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GLOBAL INFRASTRUCTURE

Construction Risk in New Nuclear Power Projects – Eyes Wide Open

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Foreword

Reducing our carbon footprint is undoubtedly one of the greatest global challenges facing industrialized nations in the 21st century. But to limit the output of carbon dioxide from power plants will require the replacement of existing fossil fuel technologies with low-carbon technologies. At the same time, the production and use of electric vehicles, light and high speed rail, and other transport systems over the next decade will drive ever-increasing demand for low-carbon power generation.

This has led to a renewed focus on the power industry, with some estimates putting total global energy infrastructure investment at US\$26 trillion leading up to 2030.¹ For energy specialists, there are high expectations for nuclear power generation as the lowest cost source of low-carbon electricity that can be delivered at the scale needed to meet this growing demand.² But with a legacy of budget over-runs and extensive schedule delays, validating the specialists' opinions will require the nuclear industry to deliver new nuclear power plants on time and on budget.

We are delighted to introduce this KPMG Global Infrastructure report focusing on the construction risks and models found in new nuclear power projects. KPMG has worked on numerous nuclear new builds, including key projects in the United Kingdom, the United States and the Middle East, and our experience suggests that – for the emerging nuclear renaissance to take hold – industry participants will need to understand and overcome the critical issues that we have outlined in this report.

We encourage you to contact your local KPMG member firm to discuss these issues and their implications further.

Nick Chism

Global Head of Infrastructure
Partner, KPMG in the UK.

Geno Armstrong

International Sector Leader –
Engineering and Construction
Partner, KPMG in the US

¹ *World Energy Outlook 2008*, International Energy Agency/Organisation for Co-operational and Development, 2008

² See e.g. *Powering the Nation 2010 Update*. Parsons Brinkerhoff, 2010



Introduction

The nuclear industry is enjoying a renaissance. With carbon reduction policies and questions of national energy security at the top of the global agenda, countries are increasingly looking to nuclear to provide a low cost alternative to fossil fuels.

Indeed, as of June 2010, there were 61 nuclear power plants under construction across the globe,³ and – as fossil fuel and carbon prices rise and safety and storage issues are resolved – this number will quickly rise.⁴

The cost of nuclear power generation is already competitive compared to other forms of low-carbon energy technologies such as wind power and coal fired generation with carbon capture and storage, but nuclear power has additional

³ *Nuclear power plants world-wide, in operation and under construction, as of June 30, 2010*, European Nuclear Society, 2010

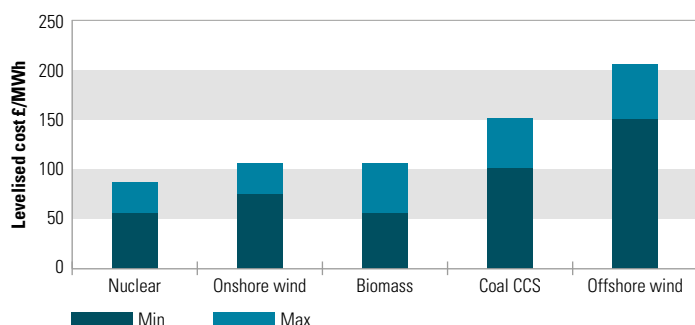
⁴ *UK Electricity Generation Costs Update*, Mott McDonald, 2010

Historically, the nuclear industry has a bad reputation for cost control.

advantages: Unlike carbon capture and storage, nuclear power generation is a fully proven technology; and nuclear power provides base load generation capacity⁵, which has yet to become a reality for either wind or solar power generation.

While nuclear plants require significantly greater initial capital outlays than other low-carbon energy technologies, the lifetime cost of nuclear power generation per megawatt hour of electricity (£/MWh) is competitive⁶, as described in Figure 1 below.

Figure 1: Nuclear is the lowest cost technology for low-carbon generation



Source: Powering the Nation 2010 Update, Parsons Brinkerhoff, 2010

Controlling capital costs, therefore, is critical if nuclear is to maintain its competitive position. Consider the financial impact of a ten percent capital cost overrun on a £4.5 billion project: the additional investment will not only have a significant effect on the recalculated lifetime cost per MWh, but will also greatly impact the project owner who will need to quickly source the additional capital.

