Accelerating New Nuclear Build

Agenda for Urgency

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Executive Summary

In the 2006 Energy Review, the Government made the case that nuclear power might be part of the solution to the twin problems of climate change and energy security. It would be the task of private industry to fund and construct any new stations. The role of Government would be to facilitate new build by addressing some of the economic and institutional barriers.

Consultation on nuclear is continuing and therefore no final decision has been made. This delay to some degree aggravates the situation in that:

- Existing nuclear plants are near the end of their lives and will close from 2011
- The commercial conditions to build new stations are not in place
- New stations will take 10 years to license, plan and build
- The UK has a strong need to reduce carbon emitting generation
- The UK wishes to reduce its growing dependence on imported gas, and
- Other types of plant may be built instead, reducing the opportunity for nuclear power, and increasing the UK's CO_2 emissions.

The most optimistic view of the current trend, reflected in the Energy White Paper, is that by 2020 only one or two new nuclear stations might be built and much of the current capacity will be replaced by coal or gas and less dependable wind generation. Progress will have been made with renewables, however the UK will have lost 10GWe of low-carbon base-load nuclear generation, will have built few new nuclear stations, and will have become more dependant (>50%) on imported electricity and gas.

As a consequence, emissions of carbon will be higher and because new fossil-fuelled stations have been constructed, this situation will continue for the 30+ year operating lives of the new generators.

Agenda for Urgency

- Low Carbon & firm generation capacity is urgently required, and
- The UK needs to secure and diversify its energy supplies
- Nuclear generation is the only technology that can satisfy these needs, but current generating capacity is nearing the end of its life & will take many years to replace
- Commercial and institutional conditions are not in place for major new nuclear build
- Global & UK industrial capability to build new stations is weak
- A joint task force is proposed to put in place the conditions for new build & ensure the programme is delivered.

There are other means of generating low-carbon electricity, but these are either less dependable, or require further development, or are more expensive.

Nuclear power has the potential to be a major component of the response to the HMG's policy because:

- The technology is developed and is available
- Nuclear power can be economic in the right conditions
- It is low carbon, and
- It is dependable as 'firm' power.

The UK's requirement for nuclear will be greater than just replacing 10GWe of capacity. To make an impact on climate change and security of supply, at least 20GWe of new nuclear power plant could be required in the next 25 years.

Because of the long period of time since nuclear power stations were built in significant numbers, the industry both globally and in the UK is much weakened. It will need positive encouragement to give it the confidence to re-equip and to re-skill, and to engage with the challenges of a large new build programme.

While HMG is taking action in the field of policy, initiating and accelerating the programme requires tangible deliverables that:

- Establish the commercial conditions for investment, and
- Make progress on a range of structural issues to both reduce uncertainty and permit speedier action by industry.

There is a need for urgency in changing the current trajectory by setting the right conditions for private industry to fund and build stations both more rapidly and in larger numbers. This cannot be done by Government acting alone because:

- The conditions to be established relate in essence to the private sector
- These issues are diverse and interactive
- The solution requires an understanding of the commercial aspects of setting the economic conditions for investment, while considering the long term economic effects on the UK.

The purpose of this paper is to propose a joint taskforce of industry experts and government officials to deliver the means and the conditions required for a successful nuclear new build programme. This taskforce should be independent of the main protagonists to be unbiased in its advice. Also, the taskforce must be knowledgeable about the industry and the requirements of nuclear power.

We believe that such a joint task force would enable the implementation of a nuclear new build policy much more rapidly and on a larger scale, should the Government decide on this objective. The scope for acceleration is construction of 25GWe of new nuclear by 2036, when nuclear generation would be ~50% of electricity supply, reducing emissions by more than 25MtneC per year and cutting dependence on imported gas for generation, by about half.

Some of the issues are addressed in the Energy White Paper. Because HMG is continuing its consultation on the nuclear aspects of the Energy Review (until October), the White Paper covers nuclear issues narrowly and in the context of a national decision to proceed with new nuclear, or not.

If this proposal for accelerating new nuclear has merit it must be worth considering whether the taskforce should be set up before the consultation period on nuclear is complete.

acumen7 is a group of experts in the fields of energy, major project development and delivery, and in construction strategy. The team has consulted widely in the industry and is proposing a process and a programme of work.

Details of the proposal, the team and of ***acumen7*** are given in the attached paper.

1. Context

In the 2006 Energy Review, HMG made the overall case for investment by the private sector in new nuclear power stations, as part of a mixed-fuel energy policy. That case considered replacing the current capacity as the AGRs close in the period until 2023.

The main thrust of the Energy Review was that there are two major and long-term considerations affecting the UK energy policy:

- The strong evidence for **climate change** is leading to the need to make a substantial cut in green-house gas emissions from all countries.

- As North Sea gas production declines, the UK is becoming more dependent on supplies from Russia and other parts of the world whose stability is open to question. By 2020, perhaps 80% of the UK gas requirements will be imported raising questions of the **security of supply.**

The UK is taking the lead in cutting green house gases and has published a draft Climate Change Bill with the objective of cutting the UK emission by 60% by 2050.

Like other countries in the EU, the UK is seeking to increase the security of its energy supplies by ensuring that a much greater proportion is either fully sourced in the UK, or uses a diverse range of fuels that are either plentiful, or come from dependable countries, or can be stored in the UK.

During the next 15 years, investments will need to be made to replace in excess of 30% of the UK generation capacity because of both ageing plants (including 10GWe of old nuclear plant) and emissions (coal fired stations that do not meet the EU emissions rules - Large Plant Directive).

Therefore, the decisions taken in the next few years will have a major effect on the energy mix in the period up to 2050 and will have a lasting consequence for the effectiveness of HMG policy in the areas of climate change and security of supply.

Currently, the electricity industry's preferred energy source for new electricity generation is gas. With the support of subsidies, investment in wind farms is proceeding in significant volumes. Also, new coal-fired stations are being considered and other technologies are developed such as carbon capture and storage.

Nuclear Power around the World

400 nuclear reactors around the world provide 16% of electricity in a safe and dependable manner

The problems of waste disposal are being solved in several countries

The whole life-cycle emissions for nuclear power are very low

New designs of reactor are even safer than the operating reactors and they offer lower costs which should be competitive with other means of generating electricity

Large scale investment in new gas stations would run counter to HMG's objective of increasing security of supply. Both coal and gas are major sources of CO_2 and construction of new combustion stations would commit the UK to a high carbon future for many years to come.

The broad case for nuclear was made both in the submissions to the Review and in the Energy Review itself. The Review concluded that there was a case for nuclear, as part of a balanced energy policy. The construction of new nuclear power stations by the private sector was envisaged to replace the current nuclear capacity which represents about 20% of current demand and makes up the main element of base-load supply. Public consultation on this proposition is continuing.

2. Setting the Policy Agenda

HMG has set out to make the policy environment for new nuclear construction more attractive. The private sector will make the decisions and invest in new stations. These will be without any direct Government involvement or support.

The Energy Review has had a positive effect on opinion as it becomes recognised that the energy issues are important and they require action that will have a long term effect. Also, nuclear power has a contribution to make to both climate change and energy security as there are few large scale alternatives with similar benefits.

The policy proposals have been laid out in three White Papers dealing with:

- Energy
- Climate Change, and
- Infrastructure Planning.

Also, the new process for reactor licensing for safety, emissions and security has been published. This is a two step process that integrates the activities of the Nuclear Installations Inspectorate, Environment Agency and the Office of Civil Nuclear Security (and their Scottish equivalent). The process separates, to some degree, the licensing of reactor designs from the specific site licence. This has several advantages including the ability for investors to select a design that already has been accepted and it would enable a fleet of identical reactors to be built because the design certificate can last for up to 10 years.

Further, HMG is committed to providing a long-term solution for the disposal of nuclear waste and is considering different structures for operators to pay for the decommissioning and waste disposal needs of new reactors.

