The Generation Gap

Part 1: *The risk of electricity supply shortfalls 2008 – 2020*

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Contents

1. EXECUTIVE SUMMARY

This report focuses on the electricity industry in the UK over the remainder of this decade and all of the next. The report is primarily based on the output of the *Inenco Future Energy Market Model (FEMM)*. The model has been used to forecast Plant Margins, the difference between the demand for electricity and the systems' capacity to supply that demand. The output from these forecasts shows that there under some scenarios there could be a shortfall of electricity supply, *a Generation Gap*.

"under certain scenarios Inenco's ***Future Energy Market Model (FEMM)*** *shows that there could be a generation gap"*

These scenarios are set against the background of the development of the electricity supply industry since liberalisation and the changes in attitudes towards the impact of human activity in the environment. Action to reduce emissions of sulphur dioxide mean that significant supply capacity will be withdrawn in the middle of the next decade. At the same time much of the existing nuclear fleet will be reaching the end of it planned working life.

Forecasts of demand based on the National Grid's Seven Year Statement show a range between a 20% growth and a 4% decline over the period of the forecast. Forecasts of supply are based on a series of assumptions relating to the commissioning and decommissioning of generation plant.

Under the high growth scenario by 2015/16 demand overtakes available supply and enters a shortfall position. The impact of such a scenario would be a combination of restriction upon supply along with very substantial price increases with all the associated impacts on consumers.

"the high growth scenario results in restrictions on supply & substantial price increases"

The mid case scenario, whilst never going into an absolute shortfall position sees significant tightening of supply which will necessarily be reflected in price increases. The scenario showing demand slowly declining maintains comfortable Plant Margins across the period of the forecast. In addition the scenario offer the opportunity to deliver emission reductions and maintain security of supply.

The positive benefits of the reducing demand scenario can be achieved and the downsides of the other scenarios can be mitigated by putting significant focus on the delivery of energy efficiency measure amongst businesses and consumers.

"Increasing focus on energy efficiency would mitigate some of the downsides"

2. Introduction

This report is the first part of a two-part set that describes a number of scenarios relating to the demand for and supply of electricity in the United Kingdom in the short to medium term. This first part concentrates on presenting the analysis behind scenarios along with a consideration of the impacts on businesses and consumers.

"this report is the first part of a two-part set & focuses on a number of demand & supply scenarios"

The second part of the set, which is expected to be published in April 2008, will focus on the types of developments that may mitigate the issues about supply and pricing raised in this first part.

The numbers presented in the report come from *Inenco's Future Energy Markets Model (FEMM)*. This model is based on a set of scenarios for the development of the demand and supply of electricity in the UK. As with any forecast model, real life can confound assumptions and the outputs must be treated with appropriate caution. This being said our model does show that under certain scenarios there will be a significant reduction in supply margins potentially tipping over into an energy shortfall in the next decade.

"under certain scenarios there will be a significant reduction in supply margins"

These outcomes are not inevitable and a range of action can be taken to mitigate the issues highlighted in the report. The questions that have to be answered relate to what extent the action we take to ensure the UK's energy security will impact on other critical objectives, like the reduction of emissions that cause environmental damage.

"a range of actions could be taken to mitigate the potential outcomes described in this report"

3. A Brief Review of Electricity Generation in the UK

Since it was privatised in 1990 the UK electricity industry has experienced a high degree of turbulence, in terms of the structure of the industry, its ownership, the favoured technology and pricing within the market.

"since it was privatised in 1990 the UK electricity industry has experienced a high degree of turbulence"

Generation in the newly privatised industry was in the hands of a small number of players. These companies sold the electricity they produced into the National Grid through the pool system at prices reflecting the cost of generation. The graph in Figure 1 below shows the changes in the so called Generation Mix, the proportions of electricity derived from different fuel sources, between 1990 and 2005.

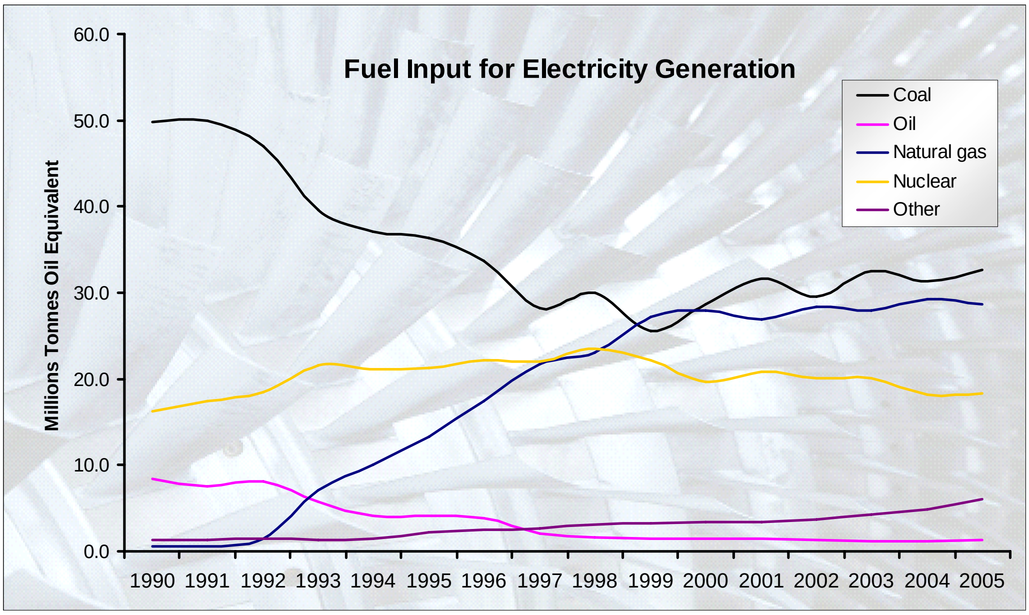

Figure 1. Fuel Inputs for Electricty Generation 1990 – 2005

Source: DEFRA e-digest supplementary information

The period between 1991 and 2000 shows the results of the so called 'Dash for Gas'. After privatisation, the use of gas for electricity generation was permitted. The advent of Combined Cycle Gas Turbine (CCGT) technology combined with the availability of plentiful supplies of North Sea gas made an attractive proposition.

"the period between 1991 and 2000 shows the results of the so called 'Dash for Gas'"

The chart clearly shows how important the CCGT stations have become. This technology has replaced some of the coal fired and most of the oil fired capacity. This change was driven by three factors:- lower wholesale prices for gas, the relatively cheap price of building CCGT stations and the improved efficiency of the design. The improvement in efficiency is considerable, the Oxford Institute of Energy Studies quotes average thermal efficiency for coal fired stations of 35% (fuel energy in to energy output) compared to 55% for CCGT plants.

"lower wholesale gas prices, relatively cheap build costs and improved efficiency have driven this change"

By 1999 for the first time the contribution from gas overtook that from coal. Over the same period the contribution from nuclear power was growing slowly but then started to decline. We will return to the story of nuclear power later. Both coal and gas fired stations have shown steady growth since 1999 along with the contribution from renewable sources.

"by 1999 for the first time the contribution from gas overtook that from coal"

By 2004, gas fired generation accounted for 36% of total UK capacity. North sea gas production, as shown in the 2007 DUKES online supplement, had peaked in 2000 and then fallen steadily from then on. In 2002 the UK was still a net exporter of gas but in 2003 this position reversed, and by 2006 imports represented over 23% of total UK gas supply.

"in 2003 we became a net importer of gas, with total imports rising to 23% by 2006"

The Iraq war in 2003 and the widespread political uncertainty that followed has pushed oil and gas prices back towards the record levels seen in the period of the Iran – Iraq war in the early 1980's. Whilst these prices have delivered record breaking profits for oil companies they have also resulted in significant rises in wholesale prices. As discussed before the fuel costs impact on the relative cost of generation and this is reflected in the generation mix.

"oil & gas prices are pushed back to record levels"

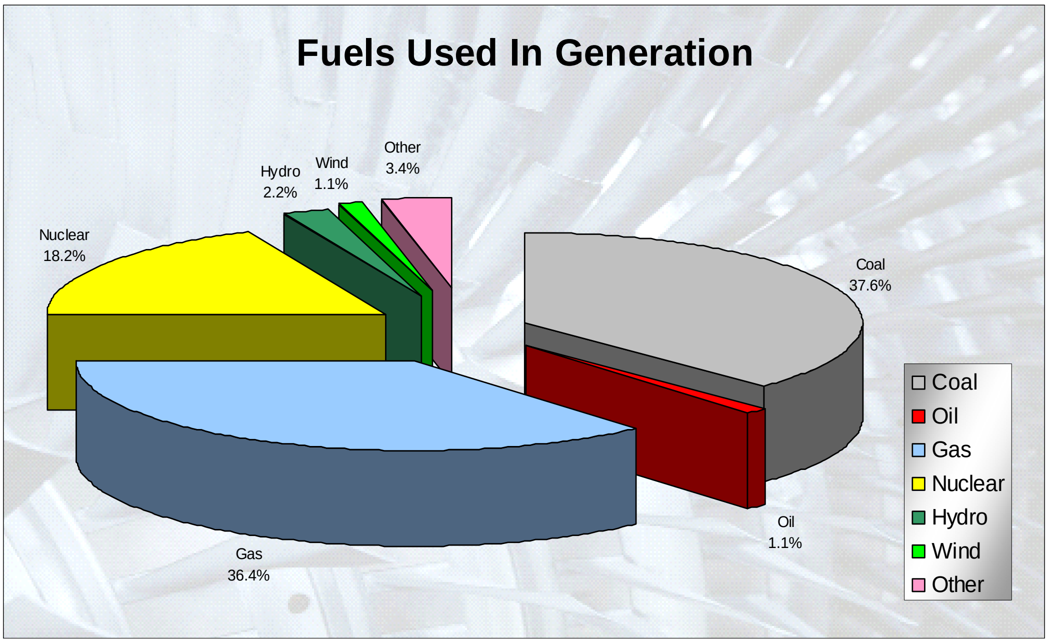

Figure 3: Generation by fuel source 2006 **Source: DUKES 2007**

"coal and gas are roughly equal in the current generation fuel mix"

By 2006 Coal fired generation had seen renewed growth and had once again become the largest proportion of UK generation. This is despite the fact that since the break-up of the nationalised mining industry in the 1980's the UK has become highly dependant on imported coal for generation.

"by 2006 coal fired generation had seen renewed growth "

Nuclear power has had a difficult history in the UK. At the time the first nuclear stations came on line there was the promise of virtually unlimited electricity, "too cheap to meter". This promise, usually linked to Walter Marshall although it was probably made by Lewis Strauss[1] who was the chairman of the US Atomic Energy Commission, has never been realised. Development of our nuclear capacity has come in waves, for each wave ambitious plans were set out but delivery was patchy and often delayed [2].

