IFNEC

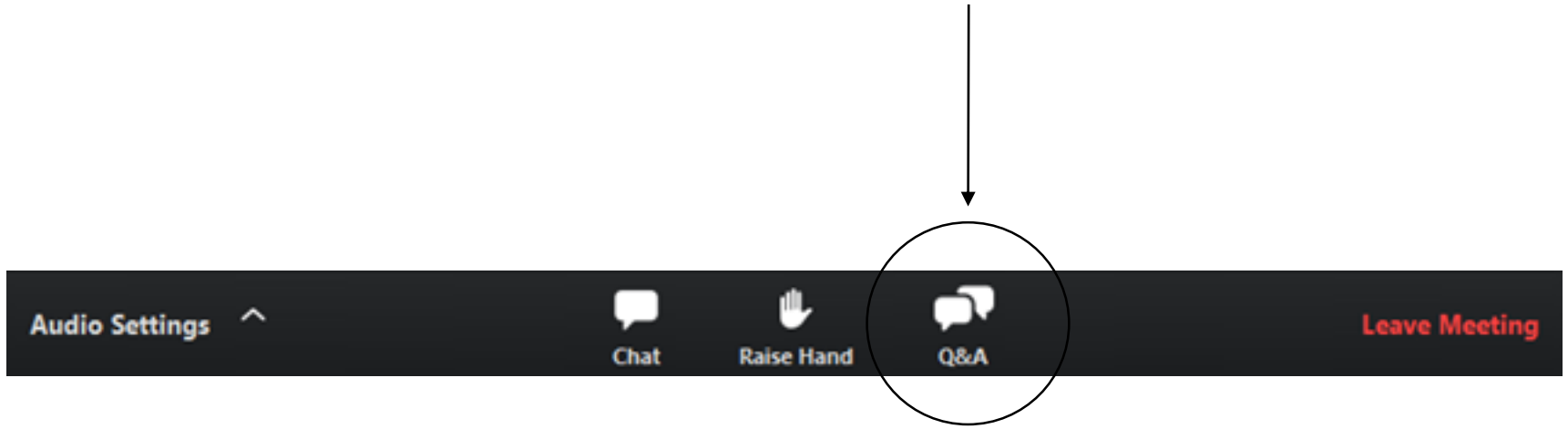
INTERNATIONAL FRAMEWORK FOR NUCLEAR ENERGY COOPERATION

June 2020 is IFNEC's SMR Month

The webinar will begin shortly

Welcome !

To ask a question to the panelists
Please type your question in the Q&A section
Panelists will answer live or in writing



Opening remarks

Kenji TOTOKI
Deputy Director-General for Nuclear Energy Policy
Cabinet Office – Japan
IFNEC Nuclear Supplier and Customer Countries Engagement Group Co-Chair

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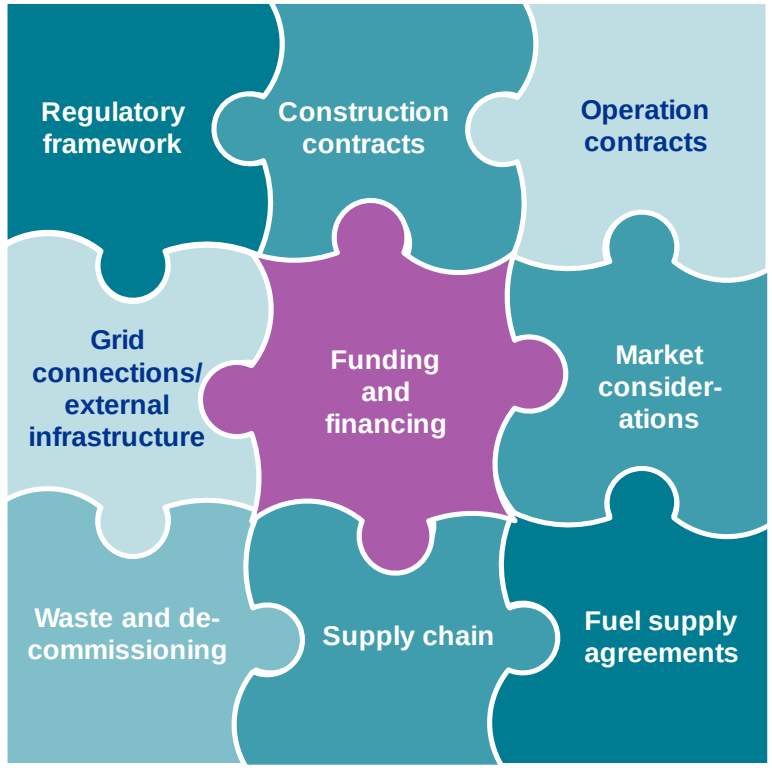
Presentation of panelists by

Satoshi MIKITA
Japan Bank for International Cooperation

JBIC JAPAN BANK FOR INTERNATIONAL COOPERATION

PUBLIC-PRIVATE RISK SHARING
Its contribution to lowering financing costs and enabling nuclear new build

Dr. Jan Horst KEPPLER
Senior Economic Advisor
OECD Nuclear Energy Agency
NTE Division



KPMG, 2013, NEA 2015

Risk-sharing in Financing New Nuclear Power Plants

- Nuclear energy is a proven low carbon source for large amounts of round-the-clock baseload electricity that provides great benefits;
- Benefits beyond electricity production (**air quality, climate change, stable, dispatchable, inertia, human capital, energy security**) similar to infrastructure investment;
- The construction of new nuclear power plants presents also a complex industrial challenge presenting significant risks in a number of dimensions;
- In particular, NPPs are highly capital intensive: 80% of lifetime costs (pre-construction, construction, operations and decommissioning) are due before the first MWh is produced;
- To maximize the benefits and minimize the costs, the different risks need to be carefully defined and allocated to the parties best equipped to manage them;
- Optimised risk sharing between governments, vendors, investors, operators and consumers can minimize the financial costs of risks and lower the overall costs of new nuclear projects.

Who Carries which Risk with Different Financing Models?

Principal dimensions of risk having an impact on the cost of capital

- Design and development risk: vendor, government (RDD policy)
- **Construction risk**: vendor/contractor (fixed price), operator/investors (merchant), government (equity stake), consumers (RAB, CWP, PPA)
- Operational risk (technology): operator
- Operational risk (accident): operator up to liability limit, beyond that government
- **Operational risk (market, price and quantity)**: operator/investors (merchant), consumers (CFD, regulated tariff)
- Operational risk (regulation and politics): operator/investors if no compensation, government otherwise
- Decommissioning and RWM (regulation and politics): depending on liability operator/investors or government

What is Different for SMRs?

- The category of small modular reactors is large and spans micro-reactors in the single-digit MW-range to baseload providers of 300 MW and above.
- Commercially most advanced projects are towards upper end of range. Projects still *large*.
- However investing USD 1.5 billion rather than USD 7.5 does make difference for utilities in challenging electricity market environment with uncertain outlook.
- With factory-build rather instead of stick-build, some financial risk will be shifted to vendors who will now have to bear higher fixed costs…
  - Are governments more inclined to shoulder part of the risk of vendors or of operators?
- New technologies yet to be proven, but greater operational flexibility and smaller core sizes promising greater safety and, perhaps, easier interaction with regulators .

