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Financing Nuclear Power Plant Projects
A New Paradigm?

Fabienne Pehuet Lucet

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IFRI
27, RUE DE LA PROCESSION
75740 PARIS CEDEX 15 – FRANCE
Tel: +33 (0)1 40 61 60 00
Fax: +33 (0)1 40 61 60 60
Email: ifri@ifri.org

IFRI-BRUXELLES
RUE MARIE-THÉRÈSE, 21
1000 – BRUSSELS – BELGIUM
Tel: +32 (0)2 238 51 10
Fax: +32 (0)2 238 51 15
Email: info.bruxelles@ifri.org

WEBSITE: *Ifri.org*

Author

After a few years in the French Diplomatic Service, Fabienne Pehuet Lucet began her career in Finance in the pharmaceutical industry with Eli Lilly in the United States. She then worked as a trader on the financial markets in Paris. Her experience in the nuclear energy business dates from the 1990s when she joined COGEMA (now AREVA NC) where she held management positions in Finance and Strategy. After AREVA was formed she joined FCI, the connectors business of AREVA at that time where she served as SVP Audit. In 2003, she was appointed Marketing Director of the AREVA Group. From 2007 until 2012, she developed a new feature for the Group as SVP Partnerships and Local Cooperation.

Since 2012, Fabienne Pehuet Lucet is helping companies to develop or refocus their activities in the Energy, Industry and Infrastructure fields.

Fabienne graduated from Institut des Etudes Politiques (Paris) and Columbia University (NYC) SIPA/MIA Finance & Banking.

Executive Summary

Considerable investment will be needed in order to meet increasing world-wide demand for energy and replace ageing existing plants. In a context where struggling against climate change is a widely shared objective, a sizeable portion of the $16000Bn future investment in electricity generation should be made in low-CO_2 sources of energy - renewables and nuclear power generation facilities. The magnitude of capital needed to finance such large energy infrastructure programs raises questions about funds availability, project selection and investment priorities. Only projects considered viable and profitable over the operational period of the plant can attract financing, and the most attractive projects will be funded and launched prior to others.

Nuclear projects present specific features and risk profiles which make them more challenging to finance than other electricity generation plants. Specific extrinsic risks are related to the environment of the project. Political and public acceptance risks are decisive for nuclear programs' sustainability, as government energy policies can be reverted and public opinion can influence decisions on nuclear projects. Nuclear power plants are being built in a multi-layered legal and regulatory environment: construction can be stopped or delayed on the safety authorities' requirement.

Specific intrinsic risks lay with the construction risk profile and technology risks during construction. Electricity generation is a highly capital-intensive activity with significant upfront costs. It is particularly true for low-carbon sources of energy, where operating costs are rather low, while initial investments are huge, compared to thermal power plants. Nuclear power plants feature the highest overnight cost in $KWh, the largest capacity, operate for very long periods of time (60 years) and take longer to build than other power plant generation technologies. As it is not unusual to build several units on a same site, nuclear power plants are among the largest power plants generation projects. Technology risks are substantial for new designs until a proven record of construction and sound operation builds up. The complexity of the projects makes them more sensitive to high risks of construction delays and cost overruns.

As nuclear power plants projects are associated with a high risk profile, risks assessments and compliance with demanding risk management principles are prerequisites for any financing commitment. Nuclear projects have to comply with specific lending policies of the banking institutions, as well as exhaustive risk reviews per project. In recent years, managing Environmental and Social risks according to the Equator Principles became an obligation for all projects financing by a financial institution, with more stringent obligations concerning nuclear projects.

Because of their specificities, nuclear projects are widely perceived by the financial institutions as “complicated to finance”, with a lot at stake including reputational risk.

There are currently 435 operable nuclear power reactors around the world, with a further 71 under construction. Two main proven financing models were applied to nuclear plants in the past: the national model, and the corporate model. The historical model of financing is the national model. It allowed for the most efficient risk allocation model in then-regulated national electricity markets: government or state-owned utilities with government guarantee assumed the risks of building nuclear power plants locally. The national model has proven to be efficient in France, Russia and the USA where it was modified to support private business initiatives. It was then replicated in Japan, Korea and China where significant nuclear programs were developed. In the corporate business model, the owner of the plant assumes most of the risk, but various schemes are used to mitigate the owner’s risk by transmitting large areas of risks to others: vendors for construction risk as in Finland, government through loans guarantees etc…

As projects became international, a set of common principles were approved by OECD countries concerning financing and the role of Export Credit Agencies. The objective was to provide competition rules whereby exporters compete on the basis of the price and quality of their products rather than the financial terms provided. Various combinations of these models were and still are implemented. Pure Project Finance was not implemented for nuclear power plants, but the model nurtures reflections about new financing models.

The context in which nuclear power projects are now decided and financed changed drastically: it is a new paradigm.

Risk allocation and financial conditions are at the forefront of competition to win new nuclear projects’ tenders insofar as reducing uncertainties is a decisive competition edge.

In a context of electricity market deregulation and high construction risks, investors and lenders require more and more securities to enter nuclear projects. Securing revenues by entering into long term purchase agreements or tariff schemes and sharing the owner’s risk by taking equity or debt interest contributes to reducing uncertainties and build investor’s confidence. Recent financing schemes such as those proposed in the UK contribute, in this regard, to the feasibility of new nuclear power plants projects. The Build Own Operate model recently contracted for the Akkuyu project in Turkey goes beyond mere financing and long term price agreements, as most of the overall viability risk of the project is transferred to the vendor.

After the 2008 financial crisis and its regulatory consequences, new constraints were imposed on banks. It is now necessary to consider new funding resources and new financing schemes to supplement traditional financing. As innovative fund raising and financing of nuclear projects is needed, financial conditions are now at the forefront of competition.

Concurrently, competition to win new nuclear tenders exacerbated in recent years as markets became global and new-comer exporters of nuclear power plants' have been pursuing ambitious objectives on the international markets. The traditional competition system is organized along the OECD guidelines, ECA financing and the EU rules, whereas the challengers' competition system is free from such regulations and constraints. This provides countries such as Russia and China with possibilities to propose more advantageous financing and risk allocation schemes than the OECD countries, often through government to government agreements.

The traditional vendors and nuclear projects' stakeholders are entering a new, more complex multilateral competition field requiring new strategies built on the protagonists' respective strengths. The international nuclear market is more and more intertwined. Overlapping competition systems now co-exist, bringing about major alliances and partnerships cutting across national boundaries and references to win nuclear tenders.

Numerous open questions remain regarding the new-comer exporters' market penetration in Europe and elsewhere. In lack of strong construction records and amid large uncertainties over project viability, financing and risk sharing have recently been the deciding factors of nuclear deals.

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Introduction

Considerable investment is required to meet increasing world-wide demand for energy and replace ageing existing plants. A recent International Energy Agency (IEA) study estimates the total amount of investments required at $48,000 Bn (60% replacing plants, 40% to satisfy demand growth). Electricity generation projects investment alone should reach $16000 Bn before 2035.

In a context where fighting against climate change is a widely shared objective, a sizeable portion of future investments should be in renewables and nuclear power. The proportion of nuclear projects of the required investment depends on various conditions; starting with the political decision from governments to continue, resume, or initiate nuclear energy generation plans.

The capacity to develop new nuclear projects depends also on the existing local industrial infrastructure and capacity to develop new capacities in line with the very demanding quality requirements (codes and norms) of the nuclear construction industry. Access to sufficient trained personnel overtime is also a conditioning factor. The launching and realization of nuclear power projects is thus not only a question of political decision: it involves a time dimension and a relevant socio-economic growth potential.

Even after the decision is made and the program is initiated, the outcome of a nuclear power program remains uncertain. Projects that were announced and never built or long delayed are plenty in the history of nuclear power energy. External risks play a key role in this regard: change and/or uncertainties related to the relative costs/competitiveness of energy sources, lack of sufficient budget or financing change of government policies, loss of confidence from the public, nuclear accidents in some part of the world, etc.

Following a period of intensive development in the USA, Europe and Russia, new nuclear investments stalled in the USA and Europe after the two major accidents of TMI (1979) and Chernobyl (1986) while the Chinese program started. Nuclear projects investments resumed in the 2000s in Europe with the OL3 project in Finland. Nuclear energy was then reconsidered in the light of global energy and economic growth, climate change, availability of new technologies and energy prices favorable to nuclear.

Some ten years later, in 2015, the landscape for competing in winning nuclear tenders and building nuclear projects differs considerably. In this new context, it appears that financing and project structuring play a key role. The financing issue was less crucial when the first nuclear programs were launched and built. At the time, large programs were initiated in the USA, Europe and Russia which were led by centralized governmental decisions, supported by “national” technologies and industries as well as access to finance resources either provided or guaranteed by the State, and regulated prices of electricity or tariffs. The OECD guidelines on financing nuclear power contributed afterwards (1990) in taming competition within then-segmented export markets. In a wave of electricity price deregulation, globalization of nuclear export markets, the emerging challengers’ ambitions and the consequences of the 2008 financial crisis, financing has become a diriment factor in building new nuclear power plants.

The first part of this study highlights the specific features of nuclear power plant financing. Risk profile of nuclear projects as well as compliance with demanding risk management principles render financing nuclear projects quite challenging.

The second part analyses how it has been possible to finance the construction of more than 400 nuclear power units worldwide and the evolution of financing schemes in a then-level competition field, across a variety of nuclear project execution contexts.

The third part illustrates the change of paradigm in competitive nuclear markets. Electricity markets were broadly deregulated during the nuclear markets’ slump in Europe and in the USA leading to less visibility over future projects’ viability. The context of financing changed drastically after the 2008 financial crisis and its regulatory consequences. Strong challengers with global markets’ ambitions emerged, reshuffling the cards of competition and disrupting the traditional nuclear markets.

Financing Nuclear Power Projects: Specific Features

As for any project, the basics of financing apply to nuclear power plants projects. Funds are raised through debt and equity in various proportions from investors and lenders convinced of the project's viability. Investors expect to participate in future profits while lenders expect the debt repayment (capital plus interests) as stipulated in the loans contracts. Lenders and investors often commit to finance the project as early as the bidding period. Funds are drawn during the construction period and the loans are reimbursed during the operations period, over the maturity of negotiated loans.

Financing nuclear power plants is specific mainly because high extrinsic risks bear heavily on the feasibility of the projects. As such risks are quite unpredictable, complex and difficult to mitigate, and despite compliance with demanding risk management principles, specific financing schemes/models have to be developed for nuclear power plants projects.

Specific features and risk profile of Nuclear Power Plant Projects

Nuclear projects, specifically new nuclear power plants, present characteristics which increase the challenges of financing for investors and lenders. Both extrinsic and intrinsic risks create a particular profile for nuclear power plants projects.

