REF

RENEWABLE ENERGY FOUNDATION

CARBON ABATEMENT TECHNOLOGIES (CAT): A STRATEGY FOR FOSSIL FUEL POWER GENERATION

28 October 2004

Carbon Abatement Technologies (CAT): A Strategy for Fossil Fuel Power Generation

The Renewable Energy Foundation

The Renewable Energy Foundation welcomes the opportunity to comment on the consultation prepared under the Cleaner Fossil Fuels Programme, *A Carbon Abatement Technologies Strategy for Fossil Fuel Power Generation*.

REF is a newly created foundation which has arisen from widespread and growing public concern that the current renewables energy policy is in itself unbalanced, and causing subsequent imbalances in the rest of the energy sector. The Foundation encourages the development of renewable energy and energy conservation whilst safe-guarding the landscapes of the United Kingdom from unsustainable industrialisation. In pursuit of this goal, REF highlights the need for an overall energy policy that is balanced, ecologically sensitive and effective.

The Renewable Energy Foundation is currently commissioning research and commentary from leading consultants and industry experts in order foster a full and informed debate. For further information see **www.ref.org.uk**.

While focusing on renewable energy technologies, REF recognizes that a non-confrontational relationship with fossil fuels is essential for reasons of economy and social responsibility. Many renewables are intermittent, some randomly so. Consequently, and for the foreseeable future, renewables must work in partnership with fossil generation. It is therefore essential that Carbon Abatement Technologies are developed as rapidly as is technologically and economically feasible.

Introduction

Given man's long technological acquaintance with carbon dioxide it is surprising to find, in 2004, the DTI remarking in relation to CO_2 capture and storage that "a number of countries now agree that it will be take around 10–15 years of research and development to bring some of the technologies to a point when they can be commercially deployed".

Bizarrely, and in contradiction of this remark, the Consultation Paper itself contains references to the DTI's first hand knowledge of Carbon Abatement Technology in use today in North America and offshore Norway. These projects harness in practical applications the very technologies that the DTI is suggesting need nearly two decades of further research. Carbon dioxide capture is well understood, and extensively applied, and it is difficult to see why it cannot be deployed in the UK in the near future if the government wishes to make positive progress towards achieving its commitments to CO_2 reduction.

CO_2 abatement can be achieved in different ways:

- Emissions can be **avoided** by the use of some predictable renewables such as hydro-electricity, tidal flow, solar or the use of nuclear power generation. However, low-value randomly intermittent renewables, such as wind-power, do not seem likely to achieve the reductions with which they are credited.
- Emissions can be **reduced** by using energy substantially more efficiently. For example, the use of high efficiency hybrid engines, combined cycle gas turbine systems, micro-CHP, fuel cells and renewables such as biomass and wind
- CO_2 can be **captured and stored** in geological strata. The CO_2 can also be utilised to extract additional crude oil from existing wells by Enhanced Oil Recovery (EOR) where the gas will remain in perpetuity

The prime objective of the Consultation Document is this last point – capture and storage although the others offer lower cost potential. The first step is CO_2 capture, a process well known to chemical engineers. The amine family of regenerable sorbents have been used for over 50 years especially in the oil industry. Rectisol, Selexol, DMEA etc. are all commercially available regenerable sorbents of CO_2. If very large volumes of gases are to be handled, then the industrial gases companies all have technology to separate and capture CO_2. While research may help to fine tune mass handling of gases, the fundamental principles are well understood by the process engineering professions

The DTI Mission to the US and Canadian facilities referred to in the text was followed by a further Mission to Australia. Both Missions are documented[1] and available on the DTI website. The DTI also published a report by Dr G Marsh[2] indicating the "win-win" merits of Enhanced Oil Recovery in the North Sea. The report predated by a year the recent increases in oil price which appear to create a substantial incentive to take advantage of storing CO_2 in old oil wells while simultaneously recovering more indigenous oil and the royalty revenue it brings to government.

