Avoidance of Cost Overruns and Delays During the Nuclear Power Plant Construction Period

By
ABDULLAH OYANIK
L.L.B, September 2017, Marmara University
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Professor Lin Harmon-Walker
Interim Director of the Environmental and Energy Law Program

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Abstract

(**Avoidance of Cost Overruns and Delays During the Nuclear Power Plant Construction Period**)

Building nuclear power plants is a troublesome process in which high capital investments and advanced technological expertise are prerequisites. Also, nuclear policies are supposed to be supportive for these projects so that projects can be completed successfully. Otherwise, in lack of any major elements, cost overruns and delays are inevitable.

This thesis analyzes the construction and policy risks that investors may face during the construction period of nuclear power projects (NPPs), and their impressions on the operation phase. NPP construction risk is clarified by evaluating sponsors and contractors' relationships, financial methods, and major points of Engineering, Procuring, and Construction (EPC) contracts. Government policies that may influence these projects, including the licensing process of nuclear plants and carbon tax and government guarantees, are explained. The effects of nuclear liabilities and the Fukushima disaster on under-construction nuclear projects are discussed. Finally, the Vogtle Project in the United States, which incurred cost overruns, is analyzed, and the reasons behind the construction risk are evaluated with further advice such as a streamlined licensing process, better connection among sponsors and contractors. The final part

of the paper discusses how project parties can minimize extra costs and postponements through modifications to nuclear power projects.

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1. Introduction

Nuclear power projects (NPPs) are complicated and risky investments, since during their construction period political changes, electricity market conditions, and human faults may dramatically reshape investors' prospects. Also, constructing NPPs takes 5 to 8 years, which is mostly a subject of recalculation, even more NPPs may not be finalized in the building phase as the level of risks escalates. Therefore, these projects have been plagued by cost overruns and delays.

This thesis examines major reasons for additional expenses and postponements, and their reflections on the projects' operation. Primarily, the Engineering, Procuring, and Construction (EPC) contractor has the duty of building the power plant on time and faces risks in construction and timing. As long as the EPC contract is formalized elaborately and the qualified contractors are assigned to the projects, these risks can be minimized.

Additionally, postponement and expense are not the only risks. Nuclear energy has been utilized for peaceful purposes since the 1950s, and the technology has been developed significantly since then. However, a few nuclear disasters have occurred for various reasons, which have affected the public's opinion toward nuclear energy. Specifically, after the Fukushima catastrophe in 2011, some countries have even halted their nuclear projects.

However, nuclear energy is a clean energy source and can provide 'baseload power energy' which means the energy can be generated significantly regardless of natural conditions. Other

renewable energy sources such as wind or solar do not provide energy that is as consistent, adequate, and reliable as NPPs.

While countries adopted new safety measures as a result of these disasters, those measures incurred extra costs for investors. Therefore, financing high upfront capital investments has become more challenging. Additionally, there are discrepancies in nuclear liability coverage depending on different countries' covered territory and liability limits, so there may not be adequate coverage for possible disasters. In this respect, governments may take a step further, and guarantee these projects in various ways and revise their regulations thereby funding nuclear projects can be promoted.

However, there are also other concerns regarding the licensing procedure of nuclear plants. Since nuclear plants incorporate advanced technology, their licensing process may take longer than the initial expectations. For this reason, some countries revised their policies, but it looks like that there is still a need for more investor-compatible nuclear policies. On the other hand, investors become a part of these projects with the expectation that during the operation, plants are going to yield adequate revenue to cover debts, which depends on market conditions, and generally longer construction periods result in lower recouping of investments and profit from the project.

Finally, considering these hurdles, this paper analyzes the impacts of the cost overruns and delays on the Vogtle projects in the state of Georgia, USA. Although in this state the electricity market is regulated, and the project had a long-term power purchase agreement and a government loan guarantee, the constructor declared bankruptcy due to delays and cost overruns during the construction period. The lesson learned from Vogtle is that nuclear projects must control various dynamics which must be managed so that they function synergistically together.

2. Major Setbacks During the Construction Period

2.1. Construction Risk

Nuclear power projects are complicated and require high up-front investments, and these projects are dependent on many factors such as state policies and the market and financial environments of the country, thus most projects suffer from massive amounts of cost and delays.[1] It is clear that at the beginning of the process, planning NPPs in clear and elaborate detail is an essential and inevitable step to prevent insolvency issues. Regardless of the type of project, throughout the construction period of infrastructure ventures, the risk of delays and cost overruns will likely higher than the operation period , especially for NPPs in which the process usually takes 5 to 7 years.[2] Therefore, like other project challenges, the construction risk should be allocated to the party that is best able to manage and mitigate the risk. [3]

Furthermore, the favorable financing method of NPP construction should be based on the framework which allocates risk clearly between the parties and includes incentives for each entity to satisfy their duties; otherwise, these risks can rise to a level that may lead to insolvency of parties.[4] For instance, Westinghouse Electric Company LLC declared bankruptcy due to the fact that two NPPs (Vogtle in Georgia, and Virgil C Summer in South Carolina) experienced delay and cost overruns during the construction period, which was also sponsored by the Toshiba

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[1] D. H. Joyner, "Nuclear Power Plant Financing Post-Fukushima, and International Investment Law," *The Journal of World Energy Law & Business* 7, no. 2 (April 1, 2014): 69–92, https://doi.org/10.1093/jwelb/jwt012.

[2] Jason Crowell et al., "NUCLEAR EPC SOLUTIONS: UNLOCKING EFFECTIVE CONSTRUCTION RISK ALLOCATION TO SUPPORT BANKABLE NUCLEAR POWER PROJECTS," n.d., 15. http://peacecrowell.com/wp-content/uploads/2015/10/Nuclear-EPC-Solutions.pdf accessed 10/20/2020

[3] John M. Niehuss, *International Project Finance in a Nutshell*, Second edition, West Nutshell Series (St. Paul, MN: West Academic Publishing, 2015) p. 104.

[4] Crowell et al., "NUCLEAR EPC SOLUTIONS: UNLOCKING EFFECTIVE CONSTRUCTION RISK ALLOCATION TO SUPPORT BANKABLE NUCLEAR POWER PROJECTS," n.d.

Corporation that lost a significant amount of its investment.[5] Consequently, in order to minimize insolvency issues, the project's structure must be elaborately and clearly devised, while considering each aspect of the project, from the type of contracts such as construction contract, power purchase, loan, supply, and shareholder agreements to the project parties, sponsors, lenders , governments, contractor and suppliers.

2.1.1. Basics of NPP Projects

The successful building of NPPs is critically based on sponsors' experience and capability such as having resilience to financial fluctuations, adequate funding sources and certainly extensive project knowledge, which are exceptional assets, so that the project can be supervised in a safe, professional, and timely manner, and by assigning highly qualified contractors for each of the separate sections, which is the way of using funds efficiently, in order to minimize the construction risk.[6] Sponsors that do not have these capabilities can seek an arrangement under turnkey, lump sum methods by paying the project cost to a qualified contractor.[7] Furthermore, these are projects likely built for public services, so private companies assume nuclear projects under concession agreements with governments which do not want to undertake the complicated construction risks and prefer instead to pay the lump sum cost for these projects to the concessionaire.[8] There are a few kinds of concessions agreements, such as build and transfer

[5]https://www.reuters.com/article/us-toshiba-accounting-board/huge-nuclear-cost-overruns-push-toshibas-westinghouse-into-bankruptcy-idUSKBN17006K

[6] Howard M. Steinberg, *Understanding and Negotiating EPC Contracts* (Milton Park, Abingdon, Oxon ; New York, NY: Routledge, 2017) at page 28.

[7] Practical Law Finance, "Understanding Project Finance Construction Contracts," Thompson Reuters Practical Law, available at https://content.next.westlaw.com/Document/I03f4d89feee311e28578f7ccc38dcbee/View/FullText.html (last visited Oct. 17, 2020)

[8] Michael Kerf et al., *Concessions for Infrastructure: A Guide to Their Design and Award*, World Bank Technical Papers (The World Bank, 1998), https://doi.org/10.1596/0-8213-4165-0.

(BT) under which the contractor builds the power plant for the government on a fixed price; build, own and operate (BOO) in which contractors build, own and operate the power project for a specified time period.[9]

Furthermore, EPC contractors will likely establish a common legal ground which might be either a consortium, a joint venture, or an alliance in order to strengthen their commitments to the project so that the construction risk can be allocated among them.[10] This underpins more straightforward budget management given the fact that nuclear projects entail risk in various specialties.[11] Additionally, the parent company's guarantees are required in order to minimize the risk, since most companies join the consortium with a new entity which does not have a significant amount of resources. Sponsors should be prudent regarding the consortium agreements. The risk allocation between contractors must be specified to determine the responsible contractor in each area of the work. The contracts must discuss and assure the arrangement's provisions under parent guarantees for each subtopic, so that the parties can have clear background information and guidance, should they face insolvency issues.[12] Usually, there is an engineering company that assumes the risk of project performance and scheduled operation date, then the subcontractors likely join into the project.[13]

[9] Steinberg, *Understanding and Negotiating EPC Contracts*.

[10] Ibid page 38

[11] Ibid

[12] "Federal Loan Guarantees for the Construction of Nuclear Power Plants," n.d., 42.

[13] Crowell et al., "NUCLEAR EPC SOLUTIONS: UNLOCKING EFFECTIVE CONSTRUCTION RISK ALLOCATION TO SUPPORT BANKABLE NUCLEAR POWER PROJECTS," n.d.

2.1.2. The Financial Model

After the EPC contract type and the entity structure are chosen by the contractor and sponsors, the financial model will be determined by evaluating major features of the project, such as the capacity factor of the plant, because the project's success depends on how lucrative the project is likely to be.[14] Moreover, the method of financing nuclear power plants is similar to other infrastructure projects in which the main goal is basically mitigation of risks through protective measures. Starting from the earliest planning stages of a project to building a new NPP, prudent owners will seek to establish the project in such a way that financial risks are, to the extent possible, kept to a minimum level or even eliminated.[15] The financial risk is partly based on the accurate prediction of the total cost and the level of project bankability, which are essential principles for financing the project, since more cost overruns in the project means less return for sponsors.[16] Furthermore, since NPPs are highly capital intensive, and require substantial financial resources, the financial structure of the projects may significantly influence the procedure for mitigating possible risks, since the project could either be sustained by sponsors' recourse or from the project's revenue , depending on the structure as discussed below.[17]

2.1.2.1. Corporate Finance

Albeit that there are a few methods to funding costly power projects, fundamentally, debt and equity are basic financial elements that are likely used in various ratios in infrastructure

[14] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), eds., *The Financing of Nuclear Power Plants*, Nuclear Development (Paris: Nuclear Energy Agency, Organisation for Economic Co-operation and Development, 2009).

[15] Steinberg, *Understanding and Negotiating EPC Contracts*.

[16] Joyner, "Nuclear Power Plant Financing Post-Fukushima, and International Investment Law."

