



**SUBMISSION BY PROGRESSIVE
ENERGY LIMITED TO THE
PERFORMANCE AND INNOVATION
UNIT ENERGY POLICY REVIEW**

“GREEN ENERGY FROM COAL”

- *There is a case for maintaining the current mix of the different sources of primary energy supply, coal, gas, nuclear, oil, and renewables, that ensures both security and diversity of supply. The UK still has a large resource of coal and a nuclear capability, as well as access to renewable energy, all of which can help to provide this balance*
- *The technology now exists to provide bulk supplies of electrical (and other) energy from fossil fuels, in a manner that meets the objectives of “sustainability”. This includes removal and sequestration of the CO₂ in plant from which other emissions are very low. A scenario in which there is a balanced mix of coal, gas, nuclear, oil, and renewables is no longer inconsistent with environmental sustainability.*
- *Amongst the cleaner coal technologies, IGCC technology is particularly capable of reducing the impact of future coal use on the environment. The potential exists for very low emissions of NO_x, SO_x, particulate and CO₂. IGCC also brings within reach the possibility of a hydrogen economy in the UK*
- *Demonstration plants will delay, by up to a decade, the widespread introduction of a technology that can make a major impact. Progressive Energy strongly recommends that policy is implemented through market stimulating policies*
- *British industry can start construction immediately, developing the track record to compete in a large international market.*
- *Progressive Energy support a “New and Renewables Obligation” that recognises the potential of gasification technology to provide secure, diverse, sustainable energy through the use of coal, and to deliver the substantial environmental benefits associated with CO₂ capture and sequestration*

SUBMISSION BY PROGRESSIVE ENERGY LIMITED TO THE PIU ENERGY POLICY REVIEW

1. The Need for a Review

The UK has led the world in showing how electricity and gas can be operated in a commercial, rather than State-run context. It is appreciated that commercial objectives are not the whole picture, and other factors are equally important. The Performance and Innovations Unit's (PIU) review of Energy Policy is responding to Government policy objectives, which seek to:

- ensure secure, diverse and sustainable supplies of energy at competitive prices (Strategic Matters)
- reduce the impact on the environment and to secure the sustainable use of natural resources (Environmental Matters)
- promote fair and competitive energy markets in the UK and EU (Political Matters)

Regulation is used to provide an optimum balance of these objectives. The basis for such regulation needs to be subjected to periodical review, and Progressive Energy welcomes the opportunity to contribute to the debate.

2. Strategic Matters

2.1 Security

The primary sources of energy are, coal, gas, nuclear, oil, and renewables.

Oil and Gas

The European Commission Green Paper "Towards a European Strategy for the Security of Energy Supply" predicts that the European Union will become increasingly dependent on external energy sources and that based on current forecasts, dependence will reach 70% in 2030.

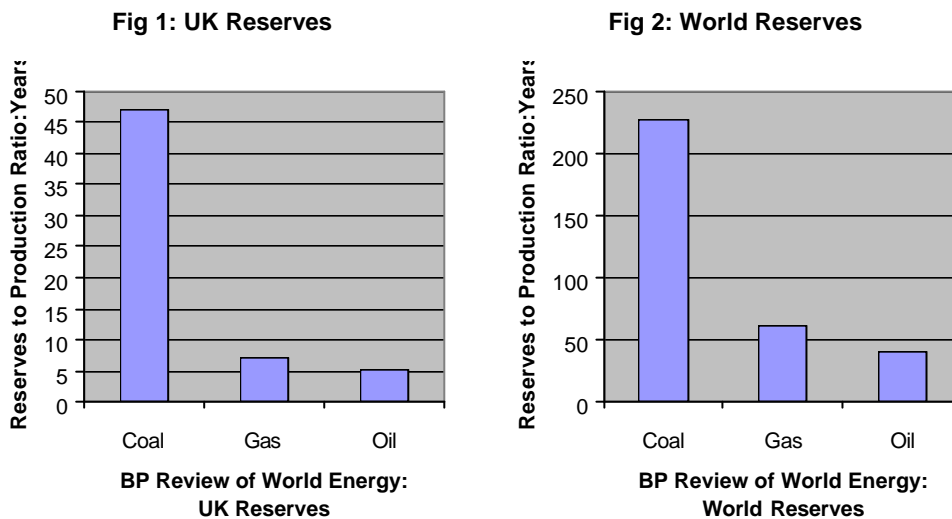
BP in their submission to the PIU, projected 80-90% dependence on imported oil by 2020 for the UK: it is likely that UK continental shelf gas production will decline from 2004, by 2010 the UK's import requirement could range from 30-60 bcm/annum, (compared to a Transco base forecast demand of 112 bcm/annum), and by 2020 up to 80-90% of the UK's gas could be imported. This has implications not only for the power generation sector but also for other sectors. In particular, security of supply could be adversely affected in the transport sector where there is currently almost no fuel diversity.

Oil and gas will ultimately be obtainable only from outside of the EU, and without indigenous supplies, the UK will become vulnerable to political disturbances in those areas.

