

**Brief** October 2009

# Forging a nuclear renaissance

## Making new nuclear a reality

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Reaching the UK's carbon reductions target will require a strong contribution from all electricity generation technologies. If new nuclear plants are delayed or not enabled to play a key role in reducing power sector emissions, our energy future risks being less secure and more expensive.

This brief argues that:

- Nuclear power is essential for a balanced energy mix
- Technical barriers can be overcome
- The overall economics of new nuclear are favourable but contain uncertainties
- New nuclear will create economic opportunities.

### **Nuclear power is essential for a balanced energy future**

#### **New nuclear enables decarbonisation**

For the UK to have a realistic chance of meeting our national commitment to reduce greenhouse gas emissions by 80% by 2050, our electricity generation must be largely low carbon by 2030. In our recent report *Decision time – driving the UK towards a sustainable energy future*, we estimated that around 80% of generation would need to be 'zero carbon by that time' (Exhibit 1, page 2). As a proven low-carbon technology (see Sizewell B case study, page 3), this is supported by the public (see exhibit 5, page 3) nuclear could make up a significant part of this 80%. But given that almost all the UK's existing nuclear stations will have closed by 2030, this will mean constructing new nuclear plants.

#### **New nuclear contributes to energy security**

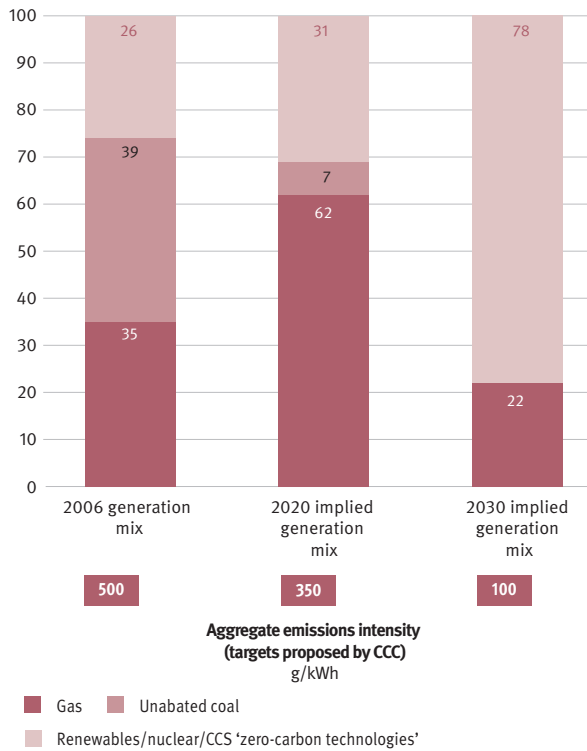
In terms of electricity generation, security is best guaranteed through having a diverse range of generation technologies and fuels, a large proportion of which are indigenous. Nuclear effectively falls into this category, as the uranium fuel for nuclear plants can be easily stockpiled in the UK and can be sourced from a range of stable exporting countries.

#### **New nuclear can help moderate electricity prices**

The scale of investment in electricity generation and grid assets which the UK requires implies rising prices over the medium term. While it is unlikely that rises can be avoided, a significant element of nuclear generation in the electricity mix can help moderate prices. This is in part because nuclear generation is not exposed to price fluctuation in global gas, coal or carbon markets, and in part because new nuclear is likely to be less expensive than some other forms of low-carbon generation (Exhibit 2, page 2)

### Exhibit 1 Meeting carbon targets will require a major shift in the generation mix

Generation mix based on 2020/30 aspirational targets on carbon intensity, %



Source: CBI analysis

### How much new nuclear do we need?

The electricity mix will be determined by the investment choices of energy companies, responding to market conditions and the policy framework. But based on the need to achieve around 80% zero-carbon generation by 2030, and the relative cost and commercial factors which energy firms will take account of, we believe around 16GW of new nuclear (equivalent to 10-12 reactors) is a plausible outcome by 2030. This would equate to perhaps 6-10 new nuclear plants (as some plant designs have twin reactors), all of which could be accommodated on existing sites. Exhibits 3 and 4 (page 3) show a possible generation scenario – the ‘balanced pathway’ – that would enable the UK to achieve a decarbonised electricity supply at an acceptable cost.

