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GEO ENeRGY

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

EU FP7: Zero CO_2 Emission and Mineral Resources Technology Platforms

The 7th EU Framework Programme for R&D, which will run for 7 years from 2007, is in the process of being defined. In addition to identifying the most promising research areas, the EC is also focussing on creating strong links with industry. This is done through the creation of a number of European Technology Platforms (ETP) in key areas. The ETPs will assist the EC in the development of research and implementation strategies. In June of 2005 the Zero Emission Fossil Fuel Power Plant (ZEFFPP) Technology Platform was founded. It is steered and monitored by the Advisory Committee of 26 members representing industry and research across Europe. A Mirror Group ensures ties to national authorities.

Vision statement of the ZEFFPP ETP:

To enable European fossil fuel power plants to have zero emission of CO_2 by 2020

The ZEFFPP ETP is aimed at identifying and removing the obstacles to the creation of highly efficient power plants with near-zero emissions, which will drastically reduce the environmental impact of fossil fuel use, particularly coal. This will include CO_2 capture and storage, as well as clean conversion technologies leading to substantial improvements in plant efficiency, reliability and costs.

The Technology Platform will build on ongoing and new projects in the Commission's Framework Programmes and in member states and might also include a number of panels and initiative groups necessary to optimise its functioning and achieve the Technology Platform's overall goal. These activities will be complemented by new initiatives for public-private partnerships and linked to industry projects, when appropriate. The ETP was officially launched in Brussels on December 1, 2005.

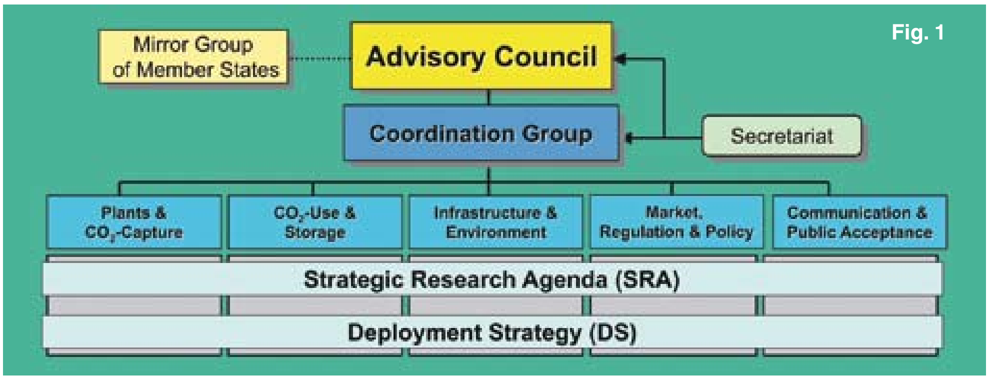

Fig. 1

More information is available at the dedicated website <http://europa.eu.int/comm/research/energy/nn/nn_rt/nn_rt_co/article_2268_en.htm> or at the ENeRG website.

On January 10, 2006 the Advisory Council of the ZEFFPP ETP established five work groups that will provide texts for the elaboration of two documents directed to the EC and the power industry. These documents, called Strategic Research Agenda (SRA) and Deployment Strategy Document (DSD) will give a complete overview on the current status of Carbon Capture and Storage (CCS) technologies, and provide recommendations for a route map, which will lead to a commercial deployment of these technologies by 2020.

Work Group 2 is responsible for the work related to 'Use and Geological Storage of CO_2' issues. It is composed of 22 members from different work areas, including oil and gas industry, power companies, equipment suppliers, NGOs and research organisations.

The group is lead jointly by Tore A. Torp from Statoil and Niels Peter Christensen from GEUS (Denmark). ENeRG is represented by its president Mr. Ludovit Kucharic (Slovakia) who will contribute with the ENeRG point of view to both documents.

Once the five work groups have completed their work the Advisory Council will compile and edit both documents, which are expected to be launched officially in July 2006. The documents produced by the ETP will serve as input and inspiration for the European Commission, when defining the contents and priorities of FP7 in the important area of CO_2 emission reductions from European power plants. Activities of the Technology Platform will continue after this date in order to implement a new strategy and to engage working groups for co-operation on EU 7th Framework Programme. The structure of the platform and the work groups is shown in Fig. 1.

