MURPHY
Energy & Infrastructure
CONSULTING
LLC

SMR Project Development, Financing, and Project Delivery in ASEAN

Opportunities and Challenges in Deploying Small Modular Reactors in ASEAN

Webinar hosted by the Energy Studies Institute - National University of Singapore

PAUL MURPHY
3 September 2020

CHANGING THE DYNAMIC
TO SOLVE THE FINANCING DILEMMA

Financing a Nuclear Power Project (NPP) is often the greatest challenge for NPP development

But SMRs represent a paradigm shift for NPP development, which, in turn, creates new opportunities for financing

- Lower aggregate cost
- Shorter construction period
- Greater construction certainty (factory assembly)
- Scalability and “Right-Sizing”
- New applications

MURPHY energy & infrastructure CONSULTING, LLC

CREATING PROJECT DEVELOPMENT OPPORTUNITIES

- Lower cost means that less debt and less equity need to be sourced
- Lower cost creates greater possibilities for balance sheet financing
    - Lower cost means less hit to the balance sheet for sponsors/owners
- Shorter construction schedule means less interest during construction
    - Shorter construction period also reduces equity hold
- "Scalability" means earlier revenues to support the financing for additional units
    - Phased operations if multi-unit site
    - Development by units or modules to match demand growth
- Lower cost and shorter construction reduce aggregate contingency needed in the financing plan (and, thus, less completion support)
- Size creates new deployment opportunities and applications

MURPHY energy & infrastructure CONSULTING, LLC

FINANCING SOURCES AND STRUCTURES FOR NUCLEAR POWER PLANT DEVELOPMENT

Sources:

- Debt: export credit agencies; government-to-government loans; bond issuances (maybe); host government debt / cooperative funding
- Equity: utility balance sheet; host government investment; vendor equity
  - Consider: strategic investors vs. classic financial investors in the case of SMRs
  - Consider: role of sovereign wealth funds

Structures:

- Offtake: regulated market (incl. Regulated Asset Base); structured sales (e.g., Contract for Difference, Power Purchase Agreement); aggregation of high-end users (e.g., Exeltium in France)
- Ownership: national/regional/state utility; multi-owner models; BOO(T); *Mankala*
- Refinancing: capturing less expensive money after commercial operation
- Guarantees: loans; offtake structures
- Fiscal policies (as supported by the project justification): taxes, accelerated depreciation, etc.
- Clean energy support: Zero Emissions Credits, subsidies, etc.
- ***Applications-based structures: Potential roles for SMRs ?***

MURPHY energy & infrastructure CONSULTING, LLC

NPP FINANCING FUNDAMENTALS

Basics

- Program development for newcomer countries
- Market conditions
  - "Competitive" markets with subsidized and preferred competitors
  - Total system costs of electricity are not assigned
  - "Clean Energy" designation (absence of)
- Regulatory risk
- Long construction periods
  - a particular challenge for **EQUITY**
- High construction costs
- Public acceptance
- Monetizing the intangible benefits
  - Energy Security
  - Energy Diversity
  - Clean Energy
  - Asset life beyond 30 years

Challenges

- Viable project economics
- Proven technology
- Creditworthy parties for financing and for offtake
- Experienced project delivery team
- Reputational risk *(Q: Is this a "good project"?)*
  - Nuclear Liability
  - Sustainability
  - International Treaty Commitments
  - Prudent Industry Practice / International Best Practices
  - Capable National Regulator
  - Experienced project participants
- Importance of sustained government commitment
- Assessment of country risk

MURPHY energy & infrastructure CONSULTING, LLC

THE IAEA'S 19 CATEGORIES FOR NUCLEAR INFRASTRUCTURE DEVELOPMENT

- The IAEA has identified 19 categories for nuclear infrastructure development.
- Each of the 19 categories must be assess for each of the three phases of the Milestones Approach.
- These 19 categories are consistent for both large reactor and research reactor guidance issued by the IAEA.
- The IAEA's country reviews base assessments on the 19 categories.
- Financial institutions will rely on IAEA reviews to assess the quality of the national nuclear program and the nuclear power project being financed, as part of their overall diligence process, which considers reputational risk factors.