Extrinsic risks: global environment of a nuclear project

a) Governmental policies and public acceptance are critical in nuclear programs sustainability

Governments and other public bodies have a central role in setting the policy and legal framework of nuclear activities. Energy policies and strategies are established by governments, with or without nuclear as part of the energy mix. As for any governmental policy, there is no guarantee of the stability of energy policies. Government commitment to nuclear is thus a risk area for lenders.

Where nuclear is part of the national energy strategy and policy, it is necessary to measure and monitor the confidence of the public at large towards nuclear power. Despite its low-CO_2 characteristics, nuclear carries a mixed, if not negative, “image” risk (reputational risk), due to potential environmental and social consequences of nuclear activities and the fears associated with the technology. Public opinion can reverse the government’s commitment to nuclear power. The decision of a nuclear phase out by 2022 taken by Germany in 2000 and confirmed in 2011 is illustrative in this regard. Nuclear projects are also under close scrutiny of local stakeholders as well as national and global NGOs involved with energy and environment.

As a consequence, reputational and potential disruption risks are seriously considered when contracting or financing nuclear power projects.

b) Nuclear power plants are being built in an increasingly complex legal and regulatory environment

Multiple institutions contribute to the regulatory framework of building and operating nuclear power plants. The global framework of every nuclear project organization is set by generally accepted guidelines from the International Atomic Energy Agency (IAEA), and global professional organizations, but as the responsibility resides with the local governmental authorities, implementing a nuclear project or financing it requires knowledge of and compliance with every local political and regulatory framework, which adds to the overall complexity.

A global framework of principles and regulations drive the development of nuclear activities, IAEA, in this regard having a fundamental role. A set of treaties and conventions, rules and principles of regional institutions and professional associations such as the World Association of Nuclear Operators (WANO), in addition to national regulations, complement the IAEA rules and contribute to regulating and controlling nuclear activities. Regulatory areas concern non-proliferation, peaceful use of nuclear energy. The norms and rules of industrial nuclear projects, involve interactions between nuclear materials and the environment whether accidental or not, during the plant’s life time: pre-construction phase, construction, operation period, post-operation period until and during dismantling, fuel recycling and waste treatment/storage. Specific construction and manufacturing codes apply to nuclear equipment manufacturing depending of the equipment’s future exposure to nuclear materials or reactions.

Ministerial departments and public bodies organize the legal and institutional framework of nuclear activities related to nuclear power generation in a given country. That framework concerns: licensing rules, nuclear safety organizations, nuclear liability insurance rules, site permits, waste management and spent fuel policies and decommissioning. The set of regulations governing nuclear industrial activities is among the most stringent and probably the most complete of all, as it covers the entire life cycle of any nuclear activity.

External risks arise early as the bidding period, as government decisions or public acceptance can impact the final investment decision. They are also quite high during the preconstruction phase, which entails difficult hurdles such as licensing, site permitting and environmental inquiry surveys.

Risks extrinsic to nuclear projects have often caused long delays and disruptions in nuclear programs; because they are perceived as complex and difficult to mitigate. Extrinsic risks bear heavily on nuclear project's feasibility/viability.

Intrinsic risks

The characteristics of the projects themselves make them challenging to finance.

a) High upfront capital costs

Nuclear power projects are among the largest infrastructure projects. Plant capacity (MW) for nuclear is by far the highest, 1400MW on average, with a range of 954 to 1650 MW depending on technologies. Building a nuclear power plant is a multi-billion-dollar project. It can range from $3 to $5Bn for a single new nuclear power plant unit, and often several units are planned for development. It is not unusual to build 4 to 6 units on a site and for countries to engage in building nuclear programs of 10 or more units, meaning some $50Bn to be invested over ten to fifteen years. This is the case today for China, India, the United Kingdom and potentially Saudi Arabia.

Electricity generation, in general, is a highly capital-intensive activity with significant upfront costs. According to IEA in the World Energy Investment Outlook Special Report (2014)[1], nuclear has the highest overnight cost in $KW of all power generation technologies.

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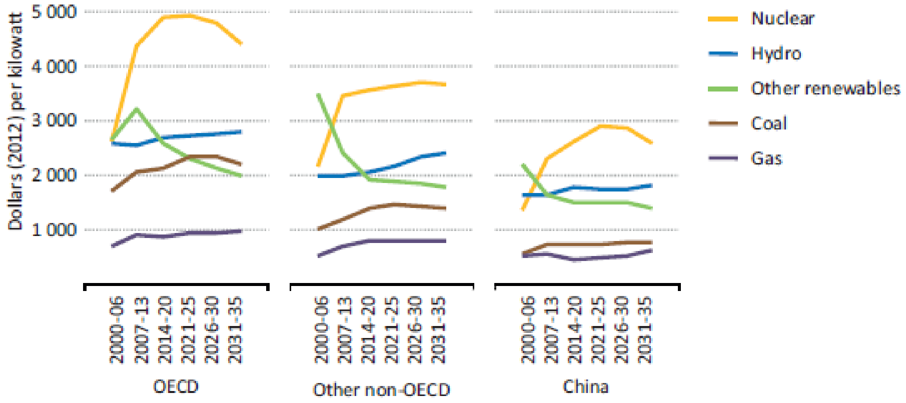
1. Disponible sur : <www.worldenergyoutlook.org/investment/>.

Average annual unit investment cost in power plants by type in New Policies Scenario:



Note: Unit costs do not include investments in carbon capture and storage.

Source: IEA: World Energy Investment Outlook Special Report 2014

In preparation of the World Energy Investment Outlook report, IEA decided to update the investment cost data to feed into the IEA Energy World Model, leading to significant changes in technology investment costs compared to reference costs used previously as in the 2010 IEA report on "Projected costs of generating electricity". The report[2] concluded the following most significant changes:

- Nuclear unit costs in the US, the EU and China increased by 10-40%,

- Wind offshore unit costs increased across all regions by 30-50%, while, onshore wind decreased by 15% in China

- Combined cycle gas turbines unit costs increased within OECD by 10-20%.

The new set of investment cost data confirmed nuclear power generation as the most capital intensive of all existing power generation technologies (per KW installed).

Obviously, the KWh cost of electricity comprises more than just investment costs. The "levelised cost of electricity" method, commonly used to calculate the total cost of electricity generation whether nuclear, gas, coal or renewables, takes into account all costs incurred over the total life of a generation plant.

2. IEA: World Energy Investment Outlook Special report 2014

In the case of nuclear power generation, higher upfront capital costs are compensated by other variables such as high utilization rates and long lifetimes providing base-load power for 40 to 60 years.

Under the assumptions of the 2010 IEA report "Projected Costs of Generating Electricity", the KWh price of electricity generated by nuclear technology was found lower than for electricity generated by other technologies.[3] This is likely to change with the next issue of the IEA report based on new investment costs assumptions including among others higher capital costs for nuclear generation technologies and lower costs for renewables, notably solar technologies.

b) Construction risks

In addition to higher capital costs compared to other technologies, nuclear power plant projects also have longer lead times. The plant construction can take seven years on average, compared to four years for coal, two years for CCGT, one to two years for onshore wind and Solar PV. [4]

Therefore, combined with high upfront costs, construction risks are higher in nuclear power projects. They stem from potential construction cost overruns before the commissioning of the plant and uncertainty concerning the length of the construction period. The high share of construction costs in the nuclear KWh cost is a salient feature of the nuclear power projects. As they are incurred before the commissioning of the plant, the economics of nuclear energy is widely dependent on investment costs and construction planning control. Construction risk is thus a major item considered by investors and lenders when considering financing for a nuclear power plant project.

c) Predictable operating costs

After construction, the operating period of nuclear plants is now anticipated to be sixty years. The plants built in the 1970s were anticipated to run for forty years; many of them have been "upgraded" in the USA and are now being authorized to operate for sixty years. Nuclear plants now being built are Gen3 designs with a design lifetime of sixty years; it compares with anticipated operating periods of twenty-five to forty years for other technologies.

Economic (costs) uncertainties during operations are smaller than in other types of power plants: operating costs are predictable. They account for 25%, while fuel prices are less than 10%, compared to 60% for fossil fuels.

d) Technology risks

New designs can also increase the construction risk. Implementing a new design in construction can cause numerous delays and high cost

3. IEA Projected Costs of Generating Electricity 2010: Median costs values –Table 5.2
4. IEA Projected Costs of Generating Electricity- 2010- Table 5.2
and IEA- WEIO 2014: power generation investment assumptions

overruns. As construction costs are so high in total nuclear KWh costs, if unexpectedly increased, they can penalize the global economic viability and the risk profile of nuclear projects.

Technology risks are substantial for new designs until a proven record of construction and sound operation builds up. Lenders have addressed such risks in the past, and are now facing them again as new generations of plant designs are being built. Mitigating construction risks includes avoiding building a first-of-a-kind nuclear power plant. Most tenders now require vendors to propose a proven design and a "reference plant" in operation.

Compliance with demanding risk management principles through the financing institutions.

Because of the specificities of nuclear projects, not all financing schemes can be applied to nuclear power, and not all financial institutions will be willing or able to finance the projects.

Regardless of the share of debt and equity in financing a project, investors and lenders are mobilized to verify the overall viability of the project candidate. They have indeed a choice among a variety of projects to finance, across a variety of business sectors and countries. Committing to nuclear power plant projects therefore requires a thorough examination of the specific risk profile of nuclear projects, including external risks as their occurrence can compromise the viability and even the completion of a project.

Formalized and specific lending policies

The first screening phase of nuclear projects examines their compliance with the lending policies of the institution.

Banking institutions have defined and formalized lending policies specific to nuclear projects. These policies comprise a set of specific assumptions and prudential rules that banks take into consideration before committing to finance a project.

Financing of nuclear power traditionally involves international and local banks, as well as export credit agencies (ECAs), and public regional lending agencies. Because of the size and complexity of nuclear projects, leading syndication banks are always large global banking institutions. Most of them make a summary of their lending policies public via their websites according to their transparency policies. This is quite appropriate, given the importance of public acceptance for nuclear power development.

Such lending policies are not just aiming at qualifying the nature of the risk, they also require that the host country and the future operator of the plant demonstrate their ability to monitor, mitigate and ultimately reduce risk. Reducing risk for the overall project is indeed the ultimate goal, risk allocation being secondary, though important.