"Nuclear power has had a difficult history in the UK, with development coming in waves"

Sources - 1. New York Times, September 17, 1954 2. 'A way forward for nuclear power ' Ham & Hall 2006

Despite concerns linking acid rain formation to emissions from coal fired power stations, nuclear power has had, by far, the most public opposition. Even from the early days of the programme the public perception was that nuclear plants were dangerous, and well publicised accidents only reinforced this view. By the 1970's when plans were being laid for the third generation of stations, these public concerns along with disagreements about which type of reactor should be built, saw the planned programme being cut back.

"public perception was that nuclear plants were dangerous"

The experience of building Sizewell-B with its record breaking planning enquiry, meant that it was not in service until 1995, although it had formed part of the planned programme from the 1970's. This was the last nuclear station built in the UK. Coming up to date a number of the stations built in the earlier phases are approaching their decommissioning dates. The public concerns over nuclear power have remained with major environmental pressure groups like Friends of the Earth still being opposed to it on principle.

"Sizewell-B, conceived in the 1970's, did not come into service until 1995"

4. Environmental issues

The emergence of concerns over the impact of human activity on the environment and its movement into the mainstream of political and public debate has been one of the key developments in the latter part of the twentieth century and the early part of the twenty-first.

In the 1960's the scientific community started to become aware of the impact that acidification of rainwater was having particularly on forests in Europe and the US. The source of this acidification was identified as the sulphur dioxide (SO_2) that was coming from the burning of coal. It is worth pointing out that the first observation of the effect had actually been made in Manchester in the 1850's when coal was the predominant fuel but the linkage to environmental damage had never been made.

"large coal burning power stations were identified as major sources of SO_2 emissions"

By the time the linkage was made, coal use was significantly lower in general and large coal burning power stations were identified as major sources of the SO_2 emissions creating the problem. By the late 1980's European legislation was in place that reduced these emissions, and more recently the Large Combustion Plant Directive (LCPD) has strengthened the controls. We shall return to the impact of the LCPD later.

"by the late 1980's legislation was in place to reduce S02 emissions"

After Acid Rain the next big area of concern was the ozone layer and its degradation by chlorofluorocarbons (CFC's). First identified in 1985 in the Antarctic, it was only two years until the Montreal Protocol was signed and action began to reduce the use of CFC's. This activity is widely regarded as the most successful environmental campaign to date and was perhaps helped by the fact it was a relatively simple mechanism and an easily targeted change.

Today, however, both acid rain and ozone depletion have been overtaken by concerns about climate change. Like Acid Rain the idea that carbon dioxide concentration in the atmosphere could impact on global temperature had been first proposed before 1900. Much work had gone on but there had been, and remains, controversy about whether this 'Greenhouse Effect' was real and whether human activity was a contributory factor.

"the idea that carbon dioxide concentrations in the atmosphere could impact on global temperatures was first proposed before 1900"

By 1988 however the Intergovernmental Panel on Climate Change had been formed in recognition of a growing weight of evidence. This was followed, after many years of debate, by the signature of the Kyoto Protocol in 1998 and the almost worldwide adoption of greenhouse gas reduction targets

In the UK these targets have been translated into three pieces of legislation affecting businesses. Firstly the Climate Change Levy which was introduced in 2001 and applied a levy on the energy bills of energy intensive organisations. 80% of this levy can be offset if organisations adopt strict carbon emission reduction targets. In 2005 the European Union Emissions Trading Scheme (EU ETS) was introduced impacting on 12,000 major carbon emitters across the EU. More recently the introduction of Carbon Reduction Commitment which exerts control over energy efficiency through a carbon trading scheme amongst large organisations that are not considered energy intensive.

"the Kyoyo Protocol has heavily influenced UK legislation on climate change"

5. Impacts on Electricity Generation

The CCA and CRC are focussed on end-users of electricity. There is no differentiation between the energy sources used so that nuclear power, which can be viewed as low carbon (although uranium enrichment is a very energy intensive process), does not get different treatment from coal fired generation.

At the same time, carbon emissions from power generation account for over 25% of total UK emissions. These emissions are have been regulated since 2005 by the EU ETS. This scheme works on a cap and trade basis with an overall UK allowance for emissions. The report for the trading year 2006 has just been released showing that the UK produced 33 million tonnes of CO_2 above its' allowance. This was attributed to increased use of coal fired stations given the high relative price of gas.

"carbon emissions from power generation account for over 25% of total UK emissions "

Organisations that use more than their allotted allowance have to buy additional allowances on the EU carbon market. This is viewed as a means of ensuring that emissions are controlled. This functioning of the scheme has been weakened in the early years of operation by there a significant over allocation in some member states leading to a very price for carbon compared to expectations.

"the EU ETS exerts considerable pressure on the generation industry to find lower carbon sources of fuel"

The scheme does, however, exert considerable pressure on the generation industry to find lower carbon sources of fuel. The parliamentary office of science and technology in its October 2006 'Postnote' produced figures showing that gas fuelled generation has a carbon footprint that is half the size of coal fired capacity. In this context, the 'dash for gas' can be seen as a contribution towards cutting emissions.

"of existing coal fired capacity just over half have announced plans to meet the emissions standards "

The LCPD referred to earlier means that unless fossil fuelled power stations can meet emissions targets for a range of gases including Sulphur Dioxide and Nitrogen Dioxide then they will have to be closed after a maximum of 20,000 operating hours. Of the existing coal fired capacity just over half have announced plans to meet the emissions standards. The remaining stations will have close creating a substantial reduction in supply capacity. We will detail the impacts of these closures later.

Electricity generators are paid for the power they provide into the national grid under the British Electricity Trading and Transmission Arrangement (BETTA) which replaced the New Electricity Trading Arrangment (NETA) in 2005. The price they received fell substantially between 1999 and 2003. These low prices, according to Ham and Hall (2006), along with the structure of NETA meant that coal fired plants, having the most flexibility, became the preferred source of generation.

"plant which have opted out of the LCPD are using their allowed hours faster than originally expected"

This shift in the generation mix is behind the UK's excess carbon emissions under the EU ETS. It also means that those plants which have opted out of the LCPD are using their allowed hours faster than originally expected, bringing forward the date when they will have to be withdrawn.

Looking at the combination of economic and regulatory impacts we can see that the generation industry faces squeezed margins on fossil fuel capacity, the planned withdrawal of substantial numbers of stations and increased pressure to invest in delivering lower carbon technology. We now turn to examine the results of these factors on the ability to meet the UK's energy demands.

6 Supply and Demand Forecasting

6.1 Introduction

This section describes the information used as inputs the *FEMM* forecasting model and hence our views on the future trends for electricity supply and pricing. Key factors in our consideration are changes in the generation mix, the introduction and withdrawal of capacity and the availability of new sources of power like renewables and interconnection.

"key inputs into the Inenco FEMM include; generation fuel mix, introduction & withdrawal of capacity and new power sources such as renewables and interconnection"

Outside of very simple systems, accurate prediction of customer behaviour has always been a challenging task. In the case of electricity demand and supply, the Department of Business, Enterprise and Regulatory Reform has gone on record, in the 2007 edition of its Energy Markets Update, to say that:

"Both the demand for electricity and the level of capacity that will be available to produce it are subject to a very wide range of uncertainty over the next decade. On the supply side, for example, there is uncertainty both around the timing of forthcoming closures of existing coal-fired and nuclear capacity and around the timing and amount of new build"

The forecasts presented in Section 8 are intended to illustrate the potential movement of UK electricity demand and supply over the next decade. Based on three broad scenarios they look a supply margin levels as well as the possible generation mix to assess the implications of these scenarios.

"the forecasts illustrate the potential movement of UK electricity demand and supply over the next decade"

Any econometric model for electricity demand would contain a wide range of variables. These would include economic activity, pricing along with the level of energy efficiency activity in various sectors of the market. This type of forecasting is beyond the scope of the present report and therefore we are using the forecasts from the 2007, Seven Year Statement by the National Grid. This provides expected peak demand levels for High, Sustained and Low demand growth scenarios up to 2013/14.

"National Grids Seven Year statement (2007) is used as the basis for the demand forecasts"

These figures provide us with an accurate measure of generation needed as they include station demand, transmission losses and assume a flow of 300MW to Northern Ireland via the Moyle interconnector, as is the seasonal norm. From 2013/14 onwards we extend these figures at the average growth rate of each scenario.

Table 1: Winter Peak Demand Levels (GW)

Winter	High Growth	Sustained Growth	Low Growth
2007/08	61.0	61.0	61.0
2008/09	63.2	61.4	60.1
2009/10	64.2	62.0	60.2
2010/11	65.4	62.7	60.2
2011/12	66.2	63.0	59.9
2012/13	67.2	63.5	59.7
2013/14	68.1	63.9	59.5
2014/15	68.9	64.3	59.3
2015/16	69.8	64.6	59.2
2016/17	70.7	65.0	59.1
2017/18	71.6	65.3	58.9
2018/19	72.5	65.8	58.7
2019/20	73.3	66.1	58.6

Source: National Grid / FEMM

“Inenco’s FEMM extends National Grids demand forecast beyond 2013/14 at the average growth rate for each scenario”

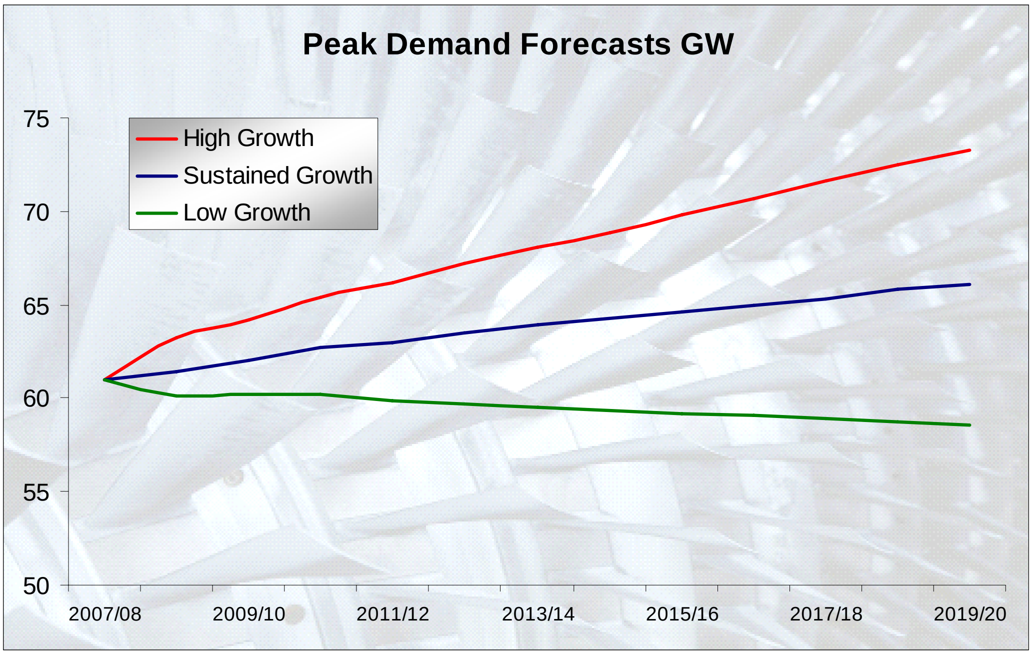

Figure 4: Peak demand forecasts from the FEMM forecasting model

“the final outcome is likely to fall within the rage illustrated”

It is worth noting that the final scenario described as low growth actually shows a slow decline of demand. We must also recognise that the three scenarios taken together represent the mid, upper and lower points of a range of outcomes and that the final outcome is likely to fall somewhere within that range.