Historically, the nuclear industry has a bad reputation for cost control. In the US for example, the nuclear construction program of the 1960s and 1970s delivered costs per unit that were typically two to four times the original projected costs.⁷ More recently, budget over-runs and delays on next generation new build nuclear projects clearly demonstrate that the nuclear industry continues to repeat its failed management and project control processes of the past.

There are typically three key reasons that are most often cited for poor cost control in the nuclear industry:

- 1) changes in the regulatory environment;
- 2) lack of standardized engineering solutions; and
- 3) overly ambitious cost targets set by project owners and contractors.

Very often, the risk of cost increases and delays can be mitigated if the regulatory environment remains stable and the development of technology is incremental, as is the case for the South Korean nuclear program⁸ and the CANDU program outside of Canada⁹.

While this KPMG Spotlight Report focuses specifically on the construction risks involved in a new nuclear power project, there are a number of other critical considerations for investors including the concurrent balancing of construction risks with market risk, regulatory risk, legal and political risk, environmental risk, and operations risk. As highlighted in this report, this interplay is critical for a new nuclear power project to achieve its potential as the most economical alternative for low-carbon electric power generation.

⁷ *Business Risks and Costs of New Nuclear Power*, Craig Severance, 2009

⁸ AECL Company Profile, <http://www.aecl.ca/Assets/Publications/Fact+Sheets/Profile.pdf> Accessed 24 August 2010

⁹ AECL Company Profile, <http://www.aecl.ca/Assets/Publications/Fact+Sheets/Profile.pdf> Accessed 24 August 2010

⁵ The term base load is used to refer to energy of constant (as opposed to a fluctuating) supply

⁶ *Nuclear power plants world-wide, in operation and under construction, as of June 30, 2010*, European Nuclear Society, 2010

Why Construction Risk Matters

Nuclear new builds are both high value and high risk construction projects with a historical precedent for significant delay claims, cost growth, and – ultimately – investor disappointment.

This unfortunate (yet wholly justified) reputation clearly impacts the economic case for new nuclear power projects when compared to other forms of electric power generation. With past performance in project development effectively eliminating the option of financing new nuclear power projects using either non-recourse or limited-recourse project finance methods, investments in nuclear new builds will need to be financed against either the balance sheet of the project owner or through direct government support (to either the owner or sponsor). This approach can be seen in the current United Arab Emirates nuclear program where the prime contractor is 100 percent government owned, and the project is being backed by sovereign funds.¹⁰

For project owners, the need to fund new nuclear power projects on their balance sheet puts an obvious constraint on their development portfolio, with even a modest cost overrun resulting in a significant impairment concern for any utility.

While some project owners have elected to transfer the risk of cost increases and schedule delays to its contractors, as is the case for the Olkiluoto 3 project in Finland, this risk management technique has provided little comfort to the financing community and does little to demonstrate that construction risks have been properly addressed and mitigated.

Compounding this issue is the likely influence of this type of funding on the corporate credit rating of the project owner. Indeed, Moody's – a global ratings agency – suggests that investing in new nuclear generation projects has historically had an adverse impact on credit ratings¹¹, reflecting the higher business and operating risk profile of the investment. In turn, institutional investors often see nuclear new build projects as a potential risk for the project owner that may result in negative cash flow implications, thereby driving down the investment profile and market value of the company. It is critical, therefore, for project owners to mitigate and manage construction risk in order to limit balance sheet exposure and maintain both favorable investor sentiment and existing credit ratings.

Project owners will find that the solution can be facilitated by the adoption of appropriate risk sharing and mitigating techniques. For new nuclear power projects currently in the conceptual or design phase, the risk allocation techniques that can be embedded in project finance structuring will almost certainly help address the myriad of construction risks faced by nuclear new builds, particularly in the areas of risk sharing, interface management, and dispute resolution.

¹⁰ Official ENEC Press Release – Selection of Prime Contractor, ENEC, 27 December 2009.

