

Is nuclear the key to global decarbonisation?

Simon Taylor, EPRG and Judge Business School,
University of Cambridge

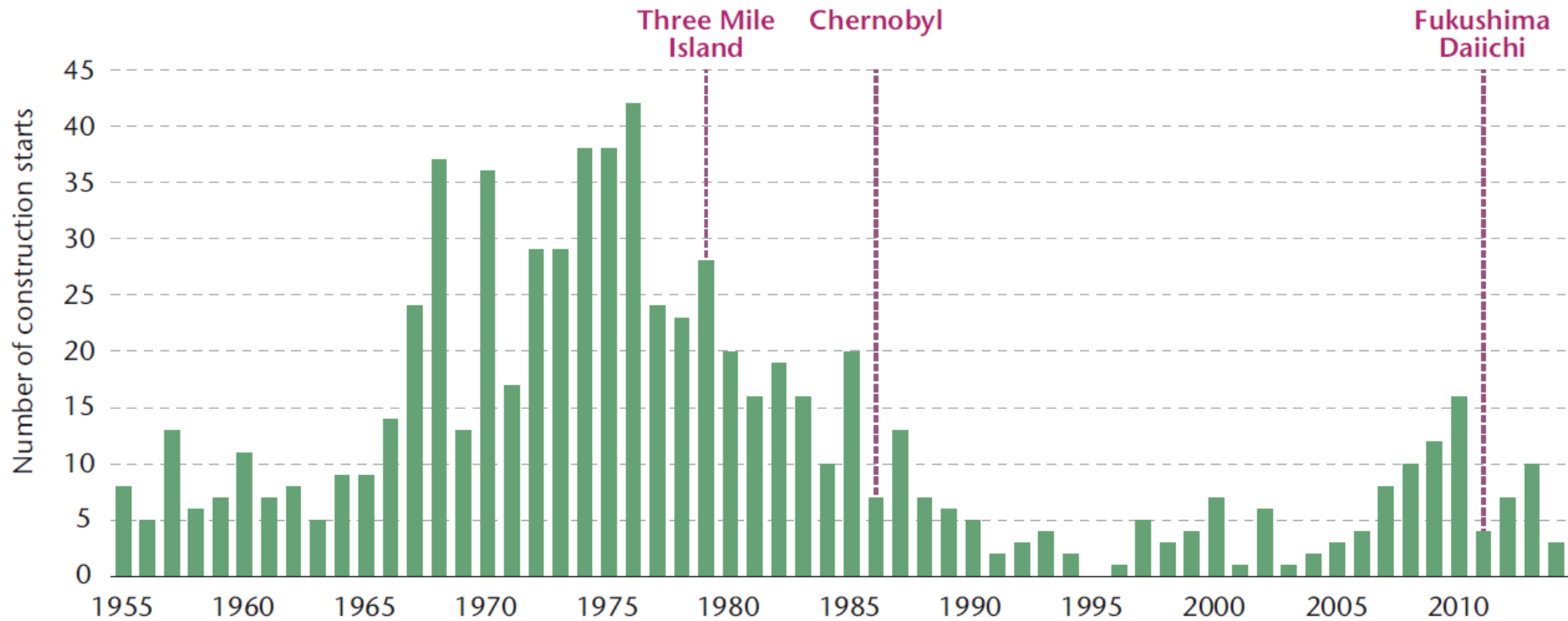


Is nuclear the key to global decarbonisation?

