

THE FISSION THING

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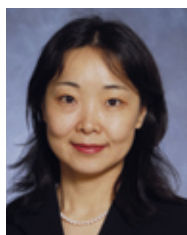
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Sponsors have made some tentative moves to share risk on new nuclear plant construction. But lender and investor perceptions are still obstacles to further shifts.

The re-emergence of nuclear power has benefited from the worldwide growth in energy demand, the desire of countries without fossil fuel reserves for energy security and others for energy diversity, the acknowledgement that nuclear power can help reduce carbon emissions and global warming, and the attractive long-term economics of nuclear power. The amount of capital necessary to respond to the need for nuclear power is projected to exceed the capacity of traditional methods and sources for financing nuclear power plants.

Although nuclear power plants are similar to other complex power projects in many respects, they currently have several distinguishing features, including high capital costs (for the large light-water reactors but not for the increasingly visible, small modular reactors), long construction periods, complex legal issues and regulatory uncertainty (in various circumstances), nuclear waste management, heightened environmental responsibility and mixed public opinion about nuclear

power. These distinguishing features have caused nuclear power plants to be traditionally financed through direct or indirect government funding, corporate balance sheets, or a combination of both. To date, limited or non-recourse project financing has not been used to finance the construction of nuclear generating capacity.

However, current global interest in nuclear energy is causing governments, sponsors and lenders to look beyond the ways in which nuclear power has traditionally been financed. To date, 51 countries have expressed interest in nuclear energy, and 30 countries are actively pursuing nuclear power programs. With an average overall cost to build a new 1,000MW nuclear power plant ranging between \$5 billion and \$7 billion, the sources of funding that are traditionally available have become insufficient to meet the nuclear industry's increasing demand.

Nuclear power has many long-term advantages compared to fossil fuels, including significantly lower external costs such as damage to health and the environment, cost competitiveness and stable base load generation of electricity over a long period of time. But getting private

investment involved in the construction of nuclear power plants has become crucial to the success of the global nuclear development.

Emerging nuclear finance structures

Described below are six financing structures applicable to nuclear power plants that are currently in use or under consideration.

Pure equity investment

Reactor vendors and other nuclear industry companies can team up with plant owners to create project companies that will ultimately own the assets and finance them with equity contributions. These partnerships may provide the anchor capital that will allow private investors to make relatively small investments by purchasing shares in these project companies.

Recent examples include:

- Tokyo Electric Power Corporation's (TEPCO) investment in the NRG Energy and Toshiba joint venture, Nuclear Innovation North America (NINA), which is building two Toshiba advanced boiling water reactor units in Texas as part of the South Texas Project. TEPCO will invest \$155 million through its US subsidiary for a 10% stake in NINA's South Texas expansion from two to four units. TEPCO will also have a \$30 million option payment to enable it to acquire an additional 10% in NINA for \$125 million within a year.
- Luminant and Mitsubishi Heavy Industries (MHI) established a joint venture to further the development of Comanche Peak Units

3 and 4 using MHI's US-advanced pressurised water reactor. The joint venture, known as Comanche Peak Nuclear Power Company, will fund project development costs during the period preceding the issuance of the combined license to build and operate Comanche Peak Units 3 and 4. Under the terms of the joint venture, Luminant holds an 88% ownership share in the company and MHI has a 12% stake.

- In addition to the delivery of the four plants by Korea Electric Power Corporation (KEPCO) in the United Arab Emirates, published reports indicate that Emirates Nuclear Energy Corporation (ENEC) and KEPCO have agreed to key terms under which Korean investors will have an equity interest in the project.

Partnership with consumer consortium

Partnership with consumer consortium is a model adopted for the Olkiluoto plants in Finland (also known as the Finnish model). The essence of this model is to invite a number of major industrial electricity consumers to invest in the plant through a joint venture by Teollisuuden Voima Oy (TVO). Each equity investor contributes a proportion of the costs of building and operating the plant in return for electricity supplies that the shareholder can use itself or resell.

