



DEVELOPMENT OF A NATIONAL NEW NUCLEAR POWER PROGRAMME

Nieuwe kernenergie Wat is er voor nodig?

KIVI - Koninklijk Instituut Van Ingenieurs 28 oktober 2022, Utrecht

Introduction



**Interim Manager.
Independent Consultant.**

**Executive Advisor,
Jacobs Energy
Transition Solutions.**

Ruediger Koenig
QENIQ Advisory and Jacobs

I work as an Independent Consultant in an agile personal network. And I work closely with JACOBS in support of Jacobs' growth in the Energy Transition.

Jacobs at a glance

At Jacobs, we're challenging today to reinvent tomorrow by solving the world's most critical problems. Jacobs provides a full spectrum of professional services including consulting, technical, scientific and project deliver for the government and private sector. Jacobs leads the global professional services sector providing solutions for a more connected, sustainable world.

By the numbers

50+ Countries	55K+ Employees	400+ Offices
23.8M Metric Tonnes CO ₂ avoided for clients	\$14 Billion In annual revenue	\$2.5 Billion In client savings

Focus areas

 Cutting-Edge Manufacturing	 Mission-Critical Outcomes	 Operational Advancement
 Resilient Environments	 Scientific Discovery	 Thriving Cities

Interim Manager and Executive Advisor in clean energy value chain.

Business Development and Programme Management engagement with Jacobs.

30+ years C-level experience with investors, suppliers, service providers.

- Lead lean organisations and complex business transactions along the supply chain (engineering, manufacturing, services, commodity trading and finance, generation, power sales).
- Design and implement corporate strategies to address changing market conditions and shareholder expectations in nuclear, solar and biomass.
- Nuclear new build programme management at a European utility 2007 - 2013.
- Advisory Board Member at ENLIT EUROPE (former PowerGen) and at Asia Business Platform.
- Affiliated Partner, NECG - Nuclear Economics Consulting Group.

Current key agenda: “Managing The Transition Gap”

The Transition Gap - a global challenge

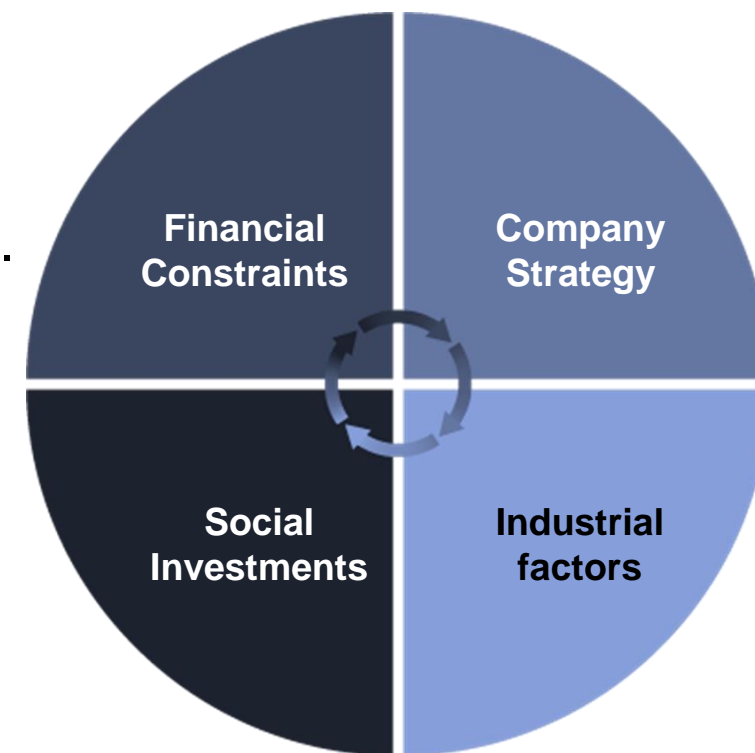
**The 'old energy system' will be replaced –
within the next 15~20 years:**

A completely new system will be placed on top of the existing one...
... the old must make room for the new...

a multi-trillion EURO task

overlaid by

a multi-trillion EURO task



Decommissioning and repurposing = a holistic challenge for our industry and society.



PRESENTATION OUTLINE

- **Prospects for nuclear new build are burdened by long construction periods, high perceived and actual construction cost and risk**
- **EU energy policy framework expects “markets” i.e. private companies and investors to take most risks**
- **This presentation will analyze these challenges and develop some ideas how they could be overcome**

IAEA provides a reference framework for New Build

3 Phases and 3 Milestones

3 Key Organizations

19 Nuclear Infrastructure Issues

<https://www.iaea.org/topics/infrastructure-development/milestones-approach>



National position



Nuclear safety



Management



Funding and financing



Legal framework



Safeguards



Radiation protection



Regulatory framework



Electrical grid



Human resource development



Stakeholder involvement



Site and supporting facilities



Environmental protection



Emergency planning



Nuclear security



Nuclear fuel cycle



Radioactive waste management



Industrial involvement

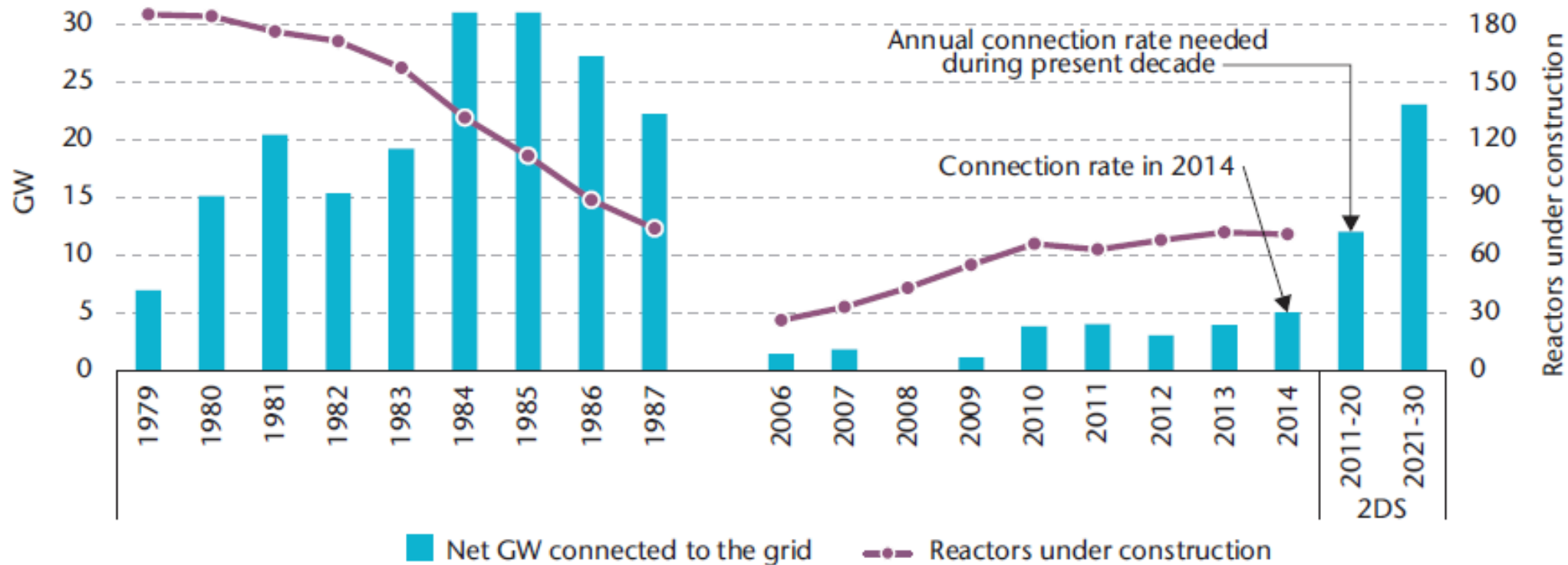


Procurement

Kivi conference today addresses these key issues.

