

# GEO ENeRGY

Promoting *R&D capability* in the service of European Industry

**CO<sub>2</sub>NET**

## The European technology-networking programme for CO<sub>2</sub> sequestration

CO<sub>2</sub>NET aims to plan, establish and build a European Thematic Network of experienced organisations and individuals in Europe, who are actively involved in CO<sub>2</sub> sequestration into geological storage and those on CO<sub>2</sub> capture and zero emission, to facilitate co-operation between these organisations and, in particular, the European-funded CO<sub>2</sub> projects.

The Thematic Network will enhance the performance and impact of the projects and increase awareness of European activities and results, so fast track the developing technologies to help meet Kyoto emissions reduction demands.

The CO<sub>2</sub>NET development programme included two Network-planning events. Statoil hosted the first of these, "Putting CO<sub>2</sub> Storage on the Policy Agenda", at its Research Centre in Trondheim in March 2001. This seminar brought together the technical and CO<sub>2</sub> mitigation policy advisory communities for informal discussions to gain an understanding of what further is needed to confirm in the policy advisors' minds that CO<sub>2</sub> sequestration is a safe and



verifiable mitigation technology option.

The second event was hosted by the Geological Survey of Denmark and Greenland in Copenhagen on 6 and 7 June 2001. The "CO<sub>2</sub> Technology Scenarios Convention" aimed to broaden the discussion across all disciplines in the field of CO<sub>2</sub> sequestration, from source to store or elimination, through **scenario building**. Technology gaps and areas for further research were identified and developed, building research teams for further research requirements.

The results from Copenhagen added the **multi-discipline perspective** to the gap analysis and draft technical plan developed at Trondheim for the Thematic Network objectives and future activities. Using the information from Copenhagen, CO<sub>2</sub>NET will develop a detailed 3-year technical and business plan for the Thematic Network.

A major assessment of this plan will be done during the third meeting to be held at the Dept. Of Trade and Industry in London on 26 September 2001. The final goal is to prepare and submit a Thematic Network proposal for EC FP5 funding for the final call closing on 14 December 2001.

CO<sub>2</sub>NET's initial partners are: **Technology Initiatives Ltd.**, **IEA Greenhouse Gas R&D programme** (IEA GHG), EU Energy-funded projects: -  
 • **Saline Aquifer CO<sub>2</sub> Storage** (SACS), managed and represented by **Statoil**, and  
 • **European Potential for Geological Storage of CO<sub>2</sub> from Fossil Fuel Combustion** (GESTCO), managed and represented by the **Geological Survey of Denmark and Greenland** (GEUS), and **European Commission**.

Twenty-five other organisations in nine countries have joined the existing partners as founders members

to develop the Thematic Network. These include: Air Liquide, Alstom Power, BGS, BP, BRGM, CGG, CSIC, Norske Veritas, Gaia, Gaz de France, Heriot Watt University, Imperial College London, IFP, Incoteco, Geological Survey Norway, NITG-TNO, Norsk Hydro, NOVEM, OGS, NGU, Quintessa, Shell Global Solutions, Texaco North Sea, TotalFinaElf, Utrecht University, Vattenfall AB.

Membership is open to the participants in EC funded and other relevant European CO<sub>2</sub> research and technology development, hydrocarbon producers in Europe, Europe-based power companies and heavy industry, potential storage operators in Europe and policy advisers in Europe. All will have existing expertise. International co-operation with CO<sub>2</sub>NET activities will be co-ordinated by IEA Greenhouse Gas R&D Programme.

If you are interested in information on sponsorship and participation, please contact CO<sub>2</sub>NET's project coordinator, Annette Cutler, Technology Initiatives Ltd on e-mail: [cutlerab@t-i.co.uk](mailto:cutlerab@t-i.co.uk) Further information can be found at [www.ieagreen.org.uk](http://www.ieagreen.org.uk).

## ENeRG fights for Geo-Energy Research Funds

**The EU 6<sup>th</sup> Framework Programme for RTD does not support European Policy on Energy and Environment according to ENeRG**

*While the EU will ratify the Kyoto Protocol – and the US will not – much of the technology to achieve results will be supplied by the Americans*

It is ENeRG's considered opinion that the FP-6 Proposal is not thematically balanced with respect to energy in the context of sustainable development and will therefore not properly address the actual and future energy needs of the European society in terms of:

**Security of supply of all energy source, sustainable development of all energy sources and competitiveness and economic growth.**

ENeRG particularly sees the need to invest in Research and Technological innovation for all energy sources, among which geo-energy will continue to play major role. Specific proposals are in the ENeRG's Position Paper summarised in the following pages.