MURPHY energy & infrastructure CONSULTING, LLC

CHALLENGES FOR SMR DEPLOYMENT

NEED

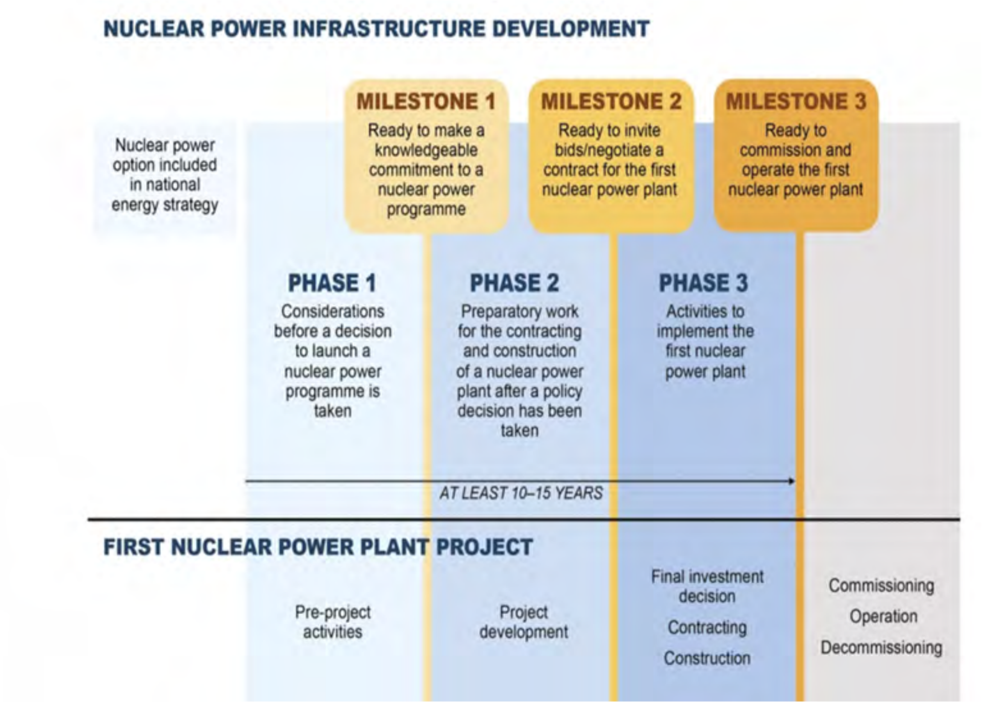
- The world needs substantially more clean energy in this century, and that is acutely true in economically developing nations. Any major new energy plant has a lifetime measured in decades, and a coal or gas plant will produce substantial carbon emissions for that duration.
- If we want the Developing World to have a Clean Growth Strategy, then Small Modular Reactors (SMRs) and Advanced Reactors (ARs) must be made more accessible to the countries that want to deploy them.
  - A "Clean Growth Strategy" is centered on the premise that development initiatives must take into consideration climate change dynamics, with a goal of creating no/low emissions profiles, particularly with regard to energy production.
- Renewable energy has a vital role to play in any climate change strategy, but nuclear energy – clean, reliable, baseload energy – is essential for development.
- For advanced, industrial societies with ever-increasing electricity dependence, carbon-free nuclear energy must play a key role in creating a sustainable future.

