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Navigating the Nuclear Sector

The Las Vegas Question for small modular and advanced reactors

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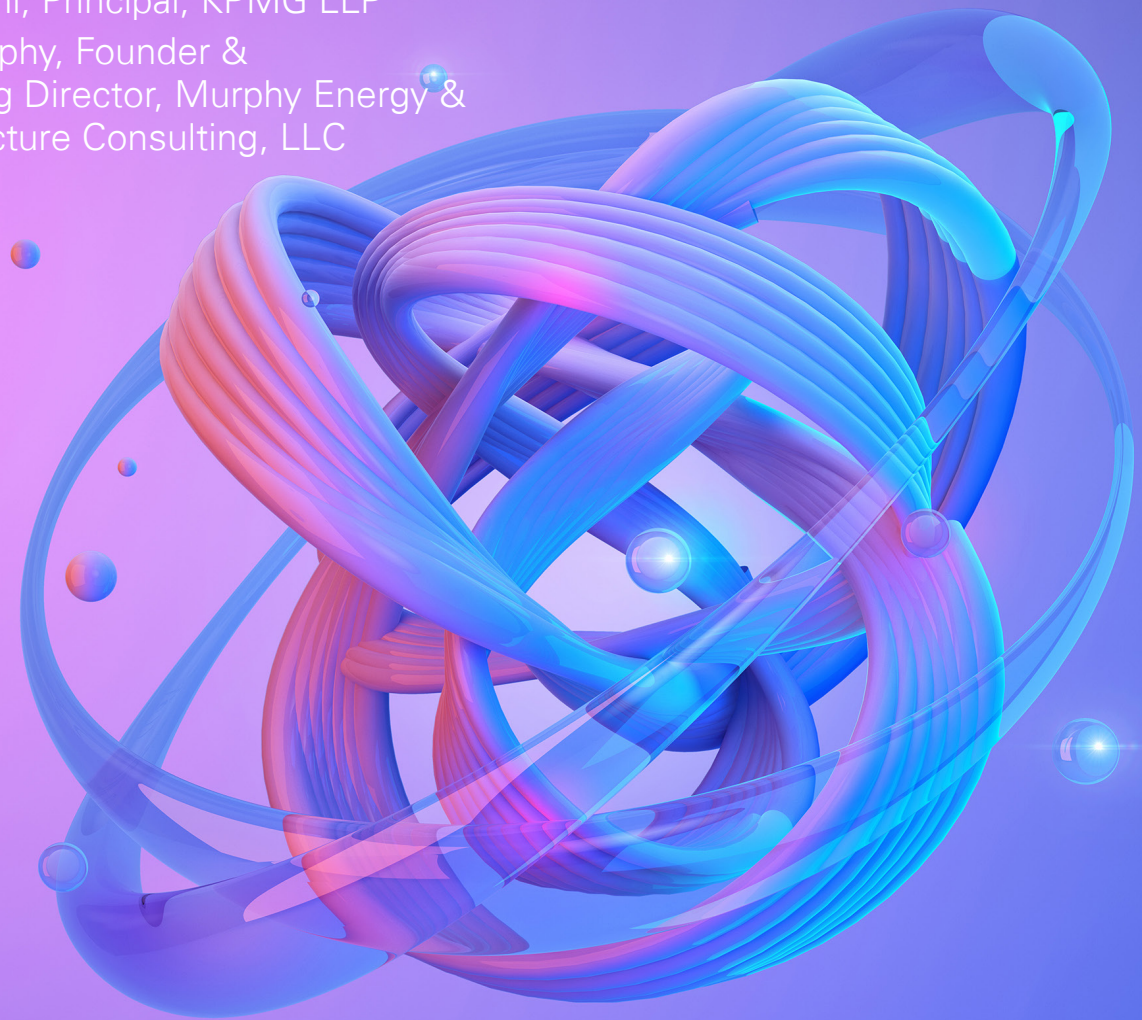

