

Partnership Strategy Analysis for South Korea's Next NPP Export Development

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1. Introduction

Although the size of the nuclear power plant (NPP) market is expected to triple by 2050, the NPP construction project still has a long construction period, a considerable cost, and a long-term payback project, and finance is always an obstacle for consumers. In the past, the NPP project in the 1970s and 1980s was a government-led project that covered the project cost from the taxpayer, but as the construction cost continued to increase and additional interest was incurred due to the delay in construction, several countries transferred the risk of construction costs from taxpayers to international contractors or investors, and suppliers through the international open-competition. [1] As a result, nuclear power plant companies tend to allocate their risk by making joint ventures or strategic agreements with each other to secure competitiveness. Looking at the projects currently under construction, Finnish Teollisuuden Voima Oyj (TVO)'s Olkiluoto 3 project signed a turnkey delivery contract of 3 billion euros in 2003 in the form of a consortium between France's Areva (66%) and Germany's Siemens (34%) (Figure 1). Besides project supervision, TVO is only responsible for site preparation and infrastructure expansion for construction, while Areva-Siemens is responsible for all other construction work. In the Olkiluoto 3 bid, price competition was emphasized, and while General Electric (GE) of the US and Atomstroiekspot of Russia participated in the bid, Areva was selected by TVO by offering a relatively low bid. However, despite the fact that the EPR is a new type, the choice of EPR also contributed to the reliability of Areva's long-established nuclear reactor and Siemens' turbine generator technology. On the other hand, in Flamanville 3 (Figure 2), there was no general bidding stage as EDF directly selected Areva. This means that EDF and AREVA have a long-term partnership because the French government owns both companies, so there is little incentive to compete. However, Bouygues signed the contract after EDF's bid. EDF and Bouygues have been partners since the 1990s, and in May 1994, they signed a strategic international partnership agreement, maintaining a long-term relationship. [2] Another project Vogtle 3&4 in the US. Looking at the organizational chart in Figure 3, the owners are four companies: Georgia Power, Oglethorpe Power Corporation, Municipal Electric Authority of Georgia, and Dalton Utilities. They hold 45.7%, 30%, 22.7%, and 1.6% stakes, respectively, reducing the burden of capital investment. [3]

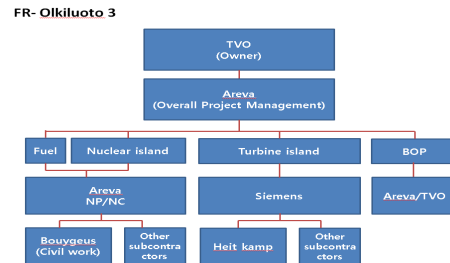


Fig. 1. Organization chart of Olkiluoto 3 project (France)

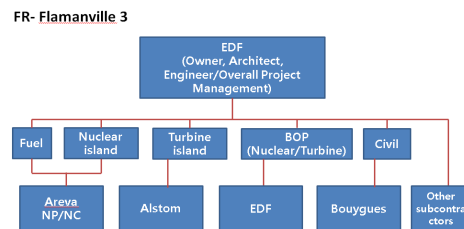


Fig. 2. Organization chart of Flamanville 3 project (France)

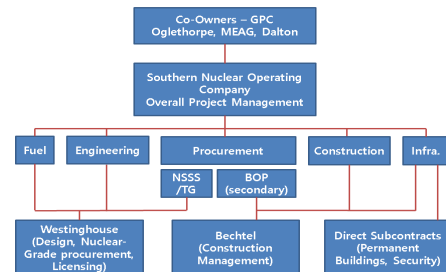


Fig. 3. Organization chart of Vogtle 3&4 project (US)

As such, the circumstances and conditions of each project are different, but they have in common that they strengthen the NPP construction capability and competitiveness by strategically forming partnerships based on the needs of each other under the same purpose. South Korea has the capability to participate in the bidding alone, but France, a competitor, can also take charge of the entire cycle of NPPs, and has built a supply chain through cooperation with EU countries for a long time. Therefore, South Korea needs to secure export competitiveness through close cooperation with the US, including Westinghouse (WEC), which owns the source technology of APR1400. In this paper, literature and articles are reviewed to investigate the NPP contract structure and bidding cases, and South Korea's strengths, weaknesses, opportunities, and

threats are analyzed through SWOT analysis to identify their export competitiveness. And based on this, partnership strategies with US and local companies are analyzed to present a partnership frame in which both South Korea and the US can win-win.

2. Methodologies

2.1 Literature & articles review

Bidding information and articles from several NPP import countries, including BNPP project, are collected and analyzed to investigate the background data for a partnership strategy with the US and local companies.