When complete, all these actions will make a major difference to the risk profile of any nuclear investment and therefore will influence utilities and others to consider nuclear as a potential means of replacing, or adding to, generating capacity.
However, the actions required to create the conditions for investment in new nuclear power stations are spread across many government bodies and agencies. The changes in policy need to be matched by changes in approach to provide the momentum to deliver new investment in the timescales required to meet HMG energy policy objectives.

The question is:

How will the leadership and coordination for this programme be provided?

Leadership is required

Large number of policy initiatives

Public yet to be convinced

The UK electricity market that does not support investment in capital intensive generation

International nuclear industry with depleted resources

Private funding as the vehicle for nuclear build is new to the UK

3. Conditions for Investment

HMG has yet to make a decision fully to support nuclear power. That case depends on the need to address climate change and security of energy supplies at a time when new capacity is required because both existing nuclear and older coal fired plants will close in the next 15 years.

The case for nuclear, the need for urgency and the factors that affect the investment decision by the private sector are linked together as laid out in Figure 3.1 below.

It is clear that the UK utilities during the next few years will need to invest in some form of new power generation plant. There are public policy reasons for that plant to be low carbon and to be able to provide secure capacity.

Also, the industrial capacity (both global and within the UK) to deliver the type of programme that would be required, is not in place.

These issues are examined in the following sections:

Case for nuclear investment	**Section 4**
Need for urgency in changing the conditions for investment	**Section 5**
Industrial capability & implementation	**Section 6**

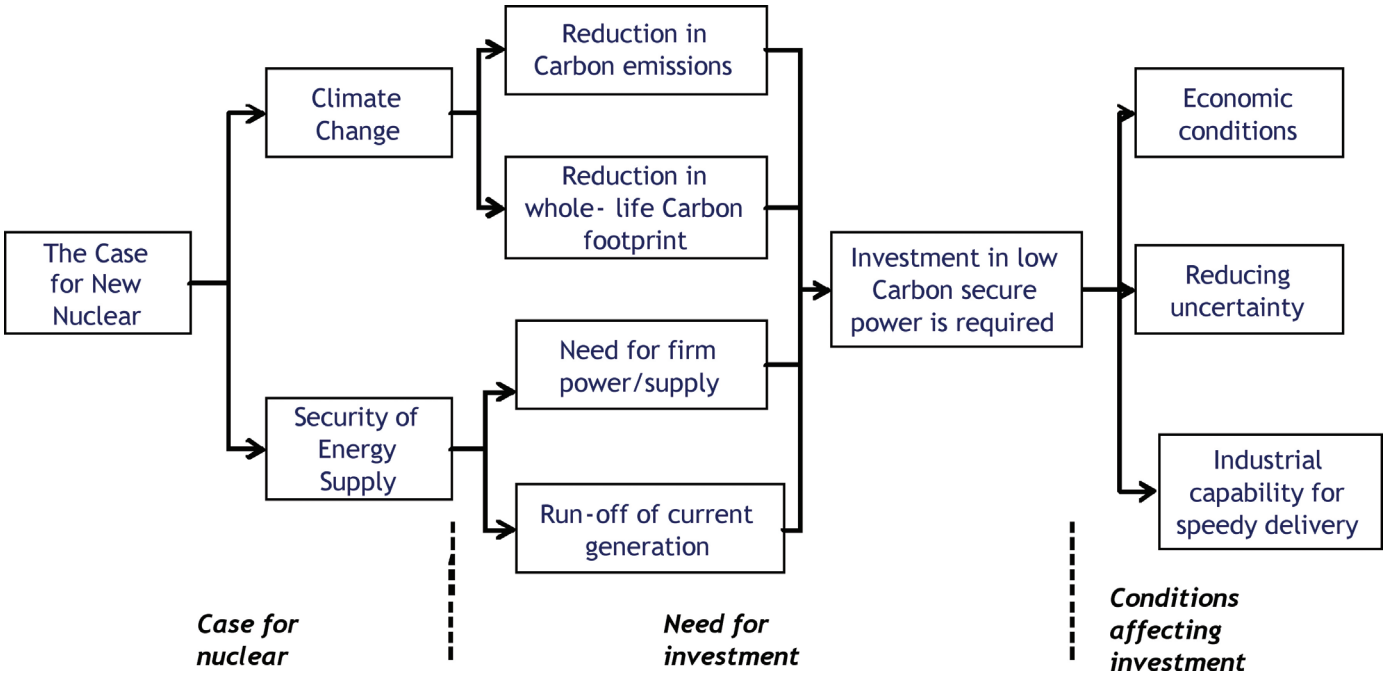

Figure 3.1. Investment Case Logic

Nuclear power has the advantages that it is:

- Developed and available
- Economic in the right conditions
- Low carbon, and
- Dependable as firm power.

However, public acceptance of new nuclear construction has yet to be established. Also, the conditions for private investment in new nuclear do not currently exist. This is both because of the nature of the electricity market and the uncertainties that an investor would face.

4. Case for Nuclear Investment

The national case for nuclear lies in its ability to make a large contribution to climate change and security of supply, while being both a firm form of power and under the right conditions, economic.

The two main issues of climate change and security of supply are discussed here. Many other studies (as summarised in the Energy Review) have shown that nuclear can be economic. Because the investment will be made by the private sector, it will not occur unless private investors consider the economic case to be sound. These matters are considered later in Section 6, with the other conditions required to make the case for investment in nuclear power.

Climate Change

As argued in the Stern report on the economic effects of climate change, action is required on a broad front in many countries to reduce green house gas emissions. Climate change has long lead-times both for its effects and for any remedial action. One of the main messages is that investment now to reduce carbon emissions would be less costly and less disruptive, than delaying expenditure until the effects of climate change are immediate and are adversely affecting the UK economy.

As a major developed nation, the UK should show leadership in cutting green house gas emissions of which carbon dioxide is the most important. The Government has welcomed the EU commitment to cutting emissions by 20% by 2020 and is going further in the draft Climate Change Bill setting a target to reduce emissions by 60% by 2050. These are very challenging targets. They will require success on all fronts – energy savings, low-carbon and renewable, nuclear and new power technologies.

An immediate challenge for the electricity sector is the imminent closure of the last of the Magnox power stations and the subsequent closure of the AGRs. The trend of these closures is shown in Figure 4.1 below, where the loss of nuclear capacity is compared against a traditional view of the construction of new nuclear stations.

There is a medium term prospect of making conventional forms of generation (coal & gas) low-carbon, by capturing CO_2 from the process and storing it at high pressure underground, or in the old oil/gas fields such as those in the North Sea (Carbon Capture & storages - CCS).

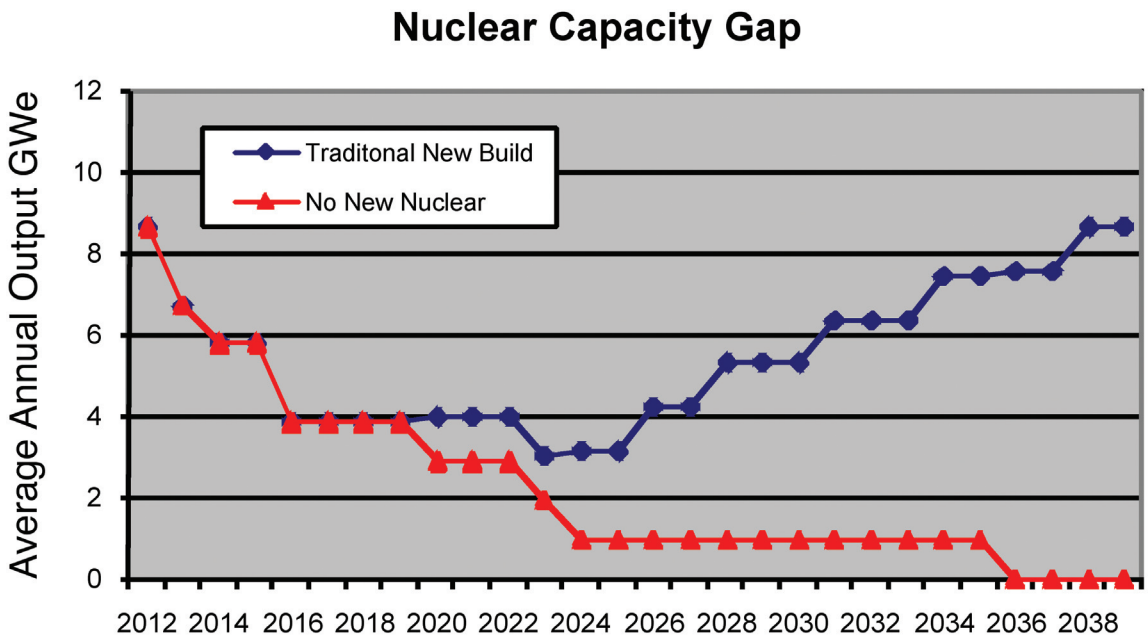

Figure 4.1. Nuclear & Low-Carbon Capacity Gap

These CCS technologies are promising but have proved expensive in early pilot/demonstrator plants. They have yet to be fully demonstrated as complete systems and on a large scale.