Importing 80-90% of the UK's oil and gas by 2020 would also have a significant adverse impact on UK Balance of Payments, as well as affecting UK Taxation Revenue, Employment and Investment.

Coal

Both the UK and the world have extremely large coal resources as shown in Figures 1 and 2. The UK also has a coal extraction and supply industry capable of matching world coal prices when delivered to UK power station sites.



As well as access to significant indigenous reserves, coal has the advantage of being a comparatively stable primary energy product to import, which has demonstrably less price volatility than oil or gas, and where there is little constraint on continued availability.

Nuclear

The UK has much experience in nuclear power, but the predicted generation cost from new power stations is very high. The safety record of UK nuclear power stations is good, and the more modern designs are returning high load factors. A closure programme for the older (Magnox) stations has been announced, and by 2010, the contribution of nuclear power to the overall energy mix will be reduced by over 3GW, leaving a gap to be filled from elsewhere. Further plant closures may be predicted in the following decade.

Renewables

Many potential sources of renewable energy have been identified. Several of these can play a part of an energy mix, and the Government has provided a number of financial mechanisms to stimulate their use. There are a number of barriers to wider exploitation, mainly associated with economic performance and the match to energy market needs, but also the need to take into consideration wider issues (eg. effect of wind farms on the landscape). Such financial mechanisms will need to continue if Renewables are to make a significant contribution and few commentators predict that a higher percentage of the market is possible over the next 20 – 30 years. The security of Renewable energy is implicit.

2.2 Diversity

Forecasting the future is difficult: DTI Energy Paper 68 gave a projection that indicated that the proportion of electricity generation fuelled by natural gas would progressively increase, with around 25% of existing capacity (mostly coal and nuclear) being replaced by natural gas technologies over the next 20 years.

This would lead to about 50% of the UK's primary energy being dependent on gas, and about 64% of electricity generation being dependent on gas. The reduced diversity exposes the UK economy unnecessarily to future political and price shocks.

2.3 Sustainability

Energy Paper 68 predicts that the UK needs to build 15% additional generation capacity in the next decade, and 25% over the next 20 years in order to meet the increasing demand and to replace ageing nuclear plant, old coal stations, and the first generation of CCGTs.

Renewable technologies have a role in this additional capacity, and market mechanisms are being implemented to support a renewables programme. However, it is extremely unlikely that the renewables programme alone will be capable of meeting the new generation capacity requirement. There is a real opportunity for advanced "cleaner" coal plants to make a major contribution to a long term energy strategy; ensuring a balanced, secure mix of energy to the electricity generation, transport and other sectors in a sustainable way.

There is a case for maintaining the current mix of the different sources of primary energy supply, coal, gas, nuclear, oil, and renewables, that ensures both security and diversity of supply. The UK still has a large resource of coal and a nuclear capability, as well as access to renewable energy, all of which can help to provide this balance

3. Environmental issues

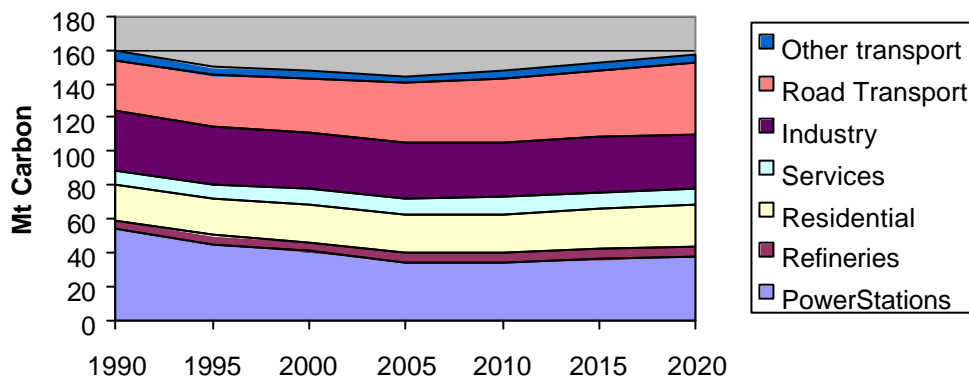
3.1 Reducing the Environmental Impact

Carbon Dioxide

Figure 3 shows that the central scenario in Energy Paper 68 forecasts that Carbon Dioxide emissions would increase, rather than be substantially reduced, in the medium term.

The reductions in Carbon emissions achieved in the period from 1990 to 2000 have been mainly from the power station sector. Continued reductions in the period from 2000 to 2005 are mainly projected from a continuing switch from coal to gas fired fossil generation and an increase in renewable generation.

**Figure 3: EP 68
Central CO2 emissions scenario**



Other pollutants

Much has been done out over the past 25 years to improve the emissions performance of the UK's generating stock in terms of other pollutants. Precipitators have reduced particulate emissions, with those coal-fired stations without precipitators being closed down. The retrofitting of low NOx burners to PF-fired coal stations, and the use of low NOx combustors in gas turbines has significantly reduced the emissions of NOx. Fitting Flue Gas Desulphurising equipment (eg. Drax and Ratcliffe power stations) and imposing sulphur emission limits to existing coal-fired stations (albeit in conjunction with increased CO₂ emissions), coupled with using low-sulphur natural gas in CCGTs and elsewhere in some "conventional" power stations has significantly reduced the emissions of SOx. Emissions to water have also improved.