6.2 Generation

As shown by the generation mix charts presented earlier, electricity is not just supplied by one fuel source. The need for security of supply and the development of new technologies means the generation mix is now as diverse as it has ever been. Table 2 below sets out the mix in the UK in 2007, it is immediately obvious that the bulk of supply however comes from Coal, Gas and Nuclear plant with Gas and Coal stations providing around 70% of total generation capacity. Accordingly it is easy to understand why, although not the only factor, wholesale gas and coal prices have a significant influence on power pricing.

"Gas and Coal stations provide around 70% of total generation capacity

In the 2007 figures, renewable sources account for a little over 3.5% of the total capacity. The future role of such sources is the subject of much debate. It is important to recognise that for both Wind and Hydroelectric power an availability factor must be taken into account.

The availability factor is most easily understood in relation to wind turbines. For a turbine to produce its maximum output the wind speed must be at least at its rated wind speed (for example 14 m/s) and below its cut out speed (for example 25 m/s). Above the cut out speed the turbine must be shut down or face damage, below rated speed the turbine will produce power below its rated level. When we take these factors into account we can arrive at an availability factor for the power source. The industry accepted availability standard for Wind power is 35% and for Hydroelectric power it is 60% as an average over a year. In other words, there is no guarantee of **any** generation from these sources when it is most needed although in general for the UK there the winter months have more wind than the summer and more rainfall to drive hydroelectric sources.

"the industry accepted availability standard for wind power is 35% and for hydroelectric power it is 60%"

Whilst it is essential that the industry continues to invest in the development of renewable sources, we must ensure that there is sufficient capacity in other types of generation to cope with demand levels when renewable outputs are low.

"we must ensure there is sufficient capacity in other types of generation to cope with demand"

Table 2: The UK Generation Mix and Total Capacity.

	Maximum Capacity (Mw)	% Of Total Capacity
Nuclear	11,005	14.0
Coal	28,912	36.7
Gas: CCGT & CHP	27,273	34.6
Oil & OCGT	4,085	5.2
Hydro	1,028	1.3
Wind & Biomass	1,782	2.2
Pumped Storage	2,800	3.5
TOTAL GENERATION	76,885	97.5
Interconnector:		
France - UK	2,000	2.5
TOTAL CAPACITY	**78,885**	**100.0**

Source: National Grid, Seven-Year Statement, 2007

"coal & gas currently dominate, with Nuclear representing 14%"

The relative contribution of the various sources to the mix plays an important part in determining the wholesale cost of power. This variation comes from the cost of fuel inputs, relative efficiency of fuel conversion, capital and operational costs and for fossil fuel plants the cost of carbon through the EU ETS.

"the generation fuel mix plays an important parting determining the wholesale cost of power"

This mix, and the associated plant margin, is at least to some extent controlled by the power companies unlike the cost of fuel which is driven by world commodity prices. The proportions in the mix by 2020 are hard to predict but we will move on to look at the key issues affecting different types of generation and consider the likely impacts.

6.3 The Large Combustion Plant Directive

The LCPD is one of the biggest topics in the energy industry at the moment; the directive is designed to limit harmful emissions from electricity generating plant, as well as other industrial sectors, by enforcing stringent air-quality measures effective as of 1st January 2008.

"the directive is designed to limit harmful emissions from electricity generating plant"

Plant that does not meet the standards set out by the directive either has to fit emission reducing equipment or "opt-out", in which case they are restricted to a maximum of 20,000 operating hours before 2015. Once 20,000 operational hours or the year 2015 is reached the plant must cease operation completely.

The plants listed below have opted out of the scheme and hence must close by 2015.

Table 3 Plant opting for limited life.

Station Name [1]	Capacity (Mw) [2]	Primary Fuel Type
Tilbury	1,102	Coal
Cockenzie	1,152	Coal
Didcot	2,109	Coal
Ferrybridge C, Units 1 & 2	1,000	Coal
Ironbridge	964	Coal
Kingsnorth	1,966	Coal
Littlebrook	1,105	Oil
Fawley, Units 1 & 3	1,036	Oil
Grain	1,355	Oil
TOTAL	**11,789**	

Source: [1] National Emissions Reduction Plan (NERP), December 2007 Update.
[2] National Grid, Transmission Entry Capacity (TEC) figures, 2007.

"9 plants, representing almost 12GW's, have opted out of the LCPD and hence must close by 2015"

It is clear from Table 3 that the majority of the opted out capacity is at coal fired stations. Closure of these stations would have a significant effect on the targeted emissions and will also radically change the makeup of the Generation Mix. It is also worth noting that as mentioned earlier market conditions have seen the proportionate use of coal increase and hence coal fired stations are using up their allowed hours faster than originally expected.

"closure of these stations would have a significant effect on the targeted emissions"

Most commentators within the industry expect the majority of coal plants to have used their allocated hours by the end of winter 2013/14 with some of the plant closing in the spring of 2013. Running hours and ultimately the closing dates of the plant will depend on several variables including reliability of the UK's aging nuclear fleet, demand levels and profitability of operation. It is worth noting that as these plants have limited operational lives and therefore limited future profitability, that if a fault were to develop, there may not be the economic case to carry out necessary repair, thus further adding to the difficulty of predicting closure dates.

"the majority of coal plants will have used their allocated hours by the end of winter 2013/14"

The "opted-out" plants consist of both coal and oil fired generation, with the affected oil plants having a combined capacity of 3,496MW. Due to the high price of oil, recent running of these plants has only been economically viable at times of extreme system tightness and thus they run limited schedules anyway.

It is predicted, therefore, that none of the oil plant will breach the 20,000 hours running limitations, and the capacity will remain available until enforced retirement in 2015.

"none of the oil plants will breach the 20,000 hours running limitation and will remain available until 2015"

If the prices of gas and coal remain on their recent tracks or if the price of oil was to decrease substantially, it may become economically viable to run this capacity more often, but for the purpose of this report we will assume this does not happen and oil capacity is used sparingly. It is also assumed that wholesale electricity prices continue at a level viable for the coal plants to run normal maintenance and repair schedules, so none of the plant closes before the 20,000-hour threshold is reached.

" we assume oil plant will be used sparingly on economic grounds"

Working with these assumptions, we have compiled likely reduction of available capacity figures, below, for three different running schedules, Present Pattern, Industry Expectation and Reduced Hours. These figures are shown in Table 4 below.

Table 4: Assumed available capacity of opt-out plant for forecasting purposes.

Start of winter	Coal (MW)			Oil (MW)
	Present Operating Pattern[1]	Industry Expectation	Reduced Hours	
2007/08	8,293	8,293	8,293	3,496
2008/09	8,200	8,293	8,293	3,496
2009/10	8,200	8,293	8,293	3,496
2010/11	8,200	8,293	8,293	3,496
2011/12	8,200	8,293	8,293	3,496
2012/13	6,200	7,800	8,293	3,496
2013/14	2,200	5,528	7,293	3,496
2014/15	2,200	2,764	7,293	3,496

(1) Source: BERR, Energy Markets Outlook, October 2007

The modelled data shows that there is a significant reduction in available capacity from the opted out plants after 2013 in both the 'Present Operating Pattern' and 'Industry Expectations' scenarios. The 'Reduced Hours' scenario would only realistically apply if demand was low or coal prices rose very steeply does offer a more consistent available capacity

"there is a significant reduction in available capacity from the opted out plants after 2013"

6.4 Nuclear Power

The UK's nuclear fleet is reaching the end of its designed operating life. The average nuclear plant in the UK is 26-years old and as a result the fleet is becoming increasingly unreliable. In January 2008, the UK Government announced that it supports the development of new nuclear build and that it regards nuclear power as an essential part of a diverse generation mix for the future helping us comply with our Kyoto Protocol obligations.

"the UK Government announced that it supports the development of new nuclear build"

So, with high levels of investment interest, from companies like EDF and E.on, and a green light from the government, the stage is set for a new fleet of nuclear stations to act as a replacement for forthcoming nuclear, oil and coal closures. Delivery dates have been quoted for 2017 but most industry commentators believe that with planning and approval likely to take around six years and construction expected to take a further six, the earliest we can reasonably expect to see new build in operation is 2020.

"the earliest we can reasonably expect to see new build is 2020"

With large amounts of capacity due to close before 2020 and new nuclear build being unavailable until after this date, our electricity system could face a serious tightening of plant margins in the intervening period and in the worst case scenario a generation gap, that is there being insufficient supply to meet peak demand, is possible.

"in the worst case scenario a generation gap, that is there being insufficient supply to meet peak demand, is possible"

Whilst an absolute power shortfall is an unlikely outcome it could occur without appropriate action being taken. Even without a real shortfall we believe that action is essential to address the issue because as we will discus in section 8, there maybe serious repercussions for wholesale power prices and hence on energy prices to end users.

"serious repercussions for wholesale power prices and hence on energy prices for end users"

There has been much talk about extending the operational lives of existing plant until new build becomes available but this option presents its own problems. Firstly, given that Dungeness-B has been granted a 10 year extension and Hunterston-B and Hinckley-B have been granted 5 year extensions, the extra capacity from extending the operating lives of remaining nuclear plant would be a relatively small proportion of total demand. Secondly any operating life extensions have to be approved by Nuclear Installations Inspectorate (NII) and although likely there are no guarantees further extensions would be approved.

It should be noted that although Hinkley-B and Hunterston-B have been granted extensions they have had to reduce their output to just 70% to achieve this. The forecasts later on in this section show the impact varying closure times will have on supply margins, possible closure dates and assumed running load are listed below in Table 5.

"although Hinkley-B and Hunterston-B have been granted extensions they have had to reduce their output to just 70% to achieve this "

Table 5: Current nuclear plants and assumed closing dates.