ENeRG – European Network for Research in Geo-Energy

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ENeRG is also involved in the creation of a new Technology Platform on Sustainable Mineral Resources (SMR), which was officially launched on March 21, 2006. This Technology Platform initiative will hopefully result in a research agenda that will encompass the wide spectrum of essential mineral resources (metals, non-metals, minerals, building materials etc) as well as energy mineral resources as oil, natural gas and coal. The Technology Platform intends to contribute to the modernisation and reshaping of one of the fundamental pillars of the European economy and society: the European extraction and processing sector of energy and non-energy minerals.

Vision for 2030 by the SMR ETP:

- **Securing the future supply of / access to European raw materials;**
- **Supporting the revival of exploration of Europe's mineral potential;**
- **Developing innovative and sustainable production technologies;**
- **Implementing best practices;**
- **Reuse, recovery and recycling as well as new product applications;**
- **Creating European added value through R&D-based technology leadership, education and training, which could also be of benefit to developing countries, should the Commission agree to recognise the mineral resources sector in its development policy.**

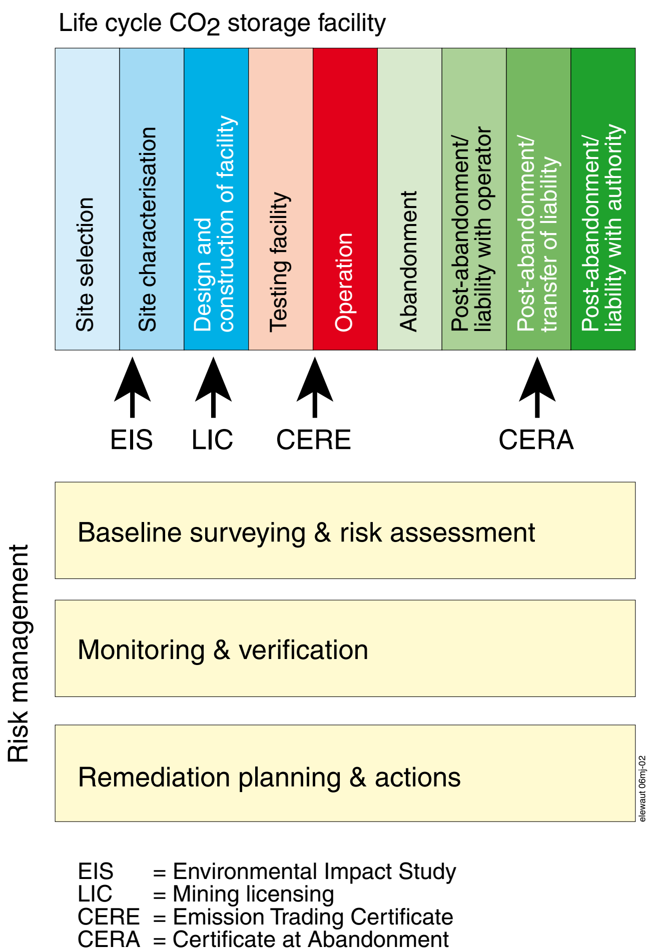
The SMR has organised a secretariat in Brussels. More information is available at the website <http://www.etpsmr.org>.

Roberto Martínez, Ludovit Kucharic and Niels Peter Christensen

CO2ReMoVe – a New European Research Project on Monitoring and Verification of CO_2 Storage

The CO2ReMoVe project will investigate ways of monitoring and verifying CO_2 injected into geological storage sites. This large project is partially funded by the European Commission's Sixth Framework Programme for Research, Technological Development and Demonstration Activities. The project started on the 1st March 2006 and over 5 years 30 partners from 12 different countries from all over the world will invest 15 million EURO in an effort to bring together all relevant research, industry experience and know how in the field of underground storage of carbon dioxide. TNO, The Netherlands Institute for Applied Scientific Research, coordinates CO2ReMoVe.