In line with their lending policies, financial institutions review project qualification for financing. According to a banking institution met by the author, main assumptions and prudential rules that banks take into consideration before committing to finance a nuclear power plant are the following:

- The host country, where the nuclear power station is located
- Status of the country vis-à-vis IAEA (membership), observance of relevant IAEA conventions
- Status of the host country vis-à-vis the Non-Proliferation Treaty (signatory) and vis-à-vis the safeguards arrangements with the IAEA
- Existence or setting up of an acceptable legal and independent regulatory regime governing the nuclear sector and its safety rules, with an independent nuclear safety agency and offers strong state support (including a civil nuclear liability act)
- Nature of reactors purchased (Gen 2 + / Gen3 type reactors only) and existence of a dedicated team working on its nuclear power plant program
- Purchasing of technologies with an already approved design
- Inclusion of financing schemes in program planning from the start to reassure the international political and banking communities
- Implementation by the future operator of the plant of management systems and policies (protection of workers/populations, management of fuel and waste, emergency preparedness, monitoring & maintenance, cooperation with IAEA…)
- In-depth due diligence of the plant as validated by Environment and Safety (E&S) consultants to ensure the compliance of the nuclear power plant with the IAEA requirements, the International Financial

Institution (IFC) and Environment, Health and Safety (EHS)[5] guidelines, and other industry standards

- Experience of the future operator in nuclear plant management

- Reports from IAEA missions (operational safety review) and/or peer reviews for instance through WANO are appreciated.

Exhaustive risk reviews

All stakeholders involved in a project conduct a risk assessment in the scope of their involvement. Investors and lenders are committed to the overall success of the project. This covers the entire scope of realization, from the bid period to the end of operations. This is why banks and investors conduct the most exhaustive risk reviews.

Risk assessment and risk mitigation plans are prerequisites to obtain any financing commitment for a project, but they are more demanding for nuclear power projects.

The potential impact of extrinsic risks makes the risk mapping, risk allocation and risk remediation plan more challenging than for other projects.

Risk review usually comprises:

- Risk mapping: identification and qualification of risk. In the case of nuclear project: qualification of level of control over a specific risk.

- Risk allocation to risk owner: effort to identify a principal risk owner, responsibilities and possible accountabilities. In the case of nuclear projects: risk allocation is to be found among public bodies or government, private contractor, and the utility.

- Possible risk mitigation: what can be undertaken to mitigate a specific risk.

The nature, magnitude and potential consequences of risks vary greatly over time. Because lenders and investors are concerned by the overall viability of a nuclear project, risk reviews have to be conducted for the overall project and for every period of the plant's life: pre- construction, construction, operating, and back-end periods.

5. Environment, Health and Safety

Items of a risk review for a nuclear power plant project

Pre-construction Period

Energy policy

Public acceptance

Licensing process (permits and sites)

Construction Period

Technology, Design

Manufacturing completion including commissioning

Delays

Cost overruns

Legal (force majeure, insurances etc…)

Financing (funding/equity/debt, interest rates…)

Nuclear incident

Environmental

Political

Operation Period

Operational risk

Fuel supply

Financial (Debt Services…)

Nuclear incident

Environmental

Political

Back-end Period

Spent fuel treatment and waste management

Decommissioning

Nuclear incident

Environmental

Political

Source: banking institution met by the author.

Risk exposure of investors and lenders is greatly reduced after the construction period, but given the uncertainty of the duration and outcome of the bidding/pre-construction and construction period, commissioning of the plant usually occurs at least ten years after the launch of the tender. Lenders and investors commit to finance the project during the bidding period, most often about three years before construction starts. The funds are drawn during the construction period. During the operation phase, the loan is reimbursed over the negotiated maturity, usually fifteen to eighteen years. Risk reviews for nuclear power projects are thus also specific because of potential causes/risks of unexpected delays associated with the very long periods of time involved.

Obligations regarding Environmental & Social risks

In addition to conducting extensive risk reviews and formalizing lending, special requirements have recently (early 2000s) been added regarding environmental and social issues. Managing environmental and social risks has become indeed a stringent obligation.

The International Finance Corporation (IFC) Sustainability Framework and the Equator Principles (EPs)[6] Framework set the standards and references for addressing environmental and social risks in infrastructure projects. "*Risks arising from environmental problems or social discontent surrounding a project can be extremely costly in terms of delays and stoppages, negative publicity, threats to opening license, and significant unforeseen expenditures. At the same time, reputational damage to a company can far exceed the immediate cost impacts of a single project. Companies that proactively seek to reduce and manage these risks can benefit from improved business performance over time*"[7].

The EPs have provided a platform for engagement with a broad range of stakeholders, including NGOs, clients and industry bodies. Many infrastructure project financing schemes, of which most are nuclear power plant projects, require loan syndications with numerous international lenders, all complying with the EPs whether they are official EPs banks or not, even if a non-EPs bank was the Mandated Lead Arranger. As of 2012, 86% of International Finance debt complied with the E P.

All of the nuclear projects financed through international financial institutions are now governed by the EP. This involves performing environmental and social specific risks assessments, action plans and reporting according to the EPs guidelines, through the lead banks. As nuclear energy projects fall into the "high risk"

6. The Equator Principles (EPs) is a credit management framework for determining, assessing and managing environmental and social risk in project financing transactions. Close to 100 Financial institutions in over 35 countries have officially adopted the EP principles. Multilateral development banks including the ERBD and major ECAs (Export Credit Agencies) common approaches are increasingly drawing on the same standards as the Equator Principles.
7. Source: IFC website

category of the EPs[8], the assessment and monitoring of EPs risks is the most demanding.

For all category high-risk projects, an independent environmental and social consultant must be contracted, with the role to:

- Review the borrowers' commitments in light of Environmental Impact Assessments (EIAs), Environmental, Social and Health Impact Assessments (ESHIAS) performed by the host country.

- Provide independent monitoring and reporting information over the life of the credits/loans.

- Help design action plans and management systems in line with the EPs requirements, and ensure they are complied with during the projects' operational and decommissioning phases.

It is to be noted that the E Ps Financial Institutions reporting is shared with the other banks involved in the syndication.

Risk reviews and risk allocation exercises, as well as engagement to enter into risk mitigation plans as per the EPs, are now widely performed. As financing is key to realize nuclear projects, they are almost inescapable: (i) they constitute a demanding and shared set of governance principles, (ii) as there is often a need for a large group of bank to syndicate the loans, the Mandated Lead Arranger as well as all the other banks have to comply with the EPs standards.

Because of their specificities (size, construction risk, political and regulatory risk, importance of public acceptance), nuclear projects are widely perceived by the financial institutions as "complicated to finance", with a lot at stake including reputational risk. Stringent risk reviews and high hurdles to pass to qualify for financing certainly have positive consequences on projects global governance but also render nuclear project financing more complex.

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8. According to the EPs, "High-risk category A" : potential significant adverse environmental or social risks and/or impacts that are adverse, irreversible, or unprecedented - "Medium risk (category B)" Impacts few in number, site-specific, largely reversible, readily addressed through mitigation - "Low risk (category C)": minimal or no impact."

Financing Schemes: Evolution and Perspectives

As outlined above, only projects considered viable and profitable over the operational period of the plant lifetime can attract financing. Main considerations thus include the project structure and risks, anticipated price of electricity, electricity market size, profile of investors and lenders, availability of funds and the global financial engineering. In this respect, various financial models can be found in the history of nuclear projects.

The **historical model** of financing nuclear power is the national model, as it allowed for the most efficient risk allocation in former regulated national electricity markets: government or state-owned utilities with government guarantee assumed the risks of building nuclear power plants locally.

At the same time, some projects financed "on balance sheet" also emerged, especially in the US,. This method became the **corporate model**. This model has since evolved in complexity. The owner of the plant assumes most of the risk in the corporate model, but various schemes are used to mitigate the owner's risk by transmitting large areas of risks to others: vendors for construction risk like in Finland, government through loans' guarantees etc…

As projects became international, a set of common principles were approved by OECD countries concerning international financing and **the role of Export Credit Agencies** (ECAs).

The national business model

Nuclear energy for commercial electricity generation reached technological maturity in the 1960s. During the next twenty years, economics and politics have been strong drivers of nuclear energy generation growth. Governments were pushing for nuclear energy development while, in most cases, utilities were government-owned, often in a form of a national monopoly. Even when utilities were privately held, electricity markets were highly regulated. Utilities would recover their costs through electricity tariffs calculated to allow for an appropriate return, on a cost-plus basis. Those guaranteed tariffs gave visibility to the viability of the projects over the operational phase and thus reduced perceived risk.

This appetite for nuclear was only reinforced by the 1973 oil crisis and its consequences on energy markets. Political will to reach security of supply caused a surge in nuclear power generation in many countries. Nuclear power could indeed give access to a domestic supply of electricity regardless of fossil fuel resources in the country. Developing nuclear power plants was readily feasible in countries where civil nuclear programs for electricity generation had already been developed, for the most important ones derived from nuclear research programs initiated before or during WWII. Institutional frameworks, research teams and infrastructures as well as access to nuclear materials were a solid basis to the development of civil nuclear applications such as power generation in those countries. [9]

Hundreds of nuclear power plants of various technologies were ordered in the 1970s and 1980s. "National champions" of the nuclear supply chain emerged. Large programs were committed to in a number of countries, with strong support from the State, whether in the USA, France, Russia, Canada, Germany, or in Japan and Korea.

In the context of financing a national program involving industrial "champions" as well as state-owned or large utilities, governments would bring a strong support to the program, including direct or indirect financial support. Among all, France is the archetypal country of the nuclear national model. Fifty-eight reactors were built over fifteen years, providing 75% of the electricity consumption. The nuclear sector is widely developed, supported and monitored by specific regulations, institutions, research centers, education programs, industry and a large utility, EDF. Until 2005, EDF was indeed "*a state – owned, vertically integrated utility, with a near monopoly on electricity production and supply in France, operating within a clear regulatory framework. Electricity tariffs were set according to an expected rate of return on investment. Before 1980, the French government financed part of EDF's investments directly through capital increases, the remainder being financed with cash flow. From 1980, EDF was authorized to borrow up to EUR 40 billion from commercial sources without government guarantee. The company was rated AAA and lenders felt confident they would be repaid due to EDF's position as a monopoly electricity supplier*"[10].

Russia and later Japan, Korea and China developed nuclear along a very similar national model.

The US federal government had the objective to build a strong national nuclear base as well. It played a leading role in supporting nuclear research and development, but economic conditions at the state level were also decisive. Electricity market regulation falls under

9. In 1968, the TNP clarified links between military and civil nuclear energy. As a complement, it is recognized that all countries have access to peaceful use of nuclear energy.
10. Nuclear Energy Agency, *The financing of nuclear power plants*, 2009.

state responsibility in the USA. Whether electricity markets were regulated or not had thus a direct impact on local decisions to invest in nuclear power plants, as it created quite different economic conditions regarding future revenues from the projects. The private sector is dominant in the USA, which differs from the situation in France, Russia or China. Investment in commercial nuclear power plants was made by private sector utilities in the 1970s and 1980s, some of them quite small in size which limited their capacity to endorse risks related to nuclear power plant projects. In spite of severe delays and large cost overruns, leading to increased caution from investors for future projects. More than 100 reactors were built in the USA during this period.