Approximately 25% comes from any new investment (such as the recent Olkiluoto-3 construction), from equity capital injections or from subordinated shareholder loans. Under TVO's Articles of Association,

each shareholder is severally liable for annual fixed costs, including paying debt installments on an annual basis, in proportion to its shareholding. The Olkiluoto-3 project financing plan requires additional equity investment as the project proceeds.

This model can be considered in countries where there is sufficient concentration of energy intensive industries, but is unlikely to be considered in countries where the power must be sold to the grid at a low price or where the grid must deliver the power to all takers at the same cost. Participation in such a partnership could potentially be open to market players other than industrial electricity consumers. Utilities that have surplus capital and are interested in market expansion in the nuclear industry, either domestic or international, will be well-received in countries where investment is a major impediment to the construction of new nuclear power plants. There is a lot of potential in the next few years for this type of partnership or industrial alliance to form.

Power supply tied to equity investment

Nuclear utilities and electricity-intensive industrial consumers can form long-term industrial and commercial partnerships on the basis of sharing risks associated with the performance, scheduling and development of the utilities' nuclear capacity. Both utilities and industrial consumers can benefit from this type of partnership, which contributes to furthering utilities' investment plans in new nuclear power

plants and provides secured sourcing of electricity for participating industrial customers for as long as the arrangement lasts.

The recent *Électricité de France* (EDF) and Exeltium deal sets up such a model for other countries to consider, but governments may have to play an active role in facilitating such an initiative. Exeltium is a consortium of electricity-intensive industrial consumers set up by six founding members, and later joined by 20 other industrial shareholders. The consortium signed a long-term electricity supply contract with EDF under which EDF is to supply an average of 55% of the consortium's electricity needs at an average price of around Eu37 per MWh. To access electricity at a low and stable price for a 24-year period, the consortium agreed to pay a large part of the long-term electricity contracts in advance as an investment in further power capacity.

Exeltium reached financial close with 10 banks providing a loan of Eu1.7 billion. This model can be duplicated and used by countries to finance the construction of new nuclear capacity by using advance payments (contractual proceeds) made by industrial consumers upfront under long-term electricity contracts.

Asset pooling for portfolio investments

For equity investors other than industry energy players, particularly financial sponsors, an alternative approach could be asset pooling, where a group of investors that are prepared to invest in the nuclear

industry create a joint fund and then invest in a range of nuclear portfolios. This could be an option for various institutional investors such as pension funds or insurance companies that are typically seeking investments with long term, stable and predictable returns.

Debt financing

While plant owners and project sponsors prefer debt, commercial lenders expect a high equity component to reduce their own exposure. Insofar as debt financing is available from commercial lenders, these loans have been secured against the assets of the sponsoring utilities and not against the nuclear project itself. For instance, the recent conditional commitment to providing a loan guarantee from the United States Department of Energy to Georgia Power's Vogtle 3 and 4 nuclear project benefited from a corporate guarantee from the sponsoring utility. The availability and cost of debt financing depends on the strength of the balance sheet of the sponsoring utilities. During the construction phase of a new nuclear plant, banks are most likely to favor this corporate financing approach backed by the balance sheet of one or a consortium of large, virtually integrated utilities with expertise in nuclear construction and operation, strong existing assets and large base of consumers. EDF's Flamanville 3 project is a good example of this more traditional way of financing.

Debt financing introduced at different phases of a project could take a different form. While balance sheet financing is generally required by banks to provide financing for the

construction phase, non-recourse financing is likely to be considered by banks for the operational phase.

Phased financing

Nuclear projects present different and distinct phases (development, construction, operation and decommissioning), which may or may not be attractive or suitable to various types of investment groups according to the risk profile they carry. While during the lowest-risk operational phase, equity holders, funds and long-term debt holders are potential investors, the development, construction and decommissioning phases present higher risks that may only be suitable to certain investors.

