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Current status and emerging trends in financing nuclear power projects

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ABSTRACT

Traditionally, governments have used domestic public sector funds to finance nuclear power projects. However, a recent trend shows that governments, world-wide, are increasingly looking towards the private sector for new financing approaches with different risk and ownership structures that mitigate target risk mitigation, and new contractual arrangements that aim to lower the fiscal burden associated with nuclear power projects. This paper gives an overview of the major challenges related to financing nuclear power plants such as the high upfront capital cost, sensitivity to interest rate and long construction time. The paper then discuses existing and emerging financing strategies and contractual arrangements for both, government and private investors. The analysis eventually evaluates the potential of the emerging financing approaches to resolve some of the challenges associated with the deployment of nuclear power but there is no one-answer, as each project is unique and requires careful review regarding the applicability of the financing model, as some of these approaches may have their own challenges.

1. Introduction

The next decade is critical for nuclear power. Proponents of nuclear power believe that the shift away from carbon-producing energy sources represents an opportunity for expanding global capacity of nuclear electricity. However, the nuclear industry is struggling with internal and external challenges that could hinder such prospects. At the 2015 United Nations Climate Change Conference, known as COP21,[1] in a historic stance, the world agreed that climate change is a major issue, with 196 countries signed an agreement to abate the rise in global temperature to 2C (3.6F) by century's end.[2] A mix of technologies including nuclear and renewable is perceived by many as the most effective way to tackle climate change [1,2]. In addition to global warming, which is rated as one of the top risk at the Annual World Economic Forum 2016 [3], many competing factors are likely to influence future energy investments. Improving energy security, innovative financing, reducing costs, deregulating electricity markets and supply chain backlog are probably the most important factors that governments consider when shaping their energy policies. The weight assigned to these factors, however, could differ substantially from one country to another, based on the country's economic climate and the type of project and technology under consideration.

One major challenge associated with the deployment of nuclear power is financing, which, regardless of its mechanism or source, remains a barrier due to the large-scale of funds required and long tenor, in line with the economic life of the nuclear assets.[3] The diverse and exclusive set of risks involved and the waning economic competitiveness of nuclear electricity, due to high investment costs and the despatch risk in deregulated electricity markets. Furthermore, there is also fierce competition from alternative investment proposals (e.g. power generation projects using different technologies such as gas, hydro, wind, solar), which are less contentious from a reputational point of view and more in tune

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[1] COP stands for "Conference of Parties", said parties being the countries that ratified the UN Framework Convention on Climate Change in 1992 at the Earth Summit in Rio de Janeiro, Brazil.

[2] The first time in over 20 years of UN negotiations, to achieve a legally binding agreement on climate, with the aim of keeping global warming below 2C. http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/.

[3] Up to 80 years in case of license renewal(s) [4].

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with the political and general public mood. In that context, investors from the private sector, appear to be struggling to find "good reasons" to support nuclear power versus other technologies.

In this paper, we present a holistic view of financing nuclear power projects, from outlining the economic and fiscal challenges faced by project developers and investors to examining the existing financing strategies and contractual arrangements available when considering nuclear power projects. The paper also evaluates the potential of emerging financing approaches to resolve some of the challenges associated with the deployment of nuclear power. Section 2 outlines key economic features of nuclear power and the basics of financing. Section 3 highlights the challenges and risks of financing nuclear power projects, while the different types of financing approaches of nuclear power projects are discussed in Section 4 and 5. Next, Section 6 discusses contractual and ownership arrangements, employed for the infrastructure projects and finally, Section 7 concludes the main findings.

2. Background

2.1. Overview of key economic features

Compared to other energy sources, nuclear power is highly capital-intensive, which brings in higher sensitivity to interest rates. Although the cost of building nuclear power plants generally varies with geographic location and the unique circumstances of each project, its per kilo-watt (electric − kWe) cost range is substantially higher than that of traditional sources of energy such as natural gas, and is becoming increasingly less competitive against renewables.