Station Name	Reactor Type	Capacity MW	Build Date	Original Planned Closures (1)	Forecast Scenarios:	
					Current Schedule	Further Extensions
Oldbury	Magnox	470	1967		2008	2008
Wylfa	Magnox	980	1971		2009	2009
Dungeness B	AGR	1,081	1983	2008	2018 [A]	2018 [A]
Hartlepool	AGR	1,207	1983	2014	2014	2019 [B]
Heysham 1	AGR	1,203	1983	2014	2014	2019 [B]
Hinkley Point B	AGR	1,261	1976	2011	2016 [B]	2016 [B]
Hunterston B	AGR	1,210	1976	2011	2016 [B]	2016 [B]
Heysham 2	AGR	1,203	1988	2023	2023	2023
Torness	AGR	1,200	1988	2023	2023	2023
Sizewell B	PWR	1,190	1995	2035	2035	2035
Total		**11,005**				

A: 10-year extension granted. B: 5-year extensions granted, load reduced to 70%.
(1) Source: British Energy website, www.british-energy.com

Even if we assume that Hartlepool and Heysham 1 are also granted 5 year extensions the amount of capacity that would be retained taking the load reduction into account would be under 2GW.

6.5 Conventional New Build

Table 6 below is a list of CCGT and/or CHP either under construction, or plant which is in the planning stage and likely to be approved and operational before 2020. The introduction of new plant is crucial in order to maintain generation margins due to the uncertainty regarding closure dates of existing plant.

"The introduction of new plant is crucial in order to maintain generation margins due to the uncertainty regarding closure dates of existing plant"

For the purposes of forecasting margins we have to consider the start-up date of new plant. We have listed below the first winter for which each new build would be available according to dates published by the operators and / or the National Grid.

Table 6: Assumed Start dates for new build.

Station Name	Capacity MW	Plant Type	Published Dates	Delayed Dates
Langage	890	CCGT	2008/09	2008/09
Immingham Stage 2	450	CHP	2009/10	2009/10
Grain	1275	CCGT/ CHP	2010/11	2011/12
Drakelow	1220	CCGT	2010/11	2012/13
Uskmouth	800	CCGT	2010/11	2011/12
Staythorpe	1650	CCGT	2010/11	2012/13
Marchwood	840	CCGT	2011/12	2012/13
West Burton	1270	CCGT	2012/13	2014/15
Sutton Bridge	1260	CCGT	2012/13	2014/15
Pembroke	2000	CCGT	2012/13	2014/15

"significant new conventional capacity is planned, but the majority will not be available until 2012 and beyond"

It is worth noting that new plant may suffer some form of delay in either planning or construction. For instance the first new build listed, Langage, was due on-line in 2007 however the date has been reforecast and is now expected before winter 2008/09. Due to the likelihood of delays, we have produced a second schedule assuming 12 or 24-month delays, dependent on size and build complexity for plant that is not already in advance construction phases.

"Langage was due on line in 2007 however the date has been reforecast and is now expected to be before winter 2008/09"

6.6 Renewable Energy

Renewable energy is at the forefront of political debate, government targets envisage 10% of generation coming from renewable sources by 2010. The benefits of renewable energy sources are clear but attention must be drawn to the constraints. We referred to the availability factors for certain types of renewable power, namely wind and hydroelectric generation earlier. Whilst an availability factor is applied to all types of generation the relatively low figures for these two sources can present a challenge to the security of supply.

"government targets envisage 10% of generation coming from renewable sources by 2010"

At present there are around 500 renewable projects with a combined capacity of around 16,000MW proposed or approved (1), for the forecasts in this report we assume as our base case, that half of these get built, with completion staggered evenly over the next twelve years. Half of the proposed new build is wind generation, both on and off-shore projects, the remaining projects are either hydroelectric or biomass generation, with the bulk being hydroelectric.

"we assume as our base case, that half of the currently planned renewable projects get built"

These assumptions give us a year on year capacity increase of 400MW for wind power and 300MW for hydro and 100MW from biomass schemes.

(1) Source BERR Energy Markets Outlook, October 2007.

6.7 Interconnection

With the European Union there is a desire for increased interconnectivity between the electricity networks of member states. An EU Green paper has suggested interconnection capacity targets of 10% of installed generation capacity would be achievable. On this basis, it is expected that the UK will develop more interconnection capacity linking itself to other systems throughout Europe and eventually further afield.

"interconnection targets of 10% of installed generation would be achievable"

Table 7: Import and Export Capacities

Connection	Import Capability MW	Export Capability MW
France	2000	2000
N. Ireland	80	500
Netherlands [A]	1000	1000

[A] Expected on-line for winter 2010/11

Currently the UK has connections to France, Ireland and a connection to the Netherlands is expected to be operational by the end of 2010. Due to the extensive planning and investment needed for such projects we will assume that these are the only connections available before 2020. It should also be noted that the connections are all two way and there is no guarantee that capacity will be available at times of peak demand.

7. Forecast Plant Margins and Generation Mix

We have now described the key inputs to our model of demand and supply for the UK electricity market. One of the key outputs of the model is the Plant Margin that is the difference between demand and generation capacity.

"Plant Margin is the difference between demand and generation capacity"

There are two versions of this Plant Margin figure. The first is simply the difference between the nominal capacities of all of the generation plant and the peak demand. The second figure then adjusts this Plant Margin on the basis of Availability Factors.

We referred previously (see section 6.2) to the concepts of Availability factors particularly in relation to renewable power sources. In fact all types of generation plant have Availability Factors associated with them which will vary from plant to plant on the basis of age, fuel input and maintenance requirements.

"plant availability factors vary on the basis of age, fuel input and maintenance requirements.

The assumed availability factors used in our forecasts for various types of generation are listed below. They represent the percentage of total capacity likely to be available on any given winter day. Winter is used for the calculations as this is historically when peak demand occurs and is unlikely to change in the foreseeable future.

Table 8: Assumed Availability Factors

Generation Type	Assumed Availability Factor
Coal Fired	85%
CCGT & CHP	90%
Nuclear	80%
Oil and OCGT	95%
Wind & Biomass	35%
Hydroelectric	60%
Interconnectors and Pumped Storage	100%

Source: National Grid Winter Consultation Report 2007/08

"in reality biomass has a higher availability facto than wind, but with only 45MW the overall effect is negligible"

The table above indicates that Wind and Biomass generation have an availability of 35%. As a point of interest the real availability of biomass generation is believed to be much higher perhaps as high as 85%. At present the UK only has around 45MW of biomass generation and so the effect is negligible. In the future this position may change and a separate category may be required.

8. Scenario Analysis

8.1 Introduction

By combining all of the inputs described above the *FEMM* produces an output for the three demand scenarios described in section 6.1. As mentioned previously it is worth noting that the demand figures used are based on the forecasts contained in the National Grid's Seven Year Statement. The three scenarios are

⇒ *High Demand Growth*
⇒ *Stable Demand Growth*
⇒ *Slowly Declining Demand*

"the Inenco FEMM produces and output for 3 different demand scenarios"

For each of the scenarios presented we have provided the following information

- An introduction describing the assumptions used in the scenario
- A chart plotting peak demand forecasts against supply capacity. The supply figure includes our assumptions about availability as described above
- A chart plotting the percentage supply margin that is the difference between supply and demand. This include both total supply margin and also the margin after applying availability
- A series of charts showing the generation mix at 2007/08, 2013/14 and 2019/20
- A commentary on the likely impacts of the scenario

8.2 Scenario 1: *High Demand Growth*

In this scenario, demand grows quickly and averages around 1.5% per year over the forecast period. This type of growth defines a future where the active pursuance of energy efficiency remains confined to a minority of consumers.

"the high demand growth scenario assumes an average demand growth of 1.5% pa over the forecast period"

Key Assumptions

Short Term

- LCDP plants continue to run at current schedules
- Nuclear plant extensions are granted
- Renewable construction delivers 10% over the base case

- Strategic placement of new renewable build allows the availability factor for wind to rise to 40%
- The published schedules for new conventional build and Brit-Ned are met

"key assumptions are run through the Inenco FEMM"

Medium – Long Term

- Continued use of opted out LCPD plants means they have to be withdrawn before 2015
- Nuclear stations running extended lives are less reliable and availability falls
- The growth of intermittently available renewable capacity increases the gap between plant margins and available margins

Outcomes

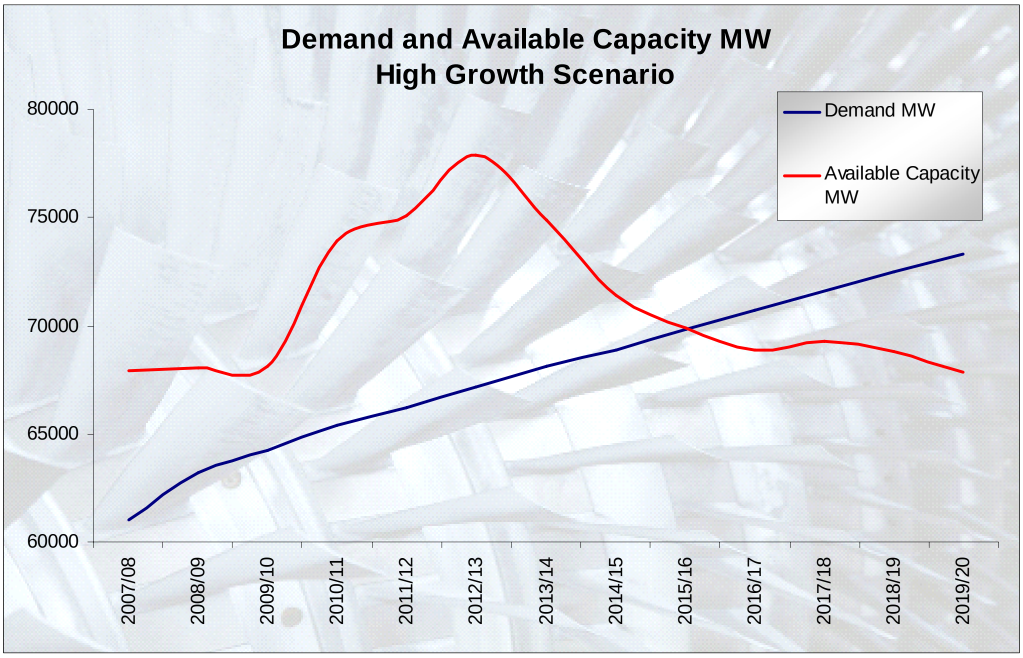

Figure 5: High growth scenario. Demand and Supply (Assumed Availability)

"by 2015/16 supply dips below demand and the scenario enters an energy shortfall"

Demand grows strongly across the forecast period. As the plant closures start to phase in 2012/13 the available capacity starts to decline rapidly. By 2015/16 supply dips below demand and the scenario enters an energy shortfall. It this situation although demand is still nominally growing it would be limited by the available supply and it is likely that a number of emergency demand management measures would have to be put into place.