[17] Steinberg, *Understanding and Negotiating EPC Contracts*.

projects.[18] Traditionally, NPPs have been financed through corporate finance around the world due to the fact that these projects entail a high level of construction risk and capital intensive investment and few companies are able to fund these projects by their balance sheets, involving their company equities and loans.[19] Since projects are likely based on a balance sheet, all stakeholders and financiers of the company share in the project risk, so the sponsors of the project will take on the greatest portion of the risk throughout the construction period. [20] On the other hand, allocation of both expenses and risk with sponsors is the main benefit of corporate finance for lenders because they can go to companies' balance sheets under corporate finance in case of insolvency.[21] Furthermore, once NPPs are financed, it does not mean that the projects are not able to refinance again, specifically along with commencement of power plant operation, when it is likely that the financial status of the project is restructured by considering current measures.[22]

2.1.2.2. Project Finance

"Project finance is a method of raising long-term debt financing for major projects through 'financial engineering,' based on lending against the cash flow generated by the project alone; it

[18] Joyner, "Nuclear Power Plant Financing Post-Fukushima, and International Investment Law."

[19] Fabienne Pehuet Lucet, "Conditions and Possibilities for Financing New Nuclear Power Plants," *The Journal of World Energy Law & Business* 12, no. 1 (March 1, 2019): 21–35, https://doi.org/10.1093/jwelb/jwy032.

[20] Fabienne Pehuet Lucet and Institut français des relations internationales, *Financing Nuclear Power Plant Projects: A New Paradigm?*, 2015, http://www.ifri.org/sites/default/files/atoms/files/nuclear_power_plant_project.pdf.

[21] Eilís Ferran and Look Chan Ho, *Principles of Corporate Finance Law*, Second edition (Oxford, United Kingdom: Oxford University Press, 2014).

[22] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

depends on a detailed evaluation of a project's construction, operating and revenue risks, and the project risk allocation between investors, lenders, and other parties through contractual and other arrangements."[23] Project finance, which has been used for less complex infrastructure projects, is an unusual technique for funding nuclear power projects.[24] Recently, governments have utilized project finance through public-private partnerships to develop their substructures, which used to be conventionally financed just by governments. [25] Even though a few project owners tried the project finance method to fund NPPs, the process was never completed lucratively, entailing complex prescribed provisions which did not fit on the nuclear projects' outline.[26]

Project financings are typically structured as "non-recourse" or "limited recourse" financings.[27] In non-recourse NPP Projects, lenders can be paid only from the project revenues, without recourse to the equity investors. In limited recourse projects, lenders rely primarily on the private partner's revenues to repay their loans but have certain additional limited recourse to the equity investors.[28] The premise of a non-recourse or limited recourse project financing is inextricably linked to the ability of lenders' assessment of the project through debt service coverage ratio (DSCR) which is a dimension of the project's capability regarding paying the debt, giving an idea regarding the project viability, and in respect of nuclear projects, the total cost is

[23] E.R. Yescombe, Principles of Project Finance, 2014, page 1.

[24] imon Taylor, "Can New Nuclear Power Plants Be Project Financed?," no. 1118 (n.d.): 20.

[25] Niehuss, *International Project Finance in a Nutshell*.

[26] Taylor, "Can New Nuclear Power Plants Be Project Financed?"

[27] Frank J. Fabozzi, Carmel F. de Nahlik, and Peter K. Nevitt, *Project Financing*, Eighth edition (London, United Kingdom: Euromoney Books, 2012).

[28] Jeffrey Delmon and Victoria Rigby Delmon, eds., *International Project Finance and PPPs: A Legal Guide to Key Growth Markets* (Alphen aan den Rijn: Kluwer Law International, 2013).

considerably high compared with other infrastructure projects so that recouping risk is more difficult.[29] Furthermore, due to the recourse limitation, lenders oversee infrastructure projects diligently by limiting material changes at the projects or request approval for any modification resulted from other parties' attempts.[30]

Under the project finance circumstances, a company, called a special purpose vehicle, is established by investors for the exclusive purpose of managing the project to be constructed, and a syndicated bank then funds the company.[31] In case of default, parent companies may not be liable due to the fact that lenders can only go to the project revenue under non-recourse finance, so it is expected that lenders exercise extensive due diligence in order to mitigate risks.[32] However, NPPs incorporate a high level of construction risk which might be inadmissible to construct without non-recourse since lenders do not likely delimit their alternatives in case of insolvency. Consequently, in order to enhance the bankability of NPP, at least along the construction period, there could be a limited recourse on sponsors.[33]

Since project finance has sophisticated features, and at least requires limited recourse financing, it is supposed to be redesigned if the project finance's financial structure is applied to NPP for

[29] E. R. Yescombe, *Principles of Project Finance*, Second edition (Amsterdam ; Boston: Academic Press is an imprint of Elsevier, 2014).

[30] John Dewar, ed., *International Project Finance: Law and Practice* (Oxford ; New York: Oxford University Press, 2011).

[31] Richard A. Brealey, Ian A. Cooper, and Michel A. Habib, "USING PROJECT FINANCE TO FUND INFRASTRUCTURE INVESTMENTS," *Journal of Applied Corporate Finance* 9, no. 3 (September 1996): 25–39, https://doi.org/10.1111/j.1745-6622.1996.tb00296.x.

[32] Danielle Nel, "ALLOCATION OF RISK IN PUBLIC PRIVATE PARTNERSHIPS IN INFORMATION AND COMMUNICATIONS TECHNOLOGY," *International Journal of EBusiness and EGovernment Studies*, January 3, 2020, 17–32, https://doi.org/10.34111/ijebeg.202012102.

[33] Taylor, "Can New Nuclear Power Plants Be Project Financed?"

the purpose of assuring lenders that the project is bankable. Firstly, Construction risk is one of the main issues since NPPs are inherently costly projects, for instance a 1,100MW plant costs approximately between $6 billion to $9 billion[34] and it requires a high level of complex technology, which is daunting for lenders. Furthermore, nuclear power projects have a notoriously very poor track record with delays and cost overruns - the Vogtle project is one example.[35] While delays can occur in any large construction project, banks are very unlikely to finance nuclear power projects until there is some proven record of on-time construction since under the project finance conditions, lenders look forward to 'predictable and motivating' recoupment.[36]

Another issue for lenders is the step-in right, which typically means the ability to step into the shoes of their borrower if it is defaulting under the relevant contract.[37] This right might be troublesome for two main reasons.

First, given the fact that the number of nuclear plant operators is limited around the world, lenders may not easily find a qualified operator after default of the borrower.[38] Second, even supposing that step-in solutions are feasible, there are two major setbacks with step-in rights that are inherently part of the operation of NPPs: 1) the lenders are going to supersede the company

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[34] https://www.synapse-energy.com/sites/default/files/SynapsePaper.2008-07.0.Nuclear-Plant-Construction-Costs.A0022_0.pdf

[35] https://cleanenergy.org/blog/is-there-more-trouble-ahead-for-plant-vogtle-expansion-experts-testify-that-serious-challenges-remain/

[36] Taylor, "Can New Nuclear Power Plants Be Project Financed?"

[37] " https://peacecrowell.com/wp-content/uploads/2015/10/Article-Project-Finance-Structures-for-Nuclear3.pdf

[38] ibid

to supervise the operation, which likely entails protracted and expensive process since the nuclear agency's confirmation is required, and 2) lenders may possibly undertake the nuclear liability risk themselves once they step into the project.[39]

To summarize, albeit that the extra complexity and transaction costs of arranging project finance, including very detailed contracts, make it more expensive than normal corporate finance, and that lenders require expanded management power on projects, project finance provides access to a large pool of debt financing from banks and bond holders.[40] Also, project finance enables an electricity company to consider building more power stations than it may not be able to finance through its customary corporate financing and is a simpler technique because of including more equity stakeholders, whose assets will not be at risk.[41] While project finance has many benefits, building a NPP with a project finance structure could be extremely onerous with very poor track record and low reputation, and a corporate finance module is still more compatible with the nuclear project conditions, allowing recourse to the projects' sponsors.

2.1.3. The Design Risk

The most delicate phase of constructing power plants is the design phase in which sponsors should analyze watchfully all documents and records, because major verdicts as to the project's expenses and features are reached in this process.[42] Examining all papers, sponsors may have a better vision of the project, and that is important since a fault in this phase that was not recognized by parties may not be able to rectified with basic alterations later on.[43] Also,

[39] ibid
[40] Taylor, "Can New Nuclear Power Plants Be Project Financed?"

[41] Ibid.
[42] Lucet and Institut français des relations internationales, *Financing Nuclear Power Plant Projects*.

[43] Steinberg, *Understanding and Negotiating EPC Contracts*.

sponsors should analyze all documents regarding the reactor design so that in case of a dispute as to the design, the contention should be resolved as soon as possible in order to minimize possible extra costs.[44] Furthermore, the EPC contractor may claim irresponsibility in case of deficiency of project performance by saying the fault is caused by the sponsors' approval of documents; therefore, sponsors may only check up and specify their concerns on the constructor job.[45] It might be possible for sponsors to protect themselves through a provision in the documents that confirmation of design by sponsors does not excuse contractors for faulty design, although that is a controversial topic, since it may not be adequate to protect sponsors in a judicial procedure.[46] Preferably, contentions regarding the design should be figured out before the contractor proceeds to work on the project by agreeing on a settlement where the parties agree in advance about the design details, and sponsors' comments might give a valuable criticism for the project, rather than approving the documents.[47]

Furthermore, the construction risk can be eliminated by using a proven design which can be built with a little adjustment for a particular site. Risk is likely to intensify with first-of-a-kind (FOAK) plants[48] such as the AP1000 nuclear plant. Although FOAK plants are based on know-how and knowledge from prior designs, greatest experience is being earned after the construction period, and FOAK plants are usually 15-55% more costly than traditional plants.[49]

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[44] Ibidk
[45] Ibid
[46] Ibid
[47] Crowell et al., "NUCLEAR EPC SOLUTIONS: UNLOCKING EFFECTIVE CONSTRUCTION RISK ALLOCATION TO SUPPORT BANKABLE NUCLEAR POWER PROJECTS," n.d.

[48] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

[49] "Current Status, Technical Feasibility and Economics of Small Nuclear Reactors, OECD,2011, p. 17.

2.1.4. EPC Contractors

Constructing nuclear power plants requires complex technology and upfront investment, thus large companies which have an experience in engineering and constructing power generators likely assume the risk through the 'Turnkey EPC contract' under which they deal with all parts of the project regarding engineering, procurement and construction with the expectation of a fixed price.[50] Under the EPC contract, contractors are in charge of completing the project by a certain date, which also means that operators can expect to commence 'turn the key' operations and generate energy on this date.[51] Otherwise, contractors are charged with 'liquidated damages' which is the interest fee that the sponsors are obliged to pay lenders, including the money that sponsors are responsible to pay to utilities under the power purchase agreement, and the profit that sponsors expect under the contract.[52]

Furthermore, the contractors are accountable for the performance level of the project, given the fact that project participants must meet minimum performance expectations. If the plant is not able to generate promised electricity in an hour due to low quality workmanship, that performance deficiency would be compensated by the contractor possibly paying liquidated damages, which are likely to be under 15% of the contract price.[53] Nevertheless, in order to complete the construction process on time and to avoid insolvency issues or being charged with liquidated damages, the relations between sponsors and contractors are supposed to be solid and credible.

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[50] Steinberg, *Understanding and Negotiating EPC Contracts*.

[51] Crowell et al., "NUCLEAR EPC SOLUTIONS: UNLOCKING EFFECTIVE CONSTRUCTION RISK ALLOCATION TO SUPPORT BANKABLE NUCLEAR POWER PROJECTS," n.d.

[52] Ferran and Ho, *Principles of Corporate Finance Law*.

