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# First Wave or Second Wave?

**It is time for US nuclear power plant projects with a first-wave build strategy to consider moving to the second wave**

By **Edward Kee**



## Introduction

Most new nuclear power plant projects in the US seem to be pursuing a first-wave build strategy. This strategy involves a significant early commitment of resources, while deferring the investment decision and retaining the option to defer or cancel the actual power plant investment as long as possible.

Only a handful of these projects are expected to actually start construction in the first wave. The other projects could lower costs and risks by moving to a second-wave strategy now.

## Background

As of May 2009, 17 Combined Construction and Operating License (COL) applications for 26 new nuclear units had been docketed by the US Nuclear Regulatory Commission (NRC). Many of these projects are aiming to start construction in the first wave (i.e., as soon as a COL is approved by the NRC, now expected to be in 2012).

A first-wave nuclear project involves a fairly large commitment of resources, even though project sponsors may not yet have committed to invest in the nuclear power plant.

A year ago, most of the first-wave projects had a good chance of starting construction as soon as a COL was approved. Today, only a few are expected to actually start construction in the first wave.

Developing and implementing a second-wave strategy now, rather than waiting until COL approval to make that decision, may be a way to lower costs and risks for some projects.

## First Wave or Second Wave

A first-wave nuclear project is generally expected to start construction as soon as a COL is approved in about 2012.

A second-wave project would aim for a later construction start. Second-wave projects might start construction as early as 2014, a year or two after the first-wave projects start construction; as late as 2020, a year or two after the first-wave projects are completed and placed into commercial operation; or even later.

While it is possible to keep a first-wave strategy intact right up to COL approval before deciding to move to the second wave, many of the first-wave projects might decide to pursue a second-wave strategy earlier.

## Why Be in the First Wave?

A typical first-wave strategy is aimed at being first in the queue.

A key driver of the first-wave strategy is the EAct of 2005, which created a race by limiting benefits to only the first few new nuclear power plants, with these benefits being allocated on a first-come-first-served basis and to projects that have accomplished certain activities on or before a defined date (e.g., COL filing by 31 Dec 2008).

The NRC COL process dedicated resources to COL applications as these applications were received so that early COL applications would receive NRC resource commitments and schedules that might mean earlier COL approval.

A first-wave nuclear build strategy was also aimed at ensuring that the project could start and complete construction in spite of the potentially high demands on the nuclear industry if all first-wave projects started construction at the same time, with a general view that the first projects to start construction might be able to lock in resources that would be unavailable to other projects for some time.

Reactor vendors and EPC contractors may have encouraged a first-wave strategy by offering more attractive terms to buyers willing to commit to being early in the overall build sequence.

Finally, some utilities with a first-wave nuclear plant strategy have (or had, until the recent economic down-turn) a need for new baseload capacity and might have to build a coal or gas power plant to meet demand unless the nuclear plant were built on a first-wave schedule.

In spite of these potential benefits, a first-wave project may face higher risks and costs, including scarce nuclear industry resources; uncertainties about carbon control and electricity demand; organized anti-nuclear efforts; some degree of first-of-a-kind (FOAK) risks and higher costs; and difficult markets for nuclear financing and funding.