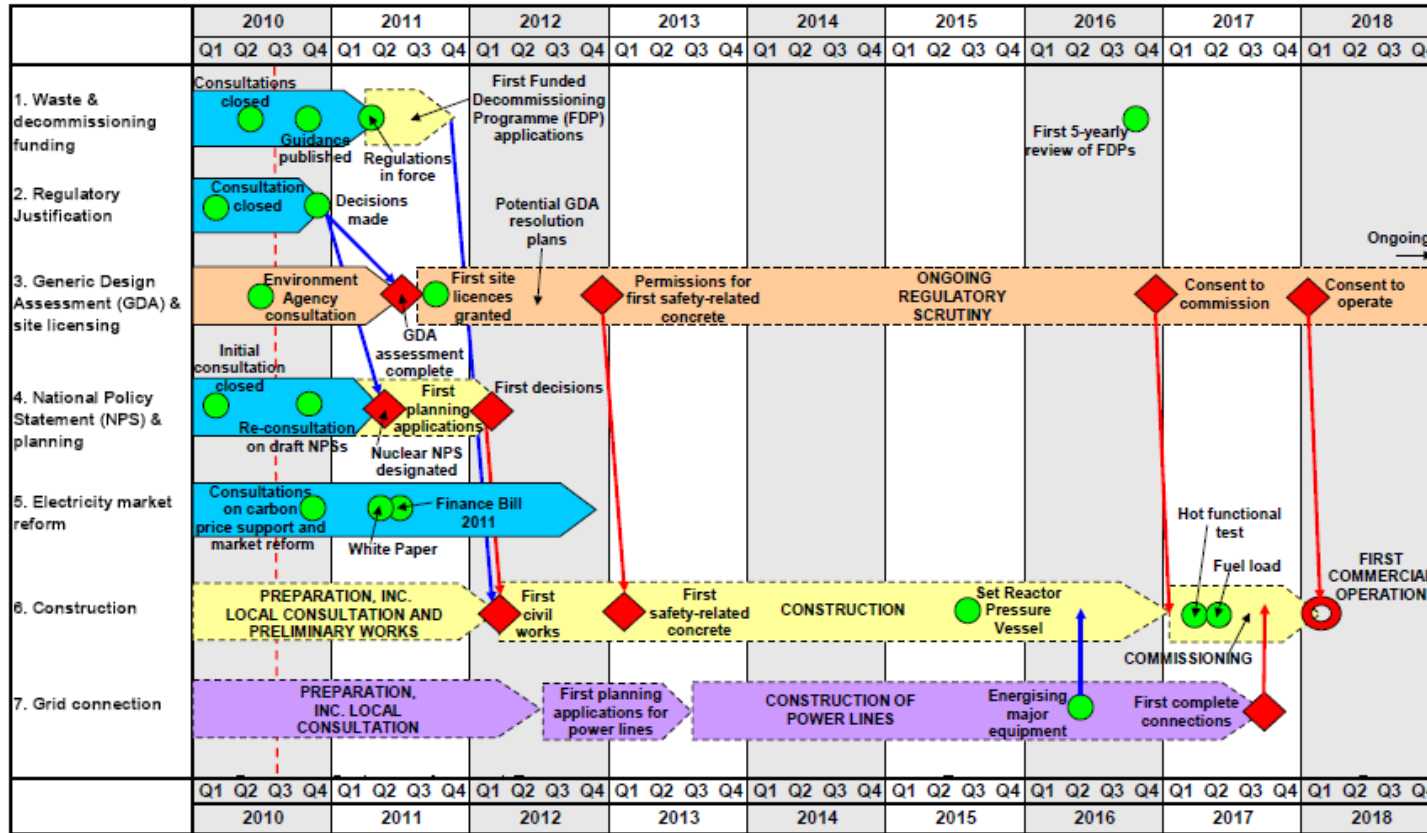
Ambitious construction program is possible

Has been achieved before, and has been achieved more recently outside Europe.



Applying a Framework

UK experience since 2010: excellent design and execution, but ...



2008/09 Britain must build "at least" eight new nuclear power stations during the next 15 years to replace its ageing plants and contribute to a "post-oil economy" that is cleaner and much more efficient than in the era of "cheap energy and careless pollution", ... "first new reactors could feed electricity into the national grid by 2017" – or "10 sites within a decade"

2010 "8 potential new nuclear power stations to be operational by 2025"

2022 one (1) project under construction, planned to be commissioned in June 2027.

- KEY:**
- Government
 - Regulators
 - Operators
 - National Grid
 - Milestone
 - Critical path
 - Generic activity
 - Project-specific activity

INDICATIVE TIMELINE FOR FIRST NEW NUCLEAR POWER STATIONS

NOTES:

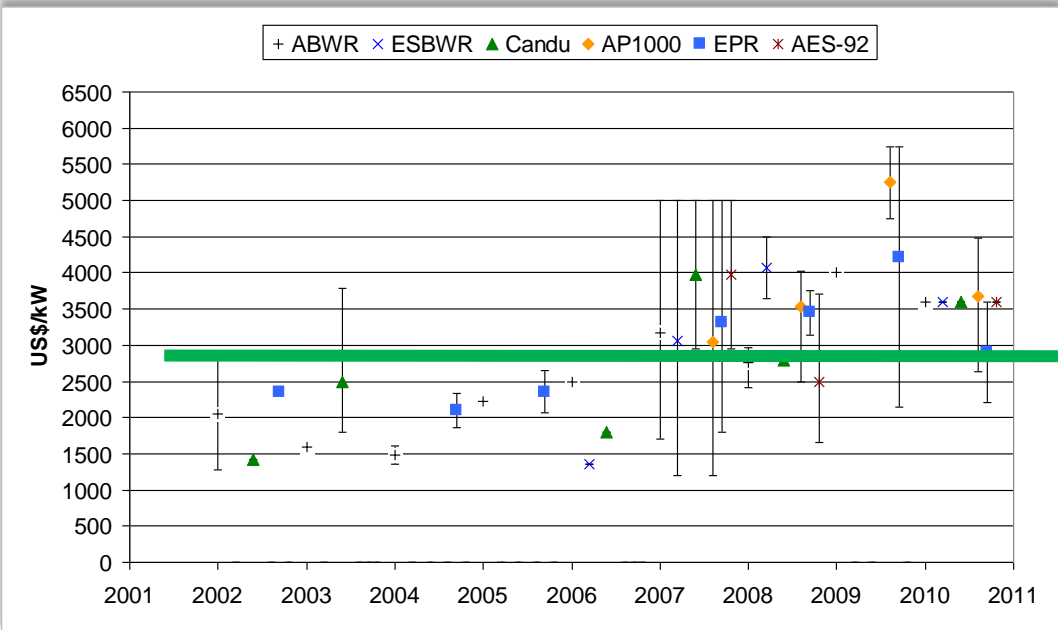
- All timings given in this plan are indicative only and subject to change. This document was current as of **AUGUST 2010**.
- This plan shows an indicative pathway to commercial operation of the first new nuclear power station by 2018. In line with announcements from prospective operators, other new nuclear power stations are expected to become operational after 2018.
- Assumptions in this plan about future timings/milestones in no way prejudice the outcome of current or future Government processes, regulatory approvals or planning decisions.
- "First safety-related concrete" refers to structural concrete within the nuclear island.