CHALLENGE

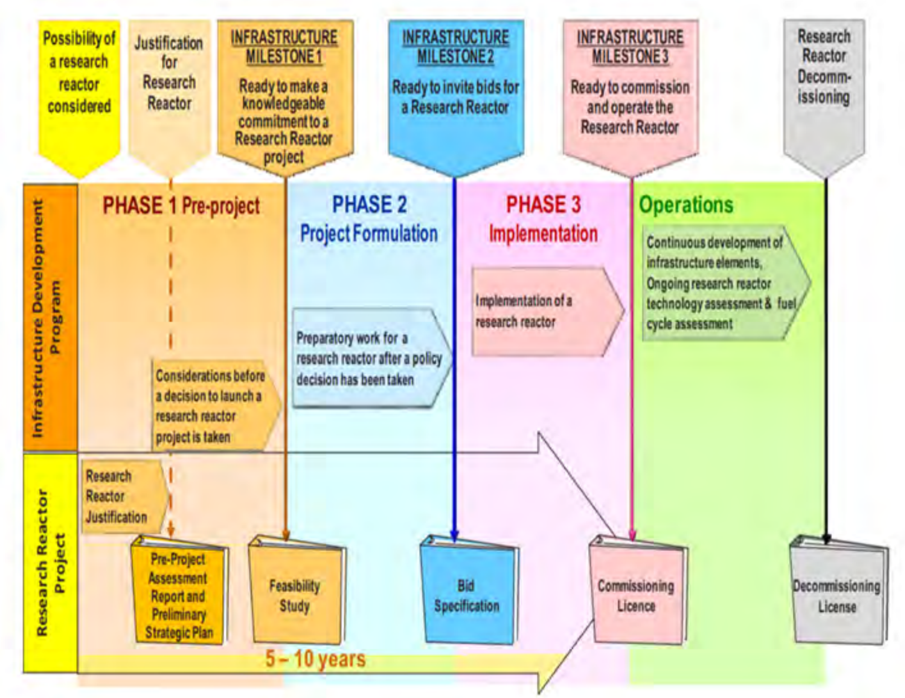
- Current international guidance (IAEA Milestones Approach) sets out a path that is proving to take too long and be too expensive.
- The UAE is a recent example of a new civilian nuclear power country developing a program under the Milestones Approach (and applied by the export credit agencies that provided financing to the Barakah NPP).
  - Upon examination of what the UAE has done, it is abundantly clear that most other countries, especially those from the Developing World, cannot replicate the UAE's admirable approach. Notably, with a rough estimate of a program start date of 2007 and a commercial operation date for Unit 1 of the Barakah NPP in 2020, the UAE program spans 14 years, just slightly inside of the IAEA's 15-year time frame. If, with its financial resources and streamlined political system, the UAE is barely coming under the outer limit set forth in the Milestones Approach, then most, if not all, Developing Countries can be expected to take longer, which calls into question the time frames of the Milestones Approach. Unfortunately, the Milestones Approach creates a high (and unrealistic) barrier to entry, which limits the ability of SMRs to be a meaningful solution for a Clean Growth Strategy for the Developing World.
- Therefore, a new methodology is required to support SMR and AR deployments for civilian nuclear power programs in newcomer countries. The current approach is not feasible for virtually all Developing Countries, especially if substantial external financing for the nuclear power plant is needed.

THE MILESTONES APPROACH: LARGE REACTORS & RESEARCH REACTORS

For Large Reactors (2007):



For Research Reactors (2012):



- Note that the IAEA has no specific Milestones Approach for SMRs.
- Note that the time frame for Research Reactors is 50% less than the time frame for large reactors.
- Consider that Unit 1 for the Barakah NPP (UAE) entered into operation just inside of the 15-year window of the Milestones Approach.
- Consider at the moment, the IAEA's reactor database shows that, in Developing Countries alone, there are 87 operational research reactors, with 7 under construction, and 11 planned.