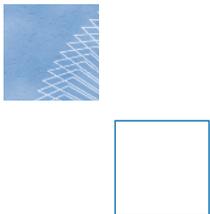
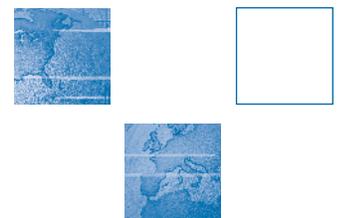
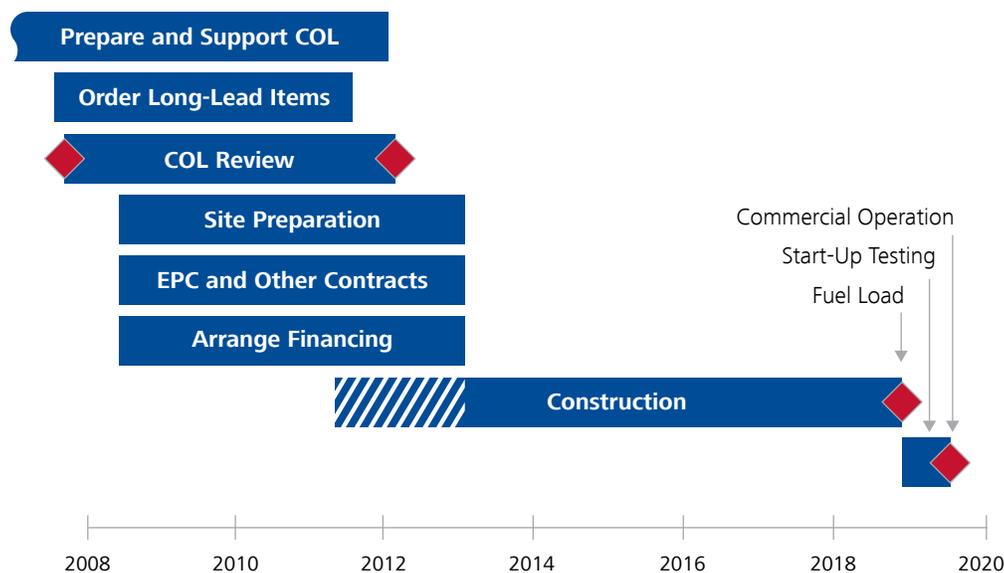


Figure 1: **Typical First-Wave Project**



## First-Wave Activities

A first-wave nuclear build strategy includes committing the significant resources required to ensure that construction can start as soon as the COL is approved, but without making a firm commitment to invest.

A major decision point for a first-wave project is at the time of COL approval, when the project sponsor must decide between proceeding with the investment or not. Most first-wave strategies also include intermediate decision points and “off-ramps” that allow the project sponsor an opportunity to delay or cancel the project prior to COL approval.

There may be significant opportunities to lower cost and risk by taking an earlier “off-ramp” and moving to a second-wave strategy prior to COL approval, but only a few companies seem to have taken these off-ramps.

## Second-Wave Strategy

The benefits of a second-wave strategy come from the additional information that will be available. This information, some of which is linked to the outcomes of projects that start construction in the first wave, will allow better decisions to be made by second-wave projects.

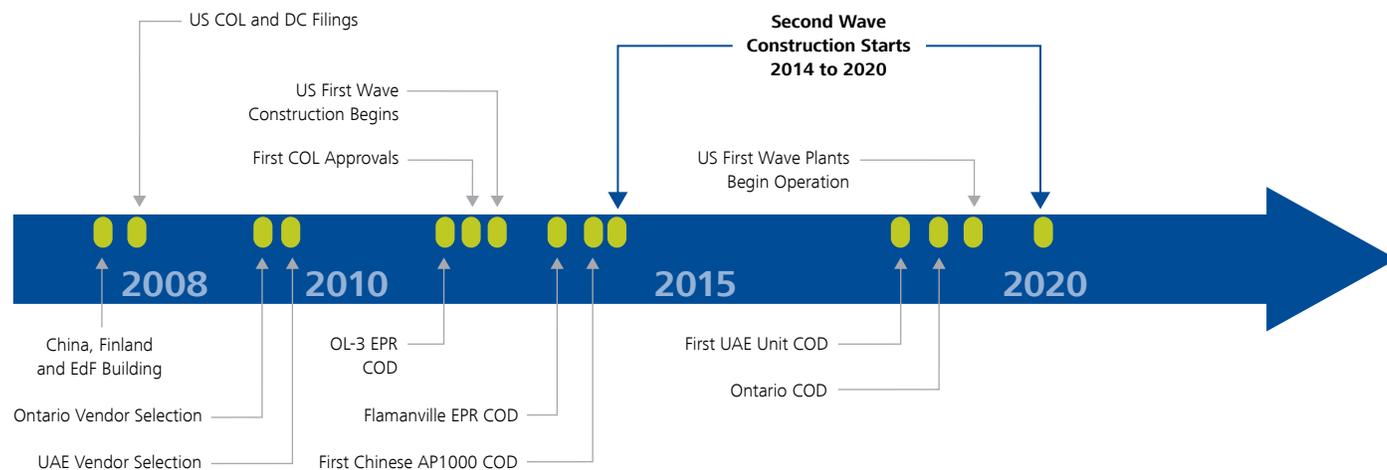
Some additional information will be available to second-wave projects in 2014, but even more information will be available by 2020. These dates assume that at least one first-wave project actually starts construction in 2012.