### Technical barriers to new build can be overcome

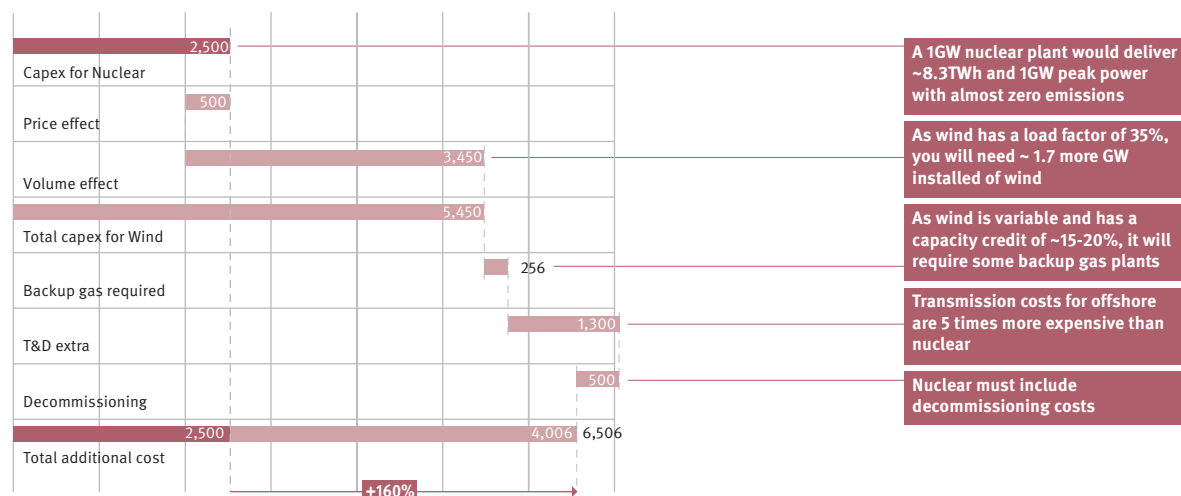
#### Planning reforms will be implemented

The government has proposed changes to the planning regime with national policy statements (NPS) and an Infrastructure Planning Commission to oversee all new major infrastructure projects in a streamlined process.

It is vital that the nuclear NPS is published as quickly as possible, and that there is cross-party consensus on the need to approve new nuclear stations rapidly, so investors can develop their plans in advance of the 2010 general election.

### Exhibit 2 For the same power generation and CO<sub>2</sub> emissions, building offshore wind requires two to three times the investment required for nuclear

Total capex difference between nuclear and offshore wind to generate 8.3TWh per year and 1GW of peak demand, £m

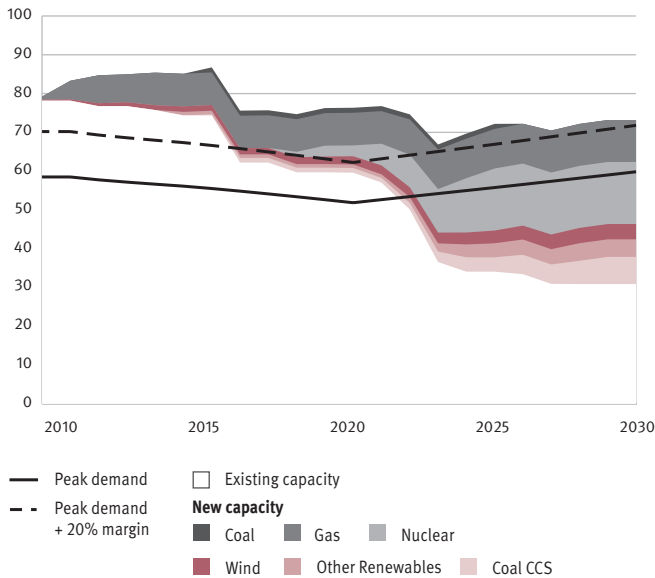


Assumptions:  
 - Offshore wind: capex/KW: £2000, load factor: 35%, capacity credit: 18%, T&D capex: £400/KW offshore, £100/KW onshore, gas capex: £500/KW  
 - Nuclear: capex/KW: £2500, load factor: 90%, T&D capex, Decommissioning costs