On Construction Risks

Construction risk: vendor (fixed price), operator/investors (merchant), government (equity stake), consumers (RAB, CWP)

Building new nuclear

- It's complicated
- Hard to have confidence around eventual cost or completion date
- Limited contractor experience
- Contractors may have limited resilience to cost overruns; support/warranties may be of limited value
- Contractor replacement scenario challenging and expensive
- Exposure to regulatory/policy changes during construction and commissioning
- Significant liquidity risks over long construction period when (absent a RAB model) there is no revenue

MOODY'S INVESTORS SERVICE Moody's presentation to Foratom, May 2020 6

- **Who can borrow at lowest rate for given NPP project?**

Cost to UK Consumers under RAB

(£/MWh) Construction cost

IRR	£18bn	£20bn	£22bn	£24bn
4.0%	36	38	40	41
5.0%	43	45	47	50
6.0%	49	52	55	58
7.0%	56	59	63	66
8.0%	63	67	71	75
9.0%	69	74	79	83

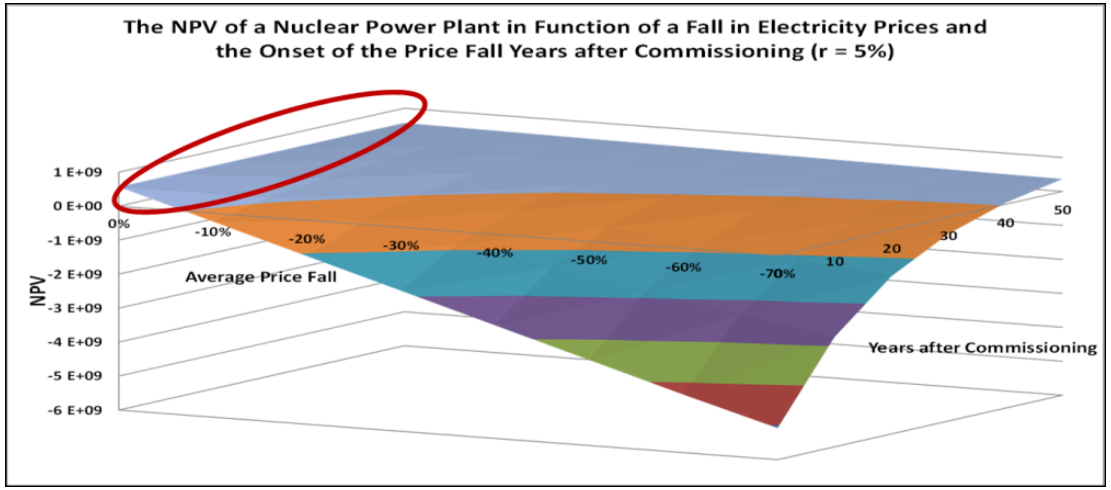
£62 of the £92.50 HPC strike price is related to financing, of which more than half is construction risk premium EDF Energy (2020)

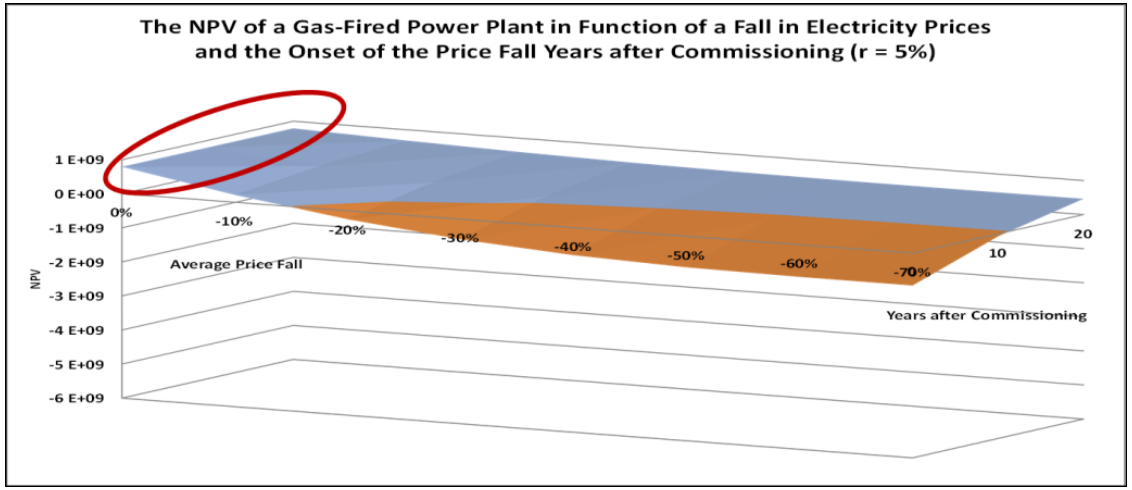
On Market Risks I

Operational risk (price and quantity):
operator/investors (merchant), consumers (CFD, regulated tariff)

Who can best bear impacts of price volatility?

A liberalised market with volatile marginal cost pricing is not a level playing field but discriminates against capital-intensive low carbon technologies. Investment in low carbon technologies inevitably requires some form of stability in electricity prices.





On Market Risks II

Why the costs to consumers to engage in fixed price contracts are limited (and may even be negative):

- Long-term fixed price arrangements such as CFD, regulated tariffs, PPAs but also FITs become valuable for generators if there is risk that prices fall (likely due to VRE);
- In this case, consumers benefit from lower wholesale market prices but will need to pay higher compensation payments to bridge the gap between market prices and the agreed strike price;
- The net effect will be second-order for consumers, while it would have been first-order for generators.
- The cost of bearing the risk is higher for generators than for consumers;
- Put differently, in fixed price arrangements consumers forego the potential upside of lower prices in return for lower average long-term costs.

Concluding Remarks

- In many dimensions of risk (design, construction, accidents, regulation, politics, RWM), governments potentially have direct role to play.
- The two largest risks of NNPP projects remain **construction risk** and **market risk**.
  - For market risk, the argument for having consumers forego the potential *upside* of lower prices in return for stable costs of low carbon investments seems straightforward.
  - For construction risk, similar trade-offs may exist. However, RAB and CWP have consumers assume potential *downside* risks, while reducing incentives for efficiency.
  - The alternatives to lowering the cost of capital, i.e., loan guarantees, fiscal incentives or direct public equity stakes should be considered. Final trade-offs should be made on empirical grounds.
- The arguments for Gen 3+ reactors and SMR are not fundamentally different, except that with latter some risks will shift to *pre-construction* phase of individual plant.
- Electricity consumers, tax payers and voters are the same people. The external benefits of nuclear are an important argument to engage in broad, well-prepared and adequately communicated forms of risk sharing.

Financing an SMR Project: Considerations from the Financial Community

PAUL MURPHY
Murphy Energy & Infrastructure Consulting, LLC

MURPHY energy & infrastructure CONSULTING, LLC

MURPHY energy & infrastructure CONSULTING, LLC

PRESENTATION OUTLINE

- The SMR Dynamic
- NPP Financing Sources & Structures
- NPP Financing Fundamentals
- SMR Differentiators
- Concluding Thoughts

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**

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
- **Lower cost and shorter construction reduce aggregate contingency needed in the financing plan (and, thus, less completion support)**

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.