Source: UK Office of Nuclear Development - August 2010

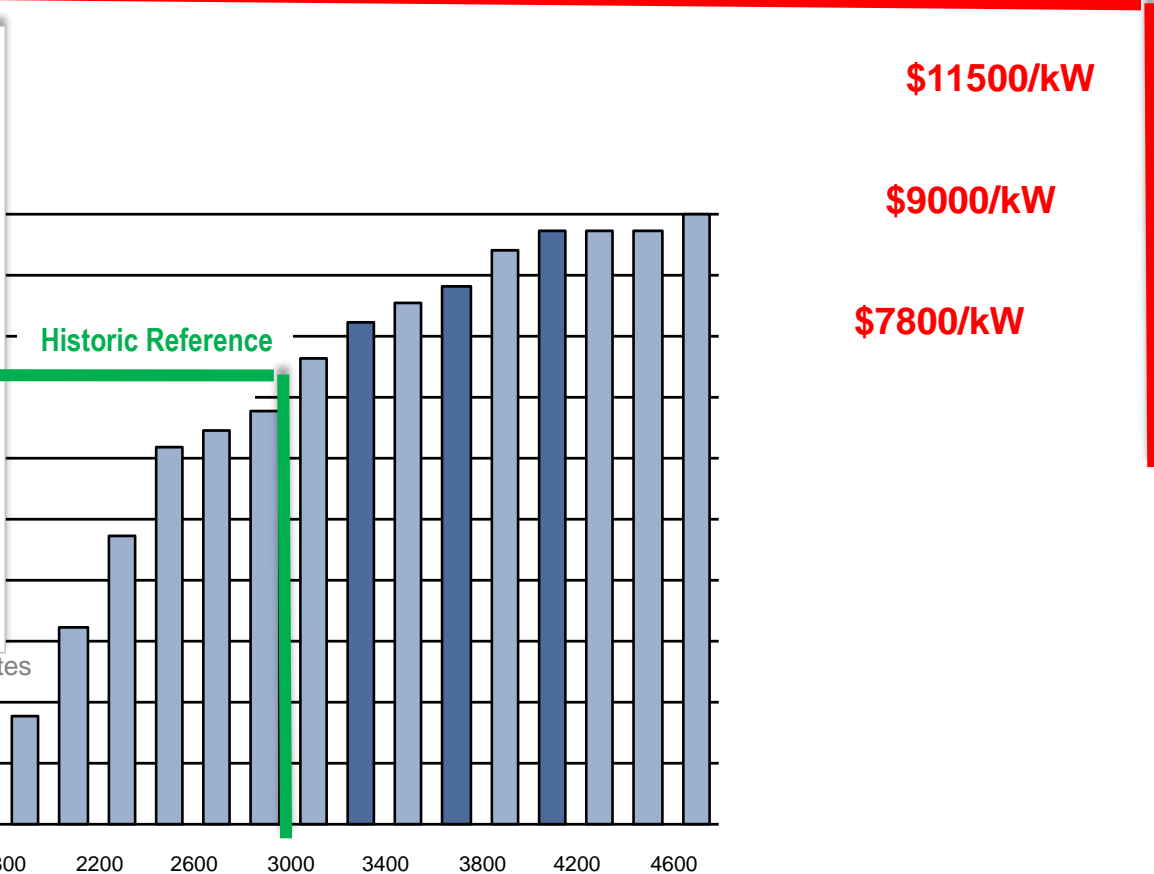
Cost Estimates – How it started, how its going

“From hype to wretched”

Recent European Experience



Historic data, based on published cost estimates



Cost reductions below historic levels were **expected** (modularisation, less components, smaller footprint, learning curve, etc.) ...
... **but not delivered so far.**

Nuclear New Build in Europe faces particular challenges



Political framework

- Long-term society commitment is a prerequisite for investors
- Sustainable licensing framework needed
- Clear definition of responsibility and costs for nuclear back end
- Energy market regulation and government intervention (renewables support, special taxes and levies, etc.)
- Current developments (political and nuclear)



Financing against an “unregulated” market

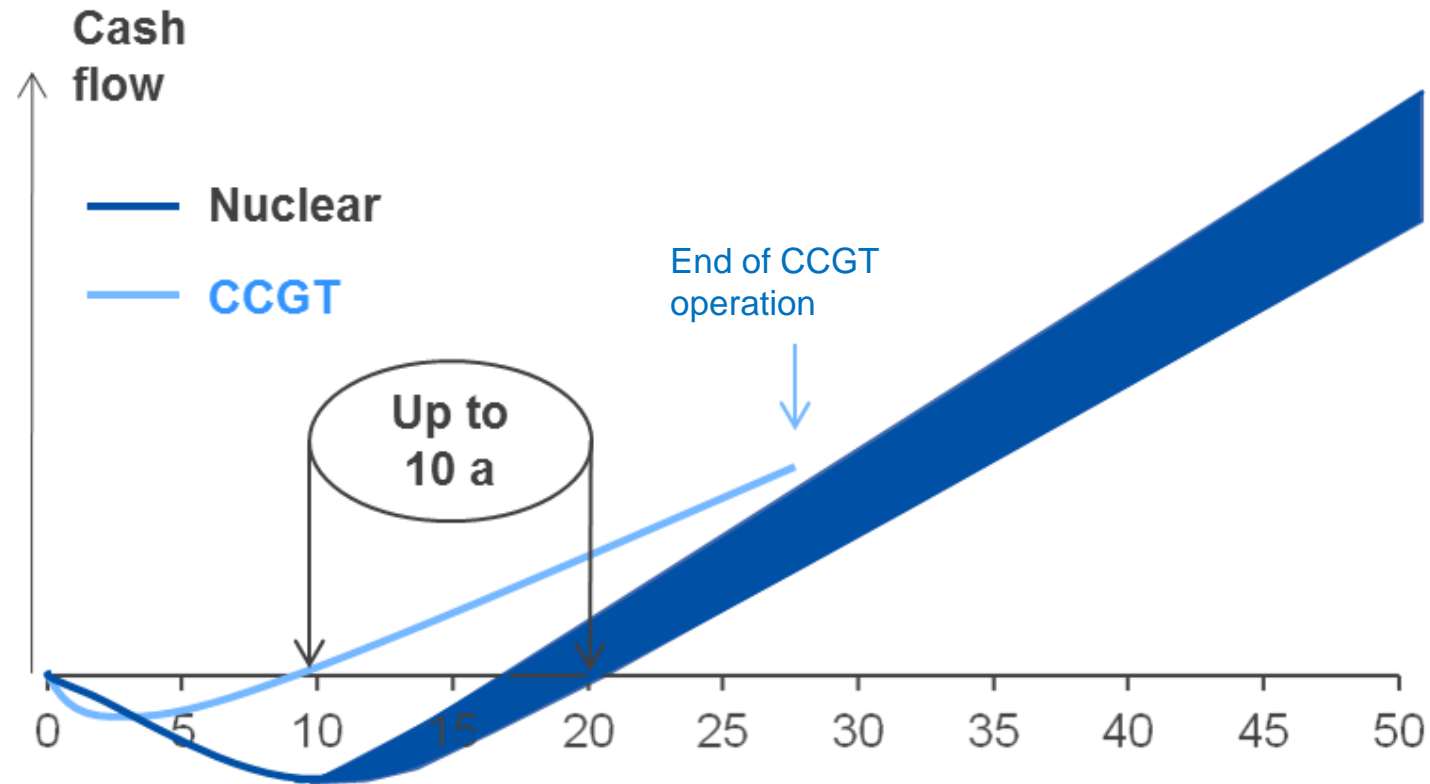
- High upfront costs - balanced out lower costs over lifetime
- No non-recourse financing
- Nuclear as a price taker

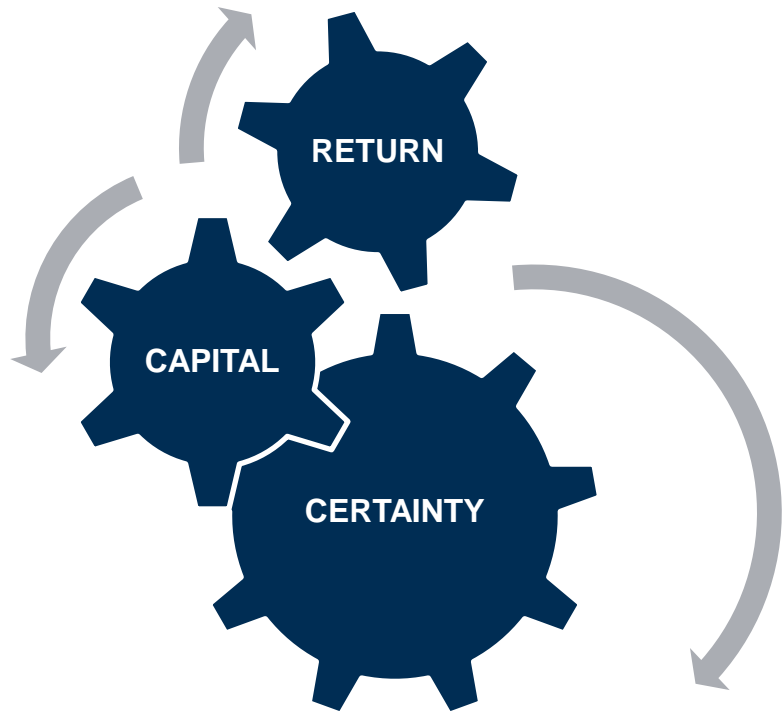


Project Model

- Supply Chain Development
- Technology at highest safety and quality standards
- Complex project execution
- Limited economies of scale

Payback is in the long run





RETURN: Revenues (offtake volume and rates) can be made reliable by government action. Operating and backend cost are predictable and favorable. Initial CAPEX is high risk: cost estimates have tripled since 2007 but this is (partly) due to multi-layered risk compounding. Long duration compounds the problem.

