NERA
Economic Consulting

Global Nuclear Power Developments

China Leads The Way

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Insight in Economics™

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The views expressed in this presentation and discussion are mine and may not be the same as those held by NERA's clients or my colleagues.

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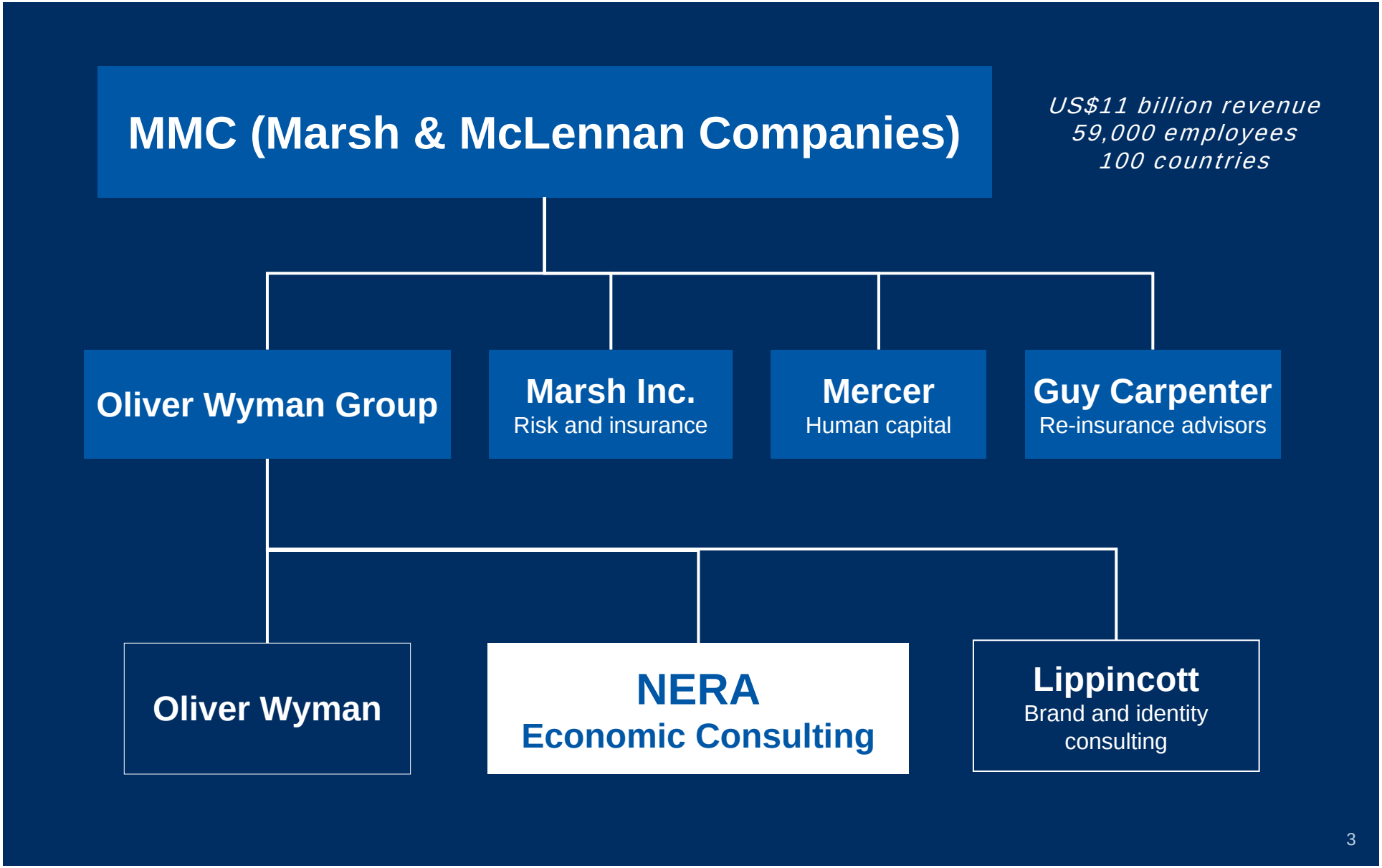
Introduction to NERA

NERA is part of MMC



About Our Firm

NERA Economic Consulting

NERA Economic Consulting is an international firm of economists who understand how markets work

- NERA economists devise practical economic advice related to highly complex business and legal issues arising from:
  - Competition, regulation, public policy, strategy, finance, and litigation
- We create strategies, studies, reports, expert testimony, and policy recommendations that:
  - Reflect our specialization in industrial and financial economics
  - Build upon our more than 45 years of practical experience
- We are widely recognized for our independence
  - Our clients come to us expecting integrity and the unvarnished truth
  - We commit to deliver unbiased findings

Our Global Presence

NERA Economic Consulting

Our global team of more than 500 professionals operates in more than 25 offices across North America, Europe, and Asia Pacific.

Nuclear power engagements

- **Due diligence**
- **Regulatory approval and rate cases**
- **Design and vendor evaluation**
- **Market and industry analyses**
- **Litigation and arbitration**
- **Risk**

Case Experience: Nuclear industry litigation

Project description	**Current and past litigation/arbitration cases in nuclear power industry**
Case overview	**Case issues include global market size, market dynamics, global nuclear fuel cycle markets, latent defects, nuclear power strategies, and related issues.** **Cases are confidential, but the expertise and insight from developing expert testimony and analyses enhances NERA's ability to provide high-level advice to clients.**
Key outcomes	**NERA experts conduct detailed analysis, file testimony, rebut the testimony of opposing experts, and are subject to cross-examination**
Relevance	**Relevant, interesting and timely insights into global nuclear power markets, vendor strategies, and related issues**

Case Experience: National nuclear roadmap

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Project description	**TNB – Malaysian electric utility - nuclear roadmap**
Case overview	**Formulated a policy and strategy road map for Malaysia to develop its first nuclear power plant. This engagement drew on the IAEA milestones, readiness assessments, and related materials. We added a new "Phase Zero" to the standard IAEA milestones. Included a review of nuclear plant designs, vendors, costs, risks and related issues** **Edward Kee, prior to joining NERA, was the principle consultant on this engagement.**
Key outcomes	**The Malaysian nuclear roadmap has formed the basis of decisions and activities in the new nuclear power program.**
Relevance	**The IAEA milestone and NEPIO approach may provide useful insights for any national nuclear power programme.**

Case Experience: Due diligence

Project description	**US DOE Loan Guarantee Program**
Case overview	**NERA is providing market and regulatory assessment and due diligence support to the US DOE Loan Guarantee Program. The Loan Guarantee Program provides credit support and financing to innovative energy projects, including four advanced nuclear projects. NERA's advice, part of the credit review process, covers economic, regulatory and market risks of the projects.**
Key outcomes	**NERA's analyses support US Federal Government decisions to extend debt financing and to structure credit facilities.**
Relevance	**Detailed assessment of regulatory / market issues for new nuclear projects provides insights into project risk and related issues.**

Case Experience: Financing support

Project description	**Enexus Financing Support**
Case overview	**NERA provided market due diligence and financing support related to Enexus, the proposed spin-off of Entergy's US nuclear generation business. NERA's work included projecting the future financial performance of the assets of the company to support the multi-billion dollar financing of this merchant nuclear generation fleet.**
Key outcomes	**NERA's analyses supported debt financing for a very large portfolio of merchant nuclear facilities.**
Relevance	**NERA's analyses have credibility with investors – may be useful in other nuclear projects with market funding.**

Case Experience: Eskom Nuclear One

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Project description	**Assistance to Eskom in Nuclear One programme - procurement of first plant of major nuclear fleet (2008)**
Case overview	**Eskom, with the Koeberg nuclear plant, implemented a strategy to procure a nuclear fleet. The first step in this process was the procurement of the Nuclear One plant. A shortlist of two vendors/designs (EPR and AP1000) was asked to bid; bids were received in early 2008. The project was terminated in late 2008 due to funding difficulties.** **Edward Kee, prior to joining NERA, was a key advisor to the Eskom Financial Director and to the Nuclear One Procurement team.**
Key outcomes	**The economics and strategy for nuclear fleets, for local industrial development, and other issues were analyzed. A key issue was the role of government and a series of alternate funding/ownership approaches were developed.**

Case Experience: Nuclear competitor analysis

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Business Problem

Nuclear industry client was interested in analyzing strategic options in the nuclear industry.