Also, the costs of the additional capital equipment, infrastructure and energy required for the process have yet to be fully evaluated and may make CCS generation uneconomic.

As described in the Energy White paper, the need in the longer term is to reduce carbon emissions further (by 60% by 2050). Once CCS is proven to be practical and not too costly, coal could once again become a major component of the UK's electricity system. However, it would be unwise to count on CCS until the technology is demonstrated and proven.

A large amount of wind power will be constructed during the next 15 years to meet Government targets for renewable sources of generation. This new wind capacity is unlikely to fill the whole of the low-carbon gap for a number of reasons:

- There is a lack of on-shore sites that are acceptable to the general public
- The variability of wind at many on-shore sites adversely affects annual output and hence project pay-back
- Off-shore wind generation has higher capital cost though because the wind speeds are higher and more constant this disadvantage is to some extent off-set.

It is recognised that wind generation lacks dependability and requires conventional power as back-up (somewhere in the electricity supply systems) to provide power for periods of low wind affecting the whole of the UK. The cost of this additional back-up to make wind generation 'firm' needs to be considered.

Wind is an important resource for future electricity generation

Wind will be major component of renewable generation which will make up ~15% of supply by 2020

Sites, economics & lack of dependability limit growth of wind

Other renewables such as hydro, wave, tide, or wood & waste is either expensive, or the scope for their expansion is relatively small.

Most of the larger hydro-generation opportunities have been exploited. Wave has been studied extensively and some demonstrators are being constructed but they are expensive, small in scale and difficult to maintain.

Tidal barrages have some attractions because they are dependable and can have scale, but they have very high capital costs and affect large areas of what are often picturesque and scientifically sensitive areas. To be viable, such projects may require large and continuing subsidies probably beyond the duration of the current renewable obligations.

Nuclear capacity gap leads to 50 Mtne of additional Carbon emissions

UK dependant for imported gas for ~60% of electricity generation by 2020

Nuclear could play a major role with construction of ~25 GWe

Energy from crops grown specifically for the purpose, or from waste is be developed but on a small scale because the large volumes of material required to be collected and transported to the power station are a significant factor in the economic case and the overall energy balance.

It is forecast in the Energy White Paper that in the period up to 2020 other types of firm power such as current designs of coal or gas power station will be built to meet demand.

Without a significant change of direction the decline in nuclear shown in Figure 4.1 will become unavoidable. Even with the limited nuclear build that seems possible there will be a loss of over 350 TWh of carbon-free generation (equivalent to **~50Mtne of Carbon emissions up to 2036).**

If as seems likely the stations were replaced by a mix of fossil fuel generators this would lead to an additional **200Mtne of Carbon** emission during the operating life of the new stations.

This level of lost low-carbon generating capacity cannot be exchanged for additional wind or wave power. Urgent action is needed to ensure that, at least, the proportion of nuclear generation is maintained in the UK by constructing new stations on an accelerated timescale.

Security of Supply

As the North Sea output declines the UK is in the process of rapidly becoming a net importer of both oil and gas. It is estimated that by 2020 over 80% of the gas will be imported. As well as being the dominant fuel for space heating, gas is also a major component of electricity generation. Because of the low capital costs and the somewhat lower carbon emissions, further gas power stations will probably be constructed and gas will move from about 35% of electricity generation to more than 60% by about 2020.

Therefore on current trends the UK will be dependant for its main energy sources on imports much of which will increasingly come from less dependable countries like Russia, former Soviet republics, North Africa and the Middle East, as well as the more benign Norway.

Further investment in the North Sea will delay the onset of the problem and clean coal with carbon capture might make a contribution to the solution. However, the only large scale source of clear energy that is proven and is available and can be insulated from international gas prices is nuclear.

Nuclear energy requires imported Uranium. Sources of Uranium have not been fully developed and much of the current supply is in stable countries such as Australia and Canada. Current resources are estimated to be enough for the world demand for more than 50 years.

As nuclear power is pursued by other countries, the cost of fuel will rise but as fuel accounts for only a small proportion of the cost of nuclear generation, this will not have a major effect on the economics of nuclear generation. The higher price of Uranium will stimulate new investment in mining and it will increase the available resource. In the longer term, other nuclear fuel cycles may have to be considered. Alternative fuels are included in the Generation IV International Framework R&D programme.

There are over 400 nuclear reactors generating 16% of the world's electricity. Therefore it can be claimed with confidence that nuclear is available and is reliable.

For some time nuclear power will be the only large scale, secure and dependable source of clean energy and therefore should be the main way in which the UK addresses the twin challenges of climate change and security of supply. This would be consistent with setting the conditions for private investment not just for the 10GWe to replace the existing capacity but perhaps 25GWe to change the balance of the energy mix and make progress on both climate change and energy security.

Barriers to effective action are considered next.

5. Need for Urgency

Timescales for nuclear projects are of necessity long. Both the scale of the investment and the size of the construction task mean that following normal methods, the earliest a new reactor would begin to operate, under current conditions, would be about 7-8 years after a final decision to proceed were made by an investor and/or utility.

Before such decisions to proceed could be taken, the programme of work to establish and control investor's risk will take several years and has many parts:

- Reactor designs need to be licensed
- Sites need to be acquired and planning consent obtained
- Nuclear waste policy, the plan and cost tariff need to be developed and agreed
- Plans and prices for the construction of reactors developed
- Changes to the electricity market and emissions trading scheme (ETS) need to be made.

Perhaps as important, there is a need to gain the acceptance by the general public that nuclear is the right way of meeting the UK energy needs as part of a balanced energy policy.

While public opinion has moved from viewing nuclear negatively, the current position is currently at best balanced. Now that there are strong environmental and security of supply arguments in favour of nuclear, the task of persuading the general public is very important because it underpins all the other activities.

Design licensing and planning is a major concern for potential investment because of the long timescale of the previous project – Sizewell B: and because of the poor record of design standardisation in the UK programme previously, some of which was caused by the iterative approach to design licensing.

New reactors based on established designs will be bought from abroad. These new designs are claimed to be lower cost and therefore are able to compete with other fuels. This has yet to be demonstrated because none have yet been built and operated. Furthermore, reactor vendors are unwilling to offer turn-key contracts for new nuclear power stations, and the UK industry which would be involved in the construction is much weakened compared with its position when it completed the last reactor (Sizewell B) 15 years ago.

NNB program is not assured

In the next 15 years new nuclear power stations will either:

- not be constructed when the current capacity is retired, or
- be built too late & in such small numbers as to have minimal impact on climate change and security of supply.

By 2020, the UK situation for both security of supply & emissions could be further away from target objectives.

The current legal and administrative framework for **planning and approval of** major infrastructure projects is both long and uncertain.

The last nuclear power station in the UK had a four year planning inquiry that cost several hundred million pounds. More recently, Terminal 5 at Heathrow had a 7 year planning process. The length of time inhibits the speedy progress required by HMG agenda and the uncertainty of outcome inhibits private investment.