Source: CBI analysis

### Exhibit 3 The 'balanced pathway' – capacity

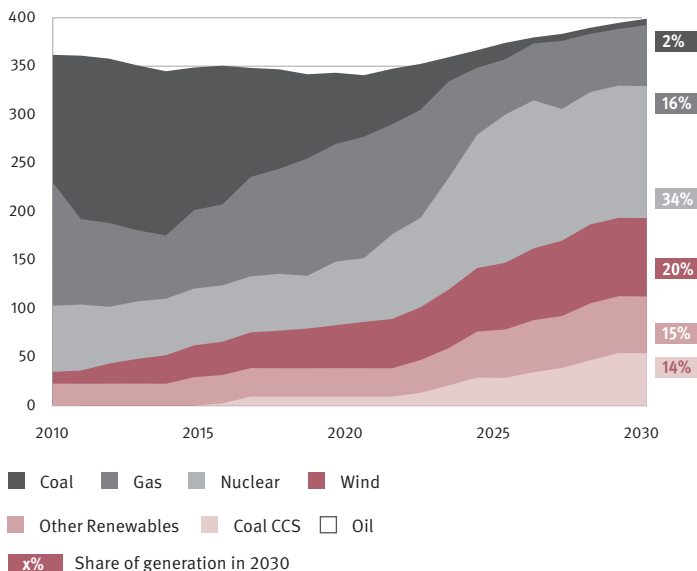
Projected existing and new electricity generation capacity<sup>1</sup>, GW



Source: CBI analysis

### Exhibit 4 The 'balanced pathway' – generation

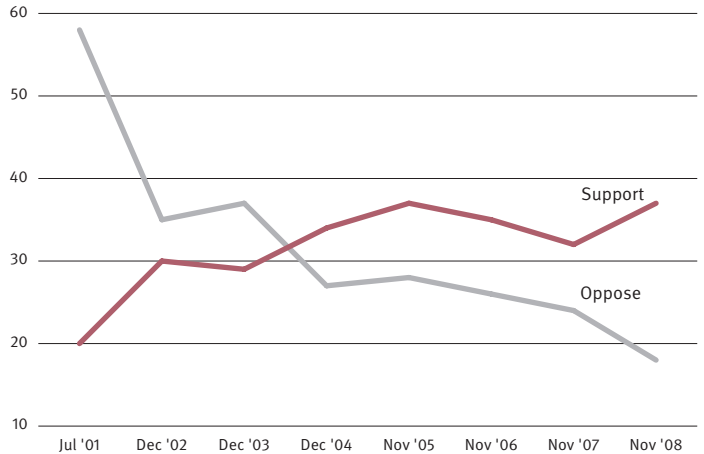
Projected total electricity generation<sup>1</sup>, TWh



Source: CBI analysis

### Exhibit 5 Increased public support for new nuclear<sup>2</sup>

To what extent would you support or oppose the building of new nuclear power stations to replace those being phased out (%)?



#### Case study Sizewell B environmental product declaration

Located near Leiston on the Suffolk coast, Sizewell B is the only pressurised water reactor (PWR) plant in the UK. It has a net electrical output of 1196 MW and has been operational since 1995.

An environmental product declaration (EPD) was developed for this power station which describes the environmental impacts of the electricity produced. Lifecycle analysis was used to cover the entire fuel cycle (below) and addressed CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub> emissions, and spent fuel and nuclear waste.