2.2 SWOT analysis

SWOT analysis is a tool that supports managers to efficiently manage the project by identifying the situation of the project organizationally and environmentally. This tool is composed of four factors: Strengths (S) and Weaknesses (W) of organizations and projects, and Opportunities (O) and Threats (T) affected by the environment. Using data collected through literature and articles, South Korea's SWOT factors are analyzed and applied to strategy establishment for partnerships. [4]

3. Client's Ownership

The scope of financing for NPP import countries has a huge impact on tenders' participation in bidding. If the client's ownership is high with the host country's enough budget, tenders with low financial risk can easily participate. On the contrary, if the client's ownership is low with low financial support, the financial risk of the exporting country will be high. Therefore, the entry strategy should be different depending on the level of ownership of the client. [5]

When the client almost covers the required project cost, EPC-centered orders will be received, and more bidders will be able to participate. Diplomatic competitive strategies intensify to increase competitiveness. If there is no difference in technology between competing countries, it is easy to think that price will have a huge impact. However, since clients with high ownership are more likely to run the project centered on their own, and can focus a lot on the establishment and sustainability of their own nuclear industry, alliances with local companies can also be a very important factor to compete. For the Dukovany 5 project in the Czech Republic, which is currently under bid, the Czech government provides a 100% loan and guarantees the purchase of electricity for above-market price and other benefits for 60 years. [6] The countries participating in the bidding are South Korea, the US, and France, but they all have good technology and have a lot of experience in building NPPs, so they are strengthening their competitiveness through political

and diplomatic power, such as expanding agreements with local companies and cooperation in other fields than nuclear power.

On the other hand, when the owner relies on the other country's financing like Build-Own-Operate (BOO) delivery approach, the international contractor's utility will take the lead in overall construction and operation, and if the client invests their money like a Build-Own-Transfer (BOT) approach, the client takes the initiative in the project. The former is more focused on price and construction schedule, so the contractor is almost free to use local resources, but in the latter, the ratio of local content as well as the technology and price of the bidder can act in a complex way. For example, Poland is conducting a \$40 billion bid to build a nuclear power plant, with Polskie Elektrownie Jądrowe (PEJ) owned by The State Treasury holding a 51% stake and a co-investor 49%. Poland is focusing on the safety of nuclear reactors as much as it is the first time to build a nuclear reactor [7], but South Korea, the US, and France, which are competing bidding countries, in addition to technology and price, actively support the development of the Polish nuclear industry market through partnerships with local nuclear companies to ensure competitiveness. [8,9,10]

4. South Korea's competitiveness (SWOT analysis)

4.1 Strengths

The first strength of South Korea is technology. In the early days of the NPP project, it relied on the technology of the US, but for the technology independence, the nuclear power plant standardization development industry was promoted, and the APR 1400 was developed to equip the independent technology and construction capability further strengthened. In addition, APR 1400 confirmed the stability and efficiency of South Korea's nuclear power plants through the construction and operation of Shin-Kori Units 3 & 4 despite being a new reactor.

Second, South Korea is one of the few countries that can provide all nuclear power-related services as a multiplayer from design to manufacturing, construction, operation and maintenance. Since placing the order for Kori Units 1 & 2 in the 1970s, a total of 30 domestic nuclear power plants have been built, including 4 under construction. Since they have been continuously constructing and operating domestic nuclear power plants so far, many experiences and lessons learned have been accumulated, and a solid supply chain has been built.

Third is price competitiveness. South Korea was able to be selected as a contractor for the UAE's BNPP project, and its low price played a big role. According to the IEA's 2010 report, APR1400 overnight construction cost was up to 60% cheaper than EPR and 32% cheaper than the US. [11]

Lastly, there is the government's active support. When the new government took office in 2022, it set a goal of exporting 10 units by 2030. In this regard, the government has visited Saudi Arabia, the Czech Republic and Poland, where they are participating in the bidding, to strengthen cooperation and provide opportunities for continuous exchange, such as signing business agreements with each government and companies in the nuclear power sector.

4.2 Weakness

Compared to other export countries, South Korea is in a relatively limited financing environment. Most of the NPP project finances in South Korea are met by policy financial institutions such as the Export-Import Bank of Korea. However, there is a credit limit for the same-entity, which makes it relatively disadvantageous to procure large-scale financial resources compared to other countries that do not have the limit system. [12] And because it has used government bonds to finance the NPPs construction, it is greatly affected by the government's energy policy.

Another weakness is the lack of fuel cycle supply, poor radioactive waste management, and the lack of technological independence for design code, instrumentation & control system (MMIS), and reactor coolant pump (RCP) from WEC.

Lastly, while competing countries such as China and Russia, France, and the US are merging and partnering between companies, and increasing the size of the companies, the NPP export companies in South Korea are divided into Korea Electric Power Corporation (KEPCO) and Korea Hydro & Nuclear Power (KHNP). There is no impact on the export yet, but the future impact is unknown.

4.3 Opportunities

The delay in construction of new reactors in France and the US incurs huge additional costs, causing lawsuits and disputes among stakeholders. Common factors for delays include: 1) rework due to improper design before construction begins, 2) poor project management, 3) lack of experienced workers, and 4) lack of material supply chain. [13, 14, 15] Future clients may not trust the construction schedules and costs offered by French and US companies.