The Energy Review proposed a two-stage planning process with a single strategic planning enquiry that would address the principle of restarting nuclear build, followed by the local planning enquires

that considered only the local planning issues. Similar ideas have been proposed by the Barker inquiry for all major infrastructure planning projects. HMG is considering either an independent planning commission, or hybrid bills as the means of streamlining the planning of major infrastructure projects.

HMG's policy direction is right, but the question is: Will the legal, organisational and cultural steps be taken to make the process sufficiently focused and clear?

The costs of nuclear waste disposal are to be included in the costs of electricity generation. These include the cost of processing and disposal of spent fuel, routine waste arising and the waste resulting from final decommissioning and dismantling of the plant.

Currently, there is no defined disposal route for intermediate and high level waste though CoWRM has proposed a deep geological disposal. This aligns well with what other countries are proposing.

The questions now are:

- What type of fuel (in the near term: Uranium or MOX) is to be used?
- Will the fuel cycle be once through, or include the option of reprocessing?
- How will HMG take the financial responsibility for building and operating a national waste repository?
- What funds will a station operator have to put aside for nuclear waste?
- Who is going to do the station decommissioning?
- What is the complete extent of the operator's liability?
- How can these funds be protected from failure of the generating company or from being used for other shorter term purposes if transferred to Government?

Many other countries have answered these questions in ways that give financial certainty for a private investor. Similar changes need to be implemented for the UK.

DTI has just appointed an adviser in nuclear waste pricing with experience of infrastructure costing and financing. It is expected that he will develop a tariff for nuclear waste and decommissioning costs and propose how these funds should be accumulated and protected during the life of new nuclear plant.

The case for any nuclear power investment depends crucially on the **stability of** and the **long-term price of electricity.** During the last few years, the market has displayed extreme volatility. Although the new market design was intended to promote traded markets, there is little evidence that long-term (more than 1 or 2 years), deep, liquid or markets for bulk supply have emerged or indeed will emerge. This is a common concern in all of the liberalised markets in Europe.

The UK balancing mechanism has had many amendments proposed since its inception in 2001. Some of the amendments accepted by Ofgem have had significant effects on the price level and some of the proposals could also affect the market position of particular generators. Therefore the existing electricity market is both

Progress is required on a broad front

- Positive arguments to be put to the general public
- Changing attitudes to licensing and planning
- Waste policy & funding
- Challenge and opportunities from new designs of reactor
- Electricity market reforms

volatile in its behaviour and constantly affected by regulatory action.

Additionally, moves within the EU to create first regional and then a pan-European electricity market have the potential to change significantly the market mechanisms within the UK for better or worse.

These issues make an investment decision of the scale and the expected duration required for nuclear power stations, problematic.

There exist a number of potential changes to the electricity market mechanisms that would reduce the volatility in price. The expected level of price volatility has implications with wide potential effects, including on:

- Contracts for wholesale supplies
- Drive for vertical integration of generators and supply companies, and
- Risk sharing for new build i.e. consortia.

The deregulated market for electricity in the UK has evolved in such a way that gas-fired generation sets the wholesale price of electricity. In times of excess supply, such as during the period 2001-4, electricity prices were driven down to a level so that only plant that had depreciated assets and low fuel costs were able to operate at a profit. Stations with high fixed costs such as Drax and British Energy's reactors did not have the option of not operating and therefore made substantial losses.

Without changes to the operation of the electricity market and its attendant mechanisms (e.g. EU Emissions Trading Scheme) the uncertainty about investment will prevent consideration of the more capital-intensive means of generation such as nuclear.

We can conclude that the conditions do not yet exist for one to be confident that sufficient investment will be provided for a large scale nuclear new build programme.

Conditions for major investment in nuclear power **do not currently exist**

and **by 2020:**

- Position on climate change & security of supply will be worse
- New capacity will lock-in this weak position until 2040

- unless urgent action is taken.

Therefore, during the next 15 years it is likely that new nuclear power stations will either not be constructed when the AGR stations are retired, or new stations will be built in so small a volume to have minimal impact on HMG's priorities of climate change and security of supply.

By 2020, the position on both of the government's policy objectives – security of supply and reducing carbon emissions will be much further away from its target objectives than now.

Also, investment in new coal and gas stations will have taken place to meet demand. These stations will continue to operate for many years and therefore the UK will be locked into this negative position for decades to come.

6. Industrial Capability and NNB Implementation

The responsibility for the investment in nuclear should and can be a matter for the private sector. This is consistent with a deregulated energy market and it will ensure that the investment decisions are driven purely by commercial considerations. Other countries are taking similar private funding routes for new nuclear.

Private investment is behind the new reactor at Olkiluoto in Finland, though under different conditions from the UK. Also, in the US over 20 projects are in development to construct new nuclear power plant using private funding. Some of these projects are close to taking the investment decision and to let contracts which will allow construction to start. In both cases, many years of work prepared the ground and gave confidence to investors to support these programmes.

The question is not whether building nuclear power stations by private means is feasible - rather the questions are of commercial and institutional conditions and of timescales.

Industry's view of the UK Government's approach is that while it has many of the right ingredients, it does not as yet have the clarity, or the unified ownership to enable early investment in new stations. Also, many of the processes, attitudes and structures that were established many years ago still exist and will inhibit the programme. These were established for different conditions when:

- All generation was publicly owned
- Public support was much weaker soon after the Chernobyl accident
- The reactor design was seen at the time as novel in the UK and was linked to the weapons programme.

The economic and regulatory conditions need to be very different for private investment, for reactor types that have a much better and more solid operating record and for which a positive public case can be made.

US experience has some similarities & differences

Needs for new nuclear recognised by Government

Changes made to licensing process

Understanding that waste issue must be addressed

Substantial volume of new build is contemplated using private investment, but

UK electricity market does not assure recovery of investments

No pump priming spend or incentives for nuclear

Pre-licensing process to be demonstrated & un-funded by HMG

UK industry is in a weaker condition

There are some similarities between the US and the UK situation for re-starting nuclear construction, but there are significant differences.

In the US, it was recognised in 2000 that nuclear power would be required as part of their power investment. Because of this early start the US has had more time and the closure of their reactors is further in the future because their light water reactors are proving more amenable to life extension.

A government/industry group was formed (NuStart) to take forward the new licensing and

Weakened UK Nuclear Industry

By the time that the construction of a new nuclear power plant starts it will be about 20 years since the last nuclear power station was built in the UK.

Nuclear power stations combine a standard international design of reactor system (for example: Areva, GE, AECL or Westinghouse) with a power conversion system (steam turbine and high voltage equipment) from vendors such as GE, Siemens or Alstom. These systems will be integrated either by an architect-engineer ("Systems Integrator") or a large construction company with the required nuclear construction management skills. In the past, the nuclear utility (e.g. British Energy) took this role, designing the plant interfaces and managing contracts for construction with industry. These types of nuclear engineering and management skills are essential for the contractor to be able to accept and manage the risks of the project and deliver on-time. Also, such skills are very important to the success of the NNB programme because low cost and speedy construction are fundamental to the economics of nuclear generation. While nuclear construction management skills still exist to some degree, it seems that they are not present in sufficient scale in any UK construction company for them to able to offer a fixed price for a series of nuclear power plants.

Several studies have assessed the level and availability of skills in the UK industry for NNB. These studies recognise that much of the construction would employ general engineering skills from the broader industry. However, there are shortages in key trades (for example welders), in nuclear specialists and in the experience of constructing nuclear plant.

In principle, the UK industry would be capable of manufacturing many of the components and systems for a nuclear station, but there are questions of competitiveness because of the high cost of manufacture in the UK and the current low level of involvement by the UK in global markets.