The Three Mile Island accident (1979) resulted in greater opposition to nuclear power and tougher regulatory requirements, leading to more delays and increased costs for the projects under way at the time. Only a few years after the TMI accident, in 1986 the Chernobyl accident made nuclear power more controversial around the world. Relatively low oil and gas prices in the late 1980s until after 2000, lower electricity demand growth, and high interest rates discouraging capital investments are the main reasons behind the lack of new orders for nuclear power plants placed after 1980 in the USA[11].

The national model proved to be very efficient in France, Russia and the USA to develop large nuclear programs. This model was replicated in Japan, Korea, China, where significant nuclear programs were developed.

Is this model still relevant?

At the turn of the century the context became favorable to nuclear power because, among other circumstances, of proven operational performances of existing nuclear power plants, high volatility and rise of fossil fuel prices and international initiatives to curb carbon dioxide emissions. As nuclear became a more attractive source of electricity, new nuclear power projects were considered but launching new investments was more challenging than before because of significant changes impacting the electricity markets. Many electricity markets had been deregulated or were evolving towards more deregulation in Europe, in the USA and in Asia. Government-owned utilities are now just a few; some of them are even partially listed. State aid was regulated in Europe, and sovereign guarantees rarefied.

The US government addressed these issues by providing a new regulatory and financing framework to encourage new nuclear power projects. In 2002, the US Department of Energy (DOE) launched the Nuclear Power 2010 Program, followed by the US Energy Policy Act in 2005, with the objective to address the obstacles

11. 1974 was the last year for an order that was not cancelled subsequently.

to new nuclear projects. The aim was to provide more visibility, reduce investor risk and facilitate financing. On the regulatory side, the Nuclear Regulatory Commission (NRC) revisited its licensing process. It introduced the Combined Construction Permit/Operating License (COL) and the Early Site Permit (ESP) and Early Design Certification processes, allowing for a streamlined review and approval process corresponding to actual realization steps of the projects. Furthermore, four key measures providing direct support to financing new nuclear projects were included in the US Energy Policy Act (2005):

- An insurance against regulatory delays is available for the first six plants built, $500 million for the first two and $250 million for the next four. It covers financial consequences of pushing out the commercial operation date of the plant, mainly financial costs occurring before operational date, and cost difference of replacement power.

- Loan guarantees are available for loans covering up to 80% of the investment value of the nuclear projects, with a repayment period of 30 years. The loan guarantee program is of $18.5 billion12.

- The first 6000MW installed of a new nuclear power plant are eligible for a tax production credit of $18/MWh, up to $125 Mill per 100 MW per year. Projects must have begun construction by 1 January 2014.

- The US Nuclear Liability system was extended through 2025 (extension of the Price Anderson Act).

Such measures demonstrated a better cooperation between the US government, regulatory authorities and industry. They increased the confidence of investors in future nuclear projects and allowed to filing of eighteen COL applications by 2014. Nineteen loan applications from seventeen utilities to support the construction of fourteen power plants were submitted to the DOE as of October 2008.

12. Whether directly, or indirectly through state-owned utilities or state-owned banks, nuclear projects have been often financed by various types of government-guaranteed loans. In some instances, such guarantee was formalized by a sovereign guarantee concerning final repayment of loans to finance a nuclear project. This was very often the case during the first era of nuclear power when the first programs were being built with strong support from governments.

The corporate business model

The traditional source of financing for private investments is corporate financing, also known as “balance sheet financing”. It consists of combining borrowing and raising equity against the assets of the company. If a company builds a new power station using corporate financing, the risk of this investment is borne by all shareholders and lenders of the company. The future global results of the company are supposed to secure sufficient dividends and reimbursement of capital and interest.

Some nuclear projects were financed “on balance sheet” in the 1980s especially in the USA, which caused severe strain on the financial results of the companies in case of construction delays and cost overruns. In order to attract investors and lenders to finance nuclear power plants projects, the financing schemes had to be revised. As applied to nuclear power projects financing in recent years, the corporate model is more complex than mere “on balance sheet” financing. It combines sophisticated risk allocation, bank loans, equity, direct or indirect government guarantees and visibility over future revenues.

Differing from the traditional “national model”, the corporate business model was used to organize the finance scheme of the OL3 nuclear project in Finland.

In 2003, Teollisuuden Voima Oyj (TVO) from Finland decided to build a new 1600 MW nuclear power plant unit. OL3 was the first nuclear unit to be built in Europe after a long time and it was going to be the first nuclear power plant to be built in a liberalized electricity market.

The TVO company, established in 1969, produces electricity for its shareholders at cost price. When the decision to build Olkiluoto 3 was taken, electricity was generated by the two Olkiluoto nuclear power plants OL1 and OL2 (860 MW each) and the Meri Pori coal fired power plant (257 MW). A majority of TVO is privately owned through PVO which holds 60.2% of the shares and is composed of various companies in the Finnish pulp and paper industries. The remaining shareholders are municipalities and municipally owned local utilities.

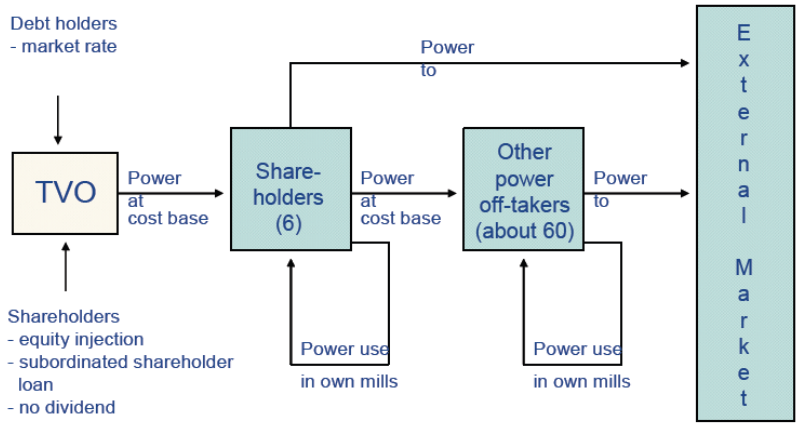
The business model for the OL3 project was quite innovative regarding project risk allocation and securing future revenues.

TVO chose the nuclear vendor AREVA (Siemens and Bouygues as consortium members) to build a new type of reactor, the first of a kind EPR. TVO signed a fixed price turnkey contract with AREVA, thus shifting the risks of project delay and cost overruns to the vendor. This contract structure protected TVO from the project costs overruns (but not from electricity production delays) but proved inefficient to avoid project delays altogether.

As was already the case for OL1&2, TVO sells all the electricity output to its shareholders. The OL3 project revenues are covered by long term power-purchase contracts. As the output is sold at cost, the operational risk is in fact passed to the shareholders of the company. The shareholders also take on a residual risk of a loss in case the future market price of electricity is lower than the electricity production cost from the plant.

The project is financed on the TVO balance sheet, 75% by debt of various types and maturities. The shareholders injected subordinated debt and equity corresponding to 25% of the financing requirements.

TVO's operating principle



Source: TVO presentation, 2007.

Initially, the OL3 financing was a "pure" corporate financing model, not a "project finance" scheme: the debt portion of the project consisted of corporate financing, through syndicated loans of various terms and durations guaranteed by a pool of banks to TVO, making it easier for the banks to enter into the syndication.

Later in the process, export credits and ECAs were introduced to improve the debt conditions. TVO requested the suppliers to provide some financing for their portion of the project, through export credits. Improvements were on the credit's tenure (twelve years from the end of the construction period instead of five to seven years) and on the credit's costs, as banks' margins were reduced thanks to the ECA guarantee.

The financing scheme of OL3, corporate financing combined with ECA financing, was/is secured by the coverage of the construction risk (taken on by AREVA) as well as the revenue risk (taken on by the shareholders).

Is project finance an option?

Possibilities of financing nuclear power plants using “project finance” techniques similar to those used for non-nuclear projects have been explored. It appears that recent financing schemes are referring to project finance techniques but do not implement pure project financing schemes.

Project finance as defined by the International Project Finance Association (IPFA) is “the financing of long-term infrastructure, industrial projects and public services based upon a non-recourse or limited recourse financial structure where project debt and equity used to finance the project are paid back from the cash flow generated by the project.” [13]

In case of project financing, a company dedicated to the implementation of a project is constituted. Often called Special Purpose Vehicle (SPV), or Project Company, it is the owner of the project to be built. Shareholders of the project company can be the company which will build the power station, utilities, or any interested investor.

Motivations to invest in a project company are mainly related to risk allocation: banks will lend to the project company, the parent company’s ultimate liability is thus limited to its specific share in the project. As the debt remains in the project company, it does not appear on the investor’s balance sheet, which is why it is said that project finance makes it possible to fund major projects “off balance sheet”.

In a project financing contract, the project business model will be appraised by the lenders/creditors in isolation from the overall viability of the sponsor companies. Lending banks to the project company will enter into a contract only if they are confident that the future cash flows of the stand-alone project will repay their loans, and that risks associated with the project clearly identified and legally traceable to the responsible party.

Project finance is used for financing various energy-related projects, such as oil refining & petrochemical plants, CCGT projects, LNG & oil development projects, gas pipelines, but it has not been implemented for new nuclear power plants projects, mostly because the contractual framework requirements of project finance and the nuclear project risk profile do not match, for four main reasons:

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13. Sources: <www.investopedia.com> and <www.ipfa.org>.

- Nuclear projects are larger and more capital intensive than any other power plant project: scale is an issue.

- Major uncertainties weigh on the risk profile of nuclear projects, which in fact prevent compliance with the risk allocation rules/clauses of a project finance contract.

- Technical and project management construction risk is high especially for projects involving new technologies. Any nuclear project can be delayed or cancelled due to regulatory changes, safety authority intervention, government policy changes or public acceptance concerns, making residual risks potentially very high. Delays incurring during the construction period can lead to considerable cost overruns. As a consequence of a business plan failure, the lenders can endure postponements of the repayment of their loans and even lose all repayments if they were not covered by insurance. The TMI-2 (Three Mile Island 2) NPP financing was a "Project Finance" scheme: the financial consequences of the TMI-2 accident were severe. Since 1979, no bank would enter in such a kind of financing scheme without proper cover and risk mitigation measures particularly concerning risks during the construction period.

- Securing future cash flows requires a strong contractual framework regarding electricity prices. Financial lenders and investors thus require long term purchase agreements with credit-worthy off-takers.

Project finance deals make it possible to cap the consequences of project risks as limited recourse is at the core of project financing. Because of this, investors and lenders require a high level of comfort regarding the overall economy of the projects, including risk management. The underlying reason for lack of pure project financing for nuclear projects is that they do not meet the essential qualification requirements for construction risk as well as rate of return (predictable and motivating). This is very unlikely to change unless/until successful track records of series of Gen3 reactors built on-time and on-budget exist for each technology and long term purchase agreements can be introduced to soften the effects of liberalized electricity markets.