The Advanced Power Generation Technology Forum and the ad hoc Working Group on Carbon Capture and Storage has also discussed the potential to use CO_2 for EOR in the North Sea with supporting evidence that indicates there is a window of opportunity to apply this technique before wells become too depleted. That time frame is well ahead of 2020. If the technology is available and a commercial application already exists that could benefit the UK in its aim of energy security and diversity, there appears to be no technical obstacle to the capture stage.

The issue of CO_2 storage has been well researched by the British Geological Survey whose data is also available to the DTI. With regard to the Regulatory Impact Assessment mentioned in the text, the assumption is made that the regime will take 5-10 years to be developed. Why? The Norwegians are already deploying the technology for the Sleipner

1 Carbon Dioxide Capture and Storage: Advanced Power Generation Technology Forum (DTI: Feb 2003). Carbon Capture and Storage: Research Development and demonstration in Australia a Technology Roadmap 2004 by CO2/CRC.

2 G Marsh, "Carbon Dioxide Capture and Storage: A Win-Win Option" (May 2003).

field and monitoring the security of storage. Australia is due to develop a similar scheme at Gorgon Project, Barrow Island where CO_2 will be removed from natural gas and the CO_2 stored. The USA and Canada are already deploying about 40 million tonnes CO_2/year for EOR. It is difficult to comprehend, therefore, why it should take so long to develop a regulatory regime designed to circumnavigate the OSPAR Agreement on pollution **at sea** when the issue is the storage hundreds of metres **under the sea bed** – especially if there are fiscal and energy security incentives to do so.

The rationale used on Page 8 that the USA and Australia are driven by the need to use coal cleanly whereas the UK is focusing on gas for power generation – a lower CO_2 – emitting fuel does not recognise the impact of growing European demand for gas on price. Coal gasification with CO_2 capture is a route that has become commercially viable in the USA. It could be used to re-power CCGT units in the UK.

Response to questions in the consultation document

Page 9:

i We agree that the technologies defined in Annex D are those relevant to UK energy supply

ii Yes, agreed

iii The UK's strengths include the presence of major companies with technical skills to implement the technology. The IEA Greenhouse Gas Programme is located in the UK and can offer guidance. The British Geological Survey had comprehensive knowledge of both the UK and the North Sea geology and the robustness of structures to contain CO_2. Access to the North Sea is a major advantage since substantial reservoirs are accessible from shore.

iv Vulnerabilities exist because overseas industrial competition benefits from governmental support. For example, President Bush has committed $1.2 billion to support the development of hydrogen, and is considering a further $750 million on a FutureGen programme to promote clean coal technology. Japan is also promoting clean coal gasification in relation to both combined cycle gas turbines and fuel cells.

v It is not advisable or adequate to leave technological development to other countries. As should be obvious, UK companies have the skills to introduce and showcase technology domestically prior to export.

vi The general benefits for the overall economy flowing from the support of reliable fossil fuel electricity supplies with lower CO_2 emissions should be obvious. At present renewables are costly, and this cannot be evaded, and any attempt to make a transition to substantial dependence on renewables, particularly randomly intermittent renewables could be damaging to the economy. Even short-term disruption to electricity supply, which becomes much more likely with the increased use of low-quality intermittent renewables, will have a disproportionately large impact on industry and the national infrastructure. On this view, the future of renewables is to some degree dependent on the economic benefits of CATs, since it

is axiomatic that if we are to develop high-tech cost-effective renewables in the future our economy must remain in a healthy condition.

vii In the longer term, hydrogen from fossil fuels may become a very important carrier for clean end-use energy. CO_2 capture incurs only a low cost increment when fossil fuels are converted into hydrogen via gasification.

viii **The main barriers to Carbon Capture and Storage (CCS) are not technical.** They are most likely to emerge from lack of understanding of the technologies by the environmentalists and the public, if they receive adverse publicity by ill-informed media reporting. A high profile media campaign by government and the industries involved could result in a win-win situation and thereby engender the full support of the environmentalist and public sectors. There may be some legal debate over the OSPAR Agreement, for example whether the geology under the sea bed is relevant.

ix A multi-group study is already in place to monitor the stability of CO_2 underground, for example at Sleipner, and could be used as a model.