CAPITAL Difficult because: (i) very few investors have balance sheets that can absorb large, nuclear cluster risk (major cost increases let alone abandonment of projects); (ii) involvement in nuclear projects hurts ratings, raising cost of debt capital cross board, leverage effect; (iii) stock markets punish if investors ignore these first two issues. - Risk allocation to vendors faces same issue.

CERTAINTY: Nuclear new build in OECD countries has terrible track record - cost and schedule seem to have no bounds. This has a circular effect in that vendors, investors, lenders include the worst case with added contingency, raising total cost and thereby absolute risk.

*) Government owned investors may be part of a geopolitical strategy with important non-financial drivers.

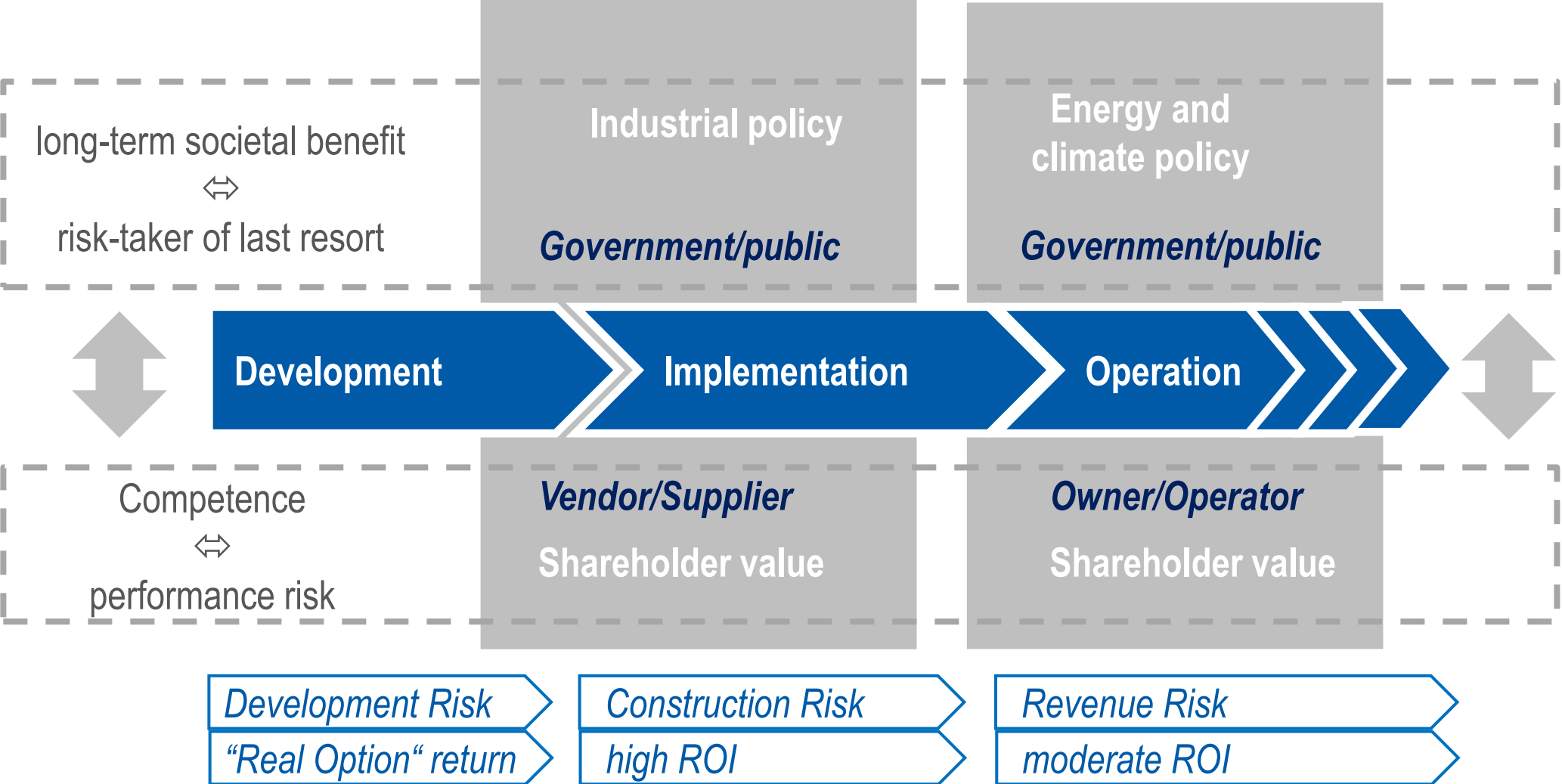
Ideal project owner – where to find?

- A reputable nuclear operator, with a complete life cycle experience
- Intimate knowledge of the different state of art technologies, applicable regulatory requirements and processes
- A proven project delivery record, first hand technical and commercial experience with nuclear new build projects
- Strong project resources, control systems and procedures to ensure certainty in project scope, cost, schedule and quality
- Strong balance sheet and very long-term investment perspectives
- Strategic interest in relevant power market
- ... no unwanted political strings attached...