¹¹ New Nuclear Generation: Ratings Pressure Increasing, Moody's Global Infrastructure Finance, 2009



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The Origins of Construction Risk

Most of the construction risk involved in nuclear new builds stems from three sources: the magnitude of the upfront capital required; the interface complexity of the project; and the uncompromising regulatory environment within which the work must be carried out. Further complicating these issues are the additional risks of uncertainty of cost, first of a kind design, duration of planning, approval, construction, and the ever-present escalation of labor and material prices.

By far the most influential of these risks relates to the highly-regulated environment for new build nuclear

projects. Design changes are not permitted without detailed assessment and approval, as even a small departure from the approved design solution will alter the validity of the safety case and lead to cost increases and potential delays. At the same time, on site construction must follow the regulator's approved designs and timelines, requiring a strict protocol to ensure that construction activities never get ahead of the approved design.

This practice goes against the grain for many large Engineering-Procurement-Construction (EPC) contractors. For these types of large infrastructure

projects, the general practice is for EPC contractors to proceed with equipment procurement and construction work based on partial engineering designs developed in advance of final drawings and specifications. While this has proven to be a profitable and efficient approach on other projects, the optimum procedure on a new nuclear power project would require the design to be fully complete and approved prior to start of any safety related construction. For the project owner, however, this translates into an extension of the overall development period, which – in turn – increases the period of negative cash flow before revenue can be generated.



Working with the Safety Regulator and Design Standardization

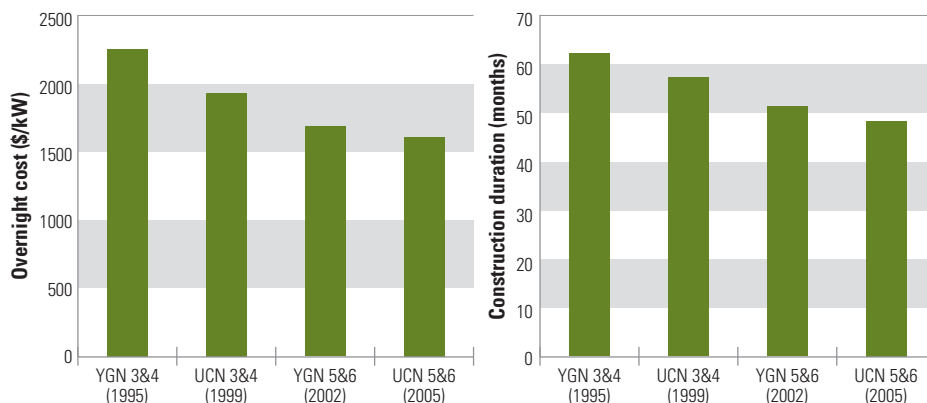
Nuclear industry safety regulations require two fundamental mindset changes from EPC contractors and related equipment suppliers. As noted above, they will first need to acknowledge and accept that concurrent development of design and construction is simply unworkable and that a longer planning and design phase will be required, including a full sign-off by the safety regulator prior to the start of safety related construction.

Second, as EPC contractors and equipment suppliers are obliged to deliver their work to the approved designs and working methods, a pragmatic and creative approach to solving issues surfacing in the field is unacceptable on a nuclear site, as the regulator can intervene and stop work if the design is compromised in any way. The risk in delivering a nuclear new build can be reduced significantly if these two behaviors are upheld during construction.

By creating and following standardized designs, valuable experience can be gained and reused, further reducing the regulatory risk. Generally, initial nuclear new builds involve a learning curve for all of the participants. But as these ‘first of a kind’ costs are removed and EPC contractors and equipment vendors gain experience in delivering new plants, the cost per MWh of new capacity for additional nuclear new builds will decline.¹² This type of design standardization is being actively pursued in many jurisdictions including the US, the UK and China. South Korea, for example, has experienced a cost reduction of approximately thirty percent¹³ on nuclear plant construction in the decade from 1995 to 2005 (Fig. 2) largely thanks to a focus on strict standardization of design, good nuclear construction practices, and stable national regulatory regimes.

A pragmatic and creative approach to solving issues surfacing in the field is unacceptable on a nuclear site.

Figure 2: Recent construction experience in South Korea



Source: Building New Nuclear Plants to Cost and Schedule – An International Perspective, Westinghouse, Sep 2005.

¹² UK Electricity Generation Costs Update, Mott McDonald, June 2010

¹³ Building New Nuclear Plants to Cost and Schedule – An International Perspective, Westinghouse, Sep 2005.