Since 1990, Europe and the European Commission have invested large research efforts in CO_2 geological storage, first developing inventories of possible storage sites and volumes, then building models to study the subsurface behavior of CO_2 and reservoir to help forecast possible problems, moving on to risk analysis at different relevant time scales. Since the start of the industrial-scale injection by Statoil, offshore Norway in 1996, the focus of research has shifted to monitoring the injected CO_2. Over the last ten years, experience has been acquired from large scale projects (Sleipner, Norway; Weyburn, Canada) and smaller, so called "subsurface laboratories" in Germany, The Netherlands and Poland. Two new geological storage projects (In Salah, Algeria and Snøhvit, Norway) provide the opportunity to build on this work.



The consortium of industrial, research and service organizations propose a range of monitoring techniques, applied over an integrated portfolio of storage sites in order to develop:

1. methods for base-line site evaluation;
2. new tools for monitoring storage and possible well and surface leakage;
3. new tools to predict and model long term storage behavior and risks;
4. a rigorous risk assessment methodology for a variety of sites and time scales;
5. guidelines for best practice for the industry, policy makers and regulators.

As a result an extensive range of monitoring datasets will be collected including repeat time-lapse seismic data, microgravity surveys, down hole fluid sampling, tracers, soil gas measurements. The project will use and adapt methods already developed independently for predicting hydrocarbon production performance and for predicting safety performance of stored CO_2. It will combine these methodologies in an industrial risk assessment, for all phases of storage, i.e. base line evaluation, operation phase, abandonment phase and long term monitoring and remediation.

In parallel, monitoring tools will be compared for generic monitoring. This will be combined with innovative tool development and tool optimization, for monitoring surface and atmospheric CO_2 fluxes, as well as for detection and measurement of CO_2 in the subsurface, allowing detection and quantification of CO_2 which may have migrated from the storage site and leaked to the surface. All of the research will be systematically integrated into an experience platform that will provide the basis for best practice guidelines in monitoring and verification of geologically stored CO_2.

The recommendations from these international efforts will form an important step towards a worldwide consensus in licensing and certification of the storage sites in different geological settings, including oil and gas reservoirs, coal seams and saline aquifers. The project will build towards a better understanding of how CO_2 can be stored and monitored safely for this will be disseminated to the public and policy makers. It will also provide the tools for quantifying and monitoring injected CO_2 required for geologically stored CO_2 to qualify for credits under the emissions trading mechanism.

Currently the project is applying for an extension under yet another call for proposals from the European Commission. The extension aims at introducing to the project a number of Targeted Third Countries for specific measures in support of international co-operation. The call addresses countries in the following regions: Africa, Caribbean, Pacific, Asia, Latin America, Mediterranean, Russia and new independent states, Western Balkans.

Emile Elewaut
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ENeRG Student Prize at EAGE/SPE Conference in Vienna

The steering committee of ENeRG has selected the EAGE/SPE Vienna Conference (12–15 June 2006) to present the new ENeRG Student Prizes worth 1000 Euro. The prizes for the Best Student Paper and the Best Student Poster will be awarded on the basis of the evaluations carried out by the EAGE. The awards will be given to the students who make the best contributions as primary authors of papers and posters in categories within the field of geo-energy.

EU and China to Cooperate on CCS

In November 2005 an EU delegation visited Beijing to discuss practical ways for collaboration on CO_2 Capture and Storage (CCS). The delegation was lead by the EU Directorate for Research and it also comprised representatives for European industry and research (Statoil, BP, Shell, Vattenfall, Alstom Power, Siemens, GEUS, TNO, Sintef).

During the preceding summer an agreement was made on Climate Change and this had been followed up by agreements on CCS negotiated by the UK Presidency of the EU, who were also represented at the meetings.

The purpose of the EU delegation meeting with the Chinese colleagues from the Ministry for Science and Technology and from several research institutes was to finalise the text for a Memorandum of Understanding for cooperation on CCS (subsequently signed in Shanghai on 20 February 2006). In addition, the basis for a joint R&D projects was established.