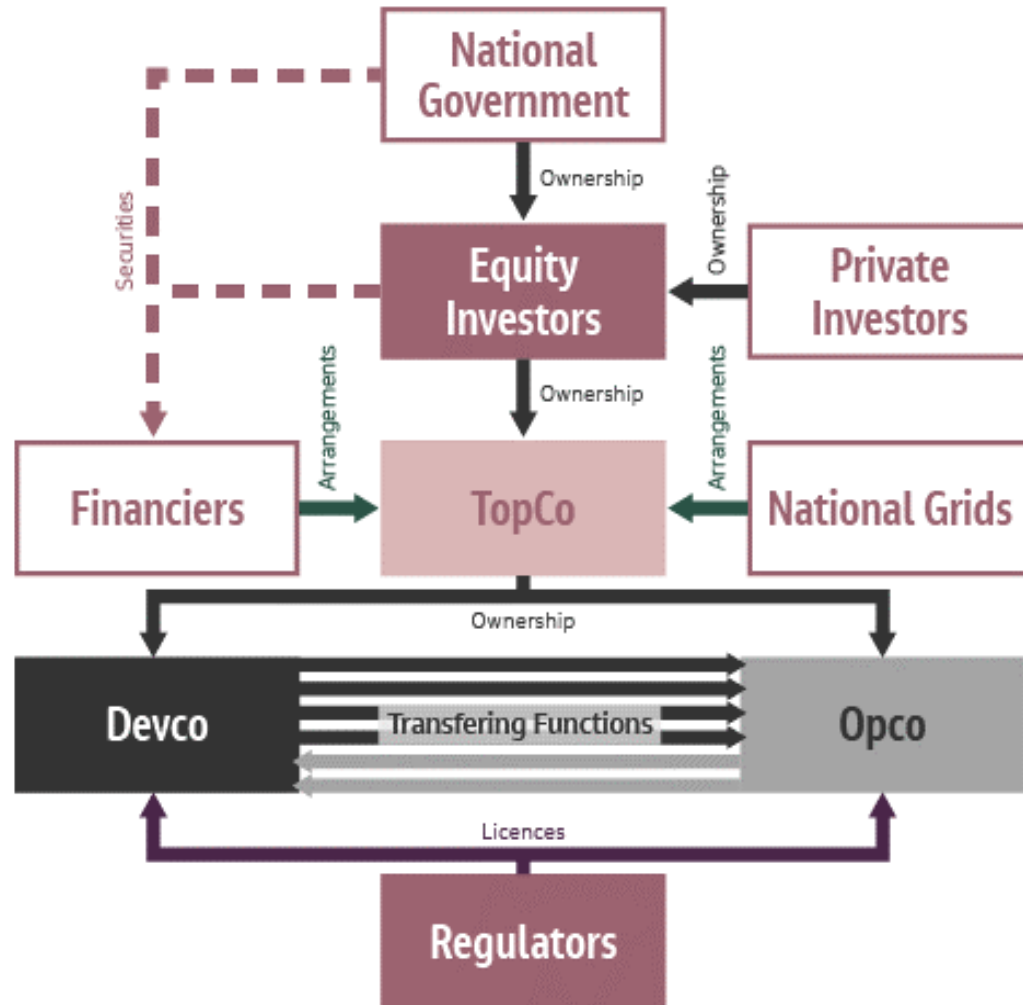


If they have all that: Why would they take nuclear new build on themselves? And how many plants could they undertake, and where? ...

Government roles

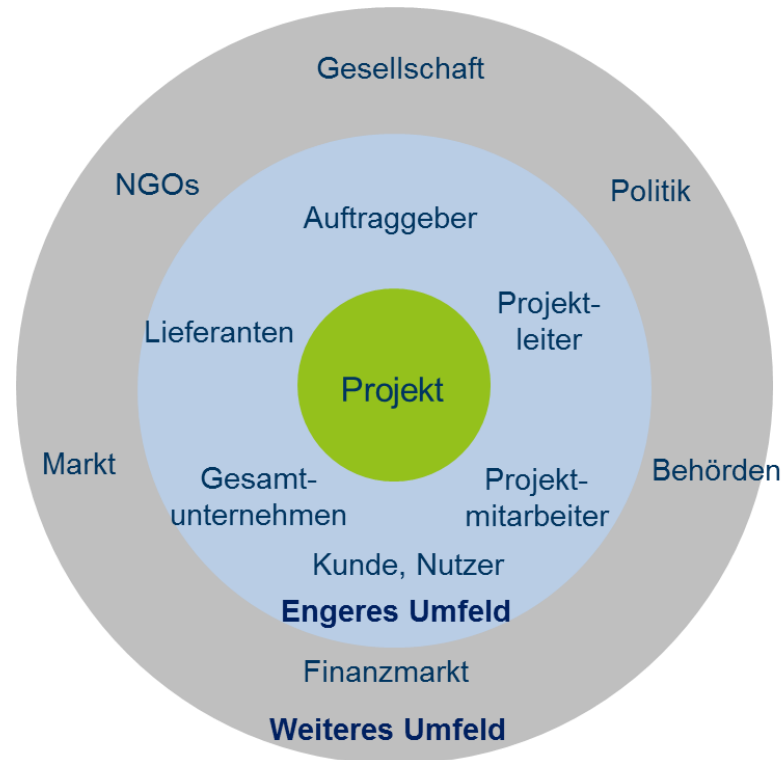


New Nuclear Build Programme Design



Grouping	Purpose
Equity Investors	NPP owners and equity investors can be National Governments or Private Equity.
Financiers	Financing parties usually providing debt funding.
TopCo	Typically Trading Company and owner of Devco and Opco (can have different ownership in more complex models).
National Grids	Use of the power when generated and revenue source to NPP.
Devco	Development company charged with contracting the NPP and holder of the Construction Licence and when completed disbands.
Opco	Operational company that will operate, maintain and be the holder of the operational licences and will continue to exist until the plant is completely decommissioned.
Regulators	Government bodies of independent regulators that issue licences to permit construction and allow nuclear operations.

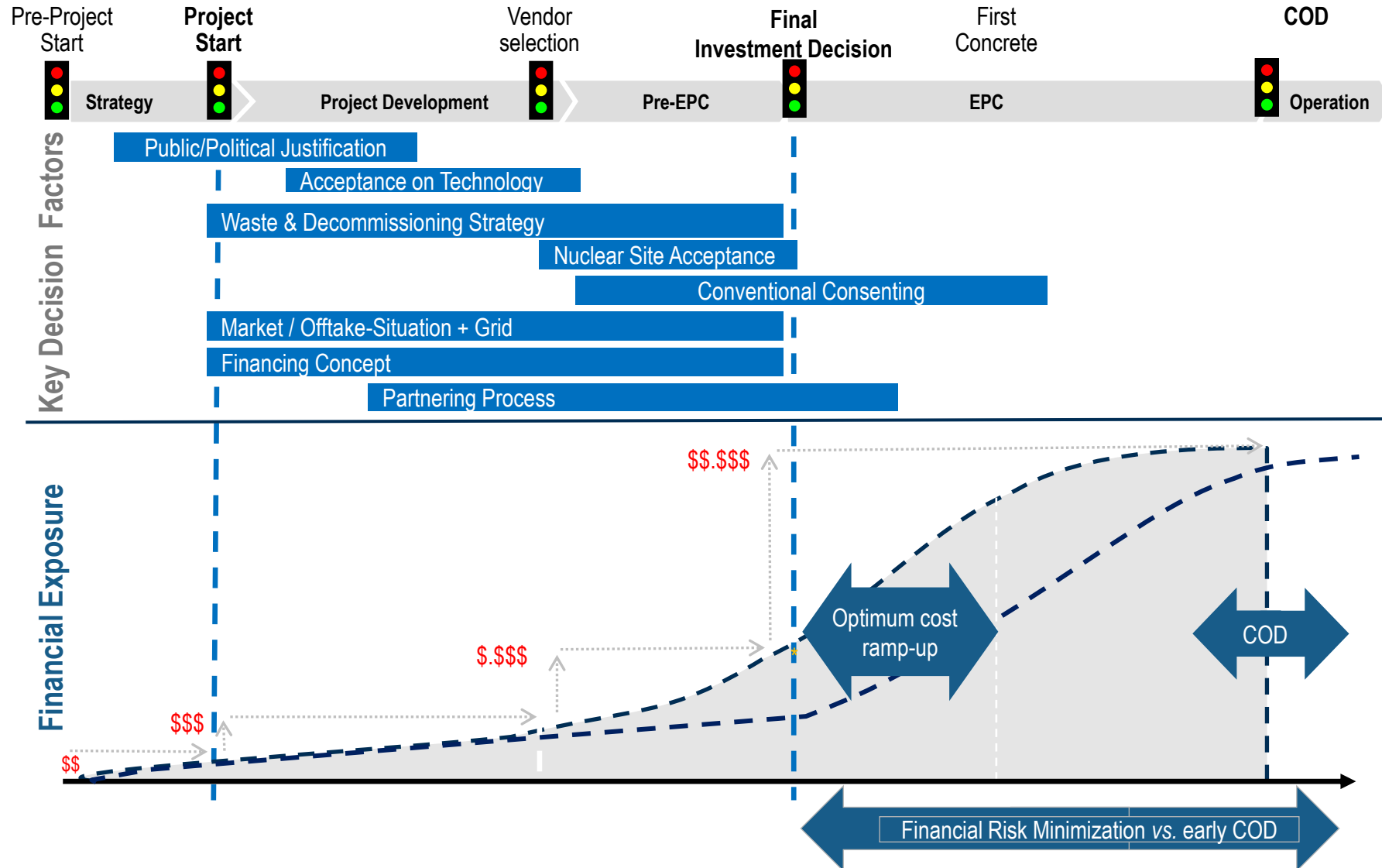
Project World



... in perspective



Seeking Certainty - Programme Design



Challenges in Power Markets, for Nuclear

Market Factors
Market Regulation Regulated-> Liberalized-> Managed
Market Structure Centralized -> Decentralized
Commodization Fixed Assets, dispatchable -> „asset light“, flexible
Finance Big regulated utility, long-term returns -> capital market driven, ROI driven -> National infrastructure, localization, exports, etc.
Capital Cost <u>including</u> System Integration
Decarbonization
Reliable/Secure Supply
Cost per MWh