With phased financing, the cost of capital for each phase only reflects the risk of that phase and each phase may present a different capital structure. For example, government funding and equity investment may be introduced to finance the initial construction phase. As the project proceeds and risks diminish over the course of construction, the cost of capital also diminishes. When the project moves from the construction to the operation phase, government support and equity shareholders can be replaced with non-recourse financing. In addition – for multiple units – the revenue stream from operating units can be used to finance new construction.

Combining the cash flow of multiple unit construction can also benefit from economies of scale by sharing plant facility resources, saving temporary construction expenses and optimising project management.

Collectively these serve to significantly reduce the overall construction price of multiple units. The phased financing model is currently being explored to finance projects in China.

Emerging nuclear risk allocation methods

Irrespective of the financing model or investment forms, private investors and lenders will examine political and licensing risks, technology choices, as well as project management, supply chain and construction risks. Below we examine some of the key risks that are particularly significant to nuclear projects and some recent developments in the nuclear marketplace.

Construction delays and cost overruns

Higher capital costs and the technical complexity of nuclear projects have elevated the risks of construction delays and cost overruns as major concerns for private sector investors and lenders. We believe, however, that this is more a perception than a reality. There are a number of factors that have resulted in nuclear power plant construction delays and cost overruns in the past. They range from technical problems, supply chain complexity, burdensome licensing and regulatory processes, and, in some cases, lack of a political consensus or public opposition to nuclear power. However today, most countries are pursuing nuclear power programs are adopting clear policies enabling the development of nuclear plants and are removing the political or

regulatory barriers that caused delays and cost overruns in the past and therefore have greatly reduced the risks arising from policy or regulatory factors.

On the other hand, the perception by private investors of delay risks and cost overruns is largely due to lack of recent successful nuclear new-build experience in Western countries. Nuclear construction in Japan and Korea over the past decades and more recently in China has proved to be a different story. A significant number of nuclear power plants have now been constructed in these countries within the expected schedule and budget and have successfully entered commercial operation.

It is, therefore, crucial for the nuclear industry to build confidence in the fact that reactors can be built in Europe and the United States as quickly as in Asia. While the Olkiluoto-3 European pressurised reactor (EPR) construction is three years behind schedule and significantly over budget, and the EPR construction in Flamanville is also reportedly delayed, delays are not necessarily inevitable with a first-of-its-kind project. A project using a similar design in Taishan, China, is reported to be two months' ahead of schedule. Westinghouse's first AP1000, Sanmen-1 in China, is also reported to be on schedule.

The difficulties of new nuclear construction projects must not be underestimated, but they can be overcome by technical improvements, disciplined project management, and carefully selected

personnel possessing the necessary skill and experience. Risks of delay and cost overruns should not be an industry issue and need to be re-assessed on a case-by-case basis.

Structuring EPC contracts

Having a well-structured engineering, procurement and construction (EPC) contract in place is a key to the success of any nuclear project. It is also a prerequisite for private investment. There are several ways in which a nuclear EPC contract may be structured to minimise the construction risk, including single point EPC responsibility and fixed price turnkey contract.

The construction of a nuclear plant involves complex supply chains that often stretch across several countries. To mitigate the risk of delays arising from supply chain issues, projects can be structured in a way that the EPC contract is awarded to a single prime contractor that serves as a sole contact point for the entire project. This contractor controls and manages sub-contract procurement and is responsible for the final delivery of the plant. Contracting an EPC contract with a single prime contractor rather than using a consortium formed by multiple contractors on the basis of joint and several liabilities will ensure clearly defined responsibilities assumed by the prime contractor, expedite the tender and negotiation process at early stages of the project and save time for the overall project before the actual construction work begins. It also shifts the risk arising from supply chain management to the EPC contractor, thus providing

comfort to commercial investors by enhancing the credibility of the nuclear project.

Not generally available in the past, a single point EPC model has recently become increasingly popular in countries that are actively seeking to develop domestic peaceful nuclear programs but have no experience or sufficient resources to manage the construction and subcontract procurement on their own. The conclusion of the single-point EPC contract between the United Arab Emirates and KEPCO has reportedly pushed a new round of industrial restructuring in France and Japan. France, in particular, has reaffirmed its integrated business model, allowing utilities to improve their availability and production in order to meet the increased demand from emerging economies seeking a similar EPC model as the United Arab Emirates.