NPP FINANCING FUNDAMENTALS

Basics

- **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
- **Importance of sustained government commitment**
- **Assessment of country risk**

Challenges

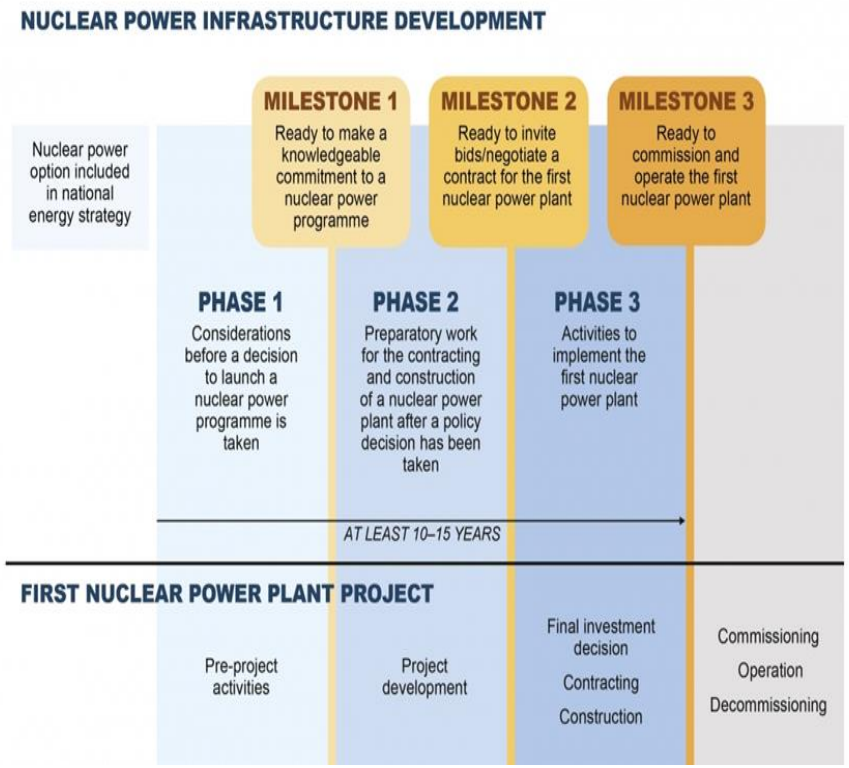
- **Program development for newcomer countries**
- **Market conditions**
  - "Competitive" markets with subsidized and preferred competitors
  - Total system costs of electricity are not assigned
  - "Clean Energy" designation (absence of)
- **Regulatory risk**
- **Long construction periods**
  - a particular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

THE IAEA'S 19 CATEGORIES FOR NUCLEAR INFRASTRUCTURE DEVELOPMENT

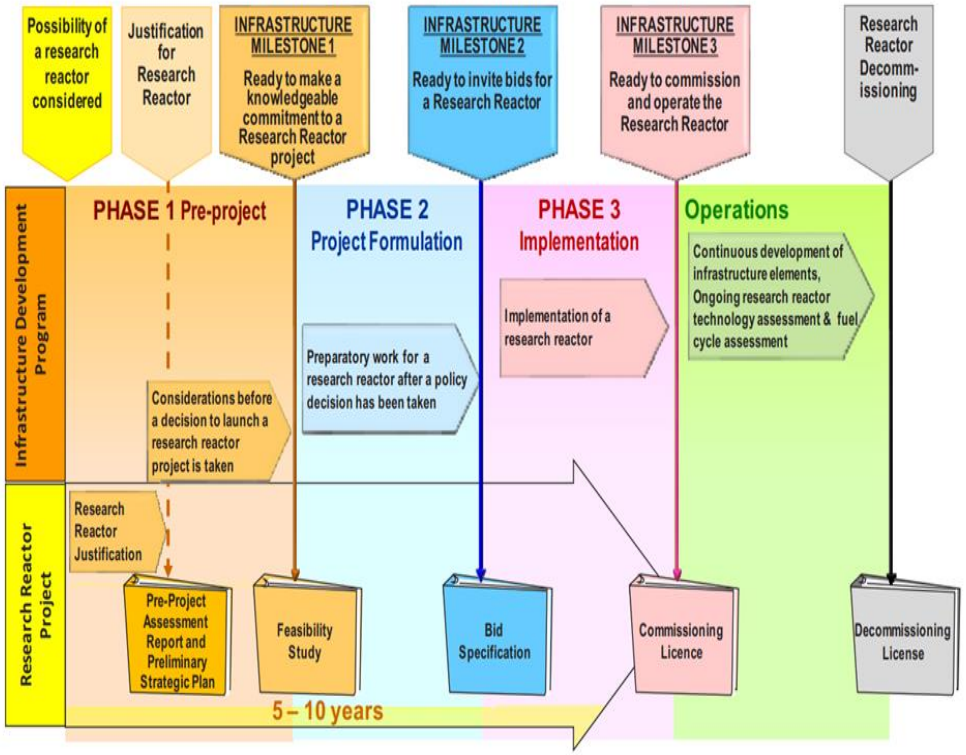
- The IAEA has identified 19 categories for nuclear infrastructure development.
- Each of the 19 categories must be assess for each of the three phases of the Milestones Approach.
- These 19 categories are consistent for both large reactor and research reactor guidance issued by the IAEA.
- The IAEA's 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.

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) will enter 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 5 under construction, and 12 planned.

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

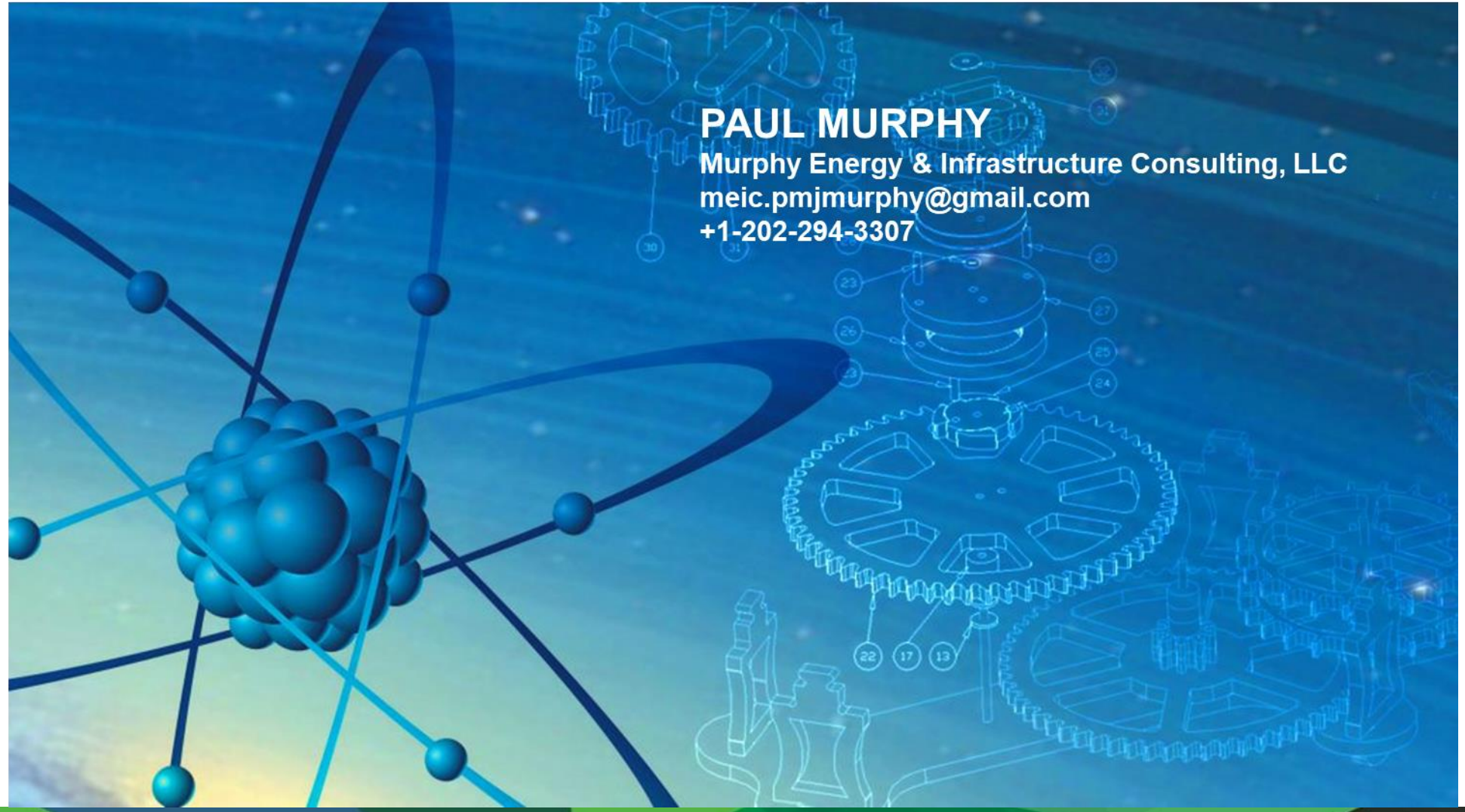
Remember:
(1) Fundamentals of project development remain, whether it is a large or small reactor project
(2) Equity will consider investment at both technology and project levels