Subsequently on January 10, 2006 a joint EU-China proposal was submitted to the EU. The proposal named COACH will act as an extension to two recently commenced EU R&D projects: Dynamis (capture and infrastructure) and EU GeoCapacity (geological storage and standards). IFP will coordinate this new project.

Enhancing the production of methane gas from deep coal beds provides an opportunity to store CO_2 in an economically attractive manner, but is a very difficult technology still under development. With a view to further the research into this area TNO is leading a project group, which will also comprise Chinese participants. This project will extend research initiated in the RECOPOL project, testing the technology on coal beds in Poland.

Niels Peter Christensen & Emile Elewaut

Scottish Centre for Carbon Storage

The Scottish Centre for Carbon Storage (SCCS) was established in October 2005 with a £1.4 million budget, funded by the Scottish Funding Council (SFC) under Strategic Research Development Grant (SRDG). SCCS is a collaboration between University of Edinburgh (School of Geosciences), British Geological Survey (BGS) and Heriot-Watt University (Institute of Petroleum Engineering) who leads the project. The vision to create this centre was to establish in Scotland, a Centre of Excellence on CO_2 storage in geological structures challenges; extending the lifespan of Scotland's oil sector research skill base. Using skills and resources currently associated with oil & gas production, SCCS provides infrastructure and links to worldwide networks concerned with the emission of greenhouse gases.

This centre focuses its research activities on the likely solutions to the global warming impact of CO_2 emission by storing captured CO_2 through injecting it into a range of subsurface structures, i.e. saline aquifers, depleted oil and gas reservoirs and unmineable coal seams. Although these structures have the potential to store considerable quantities of CO_2 there are many challenges; for example in relation to predicting behaviour over a considerable time period, ensuring an effective seal to the gas, understanding reservoir carbon dioxide interaction, identifying suitable locations and monitoring and verification of stored CO_2. The aim is to employ interdisciplinary and/or multidisciplinary approaches in tackling challenges pertinent to CO_2 storage. This centre enables researchers across the research areas of these three institutes to use their expertise and facilities previously focused on various aspects of oil and gas field R&D to pump prime research activity in this critical area. An important aspect will be networking with researchers across the world also working in this area and communicating with a broad community this technical and social challenge.

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Fatosh Gozalpour

Introduction of New ENeRG Members

Geophysical Institute, NIS-Naftagas (Serbia and Montenegro)
www.nis-naftagas.co.yu
Geophysical Institute (founded in 1946) is part of the Exploration & Development department of NIS-Naftagas (Petroleum Industry of Serbia). The main activities of the Institute include: geophysical survey design and planning, data acquisition, processing and interpretation, R&D in exploration of oil and gas, mineral and groundwater resources and geothermal energy. The institute has applied expertise in gravity, magnetics, electric, EM, reflection and refraction seismic, thermometry, spectrometry and well-logging. The Institute has 163 employees, 59 have a university degree (4 with PhDs). Geophysical Institute has been involved in numerous projects in exploration and consulting both in Serbia and internationally.

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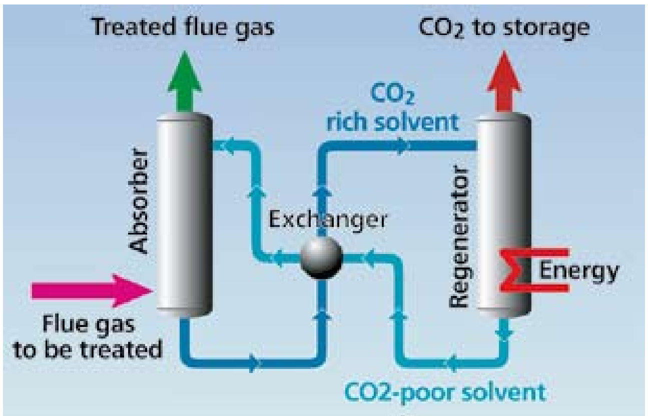
Inauguration of the Castor Project Pilot CO_2 Capture Facility

The pilot CO_2 capture unit of the European Castor project, coordinated by IFP, is being implemented at the Elsam power station in Esbjerg (Denmark). It is the first installation in the world to capture CO_2 in the flue gases of a coal-fired power station. The inauguration was on the 15th March 2005, and involved more than 150 participants.