The key role of ECAs and export credit financing

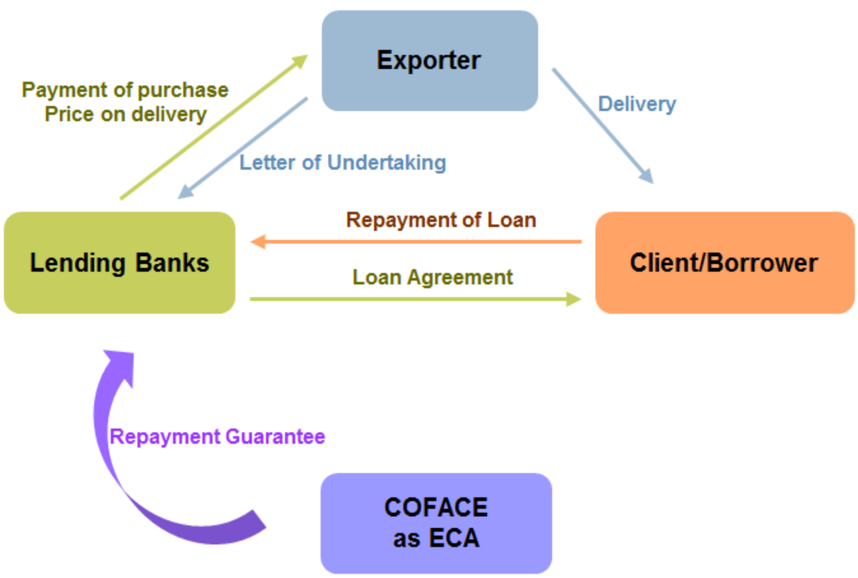
The national model which governed all early developments of nuclear power had to be adapted to building nuclear power programs in other countries, exporting equipment and technologies. Companies from countries where the technology originated and first nuclear units were built, were willing to export the technology and project management know-how. In the 1980s, emerging countries engaged in large nuclear power programs, while local banks or investors had neither the financial capacity nor the desire to fund such projects (high capital-intensity, long construction period, long period of return on investment and high completion risk.)

In this context of local funds scarcity, risks associated with nuclear projects abroad and willingness of vendors to export, funding was to be found on the international markets and new risk allocation mechanisms were developed to guarantee loans repayments.

The development of the role of ECA facilitated the financing of many major export orders including nuclear, by guaranteeing the repayment of credit loans contracted between banks and borrowers. It is the adaptation of the national model of nuclear development to the international scene.

Many nuclear programs which include an "imported" share of the project have been - and still are - financed using ECA-covered export credit schemes.

Generic ECA covered export credit scheme:



The figure above shows the link between financing and technology supply.

A pool of syndicated banks lends to a client/borrower (owner of the plant), the loan is drawn and repaid as per the loan agreement schedule/dispositions. The exporter delivers the goods and services to the client (owner of the plant) according to the project schedule, but is paid by the lending banks. The ECA brings a repayment guarantee to the banks. Such a scheme allows for some disparity between the loan drawing period schedule and the actual project expenses/deliveries schedule.

ECA schemes/loans arrangements can require very sophisticated financing engineering skills: large disparities between the project planning vs loan installment, involvement of several ECAs from several countries, number of banks involved etc.

As nuclear markets became more international, financing became an integral part of nuclear tenders and the related financial engineering a key expertise for banks to help win the tenders.

The OECD took a moderator role by adopting the “Arrangement on Officially Supported Export Credits”. These guidelines were adopted under the auspices of OECD to ensure that ECAs from member states offer similar terms in support of their domestic industry. As put by the international organization, “*The main purpose of the Arrangement is to provide a framework for the orderly use of officially supported export credits. In practice, this means providing for a level playing field (whereby exporters compete on the basis of the price and quality of their products rather than the financial terms provided) and reducing subsidies and trade distortions related to officially supported export credit*.”[14]

Though this Arrangement is not compulsory, rather providing “guidelines”, it is generally applied by the OECD member countries. A specific agreement, the “Sector Understanding on Export Credits for Nuclear Power Plants”, revised in 2009, addresses the nuclear sector. Its scope is large, covering the export of complete nuclear power stations or parts thereof, including the training of personnel directly required for the construction and commissioning of such nuclear power plants stations; the modernization of existing nuclear power plants when the projects exceeds 80 million SDRs (about $122 million)[15]; the supply of nuclear fuel and enrichment; and the provision of spent fuel management.

Maximum loan terms were extended in 2009 from fifteen to eighteen years for plant construction (two to five years for fuel and spent fuel management). The drawing period can last six to eight years, from first concrete and start of deliveries to first criticality.

14. OECD: www.oecd.org/tad/xcred/arrangement.htm
15. SDR: Special Drawing Rights. Composite currency unit calculated by the IMF (International Monetary Fund)

Repayment begins after construction, usually when connecting the plant to the grid, for a maximum period of eighteen years.

The guidelines provided by the OECD "Arrangement" have been applied by all the ECAs financing export projects from the OECD countries. Regarding scope, ECAs have been able to guarantee not only loans on the ECA country imported part, but also loans on part of the local part of a nuclear project, and part of the "foreign imported" part of a project.

Overall, the OECD guidelines have been successful in adequately financing new nuclear power plants in an organized commercial world, but some competitive advantages remain between export credit agencies from OECD member states. Specific national organizations of export finance support can introduce competitive advantages between OECD partners themselves.

For example, Coface (France), and Euler Hermes (Germany) until 2012[16] merely grant credit insurance. The funds are provided by commercial banks, at a cost that includes an additional spread over the reference interest rate (CIRR). As for the Export Import Bank (EXIM) of the United States, it can provide either just a guarantee or both a direct loan and a guarantee. As a direct lender, EXIM Bank applies the CIRR without additional spread, funding being based on the US Treasury Bonds interest rates. At times of fierce competition, and given the importance of financing in the overall cost of a nuclear power plant project, avoiding one intermediary and its associated margin can make a difference.

Japan offers traditional export-tied financing support according to the OECD consensus guidelines. But some exports, of which those related to nuclear power, are actively supported by government[17] beyond the OECD guidelines: untied financing instruments and insurance facilities which open access to better financing conditions can be granted to Japanese companies for projects and possibly equity investments overseas.

Non-OECD countries such as Russia may act outside of the OECD framework and as a consequence offer more attractive financing conditions such as longer loan periods (twenty-five years), low interest rates and access to government loans.

16. Euler Hermes (Germany) stopped supporting nuclear projects after 2012.
17. "Japan Infrastructure Export Strategy" May17th 2013 and "Japan Revitalization Strategy" July 2013.

Finding a New Paradigm

Major changes occurred in recent years, which had a great impact on nuclear project financing. Electricity markets have been liberalized, giving less visibility over the viability of projects, while at the same time the consequences of the 2008 financial crisis limited access to new funding for nuclear projects.

Financing schemes for new nuclear power plants today combine more and more securities to give confidence to equity partners and lenders. Various combinations of private sponsoring and government support co-exist.

In this uncertain context, new challengers are entering the global competition game, disturbing the traditional international nuclear markets and leading to new power maps and competition models where financing remains diriment.

Nuclear investments in liberalized electricity markets

A key characteristic of nuclear power is the high upfront capital expenditure requirement versus low and predictable operating costs, and very long operating period, sixty years for new nuclear power plants. Future cash flows are predictable at the time of the investment decision (assuming no construction cost overruns), and the required future revenues can easily be projected.

When the electricity markets were regulated, tariffs were calculated so that investors and utilities would cover their costs including financing. In contrast, the revenue side of the projects is at very high risk in liberalized power markets, whereas future costs are easily predictable.

In the context of liberalized electricity markets expanding in Europe as well as in the USA and Asia, financing nuclear power projects became extremely challenging. No investor or lender could be found for projects associated with such a high risk over future revenues. Even should the context be favorable to nuclear energy relatively to other sources of electricity generation, financing was a prerequisite to any launch of new nuclear power projects.

New strategies to finance nuclear power projects had to be developed in order to conciliate liberalized market conditions and long term visibility.

Securing future revenues through long term purchase agreements

The risks associated with liberalized electricity markets have led nuclear project stakeholders to innovate and find schemes to secure future revenues.

The OL3 business model is illustrative of such schemes. The risk over future revenues was drastically reduced, as the off-takers, energy-intensive shareholders of OL3 agreed to buy all the power output at OL3 power plant cost. This agreement was key in attracting lenders for the projects as it guaranteed that future revenue would cover the nuclear power plant's cost.

In France, where EDF traditionally finances the investments "on-balance sheet", a long term purchase agreement contract was negotiated between Exeltium, a consortium of twenty-six electricity-intensive companies, from hundred industrial sites, and EDF, in a context of market deregulation. The objective was, for EDF, to secure long-term power purchases from large customers, and for the Exeltium members, to secure electricity prices at a fixed price, based on nuclear power generation costs rather than market prices. Negotiations started in 2006 and the agreement was signed in 2010. The consortium financed a €1.7bn down payment to EDF and agreed to buy 148TWH over twenty-four years, with an exit clause after ten years and then every five years. This long-term arrangement was project financed, therefore limiting the risk for each consortium member to its share in the project. No debt had to appear on their balance sheets. The consortium financed €1.59bn of the 1.7bn down payment through a senior debt of 9.5 years duration. The electricity price was to be 42 Euros/kwh, with indexation rules including a partial index on the price of future EDF investments in nuclear power projects.

As with any hedging system, this model guarantees future cash flows and underlying deliveries, but presents an opportunity risk for the parties, depending on the evolution of market prices.

Shortly after the signature of the Exeltium contract, the electricity prices dropped dramatically in the USA, the tariff conditions applicable to energy intensive industries in Europe changed and a new legislation was passed in France (the ARENH rule)[18]. As a result, the competitors from energy intensive companies of the Exeltium members can have access to a lower price of electricity than the Exeltium contract price, either in France or outside of France. As the

18. Since 2011, EDF must sell at least 100 MWh (about 25%) of its nuclear generated electricity to its competitors at a price close to cost.

Exeltium members consider that this situation can last, EDF has been under pressure to re-negotiate the contract.

Long-term off-take arrangements at an agreed price provide the predictability of revenues required to finance nuclear power plants. They ensure economic viability of the project and give a contractual form to the agreement on price, legally enforceable or renegotiable. They are nevertheless complex to negotiate and difficult to maintain in the event that the fundamentals of economics or competition change.

In the UK, it has been recognized that predictable revenues are necessary to secure the feasibility of future nuclear investments.

