



Progressive energy

The Energy Review 2006

**Our Challenge - Securing Clean Affordable Energy for the
Long Term**

Response to Consultation

from

Progressive Energy Ltd

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Background

Progressive Energy is an independent UK clean energy project development company. The company and its principals have direct experience of many energy technologies including gas CCGT, wind, biomass, energy from waste, coal with carbon capture and storage and nuclear.

Progressive is a project development company and as such is in principle technology agnostic, committed to developing and providing plant that best matches the future market need and regulatory position. Against this business approach the company maintains a forward view of the market, developing plant to meet future needs. The Progressive Energy submission to the 2002 Energy Review identified many of the drivers and issues recognised as of concern including the shortfall in UK gas production and the dependence on imports, the rapidly growing need for replacement generating plant over the next 10 years and the fall off in UKCS oil production.

Q1 What more could the Government do on the demand or supply side for energy to ensure that the UK's long term goal of reducing carbon emissions is met?

- Energy investments are long term capital investments with typical lifetimes in excess of 20 years. The policy fixed in this energy review will condition the investments to be made over the next 10-15 years and as a comparatively high percentage (perhaps 30%) of the UK energy infrastructure requires replacement on this timescale the review will in effect determine the shape of the greenhouse gas emissions profile associated with the energy sector for decades thereafter.
- Should there be no change in policy in the short term allowing continuing uncertainty over government policy intentions, investment decisions will inevitably be delayed, resulting in a situation where the very large near term opportunities for reducing carbon emissions are deferred. This situation arises as no utility or oil and gas company has an obligation to supply and, as avoiding carbon emissions generally comes at a cost, will only invest in low carbon technologies and in the UK if it compares favourably with possible investments in other technologies and countries. The one exception to this is the renewables sector where the commitment to maintain ROCs until 2026, the setting of increasing obligation targets on supply businesses and a clear policy to protect this market segment continues to underwrite investment.
- However the growth rate of renewable generation is comparatively low and hence the carbon substitution secured is similarly limited. Additional approaches that offer the potential for major cost-effective carbon savings are required. One such technology is available for implementation now. This is clean coal incorporating carbon capture and storage (CCS). A number of specific projects, including an 800MWe project by Progressive Energy, are already under development. A policy commitment by government is required for this, and similar projects, to proceed. The effect of delay would be for the UK to emit greenhouse gases unnecessarily for the delay period and given the UK's leadership position in promoting low carbon strategies worldwide the compounded effect could be very

substantial. The Progressive 800MWe project alone will capture and dispose of 5Mte carbon dioxide per year and the electricity produced is equivalent to that from over 2000MWe of wind generation. There is an urgent need for clear policies that reward the introduction of such ultra low carbon emission technologies. Specific proposals are given in the answers to other questions below, particularly question 4.