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**

Contact Information



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Experience Sharing on Financing for Taishan EPR Project

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中广核 CGN
善用自然的能量

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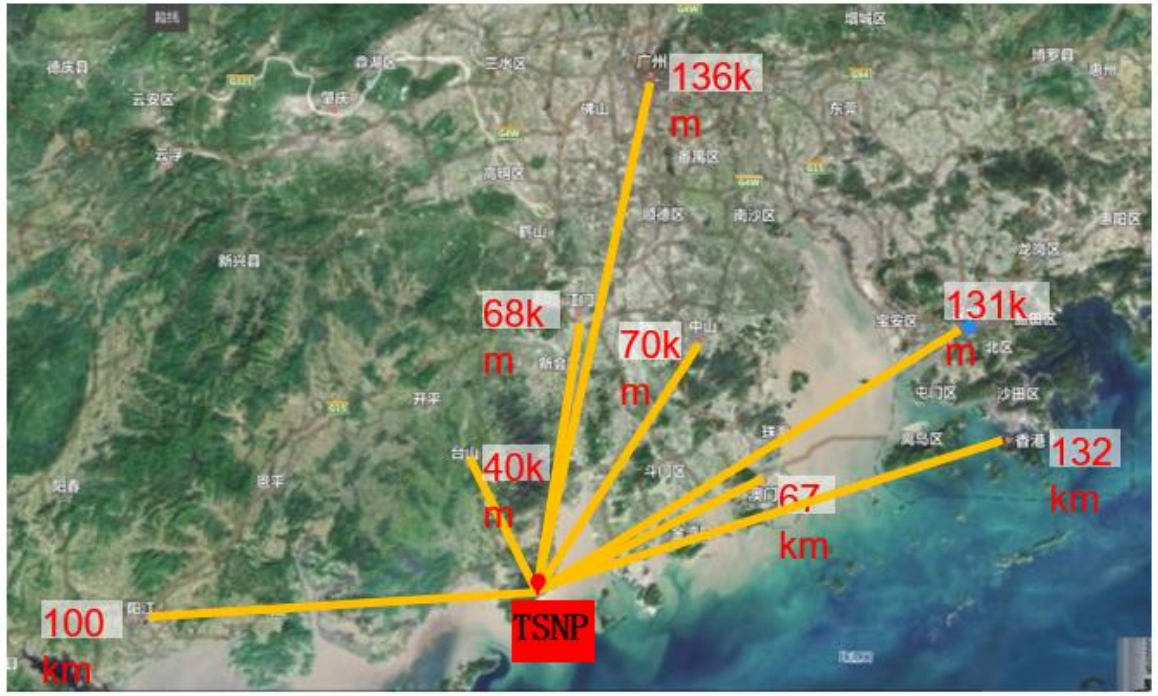
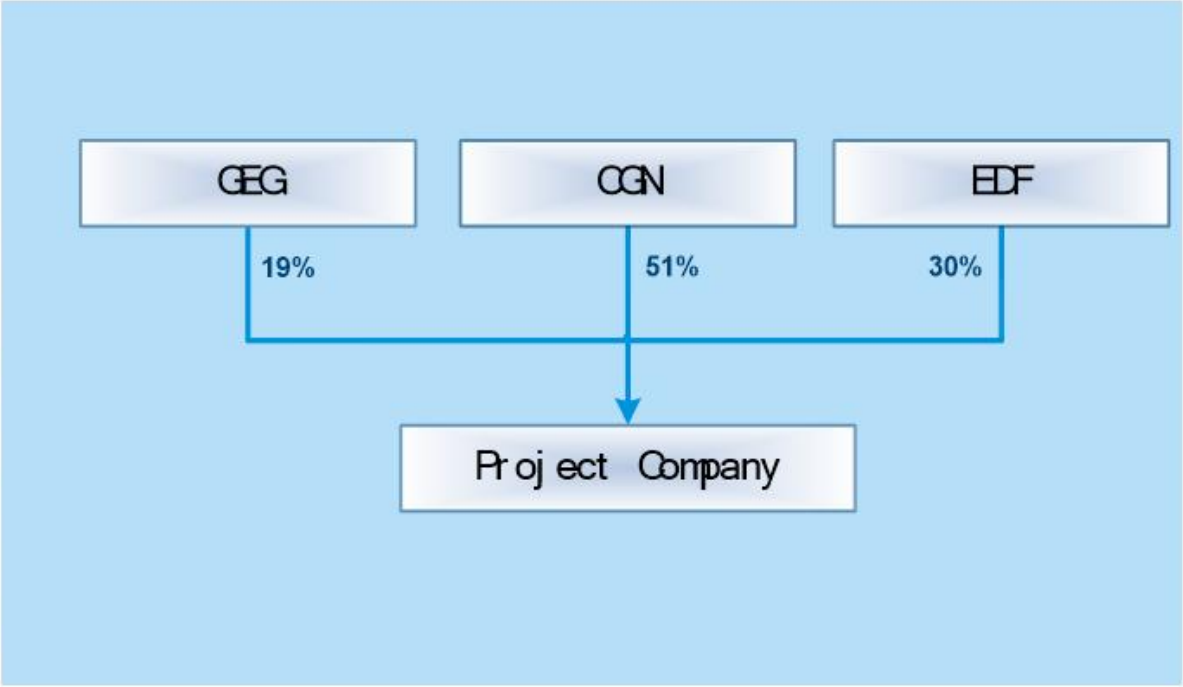
- The Taishan Nuclear Power Project is located in Taishan City, Guangdong Province. 6 nuclear generating units of the GWe class are planned for the site. Its Phase I comprises two EPR units with a single unit capacity of 1750MW, which is the largest nuclear power reactor worldwide.
- The Phase I project is jointly invested by China General Nuclear Power Group(CGN), Électricité de France (EDF) and Guangdong Energy Group (GEG). It is the largest project featuring a partnership between China and France in the energy sector.





- The two units have been put into commercial operation in December 2018 and September 2019, respectively. As of May 20, 2020, a total of 29 billion kilowatt-hours of electricity have been generated with the two units maintaining safe and reliable operations all along.

- The project integrated the core capabilities and rich experience of China and France on nuclear power construction, effectively promoted the development of nuclear power technology, equipment manufacturing and industrial chain upgrades accumulating valuable experience and expertise for the construction of EPR reactors.

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Risks Faced by Financial Institutions on Taishan Project

The 3rd-generation nuclear power plants typically involve high construction cost and long construction duration (which could be up to 10 years), and thus involve significant risks.