The Esbjerg pilot unit captures CO_2 in the flue gases emitted by the power station: this is called „post-combustion" capture.

The flue gases to be treated are directed to an absorber, where they are mixed with a solvent. Having more affinity with the CO_2 molecules than with the other components of the flue gases (in particular nitrogen), the solvent captures the CO_2 (the solvent is „enriched") and the other molecules are discharged from the absorber (treated flue gases). The solvent captures nearly 90% of the CO_2 from flue gases.



The CO_2-rich solvent is then fed to a regenerator. The device is heated to 120 °C in order to break the bonds between the CO_2 and the solvent. The CO_2 is then isolated and transported to a storage site. The solvent, recycled to its initial form („CO_2-poor" solvent), is reinjected into the absorber with the flue gases to be treated.

The Castor pilot at Esbjerg takes up the challenge of capturing combustion flue gases at atmospheric pressure. The flue gases at this pressure have a low CO_2 concentration of approximately 10% when they enter the absorber.

To tackle the problem of a low CO_2 concentration, the type of solvent favoured is a member of the amine family. Amine solvents have two useful properties: they are effective at atmospheric pressure and resistant to corrosion. Over the course of the pilot stage, several different solvents will be tested. Their performance will be compared to that of the reference solvent used in the project: MonoEthanolAmine (MEA).

Another innovative feature of the pilot is that the regeneration system uses a very little energy compared with other systems. The amount of energy required is less than 2 billion joules (heating to 120 °C) per tonne of CO_2 captured. The operation of the pilot thereby reduces the generation of secondary CO_2 in connection with this energy production.

With 420 MW of power, the Esbjerg power station is host to a pilot installation intended to capture one tonne of CO2 per hour. The pilot is expected to halve the cost of capture from €50–€60 per tonne of CO_2 at current conventional CO_2 capture operations (in particular in Japan) to €20–€30 per tonne of CO_2 avoided. The process is being tested on a scale large enough to ensure reliable industrial extrapolation.

Georges Mosditchian

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ENeRG Position Paper June 2006