The NNB programme will entail the construction of at least 6-10 stations in a period of 15 years. If done by conventional means, there would be several large sites each with 6-8000 construction workers operating at the same time, in dispersed locations around the country. These large sites are recognised to be inefficient and can, because of their separate identity, lead to detailed differences between the plants as they are constructed. Also, learning between projects is inhibited and scarce engineering and commissioning skills are split between sites and between construction projects.

A different approach is called for to deliver the large volume of projects in a restricted period (~£15bn in 15 years) and to benefit from the standardisation of design. It employs lean principles of modular design, off-site construction and modern logistics to deliver major components to site where they are assembled and commissioned. Industry is not ready for this approach to nuclear build. There is much work to be done on module design, developing the supply chain and planning logistics to align with the optimal build and commissioning sequence.

site planning process. This was possible because of joint US DoE/industry funding and because of the subsequent new-build launch funding and tax incentives that have been announced. Furthermore, the structure of their electricity markets in many States is more conducive to carrying the risks of early nuclear stations (rate-based and regulated).

The UK needs to find its own more market-orientated ways of providing financial certainty for investors. This will involve co-ordinated action between government departments as well as concerted action with industry, investors, utilities and constructors.

Unless the conditions for investment and the capability are changed, either investment will not take place, or it will be in too small volumes and at a too slow pace to be effective to delivering the energy policy objectives.

It is important that HMG both sets the tempo of the programme and provides a means of providing leadership in delivery and in recreating the capability to construct nuclear power stations. Therefore we propose HMG:

- Sets a challenging but practicable target to establish the conditions for industry to replace the current nuclear generating capacity ~10GWe with new plant by 2025 and then ~25GWe by 2036
- Establishes a new group called the Nuclear New Build Task Force - NNBTF to take a holistic view, provide an independent view of the economic issues, inject urgency, and manage uncertainty at the overall programme level, and
- Tasks this NNBTF with building **bridges** between:

Policy proposals and **the Conditions for investment**

Current industry state and **strengthened Capability**

Government and **Industry**

7. Nuclear New Build Task Force

The aim of the NNBTF is to:

- Ensure that the economic conditions are put in place for investment in New Nuclear Build
- Reduce the uncertainty for investment in NNB
- Ensure that weaknesses in the nuclear industry are addressed
- Join up the policy strands, to create an integrated and coherent picture of the programme – ensuring that issues that will impede the programme, or have been omitted, can be addressed in a timely and concerted manner.

The Task Force must be established in the public sector because the objectives of climate change and of security of supply are national ones. Also, major changes in policy and action are for the government to initiate.

Without this sort of action the NNB programme will accumulate delays and fail to make the large contribution it can make.

The role of NNBTF is shown in Figure 7.1. below.

NNBTF would enable the delivery of the programme through three axes of actions aimed at:

- Securing the commercial case by:
  - i. Ensuring the electricity market reforms and the climate change agenda supports the business case for capital intensive generation
  - ii. Considering the costs and benefits of stable electricity pricing on the UK including the effects of carbon prices together with the stimulus that a construction programme of this scale could bring to regions affected
- Acting to streamline the involvement of other parts of government that affect the institutional environment for nuclear
- Ensuring that the process and approach to construction enables a construction programme of this scale and complexity to be achieved, taking action to strengthen the industrial capacity where necessary.

Once the commercial conditions for investment are in place, industry will be able to make investments in nuclear. If the planning & licensing mechanisms can be made to operate effectively and the industry has prepared for the programme,

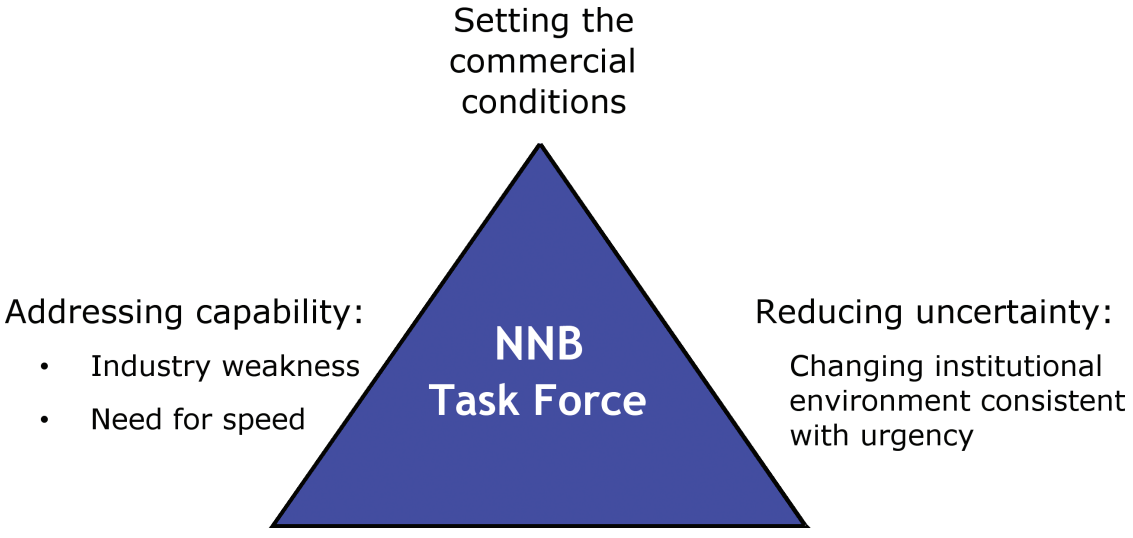

Figure 7.1 The role of NNBTF

it will drive forward new nuclear investment much more rapidly. The limit to speed of this investment will then be set only by the practicalities of construction and the needs of the electricity market/system.

The scale of the effect on nuclear output that a task force could have is illustrated in Figure 7.2 below. This shows the build-up of capacity and how the baseline case of Section 4. would be transformed by:

- Resolving the barriers to decision making and shortening the period before construction starts by 1-2 years;

constructed in one year less. Because manpower and supply chain constraints are circumvented by the construction approach adopted, at least one new station is completed each year.

The effect of these changes is dramatic. Nuclear output reaches earlier levels (~8GW average or 70TWh pa) within about 10 years (rather than 25 years for a more traditional approach) and by 2036 (within 25 years of starting construction) the programme will have made a cumulative net Carbon reduction of 45Mtne compared with the current situation and displacing ~25Mtne Carbon each year subsequently.

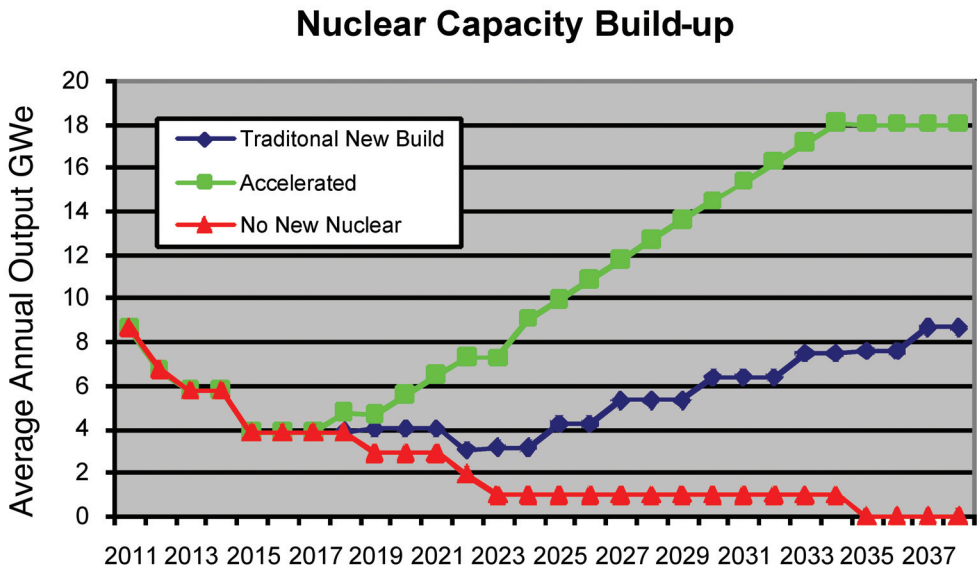

Figure 7.2

- Encouraging investment by more than one utility group, each with its own reactor design and separate supply chain, hence enabling simultaneous construction of two sets of new stations
- Employing 'lean' and off-site build principles to speed construction and remove site related resource constraints.