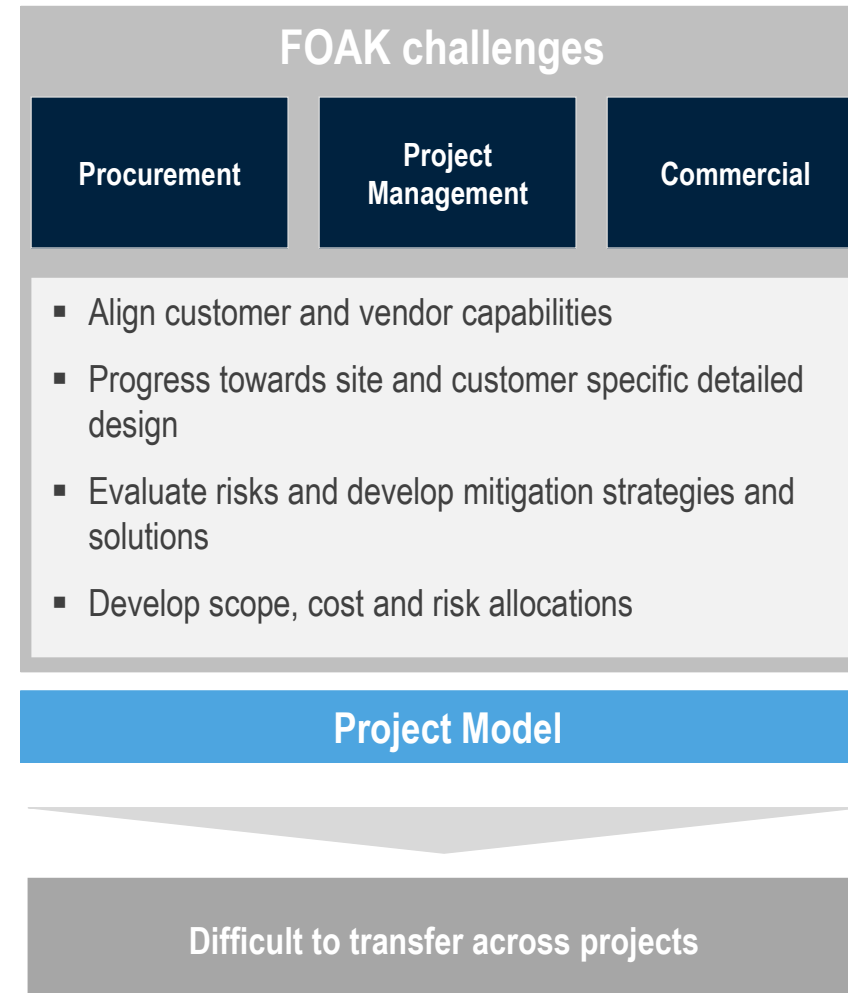
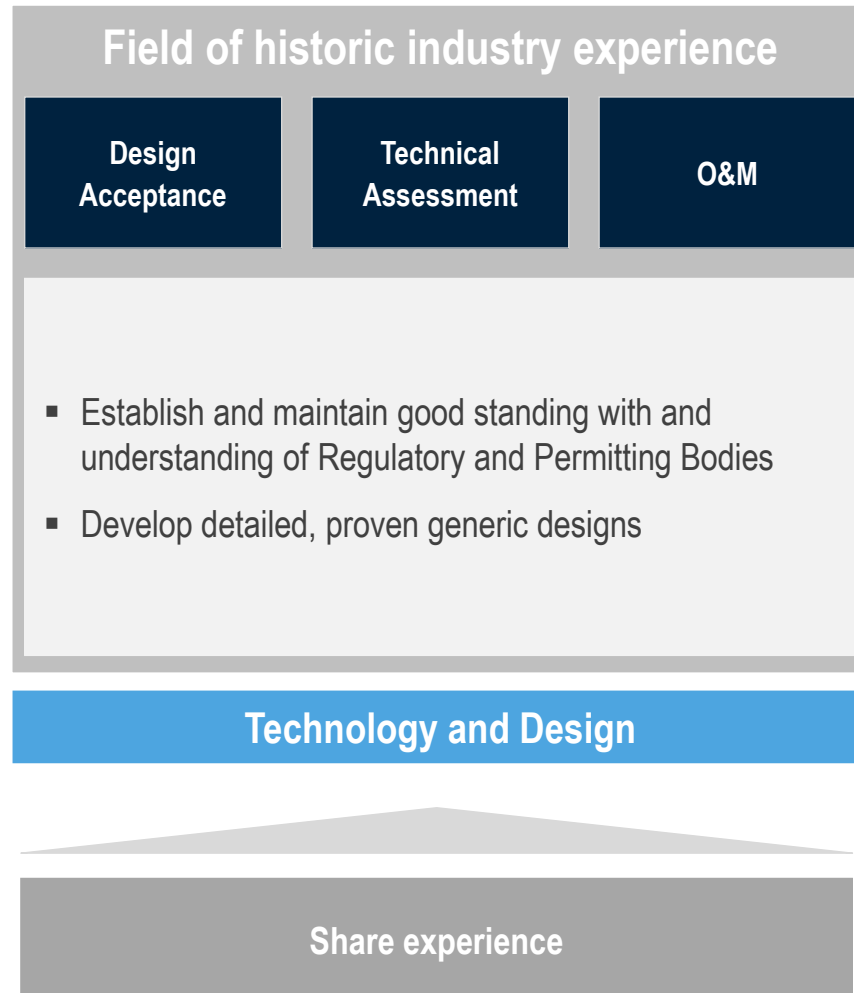
Developing Issues

- not fully understood
- provides opportunities

Established Issues

- understood but
- needs success stories

Interaction between client, supply chain and regulator needed to address first-of-a-kind challenges



Modes that drive success

- Aligned goals, metrics and recognised benefits
- Knowledgeable Investor
- Robust business case
- Requirements clarify
- Focus on relationships
- Shared Incentive mechanisms
- Openness and transparency
- Common approaches
- Deployment into supply chain
- Balanced equability in venture
- Quick decision making based on shared objectives
- Shared corrective action
- Performance improvement

Modes that cause failure

- Ambitious expectations and contracts
- Untested and non robust solutions
- Insufficient monitoring and measurement
- Punitive measures
- Unconvinced stakeholders
- Workshare orientated reward
- Supply chain failure
- Strategic importance reduces
- Disrupted/ uneconomical funding
- Little focus on the investor's needs
- Poor leadership and culture
- Adversarial relationships
- Lack of commitment to programme
- Unclear vision and mission

Project Approach *Versus* Programme Approach

- **Project Management** is suitable when:
 - The output is definite and the objective is well defined
 - There is sufficient clarity to define work-packages
 - Clear understanding of resource required to achieve the output
 - Detailed schedule of work can be derived
- **Programme Management** is suitable when:
 - An Organisation has a vision / goal but not the clear roadmap how to get there
 - The requirements are insufficient to establish a detailed project, or set of projects
 - There are multiple complex interferences, organisations etc. and large values
 - Multiple Stakeholders are involved who have an influence on how to achieve the goal and must be engaged to ensure a successful outcome

Large infrastructure projects like nuclear new build need a Programme Management approach.