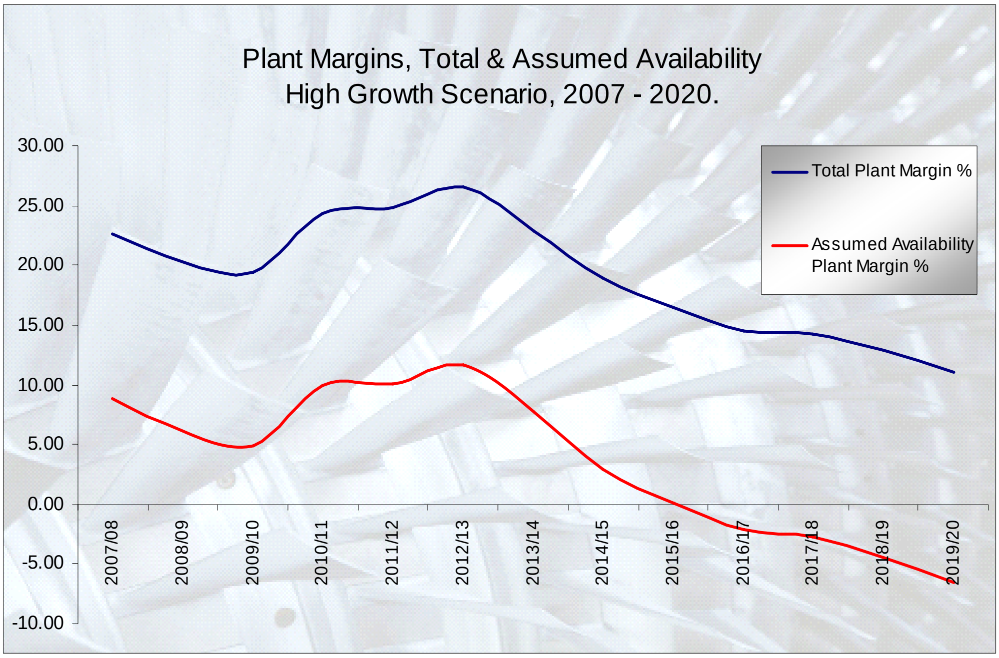

Figure 6: Plant Margins High Growth Scenarios 2007 – 2020

"assumed availability plant margin becomes negative by 2015/16"

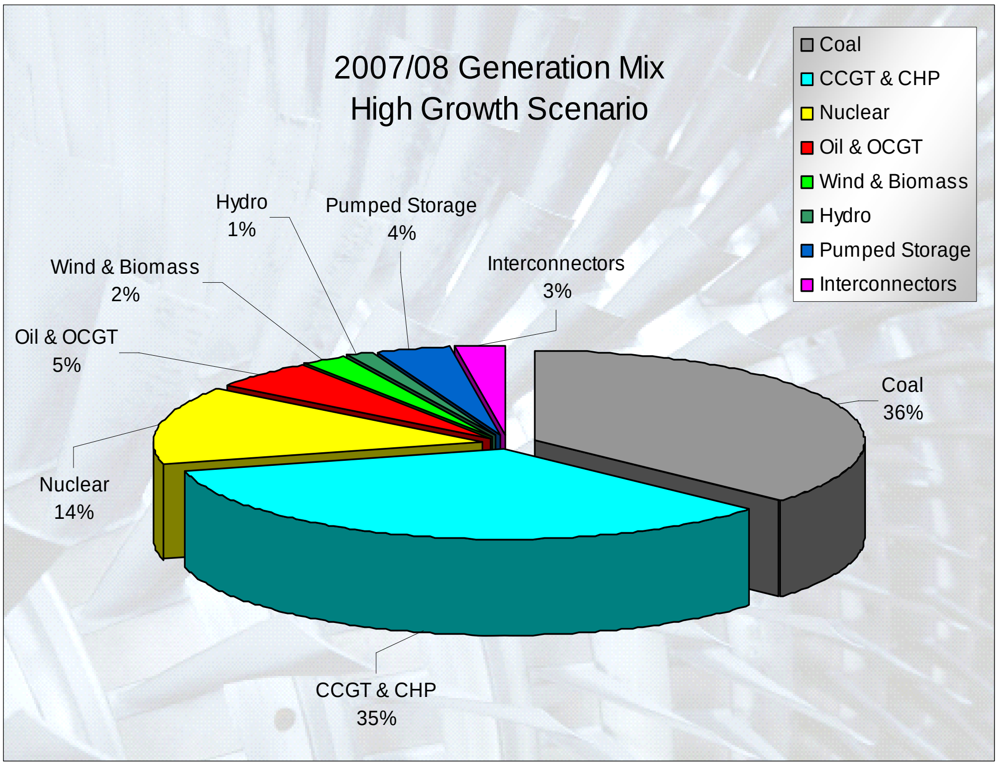

Figure 7: 2007/08 Generation Mix

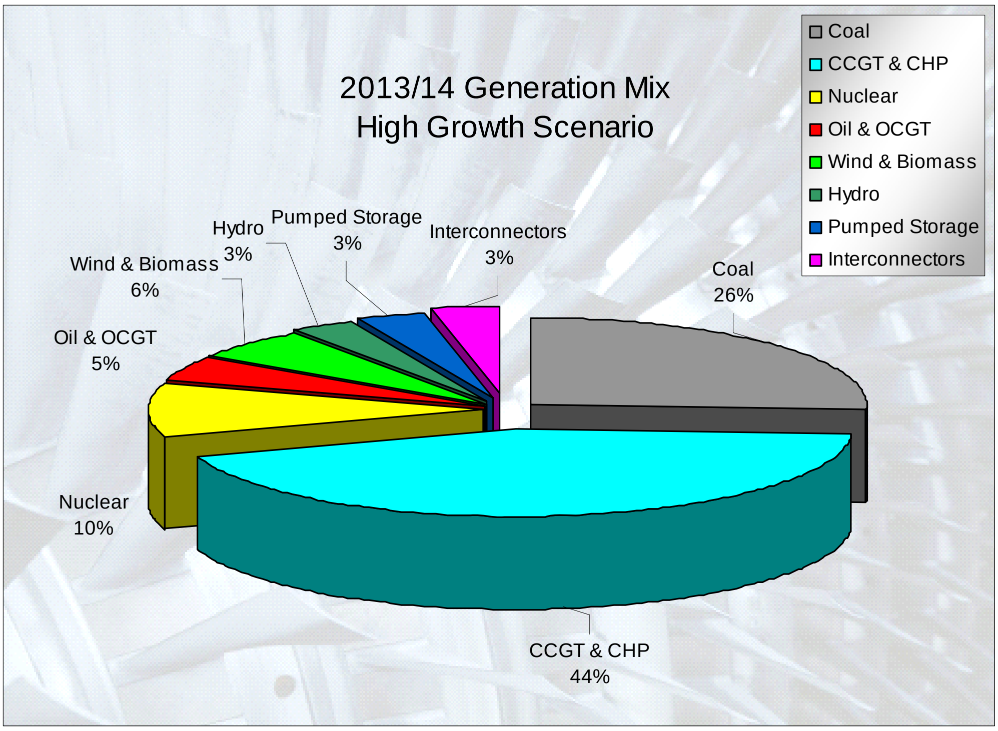

Figure 8: 2013/14 Generation Mix

"gas grows to44% at the expense of coal"

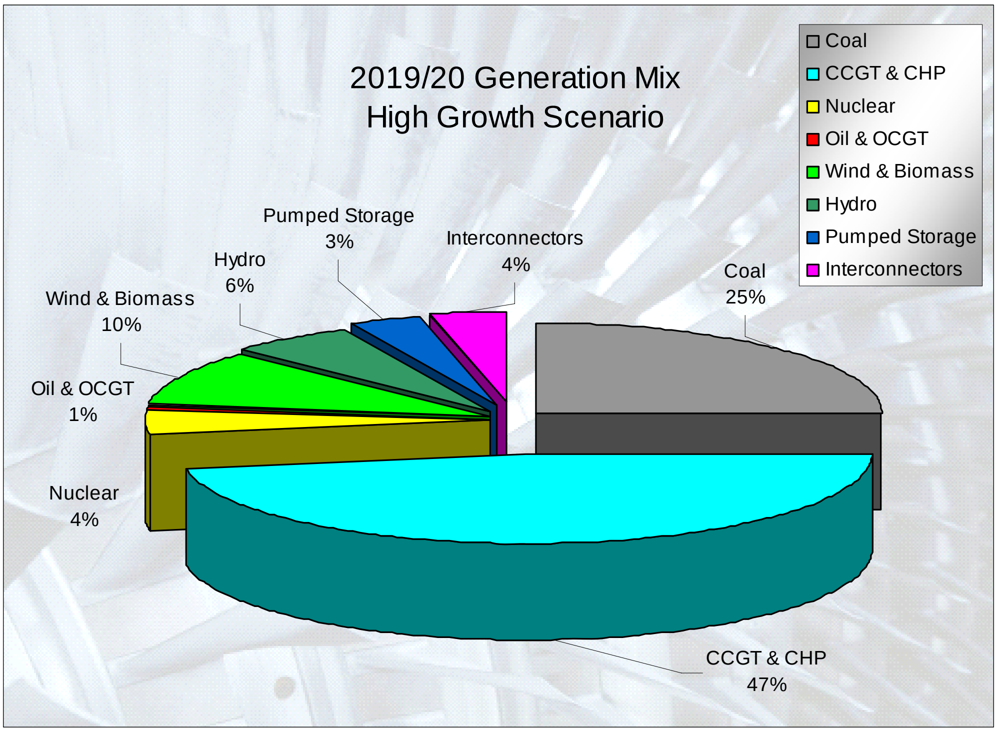

Figure 9: 2019/20 Generation Mix

"gas growth continues, now accounting for almost 50%"

Implications

The high level of demand will initially encourage power investment and there will be a drive to deliver new capacity as efficiently as possible. As demand continues to grow and the structural changes in the supply infrastructure come through the supply margins tighten dramatically. By 2016 the supply margin allowing for availability will become negative.

"the high level of demand will initially encourage power investment"

Wholesale power prices would naturally increase under such a scenario. Increased reliance on gas, which is linked to oil prices in Europe, will boost the UK market prices and add to market volatility. Tight margins and high-risk premiums as a result in increasing unreliability of the nuclear fleet and intermittent renewable generation would exacerbate the situation

"increased reliance on gas, which is linked to oil prices in Europe, will boost the UK power prices"

It should be noted that at no point in this scenario does the absolute supply margin become negative. In order to maintain the supply of energy on this demand scenario there would have to be significant action towards improving availability.

So the likely impact of this scenario in the wider context would be inflationary pressure from rising prices and the increase in fuel poverty particularly amongst the elderly where rising prices would see tough decisions having to be made.

"inflationary pressure from rising prices and the increase in fuel poverty"

There is a small possibility that without action on availability this scenario could lead to a shortfall of power at times of peak demand but we would expect only if a lot of negative influences coincide. The uncertainty of supply in this period is sure to cause major market volatility and troubling times could be lurking for the unprepared

8.3 Scenario 2 : *Stable Demand Growth*

In this second scenario there is still growth in demand but at under half the rate of the high growth scenario. This is close to the most recent movement of demand and builds in the greater awareness of energy use which is prevalent in the market.