Since the 2008 Energy Act, the energy policy in the UK has been supportive of low carbon energy generation, including nuclear power. In order to facilitate investment in low-carbon energy generation, the UK government introduced a new Energy bill (voted in Parliament in December 2013) and the electricity market reform (EMR). One of the main elements of the electricity market reform is the implementation of Feed-In Tariffs (FIT) to give particular low-carbon producers a predictable return per Kwh over a set period of time, regardless of prevailing market prices. The FIT applies to renewable sources of energy as well as nuclear and fossil fuel abated by carbon capture and storage. The FIT will be effective through a Contract for Difference mechanism (CfD) which removes long term exposure to price volatility.

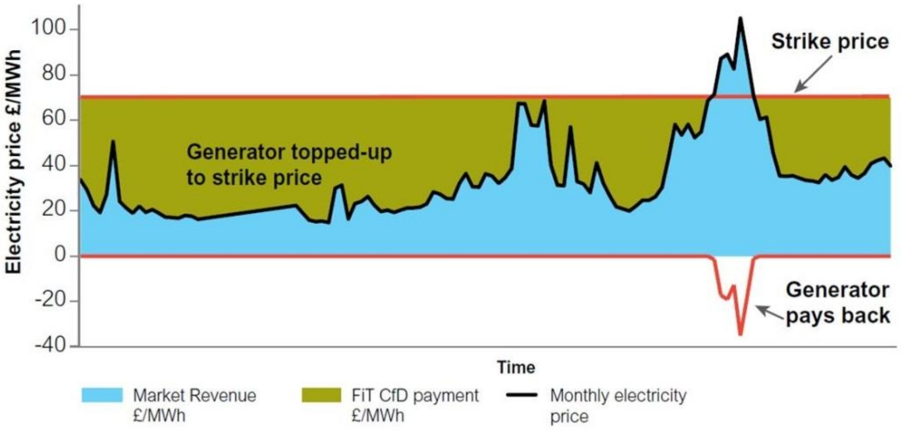
Implementing the scheme of CfD for electricity future electricity generation goes beyond a mere financing scheme for electricity infrastructure projects. It will in fact result in a partial regulation of the electricity market, as it applies to a sizeable share of the country’s future electricity output.

There is a need of 65GWe of new generation by 2025, of which 16GWe would be nuclear. This perspective motivates considerable international interest in the UK nuclear program from the main nuclear utilities and vendors from Europe, Japan, Russia, and more recently China. Eleven units are already planned to be built on five sites; the first project (2 EPR units) would be built by EDF Energy at Hinkley Point in Somerset.

In October 2013, the UK government and EDF announced that initial agreement had been reached on the key terms of a £16 billion investment contract for the Hinkley Point nuclear power station. The key terms include a 35-year Contract for Difference (CfD). The strike price has been set at £92.50 per MWh, reducing to 89.5 if a further plant at Sizewell is built. The arrangement is slated to run for 35 years from 2023, or the start of operation of each reactor, whichever comes sooner. It includes protection for the investors against political risks in the form of potential nuclear taxed, uranium and generation taxes, politically motivated shutdowns or the revision of the contract for difference scheme (CFD). Overall, EDF said that the strike price should give about a 10% return on investment.

In case the monthly electricity price is lower than the strike price, the UK government[19] will compensate EDF; conversely, EDF will repay to the government any amount in excess of the strike price.

CfD general mechanism for baseload generators:



Source: World Nuclear News, July 2011.

The UK government offers the same support to all low-carbon energy generation investments through the electricity market reform measures, as it has been recognized that liberalized markets of electricity did not allow financing for infrastructure projects. In Europe (the EU), support for renewable energy generation sources is specifically allowed by the European completion rules while this is not the case for nuclear energy generation sources. Implementation of the CfD agreement for the Hinkley Point C project was thus subject to the approval of the European Commission regarding "State Aid" and "Competition Distortion potential".

The outcome of the review was awaited with extreme interest as it would influence implementation of the Hinkley Point C project as well as future decisions to invest in nuclear power projects in the UK. The European Commission's agreement to the CfD early October 2014 opens the way to a final investment decision for Hinkley Point by EDF[20], and the launch of more nuclear power projects in the UK.

The role of long-term electricity price guarantees is central to the feasibility of investments in nuclear power plants. Implementing new nuclear power plants projects motivates entering into long term purchase agreements or tariff schemes within deregulated electricity markets in order to give visibility to potential investors and lenders about the overall viability of the project.

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19. A national governmental agency
20. This decision was still not made end of May 2015.

Sharing the owner's risk

The appropriate allocation of costs, risks, rights and responsibilities among the project stakeholders is the cornerstone of a sound project structure. The objective is to allocate ultimate risks to the responsible parties in order to mobilize every stakeholder for the completion of the plant on time and on budget.

In recent years, it became obvious that new nuclear projects would not be undertaken anymore unless the main underlying risks were addressed directly by the key players. Operators and owners of nuclear power plants are now seeking to share responsibilities and risks in new projects.

As we previously saw, the OL3 project is an example of direct involvement of large customers through equity and debt financing as well as a long term purchase agreement. More recently, nuclear vendors have been encouraged to take an equity or debt interest in the project company, mainly to demonstrate their motivation towards project completion and global viability. In the Hinkley Point C project in the UK for instance, vendors were required to participate directly in the financing of the project in form of equity. This could lead to a possible, yet to be confirmed, shareholding scheme, with EDF owning 45% of the project, AREVA 10%, and some Chinese nuclear companies 40%, while the remaining 15% being taken by other investors. This shareholding scheme marks the first occurrence of AREVA taking on some of the equity risk in a nuclear power plant project[21].

The same scheme is to be found for the other new projects considered in the UK. The Japanese Toshiba, which is the majority owner of Westinghouse, is partnering with GDF SUEZ in NuGen, the developer of the three AP-1000 which could be built at the Moorside site. Toshiba holds a 60% share in NuGen while GDF SUEZ holds the remaining 40%. With Hitachi owning Horizon, the third consortium planning to build reactors in the UK, at Wylfa, this means that all new nuclear projects built in the UK would feature part or full ownership by a reactor vendor.

It is also the case with the Sinop project in Turkey, where GDF SUEZ will hold stakes in the project company, alongside MHI and AREVA as a consortium, with 65% (and Turkey's State-run power producer EVAS 35%).[22]

Taking an equity share in the project company for new nuclear power plants projects is now part of the commercial differentiating factor in winning a tender. The shape of competition is changing in this regard, towards a new paradigm.

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21. AREVA built over 100 power reactors worldwide- more than half of them in France-
22. World Nuclear News, April 15, 2015. 'Ground Broken for Turkey's first nuclear power plant".

Taking overall responsibility of a project

In this new context, one vendor, Rosatom, is shaking the system by proposing a package deal with a total ownership of the risk. In some countries, the Russian vendor puts forward state loans and/or large equity participation with the Russian government guarantee, therefore sharing the risk (Jordan, Nigeria…), however this is not the case in Turkey. On 12 May 2010, the vendor Rosatom contracted with EUAS (Electricity Generation of Turkey) to build, own and operate four Vver-1200 type reactors on the Akkuyu site[23]. The Build Own Operate (BOO) model proposed by Rosatom, in line with Ankara's request[24], is the most integrated model ever contracted for a nuclear power plant project. It comprises financing risk, all the construction risk, operational risk and some electricity market risk.

- Financing is to be provided by Rosatom. Rosatom establishes the Project Company and raises funding for the project, 20% equity 80% debt. Initial funding is provided by the Russian Federation state loans at preferred interest rates (4 to 7%). Eventually, up to 49% of the equity shares may be transferred to other investors. Export credit for equipment/services can be provided by European suppliers (for 85% of the value if OECD rules apply).

- Rosatom bears the construction risk. This includes engineering and construction of the plant, supply of equipment and material as well as nuclear fuel and training of the Turkish staff.

- The Russian side is responsible for waste management and decommissioning of the plant.

- A Long Term Power Purchase Agreement (LTPPA) is negotiated to secure revenues: TETAS will purchase a fixed amount of electricity (70% of electricity from units 1&2 and 30% of units 3&4) for 15 years from the date of commercial launch of the 4 units at a fixed price, average 12.35per kWh. The rest of electricity production will be sold on the market. The planned electricity output for the 4 units is at least 33.1 billion kWh per year. 20% of the profits of the Project Company will be transferred to the Turkish government after expiry of the LTPPA.

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23. Total installed capacity is 4800 MWe, estimated cost is $20-25 billion, payback period 19 years, operation time 60 years, construction time 2015-2022.
24. As early as 1983, Ankara stated clearly that the Build-Own-Transfer model was the only acceptable for Turkey; The country changed its mind mid-1990s, and requested a BOO. For the whole story about the Turkish project financing, cf; Aaron Stein, "The Turkish (Nuclear) Model?" in *Arms Control WONK*, December 9, 2013.

The contract is at risk regarding construction cost overruns, sharing the investment with investor partners to be found, and the LTPPA conditions as part of the production should be sold on the market. There is no guarantee of reaching or exceeding breakeven. It is worth noting that the decision to bid in these conditions for the Akkuyu plant was taken after a thorough review of the Turkish economic situation and perspectives, assuming economic growth superior to 5% per year and expected electricity demand growth of 6,5%- 7.5% a year. Since then, economic growth slowed down in Turkey, and some political uncertainties ensued.

Is the Akkuyu contract is a landmark? The BOO business model illustrates the new Russian/ Rosatom strategy and tactics to finance nuclear power plants worldwide. It creates a competitive edge for its own benefit in winning deals over traditional "OECD members" nuclear vendors. Is it sustainable for Rosatom, especially in a context of huge drop of oil, and gas, prices? Another topic of concern could be raised about the compatibility of such a model, in a way an extraterritoriality model, with a proper regulation of nuclear safety[25].

Consequences of the 2008 crisis on financial market conditions.

When the nuclear industry recovered some dynamism ten years ago, the new nuclear projects were led by the same players as in the previous period. The OECD guidelines were by and large respected by the owners, the banks and the vendors, financing was not to be a key differentiator in the competition.

The context changed drastically with the 2008 financial crisis and its consequences.

New constraints on banks when financing nuclear power

All of the financing schemes for nuclear projects combine debt and equity, with an essential role of banks in raising funds and structuring debt. Financing nuclear power plant projects was always a challenge but it became even more difficult in the wake of the 2008 financial crisis and the resulting regulatory consequences.

