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International Atomic Energy Agency

TRENDS AND CONSIDERATIONS IN THE DEVELOPMENT, CONTRACTING, AND FINANCING OF NEW NUCLEAR POWER PLANTS

MILKO KOVACHEV
Head of Nuclear Infrastructure Development Section
Department NE, Division NENP

PAUL MURPHY
Managing Director
Murphy Energy & Infrastructure Consulting, LLC

ERIC MATHET
Nuclear Infrastructure Development Section
Department NE, Division NENP

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THE NUCLEAR CONTEXT

A Nuclear Power Program Is …

- Complex
- Capital Intensive
- Not Easy to Finance
- Time Consuming
- Politically Sensitive
- A Long-Term Commitment
- Transformational for a Country
- A Strategic Asset in (Most) Countries
- Geopolitically Significant

Image credit: Emirates Nuclear Energy Corporation

WHAT IS TRENDING FOR NPP DEVELOPMENT?

Government-to-Government (G2G) deals

Leading role of State Owned Entities (SOEs) as the leading exporters

Continued use of turnkey contracting approaches

Development of Small Modular Reactors (SMRs), and, later on, Advanced Reactors

Export Credit Agencies (ECAs) as a viable source of debt financing; Lack of financing appetite by commercial banks

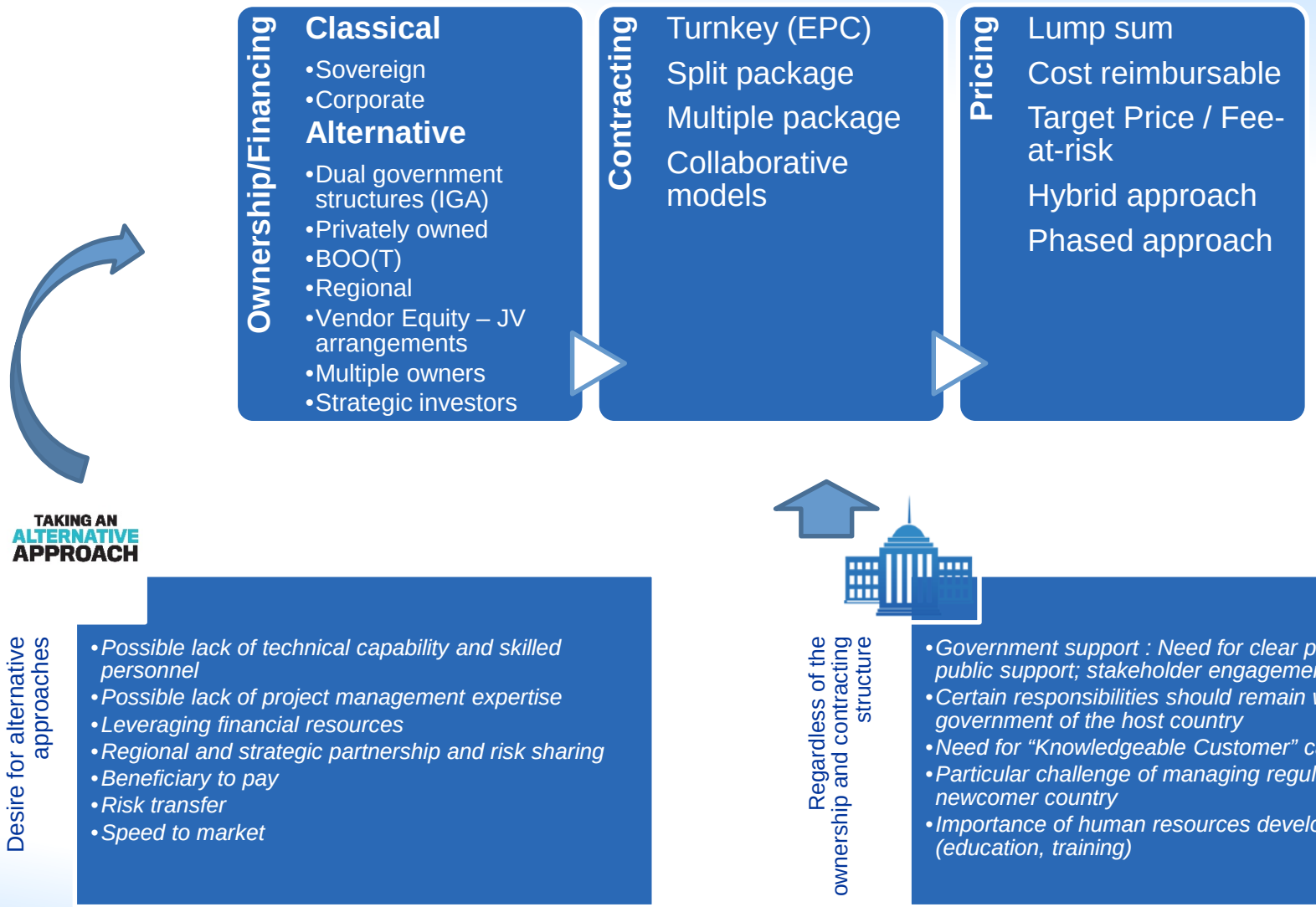
Recognition of the influence of electricity market designs on the development of, and commercial viability of NPPs