Any new plant must be able to meet, or exceed present levels. Nuclear and Renewables are well suited to do this, as are gas-fired CCGTs. PF-based plant (even supercritical designs) will struggle to do this, but IGCC is able to do so

with comparative ease, because precombustion capture of CO₂ is comparatively cheap to implement.

3.2 Environmental Sustainability

Emissions of CO₂, NO_x and SO_x and particulates from nuclear plant are effectively zero, and can make a contribution if environmental concerns associated with the fuel cycle can be managed.

The potential for Renewables should be exploited, but it is also important to understand that solutions that appear ideal in some situations are not always appropriate in others. For instance, the choices for Energy Crops in equatorial regions of the world are not transferable to the UK because of our different climate. There is also a danger that over-optimism concerning the realisable potential for Renewable energy will cause decisions for strategic alternatives to be deferred, and opportunities to be lost.

The technology now exists to provide bulk supplies of electrical (and other) energy from fossil fuels, in a manner that can effectively meet the objectives of “sustainability”. This includes removal and sequestration of the CO₂ in plant from which other emissions are very low. Once this plant has been demonstrated in the UK, it can be exported, thus addressing the world situation, including that in countries where the options for alternative energy production are limited.

The scenario in which there is a balanced mix of coal, gas, nuclear, oil, and renewables is no longer inconsistent with environmental sustainability.

The technology now exists to provide bulk supplies of electrical (and other) energy from fossil fuels, in a manner that meets the objectives of “sustainability”. This includes removal and sequestration of the CO₂ in plant from which other emissions are very low. A scenario in which there is a balanced mix of coal, gas, nuclear, oil, and renewables is no longer inconsistent with environmental sustainability.

4. Political issues

4.1 Fair and competitive energy markets in the UK and EU

Those technologies currently a part of the UK energy mix that offer the basis for a sustainable future have historically received, or are currently receiving incentives from the Treasury and elsewhere. The “Nuclear Levy”, the Non-Fossil Fuel Obligation”, and the “Renewables Obligation” are examples of some.

Public endorsement by Government of the reality of the coal option will ensure the attention of those companies who can contribute. However, market stimulation measures are needed to prompt action. This must include formal

recognition in related legislation of CO₂ sequestration as a valid means to reduce emissions.

There has been, and still is an appreciation that those technologies that pollute least should be encouraged most. Market stimulation measures are needed to prompt action.

5. Addressing the problem: “Green Energy from Coal”

5.1 “Black coal to green energy”

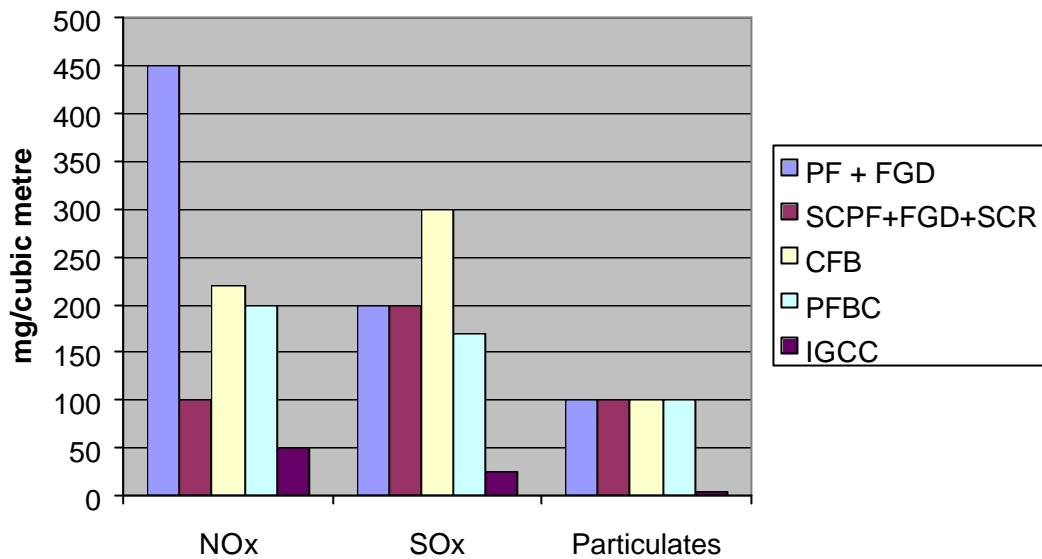
Coal fired electricity generation has more recently been associated with pollution and damaging emissions. Modern technology offers the potential for a major contribution to the UK’s energy needs to be produced using “green energy” from coal. Whilst a number of advanced coal conversion technologies are becoming established commercially, gasification technology shows particular promise because of its excellent environmental performance.