The key issues were the size and intentions of major nuclear industry competitors and projections for future growth based on strategy and financial capabilities.

Solution

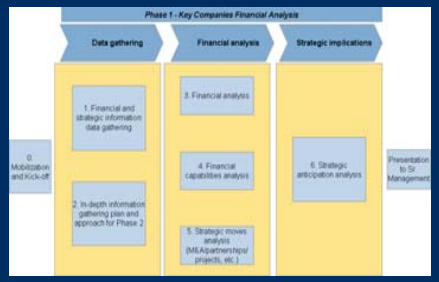
Deliverables included:

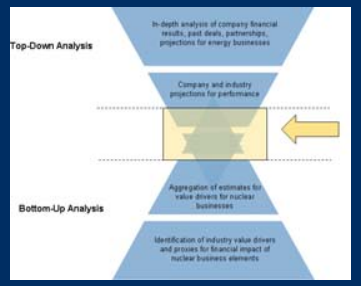
- Financial model capturing 5 years of historical financials, estimates of nuclear business results and projections of future growth
- Ratio analyses and evaluation of competitor financing capabilities
- Analysis of nuclear power value chain
- Strategic implications analysis

Oliver Wyman client team

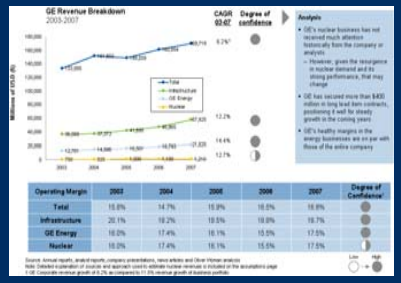
Illustrative: Approach & Analyses

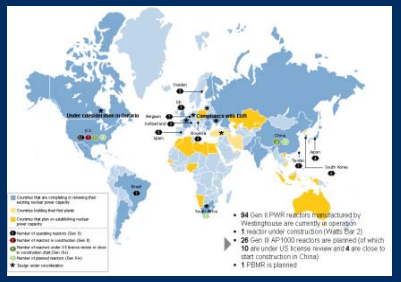
Approach

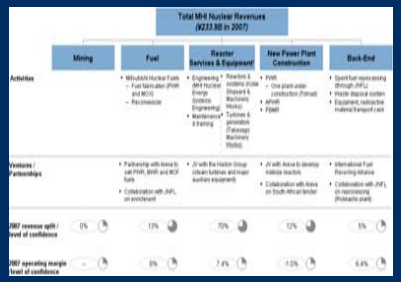


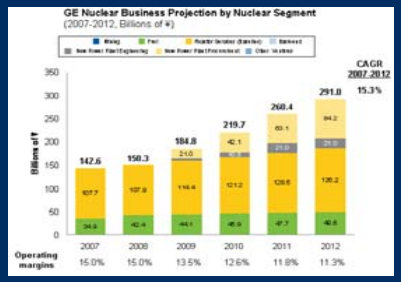


Analyses









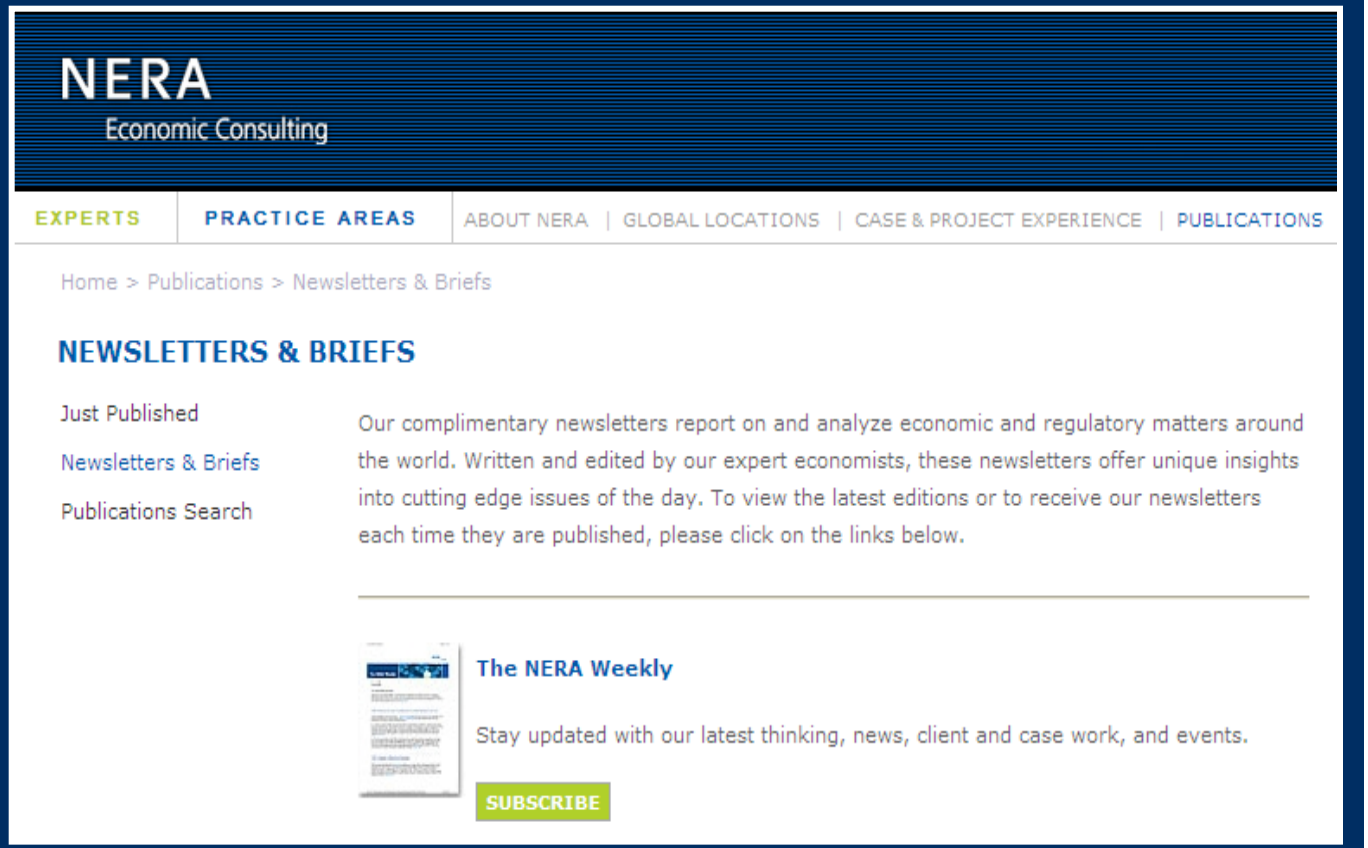
Edward Kee

NERA Economic Consulting

- Focus on nuclear power and electricity industries
- Strategic advice and expert witness testimony
- Prior to joining NERA
  - CRA International, PA Consulting Group, McKinsey & Co.
  - Merchant power plant developer
  - Navy nuclear program - qualified as Chief Engineer on Nimitz-class carriers