The risks of cost overruns during construction can also be shifted to the EPC contractor and its subcontractors in whole or in part by choosing different payment models for contract pricing. In the past, risks of cost overruns were basically shared between the parties by combining elements of fixed and reimbursable costs with each contributing a fair proportion in the total contract price. In recent market practice, however, there has been a dramatic increase in the use of the fixed-price portion of the total contract price, and that the risks arising from disparity in cost estimates tend to be borne by EPC contractors rather than being shared

between various parties. This is largely driven by increased competition in the reactor supply market and the current shifting of bargaining power from the supply side to the demand side.

Nevertheless, regardless of the bargaining power shifts between vendors and owners, a turnkey contract with high percentage of fixed price portion should be highly attractive to commercial investors.

Legal and regulatory uncertainty

Legal and regulatory risks are perceived to be high by private investors where their expectation for a comprehensive and effective nuclear regulatory regime is not met. The establishment of a nuclear regulatory regime in areas such as licensing, safety, nuclear liability, decommissioning and waste management can provide investors with comfort and certainty before they can plan a major investment in a nuclear program.

Putting into place a comprehensive regulatory regime, however, is a lengthy process. This is particularly the case for countries that are seeking to develop domestic civilian nuclear programs but have no existing legal or regulatory infrastructure. In some countries, the establishment of the nuclear regulatory regime is being undertaken in parallel with project procurement and financing. While certain risks such as those arising from unavailability of nuclear liability protection can be mitigated through contractual arrangements such as government-backed indemnifications,

countries developing new programs have to develop a clear licensing framework that does not allow for prolonged or repetitive licensing processes. A good example is the recent regulatory reform in the United States where the former two-step licensing process requiring separate construction and operating licenses was replaced by one combined construction-operating license.

Electricity demand and price risk

Due to the relatively long time periods required to repay loans or recoup equity investments required for the financing of the project's construction, nuclear power plants may be more susceptible to electricity market uncertainties. Long-term power purchase agreements with creditworthy power purchasers or regulated power prices would minimise this risk.

Alternative revenue support mechanisms such as a cap or collar on electricity or carbon prices, Kyoto mechanisms, the role of the European Emissions Trading Scheme and other carbon markets, and carbon tax can also be considered by governments to balance electricity's price risk and boost competitiveness of nuclear energy in the electricity market. Most recently, the newly-elected United Kingdom coalition government has announced a plan to set a floor on carbon pricing below which the cost of carbon emission permits cannot fall. This measure was explicitly welcomed across the energy industry, particularly by companies aiming to take part in Britain's nuclear market.

For countries such as the United Kingdom, where government funding is unavailable for any new nuclear capacity and the electricity market is a merchant market where there is no guarantee that electricity prices will be high enough to provide an adequate return on investment, alternative revenue support mechanisms will certainly provide a degree of comfort to investors while considering massive capital investment in new nuclear power plants.

Fluctuations in nuclear fuel price

Fluctuations in the price of nuclear fuel can be of concern to investors. Uranium resources are reported to be sufficient to match the growth of nuclear power, but investment in nuclear fuel cycle facilities (such as conversion, enrichment, reprocessing) will be restricted in a limited number of countries due to non-proliferation concerns. Thus nuclear fuel supply can be subject to political or market risk, given limited commercial sources of supply.

Nuclear plant owners often secure fuel supply through long-term contracts with fuel suppliers or equity investment in uranium production companies. There are also efforts at the international level to address this concern. The International Atomic Energy Agency and Russia have recently set up the world's first nuclear fuel bank to insure uninterrupted supplies for the world's nuclear power plants.

Waste management and decommissioning risks

Long-term radioactive waste disposal and decommissioning planning and funding are areas where governments need to establish clear national policies, laws and regulations. In many cases legislation requires the creation of segregated funds which can only be used for waste disposal or decommissioning. Funds can be prepaid, accumulated as a charge over the life-time of operations or guaranteed through a letter of credit. These funds will ensure that adequate funding exists for the waste disposal and eventual decommissioning of the plant.