Through the work of the task force, the 'Accelerated' programme enables construction to start perhaps one year earlier with each station

The prime focus of the NNBTF (see Figure 7.3) would be to establish the conditions for private investment. This would require an understanding of investment from a private sector context, and knowledge of the nuclear and power industries. Such private sector expertise when combined with representatives from the main departments that influence and effect the decisions on nuclear new build would make an effective means of focusing and leading change in the programme.

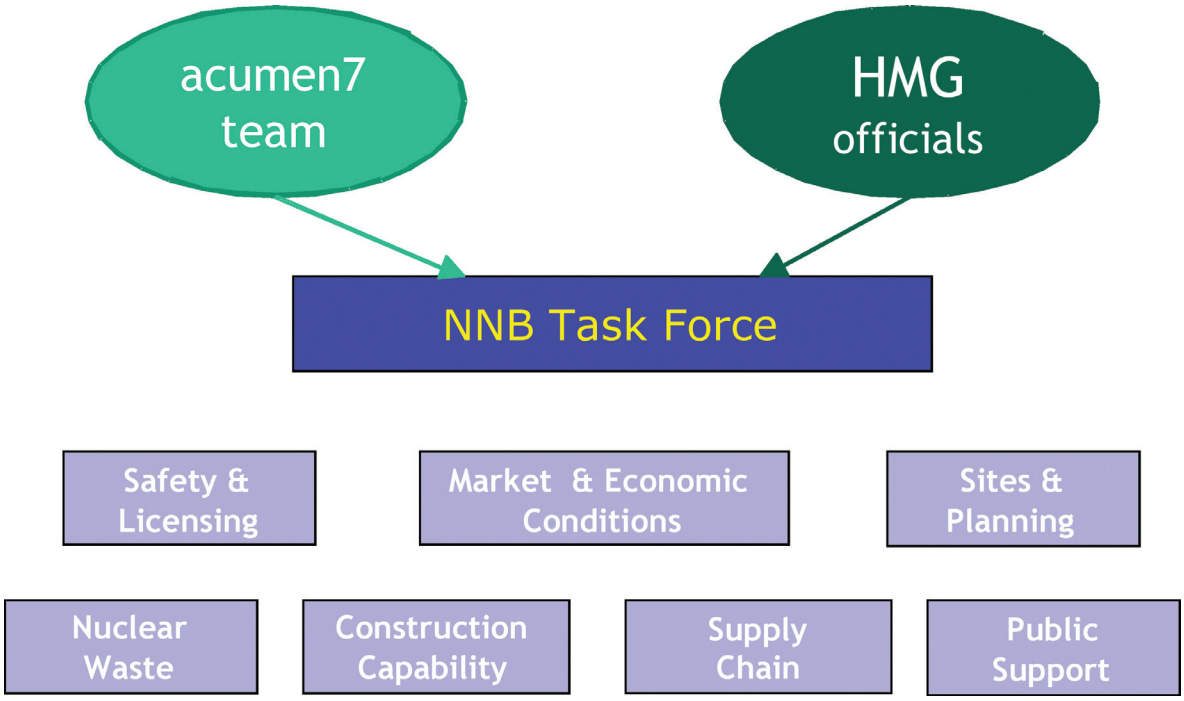

Figure 7.3 NNB Task Force Work Areas

Because the essence of the role of the NNBTF is to act as an enabler of private investment and the re-creation of capability, it will require industrial expertise in the various major areas of investment uncertainty – economics, nuclear engineering & safety, planning and construction etc.

The task force will have as its central focus the aim of creating the economic conditions for investment by the private sector. Therefore, it needs to be completely separate from the interest of investors to be independent in its advice to Ministers.

acumen7 has assembled a team specifically for this problem, and it includes people with the essential skills and industry knowledge.

NNBTF will provide drive and leadership in developing and putting in place the conditions for investment and enabling nuclear build, with a focus on at least seven areas of work:

- Shaping the market environment to achieve HMG's policy objectives in climate change and security of supply;
- Enabling UK to build low cost standard designs that are safe and licensed in a timely manner;
- Ensuring nuclear waste policy is developed to provide certainty for the public and for the industry
- Ensuring planning is conducted in a way that both allows public issues to be aired and the programme be delivered
- Deploying a construction approach that enables private funding of series-build of stations on an accelerated timescale
- Ensuring that skills, capabilities and structures of the supply chain support both the requirements of low cost and the speed of the intended programme
- Supporting HMG in developing public opinion.

The scale of change is huge, to take what is a moribund industry and enable it to deliver 10 new nuclear power stations within about 15 years, and perhaps a total of 20 within 25 years.

There are a large number of parties both in Government and in industry that will need to be involved in a successful programme. One of the ways that the NNBTF will engage both government and industry parties is through a NNB Working Group (see Figure 7.4).

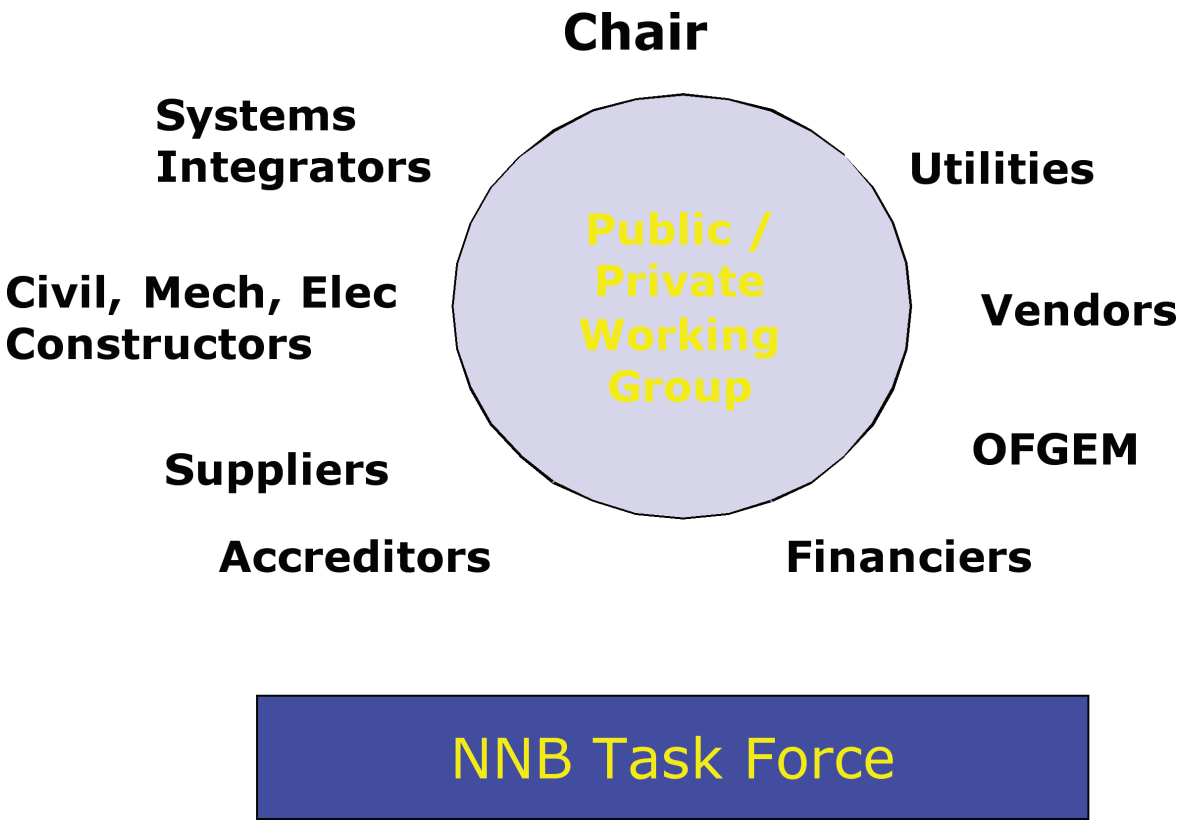

Figure 7.4 NNB Working Group

NNB Working Group will seek to establish a common purpose for the programme. Industry will be able to see that the enabling activities that are largely a matter for government, are taking place. This will build confidence for them to push forward their investment plans and for their actions to re-invigorate the industry for the challenges of construction and operation.