Project Abandon Risk

- There was no reactor with EPR-technology in operation when Taishan project began construction, leading to risks that the project may be far behind schedule or even be abandoned.

Over-budgeting Risk

- Due to potential unexpected technical issues of the new technology(EPR), the project may be over budget significantly.

Consumption Risk

- The power generated by the project cannot be fully consumed by future electricity market.

Electricity Tariff Risk

- The tariff is normally determined right before power plants are put into operation based on the market price, therefore it may be lower than planned.

Overview of Factors for Successful Financing for Taishan Project

Healthy Economic Environment

Favorable Policy for Nuclear Power Development

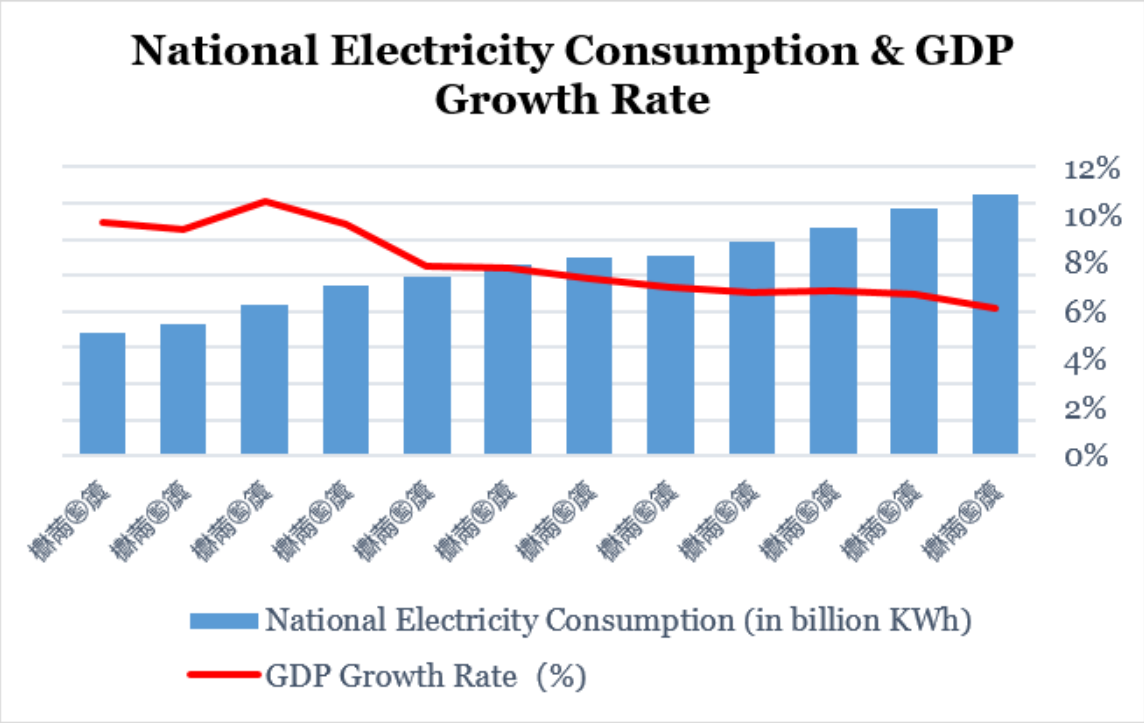
Strong, Experienced and Trustworthy Investors

Outstanding Project Management Team

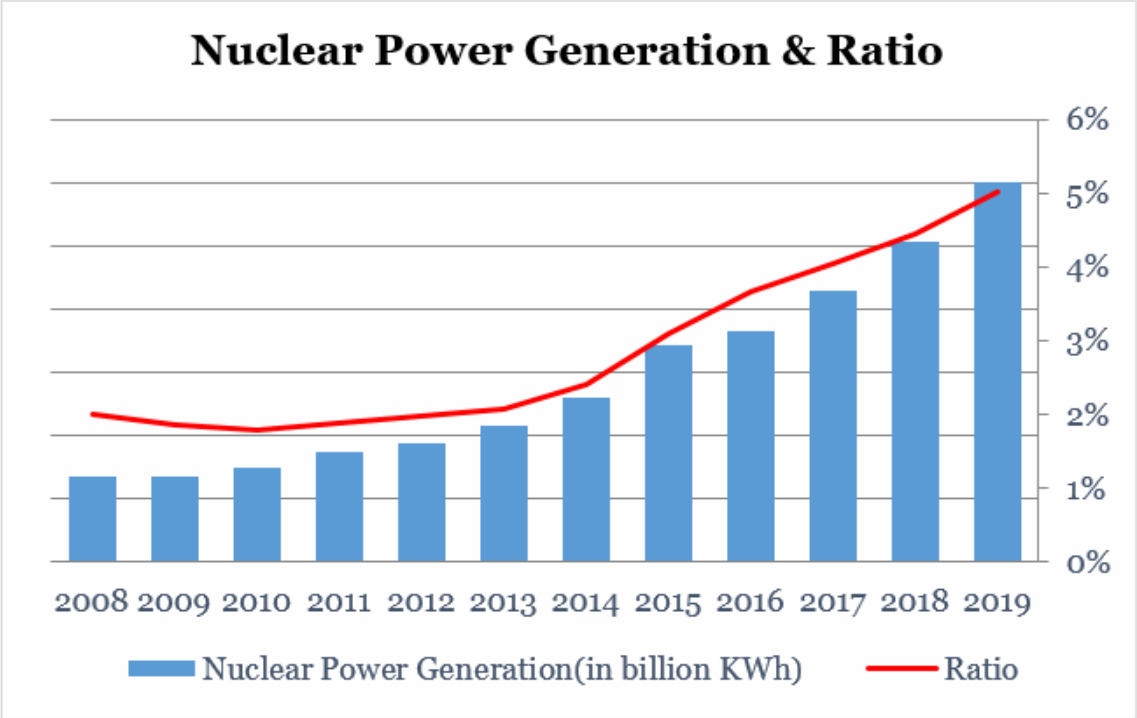
Well-designed Credit Structure

High Economic Growth Leads to High Electricity Demand

China's economy has maintained consistent high-speed growth rate and its energy demand has continued to increase. In view of advantages of nuclear energy in the electricity market, investors and financial institutions have developed positive attitudes toward nuclear energy.



Wind, CGN



Wind, CGN

Favorable Policy for Nuclear Power Development

The state has put into place a series of favorable policies in support of nuclear energy development, consumption and electricity price setting.

Nuclear Power Medium and Long-Term Development Plan

- By 2020, the installed capacity of nuclear power will reach 58 million kilowatts, and 30 million kilowatts will be under construction.

Clean Energy Consumption Action Plan (2018-2020)

- Control the scale of newly built coal-fired power plants
- Prioritize power generation of clean energy including nuclear power

Notice of the Trial Electricity Price for the First Batch of 3rd-generation Nuclear Power

In April 2019, the electricity price for Taishan Project was set at a favorable level (CNY 0.435 per kWh)

Investors with Powerful Economic Strength, Experience and Trustworthiness

- The largest nuclear power developer and operator in China
- Has an experience of more than 25 years in nuclear power construction, operation and management
- As of Dec 31, 2019, a total of 24 nuclear power reactors in operation and 5 nuclear power reactors under construction

- The largest nuclear power operator in Europe as well as in the world
- Europe's third largest energy service provider
- In the list of Fortune 500 Companies

- The strongest and largest energy enterprise in Guangdong province
- Has tens of business sectors such as coal-fired power, hydropower, wind power, new energy, and comprehensive energy services

China General Nuclear Power Corporation (CGN)

Électricité de France (EDF)

Guangdong Energy Group (GEG)

Investors with Powerful Economic Strength, Experience and Trustworthiness

Shareholder capital accounts for 33% of total investment, providing a safe cushion of funding needs and attracting bank loans.