[53] Ibid.

2.1.4.1 Subcontractors-Sponsors

The project success can be measured by looking at the actual date that the plant commences and the total budget of the project.[54] Therefore, the mitigation and allocation of construction risk is likely a supportive method to complete the project more successfully.[55] For instance, the major characteristic of the EPC contracts is that all risks regarding design, procurement, and engineering are passed through to the contractors in exchange for a certain price for the project.[56] Given the fact that the contractor undertakes a huge amount of risk and the project requires high capital investment, the project's essential parts might be overseen easily as long as allocated among subcontractors.[57] The EPC contractor's aim should be passing through the risks to these subcontractors resulting in that they will be charged with accrued expenses and delays for their assigned parts.[58] However, the EPC contractor is primarily in charge for efficiency of the project and sponsors would request recourse solely from the EPC contractor and hiring subcontractors to the project does not exculpate the EPC contractor from any responsibility in a form of arrangement term.[59]

Furthermore, in case the EPC contractor resigns from the project, what happens to subcontractors is another point that is supposed to be negotiated. There might be a provision in the contract

[54] Steinberg, *Understanding and Negotiating EPC Contracts*.

[55] Picha at all., (2015), "Application of EPC Contracts in International Power Projects" https://doi.org/10.1016/j.proeng.2015.10.061(accessed 11/04/2020)

[56] Crowell et al., "NUCLEAR EPC SOLUTIONS: UNLOCKING EFFECTIVE CONSTRUCTION RISK ALLOCATION TO SUPPORT BANKABLE NUCLEAR POWER PROJECTS."

[57] Ibid

[58] Ibid

[59] Steinberg, *Understanding and Negotiating EPC Contracts*, page 78.

which allows sponsors to keep working with subcontractors without their permissions if the EPC contractor defaults so that the project might be finished with limited delays and extra costs.[60] However, in reality, if the EPC contractor is not able to pay the subcontractors, subcontractors will likely dismiss their agreement or leave the project; therefore, should sponsors want to retain them or hire a new contractor, there would be a request of discussion between sponsors and these contractors as to their position under new contracts since hiring new subcontractors is more expensive and cause delays.[61] Additionally, since the EPC contractor is responsible to meet financial limits regarding extra costs, and inexperienced subcontractors may cause the project to deteriorate, the contract's parties may settle on a list in which qualified subcontractors who can work on the project are specified, so that undesirable consequences from inexpert subcontractors might be eliminated.[62] However, in case that the sponsors do not ratify the subcontractors on that list, their action in not approving the subcontractors does not count as a *force majeure* event, which might otherwise justify the contractor in not completing the project.[63]

Regarding the contractor and sponsors relationship, informing sponsors about crucial issues such as the early notification of setbacks, changes or delays during the construction is likely an indication of the contractor performance, thereby sponsors are able to deal more quickly with the concerns by evaluating these early feedbacks, which would otherwise deteriorate the project later on.[64] It is reasonable that the contractor is not expected to inform sponsors for minor cases and

[60] Ibid p. 81
[61] Ibid
[62] Ibid p. 79
[63] Ibid
[64] Phil Loots and Nick Henchie, "Worlds Apart: EPC and EPCM Contracts: Risk Issues and Allocation" https://fidic.org/sites/default/files/epcm_loots_2007.pdf accessed 10/24/2020.

there could be a bottom limit of extra costs or delays.[65] Furthermore, overseeing and giving instruction as a sponsor, could be an effective way to check the project conditions to see whether they comply with the requirements. However, this practice may excuse the EPC contractor from the delay or cost overruns that appear during the project following the supervision of sponsors.[66] It could be a much better solution for sponsors to discuss and remark their observations and thoughts rather than commanding the contractor with regard to how to do its business.[67] Additionally, given the fact that all concerns may not be figured out with negotiations, the contract may cover provisions for sponsors which might be a permission to make modifications in the project one-sidedly if sponsors consider that these alterations are necessary.[68] It is also another debate point for the party who is going to undertake these modification outcomes. If sponsor request them ,they will likely bear the risk of failure regarding the modification. However, it might be essential for sponsors to step in occasionally, specifically in the design stage, since some faults may not be rectified and will likely entail reconstruction of the faulty parts.[69] As a result, it is sensible to specify defects and to have an agreement on each issue at the beginning of the construction.

[65] Loots and Henchie.

[66] Ibid.

[67] Steinberg, *Understanding and Negotiating EPC Contracts*.

[68] Ibid

[69] Steinberg, *Understanding and Negotiating EPC Contracts*.

2.1.5. Insolvency Issues

Once the EPC contractor commences the project, sponsors should be prudent regarding the construction schedule, otherwise delays could be unavoidable.[70] Therefore, the project schedule in which every work time period and order is provided should be added to the contract.[71] Also, in the schedule, all major work should be specified so that the project progress can be supervised more easily. [72]Additionally, it is critical to keep up-to-date information for the contractor as third parties finish their undertakings on time, thereby the contractor keeps working in line with the contract's requirements.[73] The project schedule might be altered frequently depending on renewed conditions so parties should be checked up and informed constantly as to the project's status.[74] Additionally, under the EPC contracts, events that are accounted as a breach of the contract should be mentioned explicitly in the agreement so that parties will have an evident ground that illustrates which events may lead to default for the purpose of seeking remedies.[75]

The most critical time to find mistakes is the engineering and design stage because of the fact that failures may not be noticed until the commissioning of the project, and rectifying them may

[70] Benyamin Sadeghi, Mohammad Mehdi Mortaheb, and Hamed Kashani, "Defining Mitigation Strategies for Recurring EPC Contract Risks," in *Construction Research Congress 2016* (Construction Research Congress 2016, San Juan, Puerto Rico: American Society of Civil Engineers, 2016), 2773–82, https://doi.org/10.1061/9780784479827.276.

[71] Sadeghi, Mortaheb, and Kashani.

[72] Ibid

[73] Crowell et al., "NUCLEAR EPC SOLUTIONS: UNLOCKING EFFECTIVE CONSTRUCTION RISK ALLOCATION TO SUPPORT BANKABLE NUCLEAR POWER PROJECTS," n.d.

[74] Ibid.

[75] Loots and Henchie, "Worlds Apart: EPC and EPCM Contracts: Risk Issues and Allocation."

require demolishing or restructuring which is a costly and a protracted procedure.[76] However, difficulties during the construction phase can be handled as long as a constructive relationship is maintained between the owner and the EPC contractor.[77] Also, given the fact that an EPC contractor's monetary hardships can halt the project, any hassle regarding the budget should be dealt with as soon as possible because reestablishing financial stability gets harder as time passes by.[78]

The owner should be cognizant of the EPC contractor's main deterrent motives, which could be avoiding insolvency or abandoning the project because of cost overruns and delays which may erase its earnings.[79] The best tactic might be rewarding the EPC contractor with incentive payments for each stage to stimulate its attention to the project.[80] Also, legislation can provide protection to the contractors from default by giving permission to charge customers during the construction[81] such as the Georgia Nuclear Energy Financing Act in 2009 which put extra burden on the customers' electricity bills after getting authorization from the State Public Service Commission.[82] On the other hand, the fact that EPC contractors likely earn their price from the

[76] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

[77] Steinberg, *Understanding and Negotiating EPC Contracts*.

[78] Crowell et al., "NUCLEAR EPC SOLUTIONS: UNLOCKING EFFECTIVE CONSTRUCTION RISK ALLOCATION TO SUPPORT BANKABLE NUCLEAR POWER PROJECTS," n.d.

[79] Crowell et al.

[80] Steinberg, *Understanding and Negotiating EPC Contracts*.

[81] Phil Loots and Nick Henchie, "Worlds Apart: EPC and EPCM Contracts: Risk Issues and Allocation," n.d., 18.

[82] https://world-nuclear-news.org/Articles/Westinghouse-sale-to-Brookfield-completed

date when they deliver the project under EPC contract, and would like to sell their assets in the projects as soon as possible so that they can commence other projects. Therefore, the commitment of the contractors to the project can be strengthened by maintaining their assets and partnership rights at least until the project reaches a stable phase.[83]

As long as sponsors have closeness with the EPC contractor, challenges during the construction period are likely fixed, which are mainly derived from two reasons, delays and low-quality production.[84] Construction delays are likely due to unskilled work when the project is constructed step by step while other phases are going to stand idle.[85] That is why high amounts of liquidated damages are provided in the contract, up to 30% of the contract price, to stimulate better project management.[86] From the owner's perspective, extending the period of the construction means that the loan agreement between the sponsors and lenders has to be revised to align with the extended period, because sponsors count on a commercial operation date when the project is able to sell electricity.[87] Furthermore, after a certain date in the protracted period, lenders may step into the project, and are apt to foreclose on the project in order to market it. This does likely harm the sponsors' investments since an unfinished project is valued less than the one completed.[88] Another option is that the lenders could manage the project by themselves, finally they can allow the sponsors to keep working on the project in exchange for an extra fee, which is the most common solution.[89] As sponsors realize that the project is behind schedule they

[83] Understanding Project Finance Construction Contracts page 35

[84] Steinberg, *Understanding and Negotiating EPC Contracts*.

[85] Ibid

[86] Ibid

[87] Yescombe, *Principles of Project Finance*.

[88] Dewar, *International Project Finance*.

[89] Ibid

should inform the EPC Contractor which might reply that the project will be completed at the agreed time.[90] However, sponsors necessarily do not have to rely on that response and may hire a prestigious expert to analyze the project's position and monitor the production of the contractor.[91]

Once delays and cost overruns reach a point where the contractor is not able to maintain the project, bankruptcy could be an inevitable option.[92] The best remedy to avoid bankruptcy might be to reach a compromise with the contractor and substitute it with another contractor, whereby the original EPC contractor may opt out from the construction, and another contractor might take over its position.[93] Additionally, as soon as a company heads towards bankruptcy, workers may focus on looking for new job opportunities rather than doing their work, and the company's credit limits are restricted by its banks which expedites the process towards bankruptcy.[94]

If the contractor does not sign an agreement to leave the project, the owner can discontinue the contract based on the clauses in the EPC contract. However, in the USA, according to the U.S. Federal Bankruptcy Code, declaring bankruptcy is not adequate to terminate the contract, since the contractor can seek 'protection' from the court.[95] Therefore the clause that is incorporated in the EPC contract, that a bankruptcy claim is considered a reason to terminate the contract is overridden.[96] Nevertheless, the owner of the project may still have other clauses that can end the relationship, such as not managing the project properly, which can be challenging to prove.[97]

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[90] Ibid.
[91] Ibid.
[92] Steinberg, *Understanding and Negotiating EPC Contracts*.

[93] Ibid.
[94] Ibid.
[95] Ibid.
[96] Ibid.
[97] Ferran and Ho, *Principles of Corporate Finance Law*.

Finally, the relation between parties is a vital element of project sustainability that is supposed to be firm and accessible during all steps of the project so that contentions might be resolved with minimal harms even if the case is in bankruptcy.