No

Nuclear build remains very low outside China

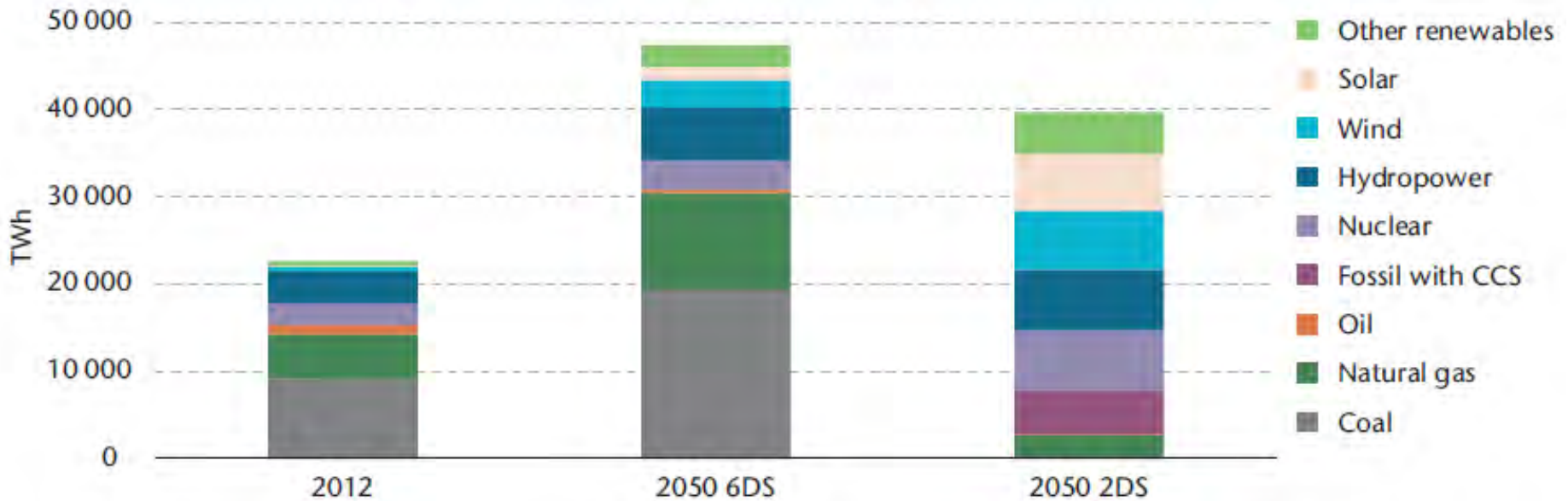
Figure 1: Nuclear reactor construction starts, 1955 to 2014



Source: IAEA Power Reactor Information System (PRIS).

IEA vision of decarbonised power sector 2050 (1)

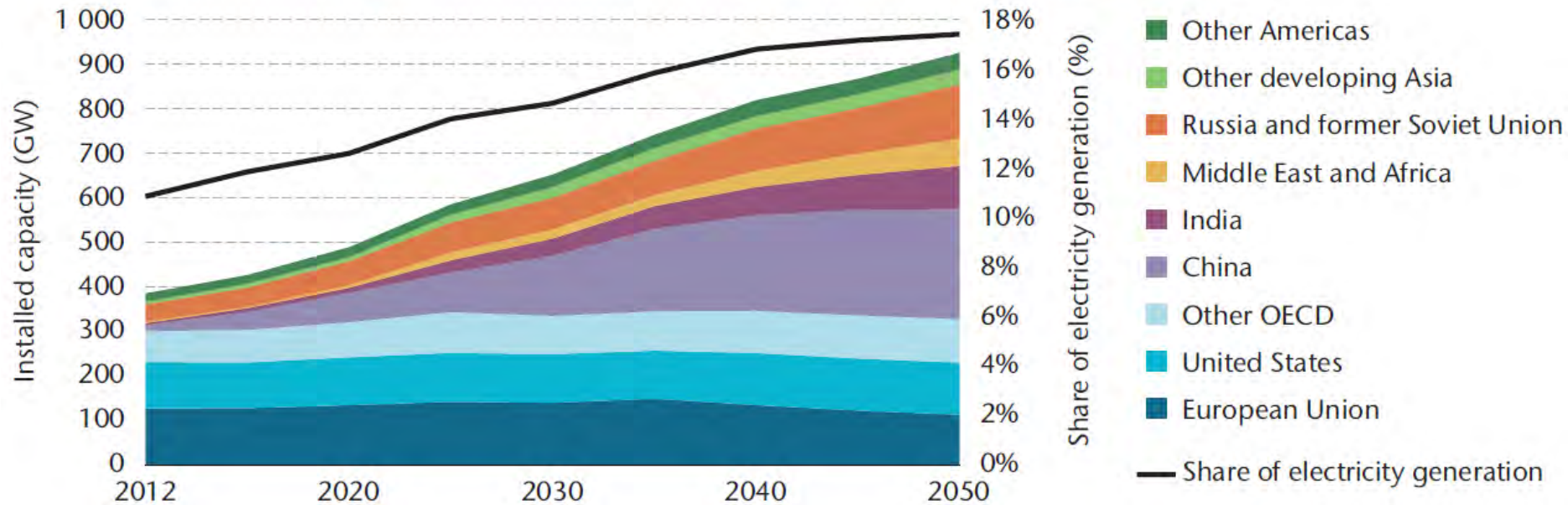
Figure 3: Electricity production by technology in the 6DS and the 2DS