"the stable demand growth scenario assumes a growth rate of under half the rate in the high demand scenario"

Key Assumptions

Short Term

- LCPD plant runs slightly reduced hours
- Nuclear capacity runs extended schedules
- Brit-Ned connector delivered on schedule
- Investment in conventional plant slightly delayed
- Delivery of conventional plant around 2013 eases supply margins
- Renewable generation delivery follows the base-case

"key assumptions are run through the Inenco FEMM"

Medium – Long Term

- Withdrawal of LCPD plant follows expected schedule
- Nuclear closure follow expected schedule
- Growth of renewable sources increases the gap between plant supply margins and Assumed Availability

Outcomes

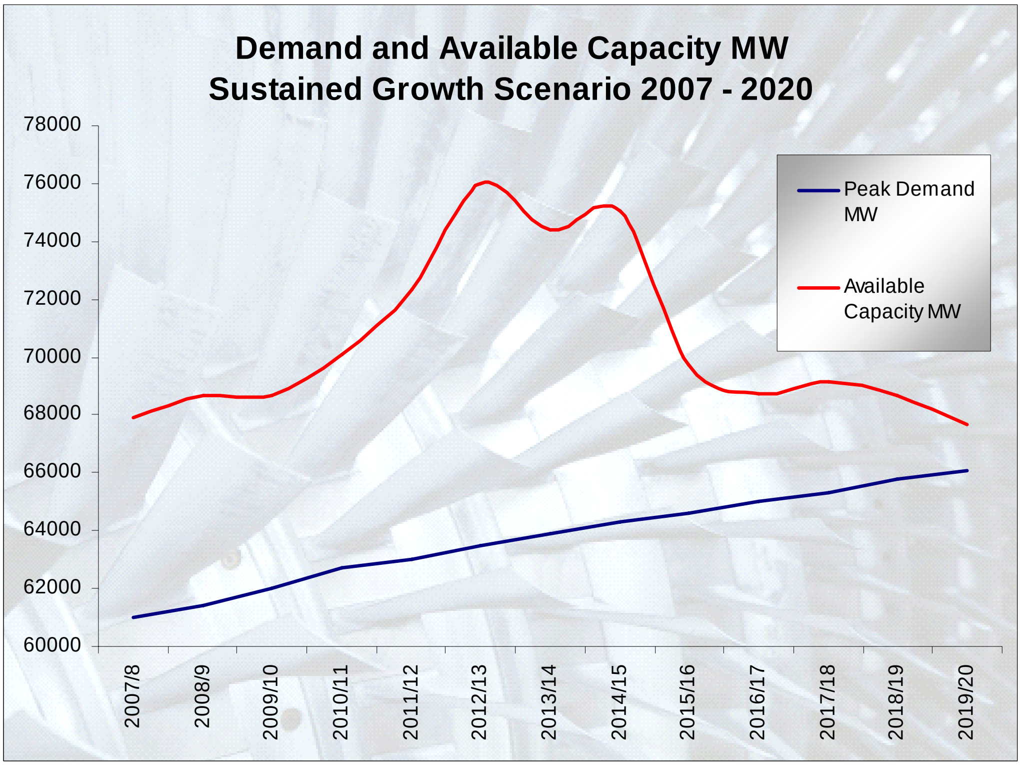

Figure 10: Peak Demand and Available Capacity Movements 2007 – 2020

"in this scenario both demand and the available capacity are less volatile

In this scenario both demand and the available capacity are less volatile. In the forecast period Available capacity remains above the peak demand at all times. What is important is that at the end of the forecast Available Capacity is still falling and there is a very small margin. If anything should create delays in the delivery of new capacity then the lines would intersect within the next two years.

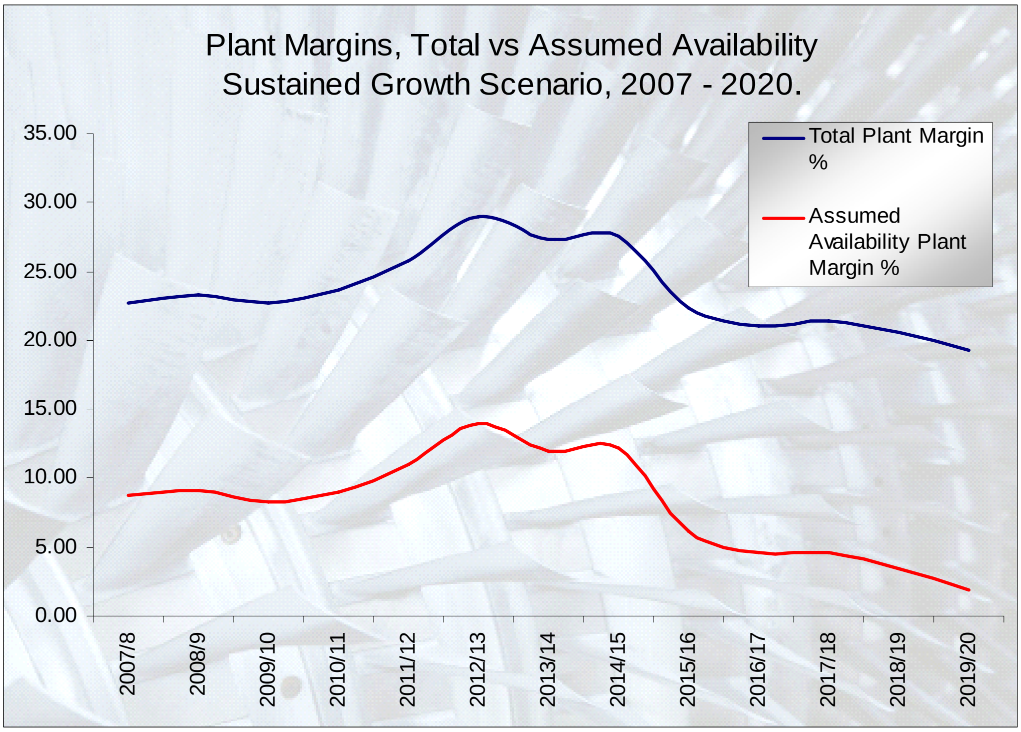

Figure 11: Plant Margins and Assumed Availability Margins 2008 - 2020

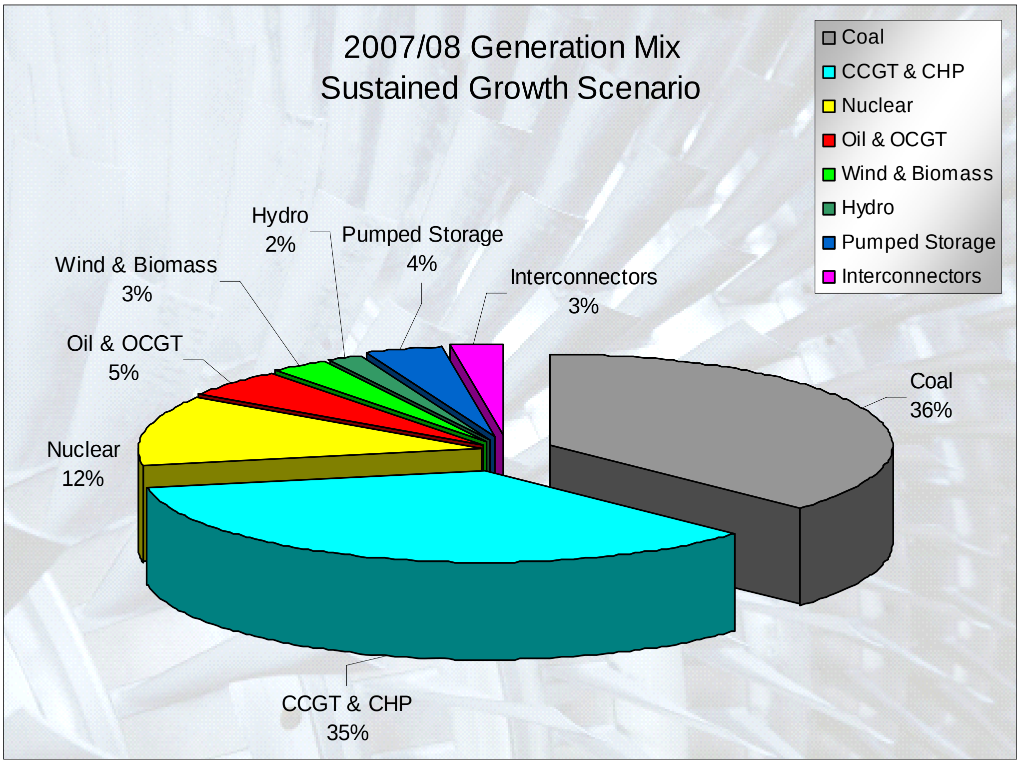

Figure 12: Generation Mix 2007/08

"assumed availability plan margin falls to below 5% by 2015/16"

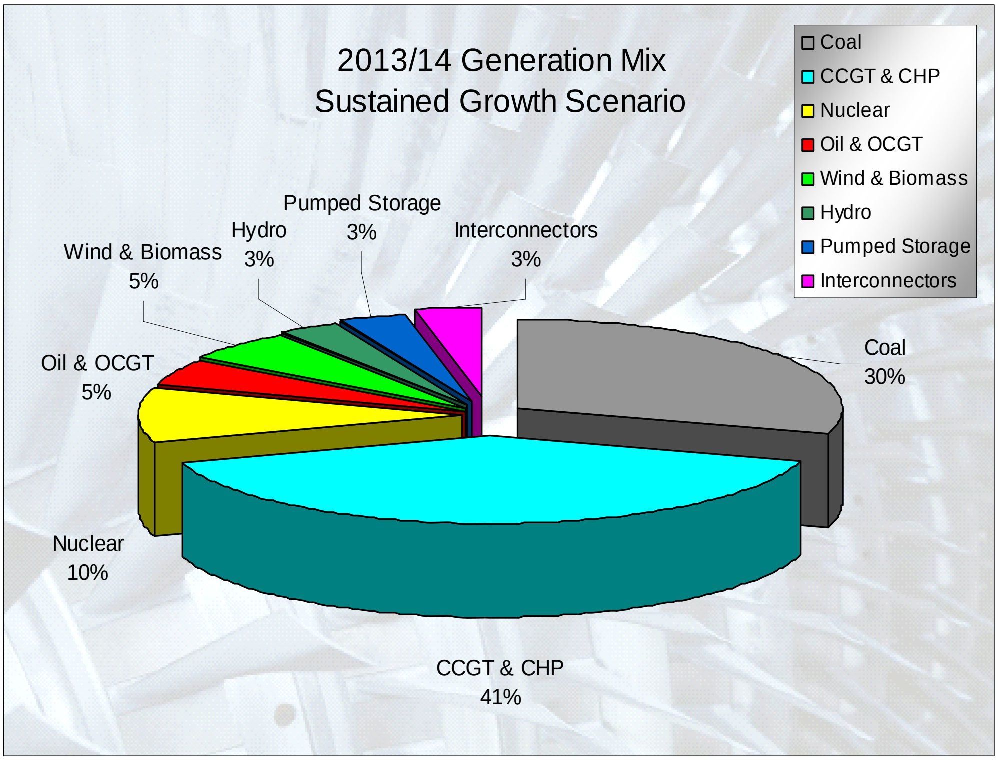

Figure 13: Generation Mix 2013/14

"gas plays a bigger part in this scenario"