Additionally, the parent company would be unimpaired as long as it does not grant guarantees on behalf of its subsidiaries that declared bankruptcy; however, for NPP projects, guarantees are required so that the parent company is likely responsible.[98] After deciding to take bankruptcy protection, the company attempts to restructure its debts under the bankruptcy policies, and after subsequently to declaring bankruptcy, it might be simpler to get funding from lenders throughout the procedure. Also, each company involved in the NPP must file its bankruptcy case individually, then the court might merge the cases.[99] Furthermore, there might be a dissuasive provision that can be added into the EPC contract in order to preclude filing bankruptcy by clarifying that in case of bankruptcy the company is accountable for the cost of replacing the contractor.[100]

Along with the EPC contractor, the parent company is also in charge under the bankruptcy file since it gives a guarantee so that the owner may replace the EPC contractors to finish the project, and the replacement contractor is likely more expensive, thus the difference is compensated from the EPC contractor and the parent company.[101] Therefore, as long as the contractor company is not in the 'zone of insolvency', the excess amount of cost may dissuade the company from filing a bankruptcy case.[102] However, the most rapid and effectual remedy among many alternatives is

[98] "Federal Loan Guarantees for the Construction of Nuclear Power Plants."

[99] Steinberg, *Understanding and Negotiating EPC Contracts*.

[100] Ibid.

[101] Jason Crowell et al., "NUCLEAR EPC SOLUTIONS: UNLOCKING EFFECTIVE CONSTRUCTION RISK ALLOCATION TO SUPPORT BANKABLE NUCLEAR POWER PROJECTS," n.d., 15.

[102] Steinberg, *Understanding and Negotiating EPC Contracts*.

to opt for a competent and trustworthy EPC contractor, since qualified contractors are much better suited to forecast the duration and the total cost of the project. An inexpensive bid does not mean that it is the most favorable one, and selecting the contractor is some form of procedure in which people's engagement to the project is a fundamental factor. [103]

2.2. The Policy Risk

2.2.1 Governments' engagement in NPPs

Government support is an inextricable part of the NPPs because of the political and the economic factors.[104] Since NPPs entail a great amount of capital investment, and high level of risk there is no option but getting back-up for the NPPs through explicit policies, otherwise the project would not be viable.[105]Also, regulatory changes might raise the project duration or the total cost. NPPs require cooperation with the authority as a prerequisite and are not likely to be bankable with government disapproval due to the fact that sponsors may not find investors willing to stand against the government policies.[106] Essentially, the main necessity regarding nuclear policies would be a smooth licensing process and regulations that stimulate the project construction and subsequent operation period by supportive market codes and certainty of policies.[107]

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[103] Steinberg.

[104] Tromans, "State Support for Nuclear New Build."

[105] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

[106] Lucet and Institut français des relations internationales, *Financing Nuclear Power Plant Projects*.

[107] "Nuclear New Build: Insights into Financing and Project Management," n.d., 248.

On the other hand, given the fact that as federal regulations are structured to ensure safe usage of nuclear technologies, and the authorities have a critical position to revise the safety requirements of NPPs, the sponsors likely fund expenditures resulting from changes in law. This is so even though the contractor is in charge of approving the work change following the amendments' rules or obligations after the contract is formalized, because the contractor may rely on the contract that parties signed at the beginning of procedure.[108]

Furthermore, the financial advantage of nuclear power is essential for reliable and low-cost electricity, since nuclear energy can provide an immense amount of energy without emitting detrimental gases to the environment,[109] and given the fact that NPPs are environmentally friendly energy sources and international regulations require lessening CO2 emissions through international instruments such as the Kyoto Protocol.[110] States may diversify their energy sources through nuclear energy which might be an incentive for governments to have an affirmative approach to these projects. Additionally, States can back the NPPs through a variety of policies, which may eliminate the major risks and spur investors into these projects.[111] Primarily, in order to give confidence to investors regarding stable nuclear policy stand, long-term agreements between the project owner and the utility might be advantageous.[112] Also, there are many major strategies that may have influence upon the NPPs' incentives, such as favorable tax regulation

[108] Steinberg, *Understanding and Negotiating EPC Contracts*.

[109] Tromans, "State Support for Nuclear New Build."

[110] https://unfccc.int/kyoto_protocol

[111] Sony Ben-Moshe, Kelley M Gale, and Breton A Peace, "FINANCING THE NUCLEAR RENAISSANCE: THE BENEFITS AND POTENTIAL PITFALLS OF FEDERAL & STATE GOVERNMENT SUBSIDIES AND THE FUTURE OF NUCLEAR POWER IN CALIFORNIA," n.d., 57.

[112] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

and government guarantees. As a result, amendment of the rules may encourage or obstruct the improvement of nuclear energy depending on States' perceptions.[113]

2.2.1.1. The Government guarantees

In nuclear power projects, a government guarantee is likely necessitated by investors in order to shield the project's revenue from risks that might deteriorate the project viability.[114] The aim of the government guarantee might be promoting the creditworthiness of the party which can be a government utility or an enterprise, and there are mainly two types of guarantees, financial and performance guarantees for the purpose of eliminating various kinds of undesirable outcomes.[115] Financial back-up might be essentially that the government assumes the debt-service responsibility of the borrower, which is uncommon in case of default, or that the government procures an assurance to lenders for the funding.[116] On the other hand, a performance guarantee is more practical since the risk management is straightforward, which is supporting the project as it has deficiency, such as a number of cars that are supposed to pass on toll roads.[117]

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[113] DANIEL SHEA AND KRISTY HARTMAN, "State Options to Keep Nuclear in the Energy Mi," National Conference of State Legislatures, (Jan. 2017), available at https://www.ncsl.org/Portals/1/Documents/energy/StateOptions_NuclearPower_f05_WEB.pdf (last checked [10/30/2020])

[114] Ben-Moshe, Gale, and Peace, "FINANCING THE NUCLEAR RENAISSANCE: THE BENEFITS AND POTENTIAL PITFALLS OF FEDERAL & STATE GOVERNMENT SUBSIDIES AND THE FUTURE OF NUCLEAR POWER IN CALIFORNIA."

[115] "Federal Loan Guarantees for the Construction of Nuclear Power Plants."

[116] Ibid.

[117] Ibid.

The guarantee may be beneficial depending on how the government guarantee is positioned, expected to be seen as a portion of the project risk allotment.[118] The guarantee may facilitate financing of nuclear projects, as it might be impossible to raise funds for projects without the guarantee especially for nuclear power projects. For instance, along with the government loan guarantee regarding the compensation of the project, the government may pledge to pay in case of shortcoming of electricity sales, which contributes to utilities' credibility and also lessens the total cost of the project since the lender may accede lower and more reliable earnings. On the other hand, a guarantee may cause negligence in the construction and operation of the project since parties can rely on the guarantee.[119]

Furthermore, a government may bear political and regulatory risk including administrative and financial volatility under the guarantee due to political unrest and changes in law.[120] The project future is likely dependent on the stability of government policies that is also the expectation of lenders and sponsors, such that any alteration regarding the licensing process may entail extra expenses for sponsors; therefore, a government may settle on either not changing laws or compensating unfavorable outcomes of changes in the laws. Also, the market risk may be covered by the authority regarding whether the project yields adequate revenue, or the demand is enough to recoup the cost so that in the long-term, sponsors have an assurance that the project is bankable.

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[118] Ibid.

[119] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

[120] Yescombe, *Principles of Project Finance*.

2.2.1.2. Carbon Tax

A number of experts believe that codifying a tax on electric generation facilities whose fuels pollute the environment by emitting detrimental gases to nature might give nuclear energy a better chance to compete with such polluting sources, such as coal and natural gas.[121] Also, carbon pricing in the electricity markets inherently improves the value of nuclear energy in the shape of a tax or emissions trading system because of the fact that nuclear power does not spread harmful gases to the atmosphere.[122]

It is clear that the climate change issue is a foremost environmental concern nowadays, and governments all around the world should take further steps to diminish effects of climate change by minimizing greenhouse gas (GHG) emissions. This can be achieved by incentivizing renewable energies and adopting a carbon tax system in which generators such as coal power plants, are responsible for harm that results from burning nonrenewable energy sources.[123] Additionally, it is a great way to meet emission requirements under the 2015 Paris Agreement. An example of a nation that could benefit greatly from a carbon tax could be the USA, due to its greenhouse gas emissions, although President Trump announced the intention to withdraw from the Paris Agreement effective November 4, 2020. The nation emitted 7 billion metric tons of carbon dioxide from nonrenewable sources in 2006, which was approximately 20% of worldwide gas emissions.[124] Of this total, 29% of detrimental gases were generated from coal, and 16% produced by natural gas usage.[125] The aim of carbon taxes is that while spurring

[121] "State Options to Keep Nuclear in the Energy Mix.Pdf."

[122] Richard Green, "Carbon Tax or Carbon Permits: The Impact on Generators' Risks," *The Energy Journal* 29, no. 3 (2008): 67–89.

[123] Ibid.
[124] Ibid.
[125] Ibid.

low-carbon generators, the taxes add extra cost to operators that are generating electricity through fossil fuels.[126] Since the companies wish to enhance their profits with nuclear projects, the risk from price competition among supply sources can be minimized with the carbon tax.[127] According to Green of International Association for Energy Economics, limiting electricity production of fossil fuel generators would give a great amount of space for nuclear energy, and nuclear plants can sell more in the electricity market up to 64% with a carbon tax along with long-term power purchase agreements.[128]

Other issues that should be considered regarding the bankability of nuclear plants is the market condition, and principally, as long as the investors are aware of the profit that can be earned once the project is commenced, they are likely to stick with the project.[129] As Carlo Mari clarified that restricting CO2 emissions by amending policies, nuclear energy has enormous capability in the deregulated market.[130]

Knowing that nuclear power projects are risky and expensive, sponsors are not prone to fund these projects. Since their profit is based on the project revenue, the more investors have better chances for recoupment from the NPPs, the more likely that any challenge during construction or after commissioning might be resolved smoothly, and there will be better refunds under the carbon tax policy. Furthermore, major rivals of NPPs are natural gas and coal plants which are

[126] Ibid.
[127] Gilbert E Metcalf and David Weisbach, "THE DESIGN OF A CARBON TAX," *HarvardEnvironmental Law Review* 33 (n.d.): 59.

[128] Green, "Carbon Tax or Carbon Permits: The Impact on Generators' Risks." https://www.jstor.org/stable/41323170?seq=3#metadata_info_tab_contents (accessed by 11/05/20202)

[129] Carlo Mari, "The Costs of Generating Electricity and the Competitiveness of Nuclear Power," *Progress in Nuclear Energy* 73 (May 2014): 153–61, https://doi.org/10.1016/j.pnucene.2014.02.005.

[130] Mari.

going to be alienated by imposing the carbon tax.[131] A sample analysis which is calculated that adoption of $50/mtCO2 carbon tax would reduce coal production by almost 40% to 100% in 2030.[132] Since the CO2 emissions per unit of energy can vary, and natural gas emits approximately 40% to 60 % less CO2 to the environment, it is clear that coal power plants would be impacted significantly.[133] Under these circumstances, nuclear power plants have better bargaining power, and sponsors would likely have a remarkable motivation to complete these projects.

2.3. Licensing Process

As discussed in section 2, the construction of NPPs incorporates a variety of specialized field work and plenty of technical and social complexity. [134] Therefore, the licensing process of nuclear power plants requires elaborate analyses of each part of the project.[135] These challenges during the licensing process may cause delays which likely generates extra expenses for investors.[136] Delay risk primarily depends on the experience of regulatory agencies in the nuclear

[131] *Carbon Pricing, Power Markets and the Competitiveness of Nuclear Power* (OECD Publishing, 2011), https://doi.org/10.1787/9789264118881-en.