2007.7
Incorporation
Registered capital RMB 500 million

2009.3
Capital Injection
Increased capital to RMB 2.1 billion

2009.12
Capital Injection
Introduced EDF and increased capital to RMB 16.74 billion

2012.10
Equity Transfer
Introduced Guangdong Energy Group

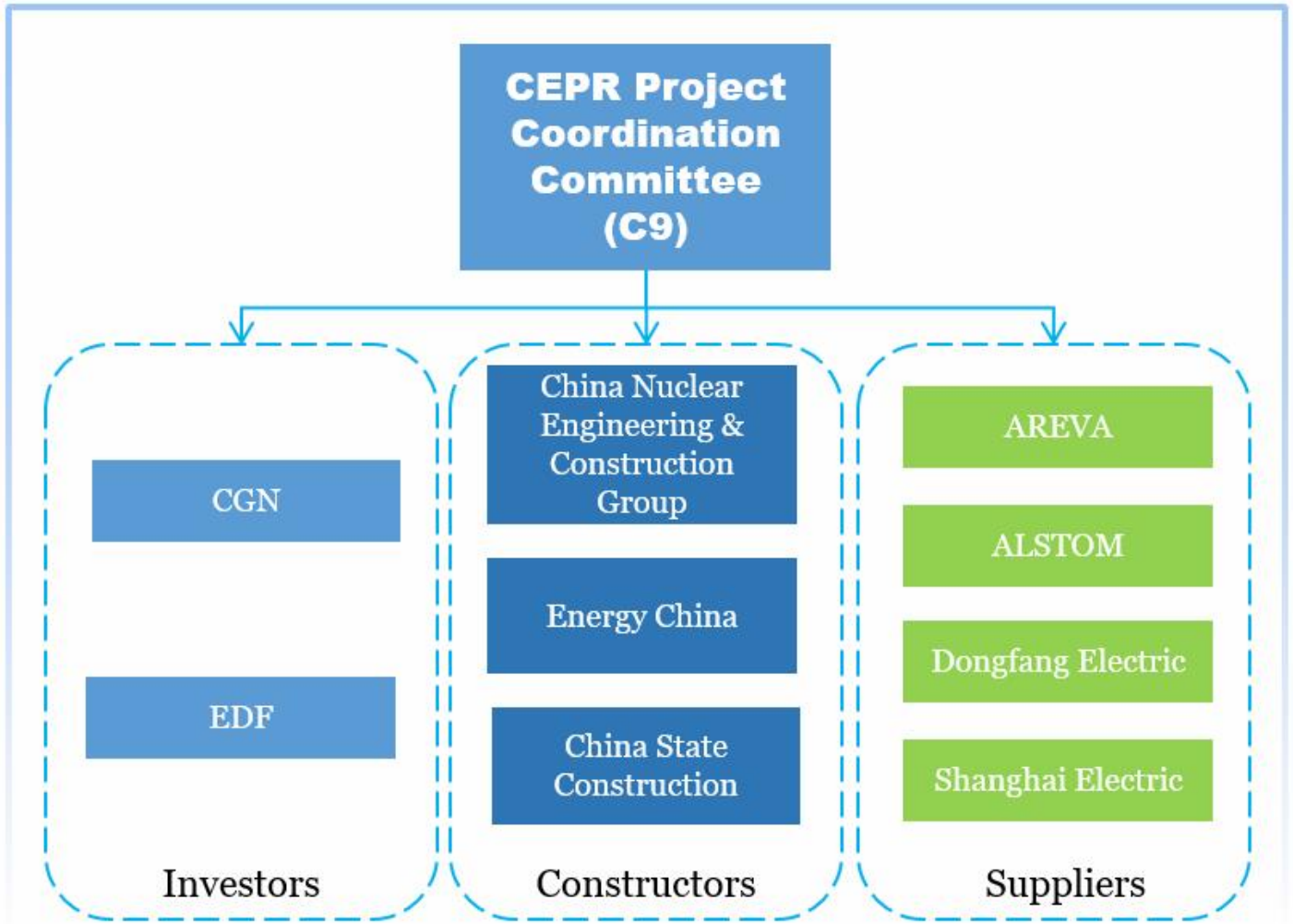
2013.4
Capital Injection
Increased capital to RMB 19.96 billion

2015.6-2016.1
Capital Injection
Increased capital to RMB 24.4 billion

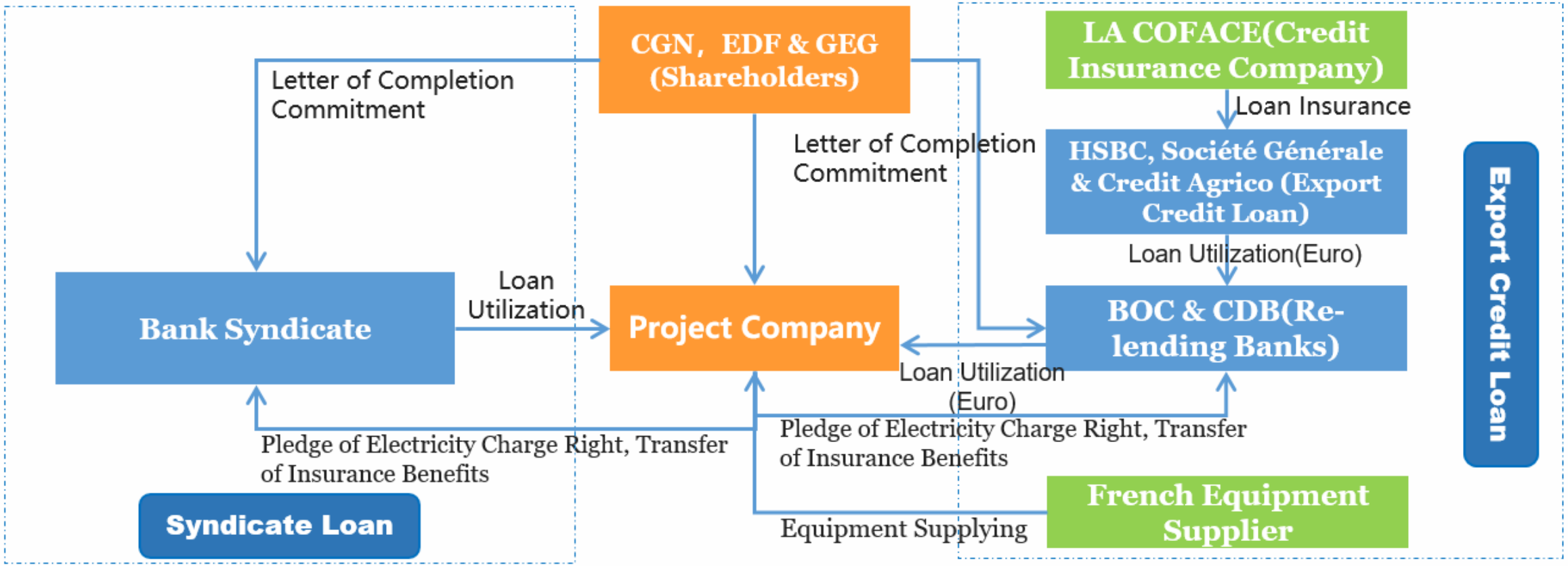
2019.7
Capital Injection
Increased capital to RMB 28.6 billion

Excellent Project Management Team

Initiated by CGN, the Taishan EPR Project Coordination Committee (C9) was established by the main investors, constructors, equipment suppliers of the project, the leaders of which consist the members of the C9. All parties deal with various problems encountered in the construction of the project in accordance with the principle of "priority on technical, quality and schedule controls."