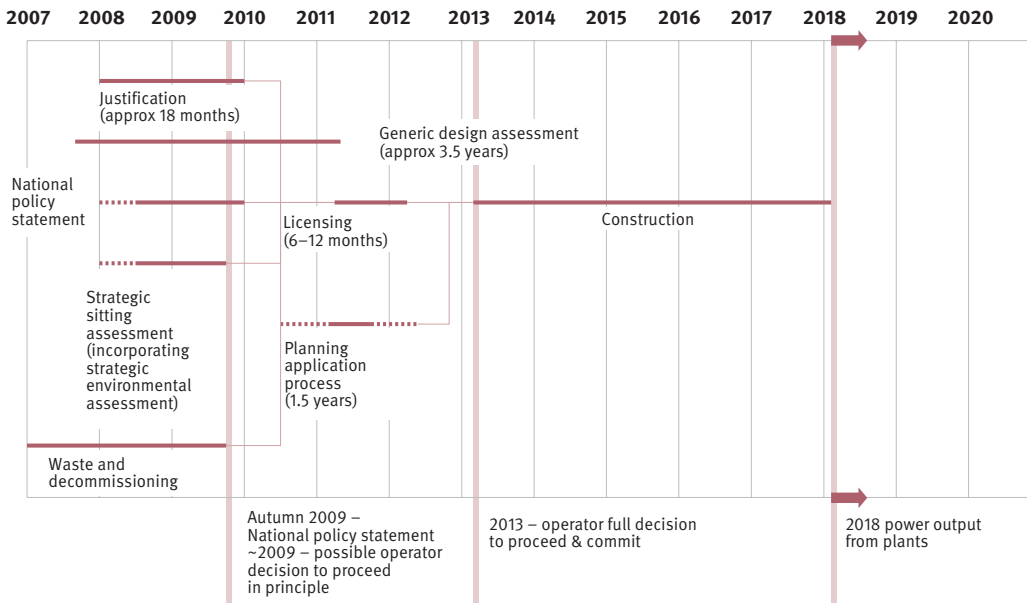
#### The nuclear fuel cycle

Calculated on a lifecycle basis, the total emissions of CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub> from electricity generated at Sizewell B are estimated at 5.50, 0.033 and 0.022 g/kWh respectively with emissions dominated by the extraction and construction phases of the cycle. These emissions are very much lower than those associated with fossil technologies and about the same as wind power.

Fuel-related radioactive waste originates from the operation of the power station and also from some of the other fuel chain facilities. The amount of spent fuel, intermediate level waste and low level waste generated is extremely low – 1.42 x 10<sup>-9</sup>, 4.14 x 10<sup>-9</sup> and 4.00 x 10<sup>-9</sup> m<sup>3</sup>/kWh respectively.

### Exhibit 6 New nuclear capacity can come online by 2018

Indicative timeline for first nuclear power station proposed by government



Source: A white paper on nuclear power, BERR (updated January 2009)

### Exhibit 7 Uncertainty on power prices and construction costs could hinder investments in nuclear power

Variable	Base case	Range	Impact on value of nuclear power plants (£m/GW), Base case: £332m/GW	
<b>Most significant variables</b>				
<b>Gas price (p/th)</b> <small>Driver of power prices</small>	50 <sup>1</sup>	30/70	-1,005	1,004
<b>CO2 price (EUR/t)</b> <small>Driver of power prices</small>	30 <sup>2</sup>	10/50	7	517
<b>Construction costs (£/kW)</b>	2,500	3,000/2,000	-393	392
<b>Cost of capital (%)</b>	7 <sup>3</sup>	8/6	-362	469
Plant life (years)	40	30/50	-216	126
Capacity factor (%)	90	85/95	-154	153
Decommissioning costs (£/kW)	500	1,000/300	-62	25

Source: CBI analysis

#### Licensing of new reactor designs

New nuclear plants in the UK would use the latest, most modern, proven reactor designs. Quite rightly, these new designs need to be licensed by the relevant UK authorities. The Health and Safety Executive's (HSE) Office for Civil Nuclear Security (OCNS) and the Environment Agency (EA) have embarked on a generic design assessment (GDA) expected by 2011. Each regulator programme runs over the same timescale.

The Nuclear Industry Inspectorate (NII) is looking at two designs, the AREVA EPR and Westinghouse AP1000. It is essential that the NII is adequately resourced to complete the task in the time available.

#### Managing nuclear waste

Nuclear waste understandably remains the main concern for the public. In practice, the construction of new nuclear stations has little impact on the challenge of managing nuclear waste as we have a legacy of nuclear waste that must be addressed, and the improved efficiency of modern reactors mean they will add relatively little additional waste (less than 10%) to the existing stock.