NERA insights

- Reports and newsletters on economic & regulatory matters
- At *www.nera.com*, under “Publications”
- Newsletters:
  - NERA Weekly
  - Climate Policy Economics
  - Energy Market Insights
  - Global Energy Regulation



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Global Nuclear Power Developments

China leads the way

Issues to consider

- Vendor / design competition
- Buyer competition
- Nuclear product life cycle
- Nuclear fleets
- 3 Approaches to new nuclear
- Role of Government

Global nuclear market
Gen II+, III & III+ reactor designs

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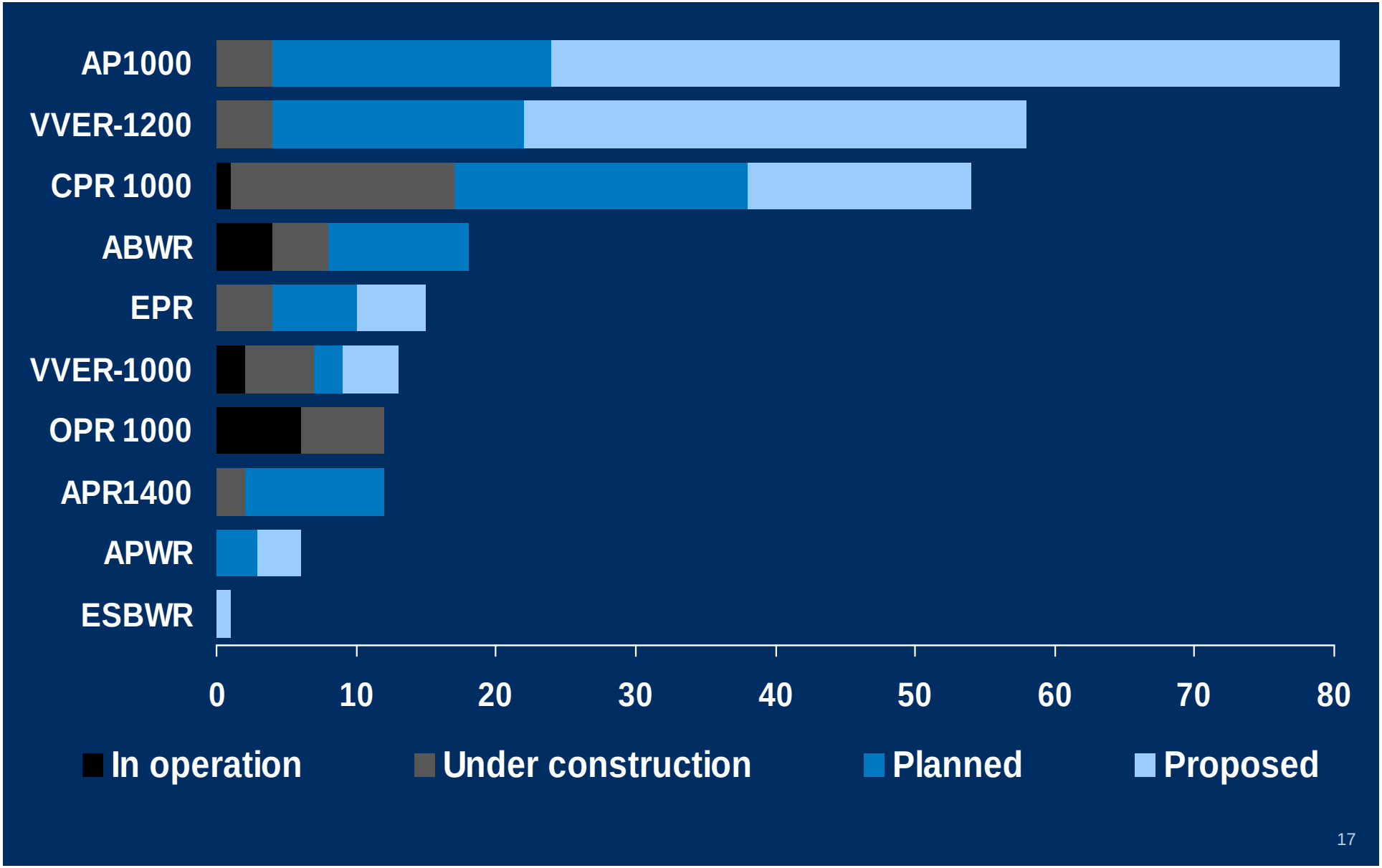
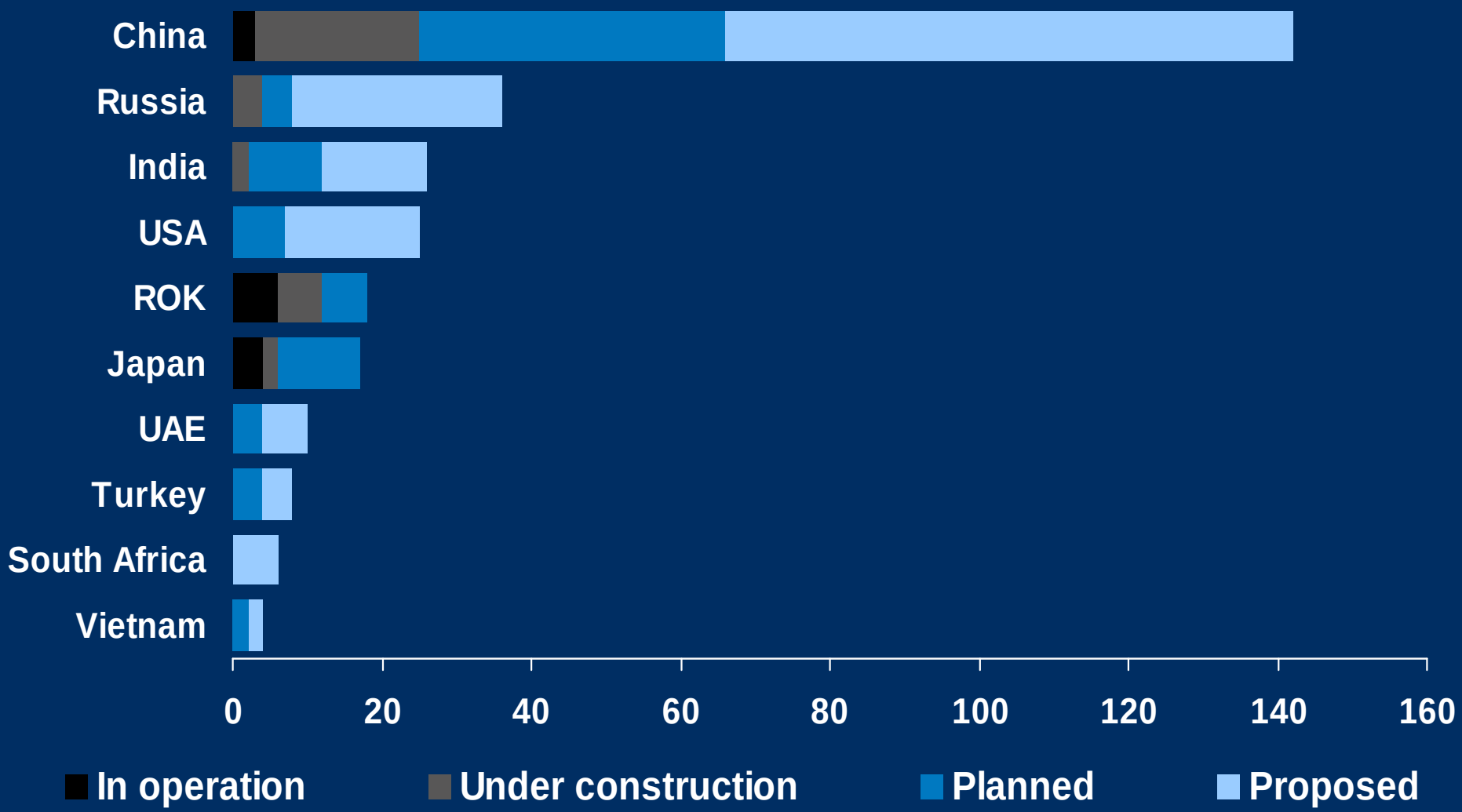