Nuclear energy's "moment"

Nuclear energy is having its "moment," led by two drivers: achieving Net Zero goals by 2050 and addressing energy security needs. These two drivers distinguish this "moment" from the hoped-for "nuclear renaissance" during the first decade of the 21st century. However, there is another aspect of this moment that is a differentiator: the advent of small modular reactors (SMRs) and advanced reactors (ARs; together with SMRs, SM&ARs).[1]

[1] The general rule is that an SMR is a reactor design that is 300 MWe or less.
See: https://www.iaea.org/topics/small-modular-reactors.

According to the definitions established by the International Atomic Energy Agency, an advanced reactor design consists of both evolutionary and innovative reactor technologies. Evolutionary reactor designs are reactor designs that improve on existing designs through small or moderate modifications with a strong emphasis on maintaining proven design features to minimize technological risk, while innovative reactor designs incorporate radical changes in the use of materials and/or fuels, operating environments and conditions, and system configurations. Advanced reactors can be classified in terms of coolant, neutron spectrum, temperature, or purpose. With regards to purpose, the reactors can be sorted in terms of experimental, demonstration or prototype, and commercial.
See: https://aris.iaea.org/.

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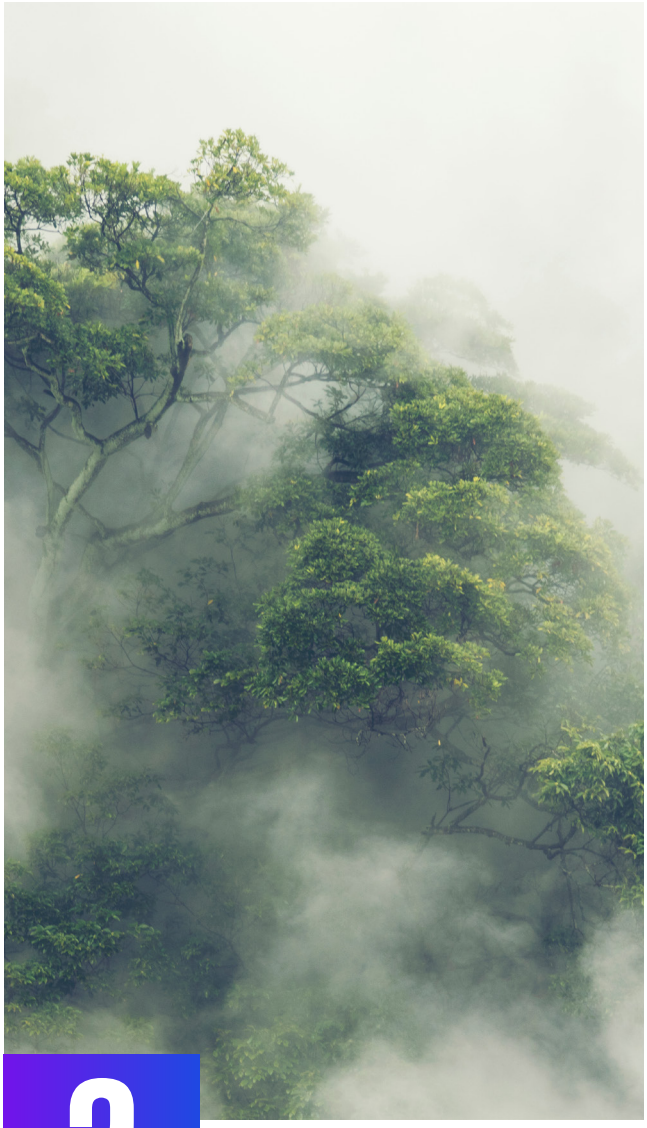
Challenges and additional considerations

These reactor designs offer new opportunities in the nuclear energy ecosystem; nevertheless, they raise two key challenges for investors and project developers: first, the first-of-a-kind (FOAK) risk associated with the development and deployment of a new technology (which is heightened in the nuclear sector because of the regulatory process);[2] and second, estimates in excess of 70 reactor design types exist, when fusion reactors and microreactors are included.

