry, United Kingdom)
2. Financial Issues: Australia's Perspective (Department of Industry Tourism and Resources, Australia.)
3. Economic Modelling of Carbon Dioxide Capture (Department of Energy, United States)

In addition statements on modelling work in progress were given by Canada and Germany.
To date most energy-economic modelling of CO_2 capture and storage has been undertaken at the national level. This has involved either systems modelling, in which carbon dioxide capture and storage competes with other supply and demand side options to provide energy services and reduced CO_2 emissions, or individual assessments of specific CO_2 capture, transportation and storage (source-sink) schemes. In both cases the aim of the work is to provide advice to national or regional policy makers on questions such as:

- What are the costs of CO_2 capture and storage schemes compared to other CO_2 abatement options?
- What are the implications for electricity generation costs of adopting CO_2 capture and storage technology?
- When will carbon dioxide capture and storage technology be needed as part of a long-term strategy for reducing CO_2 emissions?
- What is the likely size of CO_2 capture and storage deployment?
- How sensitive are the results to uncertainties over the cost and performance of carbon dioxide capture and storage and those of alternative abatement technologies?
- How will the prospects for CO_2 capture and storage be affected by different fiscal frameworks?
- What other impacts and collateral benefits may come from the deployment of carbon dioxide capture and storage technologies?

Delegates were also aware of broader models that examine energy and greenhouse gas abatement issues at the region (e.g. Asia Pacific) or global level. These models generally have a less detailed representation of energy systems, but provide the facility to address additional questions such as the variation in timing and size of deployment between regions, and the impact of global abatement measures like emissions trading. Examples of such models are POLES (European Commission), ECLIPS (Germany), AIM (Asia-pacific team) and the IIASA/World Energy Council model. Global models of this type were used to support the IPCC Third Assessment report.

Models can be classified into two broad types based on the way they are formulated and constructed. "Top down" models begin with assumed trends in macro-economic factors such as the rate of economic growth, population trends, patterns of trade, desired reduction in emissions, etc. and work downwards to project energy demands, costs and greenhouse gas emissions. Such models tend to represent technologies through cost-supply curve data, which can include implicit assumptions on improvements due to innovation that are based on historic experience. Such models are fine for examining alternative strategies for reducing CO_2 emissions, but they are limited for making detailed comparisons of alternative abatement technologies.

"Bottom up" models begin with a detailed representation of the technologies forming the current, and potential future, energy system, and examine how this will adapt to meet future demands for energy services (e.g. heat, mobility) and requirements for reductions in CO_2 emissions. This type of model is good for comparing technologies, and investigating the size and timing of their deployment. However, they are less good at looking at long-term change (i.e. beyond 2050) when there is considerable uncertainty over the cost and performance, and for that matter the identity, of the technology options to be included in the model.

The long-term projections derived from all energy-economic models entail considerable uncertainty linked to uncertainties concerning the future trend of macro-economic drivers such as GDP, population growth and social change, primary energy supply/prices and also the rate of technological advance. Consequently models should be regarded as useful tools for exploring alternative futures, the implications and interactions between different technologies and measures for abating CO_2 emissions, and variations between world regions rather than as predictive tools.

Issues and Uncertainties
Associated with the techno-economic data on CCS technologies

Presentations were given on the collection and analysis of technical and economic data characterising CCS technologies by two international programmes with considerable experience of this subject[1]: IEA Greenhouse Gas R&D Programme; and Carbon Dioxide Capture Programme.

Techno-economic data on CCS options have been produced by a number of design studies based on current technologies and designs. Several of these studies have been performed by engineering contractors using cost estimation procedures; as known technology is involved, confidence levels of +/- 25% can be achieved relatively easily and higher degrees of confidence with commensurately more effort. In addition it is necessary to estimate location specific factors (e.g. distance to existing infrastructure, site preparation) but there are tools available to do this too. Cost and performance estimates for future developments of these technologies have greater uncertainty because they involve assumptions on technical advances and improvements that may come from "learning by doing". CO_2 capture generally accounts for 60-70% of the additional cost of a CCS project but nonetheless it is important to have a full project costing in order to compare schemes.

Care is needed in comparing CCS costs from different countries because there are true variations reflecting differences in the costs of locally supplied elements of the project (e.g. civil engineering). There are also differences associated with the convention used for converting costs from one currency to another, taking account of price inflation, which would be minimised if a standardised method could be agreed. Also countries and organisations may use different discount rates and amortisation periods, reflecting national practices that can lead to differences in bottom line costs.