Nonetheless, it is right that an agreed solution to managing waste is implemented alongside the building of new plants. The Committee on Radioactive Waste Management (CoRWM) was set up in 2003 to review

E 7.1 Corresponding power prices (£/MWh) – base case: 45, range: 31/59

E 7.2 Corresponding power prices (£/MWh) – base case: 45, range: 38/52

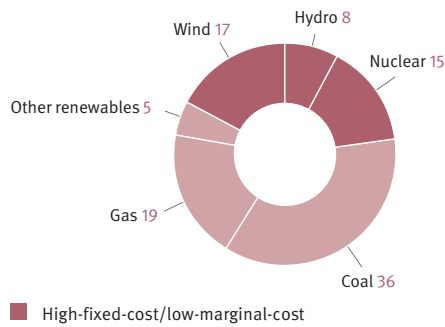
E 7.3 Based on typical cost of capital for European utilities

### Exhibit 8 Large share of low marginal cost technologies may drive low or negative electricity prices

Wind, nuclear and hydro represent 40% of installed capacity in Germany

Case example

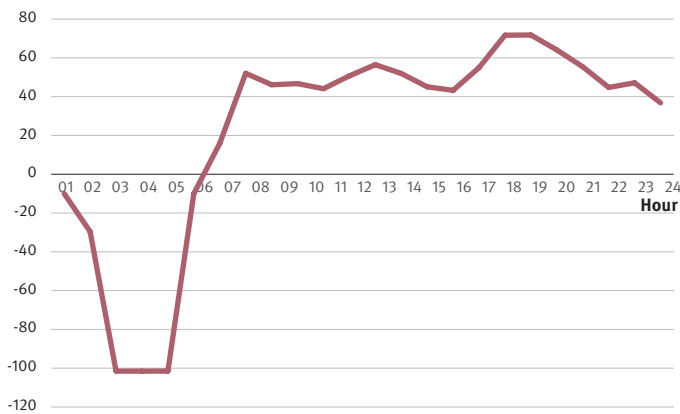
Breakdown of 2007 Germany generation mix by installed capacity (%)



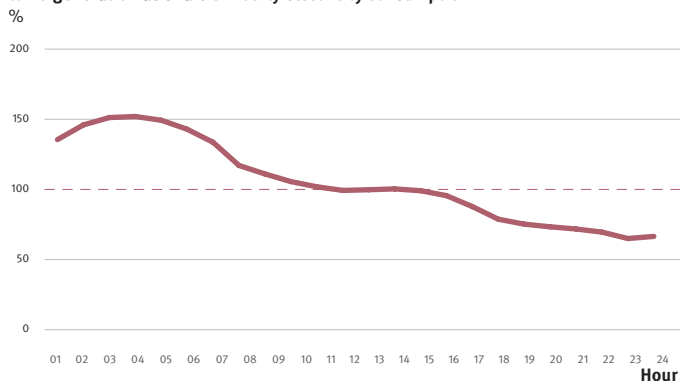
When ‘too much’ wind power comes online, electricity prices can drop significantly

Example: Intra-day trading data for EEX (Germany), 22 December 2008

Hourly electricity price  
EUR/ MWh



Wind generation as share of hourly electricity consumption



Source: CBI analysis

the options for managing the UK’s radioactive waste. In 2006 after an intensive process, CoRWM recommended that geological disposal represented the best available long-term approach and until this multi-decade process is complete, safe and secure interim waste storage is necessary. CoRWM’s recommendations were accepted by government and supported by business and CoRWM now provides independent scrutiny on proposals, plans and programmes to deliver geological disposal and robust interim storage.<sup>3</sup> The process of identifying and developing a site for a long-term waste repository is proceeding but will take time because there needs to be consultation at each stage.

The public also needs to have confidence that the funding will be available to build a repository that manages legacy waste streams and the waste from the next generation of power stations. A new funding mechanism will ensure operators are contributing sufficient funds to match the additional cost of constructing the deep waste repository so that it can also handle additional (as opposed to legacy) nuclear waste.

### The overall economics of new nuclear are favourable but contain uncertainties

#### New nuclear plants should be funded by the private sector

The UK’s existing nuclear plants were constructed with public funds as part of a state-owned energy industry. Today, as with any other electricity generation asset, new nuclear plants should be funded and built by the private sector, which should bear the risks of uncertainty in areas such as constructions costs and overruns.

#### Returns to investors on new nuclear plants are sensitive to uncertainties

Energy market trends have improved the economics of nuclear significantly in recent years. The creation of a carbon price through EU Emissions Trading Scheme (EUETS), and the long-term upward pressures for fossil fuels that would compete with nuclear as generation fuels, have all made new nuclear investments economic under a larger number of future scenarios.