Sulphur and Nitrous Oxide Emissions

Figure 4 shows that Integrated Gasification Combined Cycle (IGCC) technologies have superior performance to alternative cleaner coal technologies for emissions of Sulphur Dioxide, Nitrous Oxides and particulates. In the coal gasification process, coal is partially oxidised in a gasifier to form a synthetic gas containing mostly Carbon Monoxide and Hydrogen. This synthetic gas is then combusted in a gas turbine, providing an alternative to the use of natural gas in a combined cycle project. Up to 99.5% of the Sulphur is removed by cleaning the synthetic gas before it is burned. IGCC technology is particularly capable of utilising UK coal, which typically has Sulphur levels greater than those of typical internationally traded steam coal.

Nitrous Oxide emissions are very low, comparable to that which is achieved in a natural gas CCGT.

Figure 4: Emissions from Cleaner Coal Technologies



Carbon Dioxide

Although cleaner coal technologies produce significantly less Carbon Dioxide than existing coal generation plant, due to the achievement of higher efficiencies, they produce around twice the amount of Carbon Dioxide of new natural gas CCGTs per unit of electricity generated.

Cleaner coal technologies with Carbon Dioxide capture and storage can, achieve very low emissions and hence provide the environmental benefits as well as those of security, diversity and sustainability. The UK is fortunate in having access to large undersea potential sequestration sites. The volumes available would permit long-term storage of all the Carbon Dioxide which would be produced in the UK in several hundred years. The key issues here are:

- the cost of accessing this storage potential
- what further demonstration, if any, of storage effectiveness is required?
- identifying the most cost effective means for the Government to prime the introduction of substantial ultra low emission plant with Carbon Dioxide capture and storage.

Other by-products

The gasification process produces saleable by-products, such as inert slag and elemental sulphur.

5.2 Technology – here and now

Gasification projects are increasingly proven internationally. There have already been a significant number of demonstration projects and it is now an emergent commercial technology. There is currently a large upsurge in future projects in the USA in response to the recent increase in gas prices and USA government support for gasification projects legislated in the “Clean Power Initiative of 2001”.

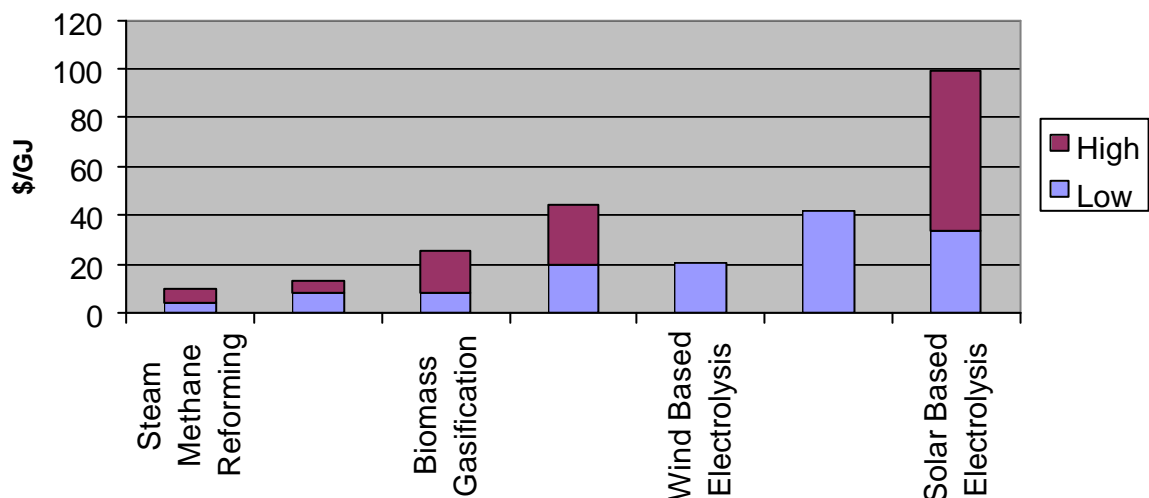
5.3 The Hydrogen economy

IGCC plant can also be configured to produce low cost bulk Hydrogen. With increasing gas costs and continuing significant improvements in the commercial performance of gasification technology since the 1996 gasification data was published, the cost of Hydrogen production from gasification projects is now broadly comparable to that from Steam Methane Reforming. Figure 5 shows the estimated cost of Hydrogen production from a USDOE study on the cost of Hydrogen production. Steam Methane Reforming and Gasification offer the prospect of lowest cost bulk Hydrogen production. This offers the prospect of competitive Hydrogen production from coal gasification projects to the:

- transport sector, e.g Hydrogen vehicles
- industrial sector, e.g oil refineries
- emergent fuel cell industry

If the Hydrogen were produced from a coal gasification project with Carbon Dioxide sequestration, this would enable reduction in emissions to be achieved in the non-Power Generation sectors through fuel substitution.

Figure 5: Cost of Hydrogen Production



5.4 Commercial considerations

IGCC plants to be built now

The size of IGCC plant that can provide the most competitive electricity generation is dictated by the availability of competitive, efficient, low emissions gas turbines, leading to a plant size of around 400-500MW or larger. With careful design, they are able to provide operational flexibility to match demand, and can provide the reliability that the market demands.