CCS technologies are generally compared in terms of their additional cost for electricity generation compared to non-capture technologies, or by converting this price differential into the cost per unit of CO_2 captured or abated. There are a number of possible variations on this approach that can lead to different results:

- Some researchers calculate the additional electricity generation cost by comparison with the same technology without capture. Others make this calculation relative to the existing plant that is expected to be displaced from the system by the capture plant. This can lead to quite large cost differences particularly if the capital cost of the existing plant is assumed to be written off.
- The cost of CO_2 capture is generally calculated from the difference in electricity generation costs and therefore is subject to the same variations as discussed above.
- CO_2 abatement costs differ significantly from capture costs because only a fraction of the CO_2 captured is actually abated. This is because capture is not 100% efficient and also because additional energy is used for the capture, transport and storage processes. These factors mean that only 50-75% of the CO_2 captured can be counted as avoided emissions (i.e. abated).
- Abatement costs are also sensitive to the generation technology they are assumed to displace from the system. Generally this is assumed to be the same technology without capture, but there are circumstances where this may be different. For example in some circumstances coal fired CCS technology may replace natural gas fired technology, in which case the level of abatement is less than if coal technology was being displaced.

Because results are sensitive to assumptions of this type it is important for these to be stated clearly in order to facilitate comparisons. Alternatively a standard set of assumptions may be specified (as done in the IEA GHG Programme) to facilitate comparisons.

Finally analysts need to be aware of other costs that are not generally included in engineering cost estimates, but may be important in determining the decisions of potential plant buyers and operators. These are transaction costs associated with such activities as regulatory and licensing procedures, costs of monitoring and verification to participate in policy measures aimed at delivering CO_2 abatement, and arrangements for long term ownership.

[1] The presentations and paper from the secretariat are available at: www.cslforum.org

Key concerns for the CSLF in economic modelling of CCS technologies

Discussion centred on what the CSLF required from economics studies and what needs to be done in order to encourage the necessary work to be undertaken. It was clear from the presentations and discussion that a lot of technical and economic modelling has been done, and is continuing, to examine national and global options for reducing CO_2 emissions. This work is organised and subject to peer review within other international fora (e.g. IPCC, IEA, Stanford Energy Modelling Forum), and therefore the CSLF does not need to take an active role in promoting model development and studies. However, there is a need for the CSLF, as the international body specialising in CCS technologies, to be involved in the representation of CCS technologies in the models and in the interpretation and presentation of the results obtained.

From this standpoint the following subjects were identified for action:

- Collect information on the work already done to model CCS technologies and the results and views coming from this work.
- Review the representation of CCS technologies in technical and economic models and suggest changes where necessary.
- Working from a CSLF perspective, draw from current modelling work the key results and issues affecting CCS technologies and present these to policy makers.
- Identify what additional modelling work is needed to address the key issues relating to CCS deployment as part of an overall global strategy for greenhouse gas abatement.
- Define the work needed to quantify the collateral benefits coming from the deployment of CCS technologies.
- Address the transaction costs involved in the deployment of CCS technologies.

ECONOMIC MODELLING ISSUES
FUTURE WORK PROGRAM

PRIORITY ISSUES	LEAD	TIMEFRAME
Commission a review of existing economic and technical modelling work examining greenhouse gas abatement to cover: • The representation of carbon dioxide capture and storage technologies in the models; • The results affecting carbon dioxide capture and storage technologies; • Key policy messages to be taken for the modelling work; and • Need for additional modelling studies.	Interested countries to nominate	15 months
Endorse the standard economic assessment framework developed by the IEA GHG Programme for use by the CSLF Technical Group when comparing the cost and performance of carbon dioxide capture and storage technologies.	Interested countries to nominate	18 months
Technical Group to undertake work to quantify the collateral benefits coming from the deployment of carbon dioxide capture and storage technologies.	Interested countries to nominate	12 months
Technical Group to undertake work to quantify the transaction costs associated with the commercial deployment of carbon dioxide capture and storage technologies.	Interested countries to nominate	15 months
Based on the results from above, arrange production of a paper for Ministers for the 3rd CSLF Ministerial Meeting highlighting the "big" messages affecting carbon dioxide capture and storage technologies that can be drawn from the modelling studies.	Interested countries to nominate	18 months