The 2008 financial crisis, followed by the global economic crisis, provoked shrinkage of the interbank market, even liquidity crises at times, and overall uncertainties over the capacities of

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25. The former Finnish regulator, Jukka Laaksonen, now Vice President in Rosatom Overseas, raised it publicly at the 2015 edition of the Carnegie Nuclear Non-proliferation Conference held in Washington, March 23, 2015. Cf. <http://carnegieendowment.org/files/09-nuclearregulation230315wintro.pdf> p. 19.

markets and banks to assume and cover their global commitments. Interventions from the federal banks helped to restore the interbank liquidity but the situation is not as favorable as it was in the 2000s when new nuclear projects were envisaged. Several initiatives were undertaken in Europe (the Basel I II and III proposals) and in the USA (the Dodd-Franck Act, the Volcker rules) with the objective to strengthen the banking sector fundamentals. These initiatives are discussed at the G20 level for a better coordination between the USA and Europe and ultimately a better global efficiency.

The banks have progressively modified their balance sheet components during the discussion period, in order to comply with the new prudential rules. The new set of rules prescribed by the Basel Committee tends to limit the risk exposure of banks regarding lending engagements, specifically by prescribing enhanced capital ratios. One of the rules deals with the common equity ratio, to assure and control that banks are appropriately capitalized. The size of the banks engagements will also be limited by implementing a new leverage ratio calculation. The total assets definition has also been revised so that assets should not be risk weighted and some assets that were before off-balance sheet should be included.

To comply with future rules, most banks are also monitoring their balance sheet size, working to reduce it by selling assets and selecting their engagements to improve their solvency ratios. The new rules do not specifically target nuclear projects, but they have an impact on their funding availability. As a consequence, ECA credits, which were before considered as “low risk” and risk-weighted in the total assets calculations, will now be included in the ratios at their bulk value.

Nuclear power projects require large amounts of debt, which will have to be declared in the bank credit engagements very early in the process. As financing is now often part of the tender requirements, the financing commitment is required before the results of the tender. Following the 2008 financial crisis, Basel III regulations required banks to earmark their loans by putting aside a percentage of equity as soon as they commit to lend money. Because of this constraint and because those commitments would refrain them from entering new other engagements during the tender period, banks are less inclined than before to finance long-term capital intensive projects like new nuclear power plants.

Consequences of the constraints introduced by new regulatory rules for the banking sector could be that nuclear projects would become relatively less attractive than other projects to traditional debt financing. Banks will be more selective than before concerning the characteristics of the projects to finance on two regards at least: the size of individual projects in the light of their balance sheet size, and the need to diversify risk exposure. Nuclear power plant projects are quite large; financing them requires mobilizing several banks through syndicated loans. Limitations of balance sheet size and risk diversification will require an increase of the number of banks in syndicated loans to finance nuclear projects, adding complexity.

Some of the new prudential rules including stringent capital ratios applied to the banking sector in Europe are extended to insurance companies' investments. They are now being challenged as they appear to contradict the "Juncker Plan" ambition for infrastructure financing.

The traditional financing model of new nuclear projects is negatively impacted by the consequences of the 2008 financial crisis. Lenders are more risk averse; they select projects carefully and require higher spreads. It is likely that new nuclear projects will attract mostly large banks from the countries where the plants are built and large international banks from the countries of vendors and investors.

New sources of financing, new financing schemes

As mentioned above, equity participation in new nuclear projects was recently open to various investors thus giving access to more financing resources, which is far from negligible in the post 2008 financial crisis context. The tendering technique of Rosatom for Akkuyu is interesting in this regard, as it is after winning the tender that equity participation in the project was open to outside investors.

Corporate bonds are frequently used by corporations to finance capital assets investments. In such schemes, the corporation engages its global balance sheet into financing new projects. Very long term corporate bonds are already used by nuclear plant owners; they could be issued even more in the future. As part of its global debt management and fund raising for the new nuclear projects (EPR in France and Hinkley Point C in the UK), EDF for instance issued 100-year (£1.35 billion and $700 million) bonds in January 2014. The previous company to issue century bonds before in Europe was GDF Suez in March 2011. Pension funds and insurance companies are the most frequent clients for long-dated maturity bonds as they match their liabilities, while utilities can align the debts' maturity with the life of their industrial assets.

The possibility for Nuclear Project Companies (SPVs) of issuing "nuclear bonds" has been explored. Because investors seek recurrent long term revenues, a strong creditworthiness on the part of bonds issuers is required; this would nevertheless need appropriate guarantees from States or regional institutions.

In this context, new proposals are emerging as a consequence of collective work being conducted within the European institutions. Since the 1970s, seven billion euros worth of loans have been granted by European Institutions for the construction of nuclear plants. The European Investment Bank (EIB) financed nuclear plants but never financed nuclear power reactors. The European Atomic

Energy Community (Euratom)[26] financed nuclear power plants projects in the past and is currently engaged in various safety related projects, providing support to the International Thermonuclear Reactor project (ITER) and contributing to the modernization of several nuclear power plants in Europe. There are still about $600 million funding capacities available from Euratom. There are ongoing discussions over increasing the European funding capacities as well as granting direct loans and guarantees to nuclear projects, especially through the European Nuclear Energy Forum (ENEF). ENEF[27] issued a report in April 2013 which recommends not only making best-use of existing EU financing tools, but also to setting up new financing tools which would have a signaling and catalytic effect for private investments in nuclear new build projects. Standby credit lines could be granted to mitigate construction risks resulting from regulatory delays, similarly to a measure existing in the US Energy Policy Act issued in 2005. Revolving facilities as well as specific financing for the construction period of the nuclear projects are also in discussion.

China took the initiative to create a new regional Asian investment bank: the Asian Infrastructure Investment Bank was launched on 24 October 2014 in Beijing. Such an institution is welcome at times when investment needs in infrastructure projects rise. Twenty-one countries including the UK have shown an interest in joining, whereas the USA, Japan and others raise the issue of compliance with the E&S (Environmental and Social rules) as well as prudential rules governing existing multilateral institutions such as the World Bank and the Asian Development Bank. [28]

Sovereign Wealth Funds (SWF) could also play an important role. They have emerged indeed as important players on the investment's international scene with $ 6605 billion now invested in real and financial assets throughout the world. Most of these funds ($4000 billion) have been originated by national resources from the oil and gas sectors. Investment policies and risk profiles of the SWFs differ widely. Most funds adopt a diversification investment policy from their country's industries and resources, with a long term investment perspective towards the interest of future generation. The SWF from the Gulf countries have to take into account the Islamic constraints on investments. In 2013, the Norway government Pension Fund (open in 1990, now $878 billion), the largest SWF, announced a diversification of some of its investment from coal and fossil fuel assets towards renewable energy assets.

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26. Euratom was created in 1957 to support nuclear research, facilitate nuclear investments and support nuclear industry.
27. The European Nuclear Energy Forum (ENEF) was created in 2007 by the European Commission as a multi-stakeholder process elaborating and discussing on the European nuclear energy policy.
28. *Les Echos*, October 27: la Chine décidée à saper le monopole des institutions financières mutilatérales.

SWFs are drawing attention to financing of infrastructure projects; they could consider investing in nuclear power projects or nuclear assets in the future. Rosatom apparently explored such possibility by seeking funding from the Russian National Wealth Fund[29] for its nuclear projects abroad, as illustrated by the recent announcement to support Rosatom's project in Finland[30].

Along with twenty other institutional investors, the Singapore Sovereign Fund showed an interest in the 3,2 USD Billion fundraising operation launched in Hong Kong in November 2014 by CGN Power Co, China's largest nuclear producer.[31]

At times of scarce and expensive financial resources, innovative financing packages and access to financing resources are key competitive advantages in the fierce competition for nuclear new build.

New power maps within the new paradigm

The international nuclear power plant market: radical changes

The international market for nuclear power plants changed radically in recent years. At the beginning of the civil nuclear programs, only a few countries mastered nuclear reactor technologies and built power plant fleets, first at home, then abroad.

Until the end of the 1990s, vendors, technologies and countries of origin were aligned and traditional export markets were identified for each large vendor. The main vendors competing on the international scene at that time were Westinghouse, General Electric, AECL, Framatome, Siemens and Atomstroyexport (ASE). Countries where large nuclear programs were built did over time develop a global industrial base covering all or most sectors of nuclear energy. This is the case in the USA, Canada, France, Russia, Japan, Korea and recently China. When France won the tender to build new reactors in Finland, it was the first reactor to be built in Europe after a long period of time; the previous reactor connected to the grid had been Civaux in France in 2002. No new project had been engaged in the USA after 1974.

In the meantime, Japan and Korea were developing their respective nuclear programs, still underway. Russia developed exports by leveraging its national programs. China accelerated the pace of its nuclear program, engaging partnerships with main nuclear technology vendors worldwide. Nuclear industries as well as

29. It was open in 2008, $88 billion invested.
30. $2.3bn will be granted as announced on January 19, 2015: <www.world-nuclear-news.org/NP-Russia-approves-funding-for-Hanhikivi-1-19011501.html>.
31. *Les Echos*, nov 25, 2014

industries providing the nuclear projects supply chain have been developing alongside such large nuclear programs.

The traditional competition game was disrupted in 2009.

In December 2009, a Korean-led consortium won a landmark contract valued at $ 20,4 billion to build 4 reactors in the United Arab Emites (UAE), beating its rivals from France, the USA and Japan. The UAE's nuclear project marked the first fleet of nuclear reactors being built in the region, and the first international deal for the Korean nuclear industry. This competitive breakthrough of Korea in the global nuclear business reshuffled the cards of the international traditional game: earlier barriers to entry in the global game were not insurmountable, and Korea had won an export nuclear deal earlier than Japan and China.

At the same time, the European Union was enlarged to 28 countries, including countries where Russian industry, including nuclear, was historically dominant. (Bulgaria, the Baltic countries, Hungary, Poland, the Czech Republic, Romania, Slovakia, Slovenia…). These markets, which were previously considered as "non-accessible" to OECD nuclear vendors, became open to global competition. Reciprocally, winning a nuclear deal in "western Europe" or in an OECD member country became a realistic objective for Russia.

Not long before that, two important moves were made by major Japanese companies already involved in the nuclear industry, Toshiba and MHI. In October 2006 Toshiba acquired from BNFL the vendor Westinghouse, owner of the AP1000 technology. In 2007, MHI entered into an agreement with AREVA to co-develop a 1100-MW reactor, ATMEA. Hitachi and General Electric also partnered with the objective to export. Through these first-rate partnerships, Japan industry boosted its access to new reactor technologies and international markets, while Westinghouse, AREVA and General Electric respectively strengthened their positions, especially in direct or indirect participation in project equity and/or financing through the banking systems and ECAs from the countries where their business partners originated.

China and Russia are currently leaders in terms of number of nuclear power plants projects being built or planned.