In the UK, utilising niche feedstocks, a new GCC plant without Carbon Dioxide removal and sequestration can be broadly competitive with a comparable new CCGT operating on natural gas at current prices. Low feedstock prices can be achieved due to the ability of gasification projects to accommodate high Sulphur or waste feedstocks in an environmentally acceptable way. The additional capital cost of IGCC is balanced by the lower feedstock price. However, investors will be cautious about investing in the first UK plants and coupled with the increased market uncertainty following the introduction of NETA and the risk of the imposition of Carbon taxes in the power generation sector, it is clear that a degree of market stimulation is needed before it can be confidently predicted that any such plants will be built.

IGCC with CO₂ removal

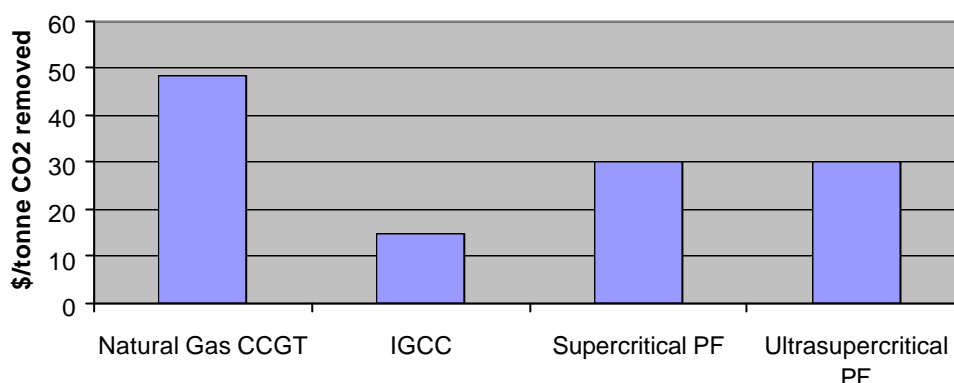
Gasification of coal can provide a synthetic gas, saturated with water, and rich in Carbon Monoxide and hydrogen. This can be readily converted to a synthetic gas rich in Hydrogen and Carbon Dioxide. This synthetic gas can either be sent to a gas turbine, where the Hydrogen is combusted to produce electricity, or the Hydrogen or Carbon Dioxide can be removed and used independently.

IGCC offers, as discussed above, the prospect of competitive bulk Hydrogen. The extent and rate to which the market for Hydrogen as a transportation fuel will be promoted and develop will depend on its future taxation treatment. A period of zero taxation could stimulate diversity and deliver environmental benefits.

IGCC also provides the most cost effective means of removing Carbon Dioxide from fossil fuel plant. This is because the Carbon Dioxide is removed prior to combustion, and is present in higher concentrations and at lower temperatures at the time of removal.

A recent study performed by EPRI concludes that “the costs of pre-combustion CO₂ removal from IGCC plants are markedly less than the costs of post-combustion CO₂ removal from Natural Gas CCGT and Ultra Supercritical Pulverised Coal plants”. Their findings are summarised in Figure 6:

Figure 6: Cost of CO₂ Removal



The consensus of the studies reviewed by EPRI was “that the cost of electricity from IGCC with CO₂ removal would be 1.1-1.9cents/kWh lower than for a Pulverised Coal plant with CO₂ removal”. The data on the cost of Carbon Dioxide removal produced in the July 2001 report “The transition to zero carbon emissions” by the Advanced Power Generation Task Force is at variance with this international consensus. The IEA study undertaken to assess generation costs for various fossil conversion technologies and the additional costs involved in capture of the CO₂ produced (on which the study was based) differs from the consensus that has emerged from a host of other analyses. Indeed the assumptions made in the IEA comparison have been formally challenged (eg paper by Holt and Booras of EPRI, 2000 Gasification Technologies Conference, California October 2000). Specifically the IEA analysis does not recognise that some modern commercial IGCC flowschemes can be designed at the outset to produce a syngas that is rich in hydrogen and carbon dioxide, resulting in a comparatively small additional cost for full CO₂ capture. The generally accepted consensus is that such pre-combustion capture provides the lowest cost CO₂ capture and that IGCC can be competitive with natural gas CCGTs at realistic gas prices.

5.5 Timescale

There is a strong need for early action to encourage the introduction of such “green” electricity plant as part of a national strategy to meet aggressive emission reduction targets and to increase the diversity and security of energy supplies in an uncertain world. These reasons for this include:

- At present the market preference for bulk supply is still to build natural gas CCGT plant and the opportunity for introducing coal IGCC or other “green” alternatives will be reduced to the extent that long life CCGT plant fills the replacement plant need. Immediate action is needed to allow the first IGCC plants to make a contribution within the current decade. Without this opportunities to build up a tranche of new ‘green’ plant will be lost for a considerable time – related to the lifetime of the new plant built in its place (>20 years). This will defer

the opportunity to reduce emissions in a significant way and exacerbate energy diversity and security concerns.

- The certain early availability of low cost hydrogen will enable a strategy to be developed for the early introduction of hydrogen powered vehicles and locally based CHP applications, offering the opportunity for major cuts in UK emissions.
- Suitable IGCC plants can be built in two stages, provided the intent is clear from the outset, with the second stage investment to capture the CO₂ being made once the sequestration site has been established. This enables the plants to be built and proven at the earliest possible stage and for the carbon dioxide sequestration to begin as soon as sequestration sites are available.
- Early introduction will allow the UK power and process engineering companies involved to develop a track record in their home market as a platform from which to compete in the large and rapidly growing international market.