- The default, and up until now preferred new plant, has been gas CCGT. This resulted from the availability of large quantities of gas from the North Sea, often associated with oil fields in the early 1990s. Supply exceeded demand resulting in low prices making gas CCGT an attractive investment option. The UK now relies on imported gas. It does not seem to yet be generally recognised that increased reliance on imported gas comes at a price in environmental terms as well as potentially impacting on energy supply reliability. Imported gas reaches the UK as LNG or in some cases after transport in extremely long pipelines. The gas liquefaction process utilises energy and further energy is expended in maintaining the LNG at the very low temperatures required. The result is that more than 25% of the available energy is expended before the gas is used in the UK. This energy use results in CO₂ emissions to the atmosphere. The overall result is that the true greenhouse gas emissions from gas CCGT in the UK using imported gas are comparable with those from a modern efficient coal power station – such as those being constructed in the US and in China. If the coal plant incorporates CCS then the result is ultra low emissions very much lower than from gas CCGT.
- It is technically possible to capture CO₂ from gas and hence to operate a gas CCGT with ultra low emissions. However as gas has low carbon intensity compared to coal and the cost of CO₂ capture is very much higher for gas than it is for coal. Several studies have shown this and indicated that CO₂ from gas are ~£40/te whereas capture costs from coal (using pre-combustion capture) are ~£10/te
- The conclusion here is that environmental policy should recognise that
 - Major projects using coal with CCS can be implemented now, and that investment can be secured for such projects if government introduces a suitable policy commitment.
 - Such projects can produce very sizeable CO₂ abatement. Consideration of over 2500MWe of projects has been announced by a number of industry companies. 2200MWe of this is coal with projects by Progressive, E.ON, and RWE and 350MWe is gas by BP/SSE. If built these projects could abate ~15Mte pa. of CO₂ if they replace existing plant that uses the same fuel.
 - These initial projects, given an appropriate policy environment, could result in follow on CCS projects to replace closing generating plant. At least 1500MWe per annum is appropriate to the plant replacement need and is technically deliverable. Such a programme with investment decisions made starting in 2007 would deliver its first savings in 2010 (at the end of the plant construction) and by 2015 would deliver 40Mte pa reduction in carbon emissions. This is material on any criterion and it follows that very serious consideration should be given by government to

encouraging the development of such a programme. The issues involved are discussed in answer to question 4.

- The balance between coal and gas generation requires consideration. The expectation is for the closure of more coal than gas plant potentially reducing fuel diversity. The impact of greenhouse gas emissions occurs irrespective of where in the world the emissions occur and in weighing the relative benefit of supporting gas or coal CCS technologies Government should take a global view of emissions and recognise that generation using imported gas is associated with substantial emissions before the gas arrives in the UK and that as a result its subsequent use to generate electricity is thus associated with specific emissions approaching those from unabated coal.
- Carbon capture for gas CCGT is expensive compared to pre-combustion capture for coal and the true specific emissions are only partially abated should CCS be fitted to the generating plant. This together with concerns on reducing energy security as the UK dependence on imported gas increases forces the conclusion that the use of imported gas for power generation should not be encouraged.

Q2 With the UK becoming a net importer and with big investments to be made over the next twenty years in generating capacity and networks, what further steps if any should the government take to develop our market framework for delivering reliable energy supplies? In particular, we invite views on the implications of increased dependence on gas imports

- The Energy Review paper rightly recognises the growing dependence of the UK on imported gas and the uncertain global politics associated with global energy markets going forward. The risk of physical supply shortages can be mitigated to some extent by seeking diverse supplies, at least in the short to medium term. However as world supply-demand tilts further in favour of producers, in the medium to long term, the UK will have to compete with other markets for gas. This competition arises as LNG tankers from anywhere in the Atlantic basin, say the middle east, are not tied to specific markets and can be diverted elsewhere. The link between the European and US markets in terms of gas prices has already been identified and this linkage will strengthen in the coming years suggesting that gas prices will be high and potentially volatile, exhibiting similar characteristics to the oil market. In addition some producer countries may choose to use their supply position to achieve political objectives. Against this background it is strongly recommended that Energy Policy seeks to avoid increasing dependence on imported gas to minimise exposure to these risks.
- Gas is certainly a flexible fuel to use domestically and is required for some industrial processes. However it is far from clear that its use for electricity production should be further encouraged. The current split in generation capacity between gas, coal and nuclear with a growing renewables tranche has much to commend it given the uncertainty and unpredictability of energy markets in the medium to long term.