Countries follow different models, with some requiring owners to record these liabilities on their balance sheets while others are allowed to externalise them through payment to external funds. But investors will seek some type of assurance that they will not be responsible for liabilities beyond the estimated cost of waste disposal and/or decommissioning.

Nuclear units under construction worldwide

Country	Reactor name	Reactor type	Total MW	Estimated start-up year
Argentina (1)	Atucha 2	PHWR	692	2012
Bulgaria (2)	Belene 1	PWR	953	NA
	Belene 2	PWR	953	NA
Brazil (1)	Angra-3	PWR	1,245	NA
China (23)	Changjiang 1	PWR	1,000	NA
	Fangjiashan 1	PWR	1,000	NA
	Fangjiashan 2	PWR	1,000	NA
	Fuqing 1	PWR	1,000	NA
	Fuqing 2	PWR	1,000	NA
	Haiyang 1	PWR	1,000	NA
	Hongyanhe 1	PWR	1,000	NA
	Hongyanhe 2	PWR	1,000	NA
	Hongyanhe 3	PWR	1,000	NA
	Hongyanhe 4	PWR	1,000	NA
	Lingao 3	PWR	1,000	2010
	Lingao 4	PWR	1,000	NA
	Ningde 1	PWR	1,000	NA
	Ningde 2	PWR	1,000	NA
	Ningde 3	PWR	1,000	NA
	Qinshan 2-3	PWR	610	2011
	Qinshan 2-4	PWR	610	2012
	Sanmen 1	PWR	1,000	NA
	Sanmen 2	PWR	1,000	NA
	Taishan 1	PWR	1,700	NA
	Taishan 2	PWR	1,700	NA
	Yangjiang 1	PWR	1,000	NA
	Yangjiang 2	PWR	1,000	NA
China, Taiwan (2)	Lungmen 1	ABWR	1,300	2011
	Lungmen 2	ABWR	1,300	2012
Finland (1)	Olkiluoto 3	PWR	1,600	NA
France (1)	Flamanville 3	PWR	1,600	2012
India (4)	Kaiga 4	PHWR	202	2010
	Kudankulam 1	PWR	917	2011
	Kudankulam 2	PWR	917	2011
	PFBR	FBR	470	NA
Iran (1)	Bushehr 1	PWR	915	2010
Japan (1)	Shimane 3	ABWR	1,325	2011
Pakistan (1)	Chasnupp 2	PWR	300	2011

Nuclear units under construction worldwide

Country	Reactor name	Reactor type	Total MW	Estimated start-up year
Russia (9)	Akademik	PWR	32	2013
	Lomonosov 1			
	Akademik	PWR	32	2013
	Lomonosov 2			
	Beloyarsky 4	FBR	804	NA
	Kalinin 4	PWR	950	NA
	Kursk 5	LWGR	915	NA
	Leningrad 2-1	PWR	1,085	NA
	Leningrad 2-2	PWR	1,085	NA
	Novovoronezh 2-1	PWR	1,114	2013
Slovak Republic (2)	Novovoronezh 2-2	PWR	1,114	NA
	Mochovce 3	PWR	391	NA
S. Korea (6)	Mochovce 4	PWR	391	NA
	Shin-Kori 1	PWR	960	2010
	Shin-Kori 2	PWR	960	2011
	Shin-Kori 3	PWR	1,340	2013
	Shin-Kori 4	PWR	1,340	2014
	Shin Wolsong 1	PWR	960	2011
Ukraine (2)	Shin Wolsong 2	PWR	960	2012
	Khmelnitski 3	PWR	950	2015
United States (1)	Khmelnitski 4	PWR	950	2016
	Watts Bar 2	PWR	1,165	NA
Total (58)			55,807	
ABWR				
FBR				
LWGR				
PHWR				
PWR				

Source: NEI, using International Atomic Energy Agency PRIS database