Energy from the Earth

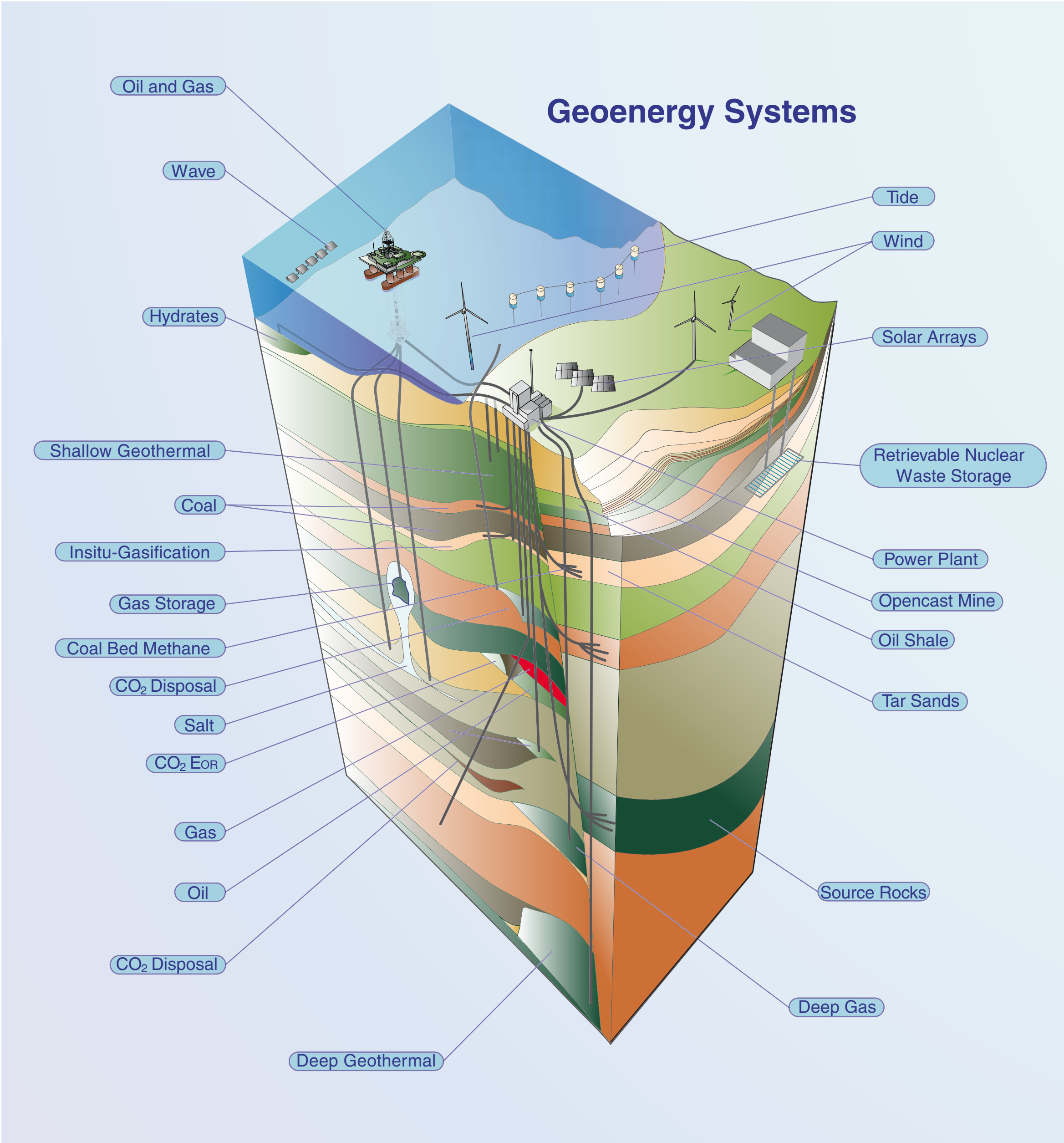
New Research Opportunities for Europe

Clever use of energy from the earth has driven our many industrial revolutions (coal, oil, gas and nuclear). Further research in the field of GeoEnergy is now needed to fully exploit the potential of and synergies between primary subsurface energy sources. Burning of fossil fuels has also lead to an increase in CO_2 in the atmosphere which is a major greenhouse gas and is contributing to global warming. Europe is a global leader in Carbon Capture and Storage and with large scale capture and storage schemes emerging, it is now time to once again invest in other primary forms of geo-energy resource research in Europe. GeoEnergy within Europe provides the comfort of energy security and nurtures a thriving small- to medium-sized enterprise (SME) sector. Energy technology is one of Europe's prime export sectors and there is surely a healthy demand projected for more advanced energy technologies into the future. Geoscientists in the 21st century need to think out of their 20th century boxes and a healthy research environment will attract the best talent to the energy challenges that our European society faces. Europe can provide significant global leadership in new sustainable geo-energy technologies.

It is likely that a large proportion of the CO_2 emission associated with fossil fuel usage for power generation can be mitigated by large scale carbon capture and storage. This underpins the need for sustained research into renewing the resource base and transforming the reserves supply. There are many aspects to geo-energy resources and many of these have been previously exploited in Europe. Future exploitation will need ever more sophisticated technology coupled with highly trained professional workforce. In the different geo-energy sectors this may include:

Coal: Easily accessible coal resources have largely been mined out in Europe. Deeply buried coal resources remain to be developed. They could potentially be exploited by using novel surface drilling techniques – in-situ gasification and utilising coal bed methane. There is also potential in Europe for Enhanced Coal Bed Methane Recovery by sequestering carbon dioxide in coal seams and increasing the yield of methane.