- As up to 30% of existing generation capacity will require replacement over the next 10-15 years there is an opportunity to limit the further growth of gas generation, encouraging coal for which the UK has significant indigenous reserves and which is available from diverse sources internationally often from politically stable parts of the world. For example most CHP plants utilise gas and currently new plants are actively encouraged by a support package giving Enhanced Capital Allowances and exemption from the Climate Change Levy. Whilst improved resource utilisation should always be encouraged, support for gas, even efficiently used gas, may not represent the most appropriate policy either from an energy security viewpoint or indeed from an environmental viewpoint.
- Clean coal with CCS is a clear choice as this can be provided in bulk today. The potential to provide maybe 8000MWe by 2015 was discussed in answer to the previous question. However this potential will not be achieved as, without a realignment of energy market fiscal and other incentive structures, investment in such plant will not be preferred.
- Residual waste is currently a much undervalued indigenous energy resource. The waste policy has focussed on disposal rather than efficient use of an energy resource. Such residual waste fuels are 50%+ biomass and hence have the potential to provide carbon neutral generation. Modern gasification processes are emerging that provide approaching 40% conversion efficiency and the resource available could exceed 10Mte pa indicating the potential for ~4000MWe of generation from this source. Unfortunately the recently proposed changes to the Renewables Obligation now allow incineration plant to secure ROCs under some circumstances providing an alternative investment in competition to the much more efficient emerging technologies, hence the current policy is very unlikely to capture the potential of the waste resource.
- The second key issue in terms of reliability of energy supplies is associated with the decline in UKCS oil reserves. 98% of UK transport relies on oil and a growing exposure to the world oil market is to be expected. The events of the past 12 months illustrate the brittle balance between world oil supply and demand now and it is clear that world demand can only be sustained by seeking to exploit more and more expensive reserves. Price volatility with sustained high prices on a rising trend are to be expected. The emissions from the transport sector already form a high percentage of UK emissions and show no signs of falling. Energy policy can respond to this situation in two main ways:
 - Seek to enhance oil recovery from UK oil reserves
 - Seek alternatives to oil for transport.
- Carbon dioxide injection into oil reserves can mobilise otherwise unrecoverable oil and enable it to be extracted. This technique of tertiary recovery is well established worldwide with ~25Mte pa of CO₂ injected for this purpose in US oil fields. Studies by Progressive and others have demonstrated the potential for this technique to be applied in the North Sea. This is a mature oil province and requires CO₂ in increasing volumes from now onward as fields approach the end of life. Three separate projects are under active consideration: by Shell/Statoil, BP and Progressive Energy. However the use of this technique for oil recovery is limited by the availability of CO₂ in bulk. The recovery factor per tonne of CO₂ is

oil field and process dependent. A recovery of 1 to upwards of 3 barrels of oil per 1 tonne of CO₂ injected should be used as a guide. Without use of this tertiary recovery technique oil will be unnecessarily left when the field becomes uneconomic and is abandoned.

- Introducing coal plant incorporating carbon capture thus provides a triple benefit if the CO₂ is used to enhance oil recovery:
 - Reliable energy supplies are underpinned by providing fuel diversity avoiding an overdependence on imported gas
 - Major CO₂ reductions (perhaps 40Mte CO₂ pa by 2015) are secured quickly
 - The maximum benefit is secured from UK oil reserves minimising and delaying the dependence of the UK on imported oil: If half of the CO₂ captured from suggested tranche of coal plant with CCS referred to above (viz 20Mte pa) were used for Enhanced Oil Recovery then this would be expected to yield 20-50 Mbarrels of oil per annum for a 15 – 20 year period. Hence the effective increase in UK oil production might be in the range 300-1000M barrels
- CO₂ capture in the context of electricity generation may be either pre or post combustion. In the former case the process involved naturally produces a hydrogen rich synthetic gas which is combusted in a gas turbine to produce electricity. This is the case for the Progressive project at Teesside which produces ~40 te hydrogen per hour. Hydrogen will also produced in bulk by the BP/SSE project at Peterhead (by a different process). This is a major source of fuel given that a hydrogen powered bus utilises ~5te pa. Given CCS, hydrogen produced in this way could over time become a major source of 'green' fuel for use in the transport industry as an alternative for oil based products. It may be used in some diesel engines now and in the longer term fuel cells may be taken up in transport applications. The availability of a major supply of hydrogen at a reasonable price is a key ingredient if this is to happen.