[132] Jonathan L Ramseur and Jane A Leggett, "Attaching a Price to Greenhouse Gas Emissions with a Carbon Tax or Emissions Fee: Considerations and Potential Impacts," n.d., 40.

[133] Ibid

[134] Raphael J. Heffron, Stephen F. Ashley, and William J. Nuttall, "The Global Nuclear Liability Regime Post Fukushima Daiichi," *Progress in Nuclear Energy* 90 (July 2016): 1–10, https://doi.org/10.1016/j.pnucene.2016.02.019.

[135] Ibid

[136] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

field, and varies since how smooth the licensing process is, the site where the power plant is constructed, and the choice of design are the major factors which are likely dissimilar in each project.[137]

The regulation regarding the licensing process plays a substantial role in the risk that might lead to cost overruns and delays, and that is why many regulatory authorities have adopted revised codes.[138] For example, The US NRC (Nuclear Regulatory Commission) issues Combined Licenses (COLs) which give permission for both the construction and operation of an NPP, and a COL is valid for 40 years after the approval. [139]

The regulation (10 C.F.R. 52) is likely to shorten the period for the generic certification of designs, and eliminate the risk of early closure of power plants; on the other hand, in the traditional model, once the construction permit is given, depending on the provisions of adequate safety and design measures, then the operating license can be issued based on the analysis of the final design, adherence to the policies of the construction permit, and the operational review.[140]

The two-step licensing model has still been issued, however discontentment with the process eventually led to the new licensing method, which is codified in 10 CFR Part 52 in the USA. [141]

Mainly, the hassles that operators have been complaining about the traditional model, including the absence of consistency, are likely the result of inaccurate estimation of the process

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[137] OECD, "Reformed and Reforming: Adapting the Licensing Process to Meet New Challenges," *Nuclear Law Bulletin* 2017, no. 1 (October 23, 2018): 7–30, https://doi.org/10.1787/nuclear_law-2017-5j8jpsz2s8f2.

[138] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

[139] https://www.nrc.gov/reactors/new-reactors/col.html

[140] OECD, "Reformed and Reforming."

[141] https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/

duration.[142] Finally, the consensus is that the procedure should be comprehensible and foreseeable so that parties can effectively adjust their schedules accordingly.[143]

2.3.1. 10 CFR Part 52

As discussed above, under Part 52, a combined license can be sought which issues a construction permit and gives a right to operate the plant with a stipulation of building the plant in line with NRC regulations. [144] The major provisions of 10 CFR Part 52 incorporate Early Site Permits, Design Certification and Combined Licenses resulting in advancement of predictability and standardization of the process. In the application for a COL, either a design certification or an early site permit can be referenced, or two of them together. [145]

2.3.1.1 Early Site Permits

An early site permit (ESP) is an initial portion of the construction permit which authorizes the applicant to handle matters such as protection from radiological harm and security, and ecological and emergency concerns. It does not require the applicant to point out a specific design; however, the "plant parameter envelope" that specifies parameters for the main features of a nuclear plant, can be noted in the ESP.[146] Furthermore, once approved, an ESP might be used in the latter license authorizations, a construction and operation permit under Part 50 or COL under Part 52.[147] Also, ESP can be given for 10 to 20 years with a renewal right.[148] NRC may issue the ESP as long as examinations, inspections, investigations, and acceptance tests are

[142] OECD, "Reformed and Reforming."

[143] Alexandre Bredimas and William J. Nuttall, "An International Comparison of Regulatory Organizations and Licensing Procedures for New Nuclear Power Plants," *Energy Policy* 36, no. 4 (April 2008): 1344–54, https://doi.org/10.1016/j.enpol.2007.10.035.

[144] https://www.nrc.gov/reading-rm/doc-collections/cfr/part052/
[145] Ibid

[146] OECD, "Reformed and Reforming."

[147] See 10 CFR 52.13 and 52.73(a).
[148] See 10 CFR 52.26 and 52.33.

"necessary and sufficient" to decide whether the power plant can be built and is qualified to operate, in line with the license requirement.[149] Issues that are resolved during the EPC process do not need to be reexamined in the latter stages.[150]

2.3.1.2. Standard Design Certifications

Standard design certification is a fundamental phase through stimulating standardization of nuclear power plants.[151] Since 1990, design certification has been issued, and under Part 52 anyone can request design certification for NPP designs.[152] The authorization may be granted for 15 years and might be renewed. [153] After authorization of a design certification, the design is not reevaluated in the COL process or under Part 50.[154] Also, the application form should illustrate how the design will fulfill requirements such as radiological safety and environmental assessments.[155] Furthermore, once a design is granted, Part 52 clarifies that there would not be an amendment in the certification unless the change is obligatory in order to be in line with NRC policies, and modifications may be sought by anyone, which would eliminate redundant policy engagement and would improve standardization.[156] Additionally, if modifications are granted, they would become requirements for the power plant's other applicants with reference to the design. [157]

[149] OECD, "Reformed and Reforming."

[150] See 10 CFR 52.39(c).
[151] Stephen G. Burns, "The Impact of the Major Nuclear Power Plant Accidents on the International Legal Framework for Nuclear Power," n.d.

[152] See 10 CFR 52.41 and 52.47(c)(2).
[153] See 10 CFR 52.55 and 52.57.
[154] See 10 CFR 52.63 and 52.98.
[155] See 10 CFR 52.48.
[156] See 10 CFR 52.63.

[157] See 10 CFR 52.63(a)(3).

2.3.1.3. Combined Licenses

Under Part 52, a combined license is issued for permission to build an NPP and an operating license is issued with a provision which is based on meeting the final safety requirements before operating a NPP.[158] Presently, there are 5 combined license holders.[159] Also, an applicant may, but is not required to, reference an ESP, a design certification, or a manufacturing license. [160] Also, in the application, it is supposed to furnish that there is an adequate guarantee that the plant will construct and operate in accordance with the license and the policies codes in which safety analyzes of the all components of the nuclear facility, the location of the NPP, the surrounding area, natural events that have been occurred in this site, critical facilities such as military bases, transportation, or industrial facilities. Emergency plans; physical security, cyber security, and safeguard contingency plans should be clearly resolved in terms of safety matters before applicants are granted COLs. [161] Additionally, the license should not pose risks for the general defense and security and the public health and safety. [162] Also, the planned ITAAC (Inspections, Tests, Analyses, and Acceptance Criteria) is supposed to provide reasonable assurance that the plant has been built according to its design features. [163]

The combined license was developed in 1990 and the first COL was issued in 2012 for the Vogtle project. Previously, two-step licensing was issued to approximately 130 units under Part 50.[164] Giving that COLs are a new way of licensing power plants; they are constantly analyzed. [165] As an example, the NRC published a few reports regarding issuance of the COL, and in

[158] See 10 CFR 52.79.
[159] https://www.nrc.gov/reactors/new-reactors/col-holder.html
[160] See 10 CFR 52.73.
[161] See 10 CFR 52.79.
[162] See 10 CFR 52.79
[163] https://www.nrc.gov/reactors/new-reactors/oversight/itaac.html
[164] https://www.nrc.gov/docs/ML1924/ML19242D326.pdf
[165] OECD, "Reformed and Reforming."

general these analyses did not find a flaw with regard to the policy structure, rather they emphasized the points that should be developed since the licensing process minimizes regulatory ambiguity by resolving safety and environmental issues before giving permission to construct a NPP.[166] For example, the first plants that were issued COLs, the Vogtle and VC Summer plants, were examined by [Nuclear Regulatory Agency] which issued a report stating that "review revealed no significant problems or impediments associated with the Part 52 licensing process itself," but the NRC identified enhancements regarding the process by analysing feedback from the nuclear industry.[167] According to the review, one of the critical factors is submission of a thorough and high-class application, and "Stakeholders indicated three areas that would enhance the quality of applications: 1) pre-application engagement, 2) an enhanced acceptance review process, and 3) the availability of guidance on level of detail." Furthermore, the NRC recommends that if applicants apply particularly for a new kind of design then pre-application engagement is quite a supportive way since the staff can comprehend the specific details of the design characteristics at the very beginning of the process.

Since, the purpose of combined licenses was ensuring the predictability of the process and development of the standardization, it might be simpler to clarify the design parameters specifically with referencing an approved design, rather licensing First of a Kind (FOAK) designs. Albeit that 10 C.F.R. 52 is a new way of licensing nuclear power plants, there are still setbacks regarding the licensing process as can be seen at the Vogtle project which incurred new

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[166] OECD.

[167] "NEW REACTOR LICENSING PROCESS LESSONS LEARNED REVIEW- 10 CFR PART 52.Pdf," n.d. https://www.nrc.gov/docs/ML1305/ML13059A239.pdf (11/06/2020)

safety requirements after the Fukushima accident. The licensing authority may cultivate communication with licensees, and revising policies based on feedback might minimize these risks.

2.4. Third Party Liability

After the declaration of nonviolent use of nuclear energy in the 1950s, third party liabilities have become an inevitable component of the nuclear industry to minimize possible adverse consequences; therefore, in order to rectify damages resulting from nuclear accidents to persons and properties,liability arrangements have been formalized by the International Atomic Energy Agency(IAEA) and the Organization for Economic Co-operation and Development(OECD).[168] The USA has its own act, the Price-Anderson Act[169], which is the first nuclear liability legislation.[170] Many countries are members of two main transnational arrangements, which are the Paris Convention[171] and the Vienna Convention.[172]

The Price-Anderson Act of 1957,[173] USA's third-party liability regime, has been amended several times. The Energy Policy Act of 2005 extended Price-Anderson to 2025.[174] Under the Price-Anderson Act, federal funds can be supplied in exchange of annual fee if a nuclear incident

[168] Heffron, Ashley, and Nuttall, "The Global Nuclear Liability Regime Post Fukushima Daiichi."

[169] The Price-Anderson Act https://inis.iaea.org/collection/NCLCollectionStore/_Public/31/051/31051426.pdf?r=1&r=1 accessed on 02/07/2021.
[170] https://www.oecd-nea.org/law/pubs/1994/liability-compensation-nuclear-damage.pdf at p. 11 accessed on 02/07/2021
[171] https://www.oecd-nea.org/jcms/pl_31788/paris-convention-full-text accessed on 02/07/2021.
[172] https://www.iaea.org/sites/default/files/publications/documents/infcircs/1996/infcirc500a5.pdf accessed on 02/07/2021.

[173] https://inis.iaea.org/collection/NCLCollectionStore/_Public/31/051/31051426.pdf?r=1&r=1 accessed on 02/07/2021.
[174] https://www.congress.gov/109/plaws/publ58/PLAW-109publ58.pdf accessed on 02/07/2021.

occurs.[175] The compensation consists of two phases and at the first step, $375 million can be provided; subsequently in case the fund is used up, the extra $111.9 million can be funded.[176] If further funds are needed, the NRC may seek extra sources once they appraise the total cost of an accident.[177]

The Paris convention (PC) was framed by the OECD in 1960 and after the Vienna Convention was designed by the IAEA which is virtually identical with the PC. Nevertheless, as discussed below, there are still differences between the two conventions as regards their regional scope and the maximum limits.[178]

After the Chernobyl accident in1986, it was clear that additional funding was indispensable for covering extra liabilities. The joint protocol signed in 1992 that can be interconnected with parties to the PC or the VC.[179] In 1997, the revised Vienna Convention (RVC) enhanced the financial security to 300 million Special Drawing Rights (SDRs),also expanded the content of the nuclear accident and the duration of raising claims.[180] apart from those, the CSC is introduced as an alternative way to other conventions which can be an additional funding way to the PC and VC.[181] Also, it does not mean that countries which are not part of the PC and VC cannot be parties to the CSC provided that their legislation includes the requirement of the first-phase

[175] Heffron, Ashley, and Nuttall, "The Global Nuclear Liability Regime Post Fukushima Daiichi."