In addition to these challenges, there is an additional consideration for SM&ARs, which is the application of the reactor as a tool. Historically, nuclear reactors have been focused on delivering baseload, clean electricity to the grid. With SM&ARs, though, these reactors cannot only deliver electricity to the grid, but also work within applications-focused project models that include hydrogen production, desalination, industrial heat, district heating, remote generation, mining, flexible operation (for pairing with renewables), and marine propulsion. In these use cases, the reactor is an element of a larger project model, which requires new thinking in terms of project structuring, financing, economic modeling, and stakeholder participation. With these applications come new entrants into the nuclear space, such as end users within the emerging hydrogen economy and hard-to-abate industrial sectors (e.g., steel, maritime shipping).

[2] Recent news from NuScale (cancellation of the Carbon Free Power Project in Idaho) and X-energy (cancellation of its special acquisition corporation and reductions in force) underscore the challenges of new technology deployments in the nuclear sector.



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The transition point

SM&ARs are currently at a transition point. For the last decade-plus, reactor designs have been in the technology development phase, with reactor vendors raising financing (and receiving government support) to advance reactor designs (to include obtaining design certification [or something short thereof, depending on the country] from the national nuclear regulatory authority) and progress the reactor prototype and/or reference plant. However, patience only goes so far in the technology development phase. As countries look to decarbonize, the global market anxiously awaits SM&AR developers to move from technology development to project delivery. Moreover, while there are many potential applications for SM&ARs—which go beyond mere on-grid project models, thereby enabling the support of multiple reactor designs and opportunities depending on the use case—limitations exist on the human resources and supply chain fronts, which could constrain an otherwise rapid global deployment of SM&ARs across various use cases that could be beneficial to Net Zero and global development efforts. Those vendors that can seize the "first mover advantage" have the opportunity to leap ahead of their competitors, as they become real opportunities for the customer base, get beyond FOAK challenges, and solidify their supply chain pipelines and project delivery models.

Unfortunately, most reactor vendors are just that—they are technology developers wishing to sell a reactor design. Yet, what is needed is the full project package—project delivery, operations, fuel, supply chain, regulatory support, and knowledgeable customers—to turn technology dreams into project realities. Innovation is important, but it needs to be translated into operating projects.

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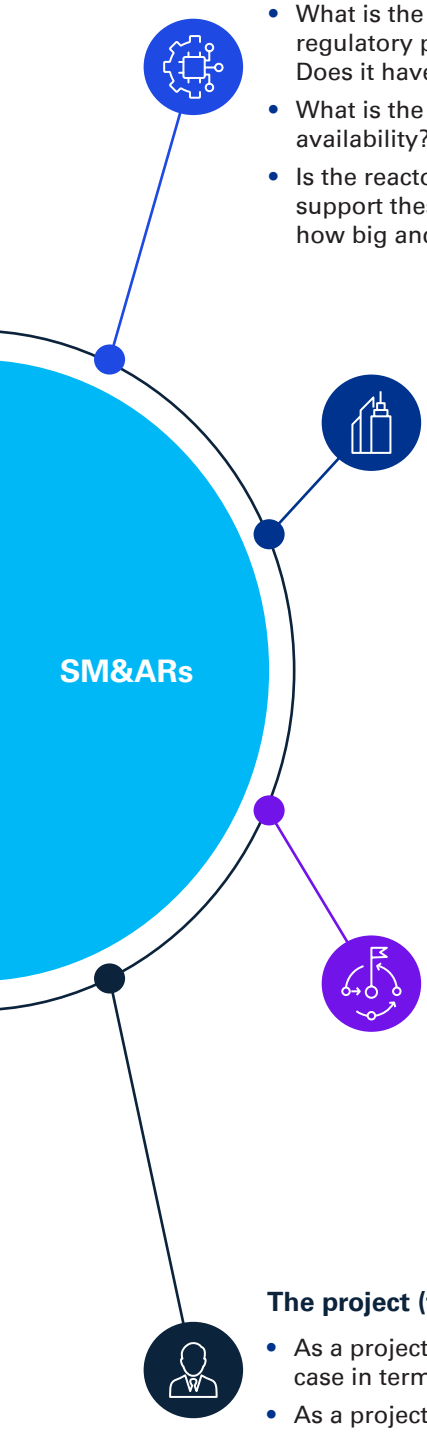
The Las Vegas Question