Moreover, the US still has limitations on financing. For example, Poland plans to build up to six units, starting construction of the first unit in 2026, worth 40 billion dollars. The ownership structure of the project is that Polskie Elektrownie Jądrowe (PEJ), which is owned by The State Treasury, will own 51% of the project and co-investors will own 49%. However, WEC plans to invest only about 10 billion dollars (Government 70%, WEC 30%). [7, 16]

4.4 Treats

Recently, in France, the government has been consolidating family businesses, such as the state purchasing all EDF and replacing the existing Areva with Orano company. And the US is also actively participating in the NPP export competition, increasing its competitiveness, with Bechtel participating in the WEC.

Moreover, as South Korea has not yet achieved technological independence from the WEC, if it competes with the WEC in the bidding, it will be an unfavorable competition for South Korea. Not only that, but the international influence of the US can also pose a threat to South Korea. In this regard, in the case of a NPP project in Saudi Arabia, APR1400 using WEC's original technology requires relaxation of export requirements from the US since Saudi Arabia did not sign Agreement 123.

5. Partnership Strategy

Table I shows the results of SWOT analysis of South Korea's nuclear power export competitiveness.

Table I: The results of SWOT analysis

Strengths	Weakness
<ul style="list-style-type: none"> - Technology - Proficient construction experience and solid supply chain - Low price - Government support 	<ul style="list-style-type: none"> - Limitations on financing - Absence of fuel cycle supply and lack of radwaste management - Incomplete technical independence - Divided export companies
Opportunities	Threats
<ul style="list-style-type: none"> - Huge construction schedule delays for new reactor projects in France and the US - Financing limitations in the US 	<ul style="list-style-type: none"> - Enlargement of export organizations in competing countries - US's APR1400 source technology ownership and international influence

By linking the factors identified here, the strengths are emphasized to seize the opportunities, the weaknesses are supplemented, or the threats are countered. Based on this, the recommended partnership strategy is as follows:

- If the client's ownership is high, the client is likely to carry out the project including operation and maintenance (O&M) on its own, and the contractor will only be responsible for project development and construction. In this situation, South Korea takes an export strategy in the form of targeting the client based on construction infrastructure such as manpower and material supply chain with abundant experience, and entrusting Nuclear Steam Supply System (NSSS) engineering and nuclear fuel cycle supply to the US to make up for South Korea's weaknesses. Conversely, if the US has an advantage in bidding due to its

technological prowess and international influence, South Korea can invest in the US and demand a contract that compensates for the US's poor material supply chain and insufficient construction experience. This will increase South Korea's chances of participating in overseas projects and reduce the financial burden on the US.

- If a client with insufficient funds demands a high initial capital delivery method such as BOO and BOT, the contractor handles the overall project including O&M or the client maintains the lead in the project depending on the degree of the client's ownership. South Korea's technology and low price competitiveness will be used to compare the construction period and expected budget with the French EPR and US AP1000, but increase financial resources with government support by easing the same-entity credit limit and improving the funding method to expand bidding opportunities, and secure export competitiveness by entering into partnerships with the US. The US, which has difficulty in raising funds, is less likely to participate in capital-intensive projects, so it will reduce the number of competitors and rather strengthen South Korea's competitiveness by securing both US diplomatic power and WEC's technology through a consortium with the US.

6. Conclusions & Limitation

South Korea's NPP export strategy depends on the client's ownership, that is, the degree of financing, and shows the need for a different strategy depending on other bidding conditions or competing countries. In the nuclear industry, where the main body was moved from the government to a company in the past, as competition between companies intensifies, companies create large companies through mergers or alliances between companies. This has further complicated the structure and competition among bidders. In response to this, it is necessary to first review South Korea's organizational and environmental conditions for the next overseas NPP project. In this study, South Korea's strengths, weaknesses, opportunities, and threats are derived through SWOT analysis, and based on customer financing, partnership strategies with the US including agreements with local companies were presented. It would be the best scenario for South Korea to independently win the APR1400 order, but if it is difficult to do so and can succeed in exporting NPPs by using the competitiveness of the US, it will be very important to establish a strategy and use it well. When the US gets an opportunity to win an order, South Korea can help and make a profit, and if it maintains this mutually beneficial relationship, it will have a

competitive edge that poses a sharp threat to other competing countries.

On the other hand, limitations are also observed in this study. First, expert interviews are needed to increase the validity and reliability of SWOT analysis results. Since SWOT analysis is in progress, it will be considered in the conference presentation. Second, since energy and nuclear-related policies and industry trends change as time goes on, the view on the results of this study cannot be generalized over time. Therefore, it should be interpreted in consideration of that point. Finally, although two strategies were presented as a result, the relationship between ordering and receiving orders also changes dynamically and complexly, this suggest results cannot be only one solution. However, this study tried to suggest a partnership frame in which multiple actors can win-win through ownership review and SWOT analysis.

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