Page 11:

i Since both fuels are important to preserve diversity of primary energy to the power sector, coal should be given equal weight to gas. Clean coal technology has been demonstrated in Europe and the USA. The outlook for gas availability and price will become progressively subject to pressures from an international market much affected by demand for Liquid Natural Gas (LNG). Europe and the Accession Countries all seek supplies of gas to meet tightening EU emissions limits. In this regard it is worth noting that the USA has already announced new projects to gasify coal for power generation via IGCC and the re-powering of combined cycle gas turbines that are uneconomic at current natural gas prices.

ii While studies on all major sources of CO_2 need to be undertaken to explore feasibility, it is probable that the brunt of any reduction programme will fall on a limited number of major fuel users. In some instances, the transport and domestic sectors are prominent examples, fuel efficiency measures is probably the only viable route to significant results.

iii Stakeholders include: power generators, major energy consumers, designers and suppliers, energy consulting companies, universities, and learned institutions (such as the Royal Society, the Institution of Mechanical Engineering, the Institution of Electrical Engineering, the Institution of Civil Engineering, the Royal Academy of Engineering, the British Geological Society, the Institution of Chemical Engineers, and the Royal Society of Chemistry).

iv The fundamental requirement of the CAT strategy is that it should be based on sound science and expert advice from the fields of chemistry, physics, and thermodynamics. It will embrace project development, engineering, economics, environmental impact, and legal aspects, most probably with international collaboration.

Page 13:

i Critical developments are needed in several areas but may be summarised under the general heading of higher efficiency in the use of energy. In the generation of electric power new designs for coal and gas power generators can and should be developed. These would include ultra super critical boilers with oxy-combustion, integrated gasification, and combined cycle systems. Techniques such as "recuperation" offer further advances on the steam cooled gas turbine CCGT technology currently on field trial at Baglan Bay. Since the USA, Japan, and China are making rapid progress in the development of fuel cells, and some UK companies are well advanced, fuel cell technologies should be pro-actively supported since they offer a pathway round the thermal limitations of heat engines.

ii The answer to this question hinges on Government energy policy. If the CO_2 targets are to be achieved without the replacement of nuclear capacity, then CCS on a massive scale becomes essential. If that is the case, an early start to the programme is vital. If gas emerges as 70-80% of the power generating capacity, the reduction targets would be met, but security and affordability of gas supplies would become major issues, and would highlight the need for gas to be supplemented by gasification of coal or other feedstocks. The BP Statistical Review of World Energy indicates substantial reserves of coal well distributed around the world. Coal offers a pathway to CCS.

iii CCS can only be one, albeit important, part of CAT. Combined heat and power in the UK has tended to be seen as district heating, but this is not always the case in the Nordic countries where local CHP generates heat and power from biomass, which is often wood. Fuel cells and gas engines can enable micro-scale CHP to develop, while the fuel gas could be produced via anaerobic digestion of agricultural or municipal waste, other biomass or natural gas. The Borough of Woking has achieved a 50% reduction in the Borough's own CO_2 emissions over the past 10 years and is an excellent example of the deployment of fuel cells.

iv Funding for international programmes in which there is only financial participation may not produce technological benefits for the UK. Truly cooperative programmes that involve UK scientists, engineers, technologists, and universities could be of benefit.

v The Annex D classifications are broadly correct. However, the House of Commons Science and Technology Committee were concerned at the fragmentation of money and effort through the diverse Research Councils. They also noted a decision-making process that slowed the allocation of funds. Other countries commercialise ideas more quickly, and this may be an area in which analysis might help to produce prompt action.

vi There appears to be a need to ensure industry is closely linked with university research, and that there is a clear business plan to move a new concept from laboratory to pilot plant and commercialisation in the shortest reasonable time.