# ENeRG main comments and recommendations regarding the EU Commission proposal for a new Framework program 2002-2006

ENeRG, the network of European R&D organizations active in geo-energy research, has produced a position paper with respect to the published 6<sup>th</sup> multi-annual Framework program 2002-2006 proposal (COM 2001/94 Final). These views are the result of discussion with members from all of the EU and are summarised below.

ENeRG welcomes many aspects of the proposition:

- Concept of the European Research Area (ERA);
- Creation of stronger links between the research initiatives at regional, national and European level;
- Concentration on a limited number of priority thematic areas;
- Emphasis on networks/centres of excellence and integrated projects;
- Participation of the developing countries in the Framework (FP) 6;
- The budget increase to 17 billion Euro and the desired scale of projects;
- Intention to increase SME's participation;
- Simplification of implementation rules and ensured flexibility;
- Support for researcher mobility and formation at all stages in a scientific career.

Nevertheless, ENeRG considers that the role of research for resolving the key energy-related issues has not been given sufficient consideration.

## Importance of Energy Research

The Green Paper "Towards an European strategy for security of energy supply", prepared by the Commission, provides several key statements in response to the observable fact of Europe's growing energy dependence.

According to the results of work carried out in the IEA Energy Outlook 2020:

- The gross energy demand in EU will be 25% higher in 2030 than in 1998;
- Oil and gas will remain the most important fuel with an expected share of more than 65%;
- Renewable energy penetration is projected to remain low and to fall short of the 12% target;
- CO<sub>2</sub> emissions are projected to exceed their 1990 level by 2010 and continue to increase thereafter at an increasing rate;
- The decommissioning of nuclear plant - as planned by several member countries - would make it even more difficult to tackle climate change in the long term.

In a reaction to the above scenario, the Green Paper solicits a wide debate and acknowledges the role of research and development. It is ENeRG's considered opinion that the FP-6 Proposal is not thematically balanced with respect to energy in the context of sustainable development and will not therefore properly address the actual and future energy needs of the European society in terms of:

- Security of supply of all energy sources;
- Sustainable development of all energy sources;
- Competitiveness and economic growth.

## Security of supply of all energy sources

As mentioned above, the Green Paper as well as previous energy forecast studies all predict diversity of energy sources and carriers. In each scenario fossil fuels is expected to remain the main energy source in Europe (more than 65% of the total).

Many studies agree that technological advances could postpone the sharp decline in North Sea production by more than 10 years (the duration of two FP's). This extension may be crucial to cover the period during which further technological development still needed for a wider use of renewable energies is achieved and provide the time for the expansion of a more extensive gas pipeline network in Europe.

Consequently, the development and integration of all these energy systems still require active and targeted research works in order to safeguard a continuous development of fossil fuel exploration, production, transport and conversion technology, in difficult areas, focusing also on unconventional fossil fuel production technologies.

## Sustainable development of all energy sources

The sustainability of improved energy production is enhanced by:

- Using energy more efficiently (increased recovery from existing resources, no energy losses). European RTD players and industry have already demonstrated considerable progress, but the potential for improvement is still very substantial. There is a direct and urgent need for Europe to build expertise on the use of CO<sub>2</sub> for improved oil exploitation, an area in which the USA holds total dominance so far.

•Development of more renewable energy sources (biomass, geothermal, wind, water, solar, tidal). In a number of member states as well as in several of the applicant countries, a considerable energy potential exists within low enthalpy geothermal sources. Although a fairly mature field of technology, renewed RTD focus could markedly improve the use of this environmentally friendly energy source in Europe.

•Making fossil fuel energy cleaner (conversion to H<sub>2</sub>, waste management, CO<sub>2</sub> sequestration). European RTD providers and industry are leading the development of knowledge and technologies for removal and storage of carbon dioxide from fossil fuel combustion. Storage of carbon dioxide in the subsurface has a huge potential at cost comparable to or less than alternative fuels. This option could very likely make it possibly to continue major use of coal, oil and natural gas without the greenhouse gas penalty. As the leading supporter of the Kyoto Treaty, the European Union has a special obligation in supporting development of a large portfolio of carbon dioxide reducing technologies for domestic and global application.