But the economics of generation investments such as nuclear with high fixed costs and long payback periods are highly sensitive to cost uncertainties (Exhibit 7, page 4). Also, as the proportion of low marginal cost technologies in the electricity mix increases, periods of very low, or even negative wholesale electricity prices, are likely to start occurring (Exhibit 8).

While spot carbon prices have been hit in recent months by the recession, the tough, declining cap on the number of permits in circulation set in EU law for phase 3 of the scheme (2013-2020), and at an indicative level out to 2025, should help provide reassurance to investors that carbon prices at significant levels are likely to be sustained into the future.

### Case study Uranium resources for the development of nuclear

Uranium is a plentiful resource extracted from mines around the world, including politically stable countries such as Canada (20%) and Australia (19%).

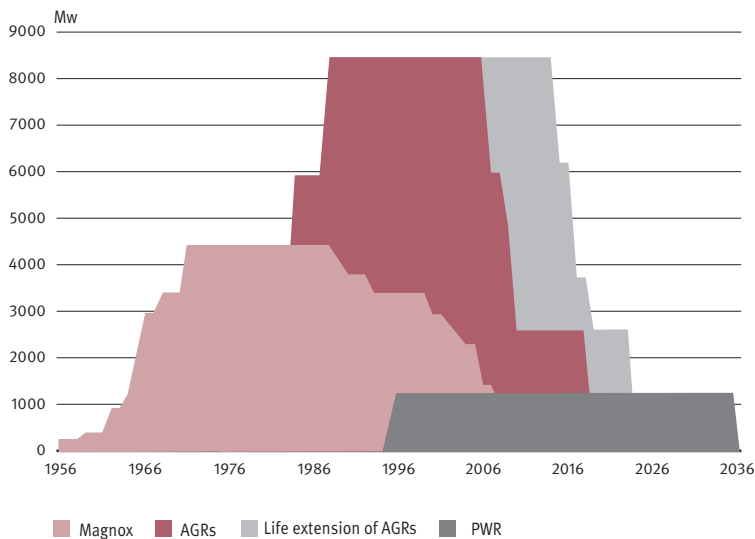
To some extent, the size of the world’s reserves of any resource is uncertain. Higher prices for a resource encourage new extraction technologies, make some reserve locations profitable to develop and promote the creation of alternatives to the given resource. The minimum answer to the question of supplies of uranium is that known reserves are roughly as abundant as tin or zinc and equate to 80 years of uranium fuel with today’s nuclear capacity of 440 or so reactors. Even with growing nuclear capacity, there are still enough known reserves for the next 40 years.

Current uranium production predominantly comes from areas that were surveyed during the 1970s and ’80s, but advances in geological exploration technologies and the prospect of new nuclear build in different parts of the world has led to known uranium reserves increasing by 15%.

Uranium accounts for only 5-10% of the cost of the electricity from nuclear power, in contrast to a gas-fired generation where the cost of natural gas can account for 70% or more of the total generating cost. Due to this, the economics of nuclear power generation are relatively insensitive to the cost of the uranium. A doubling in uranium prices would add only 10% to overall power generation costs. Based on experience with other mineral deposits, a doubling in the price of uranium would be expected to create about a tenfold increase in measured reserves. Furthermore, potential resources exist outside ‘conventional’ uranium ore deposits – for instance in the form of depleted uranium that could be re-enriched if prices rose sufficiently. Uranium could even be extracted from sea water and China is looking to recover uranium from waste coal ash.

According to the World Nuclear Association, global known reserves of uranium are more than adequate to satisfy reactor requirements to well beyond 2030.

Exhibit 9 Three generations of nuclear power in the UK<sup>3</sup>



However, uncertainty over the impact of any global climate change deal reached at the United Nations Summit in Copenhagen in December on the long-term future of the EU carbon market, and the difficulty of providing early certainty over the rules and cap level for EU ETS through the 2020s has led some businesses to raise the question of whether an additional market incentive for nuclear and other low carbon investment would be needed to guarantee low-carbon investment at the pace and on the scale required.

Different mechanisms could be used to try to provide additional clarity and confidence to investors. The potential advantage of pursuing this route must be weighed against the risk that further change in UK market regulation increases the perception among investors of regulatory risk.