The last decade has seen a further decline in the relative economics of nuclear power in most of the OECD countries.[4] From operations point of view, the main challenge is the risk of not being despatched, specifically in the deregulated electricity market. For new investments, it will be imperative to have Government support.[5]

In the case of the Vogtle project in U.S., for example, two AP1000 reactors are under construction with the actual unit capital costs increased to $6100/kWe in 2012, roughly 2.5 times the cost estimate assumed in a Massachusetts Institute of Technology (MIT) study in 2001 [8]. Since then cost estimates for Vogtle have further increased, due to delays and difficulty in meeting quality standards [10].[6] The recent cost estimates are more than $7000/kWe, see Fig. 1. Likewise, the estimated costs of constructing a European Pressurized Reactor (EPR) in Western Europe or North America range from around $5000 to $7300/kWe, or about $6100/kWe on average [11–13]. These numbers are consistent with the revised estimates for nuclear power plants that are recently constructed or under construction across the globe. Initial cost estimates, have generally been revised, in some instances more than twice, as shown in Fig. 1.

Fig. 2 shows the overnight cost data compilation in different regions (US, Europe, Asia and Middle East) and its standard deviation.[7] The range is from $3500–$5000/kWe, for all regions, except Asia, which is very daunting for newcomer countries. The costs for Asia are lower, given low input costs and very high localization rates. The standard deviation around the mean is $2000–$3000/kWe. Asian countries (Japan, South Korea and China) have maintained a momentum of nuclear power plant construction, whereas, most "Western" projects are 'first-of-a-kind' (FOAK), resulting in significant construction delays.

The outlook for future investment costs in Europe and the United States is not very encouraging. The findings from a study based on 30 U.S. and 30 European nuclear technology experts shows that on average, under a business as usual scenario, the current (Gen. III/III+) designs are expected to be somewhat more expensive in the year 2030, than they were in 2010, with the expectation that next generation of designs (Gen. IV) to be even more expensive [14].

In addition to the capital-intensive nature, nuclear energy possesses some exclusive risks, further discussed in Section 3. Collectively, these features contribute to the challenge of financing nuclear power plants. Despite these challenges, nuclear reactors are being built across the world, though at different pace and efficiency. Table 1 shows the 60 reactors that are currently under construction [15], in 15 countries, with 22 reactors in China alone. Though China's interest in investing in low carbon technologies also extends to solar and wind energy projects.

The United Arab Emirates (UAE) and Belarus are the only newcomer countries on the list, having started the construction of their reactors in 2012 and 2016, respectively. It is interesting to note that almost all nuclear power plants that are currently under construction will operate in regulated electricity markets, with substantial government support. The support may be in the form of long-term power purchasing contracts (PPA) or high electricity tariffs, in the absence of government subsidy. As shown in Table 1, Government financing and support still dominate the industry, as the leading source of finance.[8]

Government support is also looked at favourably by the financiers, whether it is in the form of PPA, government equity or government guarantee. Examples of different forms of government support include the U.S. Department of Energy's loan guarantee, for Vogtle nuclear power project of $6.5 billion [16], the UK Government's 35-year CfD for Hinkley Point C and the cooperation agreement with Hitachi and Horizon Nuclear Power to promote external financing for Wylfa nuclear power project [17].

On the other hand, nuclear power has low fuel and operational costs. According to the costs estimates of the U.S. Energy Information Administration (EIA), the variable operational and maintenance (O& M) costs of advanced nuclear are about 13% of the total levelized cost, based on 2020 costs projections [18].

2.2. The impact of Fukushima

Prior to Fukushima, the global financial crisis of 2008 had a significant impact on all large-scale infrastructure projects. The lack of liquidity in the financial markets made financing difficult for

[4] In the United States, for example, several reactors have been prematurely shut down because they cannot compete with the low natural gas prices [5]. A former staff of the U.S. Nuclear Regulatory Commission has argued that nuclear power has become so uncompetitive that market forces will phase out the US nuclear fleet by mid-century [6].

[5] Like the UK's Contract for Difference (CfD) system which provides price guarantee (eg., like Hinkley Point C price guarantee of £92.5/MWh, for 35 years), which is vital for the financial viability of the project [7]. Government support is required because of the current design of the electricity market in the UK, where short-term price signals prevail, with no new base load asset been built in the UK for many years.

[6] Westinghouse, and the operator, Georgia Power, have sued each other for nearly a billion dollars, with each blaming the other for delays and cost escalations.

[7] The term "overnight" capital cost generally includes the Engineering, Procurement, and Construction (EPC) costs, owner's and contingency costs but excludes interest during construction cost, escalation and inflation cost, as if the plant was being built overnight.

[8] Government Financing can take various form, including, State Budget (like, tax revenue), Export Credit agency Finance (ECA), Government Equity (Direct equity or Independent Public Offering), Government loan, PPA (Power Purchase Agreement) and Issuance of Government Infrastructure bonds. Vendor financing can be either equity or debt.