Contractual Approaches

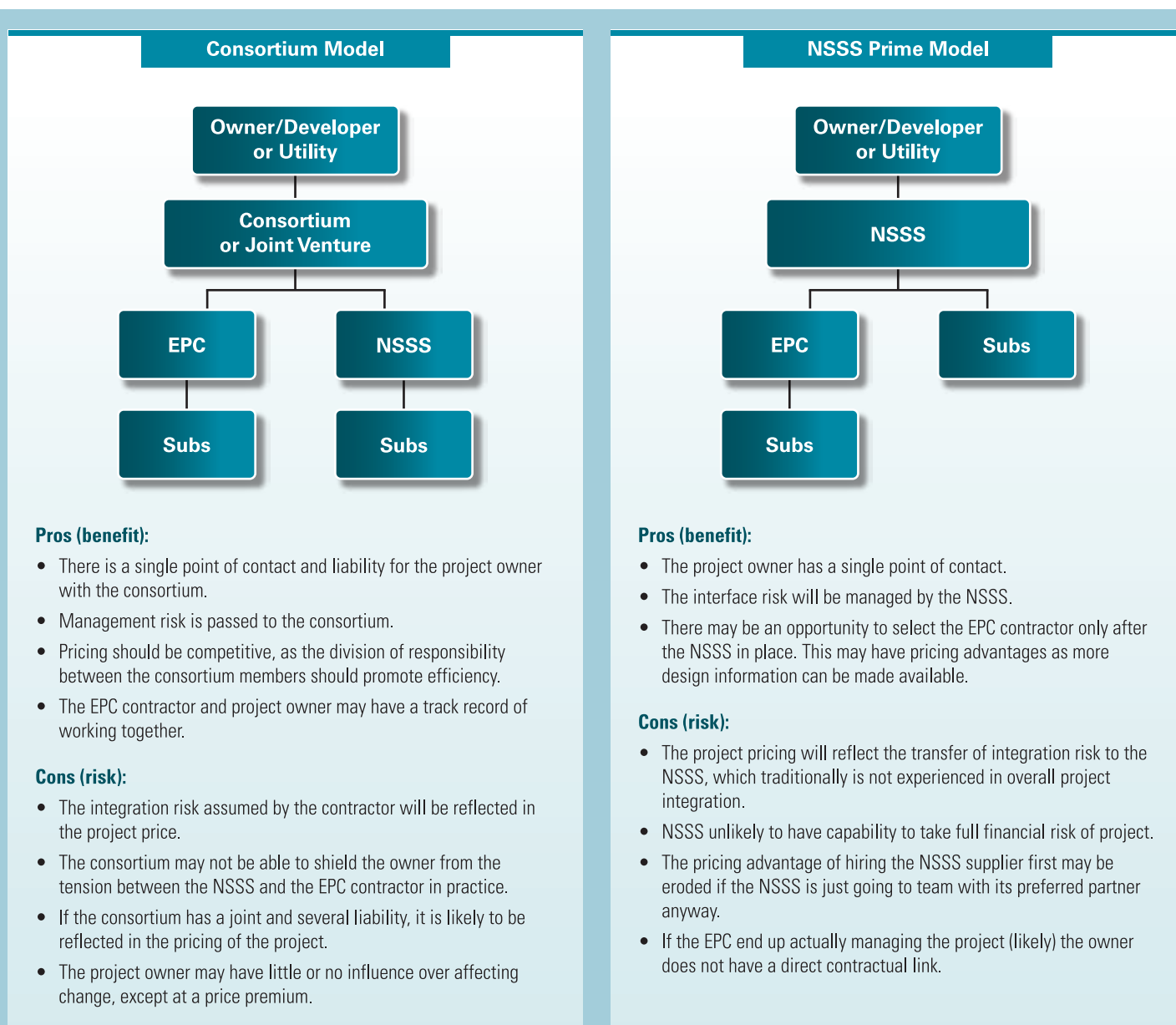
Very often, the project owner for a nuclear new build is the utility company or government entity that will become the owner (and possibly the operator) of the plant, with a number of parties working together to complete the build itself. This introduces a number of contractual and practical interface risks.