5.6 Demonstration

Demonstration is only required where the perceived technology risk is too high for the private sector to invest. This is not the case for IGCC, or for undersea CO₂ storage. A demonstration programme would delay, for perhaps up to a decade, the widespread introduction of a technology that can make a major impact on reducing emissions, and retaining a secure, diverse mix.

In contrast, market stimulation measures would ensure widespread private sector attention, and could result in the early introduction of the most appropriate solutions at the lowest cost.

Hence Progressive Energy strongly recommends that policy is implemented through market stimulation policies.

Amongst the cleaner coal technologies, IGCC technology is particularly capable of reducing the impact of future coal use on the environment. The potential exists for very low emissions of NO_x, SO_x, particulate and CO₂. IGCC also brings within reach the possibility of a hydrogen economy in the UK.

Gasification projects are increasingly proven internationally.

IGCC plant are close to being competitive to natural gas CCGT in niche applications, and the cost of CO₂ capture is lower than alternatives.

Demonstration plants will delay, by up to a decade, the widespread introduction of a technology that can make a major impact. Progressive Energy strongly recommends that policy is implemented through market stimulating policies

6. The Way Forward

6.1 Coal – a national resource

Support is required to enable coal to be used more generally as a feedstock, allowing the full benefits of access to secure, diverse and sustainable supplies of energy, and benefits to the UK economy.

6.2 Market Stimulation

Progressive Energy believes that Government should consider market stimulation measures in support of its policies in this area rather than promote a demonstration plant of some sort.

On a like for like basis, the degree of market stimulation required to establish a major contribution from coal based plant is much lower than any truly viable alternative. No other option, including nuclear and renewables, offers the same overwhelming advantages as coal IGCCs. IGCC plant can:

- supply electricity in large volumes – it could be used to underpin energy diversity and security requirements by, if seen to be appropriate, meeting the total plant replacement needs forecast in Energy Paper 68 and elsewhere
- provide clean energy at a low a very competitive price compared to alternatives - UK project applications have been considered in detail and considerable up to date cost information is available from other projects worldwide giving confidence in this statement.
- enable a clean primary fuel alternative to the current use of oil in the transport sector and gas for industrial and domestic use to be promoted – the availability of hydrogen in bulk, as required, at a price that is cheaper than dedicated alternatives, can in the medium term encourage and prime the introduction of CHP plant based around fuel cells for local application and hydrogen fuelled transport
- be introduced quickly and with certainty – the technology has reached the commercial application stage and is available for deployment now, giving the opportunity to make an early impact on emissions, and to supply hydrogen for clean energy supply in the transport, industrial and domestic markets.

IGCC technology as described here is developing at the boundaries of traditional industries. Contributions are or can be made from UK companies in the traditional power industry companies, in the chemical processing industry and in the oil and gas industry. The links between these would be

strengthened in responding to the UK market need if suitably stimulated, providing a platform for UK industry to compete in the rapidly growing and very large international market.

6.3 Carbon Dioxide Sequestration and Support Issues

If Carbon Dioxide is removed from an IGCC it can either be used for direct sequestration or for Enhanced Oil Recovery. The use of Carbon Dioxide for Enhanced Oil Recovery is well established and projects would deliver policy benefits in maximising the potential oil recovery from the UK Continental Shelf with a positive impact on Security of Supply, UK Balance of Payments, Taxation Revenue, Employment and Investment.

The base technology for Carbon Dioxide sequestration is currently being proved in the Sleipner project in the Norwegian sector of the North Sea. The cost of Carbon Dioxide capture and sequestration from IGCC is lower than for alternatives at around \$20/tonne Carbon Dioxide. This translates to an increase of around £6/MWh in the required electricity price assuming normal commercial financing criteria are applied. At present there is no market mechanism to encourage investors to make the investment required. A strategy to utilise undersea sequestration also requires Government support to define planning and licensing rules.

Progressive Energy believes that Government should consider market stimulation measures in support of its policies in this area rather than promote a demonstration plant of some sort. No other option, including nuclear and renewables, offers the same overwhelming advantages as coal-based IGCC power stations.

Coal IGCC power stations, coupled with CO₂ sequestration are a realistic, minimum cost option for delivering bulk supplies of secure, sustainable energy.

CO₂ can be captured more cheaply using IGCC than from any other fossil fuel technology

British industry can start construction immediately, developing the track record to compete in a large international market.

7. Providing the right Climate for Change

Two routes are proposed in order to provide the right climate for change, which, together will achieve the stated objectives of delivering:

- secure, diverse and sustainable supplies of energy at competitive prices

- a reduction of the impact on the environment and the securing of sustainable use of natural resources
- the promotion of fair and competitive energy markets in the UK and EU

The two routes proposed are designed in the first instance, to stimulate the right technological choices, and secondly, to facilitate environmental prudence.