[176] Jakub Handrlica, "Helen Cook, The Law of Nuclear Energy," *The Journal of World Energy Law & Business* 12, no. 3 (June 1, 2019): 275–76, https://doi.org/10.1093/jwelb/jwz005.

[177] The Price-Anderson Act

[178] "International Nuclear Law in the Post-Chernobyl Period: A Bridge Between Two Conventions on Civil Liability for Nuclear Damage: The Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention," 2006, 25.

[179] Ibid.

[180] Heffron, Ashley, and Nuttall, "The Global Nuclear Liability Regime Post Fukushima Daiichi."

[181] Ibid.

reimbursement, 300 million SDRs.[182] Under these conventions, nuclear liability legal forms, in most cases, transfer the accountability and obligations for a nuclear accident only to the operator according to the channeling principle, exculpating other parties from punishment with regard to nuclear liabilities if a nuclear incident occurs.[183] As a result, operators may face a risk which might be uncovered with the current liability conventions. For instance, neighbor states which may not be part of the Paris and Vienna arrangements are not covered for nuclear accident so that the cost resulting from the accident is not insured by the arrangements, which may be an impediment for the sponsors.[184]

Like the Chernobyl accident in the USSR and the 1978 Three-mile Island accident in the USA, the Fukushima Daichi incident in Japan prompted safety concerns about nuclear energy.[185] On 11 March 2011, the massively strong earthquake occurred at the city of Sendai and subsequently a tsunami devastated the local area where the Fukushima Daiichi station was generating energy.[186] During the incident some units were operating and the electricity grid connection was lost with the tsunami, so the site operators started the "station blackout" protocol which means the electricity power can only be provided from the utilities' central supplies, not able to generate more than a couple of hours.[187] Consequently, the electricity needed for the units cooling

[182] Ibid.
[183] "Nuclear New Build: Insights into Financing and Project Management."

[184] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

[185] Steve Thomas, "What Will the Fukushima Disaster Change?," *Energy Policy* 45 (June 2012): 12–17, https://doi.org/10.1016/j.enpol.2012.02.010.

[186] Joyner, "Nuclear Power Plant Financing Post-Fukushima, and International Investment Law."

[187] https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-daiichi-accident.aspx

procedure after shutting down for the plants was not supplied so that the reactors were harmed.[188] Furthermore, employees did not only struggled with the application of the safety protocols but also with the fact that the earthquake and tsunami destroyed the infrastructure of the platform. [189] In order to protect the population, the area was evacuated and OECD was notified as to the accident. [190]

The Fukushima disaster without doubt dissuaded many western countries from nuclear power, particularly where there was public opposition to nuclear development.[191] However, many power plants have been postponed or kept operating their power plants because there was still an immense amount of energy needed for their states.[192] The Fukushima accident triggered national willingness to revise and readapt their nuclear liability regimes in order to make sure that the compensation system functions properly for victims.[193] Also,stringent safety requirements have been imposed on nuclear reactors to resist potential natural disasters, which obviously results in extra expenditures for the projects, "Safety has a cost."[194]

The nuclear industry cannot commercialize without these liabilities because of the fact that possibility of the nuclear accident is not zero and the compensation figures are astronomical as can be seen after the other incidents.[195] Also, any new incident around the world would shake the

[188] Ibid
[189] Ibid
[190] Ibid
[191] Nadira Barkatullah and Ali Ahmad, "Current Status and Emerging Trends in Financing Nuclear Power Projects," *Energy Strategy Reviews* 18 (December 2017): 127–40, https://doi.org/10.1016/j.esr.2017.09.015.

[192] Joyner, "Nuclear Power Plant Financing Post-Fukushima, and International Investment Law."

[193] Heffron, Ashley, and Nuttall, "The Global Nuclear Liability Regime Post Fukushima Daiichi."

[194] Thomas, "What Will the Fukushima Disaster Change?"

[195] Ian Wood and Rob Broom, "Newcomer Countries, Welcome to the 'Nuclear Club' but before You Join, Plan Ahead and Take Example from Those before You; Issues Relating to Construction Contracts in Countries Developing

whole industry since most reactors depend on similar materials, and public perception of nuclear energy would likely worsen, which would be challenging to repair again.[196] These challenges can be controlled through insurance contracts and for the exceed amount of compensation can be covered with an insurance pool in which insurers come together to provide coverage, since a nuclear incident may result in catastrophic exposure and affect the whole industry.[197] Members in pool insurance may have a certain limit proportionately to their participation,[198] and eventually, NPPs might have a better bankability score.

2.5. Electricity Market Risk

Many countries oversee their electricity structures through government coordinated utilities where the electricity price is adjusted under complex policy frameworks and they aim to provide secure and reliable electricity supply.[199] However, in order to foster the efficiency of the electricity market, some countries are in the transition toward the deregulated system which causes intense competition.[200] As a result, a novel risk has appeared since the contracts among generators and customers are formed on market figures. Therefore, consumers are able to alter their suppliers based on competitiveness of the electricity price.[201] On the other hand, under

New Build Nuclear Power Plants," *The Journal of World Energy Law & Business* 12, no. 1 (March 1, 2019): 89–107, https://doi.org/10.1093/jwelb/jwy037.

[196] James W. Stoutenborough, Shelbi G. Sturgess, and Arnold Vedlitz, "Knowledge, Risk, and Policy Support: Public Perceptions of Nuclear Power," *Energy Policy* 62 (November 2013): 176–84, https://doi.org/10.1016/j.enpol.2013.06.098.

[197] Göran Skogh, "A European Nuclear Accident Pool," *The Geneva Papers on Risk and Insurance - Issues and Practice* 33, no. 2 (April 1, 2008): 274–87, https://doi.org/10.1057/gpp.2008.8.

[198] Skogh.

[199] "Nuclear Power in Competitive Electricity Markets," n.d., 63.

[200] Ibid

[201] "Nuclear Power in Competitive Electricity Markets."

regulated markets, the market risk is less puzzling through long term power purchase agreements.[202]

The major challenges of NPPs occur because of extreme expenses incurring during the construction period, resulting in vague estimations of the construction expenditures and the building time which may lead NPP investments to have unpredictable outcomes.[203] As a result of the accrued costs, the prospect return from the electricity sale goes up so that the viability of the project depending on the revenues becomes weaker as other energy sources such as natural gas price reduce significantly in wholesale markets.[204] On the other hand, in regulated markets, as the total cost enhances, the purchase agreement might be revised based on renewed circumstances.[205]

Accordingly, in nuclear power projects, comprehension of the market risk is vital for investors before funding power projects since market price of nuclear energy and the total cost of nuclear projects might substantially change throughout the project life by .[206] Also, should they generate power in the whole-sale markets, operators likely confront a variety of challenges that might be

[202] Emad Elwakil and Mohamed Hegab, "Risk Management for Power Purchase Agreements," in *2018 IEEE Conference on Technologies for Sustainability (SusTech)* (2018 IEEE Conference on Technologies for Sustainability (SusTech), Long Beach, CA, USA: IEEE, 2018), 1–6, https://doi.org/10.1109/SusTech.2018.8671337.

[203] Mari, "The Costs of Generating Electricity and the Competitiveness of Nuclear Power."

[204] Pedro Linares and Adela Conchado, "The Economics of New Nuclear Power Plants in Liberalized Electricity Markets," *Energy Economics* 40 (December 2013): S119–25, https://doi.org/10.1016/j.eneco.2013.09.007.

[205] Gauthier de Maere d'Aertrycke, Andreas Ehrenmann, and Yves Smeers, "Investment with Incomplete Markets for Risk: The Need for Long-Term Contracts," *Energy Policy* 105 (June 2017): 571–83, https://doi.org/10.1016/j.enpol.2017.01.029.

[206] Deqiang Gan, Donghan Feng, and Jun Xie, *Electricity Markets and Power System Economics*, 0 ed. (CRC Press, 2013), https://doi.org/10.1201/b15550.

reduction in demand, competition among other energy suppliers, or policy formats.[207] Furthermore, One of the vital concerns behind funding the power projects is that the plants should be able to market the power at a sufficient value thereby the cost can be recouped during the project's lifetime.[208] To this extent, the method that is used to structure and to coordinate the electricity market will have substantial outcomes for the financier of NPPs. [209]

For instance, non-liberalized markets can be categorized into three patterns.[210] In full vertical integration, the market is formed on a single entity in which generation, transmission, and distribution is carried out by this entity. [211] Also, the entity possesses all the power utilities which means independent generators have no legal basement to sell the power. [212] Secondly, in the single buyer markets, like full vertical integration, there is still one entity who supervises the market; however, independent generators can sell electricity in the wholesale market. [213] Finally, Regional monopolies give a right that regional entities can buy electricity from power generators. [214] This concept is a preliminary step of the liberalized market. Also, wholesale market figures are set by the market, albeit that the rate-payers fees are regulated by the tariffs under the

[207] "Nuclear Power in Competitive Electricity Markets."

[208] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

[209] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service).

[210] Rory Connor et al., "Legal Strategies for the Mitigation of Risk for Energy Infrastructure Projects," *Journal of Energy & Natural Resources Law* 37, no. 1 (July 2, 2020): 47–66, https://doi.org/10.1080/02646811.2018.1455338.

[211] Ibid.
[212] Ibid.
[213] Ibid.
[214] Ibid.

regional monopolies model.[215] On the other hand, completely liberalized markets, any corporation can become a power generator or the electricity buyer and do business with other parties as long as they hold the license.[216] Operators sell mostly their outputs in the wholesale markets, where electricity dealers buy the power that they sell to customers.[217] Also, the structure of wholesale markets vary from one country to another.[218]

2.5.1 Mitigation of The Market Risk

NPPs typically generate power as a baseload form which means that they operate constantly to meet the minimum level of power demand, in contrast to unstable power generators such as wind power, aligned with demand and other conditions.[219] Also NPPs are contemplated 'must run' plants; thus, NPP owners have to acknowledge that the market-clearing price is predominating over its service life, which is basically adjusted by the marginal cost of the very costly generating capacity expected to fulfill demand at the particular time.(It is usually gas fired power plant in a plenty of markets)[220] Ultimately, nuclear power plants are susceptible to market fluctuations; therefore, power purchase agreements are supposed to be arranged by including long term commitments.

The financial competitiveness of nuclear energy is an essential element that investors should consider before investing in NPPs. Comparing the provision of other energy sources cost with

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[215] Ibid.

[216] Pedro Linares and Adela Conchado, "The Economics of New Nuclear Power Plants in Liberalized Electricity Markets," *Energy Economics* 40 (December 2013): S119–25, https://doi.org/10.1016/j.eneco.2013.09.007.

[217] Connor et al., "Legal Strategies for the Mitigation of Risk for Energy Infrastructure Projects."

[218] Yescombe, *Principles of Project Finance*.

[219] OECD Nuclear Energy Agency, Organisation for Economic Co-operation and Development, and SourceOECD (Online service), *The Financing of Nuclear Power Plants*.