New industry competitors

- South Korean companies offering APR1400 to export market
- Chinese nuclear companies – talking about selling Chinese version of AP1000 and CPR1000 into export market
- India looking to sell its PHWR to smaller countries with new nuclear programs
- New companies with small and innovative reactor designs

Global nuclear market
Gen II+, III, III+ by country



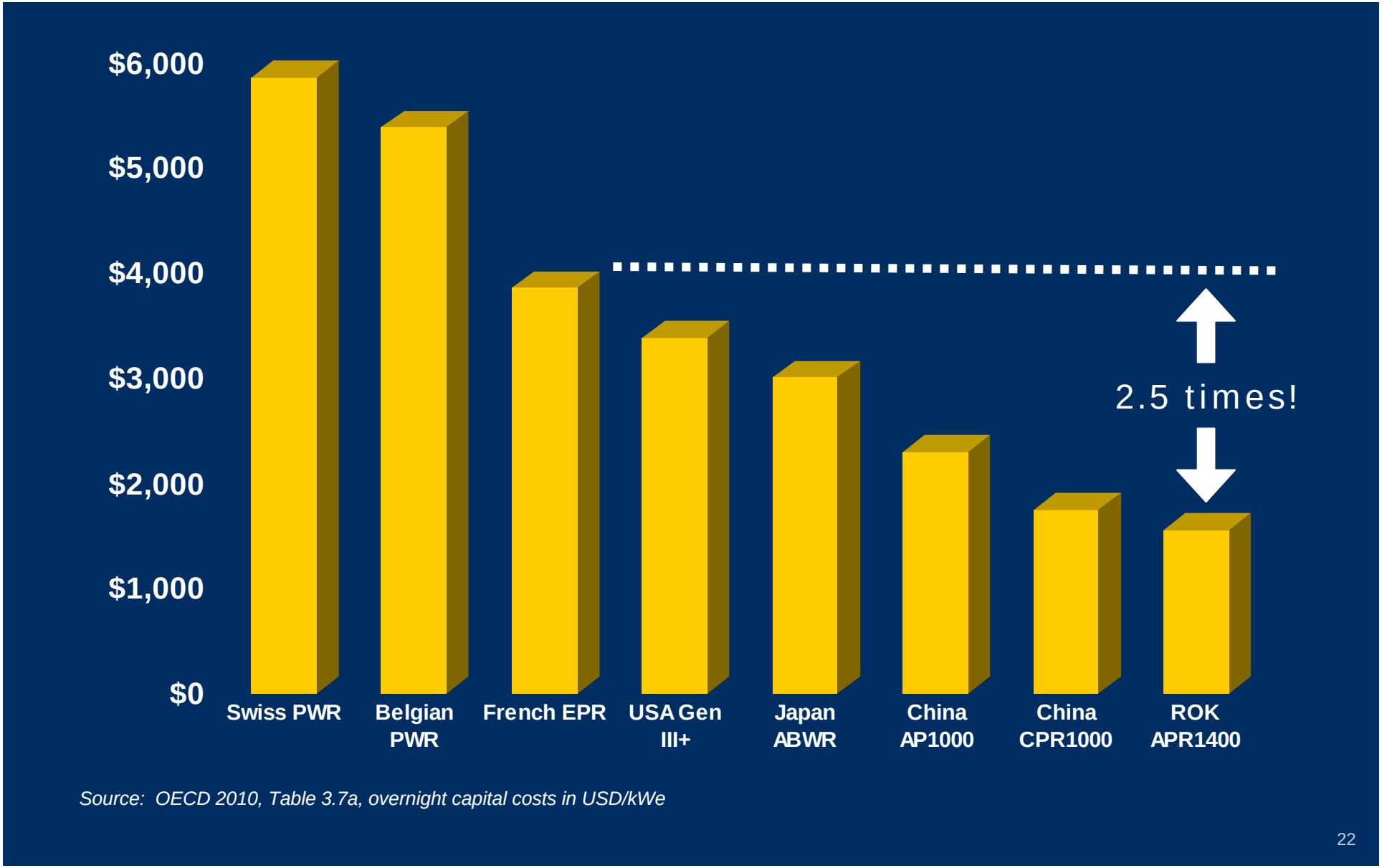
"Buyer" competition

- Many countries considering nuclear power plants
- Many, if not all, of these countries
  - Seek local content and local industrial development
  - Want local industries in global nuclear supply chain
- Key issues:
  - Size of build/buy programme
  - Credibility of nuclear build programme
  - Funding; role of government
  - Maturity of country's nuclear industry