Source: IEA Nuclear Technology Roadmap 2015
http://www.iea.org/publications/freepublications/publication/Nuclear_RM_2015_FINAL_WEB_Sept_2015_V3.pdf

IEA vision of decarbonised power sector 2050 (2)

Figure 4: Nuclear generation capacity in the 2DS by region



Source: IEA Nuclear Technology Roadmap 2015
http://www.iea.org/publications/freepublications/publication/Nuclear_RM_2015_FINAL_WEB_Sept_2015_V3.pdf



The nuclear scorecard

Strengths	Weaknesses
Proven source of low carbon energy	Expensive
Reliable operation	Inflexible
Continuous supply	State role essential
Dense	Long term waste storage not dealt with
Low import dependency	Catastrophe risk

Concepts of cost

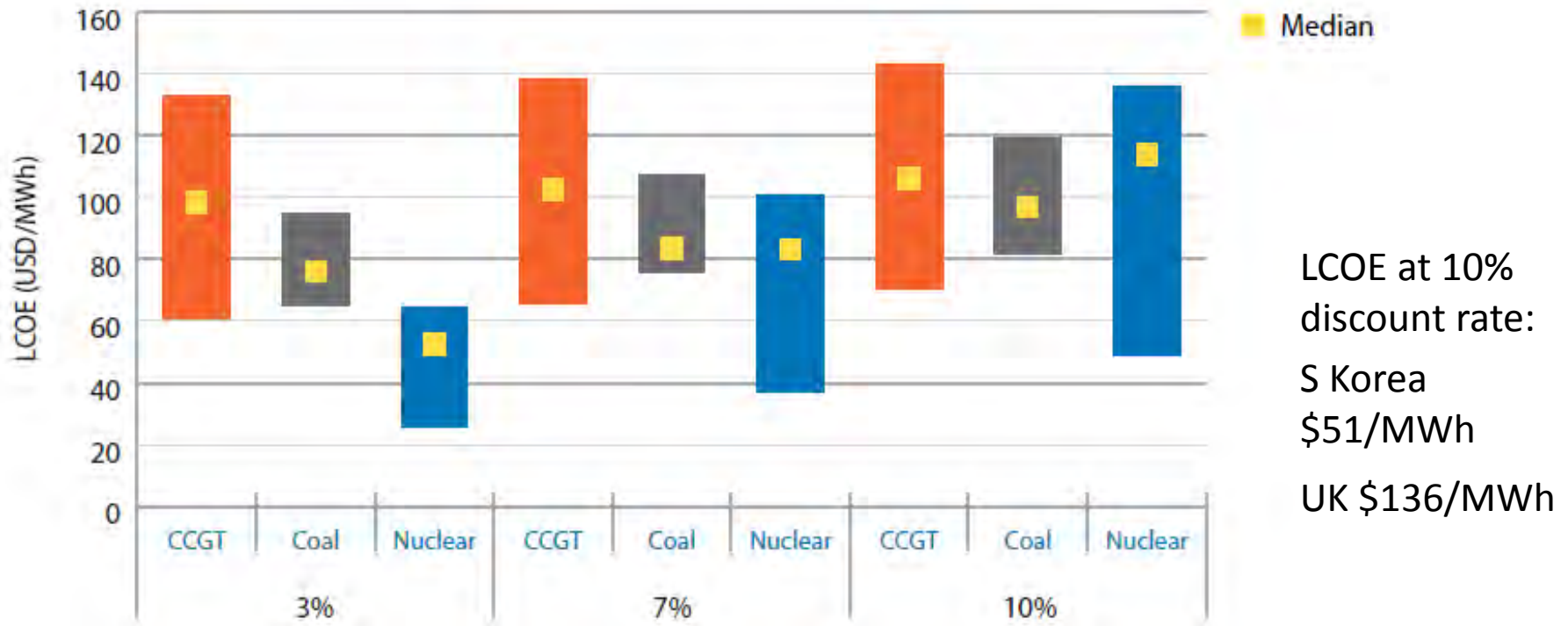
Overnight construction cost (no financing)