A Programme Management Approach

- Programme Management delivers strategically declared benefits and outcomes and is systematic, robust, auditable and adaptable to business and political change
- Programme Management recognises interdependencies and provides a shared oversight mechanism for driving cost reduction between Projects
- Introduces change management linking scope, budget and risk across a number of Projects in a controlled manner using a Project Baseline
- Provides benefits management through the integration of multiple projects, providing a common reference point for Defining Benefits, Quantifying Benefits, Measuring Benefits and Monitoring Benefits
- Recognises stakeholder engagement and communications between projects and puts in place governance and oversight to effectively achieve these

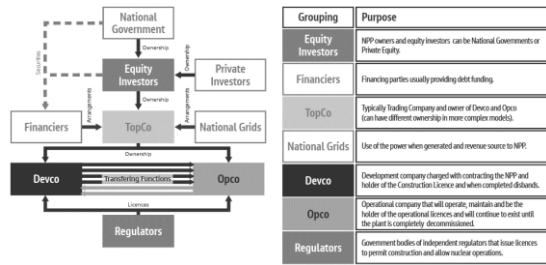
Programme Management delivers **outcomes** through a common, yet reactive and flexible methodology across multiple projects.

Programme Delivery Framework

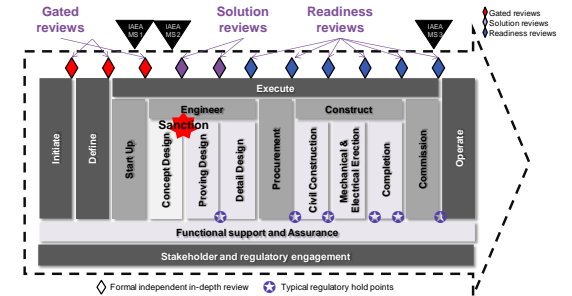
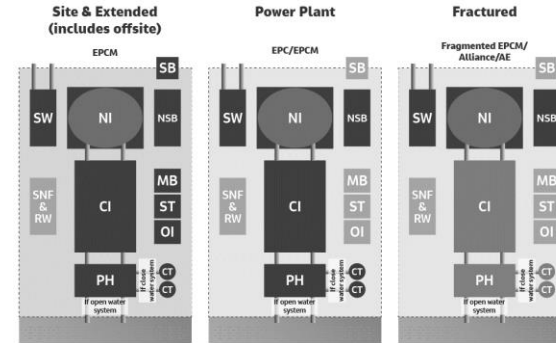
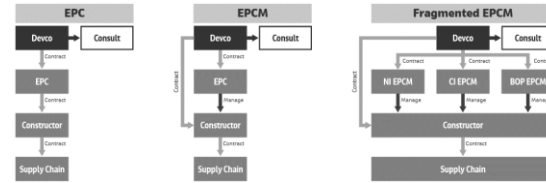
- Organizes and integrates to optimise delivery of the desired outcomes
- Standardizes delivery strategies, processes, tools and resources around a common tailored platform
- Integral and integrated elements covering initiation, delivery platform, portal, maturity and score carding
- Provides shared tools for efficient delivery to:
 - Overcome complexity and uncertainty
 - Manage risks / risk impacts
 - Provide reporting
 - Enable effective communication and co-ordination of diverse efforts
 - Realise benefits



New Nuclear Development Programmes require a holistic understanding during the planning phase.



Grouping	Purpose
Equity Investors	NPP owners and equity investors. can be National Governments or Private Equity
Financiers	Financing parties usually providing debt funding
TopCo	Typically Trading Company and owner of Devco and Opco (can have different ownership in more complex models)
National Grids	Use of the power when generated and reverse source to NPP
Devco	Development company charged with contracting the NPP and holder of the Construction License and when completed disbands.
Opco	Operational company that will operate, maintain and/or the holder of the operational license and will continue to exist until the plant is completely decommissioned.
Regulators	Government bodies of independent regulators that issue licenses to permit construction and allow nuclear operations.

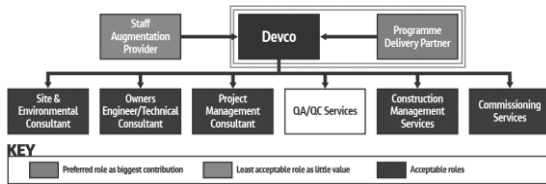


Organisational structuring

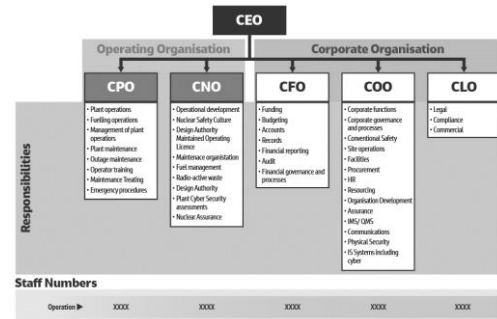
Programme structuring

Work Package structuring

Governance and Phase Structuring



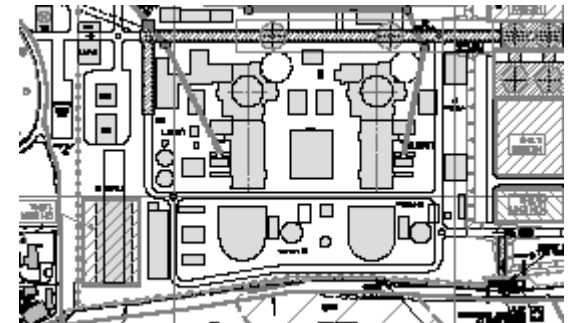
DEVCO / OPCO structuring



DEVCO/ OPCO organisations

System	Key Elements
Nuclear Steam Generator	Emergency boron system, Reactor coolant system, Chemical and volume control system, etc.
Mechanical Systems and Equipment	Sea water systems (including cooling), Cooling water systems, Demineralized water distribution, etc.
Electrical Systems and Equipment	Connections (incl. to the Grid), Unit Station/Gen Transformers, Main electrical distribution system, etc.
Fuel Handling Systems and Equipment	Fuel handling - refuelling machine, Multistep handling machine (MHDG), Handling tools - lighting - separator reactor building platform, etc.
Waste Management	Liquid Waste Management System, Gaseous Waste Management System, Solid Waste Management System, etc.