Successful plant delivery requires three main parties to come together: the Nuclear Steam Supply System (NSSS) supplier, turbine supplier, and the EPC contractor. Project owners have a range of contractual arrangements available to them, each with varying degrees of interface risk.

There are four main approaches that project owners can take:

- **consortium model:** The project owner contracts directly with a single entity that assumes full responsibility for the complete delivery of the new build nuclear plant. The single entity is generally a consortium (or joint venture) formed for the purpose of delivering a standardized nuclear design adapted to site-specific requirements.
- **NSSS as prime model:** The project owner contracts directly with the NSSS supplier. The NSSS supplier assumes full responsibility for the complete delivery of the new build nuclear plant, and – in turn – contracts with the EPC contractor and other key subcontractors to deliver the required services within the pricing constraints of the NSSS's contract with the owner.
- **EPC as prime model:** Similar to the NSSS prime model, except in this case it is the EPC contractor that assumes full responsibility for the complete delivery of the new build nuclear plant, and contracts with the NSSS supplier and other key subcontractors to deliver the project within the pricing constraints set by project owner.

Figure 3: Possible contractual approaches

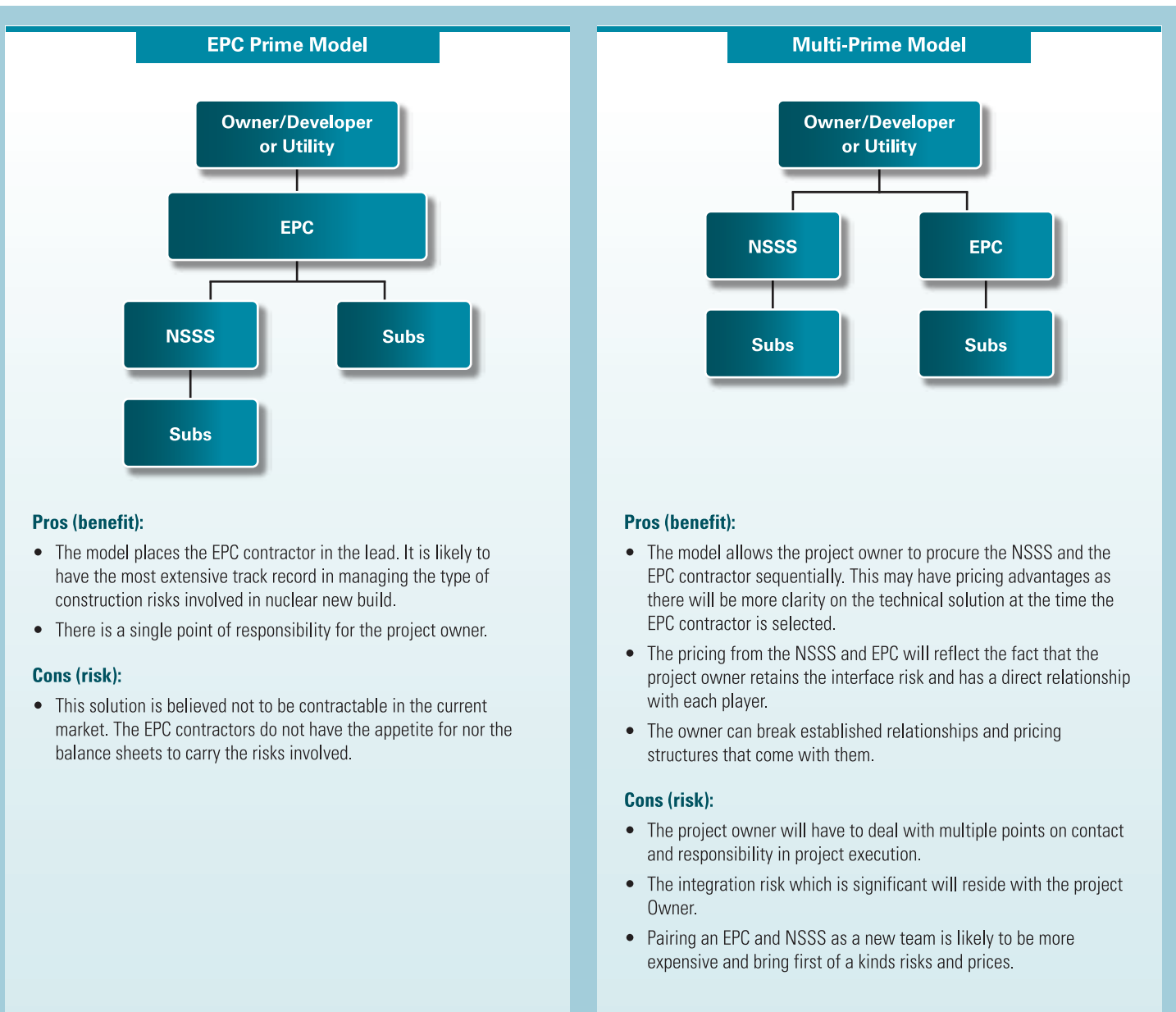


- **multi-prime model:** The project owner takes the lead role in procuring and managing both the NSSS supplier and the EPC contractor, giving the project owner maximum flexibility to select its preferred technology and de-couple the technology supplier from any prior relationship with a preferred EPC contractor. However, in this approach the project owner must manage two contracts instead of one, which increases management resource requirements and project risk.
- **multi-prime model variation – The China Model:** In this approach,

a governmental entity – not a private utility – is responsible for developing, building, and operating the nuclear new build project, contracting separately with each of the necessary parties (i.e. engineers, consultants, NSSS and other key suppliers, construction manager, construction contractors, etc.). This method allows the government entity to selectively contract for the transfer of technology and management expertise, gain access to the lowest supplier prices and leverage national resources for fabrication and construction. Ultimately, the government entity

and its national suppliers gain the experience needed to be self-sufficient in all aspects of nuclear plant design, program management, fabrication, equipment supply, construction, and operation.

The benefits and risks of each of these approaches are illustrated in Figure 3 below.