7.1 Technological Incentives

Initially, the future of coal in the national energy mix needs to be secured and encouraged. Progressive Energy believes that IGCC is approaching “commercial” status in some niche applications, but in order for there to be a more general application of coal-based cleaner coal power stations, a small amount of support is necessary. This is a necessary first step, and will permit the early construction of a number of advanced cleaner coal power stations, providing:

- a level of security for the coal industry
- increased fuel diversity
- environmental benefits on a short timescale
- the growth of technological and engineering expertise in the UK
- confidence in IGCC technology to be built up

These power stations should have, by design, the option for low cost CO₂ removal to be retrofitted with minimal disturbance, as soon as a sequestration route is available. IGCC provides this opportunity through precombustion CO₂ removal.

7.2 Environmental Incentives

CO₂

The advantages of removing and sequestering the CO₂ from fossil-fired power stations have been described above and elsewhere. In order for advantage to be taken of the national asset of conveniently located storage capacity for CO₂, some infrastructure needs to be constructed. Early definition of licensing and planning regulation is needed in order to encourage early private sector involvement.

The planning mechanism allows environmental acceptability to be tested under public scrutiny for its acceptability to be endorsed.

A small level of support for removing and sequestering the CO₂ is required to promote the construction of suitable cleaner coal power stations. We estimate this to be in the order of £6/MWh or around \$20/tonne of CO₂ removed.

Hydrogen

The goal of moving toward a hydrogen economy is clear, with the environmental advantages for national energy use well established. The Government should introduce appropriate mechanisms for priming early development in this area. These could include fuel duty for hydrogen powered vehicles which promotes uptake.

7.3 Financial possibilities

Renewables already benefit from a premium through the Renewables Obligation Scheme. Examples of routes through which such a premium for other technologies (in particular the “green coal” option) might be provided include:

- a “Low Carbon” obligation (extension of the existing renewables obligation)
- Climate Change Levy
- Carbon Tax
- Emissions Trading

Of these, the extension of the Renewables Obligation to be a ‘New and Renewables Obligation’, in order to support the introduction of low carbon emissions technologies has clear merits. Adding a percentage of nuclear and clean coal (say 25%), and possibly other appropriate technologies to a ‘New and Renewables Obligation’ Scheme would ensure a secure, diverse and sustainable energy mix at minimum cost. Support would then become available that recognises the potential of gasification technology, and its ability to provide “green” energy from coal and waste feedstocks.

The existing scheme places an obligation on all licensed suppliers of electricity to purchase a specified amount of their electricity from a defined list of technologies that qualify. In order to encourage the use of these technologies, a sliding scale has been introduced: 3% of sales up to March 2003, rising to 10% of sales by March 2011. This is effective, but has the effect of actually discouraging some technologies not on the list, even though their environmental performance would be equal to or better than the qualifying ones.

Progressive Energy support a “New and Renewables Obligation” that recognises the potential of gasification technology to provide secure, diverse, sustainable energy through the use of coal, and to deliver the substantial environmental benefits associated with CO₂ capture and sequestration

8. Summary

UK Energy Markets

Whilst commentators differ on timing and scale to some extent it is recognised that the UK will cease to be self sufficient in both oil and gas within a few years and will be increasingly exposed to international political, market, currency and commercial risks for its prime energy supplies. The dependence on imports will increase with European Union predictions indicating that up to 80% of EU requirements will come from outside Europe within 30 years.

In the UK there will be a need to replace a significant fraction of the power generation capacity over the next 20 years. DTI Energy Paper 68 forecasts that 25% of capacity will be replaced within 20 years mainly by technology that utilises gas.

Oil and petroleum products dominate transport use and gas is also used extensively in the industrial, commercial and domestic sectors.

UK carbon dioxide emissions are forecast to rise rather than fall dramatically over the next 20 years with an increase in emissions in both the energy and transport sectors.

For most scenarios with current policies it seems likely that fuel diversity will reduce, energy supply security will be lower and the gap to bridge for achievement of a sustainable energy future will increase.

The Potential Contribution from Coal

In the past coal use has been associated with pollution and damaging emissions. Modern technology offers the potential for a major contribution to the UK's energy needs to be produced using "green energy" from coal

The UK has substantial coal reserves and an extraction and supply industry capable of matching world prices. Coal is plentiful worldwide and is available from a multitude of politically stable sources. Hence its use as a substantial part of the primary energy mix can make a major contribution to meeting the need for a diverse, secure and sustainable supply of energy.

Whilst a number of advanced coal conversion technologies are becoming established, commercially, gasification technology shows particular promise.

Integrated Gasification Combined Cycle plants (IGCC) exploit the same advanced gas turbine technology as natural gas CCGTs, the present technology of choice. IGCC plants can be cost competitive to natural gas CCGT dependent on the differential price per therm of their respective fuels. This is underlined currently in the USA where there is a strong upsurge in IGCC plant orders and development interest. Progressive Energy experience is that this is close to being the case in the UK today.