### Construction Start in 2014

Some additional information will be available in about 2014 that may support an investment decision for a second-wave project.

To the extent that a second-wave project has delayed the NRC COL process (i.e., the project has the ability to modify the COL application or other details), the lessons from the first-wave projects should provide a clearer view of the timing, issues, and potential for legal challenges to the COL process up to the COL approval point.

Figure 2: **Second-Wave Timing**



A second-wave project that can avoid commitment to a reactor design (or that can switch reactor designs without large costs), should be able to choose from several standard reactor designs that will have been approved by 2014. As these approved reactor designs start construction, the degree of detailed engineering will be much higher than today and the approach to construction (i.e., modular construction) will be better known. Second-wave projects may also be able to learn from the outcomes of first-wave EPC contracts.

The financial markets may have returned to a more stable situation, making the financing of a new nuclear power plant more feasible. Also, the construction funding arranged by first wave developers may provide lessons for developers and lenders that will mean easier access to construction funding for second-wave projects. The real response of the stock market to new nuclear plant investment decisions will be known and will allow a second-wave sponsor to better assess its own decision to invest.

New nuclear power projects outside the US may be close to completion and some may have started commercial operation, reducing uncertainty about total project cost, construction times, reactor design operating performance, modular construction approaches, market success of reactor designs and vendors, and other issues.

It is possible that the US approach to control carbon emissions will be in place by 2014, allowing a second-wave project sponsor to better understand the financial implications for new nuclear power plants.

The impact on electricity demand and the need for new baseload generation due to the current economic recession, the building of renewable generation, and other factors will be better known.

#### **Construction start in 2020**

Second-wave projects that start construction in 2020, one to two years after the first-wave projects have entered commercial operation (if all goes well), will have even more information to support an investment decision.

Second-wave project sponsors as well as investors, regulators, and others will have a clearer view of the costs of new nuclear power plants and the time required to build them. The differences in cost, time to construct, and operating performance across reactor designs and vendors will also be much clearer.

One or more new US nuclear power plants may have been built, approved, and placed into commercial operation, providing a much better view of how the NRC COL ITAAC process will work.

The learning during construction of the first-wave nuclear plants may allow second-wave buyers to obtain lower costs, less risk, and shorter and more certain schedules from EPC vendors. Modifications to detailed designs and construction approaches to improve quality, lower cost, and shorten time in construction may also be available.

The nuclear fuel cycle, including the used fuel disposition issue and approach to re-processing used nuclear fuel, may be more settled. Several new uranium enrichment facilities may be operational in the US and uranium market prices may be more stable.

First-wave projects will have arranged and closed permanent financing, providing lessons and guidance for investors, lenders, and developers.

Regulated first-wave projects will have placed nuclear plant investments into rate base (and into rates), providing some lessons and guidance for second-wave project sponsors, state regulators, and others.

There will be even more experience with new nuclear plants outside the US. Reactor vendors that are not now in the US market may have entered the US market based on the success of build programs outside the US, giving second-wave buyers more options.

While the timing remains uncertain, there is a possibility that one or more alternate reactor designs (e.g., micro-reactors and Generation IV reactors) now in the research and development phase will be commercially available as an option for a second-wave project.



## Second-Wave Strategy May Look Better Now

In the past year, there has been a lot of new information about new nuclear plants in the US. Some of this new information suggests that some first-wave projects might consider a near-term move to a second-wave strategy and supports the view that only a few projects will start construction in the first wave.<sup>1</sup>

Current nuclear power plant cost estimates are high, even though these estimates are considered conservative and may mean fewer cost overruns when the projects are completed. However, the recent cost estimates are much higher than cost estimates from only a few years ago. As these higher nuclear cost estimates are incorporated into generation expansion planning models and policy analyses, new nuclear power plants may no longer be the least-cost generation expansion option.