Recognition of the role of nuclear power in a climate constrained world; importance of nuclear power as part of climate change mitigation

FINANCING AN NPP IS THE ULTIMATE TEST FOR NPP VIABILITY

- Long development / construction periods
- High upfront capital costs
- Regulatory uncertainty
- Reputational risk
- Human resources
- First-of-a-kind risk
- Safety culture
- Operational success
- Supply chain
- Sustainability of government commitment
- Fuel cycle concerns
- Environmental responsibility
- Commitment to international regimes
- Electricity market conditions

ALTERNATIVE APPROACHES



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HOW CAN NPP DEVELOPMENT CHALLENGES BE OVERCOME?

Project Deal Structuring

- Government Ownership
- Foreign Investment
- Structured offtake
- Turnkey contracting approaches
- Alternative Ownership & Contracting Structures
  - Build Own Operate
  - Regional Cooperation
- Going smaller: Small Modular Reactors

Financial Structuring

- Sovereign guarantees (of debt)
- Sovereign guarantees (of offtake)
- Regulated Asset Base approach
- Export Credit Agency financing
- G2G financing at country level (as opposed to project level; direct sovereign obligation)
- Vendor equity in owner/operator
- Refinancing / Phased Financing
- Going smaller: SMRs & phased financing

HOW CAN NPP DEVELOPMENT CHALLENGES BE OVERCOME?

De-risking the Project

- Utilizing a proven design (with operating Reference Plant)
- Regulatory cooperation (with exporting country re. design and licensing)
- Using sensible, risk-informed contracting models
- Using proven contractors with experienced teams
- Hiring subject matter experts and advisory firms with NPP experience (and engaging with them early in the process)
- Cooperation with IAEA in inviting peer review and advisory services
- Implementing “lessons learned” (both good and bad) from other NPPs
- Having a robust project risk register
- Going smaller: using SMRs

THE CASE FOR GOING SMALLER: SMRs

- Shorter construction times
- Less Interest During Construction
- Lower aggregate Total Project Cost
- Factory construction / modular construction
- Enhanced safety features (passive designs; “walk away safe”)
- Varied applications
- Suitability relative to peak load and grid integration
- Phased financing
- First-of-a-kind risk
- Regulatory uncertainty

THE CASE FOR REGIONAL COOPERATION

- Prerequisite: functioning regional market (power pool)
- Site suitability (or lack thereof)
- Leveraging / sharing human resources
- Leveraging / sharing financial resources
- Market needs & grid constraints
- Aggregation
- Cooperative development

Recognize that a regional program could take 3 forms:

Countries as co-developers and co-financiers

Host country developer, with neighboring country(ies) passive investor(s) and offtaker(s)

Host country developer, with neighboring country(ies) as offtaker(s)

Getting countries to cooperate on a project of this scale and complexity is an additional challenge.

THE CASE FOR BOO(T)

Motivations

- Risk transfer
- Speed to market
- Limited host country financial resources
- Limited host country technical expertise
- Leverage

But also consider

- Attitudes towards foreign ownership
- Is the “T” of Transfer possible?
- Sovereign/National responsibilities still remain
- “Knowledgeable Customer” capability is still critical

How realistic is BOO(T)?

