It’s increasingly evident that there is no single approach that can be applied globally to the challenges of planning, financing and building nuclear power plant. Yet such is the need for new nuclear capacity that these challenges are being overcome. Fiona Reilly, Global Nuclear Lead for PwC’s Capital Projects & Infrastructure practice, examines the key dimensions of the shifting global landscape of nuclear projects.
Nuclear power comes of age but challenges remain

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**Introduction**

Nuclear energy investment is growing around the world, fuelled by many countries’ climate change commitments and large base load power requirements. However, this growth is taking place against a rapidly changing background of parallel and often profound changes in areas that include financing structures; government regulation, support and policy regimes; project structures; operating models; approaches to extending the life of existing plant; and methods for dealing with decommissioning and waste. With varying pressures, agendas and trends applying in each of these areas in different countries across the world, it’s increasingly evident that there is no single approach that can be applied globally to the challenges of planning, financing and building a nuclear power plant. Yet such is the need for new nuclear capacity that these challenges are being overcome. Fiona Reilly, Global Nuclear Lead for PwC’s Capital Projects & Infrastructure practice, examines the key dimensions of the shifting global landscape of nuclear projects.

**Financing**

Traditionally, nuclear power plant were financed, developed and operated by governments (although countries such as the US opened up the nuclear power industry to the private sector in the late 1950s). Many countries are now seeking alternative financing options, and are increasingly looking to the private sector to develop new nuclear power plant. There can be very different reasons for governments to take this approach, including some instances where a country’s balance sheet will not support government financing, and others where financing a new nuclear plant (or other infrastructure) is not in line with government policy. The different approaches are numerous; for example, the UK has privatised its plant; others, such as Slovenia and Croatia, have maintained the plant as national assets (some of these legacy plant are now in the decommissioning stage, which raises different challenges for the countries concerned); and a few countries like Russia and China still develop nuclear power plant with significant government support.

A further shift in recent years is that government financing has taken on a new meaning, with Russia and China in particular offering complete solutions for developing nuclear projects in other countries; examples of this approach include: Russia’s majority ownership, development, operatorship and financing of a new-build project in Turkey as well as China’s development, ownership and operatorship of a project in Bangladesh. Under these schemes the country offering the complete solution will put together a consortium to deliver the project together with financing from its government, its government export credit agencies (ECAs) and/or national banks.

In all, there are seven types of nuclear financing we are seeing in the world today. Aside from ‘traditional’ government funding, the six alternative trends in nuclear financing we are seeing are: corporate balance sheet financing, the French Exceltium model, the Finnish Mankala model, vendor equity, ECA and debt financing, and private financing with government support mechanisms. In truth, however, projects only progress with a mix of these funding mechanisms.
When considering financing and structuring, the role of the government is key.
**Government support**

Even in countries where governments no longer finance nuclear power plant, the national government has a critical role to play in any nuclear project. At the very least governments are required to undertake three roles:

- policy-maker,
- provider of a strong rule of law, and
- insurer of last resort.

**Policy-maker**

Without a strong and consistent government policy in favour of nuclear power, projects will simply not get built. Once construction starts, a nuclear power plant can take five to seven years to begin operation – and then the plant will usually be operated for 40 to 60 years before decommissioning begins. The government’s policy needs to endure over the life of the plant to provide developers (investors and financiers) with the confidence to push ahead with such a long-term development. The Belene plant in Bulgaria, for example, previously suffered from changes in government policy that caused the market to lose confidence in the project.

Other outcomes can also arise; for example, when Germany changed its nuclear policy following the Fukushima incident, the utilities responded by seeking compensation for confiscation of generating rights, cancelled upgrades and the costs of early decommissioning. According to the World Nuclear Association, the four utilities affected have made provisions totalling over €30 billion on account of the government decisions. In assessing any nuclear project, financiers, investors, developers and contractors want to have confidence that they will not be impacted by a change in policy – or at the very least that they will be compensated appropriately should such a change happen.

**Provider of a strong rule of law**

Alongside certainty over policy, government needs to provide a strong and stable legal and regulatory platform on which the nuclear plant can be built. Investors and developers need to understand the regime in which they are working, and to have the assurance that the legal and regulatory position is not going to be in constant flux during their project’s lifetime. While both developers and government recognise that some changes may be required during the life of the project, they also acknowledge that the government – which establishes the laws – should be in the best position to manage the resulting risks.