[220] Ibid.

nuclear energy directly gives a better assessment regarding the nuclear power's position in the contest.[221]

The major trouble for investors is inconstancy of electricity market prices because electricity inherently cannot store up the power, and any alteration of the electricity price influences the revenue proportionately.[222] In order to minimize the price fluctuations, a power purchase agreement can be signed between the electricity producer and the off taker (buyer).[223] So that market price fluctuations can be eliminated with the constant revenue flow to generators and timely electricity flow to utilities. [224] Also, the operation and the project cost are supposed to be reflected in the electricity price accordingly. [225]

Power plants are generally run by the operator with expectation of future electricity sale; however, generators' profits are preserved from the market risk through various kinds of assurance in traditional markets and the risks are sufficiently passed through to ratepayers in a monopolized market.[226] Investors look for insulation and make lenders comfortable through signing long-term power purchase agreements so that demand risk can be eliminated by fixed prices.[227] Additionally, in order to manage the market risk in a non-liberalized market, take or pay clause, under which off-taker assumes either to take a certain amount of electricity or to pay

[221] Ioannis N. Kessides, "Nuclear Power: Understanding the Economic Risks and Uncertainties," *Energy Policy* 38, no. 8 (August 2010): 3849–64, https://doi.org/10.1016/j.enpol.2010.03.005.

[222] Mari, "The Costs of Generating Electricity and the Competitiveness of Nuclear Power."

[223] Elwakil and Hegab, "Risk Management for Power Purchase Agreements."

[224] Ibid.
[225] Ibid.
[226] "Nuclear Power in Competitive Electricity Markets."

[227] Brealey, Cooper, and Habib, "USING PROJECT FINANCE TO FUND INFRASTRUCTURE INVESTMENTS."

the expense, should be contemplated along with PPA negotiations. [228] Since single buyer structures restrict the project owners to sell electricity, investors have a great amount of negotiating strength during the discussions.[229] Nevertheless, the main concern under the regulated market is the credibility of the off-taker.[230]

On the other hand, under deregulated market conditions, the market risk's dynamics are considerably more complex so that parties such as investors, lenders should prudently outline the arrangements.[231] Like other business activities, under competitive market conditions, project owners likely put up with market risks, which are specifically high in case of electricity surplus and demand reduction.[232] Under liberalized markets, PPAs generally incorporate an "energy-only" clause so that the off-taker makes payment as long as electricity is transported to the grid, and the earnings via PPAs are unstable depending on the market value.[233] So, buyers of wholesale markets mostly do not have a position in the grid system but purchase the power in line with the deals, therefore it is pointless to purchase for available electricity, and in case of shortfalls, off-takers have an option to get the energy from other connections via their grid connections. [234] Unlike non-liberalized markets in which owners sell their powers to a single off-taker, power plant owners have an authority to decide whether to sell their electricity to

[228] Connor et al., "Legal Strategies for the Mitigation of Risk for Energy Infrastructure Projects."

[229] Elwakil and Hegab, "Risk Management for Power Purchase Agreements."

[230] Elwakil and Hegab.

[231] Daniel H. Karney, "Electricity Market Deregulation and Environmental Regulation: Evidence from U.S. Nuclear Power," *Energy Economics* 84 (October 2019): 104500, https://doi.org/10.1016/j.eneco.2019.104500.

[232] "Nuclear Power in Competitive Electricity Markets."

[233] Connor et al., "Legal Strategies for the Mitigation of Risk for Energy Infrastructure Projects."

[234] Ibid.

purchasers by various kinds of patterns such as pool agreements under liberalized markets.[235] Moreover , the capacity market clause, that a certain amount of income is paid the owners for a commitment to dispatch the existent energy as needed, can be useful to assure investors against the market risk.[236] Also, like the United Kingdom, low-carbon energy can be stimulated with a contract for difference(CFD) under which the power plant owners are paid revenues as the electricity value drops under the strike price as explained below.[237]

CFD is an agreement among a government representative utility and an operator of low-carbon energy with the stipulation that the price disparity between the overall market price(reference price) and the operator's selling price(strike price) would be covered by the less one, which is also a private arrangement albeit complying the public policies.[238] CFD keeps potentially stable the market and gives a significant competition power to low-carbon energies, especially in case that low-fuel price dominates the market. Also, Investors may have a guarantee on the project revenues.

As a result, under liberalized electricity market conditions, power project owners assume a great amount of market risk than non-liberalized markets because of the fact that in deregulated markets, operators have smaller space to transfer the risk to off-takers via PPAs. However, on the

[235] "Nuclear Power in Competitive Electricity Markets."

[236] Thomas Jenkin, Philipp Beiter, and Robert Margolis, "Capacity Payments in Restructured Markets under Low and High Penetration Levels of Renewable Energy," *Renewable Energy*, 2016, 46.

[237] Connor et al., "Legal Strategies for the Mitigation of Risk for Energy Infrastructure Projects."

[238] Fabien Roques and Dominique Finon, "Adapting Electricity Markets to Decarbonisation and Security of Supply Objectives: Toward a Hybrid Regime?," *Energy Policy* 105 (June 2017): 584–96, https://doi.org/10.1016/j.enpol.2017.02.035.

other hand, a regulated market is more suitable for high-capital intensive projects through long-term arrangements.

3. The Vogtle Project

In this section, the general analysis of "Plant Vogtle" project in Georgia, USA is conducted elaborately by evaluating the main dynamics of cost overruns and delays and solution advice is given for the nuclear project. After a long break, the USA has expedited nuclear energy programs since the electricity demand expectancy has risen, and a major example could be the Vogtle project which was assumed to stimulate the nuclear energy sector. However, like the Vogtle Project, a great amount of up-front investment and the construction risk are deterrents for the nuclear energy industry, as common setbacks of building a nuclear plant. The risks of power projects are mainly attributed to the constructor's capability, the electricity market conditions, and the state's policies which are supposed to be compatible and promising, then the project becomes feasible to commence operation. Furthermore, federal and state incentives are part of the procedure for the purpose of encouraging investors, such as incorporating the construction cost into the electricity price or granting government guarantees to the investors.

3.1. Main Dynamics of Cost Overruns and Delays

In Georgia, where the Vogtle project is constructed, electricity is generated mostly from natural gas, coal and nuclear energy[239]. Currently, 4 nuclear plants are operating in this state. [240] Along with The Vogtle project in which 2 units are constructed, the energy need considered to be

[239] https://www.eia.gov/state/?sid=GA
[240] Ibid.

compensated.[241] In the project Vogtle site, there have been 2 nuclear units in operation, and in addition to them, the Westinghouse company projected two pressurized water reactors which are roundly 1,117 megawatts. [242] For this project, the engineering, procurement and construction (EPC) arrangement was signed by Westinghouse Electric Company (WEC) which is sponsored by Toshiba and Stone & Webster Inc. with Georgia Power on behalf of the joint venture in which companies; Georgia Power, 45.7%; Oglethorpe Power Corporation (OPC), 30%; Mutual Electric Authority of Georgia (MEAG), 22.7%; Dalton Utilities 1.6% are the owners of the shares for the construction of the two AP1000 nuclear reactors.[243] In the middle of the construction period, the acquisition that the Chicago Bridge and Iron Company (CB&I) acquired Shaw company, which was in a consortium with Westinghouse under the Vogtle project, for approximately $3 billion at 2012, [244] and that CB&I Stone and Webster company was bought by Westinghouse resulting in a disagreement with Toshiba regarding the transaction's value a few years later. [245] As explained above, the interactions between constructors may shake the project's future, so in this case, the contention among contractors even leads to filing at the court. Also, Shaw company did not have an adequate capability in the nuclear field; therefore, made faults regarding nuclear components placement during the construction resulting in one-year delay. [246]

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241 **https://www.nei.org/CorporateSite/media/filefolder/resources/fact-sheets/state-fact-sheets/Georgia-State-Fact-Sheet.pdf**

242 https://www.georgiapower.com/company/plant-vogtle.html

243 "Nuclear New Build: Insights into Financing and Project Management."

244 **https://world-nuclear-news.org/Articles/Shaw-buyout-to-create-global-giant**

245 **https://www.reuters.com/article/us-toshiba-accounting-workingcapital/factbox-toshibas-dispute-with-cbi-over-nuclear-engineering-unit-idUSKBN14H1WT**

246 https://www.powermag.com/how-the-vogtle-nuclear-expansions-costs-escalated/

The fact that the project's financial status was restructured with the cost escalation which is the disparity between the cost of the initial prediction and the real cost of the construction. The total overnight cost estimates was 9.7 billion in 2009, however it reached approximately 25 billion resulting of delays.[247] There are two main dynamics behind this increase; firstly, safety demands rose to a significant level due to renewed NRC policies; secondly, foreseen construction cost including materials and labor expenses were higher than estimated costs.[248] As a result, Westinghouse company declared bankruptcy under chapter 11 in order to insulate and to restructure its nuclear business.[249] Even though, the EPC contract for the Vogtle project was signed between Shaw, Westinghouse consortium and Georgia Power in order to build The AP1000 nuclear designs on the existent nuclear site at Georgia, USA, the consortium in which the owners agreed to proceed with the project under the control of Southern Nuclear, has been building the plants after the bankruptcy.[250]

The first anticipation of completion dates for Vogtle projects were April 2016 and April 2017 respectively, and in 2012, the expected dates postponed to November 2016 and November 2017 for the unit 3 and 4 because of the fact that the steel reinforcing bar (rebar) did not comply with the design control document (DCD) according to the NRC so that the work was held on because of the inspections and license amendment requests.[251] Furthermore, on 29 January 2015, the consortium, consisting of Westinghouse, CB&I/Stone and Webster companies, altered the

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[247] https://www.power-grid.com/2018/08/09/vogtle-cost-upgrade-causes-rethinking-of-nuclear-plant-s-future/#gref

[248] https://www.reuters.com/article/us-toshiba-accounting-westinghouse-nucle/how-two-cutting-edge-u-s-nuclear-projects-bankrupted-westinghouse-idUSKBN17Y0CQ

[249] Ibid

[250] https://www.southerncompany.com/innovation/nuclear-energy/plant-vogtle-3-and-4.html

[251] **https://world-nuclear-news.org/Articles/Vogtle-making-good-progress-despite-delay**

commencement date to 2019 and 2020 for units 3 and 4 respectively which is nearly 18 months delayed, and the reason did not mention specifically in the filing.[252]

3.2. Effects of Nuclear Disasters and Liabilities

Furthermore, After the Fukushima disaster, safety measures of nuclear power plants have become stricter so that nuclear power projects have to comply with renewed requirements, which means extra time is needed to comply with the new expectations. The fact that not only the disaster deteriorated the public policy, but also increased the safety expenses, and caused delays for the under-construction projects, is another factor of delays. On the other hand, in the USA, the cap of liability insurance which is $375 million in the first phase under Price-Anderson Act is not likely adequate to cover the possible nuclear accident compensation, thus additional funding might be a necessity given that enhancement of the population and a number of properties. The insurance coverage would be higher than the time when the Act revised as can be seen after the nuclear accidents. However , it is clear that only with the Price-Anderson Act liability coverage, spurring nuclear investment may not be adequate; therefore, raising the liability cap, requiring imperative security payment, and the capability to reach additional syndication of loan with the act might eliminate liability concerns, and in the USA, the government is supportive for investors who are looking forward for an additional liability coverage.