Oil: The search for subtle traps and difficult-to-image targets remain. The North Sea is now a mature oil province and the infrastructure could be further exploited and adapted to the requirements related to the exploitation of the remaining oil resources (i.e. the 40 % to 60 % oil left behind by the current prices and technological level). Large scale Enhanced Oil Recovery using captured carbon dioxide could increase reserves by 10–15 % from existing fields. In addition, Europe is well placed to support sustainable development of oil resources in more difficult settings such as the Arctic and deep-water environments. The use of geological structures to store oil and gas has not been fully exploited in Europe and these provide opportunity for strategic secure hydrocarbon supplies.



Gas: Deep gas and tight gas reserves with CO_2 disposal could further extend the supply of gas in Europe. Gas in non-conventional rocks (shale gas) is exploited in North America and further research into these unconventional gas resources in Europe could help retain more stable domestic supply. Huge gas resources are tied up as hydrates in the seabed of some marine areas and in arctic tundra. This gas could provide valuable energy if exploited with skill. Without exploitation it represents a serious greenhouse gas threat which could be released by continued global warming.

Heavy oil and tar sands: Most of these deposits are in Canada and Venezuela but there are also significant reserves under the North Sea (ca 10 billion barrels) and in Eastern Europe. The offshore location provides real challenges for exploitation. Maintaining a watching brief on these regions and adapting technologies for the offshore environment remain the key challenges. In-situ energy conversion of these hydrocarbon resources might yet be possible with a lower environmental footprint.

Oil Shale: Scotland was a major exporter of oil from oil shales in the 19th century and oil production from alum shales went on in Sweden until the 1970's. Today Estonia leads the way in developing these resources in Europe. If these resources can be developed in an environmentally acceptable way when close to major population centres, Europe has considerable resources to tap. Deeply buried source rocks might have additional resource potential and commercial in-situ shale oil production is being achieved in the US and may have potential in Europe.

Geothermal: Much of the European focus on the development of geothermal energy took place as a result of the high oil prices in the 1970's and 1980's and was driven mainly by cost. There is a renewed need for concerted community R&D to drive forward the wider use and application of geothermal energy as an environmentally attractive source of energy. Geothermal energy systems may often be combined with seasonal storage of excess heat from local electricity production or incineration of waste.

Nuclear: Characterisation of safe long-term geological storage sites is required whether or not there is a large-scale nuclear new build programme. If new nuclear build does return across Europe then each country will be seeking its own storage sites and each will require significant up-front research as each system will be "made-to-measure" as a function of the local geological threats and opportunities.

Renewables: There is potential for using the subsurface more effectively as a short term storage site for renewable energy – methods for capturing wind energy during high wind speeds and storing in a subsurface location for future usage (possibly via conversion to alternative fuels). There is also scope for using renewable technologies to extend the use of offshore and onshore facilities. Wind might provide energy which could be used in in-situ combustion of shale oil, coal gasification, tar sands, etc. These processes require sustained energy supplies and the lower environmental footprint is likely to be more acceptable by the public. In-situ processing and refining of the various hydrocarbon resources removes many of the environmental threats that occur at the surface and to the atmosphere.

Is There a Shortage of Oil and Gas?

The Story of Peak-Oil

In the past, the production capacity for oil and gas has always exceeded the demand. The few, usually short crises in price were mainly due to supply shocks as a result of political or social instability. In the last two years, production has levelled out while demand has grown rapidly in China, the US and India, making it difficult for producers to meet with the demand. As a result, the oil and gas market is a tense market, where the slightest disruption in delivery can have a major effect on the prices of energy (e.g. recent political tension in Venezuela, rebel activities in Nigeria, tropical storm Katrina, Gazprom closing the tap). In such a market, oil and gas prices are high and present a burden to economic growth and wealth.

Some experts believe, this market tension will be short lived, as extensive investments in oil exploration and production will lead to an increased production capacity. However, as it takes time for any investment to be implemented and become fully operational, higher prices could be here to stay for another 4 to 5 years.

Other experts argue on the contrary that oil resources are limited. All the large oil fields have already been discovered, that only small and complex fields remain to be developed and that hence, the oil production will reach a maximum and from that moment onwards will start to decline. This is called the theory of Peak Oil. It was first developed by M. K. Hubbert. Hubbert predicted that US oil production would peak in the late 1960's. He derived his prediction from the assertion that oil production and discovery follows a bell shaped curve (see fig. 1).