Out of about a hundred projects engaged or ordered world-wide, one third are built in China, and one third in Russia and elsewhere by the Russian nuclear industry. China has been engaged in a large nuclear program development for the past 30 years, building all the leading technologies and developing its own from the technology transfers granted overtime. This very large nuclear country is now taking the challenge of accessing the exports nuclear markets. Some attempts were made to export the ACP1000, the third generation Chinese self-developed reactor, with no success so far. The Chinese nuclear companies participate in the UK Hinkley point C project by taking a 40% + equity share in the project alongside EDF and AREVA. As the UK government was welcoming an equity participation in the project, it is most likely that financing is, in this instance, the enabler for China to initiate participation in an international nuclear project. The very good track record of building the EPR in China also brings credibility to the overall project, despite the fact that the Chinese operational contribution to the Hinkley PointC project will probably be quite limited.

Russia, a long lasting global player in the nuclear markets, recently reorganized its nuclear operations to take positions in the new international playing field.

In 2011 Rosatom management resolved to merge the two major nuclear companies, Atomenergoproject (NIAEP) and Atomstroyexport (ASE) in order to concentrate its engineering and construction capacity to design, deliver, construct and maintain nuclear power plants. In March 2012 a new company, JSC NIAEP-ASE was formed, with representatives in 10 countries in Europe and Asia. In addition, a new entity, Rusatom Overseas, was established in August 2011 to promote and coordinate the company's international operations. It deals with pre-tender communications and leads project teams during negotiations. At the NPP construction stage, ASE-NIAEP becomes responsible for implementing the project. Rusatom Overseas is in charge of shaping the overall proposal for a given project outside of Russia, including financial aspects. Some international staff and experienced personnel in large project financing and structuring from the oil and gas industry were hired to strengthen global commercial skills. Financing schemes, equity participation as well as specific project structuring such as BOO for Akkuyu, are now part of the Rosatom's marketing to countries around the world. From Turkey to Finland, to Hungary, Jordan or Bangladesh, it seems to make a difference in winning deals… Russia is now the world's top exporter of nuclear power plants, and Rosatom's order book for building new plants abroad stands at almost $100 billion including units in Finland and Hungary.

In the fierce global competition to win large infrastructure projects such as nuclear power plants, providing financing has become a key competitive advantage. This goes beyond financing techniques and financial institutions as nuclear projects are more complex, in a dynamic international context, towards global structuring of projects where various balances of private ownership and government support co-exist.

An intertwined competition landscape

The traditional rules of competition including risk allocation and financing rules were established when nuclear technologies and know-how were exported to countries which did not have national access to nuclear power. During the first period of exporting nuclear energy, nuclear projects were launched and financed within a level-competition landscape among a group of technology owners.

Financing was feasible but was not a prominent competition tool to win nuclear power projects. The OECD guidelines for financing nuclear power plants and the role of Export Credit Agencies structured the historical competition landscape with balanced conditions among the competitors. Markets were segmented, with high barriers to entry for the USSR in the OECD markets and vice versa.

Competition to win new nuclear tenders has been exacerbated in the recent years as markets became global and new-comer exporters of nuclear power plants are appearing. OECD and non-OECD nuclear vendors are now competing for the same markets on the international scene. Companies from Russia, Korea, China and Japan aim at becoming global nuclear players alongside "historical" companies from the USA, France…

Mastering technological risk and construction risk could be a relative strength of the traditional vendors' over new competitors, but as of 2014, these vendors are not anymore perceived as clearly ahead of new entrants regarding control of technology and construction risk. The recent nuclear projects, starting with the EPR built in Finland (OL3), all involve new technologies which enhances the technology and construction risks. New competitors on the international markets are now building and operating large nuclear programs at home, demonstrating their technical maturity.

The ability to manage large nuclear projects abroad is a crucial competition issue as it can drastically reduce construction risk, but it can be separated from the competition among technologies. In the UEA, (United Arab Emirates), the Korean Kepco with no experience of building nuclear power plants abroad was chosen against traditional vendors (AREVA and Westinghouse), illustrating that the technology vendor and construction contractor can be distinct.

The recent challengers in the new nuclear markets are from non-OECD countries. They do not abide by OECD rules or EU competition regulations, whereas they have access to all the existing expertise of international institutions, including sophisticated financing schemes through International banks.

This provides countries such as Russia and China with possibilities to propose more competitive financing/risk allocation schemes than the OECD countries: very long maturity loans (25 years while OECD limits them to 18 years); very low financing rates disconnected from the financial markets; subsidized financing; direct State guarantees or financing; daring project risk taking. Even among OECD members, conditions can differ. Japan companies for instance can have access to favorable export financing schemes beyond OECD rules as large infrastructure export projects are considered "to be supported" by the Japanese government.

In the context of fierce competition for nuclear power projects, scarce financing and high risk profiles, government to government agreements have recently been revived in order to offer global attractive deals. Such government to government agreements are a great help to financing as they open the gate to government funds as well as providing local compensations, favorable local content or state aid.

Once again, there is no level-playing field in this regard. The EU rules regulating "anti-competition" and "State aids" strictly limit the content of government to government agreements from or among the EU members. Conditions are much more open for other countries: Russia, China, Korea, Japan recently negotiated nuclear power plants projects deals under government to government agreements which provided favorable conditions beyond the EU limitations/rules. The European (EU) financing institutions do not offer similar financing possibilities and guaranties to the companies originated from the EU countries. Whether from Euratom or the European Investment Bank, neither funds availability, funds raising capacities nor global European guarantees can match current conditions of government to government agreements' with Russia, China, Japan or Korea.

The competitive advantage provided by government to government agreements resides mainly within the financing conditions and state aid to local development or compensations. It fostered the success of Russia on the international markets lately and changed the competition conditions of tenders following the Akkuyu project tender results. Outside of the EU, the new export competitors such as Russia, China, Japan, Korea own a deciding competitive advantage whereas even in Europe, traditional vendors now have to address the new competitors' commercial ambitions.

In this new competition context, new strategies are emerging.

The traditional vendors and nuclear project stakeholders are entering a new, more complex multilateral competition field requiring new strategies building on their respective strengths. Recent experiences have shown that merely including a "financial package" is far from sufficient to win large nuclear power tenders. The playing field is less and less segmented, the key players in teams competing for a nuclear project are now expected to jointly address the global project risk(s) and demonstrate future accountability for nuclear project implementation and results as early as the reply to tender date.

The new paradigm of competition for nuclear power plants projects is characterized by the overlapping of strong national systems and pragmatic alliances and partnerships. The national model seems still prominent in the competition to win new nuclear power plants projects mainly because government to government agreements are flourishing and large consortium leaders of nuclear power plants' tenders are mostly nuclear vendors with strong national identities[32] and share ownerships. Rather than a mere exception, the outcome of Toshiba buying over Westinghouse (previously owned by BNFL, a UK nuclear company) is emblematic of the new paradigm of nuclear markets. The international nuclear market is in fact more and more intertwined. It goes beyond large "national" companies towards international, national or private systems. Major alliances and partnerships are developed among the major players in nuclear markets, cutting across national boundaries and references.

Whereas before the national models allowed only exclusive alliances, the new intertwined model allows for pragmatic alliances: In the UK, the British government is open to building several technologies. EDF will build EPRs (AREVA) whereas GDFSUEZ, a European company, will build AP1000 reactors with Toshiba/Westinghouse. On the technology side, AREVA developed the ATMEA reactor in cooperation with MHI, potential cooperation between EDF and Chinese companies developing a 1000MW model is a recurrent rumor, Russia builds VVER reactor models, but has wanted to enter into technological alliances with AREVA and EDF for several years. Large development costs motivated such alliances, but market considerations came into place strongly as alliances could offer new market opportunities. The Sinop project in Turkey is a landmark project regarding the new competition paradigm: after a government to government agreement was signed between Turkey and Japan, by which Japan will provide 70% of the financing of the project, Japan will export a French-Japanese Gen3 reactor, ATMEA, partnering with GDF-Suez and AREVA.

The national system gives way to the intertwined system in constituting the Consortium lead team comprising nuclear vendor(s), utilities/operators/ architect engineers, conventional island providers and civil works contractors. It is even more the case regarding the whole supply chain. All nuclear subcontractors are establishing joint ventures or partnerships in countries building nuclear projects, and provide various competing nuclear reactor models. The Kepco (Korea) AP 1450 is being built in the EAU, but the global nuclear supply chain will provide for the construction of the project.

Many open questions remain concerning the competition landscape in Europe. Russia is obviously committed to be present in the RU territory, not only through fuel cycle services deliveries. The intergovernmental agreement signed between Hungary and Russia in January 2014, for two new units in Paks, along with a credit line of €10bn, representing 80% of the cost of the project, leaves the EU Commission without any possibility to intervene. In the wake of this project, Finnish utility Fennovoima also made a Russian choice. After Russia, China is also pursuing strategic market entry objectives in the EU. As of 2014, China is entering the European market in the UK as a future shareholder of the Hinckley point project up to 30-40%. China

32. AREVA, GE, Kepco, Rosatom, MHI.

is thus entering the European market through the financial side whereas the Chinese ambitions to build nuclear power plants abroad are widely publicized. It is unlikely that China would choose a direct import of a Chinese reactor model to Europe as licensing is still a very high barrier to entry.

Conclusion

As NPPs are perceived as “high risk”, investors and lenders require more and more guarantees in order to reach the confidence level required to commit to financing a project. Only projects considered viable by lenders and investors can be launched.

Financing schemes now extend much beyond mere funding. As visibility over future revenues is required to build confidence towards project viability, long term electricity price agreements are frequent, even within deregulated electricity markets. Sharing the owner’s risk and taking on a large share of potential residual risks of a project are also enablers for launching nuclear power plant projects.

The 2008 financial crisis imposed new constraints on banks to finance large infrastructure projects such as new nuclear power plants. As a consequence, whereas financing is key to launching new projects, traditional financing is stressed. Fewer projects are launched with traditional financing schemes organized as per the OECD guidelines. As funding is scarce, traditional financing systems and guidelines are challenged, new sources of funds are explored and new financing schemes emerge.

Concurrently, challengers are disrupting the traditional international nuclear markets as they are pursuing ambitious strategic market entry objectives. Innovative financing and risk sharing schemes are emerging as strong differentiators in the competition for new nuclear power plants projects, with a risk to bias project selection at time of tender, particularly in countries where financing of such magnitude would be difficult to organize. Various competition systems are intertwined: regulated areas cut across liberalized electricity markets, government support co-exists with private ownership and national champions enter in various pragmatic alliances.

Financing remains a prerequisite to any launch of new nuclear power plant projects, and a key competitive advantage to win tenders. A new paradigm is taking shape, in the wake of the 2008 financial crisis consequences, construction delays of current nuclear projects, and breakthroughs from challengers on the international nuclear markets. If it applies mainly to new comer countries in nuclear, many open questions remain regarding the future positioning of traditional vendors and new challengers in Europe.

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Jacques Sacreste: EDF

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Anne Crépin, AREVA

Ann Mac Lachlan, Journalist

Cécile Maisonneuve, Senior Advisor, Centre for Energy, Ifri