National vendors and localisation

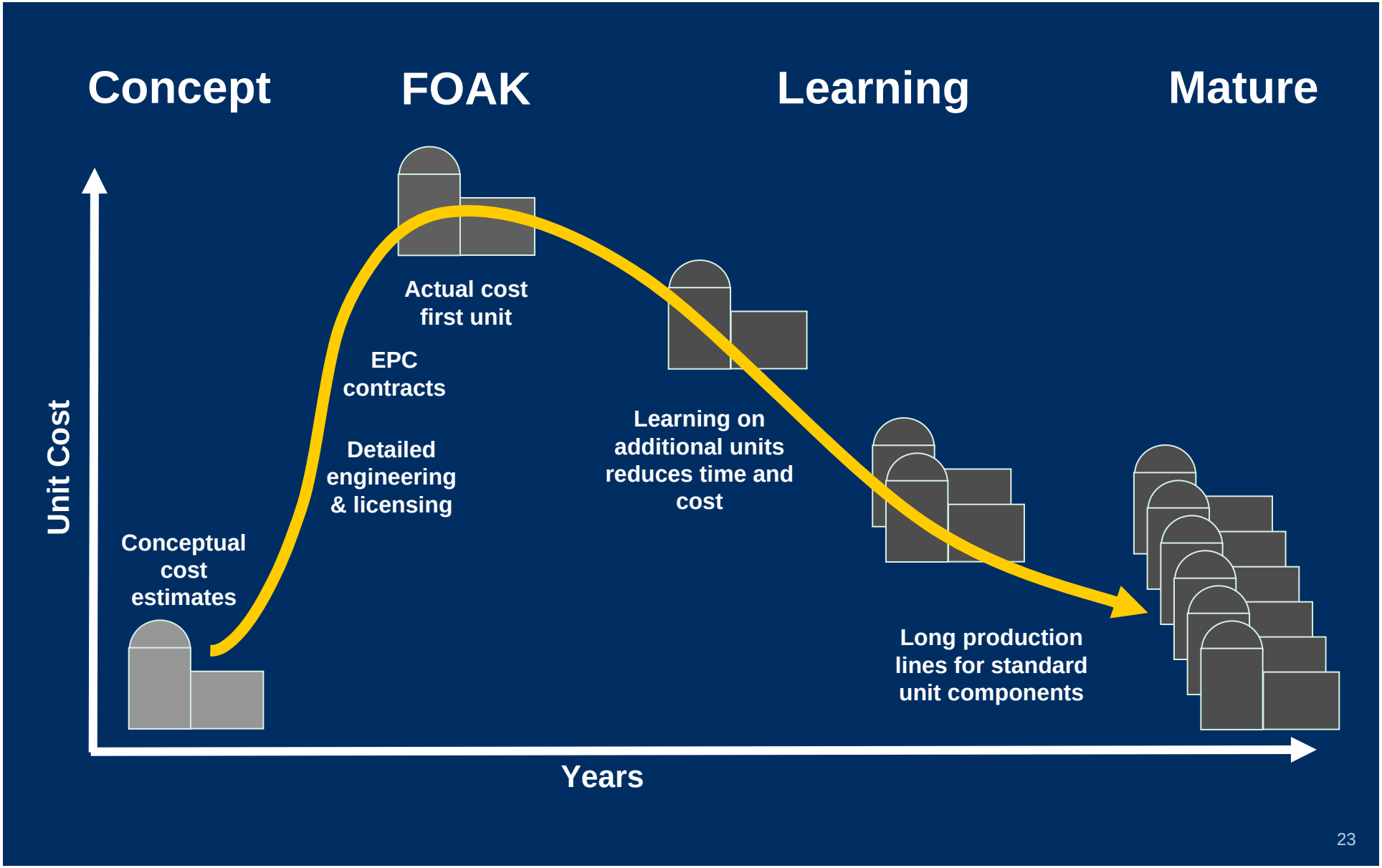
- Some current or potential nuclear vendors are also focused on their own industrial development
- National nuclear power programmes (e.g., China, Korea) are aimed at
  - Adding significant nuclear power capacity
  - Developing an internal supply chain
  - Competing in global market with home supply chain
- Government-to-Government agreements may facilitate local industrial development