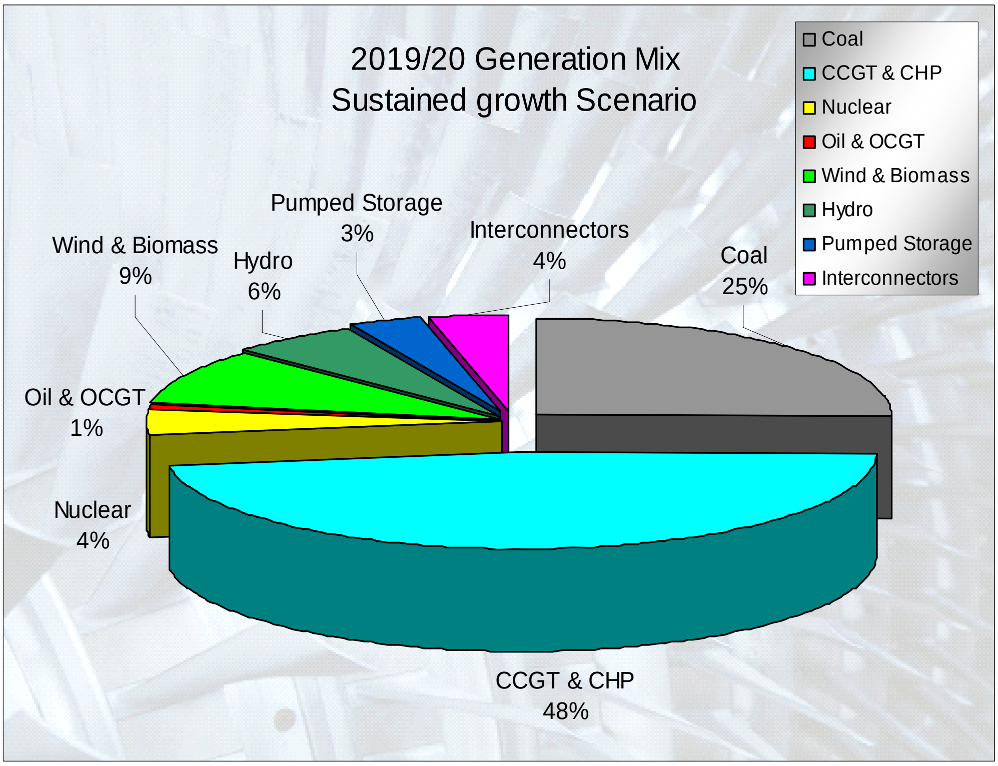

Figure 14: Generation Mix 2019/20

"the mix is similar to the high demand scenario by 2013/14"

Implications

With slower demand growth in this scenario than in the high growth scenario the case for investment in new plant will be less urgent. Supply margins remain healthy throughout the early part of the forecast period. Towards the end of the forecast the Assumed Availability Plant Margin drops below 5%. There is a risk that the lower priority on investment could mean that delivery of new capacity will be delayed to the point where the Available Plant Margin could drop to zero.

"Towards the end of the forecasts the Assumed Availability Plant Margin drops below 5%"

The tightness of the Available Plant Margin means that additional capacity, over and above that which has been accounted for in current plans, will be required to ensure energy security. This additional capacity, probably more CCGT, would add to carbon dioxide emissions requiring more of the carbon allowance under the EU ETS.

"The additional capacity, probably more CCGT, would add to carbon dioxide emissions"

In terms of energy prices to end users the combination of tight Available Plant Margins, fuel costs and the potential requirements for additional investment combine together to produce significant increases. These are would be expected to be later than in the High Growth Scenario because the Available Plant Margin starts to decline later in the forecast.

Although later in the forecast these price increases will impact on the same vulnerable groups as described earlier. Unlike the High Growth scenario the danger with this scenario is that its less extreme impacts allow a degree of complacency and hence delay in resolving the issues.

"these price increases will impact the same vulnerable groups as described earlier "

8.4 Scenario 3 : Slowly Declining Demand

In this final scenario the we see the impact of environmental concerns coming through. The picture that emerges is a decline in demand of around 4% over the forecast period. Whilst this is a fairly marginal change compared the historical pattern of demand growth it represents a major change in behaviour.

"the picture that emerges is a decline in demand of around 4%"

Key Assumptions

Short Term

- No major additional investment
- LCPD plants withdrawn on schedule

- Planned conventional plant delivered to the delayed schedules
- Nuclear plant lives extended to maintain margins

"key assumptions are run through the Inenco FEMM"

Medium – Long Term

- Gas becomes the dominant generating plant

Outcomes

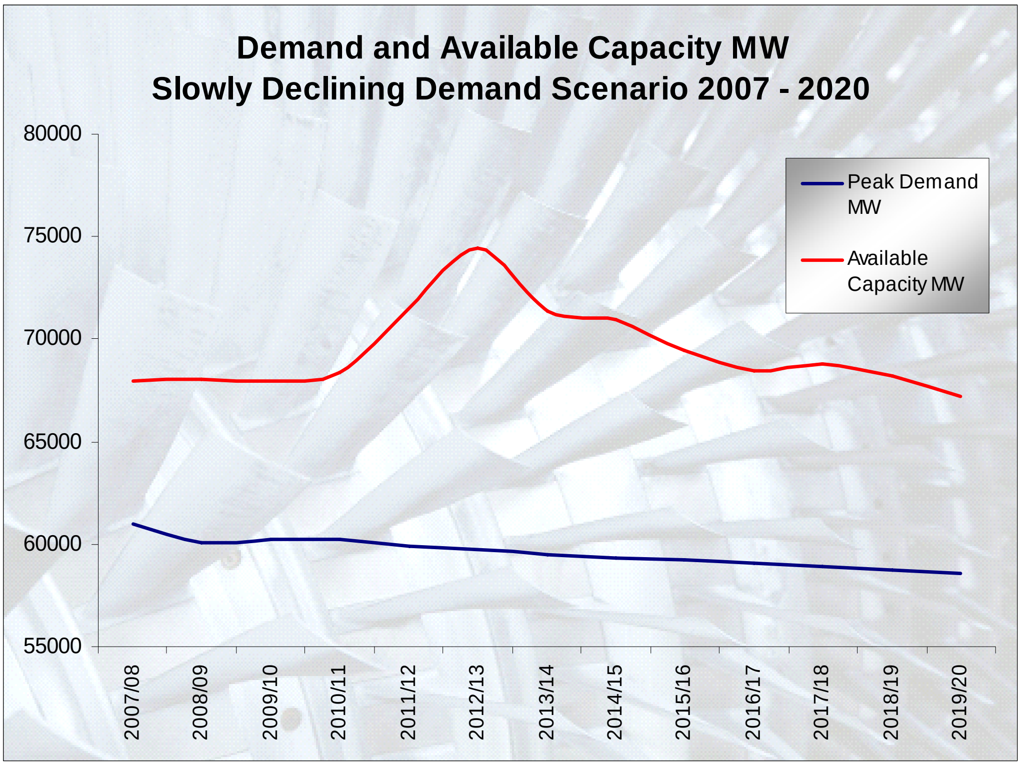

Figure 15: Peak Demand and Supply Capacity 2008 – 2020

" there is always a healthy Plant Margin in this scenario"

With the demand in this forecast declining this means that although capacity declines in line with the other scenarios, there is always a healthy Plant Margin. As we shall see later this scenario opens the opportunity to deliver both stable energy prices and reductions in carbon emissions.

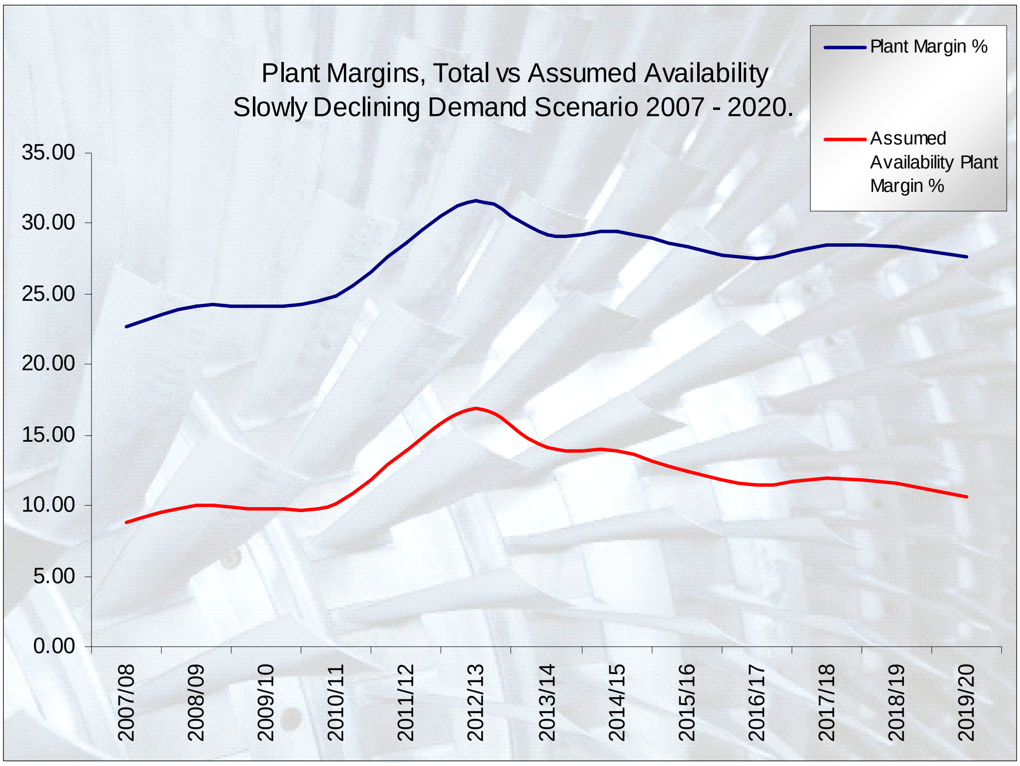

Figure 16: Plant Supply Margins and Assumed Availability Margins

"assumed availability plant margin remains above10% in this scenario"