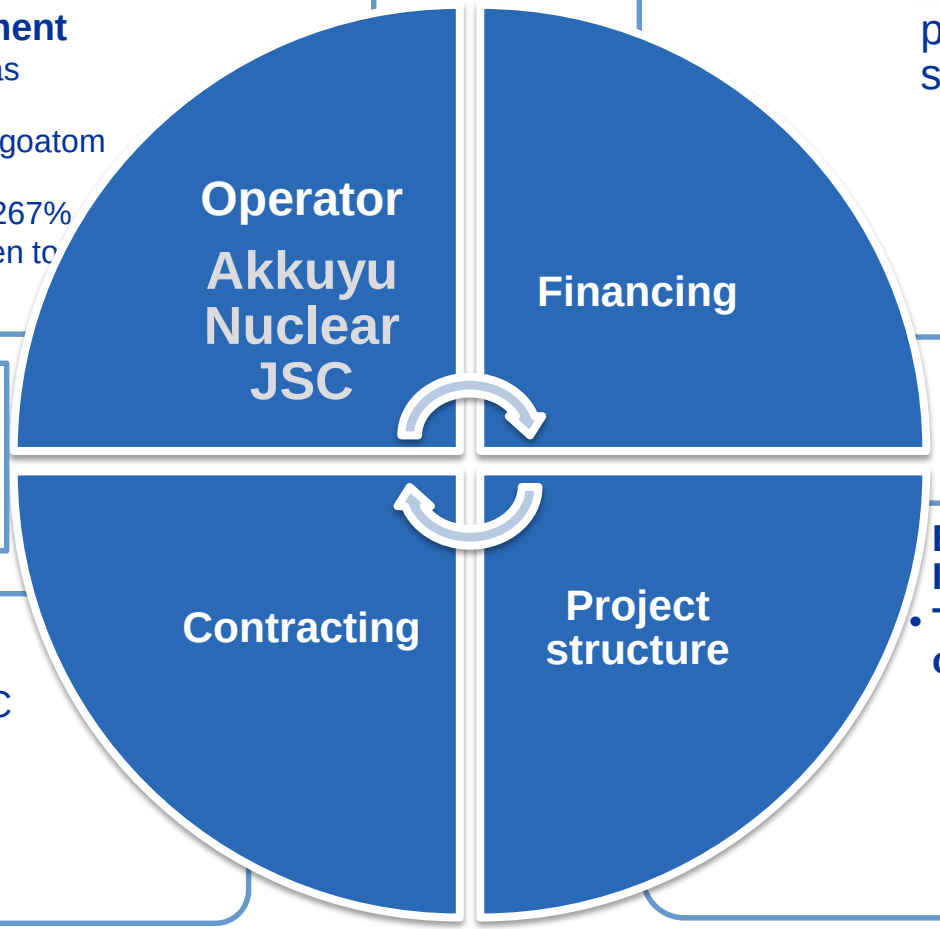
- Currently, only one project: Akkuyu NPP (Turkey)
- Complicated deal formation
- Long term bet by foreign reactor consortium on the host country
- Political risk
- Then again, how different is the Akkuyu NPP structure from:
  - Barakah NPP ?
  - Hinkley Point C ?

Turkey - Akkuyu – BOO

4 VVER-1200 reactors of total capacity 4456 MW

- **OWNER:** Akkuyu Nuclear JSC
- **Shareholders agreement**
  - CJSC Rusatom Overseas 74,915%
  - OJSC Concern Rosenergoatom 21,948%
  - JSC Atomstroyexport 2,267%
  - 49% of share capital open to foreign investors

- 100% Russian provided (but desire to sell down position)



Regulatory body
TAEK, now NDK
Agreement with Rostechnadzor

- **EPC**
  - Atomstroyexport JSC
- **O&M**
  - Rosenergoatom
- **Fuel**
  - TVEL

BOO with PPA based on IGA
- **TETAS to purchase over 15 years**
  - 70% of the electricity of first two units and
  - 30% from the remaining two units.
  - Remaining electricity in open market