•Balancing supply and demand through flexible production and energy buffers (gas, heat, H<sub>2</sub>, CO<sub>2</sub>). With the introduction of wide-scale use of climate dependent energy sources such as wind and solar systems and with the increasing use of CPH technology, the need for daily and seasonal energy storage increases proportionally. This is a relatively new area of application, using the subsurface (i.e. old gas field, aquifers, salt caverns, etc...) to provide a flexibility which could markedly improve energy efficiency.

All these topics are examined in the Green Paper and their relevance acknowledged. EneRG is of the opinion that research and sustainable development in the energy field needs to be more strongly and largely stimulated by the EU, at a level no less than in previous Framework Programmes.

## Competitiveness and economic growth

Oil and Gas companies operate globally and use technology on the basis of suitability and price. They are generally reluctant to take risks and in today's markets do not support nor finance innovative technologies or research results that are not proven.

By contrast, the service and supply industries have problems in supporting such researchers and demonstration actions, primarily in Europe where they are mainly SME's. The role of the EC as a source of funds for applied research and development in the Energy sector has been pivotal in ensuring a leading role for EU industry in technological developments within the global market. Examples of this successful effort include the development of much deep-water technology, horizontal wells and some of the leading edge seismic methods.

Investment in research and development will also underpin the efforts of top research Universities and Institutes to train high quality graduates representing the future of an important sector as the energy industry.

#### **ENeRG proposal of a specific thematic area for Energy in the 6<sup>th</sup> framework**

ENeRG proposes that the FP-6 Objective should be expanded into "**Energy, sustainable development and global change**" and has recommended some specific amendments. These include:

- The definition of a clear program for research and technical development in the area of Energy, as embodied in FP-4 and FP-5, that reinforces the capability of EC to create an ERA in an important strategic sector;
- The acknowledgement of the great added value that definitive EU RTD action can provide to the Energy sector, which in Europe is characterised by: a) the service and supply industry primarily comprise SME's; b) well established networks developed between industry and research organisations, mainly arising from previous FP's (it takes at least 10 years to build such networks, but only one year without support to dismantle them);
- The support of the EU for the development of new technologies for energy that are more compliant with environmental issues will promote their use in the global market, thereby increasing the competitiveness of European industry, and ensuring a wider use of "environmentally better suited technologies". This strategy distinguishes the European philosophy in the field of Energy, from the current stance of the US Administration toward the Kyoto Treaty.

#### **ENeRG view of research activities having an impact in the short and medium term**

Reflecting the views and observations given above, ENeRG suggests for the consideration of the European Commission that the support for research and development within the Energy sector is maintained and that the contents of FP-6 is modified with a view to:

- A balanced and proportional focus on energy supply diversity: renewable, as well as fossil fuels, and hydrogen derived from these;
- Stimulate a further shift towards the use of natural gas and hydrogen as energy carriers with emission management for fossil fuels (CO<sub>2</sub> sequestration, and geological storage). ENeRG considers the most likely development of energy supply mix over time to become: Now, mainly oil and gas; Near future, not much change, but more use of natural gas and CO<sub>2</sub> sequestration from major point sources, probably starting as CO<sub>2</sub>-EOR and retrofitting of coal power plants; Future, hydrogen could become main energy carrier, generated from renewable energies as well as from fossil fuels (pre-combustion cracking of natural gas and from purposely designed coal and heavy oil power stations from which CO<sub>2</sub> is geologically stored);

- Address both upstream, midstream and downstream issues with the focus on integration and balancing energy systems through buffers.

ENeRG particularly sees the need for the new framework program to invest in the following geo-energy areas:

- Energy infrastructure, land and subsurface use and planning;
- More efficient and environmentally friendly fossil fuel exploration and production;
- E&P for subsurface buffers and storage for oil, gas, H<sub>2</sub>, heat/cold;
- E&P for energy residue sequestration.

## **The ENeRG News**

### **Update of Framework 5 programme.**

The last submission date for integrated projects under the Framework 5 programme is 14<sup>th</sup> December, 2001. The best strategy for ensuring continued research into geo-energy is the continued submission of high quality, relevant research proposals. This will send a signal that Europe leads innovation in this area.

Further information on FP5 is available at <http://www.cordis.lu/eesd/home.html> and associated links.