Wide range of costs reflects approach to nuclear fleets

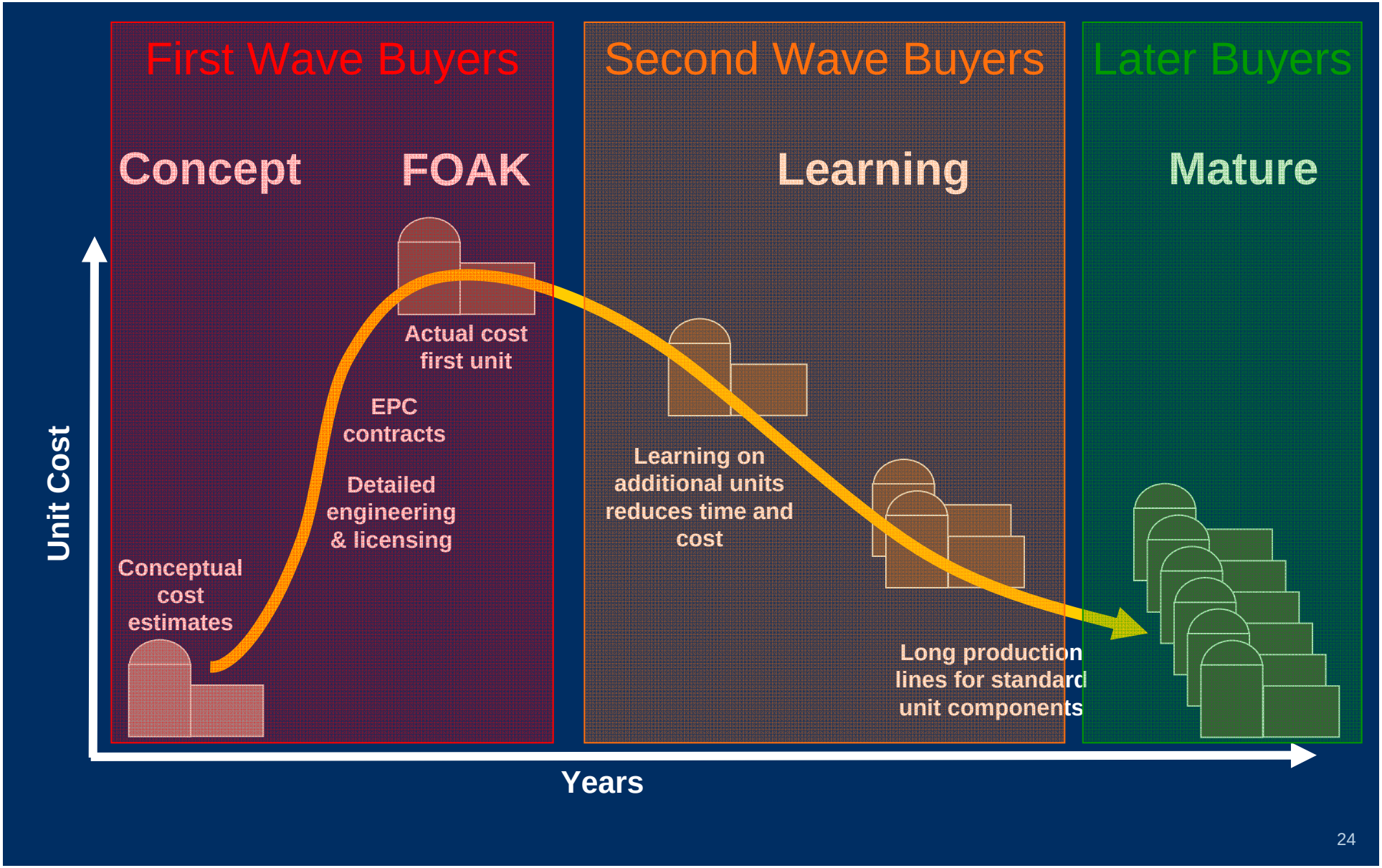


Source: OECD 2010, Table 3.7a, overnight capital costs in USD/kWe

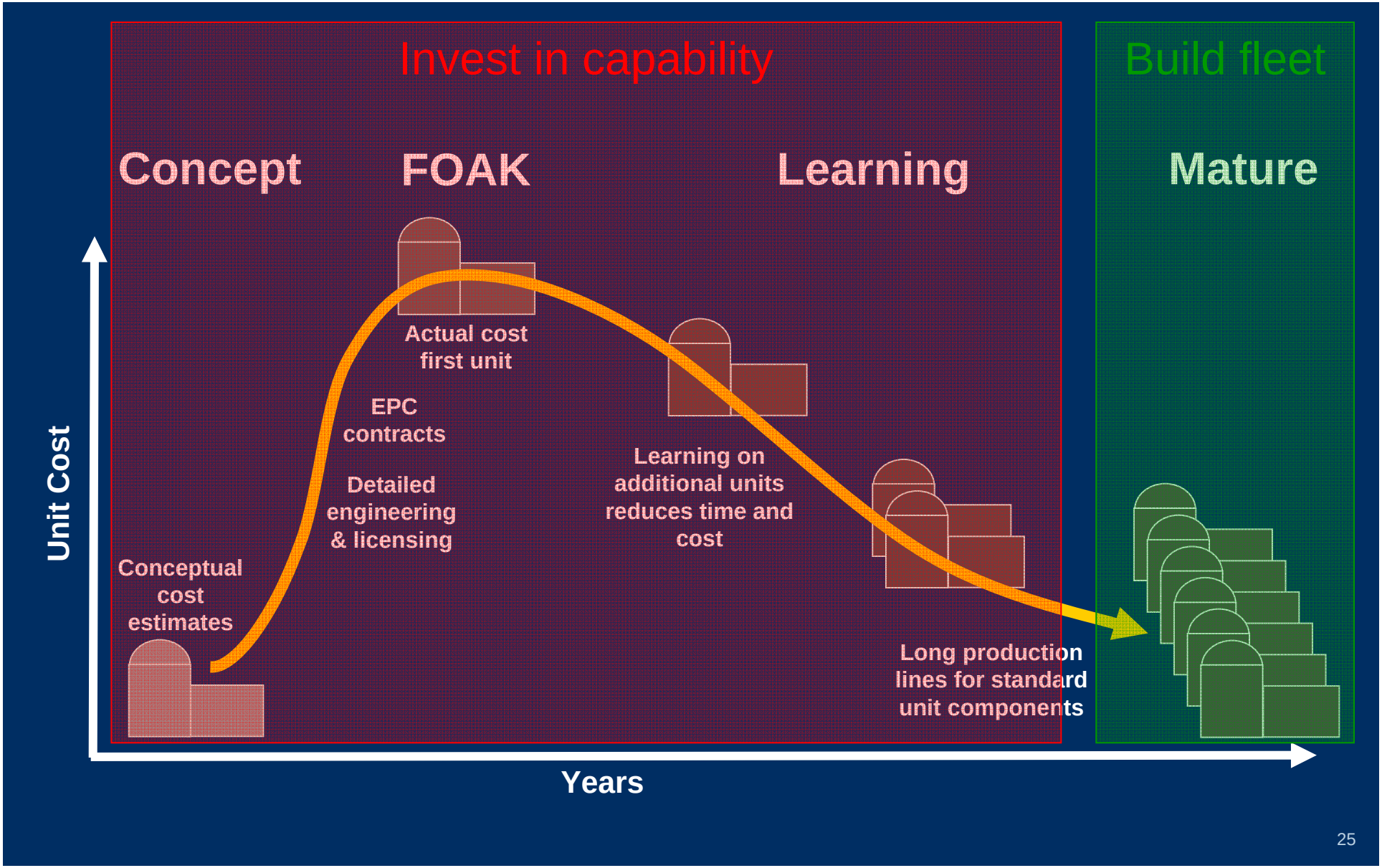
Nuclear development cycle



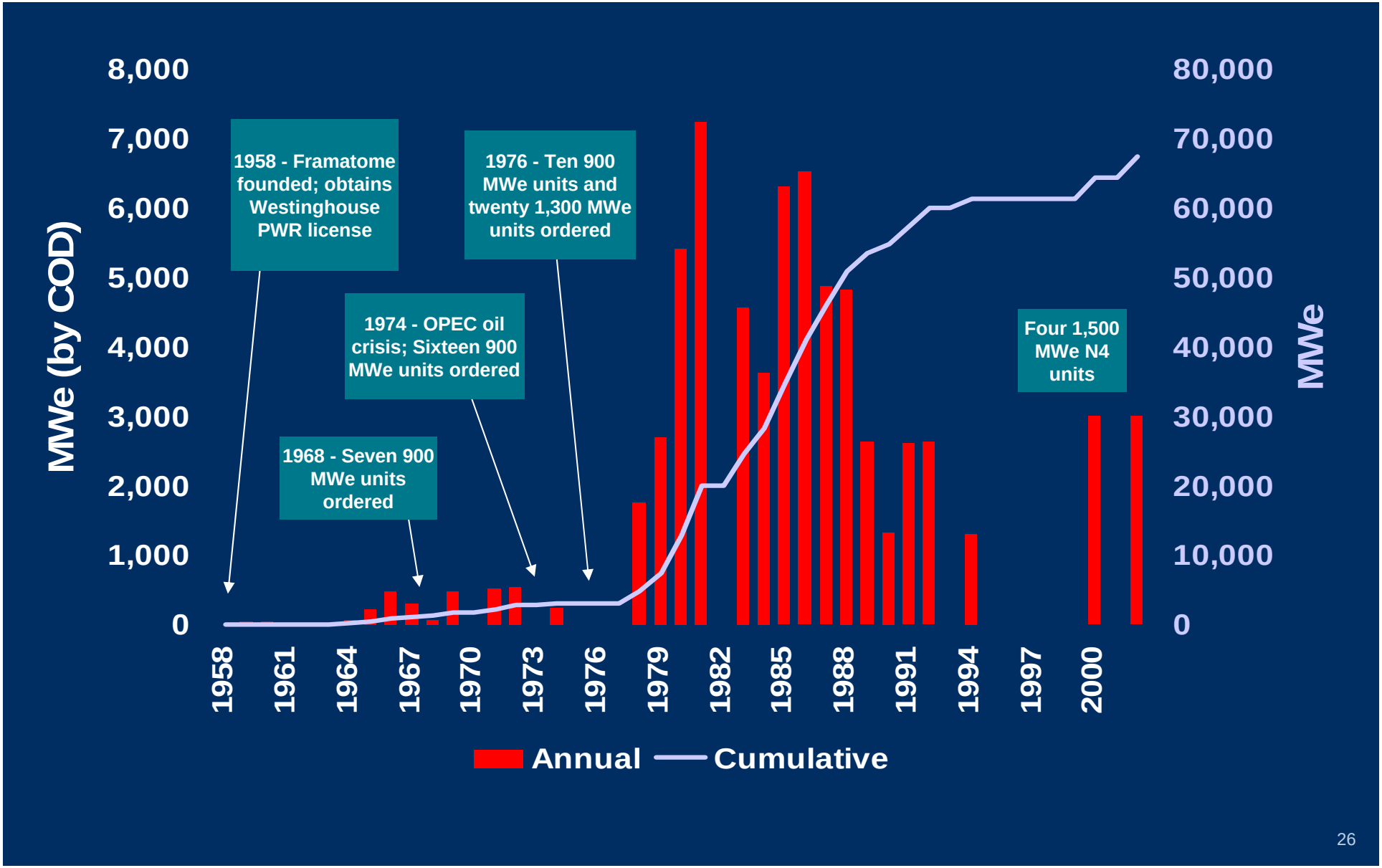
Commercial purchase approach



National fleet approach



Nuclear fleet strategy
French example



Nuclear fleet

China's approach

No fleet	Multiple units	Multiple identical units		
Single nuclear unit/plant owner Some multi-company efforts to gain fleet benefits through cooperation US nuclear management companies a more formal approach to multi-company efforts Some ability to share learning through industry groups	**Smaller fleet operators** Nuclear fleets, composed of multiple reactor types (BWR and PWR and other), reactor designs, constructors, and vintages A mix of units built by owner and acquired Benefits from single overhead, purchasing, engineering, and management	**Single owner** Common simulators, special tools, training Co-ordination of upgrades, maintenance, outages Fungible operators, maintenance teams, outage teams Operational improvement through learning across fleet	**Sequential purchase** Multiple procurements Potentially coordinated construction Learning curve benefits may not be captured by owner Financial flexibility, vendor market power, fewer options for buyer	**Bulk build** Owner is builder Coordinated construction, mobilization benefits Learning curve benefits captured Large build allows upstream infrastructure Large financial commitment, large benefits