8. Management of Uncertainty

One of the main roles of the NNBTF is to manage programme uncertainty, as viewed from the point of view of the (private) investor. Reducing uncertainty will both allow investors to bring forward their decisions and will affect their view of the economic conditions.

The process begins with identifying major business uncertainties that require action by the Government and that are impeding the overall NNB programme. These risks or uncertainties can then be addressed and managed through studies and option assessments, leading to action with industry to develop cost effective and timely solutions.

This section gives a high level view of the major areas of uncertainty and the nature of the action required to deliver the programme. The issues to be addressed are many and there is linkage between several different aspects.

The main areas of uncertainty include:

- Public opinion that supports nuclear generation
- Nuclear contribution to HMG and EU low carbon generation targets
- Effective carbon trading schemes
- Electricity price stability to deliver required investment
- Delivering nuclear waste & decommissioning pricing/funding regime
- Licensing and planning regimes that deliver safe and widely accepted new reactors
- Ensuring the market conditions for nuclear to be the lowest cost source of electricity
- Maintenance of adequate diversity in nuclear supplies to avoid single mode failure
- Industrial processes and capacity to construct the number of stations to meet the programme.

It is for Government to influence public opinion. However, public opinion is an important matter in its own right because the climate of opinion affects the acceptance of nuclear power hence the planning and the licensing processes.

Among other matters, these processes provide confidence to the public that through open debate and with professional involvement, new nuclear reactors will be seen to be acceptable.

If there are concerns about the principle of nuclear power, these planning and licensing processes may become the vehicle for resistance to the programme. However, if the public broadly supports nuclear power, the licensing and regulatory processes, though still essential will be less contentious and hence much simpler to complete.

The tables in Appendix A give an outline of the main sources and the types of uncertainty from the viewpoint of a private investor. This analysis considers some of the ways in which these uncertainties could be managed. Also, they consider where the initial or the major responsibility for action might lie.

At this stage in the programme, the majority of the controlling actions are with Government.

9. Programme of Work

The programme of work will follow from an understanding of the issues affecting private investors: what enables a decision to proceed and what impedes that decision being taken.

The elements of the decision to invest in a programme of new nuclear power stations will be brought together in the business case. In addition to the commercial conditions, preparing the business case will require consideration and resolution of important subsidiary issues dealing with:

- Reactor licensing
- Sites & operator licensing
- Construction contracts
- Fuel contract and waste costs definition
- Adequate security of the revenue model.

designs, vendors and other contractors are chosen and contracts arranged.

The current view of the industry is that one or two of the major European utilities that both operate in the UK and have nuclear fleets, may each invest in one or two stations, depending on how electricity prices are supported. This outcome would be inadequate to meet the UK long-term requirements.

It is the prime task of the NNBTF to affect positively the conditions for investment so that decisions can be made earlier and in the context of the need for a fleet of (identical) power plants, that need to be constructed in a speedy, disciplined and safe manner.

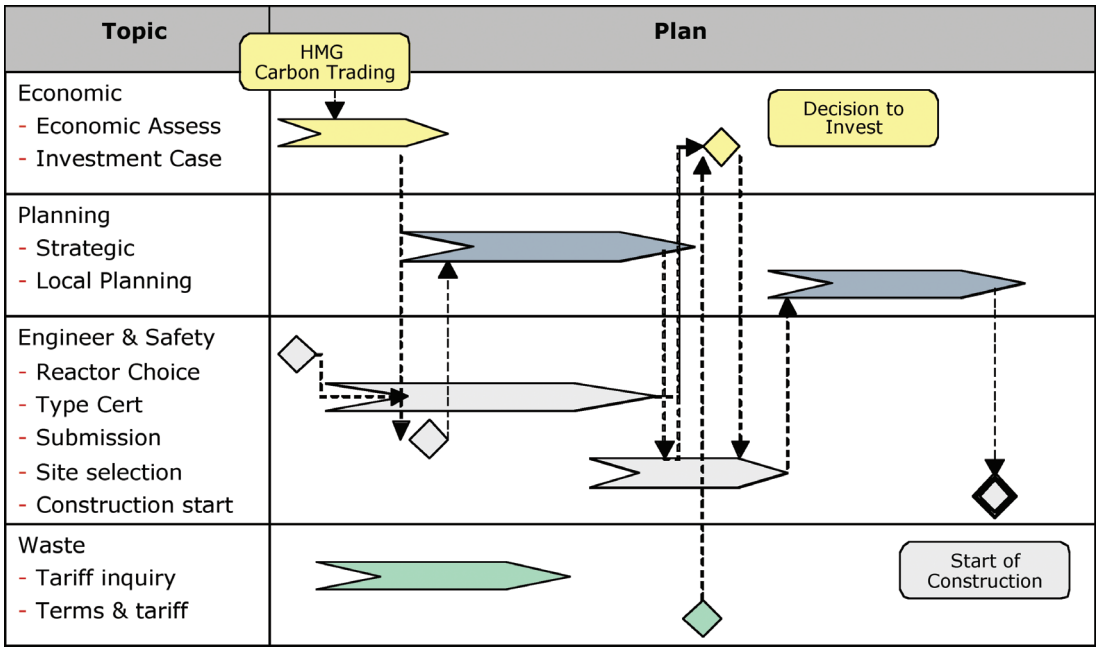

Figure 9.1 Nuclear New Build Development Outline

A high level view of the main programme as seen from an investor's point of view is shown in Figure 9.1. The main areas of work are indicated together with the links between the main tasks and the key milestones in proceeding first to the decision to invest and subsequently to the start of construction.

Utilities/potential investors are currently expecting to take 3–4 years to proceed through these issues before they can be in the position to determine whether new nuclear would be a viable and an attractive investment. Subsequently, over the next 2-3 years before construction starts, reactor

This work will of necessity, be on a broad front because of the factors to be considered many are linked and interactive. A logic map is being developed to support the planning of the NNBTF work.

The NNBTF work programme will have two main phases:

- Establishing and agreeing the taskforce aims, structure and detailed programme together with the working group
- Discharging the taskforce objective.

It is expected that this first phase will take about 3-4 months, during which time the main NNBTF work programme will be defined.

10. Proposal

acumen7 has put together an experienced and knowledgeable team to provide the industry knowledge which is at the core of the NNBTF.

This team working with government officials would provide both independent advice to Ministers and the necessary drive. The task force would establish the conditions for an ambitious and successful private investment programme in new nuclear power stations to meet the UK policy objectives.

The **project team** requires the capabilities and skills for the main areas of work described in Section 7:

Electricity markets & economics
Nuclear waste & decommissioning
Construction management & supply chain
Safety & licensing
Sites & planning
Public opinion

The team would work in a flexible but disciplined manner to define and deliver the programme. It would include:

Project leader: Tony Roulstone

Tony is by training an engineer and has 20 years experience in the nuclear industry largely designing and constructing reactor systems for submarines in a series and consistent manner to a standard design – one every 18 months.

He has operated at a senior level in Rolls-Royce for 10 years and has run a large group of heavy engineering businesses.

He now operates as a business adviser in business strategy and leading large programmes for major US & UK companies.

Structuring the programme: Sean Westrope

Sean is an experienced commercial and programme director who has led major elements of restructuring of rail and nuclear infrastructure.

He is a versatile leader with the demonstrated abilities in negotiation, structuring organisations with the interpersonal and communication skills developed in large public and private sector organisations to drive a programme to completion.