Well-designed Credit Structure for Debt Financing



- The French export credit loan covers 85% of contract prices of equipment imported from France, as well as insurance premiums paid to La Coface (the Credit Insurance Company).
- The bank syndicate includes China Development Bank, Bank of China, Export-Import Bank, Industrial and Commercial Bank of China and Agricultural Bank.

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Summary

- **Healthy Economic Environment**

  A healthy economic environment increases the demand for electricity and reduces uncertainties of electricity consumption and tariff.

- **Policy Support for Clean Energy**

  Government policy support for nuclear power clean energy will increase financial institutions' loan support

- **Investors with Economic Strength, Experience and Trustworthiness**

  Strong, experienced and trustworthy investors will greatly reduce the discontinuation or abandon risk

- **Excellent Project Management Team**

  An excellent project management team expertly controls project schedule, quality and cost through resolving conflicts in an efficient manner, reducing the risks related to project completion

- **Well-designed Credit Structure**

  A well-designed credit structure based on project funding needs, project characteristics, etc. increases the probability of success of financing

Thanks!

UK Government Role in Design, Development, Financing and Deployment of SMRs in the UK

Amjad Ghori – Managing Director - AGIAS Advisory Limited

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1. Introduction & Expert Finance Working Group ("EFWG")

In January 2018, a small group of individuals with extensive experience in finance across all disciplines, including the nuclear sector, were given the remit to independently propose role/s that the UK Government ("HMG") can play to catalyze the design, development, financing and deployment of Small Modular Reactor ("SMRs") technology and projects in the UK. EFWG's task was to:

- Address the "market failure" in getting small nuclear technologies and projects to commercial delivery in the UK, especially the inability to secure private sector financing;
- Review and analyze risks specific to small nuclear and propose methodology to appropriately allocate and manage/mitigate these risks over the project's lifecycle, including barriers to investment from an equity and debt perspective;
- Explore a range of potential financial models for SMRs which HMG could "support" to engender market confidence, especially from private sector investors/financiers; and
- Deliver a set a concrete recommendations to assist HMG to de-risk (perceived and real risks), to motivate and to catalyze private sector investment, development and financing of small nuclear projects and technologies.

EFWG Methodology and Conclusion: (1) Evidence from multiple interviews with equipment Vendors/Stakeholders; (2) Developed a Risk Register; and, (3) Examined 9 different potential financing structures to assess risk tolerance amongst the Project Participants.

EFWG concluded that UK could be well placed to develop First-of-a-Kind ("FOAK") small reactor projects with overght costs of less than GBP 2.5 billion by 2030

2. Why SMRs?

Nature of small nuclear technologies and projects:

- **DO NOT** require a "bespoke" approach for each project assuming
  - **Modularization** - The ability to split a plant into packages (modules) which can be factory manufactured, transported and assembled on site; and,
  - **Modularity** – the ability to replicate identical small reactors to achieve a "fleet" effect and lower costs.
- **DO REQUIRE** a policy framework to get **FOAK** projects financial support during design, development and construction stages to reach commercialization;
- **DO REQUIRE** "Fleet" approach vs one off, bespoke NNB megaprojects with,
- **NOAK** ("Nth of a Kind") projects is where the real benefits from SMRs can be realized w/LCOE between GBP 40Mwh to GBP 80MwH;

Vendors interviewed by EFWG:

GE Hitachi: (Gen III) 300MWe BWR based on Gen III technology	**GF Nuclear:** Supporting the SMART 100MWe PWR based Gen III technology for cogen / desalination uses
NuScale: (Gen III+) 60MWe PWR that can be built in an array of up to 12 modules to create 600MWe station	**Moltex Energy:** (Gen IV) 300MWe Molten Salt Reactor that uses conventional fuel assemblies
Terrestrial Energy:(Gen IV) 192 Mwe Molten Salt Reactor new technology with standard fuel enrichment	**Rolls Royce:** (Gen III PWR) UK Consortium for 440MWe UK SMR, based on conventional technology
U-Battery: 4MWe Micro reactor based on high temp gas-cooled tech – cogen use	**Westinghouse:** (Gen III) 225MWe PWR and 400MWe Lead-cooled Fast Reactor (LFR)

Estimated costs for these technologies ranged between GBP 100mn to GBP 2.5bn

3 . EFWG Premise and Methodology

- EFWG concluded very early in the process that the reluctance of the private sector to finance FOAK risk **necessitates a strong Government role to motivate / catalyze financing for SMRs**;
- With this very realistic backdrop, EFWG examined nine (9), financing models / structures employed in the financing of large scale energy and infrastructure projects and "tested" them against a set of the dozen criteria listed below, including State Aid:

Impact on HMG balance sheet	Risk Allocation
Impact on Policy	Revenue risk
Ability to attract equity / debt (2)	Applicability to small nuclear
Impact on cost to consumers / taxpayers (2)	Maximum gearing
Ease of setting up	WACC

- Of the 9 potential financial models / structures examined, four were derivations off a Project Finance approach (reliance on cash flow for repayment of equity/debt), while others were models / structures previously employed to finance nuclear on a global basis;
- EFWG concluded that four potential models/structures could be adapted for financing small nuclear in the UK the various roles the government can potentially play in each scenario.

4. Risk Register and Risk Allocation

- EFWG developed a Risk Register that examined critical risk inherent to NPPs and allocated these risks amongst the various Project Participants in the table below

Risk	Description	Allocation	Comments
Technology	Viability of technology	Vendor / Technology Provider	Reference plants are emerging but site-specific differences still pose risk
Siting / Licensing	Securing suitable land and GDA	Developer / Sponsor	Consideration by UK Govt to reduce approval times
Financial / Equity	Heavy up front investment	Investor / Sponsor / Govt	Does Govt need to act as Super Investor
Construction	Long construction period	Sponsor	Govts unwilling to support in non-sovereign model
Revenue / Price	Unpredictability of future prices	Government	Subsides such as FIT / CfD
Political / Regulatory	Change in Law / Policy or regulatory requirements	Government	Critical to avert future Energiwende repeat
Insurance	Adequacy of coverage	Sponsor / Operator / Govt	Govt must stand behind any gaps in coverage
Operational	Suitability of operator / plant performance	Operator / Lenders?	Lenders should consider if satisfied with regulatory risk
Nuclear Liability	Nuclear accidents	Operator / Government	Protocols define limits but Govt must be ultimate backstop

5.1 PF base w/Cfd and PPA with HMG as Investor

Criteria	Impact	Criteria	Impact
Impact on HMG balance sheet	High	Risk Allocation	Positive – more genuine partnership between public and private sectors
Impact on Policy	Low if Cfd / High if PPA – legislation requirement	Revenue risk	Low
Ability to attract equity	High – will provide confidence to co-investors	Applicability to small nuclear	Medium – HMG role positive for FOAK Low to Medium NOAK
Ability to attract debt	High – will help rating and confidence to lenders	Maximum gearing	FOAK 50/50 NOAK 60/40
Impact on cost to consumers	Low - CfD well established	WACC	Medium – subject to HMG return requirements
Impact on cost to taxpayers	Low – reduces overall cost of project	State Aid	High – State Aid challenge likely
Ability to set up	High – markets well versed		