MURPHY energy & infrastructure CONSULTING, LLC

SMR DIFFERENTIATORS

Opportunities

- Shorter construction periods
  - Potential to unlock equity
  - Shorter government hold under a **refinancing** strategy
- Factory-based construction *(?)*
- Lower quantum of financing needed
- Phased development / scalability
- Phased financing
- "Right-sizing" for grid
  - No longer an "all or nothing" proposition
- ***Unlocking clean energy finance***
- Applications / SMRs as a tool
  - Hydrogen production
  - Desalination
  - Industrial heat
  - Dedicated power
  - Transportation

Possibility of industrial "investment"

Challenges

- Comprehensive approach for SMR deployment
- First-of-a-kind risk
- Regulatory risk and lack of regulatory harmonization
- Technology development vs. project development
- Absence of "off the shelf" development and deployment models to "go fast"
- Volume business
  - Are enough buyers ready and able?
- Early stage support (= need for government support)
  - Demonstration projects
  - Design certification
  - Bandwidth (of personnel; of funding)
  - Long term technology development period
  - Export control issues

MURPHY energy & infrastructure CONSULTING, LLC

Remember:
(1) Fundamentals of project development remain, whether it is a large or small reactor project
(2) Equity will consider investment at both technology and project levels

The Fundamentals of a Viable SMR Project

- Project Delivery is critical
  - FOAK challenges
  - Need for experienced contractors
  - Need for full solution: technology, engineering & construction, operations
  - Need for a “Knowledgeable Customer”
  - Minimization of country risk factors
  - Sound regulatory regime

- The Project must make commercial sense
  - Financeability / Investability
  - Sustained government support
  - Credit behind the deal
  - Solid revenue stream
  - Believable financial model
  - Believable execution plan

Query: How does an applications-focused approach (e.g., hydrogen, desalination, etc.) change how we think about these issues?

MURPHY energy & infrastructure CONSULTING, LLC

CONCLUDING THOUGHTS

KEYS TO FINANCING

- Legislative & Policy/Government Support
- Strong Project Sponsor (incl. necessary completion support)
- Credit Behind the Deal
- Fiscal Tools (e.g. tax policy) to Support the Deal
- Project Deliverability
- Regulatory Support (at all levels)
- Economics to Support Financing (revenue certainty and suitability over a significant period) / **Project Viability**
- Stakeholder Engagement

THE CASE FOR SMRs

First, grid sizes (and corresponding electricity planning guidance) dictate that large reactors are not suitable for many of the markets in the Developing World.

Second, financing is more achievable, particularly from host government sources, given that the overall quantum of financing is less, relative to large reactors. Further, with shorter construction periods, interest during construction in reduced (which, in a multi-billion dollar project, represents a significant savings).

Third, SMRs provide a source of emissions-free generation that supports a Clean Growth Strategy, with advanced technologies and heightened safety standards (and performance, relative to the safety records of other members of its asset class).

Fourth, SMRs are scalable in their development. Currently, Developing Countries are faced with an “all or nothing” decision on 1000^{+} MWe reactors. However, with more “bite-sized” MW “chunks”, a Developing Country can begin to benefit with a first, smaller reactor, and then add addition generation capacity as its needs grow, as does its experience with nuclear power. In effect, SMRs allow for more precise demand growth matching.

Fifth, coincident with scaling of SMR units, SMRs afford the owner with the opportunity to employ new financing techniques, as revenue generated from the first unit deployed can facilitate the financing of future units (depending on the construction stagger, i.e., the more overlap, the less opportunity to support the next unit).

Sixth, SMRs in development represent the pinnacle of technology and engineering. The importation of such technology can be a driver for further technological advancement in the host country.

Seventh, Developing Countries often have underdeveloped grids with load centers being more suited to smaller generation sizes. SMRs offer the ability to disperse generation to distant load centers (relatively speaking, when considering transmission limitations).

Eighth, as Developing Countries look to industrialize, such a strategy cannot rely on intermittent generation as the backbone of the energy system. The baseload, high-capacity factor of nuclear generation creates a solid foundation upon which industrial development can occur.

Ninth, with the variety of new applications for advanced society (hydrogen production; industrial heat; inside-the-fence / dedicated power for industrial parks, data centers, etc.), SMRs can provide additional useful tools for end-users as part of a national planning strategy

Contact Info:

PAUL MURPHY

Murphy Energy & Infrastructure Consulting, LLC

meic.pmjmurphy@gmail.com

+1-202-294-3307

MURPHY energy & infrastructure CONSULTING, LLC