3.3. FOAK Risk

Additionally, the risk with the first of a kind technology(FOAK) is significant according to Nadira Barkatullah who said; the overnight cost of nuclear project could enhance up to 30%, and as long as FOAK designs are being planned to construct and under the 10% interest rate, two years postponement of the project might raise the overnight cost up to 75%.[253] In the Vogtle Project, the Westinghouse company built AP1000 design to minimize the capital cost with its

[252] **https://world-nuclear-news.org/Articles/Start-date-delay-for-Vogtle-units**
[253] **https://world-nuclear-news.org/Articles/New-trends-in-financing**

specific features ;however, it turned out that the new design led to cost overruns and delays. The first AP1000 reactor was constructed and in operation in China which also incurred delays. [254] Albeit that the new design looks promising by having better safety features and less financial burdens, they are likely to cause cost overruns due to the fact that the contractors are not familiar with them. Using the same kind of a design might be a better option in order to eliminate delays. On the other hand, the nuclear technology development might be hindered as vendors stick with the same kind of design which is another controversial issue that might be examined in further research.

3.4. Evaluation of the Bankruptcy

Eventually, Westinghouse filed for bankruptcy protection in order to resolve construction challenges regarding AP1000 nuclear designs only in the USA and found out $800 million to preserve its main business during the filing. [255] After the chapter 11 filing, The Westinghouse company agreed with the utilities that the costs was going to pay by them for a short time throughout the filing and the company pointed out that the design amendment, including the the new shelter which can resist aircraft crash, enhanced the cost substantially by $1.5 billion for each reactor. [256] As an outcome of the bankruptcy, The parent company, Toshiba which bought Westinghouse at 2006 for $ 5.4 billion , spent $3.68 billion as a guarantee for the Vogtle project, and after the bankruptcy Southern Nuclear assumed the project management; on the other hand, Brookfield Business Partners purchased the Westinghouse from Toshiba Corporation for $4.6 billion.[257]

Since the construction of nuclear power plants is costly and requires complex technology, the US federal government stimulated these projects with the loan guarantee program under the 2005

[254] https://www.cnbc.com/2018/02/12/china-nuclear-reactor-delayed-again-on-safety-concerns.html
[255] **https://world-nuclear-news.org/Articles/Westinghouse-files-for-US-bankruptcy-protection**
[256] **https://world-nuclear-news.org/Articles/US-industry-on-tenterhooks-over-Westinghouse-NEI**
[257] **https://world-nuclear-news.org/Articles/Brookfield-to-buy-Westinghouse-for-$4-6-billion**

Energy Policy Act in which the government guarantees loans as much as 80% of the construction cost.[258] Also, the Federal Bank can supply the loan rather than private companies.[259] The government backs up borrowers by refunding the money in the event of insolvency after the loan guarantee fee is paid.[260] Furthermore, Georgia Power joined the production tax credit in order to minimize financial burden.[261] On the other hand, at the state level, a construction work in Progress(CWIP) was backed the project by charging ratepayers to cover the construction cost before the nuclear plant commissioned so that the cost was added on customers' electricity bill.[262] Also Mutual Electric Authority of Georgia (MEAG) and Oglethorpe Power agreed on loan guarantee USD 1.8 billion and 3.1 billion of its construction cost of Vogtle 3 and 4 with the DOE respectively.[263]

Nuclear power financing should entail long-term market balance and a plausible security which would be an encouragement for investors. Specifically, since the electricity market is vertically integrated, Georgia power is able to sell the electricity to customers with long term arrangements and the company has a loan guarantee from the government. However, Plant Vogtle went through cost overruns. It means that supportive market conditions, the government and local support may not be adequate to guard the project; therefore, management of the project and the constructor's relationship with subcontractors plays a critical role during the construction period. As a result, the Vogtle project has been postponed a couple of times, and after each delay, the

[258] "Federal Loan Guarantees for the Construction of Nu.Pdf," n.d.

[259] Ibid
[260] Ibid
[261] "Nuclear New Build: Insights into Financing and Project Management."

[262] Ibid
[263] Ibid

total cost jumped up. Also, contractors' faults and disagreements among them are likely justifications behind the cost overruns and delays. With all these setbacks, eventually the contractor declared bankruptcy; therefore, even though other factors such as supportive policies or market conditions might be the essence of the projects, the risks depend primarily on choosing qualified and motivated contractors and allocating the risk among subcontractors.

3.5. Advancement of The Licensing Process

The Nuclear Regulatory Agency is the authority that issues nuclear reactor licensing so that before construction of the Vogtle project, the permission is supposed to be gotten from the authority. The agency has a novel licensing system rather than two-steps traditional licensing process, Combined license (COL), which issues both the construction and operation permits in line with the NRC policies which was applied for the Vogtle project.[264] However, during the process, the design certification as a part of the licensing process led to delays which is one of the reasons for added-on costs to the project. [265]

The parent company of Georgia Power, Southern Nuclear Operating Company applied the Early Site Permit in 2006 for 20 years which was issued approximately 3 years later and allowed the constructor to commence limited work, and for the combined license(COL) which was also applied by the same company, expected to be issued in mid-2011; however, it is released at the beginning of 2012 as a first combined license in USA.[266]

The fact that the main complaint regarding the licensing process was deficiency of the standardizations and "design as you go" method, NRC redrafted its policies to develop the procedure, and COL has been applied to recent nuclear plants such as Plant Vogtle.[267] However, there are still criticisms about the COL, specifically the design certification process looks like an

[264] https://www.power-eng.com/2012/02/09/nrc-grants-combined-operating-licenses-for-plant-vogtle/#gref
[265] **https://world-nuclear-news.org/Articles/Vogtle-making-good-progress-despite-delay**
[266] **https://world-nuclear-news.org/Articles/Southern-receives-ESP-for-Vogtle-site**
[267] https://www.nrc.gov/reactors/new-reactors/col/vogtle.html

obstacle, entailing massive amounts of pre-funding without an explicit plan; therefore, adopting a stage review evaluation might be a better strategy to licensing nuclear designs.[268] For instance, in the Canadian Nuclear Safety Commission's (CNSC) through Vendor Design Review (VDR), the general conformity of the design is evaluated which is arbitrary and it does not count as a design certification, nor does a construction license.[269] The CNSC's approach as to the nuclear projects through VDR could be a great solution for strengthening the standardization of the process by:

Ensuring explicit and timely feedback to vendors regarding which level the design satisfies the agency's terms. [270]

Specifying possible setbacks regarding safety concerns promptly so that vendors may have time to handle these points before modifying project's designs or safety evaluations. [271]

Furthermore, in order to minimize the duration of the licensing process, the agency's staffs should be familiar with the design before the licensee requests for the license which is what VDR presents. [272]

The VDR process consists of three stages. Initially, It appraises whether the design in general meets the agency's terms and conditions, and secondly, taking one step further, the agency checks whether or not there are major obstacles that averts the design to construct in the country. [273] Finally, an elaborate assessment is conducted for the purpose of backing the applicant to build

[268] See Global Nexus Initiative, supra note 79

[269] https://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc3-5-4/index.cfm

[270] OECD, "Reformed and Reforming."

[271] Ibid

[272] https://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc3-5-4/index.cfm

[273] Ibid

a plant.[274] There is also a "service agreement " between the vendor and the agency, incorporating projects' design review duration.[275] Also, according to CNSC, a phase 1 is expected to conclude up to 1 year, and 12 to 18 months to finish Phase 2 based on the extent of the assessment of the design[276]. Albeit that in the USA, NRC's licensing procedure likely accomplishes same results as regards whether the reactors are capable of meeting the requirements, step by step model that is exerted by the Canadian Agency which starts with general evaluation of the safety measures then dip into the point that exhaustive appraisal of design features is conducted, may develop NRC's commitment to the projects by early engagement. As a result, like what the Vogtle Project incurred, during the NPP's licensing procedure, delays and latter cost overruns might have been minimized through this adoption, and NRC policies and later changes of design features may not undermine since early interaction and constant communication are provided with the alteration.

4. Conclusion

Last of all, major reasons behind cost overruns and delays during the nuclear power projects construction, and possible results of these risks on the agreements are analyzed, also further advice is given in order to minimize risks' impacts. In the second chapter, the construction risk of NPPs initially is examined in which the importance of strong relationships among contractors and sponsors is clarified. In the third chapter, effects of state's nuclear policies and international conventions on the new-build nuclear plants are described, which are closely interconnected with the bankability of nuclear projects. Also, governments should back up the nuclear projects;

[274] Ibid

[275] OECD, "Reformed and Reforming."

[276] https://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc3-5-4/index.cfm

otherwise, it could be challenging to stimulate investors toward these projects. For example, a carbon tax or a government loan guarantee might be a way to create a proper atmosphere. In the next section, given the fact that nuclear projects are constructed for the purpose of selling electricity in their countries, the electricity market risk is pointed out. Also, even under the regulated market conditions, long term power purchase agreements or supportive price mechanisms may not be adequate to encourage investors as long as the cost jumps up to a level where sponsors may decide not to keep working on the project or may even declare a bankruptcy.

4.1. Better Sponsor-Contractor Association

Nuclear projects have complex structures in which choosing qualified constructors is the main responsibility of sponsors, and during the construction period, their connection is supposed to be reliable and reachable so that in case of default, issues can be handled quickly. Also, the risk allocations among subcontractors is specified elaborately before the construction period so that delays can be kept minimal, and subcontractors' responsibility can be circumscribed. Therefore, they might have a better reaction time to resolve setbacks in their field. Additionally, sponsors should stimulate contractors by provisions under the EPC contract, which is the way of keeping motivated contractors.

Furthermore, the plant design is also another context by which the risk may raise the peak point by using a FOAK. The nuclear plant design can be diminished by using the same kind of designs rather than FOAKs so that constructors and suppliers would be more confident with the design that they have more experience and know-how. Also, the fact that the design sufficiency cannot be measured until the operation is commenced, the performance risk is also greater which should be considered before choosing the FOAKs.

4.2. Risk Allocation and Comprehensive Liability Coverage

After each nuclear disaster, safety concerns raised significantly thereby nuclear plants' safety measures have been revised accordingly. Eventually, from generation III designs with passive nuclear safety features to the last modifications after the Fukushima catastrophe, all reforms add extra costs on sponsors' shoulders, which is the risk that should be considered before commencing the construction. The solution might be allocating any changes of nuclear policy risk to the government.

Additionally, nuclear liabilities may be a concern for investors since there might be a risk that conventions' coverage may not be adequate, considering potential devastating power of nuclear reactors. Therefore, like in the USA, government entities may take a step further and can promote investors via additional assurance, or an insurance pool might be established to offer a greater coverage for investors.

4.3. Streamlined Licensing Process

Another subject that is a concern of investors is the licensing of nuclear power plants since the prolonged process duration and lower predictability may be reasons of cost overruns. The licensing procedure is complicated and requires many months to evaluate nuclear designs, thus nuclear authorities constantly reform their policies based on the feedback. In the USA, after the 1990s, the Nuclear Regulatory Agency (NRC) has adopted Combined license (COL), which provides construction and operation permits with one application rather than two-step licensing. However, given the last experiences of COL on the Vogtle Project, it should be advanced toward smoother and more predictable procedure. Eventually, adopting the step by step model could minimize delays, like Canadian Nuclear Safety Commission's policies.

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