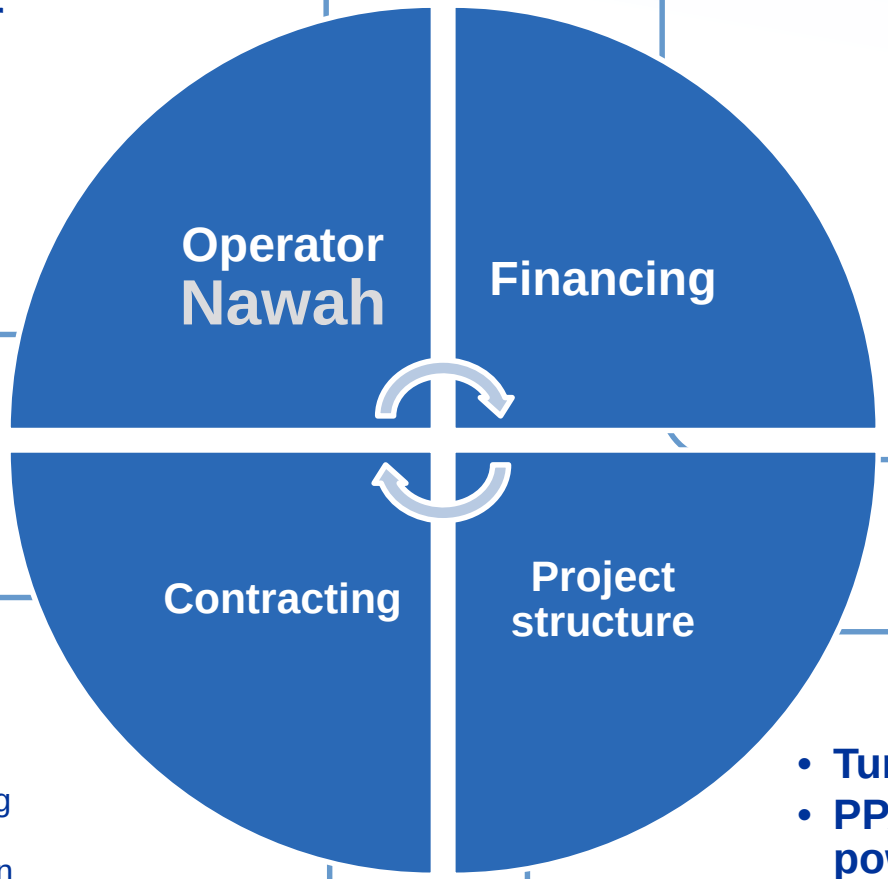
UAE - Barakah – Turnkey

4 APR1400 reactors of total capacity 5380 MW

- **JV Structure for both owner and operator (split structure):**
  - ENEC 82% & KEPCO 18%
  - Owner: Barakah One
  - Operator: Nawah

Regulatory body
FANR
Main agreement with USNRC and KINS

- **EPC**
  - KEPCO
- **O&M**
  - KHNP with KEPCO KPS
  - KEPCO E&C for engineering support
  - EDF to support the operation and maintenance
- **Fuel**
  - KEPCO Nuclear Fuel



- **Equity commitments**
  - from ENEC and KEPCO
- **Direct loan agreements**
  - from the Export-Import Bank of Korea (KEXIM)
  - from the National Bank of Abu Dhabi, First Gulf Bank, HSBC, and Standard Chartered
  - from the Dept of Finance of Abu Dhabi
  - US Export-Import Bank approved for US-sourced components (under original financing)

- **Turnkey**
- **PPA for 100% of the power**
- **Sovereign guarantee**

COMPARING AKKUYU & BARAKAH

Comparative Analysis

- Both are 4-unit deals
- Both are the first NPPs in the country
- Both rely on significant foreign involvement (beyond just reactor technology)
- Both are vertically and horizontally integrated deals
- Both are turnkey projects
- Both have strong host government commitment to the nuclear power program
- Both NPPs need to meet growing demand for electricity
- Both NPPs have motivated exporters (first BOO / Russia; first NPP export / Korea)
- Barakah has higher guaranteed offtake (100% vs. 50%)
- Akkuyu has higher foreign ownership (100% presently vs. 18%)
- Barakah debt is backed by sovereign guarantee
- Barakah has provision of substantial levels of host government debt
- Akkuyu is based on a government-to-government deal

Key Deal Points

- Foreign Government financing
- Foreign Government commitment
- Power Purchase Agreement