Demand for electricity is growing at a slower rate in many parts of the US as a result of the current economic down-turn, so that the projected need for baseload capacity may be less and later than the capacity need projected a year ago. For some utilities with industrial customers, this may be a significant change.

New nuclear plants may benefit from programs or taxes that are targeted at controlling carbon emissions. A year ago, there was hope that a change of administration would result in quick and clear action on controlling carbon. This has not happened and any real action on carbon control may be delayed or watered down or both as a result of the economic recession.

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<sup>1</sup> Estimates of the first wave vary. NEI predicts that “4 to 8” plants will be in commercial operational by “2016 or so.” DOE loan guarantees are a critical item, so the current limits suggest that only 2 or 3 plants will be built in the first wave.

DOE Loan guarantees for nuclear remain limited to \$18.5 billion. There was some hope that the new presidential administration would work to increase the amount for nuclear loan guarantees (e.g., as a part of the stimulus bill), but this did not happen. Given the high cost estimates for new nuclear power plants, this will only cover a few nuclear units. Also, the terms, conditions, and costs of the DOE nuclear loan guarantees may not be attractive. DOE is reported to be negotiating with a short list of loan guarantee hopefuls; projects not in this short list may not have much chance of a loan guarantee.

World financial markets are tight and financing any large capital project is difficult. Financing a new nuclear power plant would have been very difficult even without the financial crisis; with this crisis, it may not be possible to finance a new nuclear project. Financial markets will recover, but this may not happen in time for a first-wave project.

Nuclear build experience so far is mixed. There was some hope that nuclear project development experience outside the US would resolve uncertainties to the benefit of the US projects that would follow, but this has not yet happened. The Olkiluoto EPR project has experienced significant cost overruns and delays and is now in arbitration proceedings and the Chinese have just started construction on the first AP1000 unit.

NRC schedules are later than originally expected, with the first COL approvals not expected until late 2011 or 2012, with the potential for final approvals to be later if there are delays or challenges to the NRC process.

## Why Adopt a Second-Wave Strategy Now?

Many first-wave strategies seem to be based on keeping the first-wave option alive as long as possible. If a first-wave project waits until a COL is approved to decide to move to the second wave, this may mean higher costs and risks than deciding to adopt a second-wave strategy sooner.

If a first-wave nuclear project has little hope of being in the first wave, cutting costs and risks by adopting a viable second-wave strategy now might be an attractive option.

Some regulated utility sponsors of first-wave projects have gained approval from their state regulators to recover project development costs in current rates, allowing recovery of the cost a first-wave strategy. These “option recovery” arrangements may make it easier for some project sponsors to maintain a first-wave strategy as long as possible.

A first-wave strategy is based on ensuring the viability of immediate construction as soon as a COL is approved, but a second wave strategy could focus on lowering costs and on keeping more options open.

For example, a first-wave project that goes through COL approval might be deferred to the second wave. While the NRC rules are not clear on how long the construction permit portion of a COL will be valid, a project holding an approved COL should have 20 years or more to complete the approved project.

The problem is that an approved COL includes a specific reactor design and design version and may also refer to a specific vendor. This means that the option to re-think the design (or select a more recent design version) may require a new COL application. While updating an approved COL with a more current version of an approved reactor design might be relatively easy, switching designs may mean that a new COL application must be filed.

If a current COL applicant were to decide now to move to the second-wave, the second-wave strategy might include converting an ongoing COL application into an ESP application. This would lower costs now and increase the flexibility to select from any Certified Design at a later time.

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## How to decide?

A key to maximizing value in a major decision like a nuclear power plant investment is the ability to defer the decision as long as possible so that the decision can be made with the benefit of additional information to reduce key project uncertainties.

Whatever strategy is selected, a nuclear plant developer should have a clear view of all relevant decision and commitment points, the costs for all activities (and the extent to which these costs will be sunk or recoverable), the key uncertainties and the timing or information that will help reduce these uncertainties, and other issues. The decision analysis framework for a second-wave project will look a lot like the decision framework for a first-wave project, except with more options and more decision points and more time to gather information.

