# ENeRG Position Paper June 2006

# Energy from the Earth

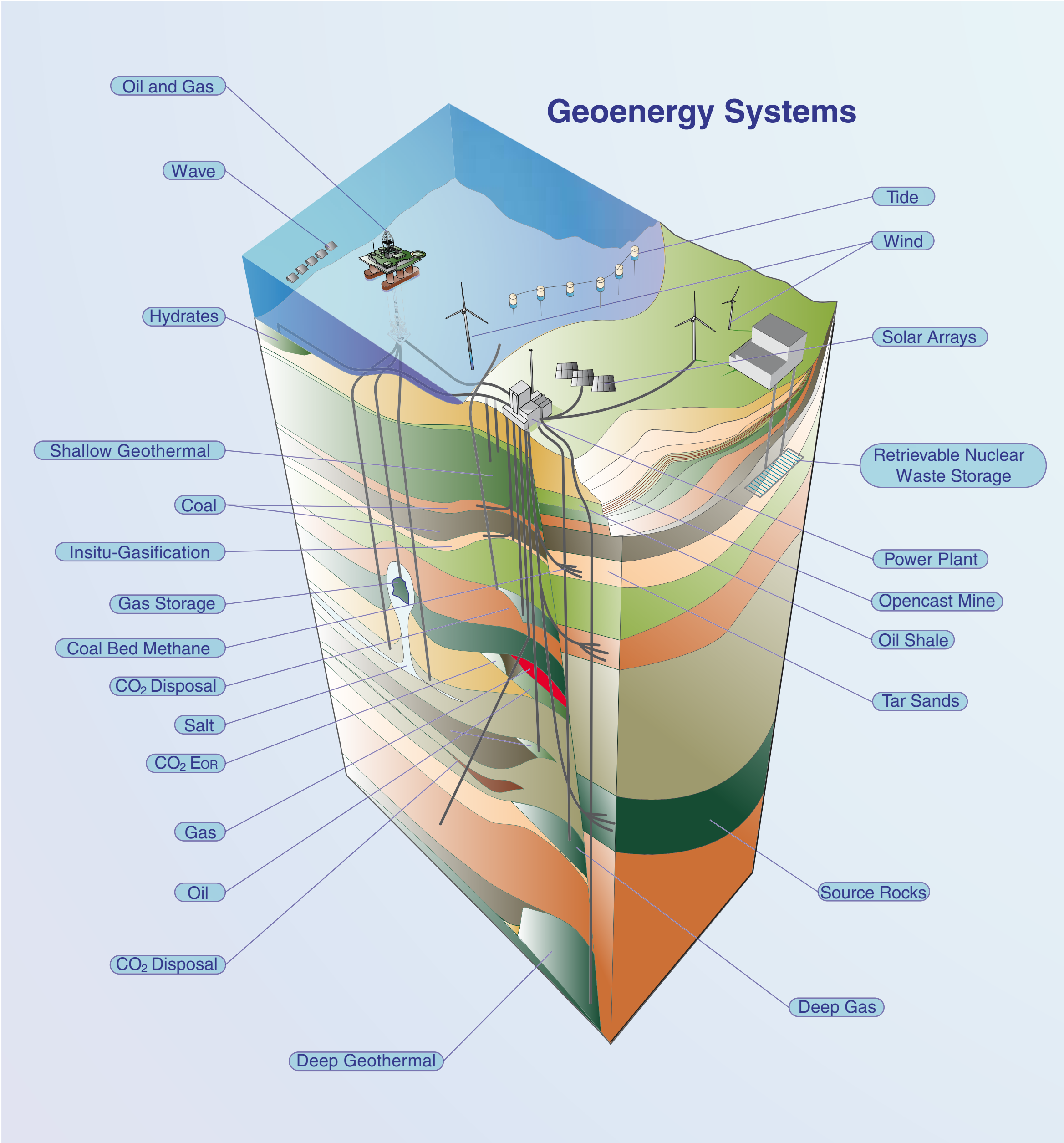
New Research Opportunities for Europe

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 21$^{st}$ century need to think out of their 20$^{th}$ 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 19$^{th}$ 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).

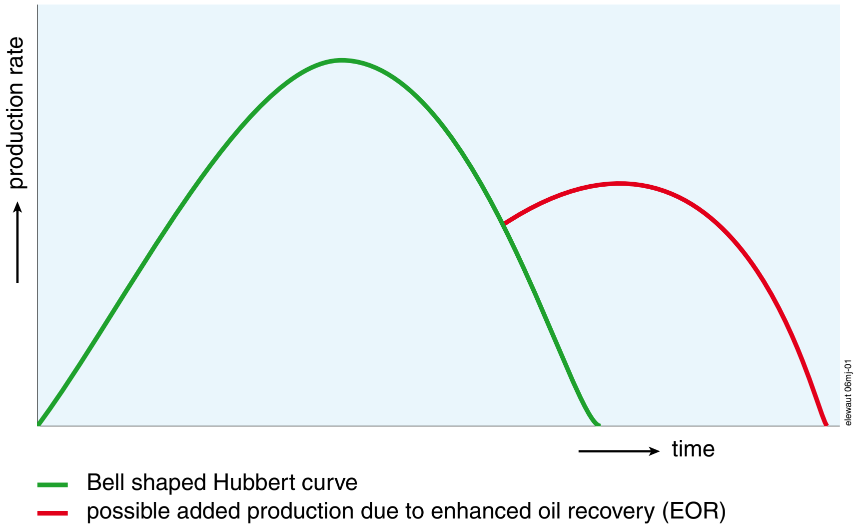



**Fig. 1: Theoretical Hubbert curve. To the right, an extension represents the added recovery, as a result of the application of Enhanced Oil Recovery (EOR) techniques.**

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.