At its very simplest, the choice of contractual approach boils down to how much risk the project owner is willing to assume and whether the pricing for that risk represents good value. However, undertaking large and complex construction projects requires a strategic approach to risk.

While well placed technically, most large EPC contractors are generally unwilling and (due to limited balance sheets) largely unable to take significant risks on a nuclear new build. This has led to the development of an interesting trend where the NSSS vendors, in their desire to kick start the industry, are taking the lead contractual position, with the owners and the EPC contractors engaged as a joint venture partners or subcontractors.

However, with the industry's patchy track record for meeting deadlines and budgets, and the relative lack of hands-on experience of most project owners, transferring risk away from the project owner may not deliver the desired results. Regardless, project owners must build the in-house capability to both successfully manage its contracts and quickly identify situations where it has to intervene in order to keep the project on track.

The in-house delivery organization established by the project owner will influence its ability to successfully manage the integration risk. While this is especially relevant in the multi-prime model where the NPSS-EPC integration risk rests with the project owner, very often project owners will find that the cost of managing the risk in-house may be no higher than transferring it to an NSSS or an NSSS-EPC consortium.

Another alternative is to adopt a multi-prime model with an additional contract for a “managing agent” or “delivery partner” to oversee the day-to-day management of the project. While a majority of the risk continues to reside with the owner, it can be mitigated to a certain extent through incentive mechanisms, while maintaining contractual control and influence. This model has been used in China and, to a certain extent, in South Korea and Japan.



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Doing Commercial Deals

There are also a number of pricing structures that can be employed with each of the models described above.

On one end of the spectrum is a full-cost-reimbursement style of contract in which the NSSS/EPC/Consortium is compensated for the actual costs incurred, along with a mark-up for overhead and profit. On the other end of the spectrum lies the fixed or firm price contract in which the NSSS/EPC/Consortium, barring any extensive contract changes, agrees to deliver the full scope of the project for a set amount.

However, given the construction risk involved in a new nuclear power project, price certainty via firm or fixed price contracts may not be a realistic option. From a project finance structure perspective, the fundamental principle is to allocate risk to the party best able to control, manage, mitigate, and/or absorb the risk, with commercial terms structured to encourage the desired project behaviors and outcomes. When adopted at the outset of the project, this type of approach can yield substantial value.