A preliminary assessment of the various options based on their ability to provide long-term clarity is as follows:

#### Capacity auctions

Require that capacity levels are allocated through auctions with long-term, fixed price agreements. Their main advantage is that they eliminate uncertainty on future revenues, although they do eliminate dynamic competition.

#### Obligations

Define mandatory capacity or reserve levels, but for a specific technology or group of technologies (eg a ‘low-carbon obligation’),

covered physically or by purchasing credits. This could be an extension of the renewables obligation and if deployed well, could reduce investment risks. The more technology-specific, though, the greater the risk of trying to ‘pick winners’.

**Capacity markets**

Set mandatory reserve levels covered physically or by purchasing credits. They do not incentivise investments in specific technologies, unless they are technology-specific (eg obligations).

**Capacity payments:**

Payments linked to reserve margin or capacity. Unlikely to incentivise investments in long-term, high fixed cost technologies. This mechanism is used to incentivize availability of existing plants.

**Carbon price floor**

Lower limit on carbon price to ensure stability of power prices. Reduces downside uncertainty of future power price but does not account for gas price volatility – a bigger driver of power price. Could also increase costs for industrial users, and may undermine business confidence that the carbon market will not be subject to ongoing political intervention.

It would be premature to act before the carbon market implications of any international climate change deal are clear, and there is not yet in any case a consensus within business on whether an additional incentive will definitely be needed and if so on what form it should take. But we believe that there is an urgent need for a joint business-government taskforce to be set up to determine:

- The most effective form of additional market mechanism to incentivise low carbon investment
- Under what circumstances introducing such an additional market mechanism would be justified
- How the introduction of such a mechanism could be used to simplify the market by reducing the overall number of separate incentives in the market.

**New nuclear will create economic opportunities**

**We can build on the UK’s long tradition of nuclear operations**

Nuclear plants have been operating in the UK for 50 years (Exhibit 10). The benefits have been significant. In 2007, the nuclear industry supplied 57,249 GWh of electricity (15% of UK supply). Nuclear electricity represents a carbon savings of 34.5 Mt of CO<sub>2</sub>e if the electricity produced had to be replaced at current UK electricity carbon intensity. The UK’s nuclear electricity production also avoids the

purchase of £743m a year in natural gas if this electricity had to be produced using current combined cycle gas turbine technology and current gas commodity prices. The development of new plants will maintain and increase these benefits into the future. But the UK is not the only country considering new nuclear. If we are to be able to access the supply chain capacity and skills that we will need, ensuring that where possible they are UK-based, government and industry must press ahead with preparing for the nuclear renaissance.

**Developing the supply chain**

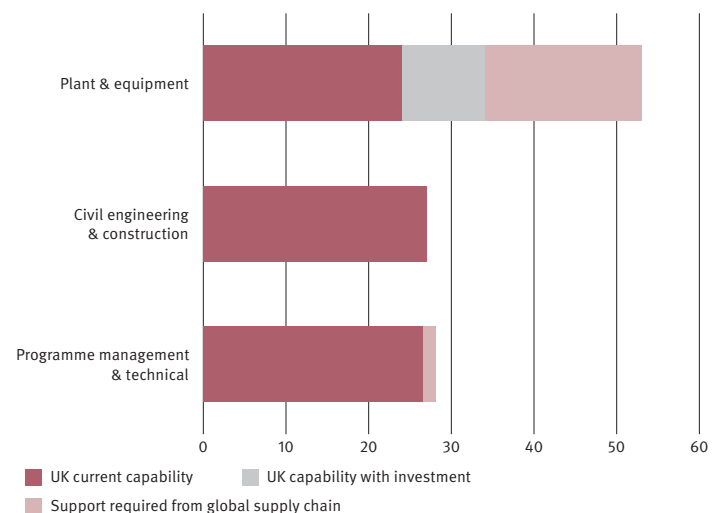
The last nuclear station to be built in the UK, Sizewell B, had almost 95% ‘local’ content. Since then, there has been a significant decline in supply chain capability.

Nonetheless sizeable supply chain capability still exists, not least to service the needs for the existing nuclear fleet, and this can provide the bedrock to develop capacity in this important area.

But there is relatively little time for the sector to develop this capability, particularly in the high value, skills intensive part of the new build programme. Some skills may need to be imported if we are to keep to the timescales we need, but if we act now we can keep this to a minimum.