Energy technologies appear less effective in moving from concept to commercialisation than companies selling mobile phones or computer technology. Lessons might be learnt by analysing the management process that lies behind these successes.

vii An early demonstration plant would certainly establish confidence in new technology and the environmental acceptability of CCS. However, in the field of gasification, which is a key CCS component, Dutch, German, and American companies are well ahead, and it may be difficult to make progress without licensing such processes. UK industry may still be able to create overseas business if it can be demonstrated that CCS is a truly global solution to CO_2 emissions control.

viii If UK targets are to be met, we need projects now, especially in view of the window of opportunity to use EOR on many North Sea wells.

ix Collaboration with other countries is clearly prudent provided the partnership benefits both parties evenly.

x **The technologies needed to make progress are available today. A delay of 10-15 years is unnecessary, and 3-5 years would be more realistic if CO_2 reduction is to be achieved. The barriers are not technical, but are created by the government's definition of incentives needed to stimulate investment and achieve the goals. A carbon tax may be the most effective driver.**

xi The CAT alternatives to which the Renewable Energy Foundation would draw attention are 1. reducing per capita energy usage through efficiency, and 2. the application of a broader spectrum of renewables, with particular emphasis on high value renewables capable of "firm" generation, and low-carbon or carbon-neutral bio-energies.

xii Government action must focus on providing scientifically sound facts about the options for CO_2 reduction. Current Advisory Groups (such as that for Renewables) are dominated by individuals with commercial and/or sector-specific interests, and make inadequate use of experts from the relevant professional organisations. This situation undermines credibility and gives undue prominence to environmental activists who wish, on grounds that are irresponsible and scarcely rational, to eliminate hydrocarbon from the energy chain in the name of "sustainability". Hydrocarbons will remain the prime source of global energy for some time to come, even if supplies of oil, for example, peak. There is, however, a pressing need to use hydrocarbons more wisely and efficiently, and this must be brought home to the public.

xiii The Technology Transfer and Export Promotion activities do not appear to have been converted into significant new business for UK industry. While China and India were seen as key markets, advanced coal projects have largely been based on Shell and Chevron/Texaco (now GE Energy) technologies. It is difficult to see serious rival technology emerging from the UK in clean coal usage but there is some strength in fuel cell development for example, Intelligent Energy and Rolls Royce.

xiv UK Government support would be appropriate in collaborative European monitoring programmes to ensure the stability of geological storage of CO_2. Assessment of the risk is vital before agreeing to significant storage in saline aquifers as large-scale leakage could cause rapid and potentially uncontrollable effects on the global atmosphere. Similar fears have already been widely expressed with regard to the escape of methane currently trapped beneath the earths crust as methane hydrate – deposits of which have been estimated to be larger than oil, gas and coal put together.

xv Emissions monitoring is fundamental to international transparency. International discussions are likely to raise many issues concerning the need to harmonise actions with points identified by the IPCC. Measurement standards need to be agreed to ensure conformity with treaties and carbon trading schemes scheduled to begin next year.

Conclusions

The Consultation Paper (and the Energy White Paper) has focused on power generation. While this sector offers the most effective point for capture and storage, reduction in CO_2 emissions needs to take place in other sectors in parallel with power. Nevertheless, the power sector could make a significant contribution to CO_2 emissions reduction through the gasification or oxy-combustion of coal. Gasification could lend itself to co-conversion of coal and biomass, a process about to be used in the Netherlands.

Recent increases in the price of crude oil create an economic framework for Enhanced Oil Recovery in the North Sea. There is little prospect of significant reduction in crude prices because of growth in the developing countries, so the UK could benefit by extending the use of its indigenous supplies while storing CO_2 in perpetuity. Application of the technology could be financed by the Treasury via a reduction in royalties required of oil companies employing EOR. The potential is highly significant: **BP has predicted a twenty year life extension for the Forties field alone. This not only gives the Treasury an additional cash flow for 20 years, but defers the payment of decommissioning costs to the well operators.**

The DTI is already aware that effective CAT technology is being used in the USA, Canada and Norway, and these proven techniques can be equally well applied in the UK if the incentives were put in place to stimulate investment. Deferral until 2020 is needless and would constitute an appalling missed opportunity. Progress in the near term will create the confidence needed in technological solutions to CO_2 abatement for wider application in future.

28 October 2004

Renewable Energy Foundation, 3rd Floor, Beaumont House, Kensington Village, Avonmore Road
London W14 8TS 0207 605 1100