Strategy: Peter Dixon

Peter has nearly thirty years experience as a business strategy consultant, working in a variety of industries, in particular in the energy and oil services industries, with clients including National Grid and Shell.

He was previously Director of Strategy for Deloitte Touche Tohmatsu, the global organisation of which Deloitte is a member. He has training in Engineering, Business and Economics.

Safety & licensing: Peter Dolan

Peter has over 30 years experience in the nuclear industry and was Director of Engineering for Rolls-Royce's nuclear business focused on small PWRs for the Royal Navy's nuclear submarines.

He now advises industry on nuclear safety processes and nuclear technology assisting clients in making cases to comply with the NII safety assessment principles & approach.

Construction industry & supply chain: Richard Ogden

Richard has had a long and distinguished career in the construction sector, particularly working with clients and developers while working at Balfour Kilpatrick Industries, British Rail & McDonald's.

He established and now chairs the (initially **dti**) sponsored cross industry focal point for lean construction Buildoffsite. It brings together clients, developers, and constructors to seek and champion faster, safer and more cost effective means of construction. Clients include blue chip architects and engineering companies such as Siemens and Corus.

He is now working with GSK to produce new pharmaceutical facilities within 3 months compared with 36 months. Utilising some of these ideas in constructing nuclear power station, it will be possible to build new power plants in a fraction of the currently planned time.

Influencing public opinion: Carol Bewick

Carol is a proven communications and public affairs director with experience of leading high exposure public campaigns. These have included such diverse subjects as communication strategy for the NDA, their contracting strategy and the establishment of nuclear Site Licensed Companies, Stephen Lawrence inquiry, Arts Council, Lottery, changes to National Insurance & amendments to the Religious Hatred Bill.

Advisory Panel:

Alexander Johnson

Alexander is Merchant Banker with extensive experience of the power and utilities sectors, privatisations in UK and abroad. He was responsible for privatisation of and post privatisation advice for Thames Water, CEGB / National Power, British Rail, Scottish Nuclear / British Energy.

He has been closely involved with government in developing policy and regulatory regimes and is a member of the Competition Commission.

David Lewis

David is an economist, project developer and business director in the energy sector. He spent 10 years as a government economist and later played a prominent role in designing and implementing the Electricity Pool during privatisation of the electricity supply industry.

Simon Murray

Simon Murray specialises in strategy, organisation development and process improvement in the infrastructure and construction sectors. He has thirty years experience in the planning, construction and operation of infrastructure and has held senior management positions in Railtrack, BAA and Arup.

Gary Sullivan

Gary specialises in Construction Logistics, supply chain development and regeneration. He has 20 years experience in the planning and operation of the logistics of complex construction projects.

Project team details

Details of the project team and advisory panel are given in Appendix B.

It is recognised that the government must apply the usual rules of public procurement and we would be happy to discuss ways of getting the team in place quickly but in a compliant manner.

11. Why acumen7?

acumen7 is a network of highly experienced independent consultants from a variety of backgrounds in business and the public sector who share a reputation and a passion for their collaborative and straightforward approach to solving problems for their clients. The members of ***acumen7*** are chosen for their experience, knowledge, their networks and their approach to business.

Experience – they have had successful careers and have demonstrated their ability to manage businesses, deliver complex development programmes and lead change in organisations.

Knowledge - they are recognised for their deep knowledge of their chosen field of work and their broad knowledge of business, public services and development.

Networks – they are at the stage in their careers where they can readily access a wide range of formal and informal networks, gaining swift access to current information and building relationships of trust.

Approach – they inspire confidence in the people around them and work within their client's organisation harnessing resources and focusing them on the problem. As independent consultants, their only interests in an assignment are satisfaction at a job well done and the fee they receive for their work.

Mission and Vision

Our **mission** is to enable our clients to solve the difficult problems that they face using the knowledge and experience of our members

Our **vision** is to be recognised for our outstanding ability to connect clients with the experienced people who can help them

Issue	Uncertainty	Management Options	Primary Actionee
1. Public opinion does not support new nuclear.	a. Without a sustained and responsible public campaign approval/siting of new stations will be compromised. b. Licensing is linked to public view of acceptability of safety. c. Progress on waste issue important to public view of nuclear. d. Changes to electricity markets to promote policy ends – low carbon generation & security of supply which will require public support.	Major public inquiry on principle of new stations to draw opposition arguments out in the open and get them addressed or countered. Public inquiry needs to be structured to deal with professional filibustering and promote public debate. Progress is required to define and implement a plan for national nuclear waste store even if the plan make take many years to complete. Market policy changes are likely to be defined to fuel type independent – not to be seen as subsidies for inefficient nuclear – not overt public funding for new build.	Utilities/HMG?
2. Is nuclear the lowest cost low-carbon generation option in the medium/long term?	a. Carbon credits ineffective at separating high and low carbon generation because of over-allocation in the UK or elsewhere in EU. b. Alternative such as CC&S emerge as lower cost options c. Wind considered as lower cost due to high level of subsidies and because responsibility for firm power not passed back to wind generator.	ETS needs to be extended in time and made effective by control of allocation, extending auctions and removal of grandfather rights. Nuclear will only be more expensive if benefits of the lower cost/lower risk new designs are not realised. Regulation should ensure costs of less dependable power fall where they are caused.	HMG Utilities/ Vendors HMG
3. HMG & EU policy is to have 20% renewables – how will adequate capacity margin be guaranteed (>30%) Who pays for additional stand-by power?	a. No capacity payments & capacity margin inadequate for low wind case etc. leading to need for demand restrictions. b. Cost of stand-by power passed on to all generators representing another (hidden) subsidy for renewables.	Changes to market to provide value to utilities for firm capacity.	HMG
4. Past experience has shown dependence on a single technology or design has high risks – commercial & reliability.	a. Replacement nuclear should be a significant/large component of the UK Grid capacity and should not be open to common model failure.	Promote competition between utilities to fill demand and between reactor designs.	HMG

Issue	Uncertainty	Management Options	Primary Actionee
5. Sufficiently stable market prices to recover costs over lifetime.	a. Utility or client does not have the funds to cover sustained low prices – possibility of default. b. Carbon pricing to provide dependable price support.	ETS needs to be extended in time and made effective by control of allocation, extending auctions and removal of grandfather rights. Nuclear will only be more expensive if benefits of the lower cost/lower risk new designs are not realised. Regulation should ensure costs of less dependable power fall where they are caused.	HMG
6. Nuclear to achieve lowest costs generation position: Capital costs much higher than forecast. Construction timescale not achieved. Non-utility risks remain leading to high discount rates.	a. Stations bought & constructed in penny pieces losing benefits of scale, construction learning and operating savings. b. Global demand for nuclear drives up nuclear vendor costs. c. UK demand for construction drives up construction costs. d. Construction risk sharing does not drive timescales of cost control. e. Planning, licensing waste and market risks not mitigated leading to high discount rates – construction and/or operation.	Utility or client requires substantial balance sheet to absorb (some of) the market fluctuations. ETS scheme to be extended in time and give independence from political interference. Changes to market structure to provide for long term contracts and/or capacity auctions.	Vendors/ Utilities
7. Waste & decommission liabilities held by HMG but not bounded. Start-up decommissioning & waste costs exceed funds provided at early stage in project.	a. Uncertainty about future waste policy and associated cost raise risk profile and hence weakens economic case. b. HMG does not give approval because of un-funded waste and decommissioning costs. c. Project cessation is itself caused by HMG/EU change of policy.	HMG to provide absolute guarantee of accepting and disposing of wastes with a define & bounded funding regime. Parent company guarantees to cover early life short-fall due to utility failure leading to plant shut down. HMG retains liability for consequence of own actions.	HMG
8. Planning uncertainties/ delays.	a. Replacement nuclear should be a significant/large component of UK Grid capacity and should not be open to common model failure.	Promote competition between utilities to fill demand and between reactor designs.	HMG