Key Challenges

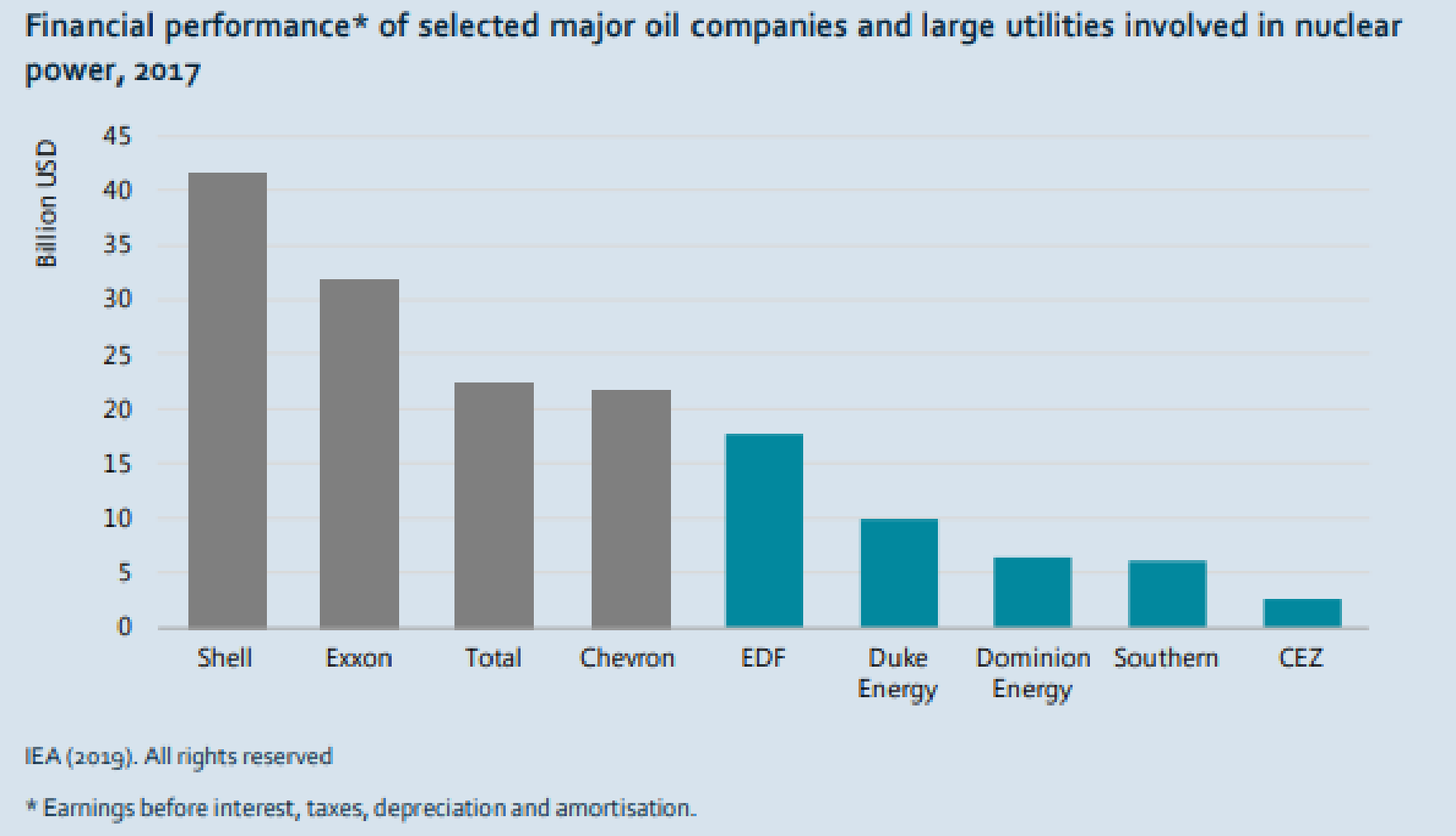
- FOAK country risk
- Geopolitics
- Akkuyu: first NPP that is BOO
- Akkuyu: market risk for 50% of offtake

NUCLEAR FINANCING MODELS

- Project Finance (never done for an NPP)
- Traditional Models (sovereign / utility)
- Government-to-Government Financing
- Loan Guarantees
- Export Credit Agency Financing
- Vendor Financing
- Investor Financing
- Host Government-Backed Offtake Agreement
- Phased Financing / Refinancing
- Alternative Structures (BOO, Regional)