So, for an investor or project developer, where does one place a financial bet within the SM&AR universe? What SM&AR design does one pick, either as a direct investment opportunity or as a key component of a larger project and/or business?

The answer to the Las Vegas Question is fact dependent and situationally dependent; nevertheless, we introduce a series of questions for examination—in effect, the "triage" of the SM& AR market.

Navigating the SM&AR landscape – Key questions



The technology

- What is the technological lineage of the reactor design? Is it based on a reactor concept that has already been proven, either at a demonstration level in a laboratory environment or an evolution of a large reactor design that is being scaled and advance-engineered for a new market offering? Or is it a concept that lacks technological precedent?
- What is the regulatory approach being pursued by the vendor? Where is the reactor design in the regulatory process? Is it working with experienced, internationally recognized regulatory authorities? Does it have a certified design (or regulatory review short of a design certification)?
- What is the fuel type for the reactor? Are there special challenges or considerations regarding fuel availability?
- Is the reactor design well-suited to nongrid applications? If so, then does it have a complete package to support these applications-based project structures? What opportunities does the application create, and how big and near-term is that market?

The company

- How big is the team? How experienced is the team? Has the vendor moved beyond "three engineers in a garage"?
- Does the vendor have strategic partners and investors? If so, then what type of strategics are they? Supply chain? Engineering? Construction? Operations?
- Does the vendor have an operating solution? An experienced operating partner?
- Has the vendor received significant government funding? From one government or multiple governments?
- How much private funding has the vendor raised? How much more does it need to raise to achieve commercial operation on its first project?
- Does the vendor have a dedicated factory to capture the benefits of factory construction in order to move from FOAK pricing to NOAK (Nth-of-a-kind) pricing?