A key issue for some first-wave projects is that they have committed to preliminary contracts, purchased early lead components, and incurred costs in order to build a viable first-wave strategy. Moving to a second-wave strategy will involve efforts to minimize the unrecoverable sunk costs from purchase of long-lead components, the cost of the COL application, and the costs of site-related work.

One recurring theme in the decision analysis of US nuclear projects is that a project that decides to cancel or defer may be able to sell its long-lead components and even its COL application to another project sponsor. This strategy may not work if only a few US nuclear power plants are actually built in the first wave and many projects are trying to find buyers that will help them recover sunk costs.

Just like there was a perceived benefit from being first in the queue to build, there may be some advantage to being one of the first projects to move to the second wave.

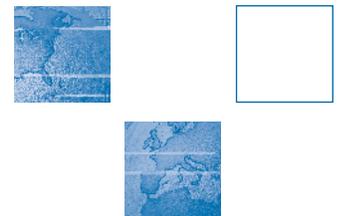
For example, many unused reactor pressure vessels may be available in 2012 as first-wave projects decide to defer or cancel investments. A few of these major components might be sold to projects outside the US that are moving to develop new nuclear power plants (e.g., the UAE), but unless world nuclear build is larger and faster than expected, the market will not be large. Selling those large components now may be more feasible than later, as multiple companies are also trying to sell into the same market.

The decision to switch to a second-wave strategy must be assessed for each company. A process of understanding the costs, exit options, and other issues involved in converting a first-wave strategy into a second-wave strategy will allow each project to achieve better outcomes.

## Conclusion

Some nuclear projects may have already moved to a second-wave strategy, including FPL's Turkey Point project (has not yet filed a COL application), Entergy's Grand Gulf and River Bend projects (delayed to about 2020 after dropping the ESBWR design), Ameren's Callaway project (announced that the project was off as a result of unfavorable state legislative outcomes; suspended NRC review), and the Constellation/UniStar Nine Mile Point project (suspended NRC review). Shortly after this article was originally published, Exelon decided to move their Victoria County Texas project to the second wave and converted the COL application into an ESP application.

There are a number of first-wave nuclear projects in the US that may be able to create significant value for shareholders (and for consumers of power, for those that are regulated) by moving now to a second-wave nuclear build strategy. It is time for all nuclear projects to take a hard look at the potential for first-wave investment and the potential benefits of a move to the second wave. The large amounts at stake mean that a formal analysis, using decision analysis tools to examine uncertainties, decision points, and external factors such as carbon prices and nuclear reactor costs to craft a strategy, may be a very good investment.



## Author's Biography

Edward Kee is a Vice President in NERA's Washington, DC office.

Mr. Kee is a specialist in the electricity industry with experience in nuclear power, electricity markets, restructuring, regulation, private power, and related issues. For more than 20 years, he has provided testimony as an expert witness on a range of electricity industry issues in state and federal courts, before the Federal Energy Regulatory Commission, and before other legal and regulatory bodies in the US and around the world.

Mr. Kee also provides strategic advice to companies and governments on issues related to the nuclear and electricity industries. He has recently advised various parties involved in developing new nuclear power plants on topics including board-level due diligence reviews, financing and loan guarantees, nuclear fuel cycle, national nuclear infrastructure development, and nuclear project procurement.

Prior to joining NERA, Mr. Kee was a Vice President at CRA International, where he led the firm's nuclear consulting effort. He previously held consulting positions at PA Consulting Group, PHB Hagler Bailly, Putnam, Hayes & Bartlett, and McKinsey & Company. He was a merchant power plant developer and a nuclear power plant engineer before becoming a consultant.

Mr. Kee holds an MBA from Harvard University and a BS in Systems Engineering from the US Naval Academy. He has authored numerous articles on nuclear power and electricity markets and regulation in publications including *The Electricity Journal*, *Public Utilities Fortnightly*, *Nuclear Engineering International*, and *Nuclear Power International*, and is a frequent presenter at industry conferences.

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