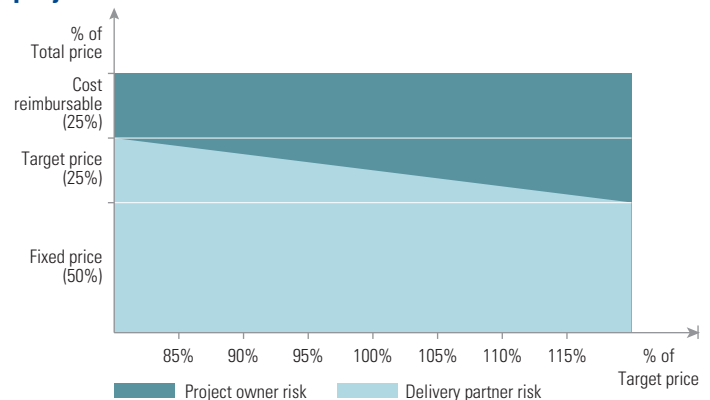
Commercial deals based on risk analysis and transfer risk must therefore be structured so that the contractual payment mechanism provides incentives for risk transfer. This approach will effectively prevent suppliers from charging premiums for risks they cannot properly manage, mitigate, control, and/or absorb.

For suppliers and contractors, cost-reimbursable contracts are preferable, as the financial risks of cost growth and non-payment can be contained. For utilities on the other hand, fixed price contracts are desirable, but mean that the NSSS/EPC assumes the full risk for project delivery, which is a position that suppliers and contractors are generally unwilling to take.

While many project owners prefer either a cost-reimbursable, target price, or fixed price type of contract, there are opportunities to structure negotiations with the consortium so the best features of all three contract types are blended to allocate specific performance risks to the party that can exert the most control over them.

As Figure 4 illustrates, a contractual risk sharing strategy that combines cost reimbursable, target price, and fixed price layers can result in the most balanced means of sharing project risk, and should therefore result in the lowest overall cost. When the forecast cost is below the target price, the project owner's risk is low, but when the forecast exceeds the target price, the risk to the project owner increases.

Figure 4: A hybrid approach to pricing a nuclear new build project



Source: Construction Risk in New Nuclear Power Projects – Eyes Wide Open, KPMG, 2011

It is important to note that the variety and structure of pricing models now being adopted for the current wave of nuclear new builds in design or under construction are constantly evolving. Project owners should therefore reflect on the specific characteristics of the project and draw lessons from other projects around the globe. The maturity of the regulator, the reactor design, and the EPC contractor's familiarity with nuclear new builds are only some of the considerations the project owner must take into account.

Governance, Process and Controls

Regardless of the contractual and pricing arrangement used, a robust risk mitigation strategy must also be employed as projects move through design, regulatory approval and into the construction phase. For the project owner, it is critical to ensure that risks do not materialize, and – if they do – that there is a system for early intervention and rapid management decision-making.

Central to this is the creation and implementation of project management processes and controls that are fit for purpose and appropriate for the contractual structure. In addition, with most nuclear new build development and construction phases spanning a decade or more, the project management processes and controls must be created with enough flexibility to adapt to changes over the project life-cycle.



The processes and controls that would govern the license applications and planning stage, for example, will look very different from those most appropriate for the construction phase. At a minimum, the system must be able to raise an early warning if cost, schedule, or quality performance trends deviate beyond expected limits.

Finally, it is important to recognize that disputes arise on all construction

projects, and that appropriate claim management processes must be put in place to deal with issues efficiently and effectively. By creating claim management processes that are tailored specifically to the project, all parties can mitigate the detrimental nature of claims and resolve disputes before significant resources are wasted on unnecessary arbitration or litigation.




Concluding Remarks

The world is embarking on a nuclear renaissance. It is now up to the nuclear industry itself to address and mitigate construction risks and deliver on the promise of competitive low-carbon electricity.

It is vital for parties involved to take a commercial approach to risk when structuring deals for nuclear new build projects. Only by adopting such an approach – combined with the development of rigorous project governance, control processes, and monitoring mechanisms – will project owners yield substantial value from nuclear new builds.

Finally – for both the nuclear industry and its potential financiers – new nuclear power projects can be approached with *eyes wide open*.



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