Strategic issues
Size of nuclear build programmes

- Low costs come from large fleet/build programme
- High demand growth = high nuclear potential
  - China, India, etc
- Lower demand growth = lower nuclear potential
  - USA, Europe
  - High cost to shift from fossil to nuclear
    - Shut down existing coal units?
    - Impose significant carbon tax?

Strategic issues
New nuclear countries

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- High growth rate in developing world, but
  - Multiple smaller countries = multiple reactor sales
  - Physical and administrative infrastructure lacking
  - Financial viability
- Nuclear power development models
  - IAEA – slow – build infrastructure, then NPP
  - UAE – fast – buy infrastructure and build NPP
  - Russia – faster – build and operate nuclear IPP

3 approaches to new nuclear

- Merchant
  - Project returns from market revenue; in regions with electricity markets
- Regulated
  - Nuclear plant in regulated rate base; traditional US approach, Eskom model
- Government utility

Merchant nuclear plants

- Operate in electricity markets
  - Limited market history (compared to plant life)
  - Volatile prices & competition
- Traditional project finance approach strained by
  - High capital intensity
  - Large project size
  - Long development period
  - Long asset life
  - Lack of long-term revenue certainty

Merchant nuclear plants
Market risk ***AND*** project risk

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- Market risks (over years 10 to 70 from today)
  - Carbon regime – might raise market prices
  - Demand – future electricity and capacity use
  - Supply - new entry, including forced renewables
  - Fuel costs – impact on market prices
  - Technology shifts - new generation technology
- Nuclear project risk and outcomes
  - FOAK capital costs, unproven regulatory process
  - Cost overruns and delays before operational
  - Project interruptions / prolonged outages

Regulated nuclear plants

- Should include a nuclear IPP based on PPA with regulated utility
- Project risks and market risks may mean risk of less than full recovery of actual costs
- US Experience in 1980s is still relevant
  - State regulators faced unprecedented rate increases
  - Prudence reviews and disallowances
  - Large negative impact on utilities and the industry

Regulated nuclear plants
Impact of disallowances in US

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- Bankruptcies and financial distress
- Utilities became wary of large capital projects
- Regulatory & industry reform
  - Better rules for large baseload investments
  - Integrated Resource Planning (IRP)
  - Electricity industry restructuring & markets

US Regulatory reforms

- US Integrated Resource Planning (IRP)
  - All supply and demand options
  - Minimize costs to stakeholders
  - Reflects uncertainty
  - Regulated utility “own-build” options included
    - Higher assurance of cost recovery if selected, but
    - Implicit or explicit cap on cost recovery
- Up-front prudence review if option nuclear selected
- Early recovery of costs (i.e., return on CWIP)

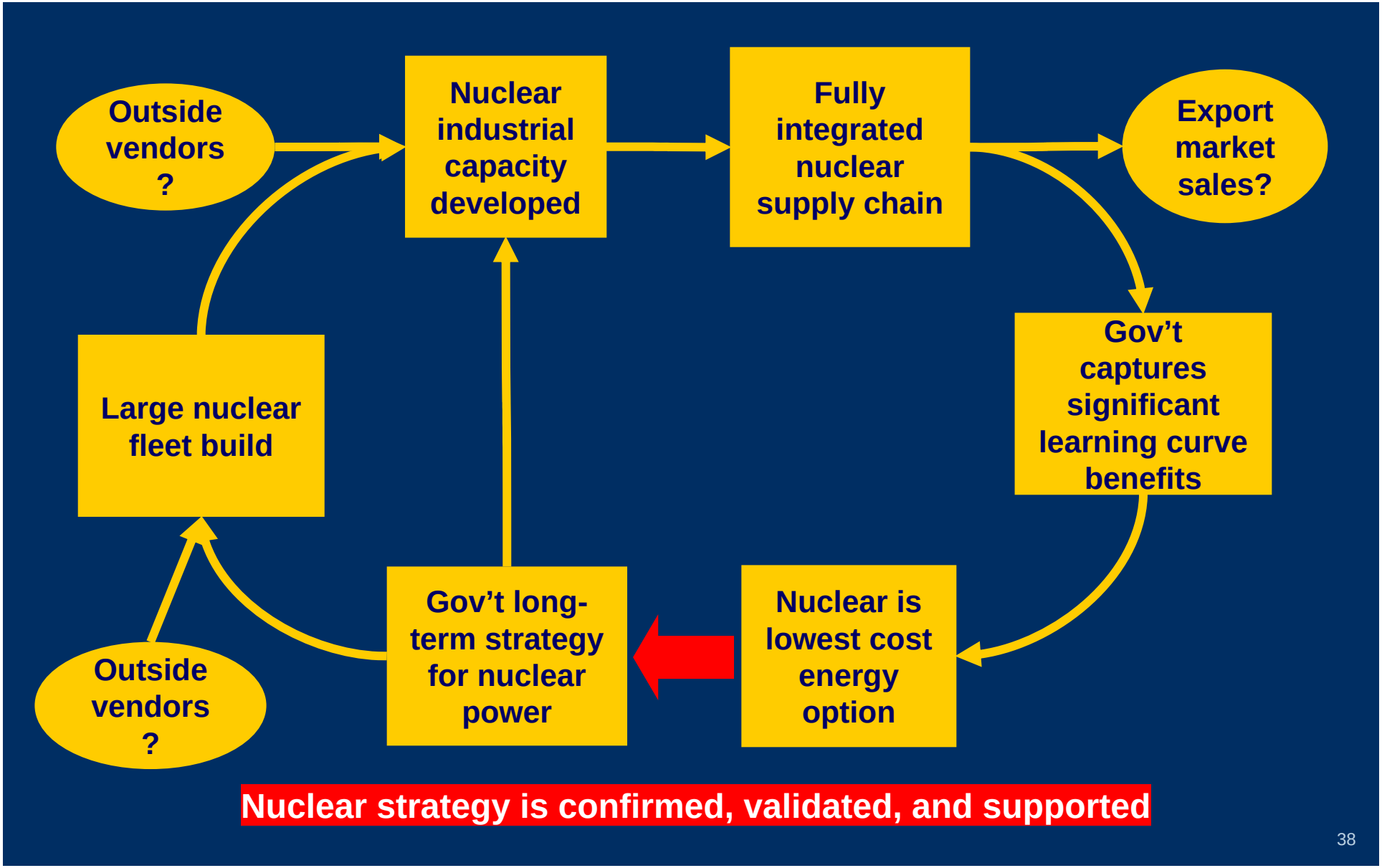
Role of government in nuclear

- All existing nuclear power plants were built with government/public ownership or support
  - Government or government utility owner
  - Regulated utility owner with regulated return
- Most of today's new nuclear build is by governments (China, Russia, etc.)
- New merchant nuclear power plants will require government assistance (e.g., US DOE Loan Guarantees; UK ~~subsidies~~ market reforms)