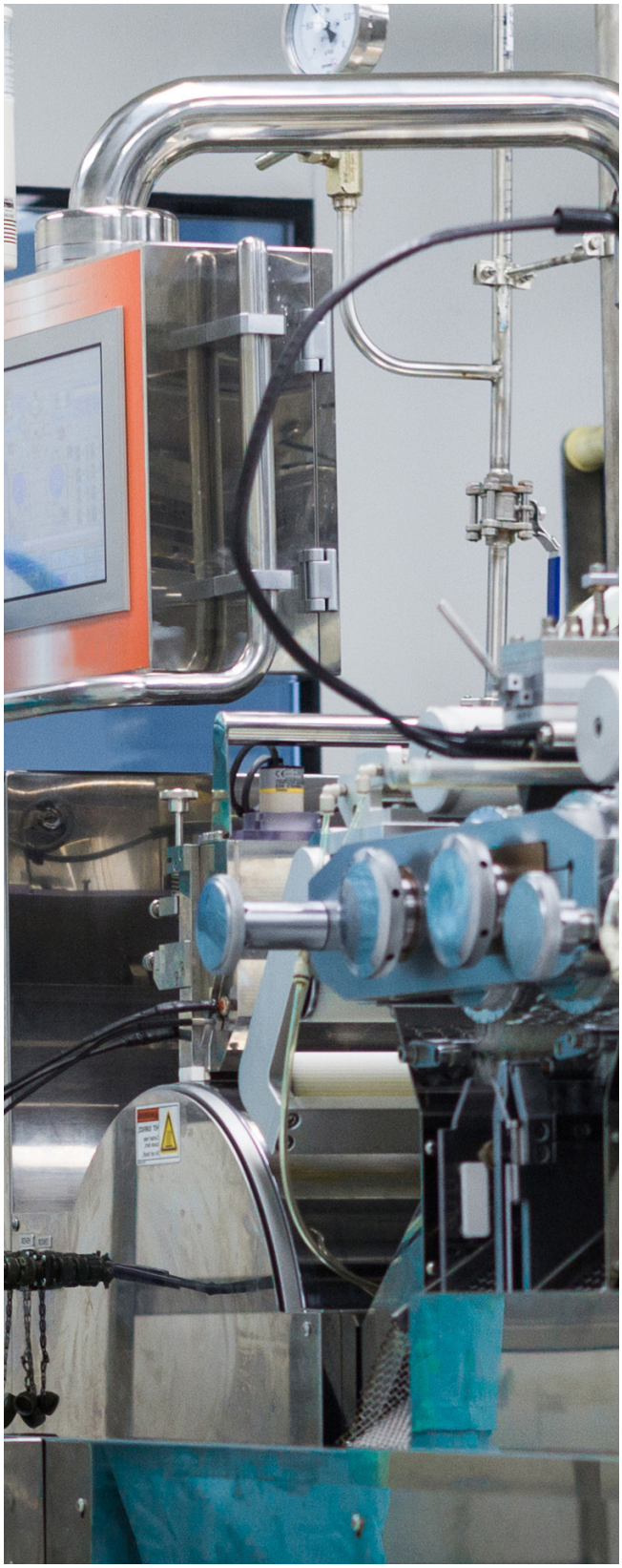
The process and the portfolio

- Does the vendor have a credible business plan to support the scaling of the technology (to include rapid expansion of the supply chain), as it moves from the first project to a sustainable business model? Does the vendor appreciate that the SM&AR space is a volume business, unlike large reactors?
- What is the economic case for the reactor? What market structures does the vendor target (regulated, deregulated) relative to its projected customer base? Do those markets support the economic case for nuclear reactors? Does the project model make economic sense?
- Does the vendor have a site? Does it have a first project? Does it have a project pipeline beyond the first project? How "real" is that project? How credible is its assessment of the asserted market?
- Does the vendor have a fully integrated project delivery offering?
- How supportive is the host government where the reactor vendor is located? How viable are export credit finance options?
- Are its announced schedule milestones realistically achievable? Or are they easily dismissed after a few questions and the application of "planning in reverse" methodologies?

The project (from the customer's perspective)

- As a project developer, what use case forms the basis of my project? Which technology best fits that use case in terms of reactor size and reactor type?
- As a project developer, what aspects of the technology and its project development pipeline help to de-risk my project (e.g., status of reference plant, bilateral relationships/geopolitical considerations, regulatory harmonization, proximity to prior/current projects for labor efficiencies and stakeholder support/engagement)?

This article is the first in a series where we will take a more detailed look at some of the questions raised above.



Concluding thoughts

SM&ARs present exciting opportunities for the nuclear sector. At a smaller scale, these designs move away from "economies of scale" to "economies of multiples," while also introducing new opportunities through applications-based project designs. FOAK risks will need to be addressed specifically, as these new technologies come to market, and supporting functions (human resources, regulatory processes, supply chain, and project delivery) will necessarily need to emerge for vendors to realize their ambitions. The intersection of policy and the entrepreneurial spirit will be critical to the achievement of Net Zero and energy security goals, not to neglect geopolitical considerations either.

The SM&AR space is emerging. The ambition is justified. The potential is great. Nevertheless, the Las Vegas Question remains, and interested parties will need to navigate the analytical questions that we have raised in this discussion.

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