Q3The Energy White Paper left open the option of nuclear new build. Are there particular considerations that should apply to nuclear as the government re-examines the issues bearing on new build, including long term liabilities and waste management? If so what are these and how should the government address them?

- New generation plant is capital intensive and the economics of the investment are improved by high utilisation of the capital plant. As a result high load factor operation is sought for most new plant – whether this is coal, gas or nuclear. Without it in many cases the investment cannot be made economic. The base load segment of the electricity market is limited and in particular new nuclear will compete with new coal for space for base load operation. As plant ages and its capital costs are written down part load operation becomes the norm and indeed this is the case with the existing coal plant – when first constructed it operated at high load factor but has become 'mid merit' plant as the plant has aged. Any consideration of economic support for nuclear or for coal with CCS must recognise this market dynamic.

- Coal plant with CCS can be operating by 2010 with a growing tranche of plant from then on. This is well ahead of the timescale possible for nuclear plant and matches the urgency of the need – the alarming rate of climate change, the need for replacement generation and the timeliness of having bulk CO₂ available to enhance oil recovery

Q4 Are there particular considerations that should apply to carbon abatement and other low carbon technologies?

- As has been discussed above coal generation plant with CCS can be developed now. A number of generation and capture technologies are under consideration for real projects:
 - Progressive are developing an 800MWe Integrated Gasification Combined Cycle (IGCC) plant that gasifies coal and separates the high pressure CO₂ produced prior to combustion of the remaining synthetic gas in a gas turbine.
 - BP and SSE have proposed removing the carbon from natural gas again pre-combustion using reacting methane with steam in a ‘steam methane reformer’ in a gas turbine plant of ~350MWe
 - RWE have recently announced consideration of a 1000MWe supercritical coal plant with post combustion capture of CO₂
 - E.On have also announced consideration of a ~450MWe coal plant with CCS

These project proposals underline that the technology has reached the stage where commercial scale projects are under active consideration now and also indicate the willingness of industry to consider such plants.

- Nevertheless CCS is clearly to be characterised as ‘Emerging Technology.’ Whilst some large scale capture plant is operating (eg the Great Plains Synfuels plant in the US captures ~1.75Mte pa of CO₂) and CO₂ is routinely used in oil fields in the US to enhance oil recovery, there are as yet no examples of large scale generating plant capturing CO₂ and then sequestering it offshore. The system integration issues involved pose novel problems and there is a real introduction risk associated with the technology.
- Utilities and other investors in generating plant have no obligation to invest in CCS, or indeed to invest in any new plant in the UK, hence it is far from clear that any of the current proposals will proceed. Investors will select technologies that provide appropriate risk adjusted returns consistent with their internal cost of capital and that match to their portfolio, market and overall business strategy. Carbon capture comes at a cost and the current market gives no encouragement for investment in CCS. This, as set out in answer to previous questions, despite the large and near term benefits of a major reduction in UK CO₂ emissions, the opportunity for cost effective replacement generation that provides diversity away from imported gas, the prospect of increased UK oil production and, in the longer term, the prospect of a low emissions option for transport fuel.