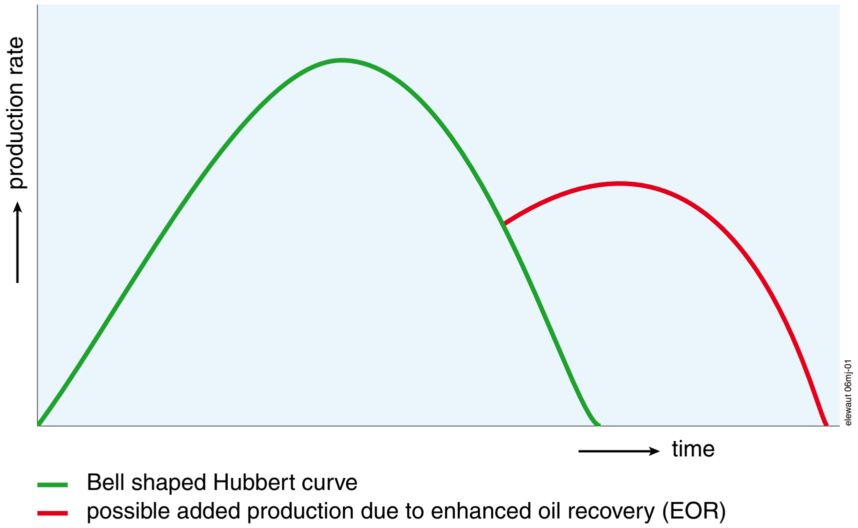


Fig. 1: Theoretical Hubbert curve. To the right, an extension represents the added recovery, as a result of the application of Enhanced Oil Recovery (EOR) techniques.

The explanation for this form of production curve is that the discovery of small amounts of oil in an area stimulates the further search for more discoveries. This adds to the reserves and the production capacity. Once all the major fields are found and brought into production, only smaller and more complex fields are left to be discovered. This adds only limited production capacity, and with time, the production will start to decline. This theory holds for a single well, a field, a region, the world. However, both the shape of the curve, as well as the total production, will depend heavily on the price and technology of the day.

The debate is on between optimists and pessimists as to whether peak oil has arrived, is imminent or is not to be expected for the coming 25 years. The International Energy Agency (IEA) maintains that there is no real reason for concern. Hydrocarbon resources around the world are abundant. The real issue is that investment is needed into projects to find new resources in technologically demanding areas such as the deep and ultra-deep sea, the arctic, or remote and difficult to operate areas. Even more investment is needed to turn these resources into reserves and bring this oil and gas, conventional or non-conventional, to production. The success of the quest for affordable energy will depend on three key factors: (i) Sufficient capital investment; (ii) Sufficient skilled human resources; (iii) Continuing technological progress. There is a role to be played for the industry, scientific research, the academia and the government to further the technological progress.

Major advances can be made, not only through finding new reserves, but also by developing new, more efficient techniques to bring non-conventional oil and gas to production (e.g. oil shales, tar sands, tight gas) as this would about double the present world hydrocarbon reserves. However, new forms of fossil fuel are still expensive but research can change that in the future, provided we invest in it.

At the same time, increased efficiency of the oil production process would have a major impact on the remaining reserves. On average, at the end of the commercial production life of an oil field, about 65 % of the oil in place is left in the ground, providing a huge scope for improved production methods. A 5 % increase in recovery worldwide would generate more reserves than presently available in the Middle East. But this will need considerable investments in research. Insufficient investments were made over the last decades, because we lived in a proven, comfortable energy status, where the need for a new paradigm was not obvious.

The industry and the research institutes have the means, the capabilities and the incentives to undertake the R&D, needed make certain that fossil fuel energy remains available and affordable after the start of the production decline and until the moment other sustainable energy forms become economically acceptable. Public policy should provide for a framework to stimulate investment in this job intensive economy. In the end, achieving a world, where in the coming 50 years, economic growth is guaranteed until sustainable energy resources are abundant and affordable, is not as daunting a problem as one may be lead to believe, when hearing about the peak oil theory.