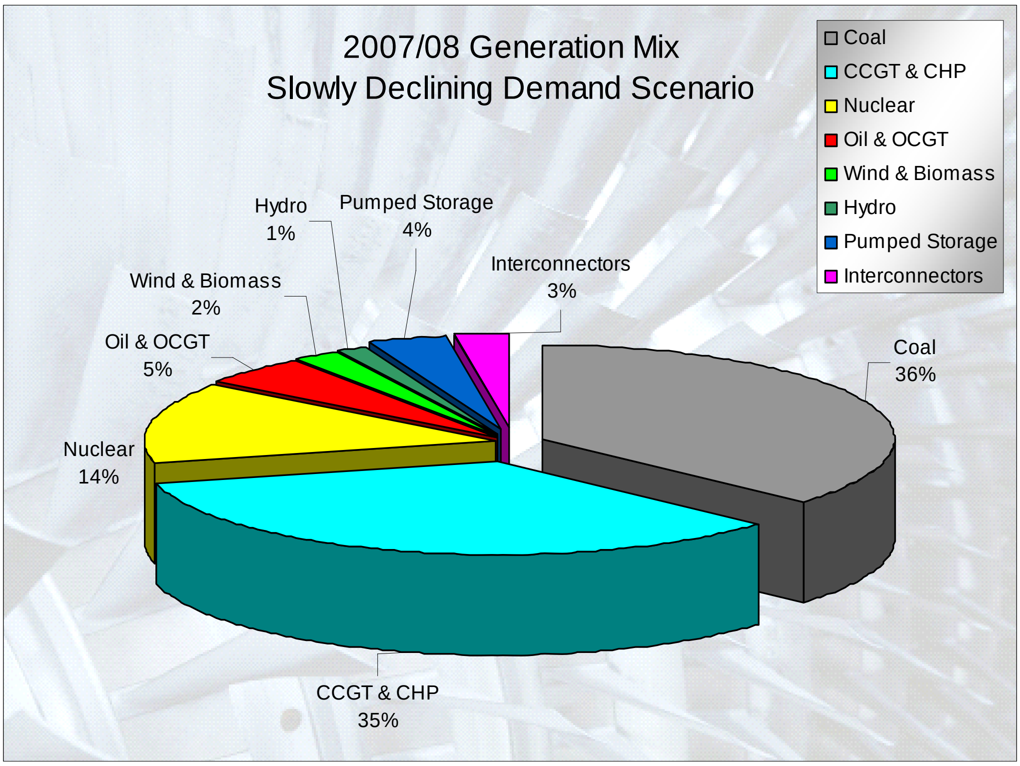

Figure 17: Generation Mix 2007/08

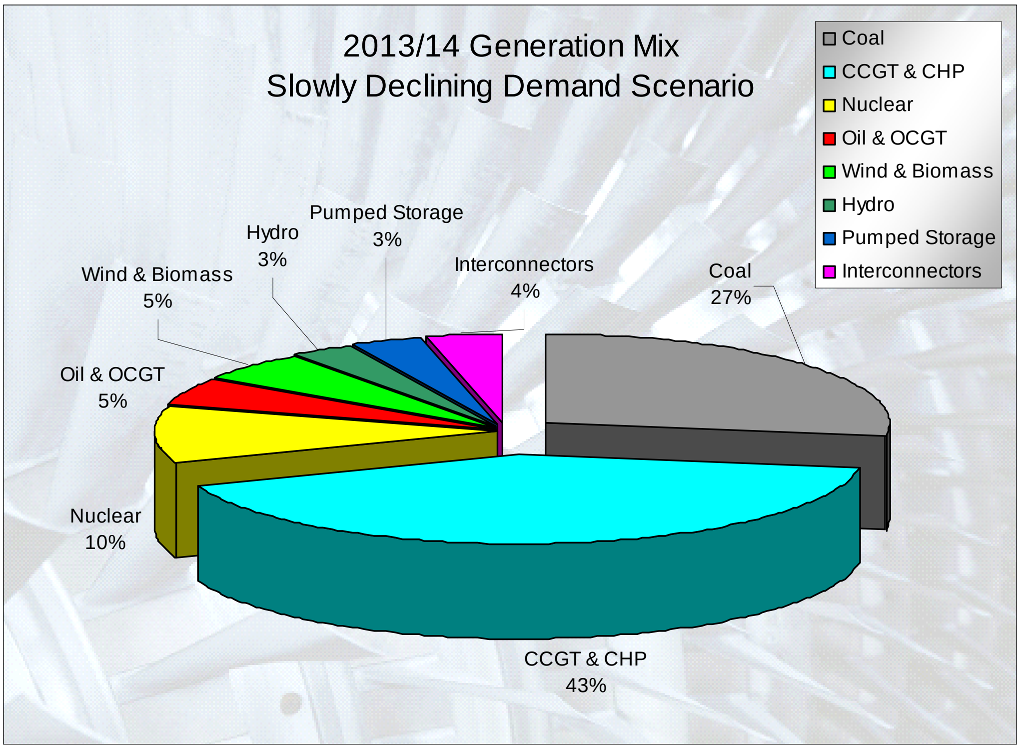

Figure 18: Generation Mix 2013/2014

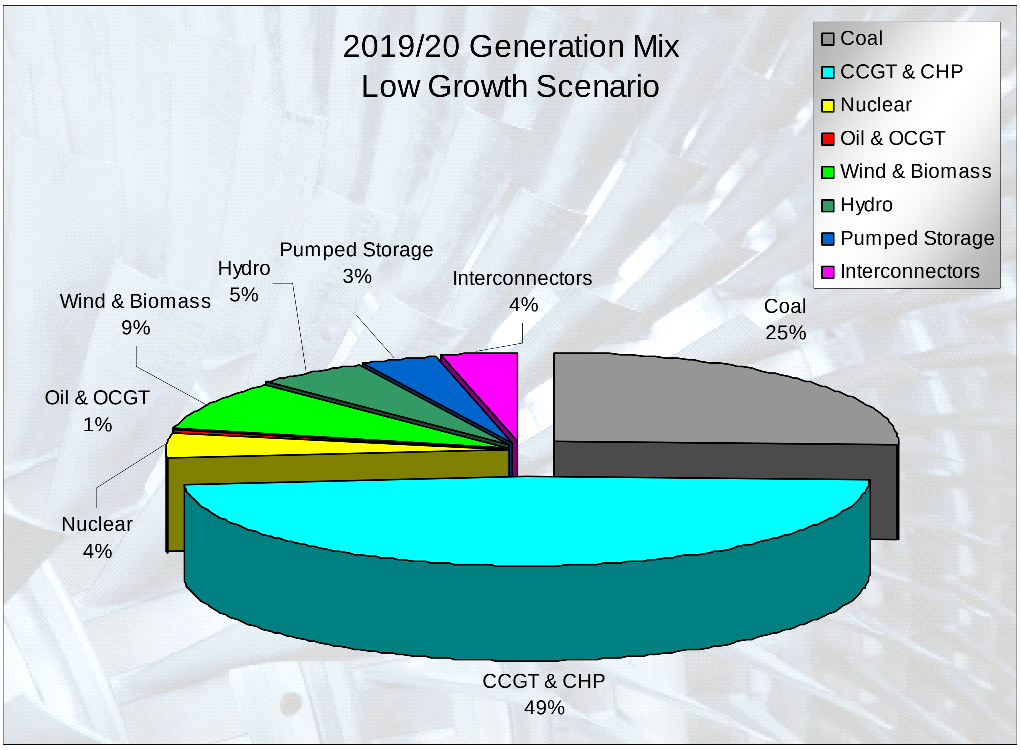

Figure 19: Generation Mix 2019/2020

Implications

The declining demand across this forecast means that there is considerably less pressure to provide replacement capacity as the LCPD plant goes offline. The planned replacement capacity will be sufficient to make up that lost from plant withdrawals. This lack of pressure also means that renewable source development is delayed. This delay arises because the price rises expected in the other scenarios are likely to be significantly lower in this scenario and hence the investment will appear less attractive.

"this lack of pressure means that renewable source development is delayed"

This is not to say that prices will not rise in this scenario. There is still a strong reliance on gas in the generation mix. This is subject to the oil market based volatility we have discussed elsewhere.

It is interesting to note that in this scenario, which provide the reductions in demand sought for environmental benefits also ends with the lowest proportion of renewable energy.

"this scenario ends with the lowest proportion of renewable energy"

At the same time it is in this scenario, with good supply margins even allowing for availability, offers the ideal chance to increase renewable generation. The renewable sources can provide low carbon power when they are available whilst there is sufficient other capacity to meet peak demand if the renewable sources are offline.

9. Conclusions

From our analysis a number of clear messages can be drawn

- Unless demand for electricity is reduced there is likely to be a significant tightening of supply before 2020
- Whilst an absolute power shortfall is potentially possible it is unlikely
- Gas fired plant will be the major replacement for withdrawn capacity locking price volatility into future power markets
- The availability factor for all generation types but especially for renewable sources has critical impact on supply margins
- High demand scenarios encourage investment in all areas including renewables

- Every scenario requires our existing nuclear stations to extend their operational lives

The picture that emerges of the coming decade is one where the market for electricity is governed by some fairly simple economic principles. Supply has limitations placed upon it and so price will be strongly linked to demand. At the same time the investment needed to reduce the pressure on supply is more likely if it has a high end use price to justify it.

"the investment needed to reduce the pressure on supply is more likely if it has a high end user price to justify it"

Energy policy in the short and medium term needs to address three key issues

- Energy Security
- Affordability
- Carbon Reduction

As with many economic situations it is not always possible to maximise the delivery of all three objectives at one time. In the high growth and stable growth scenarios the measures to provide energy security will impact negatively on Affordability and also on carbon reduction. At the same time a high focus on carbon reduction through use of renewable sources can have a negative impact on energy security.

"a high focus on carbon reduction through the use of renewable sources can have a negative impact on energy security"

The reducing demand scenario does however offer a chance to make progress on the energy issues mentioned earlier and create a virtuous circle. The reduced demand means that there will be less upward pressure on price, that the expected supply capacities can meet peak demand, and the demand reduction also leads to lower carbon emissions.

"the reducing demand scenario does however offer a chance to make progress on the energy issues mentioned earlier"

In order to take advantage of this opportunity we must find a way to achieve a reduction in demand without at the same time experiencing a downturn in economic activity. We believe that this demand reduction is possible by focussing on measures to deliver increased energy efficiency across both businesses and consumers.

"We believe this demand reduction is possible by focussing on measures to deliver increased energy efficiency"

Experience of dealing with organisations, shows that they can achieve reductions in consumption far greater that those predicted in the demand reduction scenario. If these actions can be driven out across broad sections of the business community whilst equivalent actions can be made in consumer markets the reductions would further ensure that supply margins remain positive and even grater carbon reductions can be made.

At the same time there are renewable sources of energy which can be delivered with much higher levels of availability that wind or hydroelectric sources can achieve. Further attention needs to be given to these options to ensure that there is a broad base of available power sources.

"further attention needs to be given to these options to ensure that there is a broad base of available power sources"

In the second part of this report we will look at the range of opportunities bringing energy efficiency into the way that businesses operate and individuals run their lives. It will look in detail at the implementation of these opportunities and at the kinds of issues which can hold up implementation.

Inenco Group Ltd – February 2008