The Nuclear Industry Association estimates that the UK nuclear industry has the capability of providing more than 80% of new nuclear power station projects in the UK, that a phased programme of nuclear

**Exhibit 10 UK capability to deliver a new nuclear build programme (%)<sup>4</sup>**



<sup>4</sup> The UK ability to deliver a new nuclear build programme, 2008 update [www.niauk.org/images/stories/pdfs/supplement%20for%20web.pdf](http://www.niauk.org/images/stories/pdfs/supplement%20for%20web.pdf)

power station construction is well within UK capability and that this would require less than 5% of the current UK construction resources (Exhibit 10).<sup>2</sup> Some key components currently cannot be produced by UK companies and will come from the very few overseas companies with this capability. But Sheffield Forgemasters is planning to extend its capability into very large forgings and some foreign suppliers have increased their production of other components.

To assist the development of the UK nuclear supply chain, the Chief Nuclear Safety Regulator has proposed that companies in the nuclear industry go through a pre-qualification and review process to enable the supply of products or services to meet relevant quality and safety standards. This could help ensure the supply of components meet the necessary standards in a timely manner so as not to delay or increase the cost of the nuclear new build programme. The proposal to create supply chain assurance program has merit and the CBI calls for government and industry to create a nuclear supply chain pre-qualification and review process.

The Nuclear Industry Association launched the two-year Nuclear Supply Chain Development Programme in early 2009 to strengthen and promote the capability of the UK supply chain. Also, budget 2009 announced a £750m strategic investment fund that could be used to invest in the UK nuclear supply chain capability.

#### Maintaining operating skills

One potential constraint is the ageing workforce in the nuclear industry – for example, about 30% of British Energy's staff will have retired by the time the first nuclear station is built, and a further 35% will have retired by the end of a new build programme.

Skills retention is already a challenge to maintaining the existing fleet of nuclear reactors (particularly as life extensions are realised) but is also an important part of the new build agenda. Because it is a Pressurised Water Reactor (PWR) technology, Sizewell B provides a basis for developing operational capacity to service the new stations based on the same technology.

The National Skills Academy for Nuclear launched in January 2008 is working to deliver 1,200 apprenticeships, ISO foundation degrees and training for 4,000 employees to redeploy from operations to de-commissioning. It is also developing the Nuclear Skills Passport to recognise the skills and training the industry requires.

#### Conclusion and recommendations

A new nuclear programme can help the UK meet its carbon targets, ensure we have a diverse, secure, electricity generation mix, and support the UK's strengths in engineering excellence. But the scale

of the new build programme required, and the nature of nuclear technology and economics, mean that rapid action is needed by government and business if we are to seize the opportunity.

#### Actions for government

- **Speed up the planning process.** By November 2009 the government must publish the national policy statement for nuclear and other energy technologies. Vigilance is needed to ensure that the generic design assessment (GDA) process is completed by mid-2011. Predictability and continuity with these initiatives through cross-party consensus provides valuable certainty for investors.
- **Explore need for new low-carbon generation investment mechanism.** Set up a business-government taskforce to provide clarity on the electricity market framework for the next 20 years, in particular resolving the debate about the nature and need for new market mechanisms to make returns for low-carbon investment more predictable.
- **Make demonstrable progress on a long-term nuclear waste solution.** By March 2010, the government must publish – in agreement with industry – the fixed unit price for waste and decommissioning financing.
- **Support the development of the nuclear supply chain capability.** By June 2010, specific investments in the nuclear supply chain should be made from the £750m Strategic Investment Fund.

#### Actions for Industry

- **Maintain public confidence by continuing to operate the existing assets, safely and reliably, for as long as possible.**
- **Support the nuclear and energy skills initiatives. Build on the National Skills Academy for Nuclear and produce a coherent programme of nuclear and energy skills development across education.**
- **Engage with local stakeholders at each stage of the new build process, in an open and responsive way.**
- **Work with government and supply chain to ensure the capacity and skills are developed to service new build needs.**
- **Invest in building up supply chain capability, enabling it to support the new build programme.**
- **Engage with the education sector to encourage young people to join the nuclear industry by providing work experience and internship opportunities, sponsoring students on specific courses, providing support to new graduate recruits, and by participating in degree programme advisory boards to shape course content.**