IGCC technology however holds the promise of much more than competitive electricity generation. Suitably configured such plants can also provide bulk

hydrogen at extremely competitive prices and capture the carbon dioxide produced. The CO₂ capture process is pre-combustion and hence very cost effective. A number of studies have confirmed that the lowest cost means for achieving near zero emissions is to use IGCC plants. This excellent environmental performance can be achieved irrespective of the sulphur content of the feedstock used, allowing the use of lower value coals and conversion and use of a range of wastes.

The UK is fortunate in having large offshore reservoirs suitable for the long-term storage of carbon dioxide. The volumes available would permit storage of all UK CO₂ for several hundred years. The Sleipner project in the Norwegian sector of the North Sea has demonstrated the feasibility of this storage medium as have numerous enhanced oil recovery operations around the world.

Hence there is a real opportunity for coal IGCC plants to make a major contribution to a balanced long term energy strategy; ensuring a balanced, secure mix of sustainable energy to the electricity generation, transport and other sectors.

Costs and technology introduction issues.

A tranche of coal IGCC plants are likely to represent both the lowest risk and the lowest cost alternative for the consumer and the Exchequer for ensuring a secure, diverse supply of sustainable energy in the UK.

Coal IGCC plants are close to being cost competitive compared natural gas CCGT's at the moment. However investors will be cautious about investing in the first plants and coupled with the increased market uncertainty introduced following the introduction of the NETA and the risk of the imposition carbon taxes, it is clear that a degree of market stimulation is needed before it could be confidently predicted that any such plants will be built.

The cost of CO₂ capture and sequestration is lower than alternatives but at best is still around \$20/ton CO₂. This translates to an increase of ~ £6/MWh in the required electricity price assuming normal commercial financing criteria and are applied. At present there is no market mechanism to encourage investors to make the investment needed.

Worldwide, clean coal technology has received adequate demonstration and is now an emergent commercial technology. The use of carbon dioxide for enhanced oil recovery is well established, and the feasibility of sequestration is established. A strategy to utilise undersea sequestration requires Government support to define planning and licensing rules. Progressive Energy believes that Government should consider market stimulation measures in support of its policies in this area rather than promote a demonstration plant of some sort.

On a like for like basis, the degree of market stimulation required to establish a major contribution from coal based plant is much lower than any truly viable alternative. No other option, including nuclear and renewables, offers the same overwhelming advantages as coal IGCCs. IGCC plant can:

- Supply electricity in large volumes – it could be used to underpin energy diversity and security requirements by, if seen to be appropriate, meeting the total plant replacement needs forecast in Energy Paper 68.
- Provide clean energy at a low a very competitive price compared to alternatives - UK project applications have been considered in detail and considerable up to date cost information is available from other projects worldwide giving confidence in this statement.
- Enable a clean primary fuel alternative to the current use of oil in the transport sector and gas for industrial and domestic use to be promoted – the availability of hydrogen in bulk, as required, at a price that is cheaper than dedicated alternatives, can in the medium term encourage and prime the introduction of CHP plant based around fuel cells for local application and hydrogen fuelled transport
- Be introduced quickly and with certainty – the technology has reached the commercial application stage and is available for deployment now, giving the opportunity to make an early impact on emissions, and to supply hydrogen for clean energy supply in the transport, industrial and domestic markets.

IGCC technology as described here is developing at the boundaries of traditional industries. Contributions are or can be made from UK companies in the traditional power industry companies, in the chemical processing industry and in the oil and gas industry. The links between these would be strengthened in responding to the UK market need if suitably stimulated, providing a platform for UK industry to compete in the rapidly growing and very large international market.

Public endorsement by Government of the reality of the coal option will ensure the attention of those companies who can contribute. Market stimulation measures are needed to prompt action. This must include formal recognition in related legislation of CO₂ sequestration as a valid means to reduce emissions. The package of measures deployed to facilitate introduction of renewable energy technology provides a parallel to draw on in facilitating the introduction of other green, near zero emission, technologies such as the coal IGCC described here.

Timing

There is a strong need for early action to encourage the introduction of such green energy plant as part of a national strategy to meet aggressive emission reduction targets and to increase the diversity and security of energy supplies in an uncertain world:

- At present the market preference for bulk supply is still to build natural gas CCGT plant and the opportunity for introducing coal IGCC or other green alternatives will be reduced to the extent that long life CCGT plant fills the replacement plant need. Immediate action is needed to allow the first IGCC plants to make a contribution within the

current decade. Without this opportunities to build up a tranche of new 'green' plant will be lost for a considerable time – related to the lifetime of the new plant built in its place. Hence deferring the opportunity to reduce emissions in a significant way and exacerbating energy diversity and security concerns.

- The certain early availability of cheap hydrogen will enable a strategy to be developed for the early introduction of hydrogen powered vehicles and locally based CHP applications, offering the opportunity for major cuts in UK emissions.
- Suitable IGCC plants can be built in two stages, provided the intent is clear from the outset, with the second stage investment to capture the CO₂ being made once the sequestration site has been established. This enables the plants to be built and proven at the earliest possible stage and for the carbon dioxide sequestration to begin as soon as sequestration sites are available.
- Early introduction will allow the UK power and process engineering companies involved to develop a track record in their home market as a platform from which to compete in the large and rapidly growing international market.