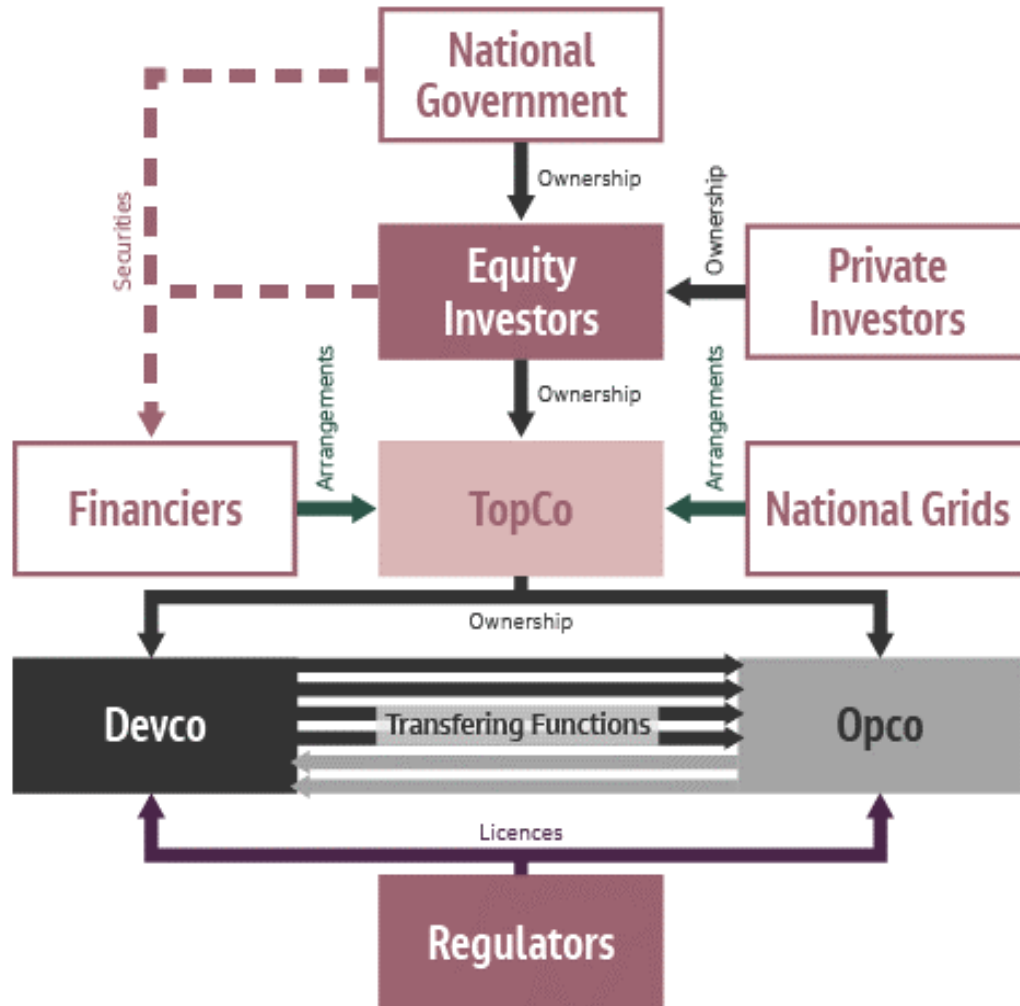
System structuring



Space/ area structuring

There are many choices to be made - and updated - in various structures to ensure the programme is optimised and aligned to the desired outcomes

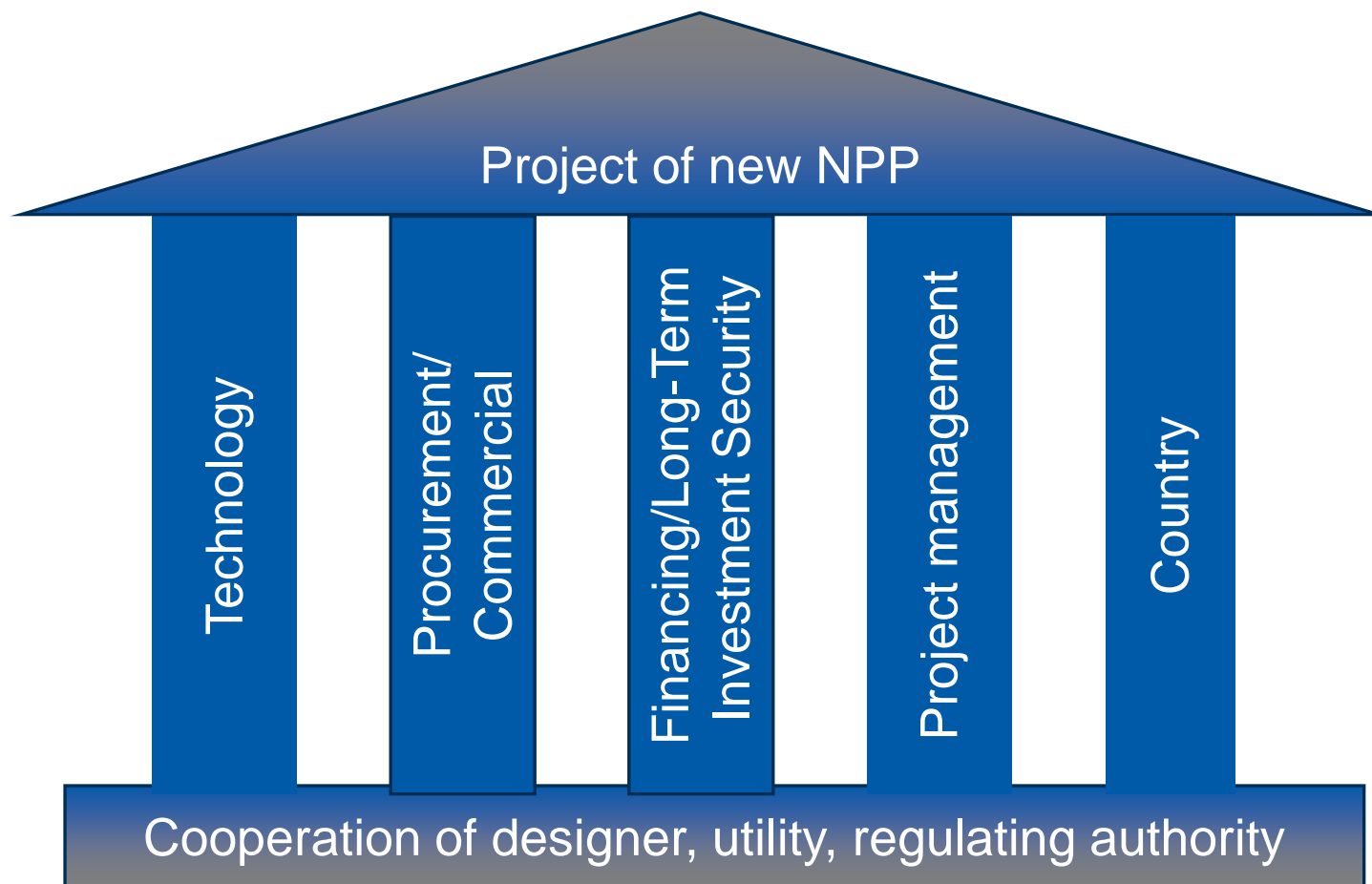
New Nuclear Build needs a dynamic organization



Grouping	Purpose
Equity Investors	NPP owners and equity investors can be National Governments or Private Equity.
Financiers	Financing parties usually providing debt funding.
TopCo	Typically Trading Company and owner of Devco and Opco (can have different ownership in more complex models).
National Grids	Use of the power when generated and revenue source to NPP.
Devco	Development company charged with contracting the NPP and holder of the Construction Licence and when completed disbands.
Opco	Operational company that will operate, maintain and be the holder of the operational licences and will continue to exist until the plant is completely decommissioned.
Regulators	Government bodies of independent regulators that issue licences to permit construction and allow nuclear operations.

Agenda

- **Programme design**
- **Business Case**
- **Competencies, Training**
- **Operating Model**
- **Regulatory**
- **Supply Chains**



Thank You For Your Attention!



DIPL.-KFM. RÜDIGER KÖNIG
PHONE +49 201 843 9593
MOBILE +49 172 868 8800
RK@RUEDIGER-KOENIG.COM
WWW.RUEDIGER-KOENIG.COM

Short Excursion (SMR)

SMRs and GEN IV advanced plants

Various anticipated benefits drive development

01

Replace large NPPs

Modular approach allows risk mitigation.

02

Replace Coal and other

Existing sites where gas and renewables are not feasible alternatives.

03

Industrial Needs and District Heating

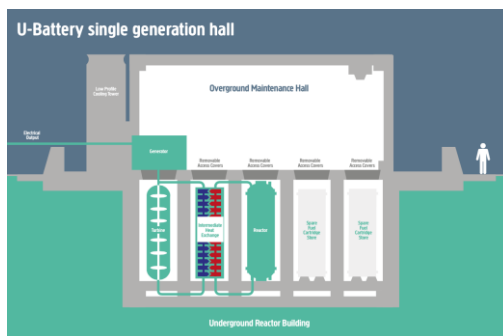
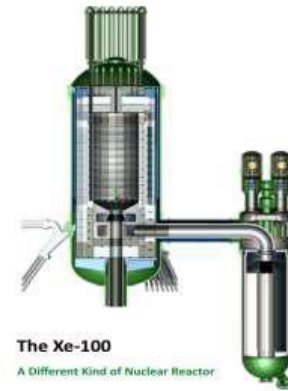
04

Special Applications

E.g. barges for offshore, desalination, or other mobile needs.

SMR – Small Modular Reactors

Many countries, many designs, many projects ...




SMR – Small Modular Reactors

... many hopes and promises. Many questions.



Small, Hi-Tech
Positive connotation.



“Nuclear”
Negative connotation and regulatory challenge



Small, Modular
Advantages for design and manufacturing



Economies of scale
Manufacturing.
Cost per MWh.



Modular
Advantages for investment and market integration



Market breakthrough and penetration