Comments:

- HMG as equity investor strengthens transaction in eyes of co-investors, lenders and other project participants
- High impact on balance sheet but will catalyze private sector finance
- Very helpful for FOAK projects

5.2 PF Based with CfD and PPA and HMG Guarantee

Criteria	Impact	Criteria	Impact
Impact on HMG balance sheet	Very High – depending on depth of guarantee provided	Risk Allocation	Medium – subject to construction risk
Impact on Policy	Low if Cfd / High if PPA legislation requirement	Revenue risk	Low – lower long term price risk
Ability to attract equity	Medium – helps rating structure and availability of finance	Applicability to small nuclear	Low – FOAK Medium to High - NOAK
Ability to attract debt	High – increases availability of finance across classes of debt	Maximum gearing	FOAK 60/40 NOAK 70/30
Impact on cost to consumers	Low - CfD well established	WACC	High – lower financing costs
Impact on cost to taxpayers	Low – reduces overall cost of project	State Aid	High – State Aid challenge likely
Ability to set up	High – markets well versed		

Comments:

- Very helpful to attract debt; 100% coverage of bonds and 80% coverage of debt
- Very high balance sheet impact – subject to depth and amount of guarantee provided
- Positive WACC impact due to lower financing costs on larger quantum of debt

5.3 Regulated Asset Base Model ("RAB")

Criteria	Impact	Criteria	Impact
Impact on HMG balance sheet	Low to Medium – depending on level of top-up payment and CfD risk structure	Risk Allocation	Medium – careful structuring of decommissioning risk
Impact on Policy	High – need to create new regulatory regime	Revenue risk	Low – transparency in price calculation
Ability to attract equity	High – easier to raise equity and easier to secure rating	Applicability to small nuclear	High – for both FOAK And NOAK
Ability to attract debt	High – debt would be raised with lower cost of capital	Maximum gearing	FOAK 70/30 NOAK 80/20
Impact on cost to consumers	High – will bear the costs not established on market basis	WACC	High – low rate of return
Impact on cost to taxpayers	Low to No Impact	State Aid	High – State Aid approval required if straightforward
Ability to set up	Medium – Have TTT example with permutations for nuclear		

Comments:

- Growing debate that RAB model is best suited for small and large nuclear
- Existence of precedent (TTT Project) allows for adjustments for nuclear to achieve success
- Strong rating potential will attract different classes of investors / financiers – competitive tension

6. Conclusions and Recommendations

- SMRs offer many advantages over nuclear megaprojects based on smaller size, modularity, shorter time to delivery all factors contributing towards de-risking projects and lowering costs;
- **Absolutely essential to establish transparent regulatory framework that addresses nuclear liability issues and Change-in-Law / Political Risks**
- **Create a baseline financing support structure that clearly addresses allocation, mitigation and management of associated that can be fine-tuned for project and technology specificity.**
- **Avail HMG balance sheet at each stage of small nuclear project lifecycle to catalyze and motivate private sector financing:**
  - Design Risk – provide much-needed early stage financing support in return for IP rights;
  - Manufacturing Risk – create/incentivize supply-chain dynamic for job creation and skills development;
  - Development Risk – mitigate construction risk through deployment of **RAB Model**
  - Revenue Risk - mitigate through **CFD and PPA** contractual structure
  - Financing Risk – participate as investor or guarantor or through RAB model all of which will attract private sector financing
  - Operations Risk – accept responsibility for regulatory risk

Recognition that UK Government needs to play a critical role in the advancement of nuclear sector, including SMR and AMRs. Great example evidenced by offer to Horizon NPP where UK Govt offered to provide CfD, debt guarantees and as co-investor.

7.1 Update on UK SMR Initiative

Key UK Government Announcements

- **June 28 2018 – Nuclear Sector Deal** – Objectives
  - 30% reduction in the cost of new build projects by 2030
  - savings of 20% in the cost of decommissioning compared with current estimates by 2030
  - 40% women in nuclear by 2030
  - a more competitive supply chain equipped to win domestic and foreign contracts of up to £2 billion by 2030

- **September 5, 2018 – Advanced Modular Reactor Feasibility and Development Project ("AMR F&D") Project**
  - BEIS is to invest up to £44 million in Advanced Modular Reactor (AMRs), defined as a broad group of advanced GEN IV nuclear reactors (vs GEN III SMRs), which use pressurised or boiling water for primary cooling.
  - Phase I : funding (up to £4 million, excluding VAT) to undertake a series of feasibility studies for AMR designs. Contracts are worth up to £300,000 (excluding VAT)
  - Phase 2: subject to phase 1 demonstrating clear value for money and government approval, a share of up to £40 million (excluding VAT) could be available for selected projects from phase 1 to undertake development activities. Up to a further £5 million may also be made available to regulators to support this

7.2 Update on UK SMR Initiative (Cont…)

- The following 8 organizations have been awarded contracts to produce feasibility studies as part of **Phase 1 of the AMR F&D** project in **October 2018**:

Advanced Reactor Concepts LLC	DBD Limited
Blykalla Reaktorer Stockholm AB (Lead Cold)	Moltex Energy
Tokamak Energy Ltd	U-Battery Developments Ltc
Ultra Safe Nuclear Cooperation	Westinghouse Electric Company UK

- As at **January 2020**, no **Phase 2 Funding** has yet been awarded as the above selected technologies need to demonstrate "clear value for money" and government approval to release up to £40 million
- Nov 6 2018 - Advanced Manufacturing and Construction Programme ("AMCP")
  - UK Government announced it will be providing £32 million for businesses to test small modular nuclear reactors and bring them to market;
  - AMCP will allow companies to bid for a share of the funding and help them commercialise the technology, which could "radically reduce" the costs associated with the nuclear industry;
  - Developers will also be invited to submit design proposals to identify potential risks with proposals early on, in an effort to reduce investment risks for potential backers

7.3 Update on UK SMR Initiative (Cont…)

- The Office for Nuclear Regulation (ONR), the Environment Agency and natural Resources Wales – will commence Generic Design Assessment (GDA) of new, small reactors in 2019.
  - With the government expectation that all future designs will go through this process, all interested parties will be able to register interest this year with BEIS, and applications for GDA entry will be accepted for review by government from early 2019
  - On **October 29, 2019** ONR issued **New GDA Guidance** for all future GDA work and reflects:
    - Improved safety standards in the previous decade;
    - The potential for Small Modular Reactor designs to enter in the GDA process in the future; and,
    - Lessons learned from previous GDA processes
- **Jan 28, 2019** - A consortium led by **Rolls-Royce**, which already makes components for submarines with pressurized water reactor (PWR) technology, requests £200 million (about $263 million U.S.) in government funding to continue its development of SMRs.
  - The consortium has said it would match the government funding and use the funds to advance its nuclear licensing process, with a goal of then attracting private investment.
  - Rolls-Royce UK SMR needed HMG support (matched by Consortium) to continue development of 220-MW SMR, a unit that could be doubled for a larger-scale project to 440 MW, at a cost of US$ 2.3bn.
  - On November 5, 2019 Rolls Royce receives £18mn from the Industrial Strategy Challenge Fund ("ISCF") to create £36mn joint investment with RR Consortium, as part of UKResearch & Innovation's Low Cost Nuclear Challenge
  - ISCF is worth up to £500mn (including co-investment form private sector) to promote SMR and ATR growth in the UK.

Panel Discussion and Q&A Session

To ask a question to the panelists
Please type your question in the Q&A section
Panelists will answer live or in writing