Financing an NPP:
The Limitations of Balance Sheets

[also, why oil and gas projects can be done differently …]



TRENDS IN THE NUCLEAR MARKETPLACE

- Financing is often the determining factor
- G-to-G deals are multi-faceted and go beyond the nuclear project
  - These deals are about fostering strategic relationships
- Deals require significant government support (by either or both of the exporting country and/or the host country)

International Project	Units	Country	Determinative Considerations
Akkuyu	4	Turkey (Russia)	BOO; PPA; IGA
Barakah	4	UAE (Korea)	Strong host country finances; SOE* vendor equity; national program
El Dabaa	4	Egypt (Russia)	G2G financing; SOE exporter; national program; IGA
Hinkley Point C	2	UK (France & China)	CfD; SOE foreign equity; additional SOE minority equity
Paks 2	2	Hungary (Russia)	G2G financing; SOE exporter

* SOE = State Owned Entity

Innovative Ideas: Phased Financing

Concept

- Utilization of different financing techniques to suit different stages of the project's lifecycle

Options

- Refinance during Construction or Operation

Reasoning

- During development and construction, nuclear financing is most challenged
  - Equity sources are limited
  - Debt sources are limited
  - Project is not generating revenue !
- Financing issues don't stop at Commercial Operation
  - Nuclear becomes an attractive investment
  - Asset is very inexpensive to run
  - Asset has a very long operation

Result

- Refinancing becomes a very real option, as do Leasing structures

Therefore

- Financing must take a "lifecycle" approach
  - (e.g., new sources of equity (pension funds and insurance companies) and new sources of debt (project bonds) after completion of first fuel reload)

Innovative Ideas: Phased Financing - Options

By considering a lifecycle / holistic approach, the Owner can lower the cost of capital over the life of the project

During Construction

- Export Credit Agency debt
- Sovereign debt
- Limited commercial bank debt
- Utility and/or Sovereign equity
- Vendor equity
- Equity Bridge Loans

During Operation

- Capital Markets / “passive” equity
- Long term investors, such as pension funds and insurance companies
- Offtakers (?)
- Leasing structures

Innovative Ideas: NPPs as Critical Infrastructure

Final Investment Decisions about NPPs tend to be made at the project level

At the project level, several considerations drive the decision:

- Levelized cost of electricity
- Net present value of the investment
- Comparisons to other forms of generation
- Reliability / uncertainty of electricity market revenue

Shortcomings of this analysis are as follows:

- Modeling, at best, only goes out for 30 years, when evolutionary designs might last for 60 - 80 years
- Energy security, energy diversity, and emissions-free generation are not inputs in a financial model
- Macroeconomic factors are not relevant in project-level modeling

However, if NPPs are viewed as “critical infrastructure”, then the analysis starts to change

Innovative Ideas: NPPs as Critical Infrastructure

- Cost still matters
- Provision of baseload, emissions-free, high capacity factor generation is valued
- Nuclear power is essential when if climate change consideration are highly valued, then the policy tools are crafted to reach the desired result
- Role of government (equity, debt, loan guarantees, offtake structures) is easier to justify (as well as creating the enabling institutional / regulatory environment)
- Government role in financing could be temporary (development & construction periods)
- Government could be the customer, utilizing power purchase contracts
- SMRs could be particularly suited to critical infrastructure applications, particularly as “inside the fence” power sources

Concluding Thoughts

Four unique challenges of the asset class:

- Overcoming development risk
- Shortcomings of financial modeling
- The intangibles of nuclear power
- Presence of safety regulator

Will climate change considerations carry the day?

Role and leadership of Government is critical

Current deregulated energy market designs create impossible conditions for NPP

The scale of financing needed is problematic

Geopolitics & National Development

- *These deals are about influence and long-term, bilateral relationships across multiple sectors*
- *These are strategic assets for the host country*

IAEA-TECDOC-1750 revision planned in 2020

ALTERNATIVE CONTRACTING AND OWNERSHIP APPROACHES FOR NEW NUCLEAR POWER PLANTS / IAEA-TECDOC-1750

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The revision process will start in

2020

IAEA
International Atomic Energy Agency

Milko Kovachev
m.d.kovachev@iaea.org

Paul Murphy
meic.pmjmurphy@gmail.com

Eric Mathet
e.mathet@iaea.org

Thank you!