However, the reality can be more complex. Nuclear regulations are often set by the nuclear safety regulator who should, under International Atomic Energy Agency guidance, be independent of government. As we saw in the US in the wake of the Three Mile Island incident, changes in regulations – or in the way they’re interpreted – can pose a risk that is difficult to manage for any developer. Developers need certainty that changes will occur only if there is a sound safety or security reason for them. However, when regulators implement changes they often cite international development as the cause – putting this risk outside the developers’ control. That said, governments sometimes provide some support and a ‘back-stop’ for non-safety related changes in regulations.

The risks around changes in regulations are heightened when the host country lacks a well-developed regulatory environment. In some ‘new entrant’ countries we have seen the basic regulations being developed in parallel with the project. This approach creates uncertainty and potentially higher costs for developers, and is best avoided.

**Insurer of last resort**

Investors in nuclear projects are often concerned about what happens in the event of a catastrophic nuclear event (CNE). The position on the liabilities for nuclear damage occurring (essentially) off the nuclear site has been established by the Paris, Brussels and Vienna Conventions and now the Convention on Supplementary Compensation for Nuclear Damage (CSC). However, under each of these conventions the liability is limited, whether it be the operator’s liability (Paris or Vienna), the countries’ first line of compensation (Brussels) or the collective countries’ liability (Brussels or CSC). It remains open to question what happens if those liability limits are exceeded.

There are also other areas of uncertainty. Insurance covering the nuclear site is a separate issue outside the liability cap provided by legislation. Imagine a scenario in which there is a CNE, and the event damages the nuclear power plant itself, resulting in it being decommissioned early. Suppose, too, that any decommissioning fund has run out, all contingent equity has been called upon and the developer has no more funds. Under those circumstances, who takes over the decommissioning and securing of the plant?

In either scenario, the only entity that can ultimately take responsibility is the government. As such, the government is effectively the insurer of last resort – whether this is explicitly stated in legislation or not.

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The rise in government involvement in financing and structuring

With the rise of private sector and ECA financing, it has been necessary to reconsider how nuclear projects can best be structured. When considering financing and structuring, the role of the government is key. We are still a long way from seeing the first non-recourse project financing in the nuclear sector, so the government support mechanisms that are being made available are crucial to getting these deals under way.

Government support mechanisms can take a number of forms, including a guarantee to support debt coming into a project (e.g., sovereign guarantee, Infrastructure UK Guarantee), a revenue support mechanism (e.g., Power Purchase Agreement, Contract for Difference), or both. Much depends on the country in which the plant is being developed, taking into account factors such as the country’s credit rating, the strength of sovereign and available funding, the electricity market in the country, the off-take regime, and the rights and obligations of generators as to the impact that the available support has on the project.

We have seen several examples of guarantees and revenue support being deployed in recent years including support in the Power Purchase Agreement in countries such as the UAE and Turkey and support through government guarantees of debt such as the US Department of Energy guarantee scheme (with cost of service regulation). However the mechanism that is attracting the most interest at present (particularly in Europe) is that which is being deployed in the UK – bilaterally negotiated Contracts for Differences together with the Infrastructure UK Guarantee.
There is no one-size-fits-all answer to how a nuclear project should be structured. Instead, the structures of these complex projects are highly customised and can take a long time to develop.

Ideally the structure will meet the requirements of the developer, the shareholders, the regulators, the financiers and the government. In developing the structure, it is vital to consider aspects such as accounting treatment and tax implications; whether a further holding company will be required for any reason; whether the financiers will require the ownership of the legal asset (the plant) and the operation of the plant to be separated; and whether there are advantages in separating the ownership from the operatorship, particularly in light of any available government support mechanisms.

Developers also need to consider the roles and requirements of any lenders to the project. Questions here include whether lenders want to try to separate themselves from nuclear liability; the extent to which any government support protects the covered lenders to the project; and how much contingent equity needs to be made available to cover cost overruns, delays or other shortfalls in the project.