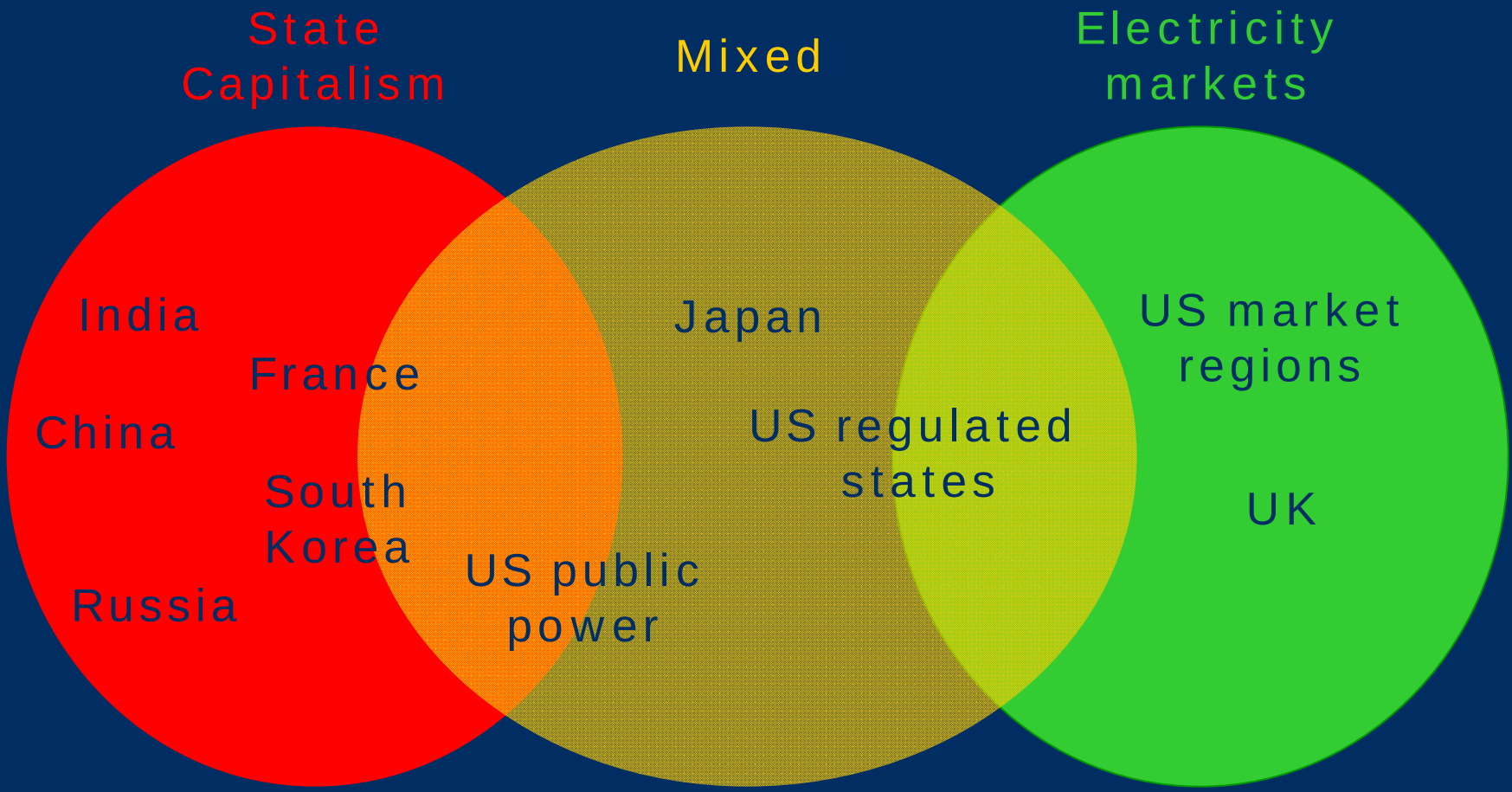
Government nuclear plants

- Government is owner or guarantor – assumes risks of investment
- Deep pockets and large size will lower cost of capital and reduce costs (e.g., assumption of risks removes risk premium from contracts)
- Credible commitment possible (e.g., UAE and China)
- Possible to link nuclear plant with other government objectives (e.g., local industrial development) more directly

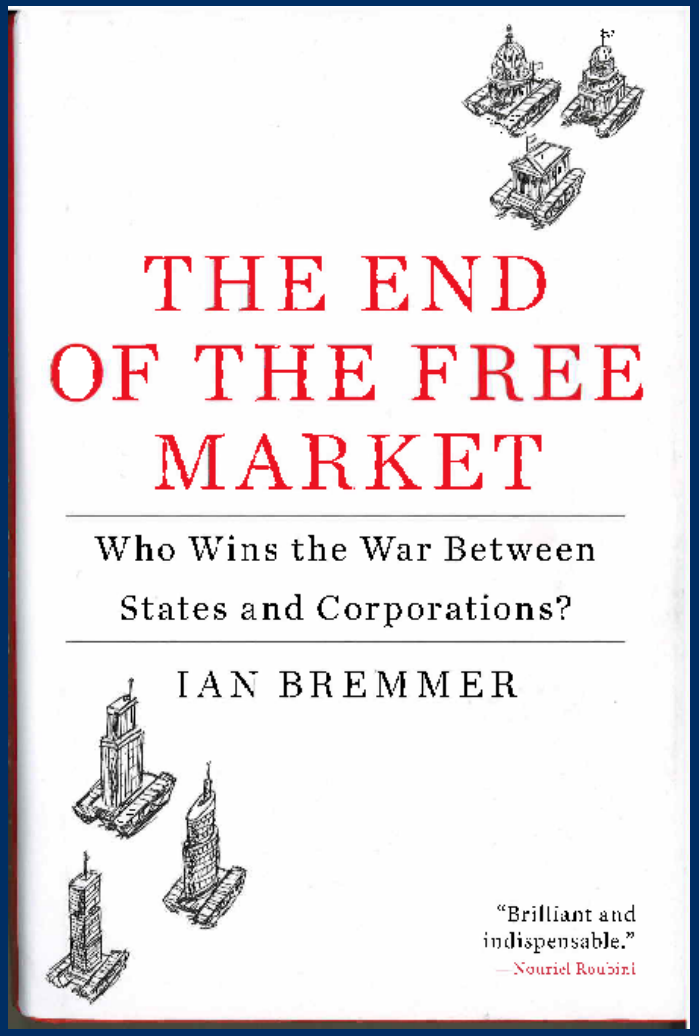
Role of Government
National nuclear power programme



Role of Government



State Capitalism



- Strategic and long-term state domination of markets
- National Corporations & State-Owned Enterprises
- Strategic goals above profits
- Inside & outside host country
- China and Russia leading examples

Summary

- Pivotal time for nuclear power industry, with high capital costs and project risk
- Key success factor is number of units built
- Large nuclear fleet build by governments
  - Capture learning curve benefits of large orders
  - Build confidence through completed projects
  - Build integrated national nuclear infrastructure
- Commercial vendors must compete with state nuclear suppliers

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