- With appropriate economic incentives these benefits can be secured. The Progressive Energy view on the incentive structure required will be set out in detail in response to the parallel consultation by the Treasury on Carbon Capture and Storage. A package of measures is suggested:
 - Consideration should be given to utilising the support package given to high quality CHP plant for coal and waste plants that incorporate CCS. This package involves 100% first year capital allowances (ECAs) and exemption from the Climate Change Levy. The former is a very effective means of assisting companies to manage the risk of capital intensive projects. The latter provides a market funded and market based mechanism that offsets the additional costs associated with CO₂ capture. As a target of 10000MWe of such plant by 2010 was set and the investment rate suggests that this target may not be achieved, it appears that current government spending plans could already accommodate the cash flow implications of providing ECAs for some CCS plant. As discussed above, the environmental logic of rewarding the use of imported gas is dubious and actively encouraging its use via the CHP support package, given the reliability and energy security issues associated with an increasing dependence on imported gas, does not seem to align well with other government environmental policies. Removal of new gas CHP plants from the list of eligible technologies for the support package would provide further space to allow this mechanism to be used to encourage CCS projects.
 - The EU ETS already encourages plant owners to minimise CO₂ emissions. The effect in the electricity market is to some extent for the wholesale electricity price to reflect the market CO₂ price modulated by the plant mix operating. However investors cannot take full regard of the carbon price and the effects of the scheme as its status beyond 2012 is unclear, the rule base which ultimately determines CO₂ price will change in an unpredictable way and each commitment period is only 5 years long – shorter than the investment time horizon for any new major investment. Nevertheless in the longer term it must be the objective for all low carbon investments to be made against this scheme. To allow CCS to be introduced transition arrangements are needed. Confirmation that CCS projects are eligible for allowances and the availability of free allowances equal to the CO₂ abated per annum together with a commitment to maintain this position for the first 20 years of the plant operation, if such a commitment can be given, would be worthwhile. In the event that auctioning of allowances is introduced then some of the revenue from the sale of allowances could be allocated to CCS projects.
 - The investment in pipelines to transport the captured CO₂ to the sequestration site and the capital establishing the sequestration site should attract ECAs and all operational costs involved should be allowable expense.
 - The net cost of sequestration as part of an enhanced oil recovery operation may not be greatly different from simple sequestration – whilst oil income is obtained, the capital costs associated with injection and separation of CO₂ from the oil produced is very much greater than the costs of pure sequestration. To incentivise EOR it should receive the same fiscal

treatment as new discoveries – in particular exemption from Petroleum Revenue Tax.

- The actual amount of CCS plant constructed will be determined by the absolute level of support, as a range of costs and risks are associated with differing capture technologies, differing transportation costs and differences in net sequestration cost. Progressive Energy believes that the incentives structure should establish market conditions that allow a number of technologies and options to be pursued. It is suggested that a combined support package that allows coal with carbon capture and sequestration in abandoned gas fields might be optimum in ensuring growth of a CCS tranche of the scale envisaged in answer to question 1
- It is important to recognise that the initial CCS projects will support the full cost of the development of the CO₂ transport infrastructure. The availability of this infrastructure will allow smaller CO₂ capture investments to be made. Progressive's project at Teesside will provide a disposal route for other sources of CO₂ in the area. The existence of the infrastructure will also provide an incentive for the construction of new plants that incorporate capture. Many of the opportunities here are not in the electricity sector. For example hydrogen production plants and ammonia manufacture offer good initial prospects. The importance of non-electricity point sources of CO₂ underlines the importance of utilising the EU ETS to incentivise CO₂ capture in the medium and long term
- The CAT strategy published in 2005 introduced the concept of 'capture ready' plant. The concept is a difficult one to understand – all plant is capture ready in that with sufficient expenditure CO₂ can be captured. Technology exists for capturing efficiently today and industry is already considering CCS projects. A programme or support associated with 'capture ready' plant can only delay real savings from the introduction of carbon capturing plants and it is recommended that the value and role of the 'capture ready' concept is re-examined.
- There are a number of non-financial challenges and issues that must be overcome to enable the full development and exploitation of CCS. These have generally been well aired and will not be repeated here. A key clarification is to clarify the conditions under which a company involved in sequestering CO₂ can withdraw. Clearly appropriate engineering confidence in continued safe storage must be demonstrated. However it is worth stating that once sealed there is little risk associated with a CO₂ storage site provided the reservoir pressure is appropriate to the geological conditions (no higher than the initial pressure in an oil or gas field). Large scale leakage is difficult to imagine and smaller leaks, should any occur, are inconsequential.