As part of the structuring it is also important to consider the procurement strategy for the project, looking at how it fits both with the regulatory regime and also with the investors’ requirements. A complicated procurement strategy, or one where the developer retains a lot of the risks, will be regarded by investors and financiers as risky, possibly making the project more difficult to finance.

Operating models

In today’s global nuclear market there are a number of different operating models, ranging from ‘thick’ or ‘fat’ models to ‘thin’ models. A ‘fat’ model – traditionally seen in markets such as France and the UK – is where the operator has a lot of people within its organisation, enabling it to operate its plant without needing to procure significant additional resource from the supply chain. In contrast, a ‘thin’ model is where the generator has sufficient capability in-house to meet its ‘knowledgeable customer’ and other nuclear licensing requirements, but relies on contractors and suppliers to meet many of the plant’s day-to-day operational needs. Many operating models around the world are not at either extreme, but somewhere in the middle.

While safety remains paramount to the nuclear industry, companies are making large investments in nuclear power plant and looking to the debt markets for financing, leading to an increasing emphasis on minimising costs and maximising returns. This has in turn encouraged a move away from ‘thick’ operating models – which are often regarded as overly cumbersome and costly – and towards a leaner operating model that allows the developer to procure services in the most cost-effective and efficient way.

When considering how lean the operating model for a project should be, the first thing to determine is what is acceptable for the local nuclear safety regulator. Regulators in some countries, such as France, prefer a thicker operating model, whereas others – in markets such as the US – are more used to seeing thinner models. Once a company has decided on the type of model, it can set about developing its organisation and integrated management systems that meet both its own objectives and also the requirements of the regulators.

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Life extensions
A number of countries with existing nuclear plant are faced with the demands of maintaining an ageing reactor fleet. This task is complicated by evolving regulatory requirements, including those introduced in response to recent disasters that have required plant to demonstrate integrity beyond their original design basis, following a re-evaluation of previous seismic and flood risk analyses.

It has long been recognised that building a nuclear power plant is a long and capital-intensive process – but that once completed the plant is easy to operate with relatively low operating costs. As long as the power plant is safe and economical to operate, it makes sense for it to continue operating as long as possible, thereby maintaining capacity. However, following the Fukushima incident, many regulators began looking beyond 'standard' safety upgrades for aging plant, and considering what additional upgrades might be needed to avoid another Fukushima-type situation. Even with these additional requirements, generators have decided to make the required upgrades and keep the plant in operation.

Disposal/long-term storage/repositories
How to deal with radioactive waste has long been a thorny question for the industry – and it is an issue that is particularly challenging in relation to spent nuclear fuel and high-level waste. While some engineers have advocated sending waste into space, the preferred method of long-term storage/disposal remains using a deep geological repository. Some countries, such as Sweden and France, are making progress on their repositories. Others are advancing more slowly, such as the US with Yucca Mountain.

Whatever the pace of progress, the siting and building of repositories are huge capital-intensive projects in their own right. So the question, once again, is being raised as to whether each country needs its own repository, or whether regional/global repositories are a better option. With some countries only having one or two reactors, is it reasonable and sensible for them to build their own repository? This is not a simple question to answer. The basic principle has always been 'polluter pays' – meaning a country/operator is responsible for its own waste. But what does this mean in practice? If a country or project pays for the development of its share of a repository, does that meet the requirements of the international community? And who is liable should a CNE occur within the repository?

In seeking answers to such questions, much can be learnt from the transfer of waste within countries and the shipment of nuclear material and waste. The key to finding answers is not working out how to deal with liabilities and costs since these can be managed; instead, the real issue is how to convince the public that regional repositories are the best approach. Countries such as France are reconciled to building a repository to deal with their own waste, but there is still resistance to the idea of taking waste from another country. Much more stakeholder engagement is needed before a regional repository will be built.

Conclusion
For all stakeholders in the financing, construction and operation of nuclear power plant, navigating through the shifting global environment described in this article raises significant challenges. To chart the right course, participants need to blend the underlying core principles of nuclear projects with an understanding of the local conditions and factors at play in each market. Armed with these attributes, the future for all actors in this growing marketplace is bright – and getting brighter.
To have a deeper conversation about this subject, please contact:

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