### **Next ENeRG meeting.**

The next meeting will be held in Vienna on 9th November. ENeRG will be inviting members from the research community in the developing areas of Europe to explain the concepts of Networks, to explain how integrated projects have worked and give an update on Framework 6 plans. Any interested parties are welcome to contact the ENeRG Secretariat: [energ@nitg.tno.nl](mailto:energ@nitg.tno.nl)

### **The new Framework programme: present status.**

The European Parliament (EP) will vote in mid-November in first lecture its report (written by G.Caudron) on the Commission proposal for the next (6th) PCRD. More than 300 amendments should be adopted. With regards to the thematic priority "Sustainable development and global change"(1.1.6), some of them are of interest for fossil fuel and CO<sub>2</sub> issues but none concern clearly oil and gas exploration and production fields. ([http://www.europarl.eu.int/committees/itre\\_home.htm](http://www.europarl.eu.int/committees/itre_home.htm)).

In a parallel way the Council of Minister of Research examines the Commission proposal in order to adopt a common position on next 10th December. Several key points like new instrument (integrated project and network of excellence) share are very discussed. Even if Energy and Transport issues have been reinforced, fossil fuels are still treated like a poor relation.

Anyway it is likely that the Council and the Commission will not adopt all the EP amendments and that the conciliation procedure will be used for a final text in the 2nd part of 2002.

# EU-R&D Project Profile : *CAT3D* A software tool for the *integrated tomographic inversion*

(Project No: OG/132/95 and OG/129/97 -THERMIE Program)

Seismic tomography provides a reliable velocity field in depth, even in areas on land characterised by structural complexities. This velocity field is an optimal input not only for the pre-stack depth imaging, but also for extrapolating the high-resolution well data in the surrounding space. This information is a basic tool for the exploration and production of hydrocarbon. Further applications include mining, civil engineering and hydrological prospecting.

Tomographic inversion of travel times allows estimating the seismic velocities in 3D for complex geological structures using conventional surface surveys and, if available, vertical seismic profiles, cross-well data and well logs. A tomographic analysis is particularly useful when the target is not well resolved by traditional tools, as it happens often for stratigraphic traps, faulted zones, dipping layers and strong inhomogeneities in the overburden.

OGS developed new algorithms for 3D tomographic inversion in irregular grids by using direct, reflected, refracted, diving and diffracted waves, both separately and jointly. This method was implemented in a software package named CAT3D, which is being



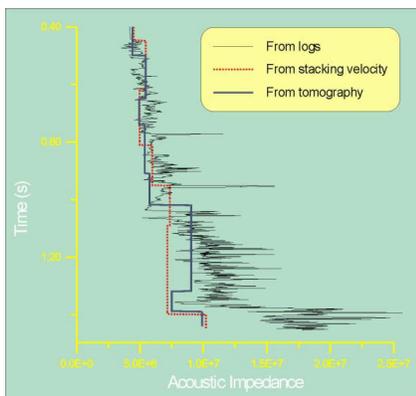
commercialised both as a software tool and by geophysical services.

A basic feature of the new method is the iterative fit of the local resolution. There are several factors that require such approach. First, the location of sources and receivers is rarely regular, because of navigation problems (at sea) or natural and human obstacles (on land). Secondly, the physical resolution of seismic waves depends on their local wavelength and bandwidth in the Earth, and thus on the anelastic absorption and velocity field itself. Thirdly, when most ray paths are roughly parallel, they cannot resolve well the velocity changes along that direction, because mathematical instabilities arise. Irregular grids allow removing the instabilities and non-uniqueness of solutions that characterise the conventional tomography.

The results obtained with real 3D data demonstrate the superiority of the tomographic approach with respect to conventional algorithms. For example, only seismic tomography can fully integrate different wave types, e.g. reflected and head waves. Since it does not assume a simple stratified Earth model, as stacking velocities do, it can handle more complex geological structures and local inhomogeneities.

Acoustic impedance is an optimal lithologic property for bridging seismic reflectivity (obtained by surface seismic) and rock parameters as local velocity and density (obtained by well logs). The variations of acoustic impedance in space and time can mark the limits of reservoir boundaries, since it is related to the rock saturation with oil, gas and water. The figure allows comparing the estimates provided by a conventional approach (red dotted line) with the tomographic result (continuous blue line) in the time domain. We see that reflection tomography can predict better this rock property in depth. In the upper part, up to 1 s, the differences between the two approaches are not relevant; in the lower part, the velocity obtained by coherency spectra fail to "see" a sharp step at about 1 s and a velocity inversion at 1.4 s. Both anomalies may be related to important lithological changes.

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