Levelised cost of energy(LCOE) over lifetime, discounted

Ex ante price charged to customer to justify investment

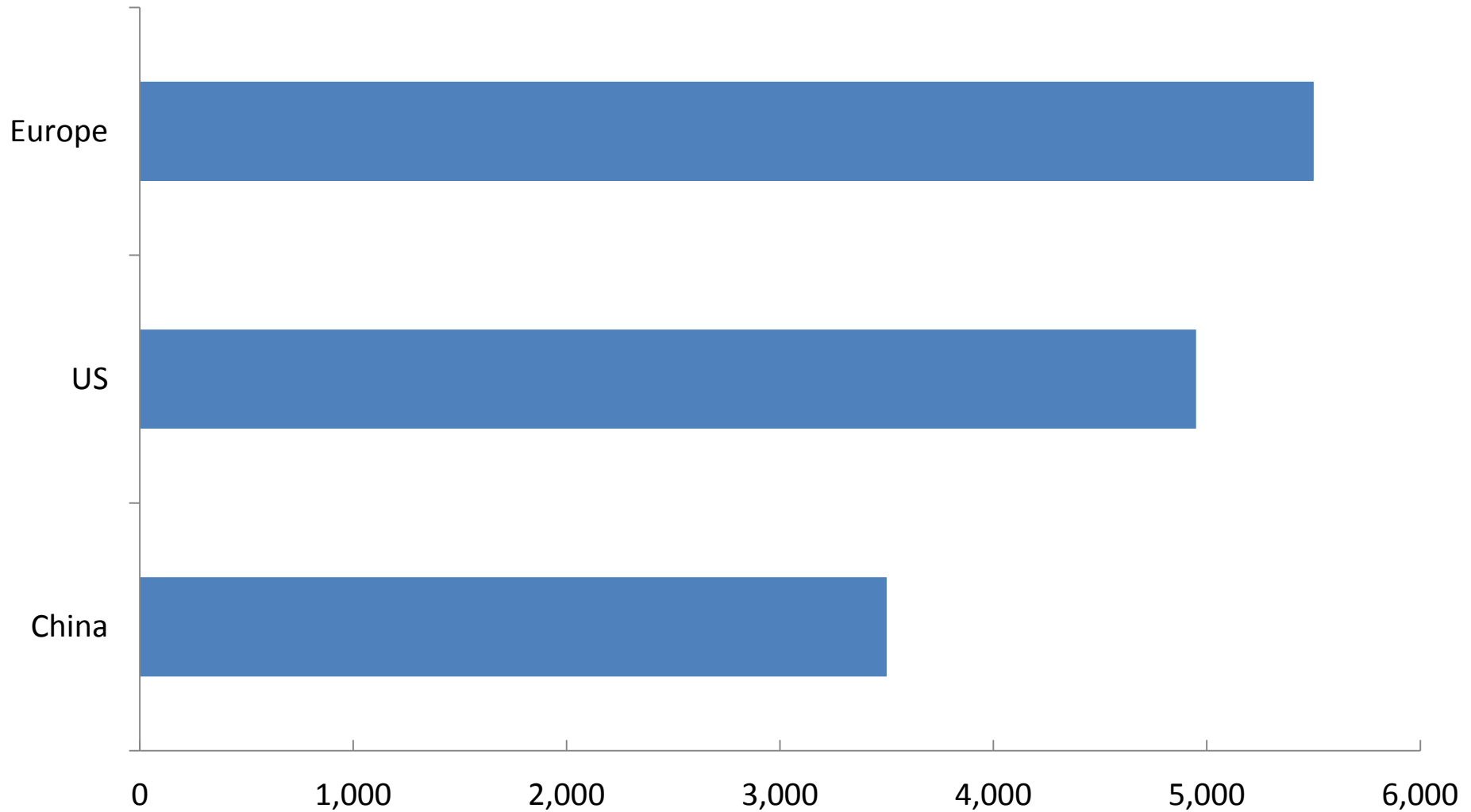
OECD estimates of levelised cost

Figure ES.1: LCOE ranges for baseload technologies (at each discount rate)



Source: OECD *Projected Costs of Generating Electricity – 2015 Edition* <http://www.oecd-nea.org/ndd/pubs/2015/7279-proj-costs-electricity-2015-es.pdf>

IEA estimated overnight cost (\$/kW)



The troubled EPR

Olkiluoto 3 – Finland

Original scheduled operation – 2009

Latest estimate – 2018

Original cost – €3.2 bn

Latest estimate - €8.5 bn



Flamanville 3 - France

Original scheduled operation – 2012

Original cost - €3.6bn

Latest estimate €10.5 bn

Expected operation 2018 Q4



Taishan 1 & 2 – China

Unit 1 original scheduled operation – 2014

Construction finished December 2015

Testing in 2016



State involvement in current projects

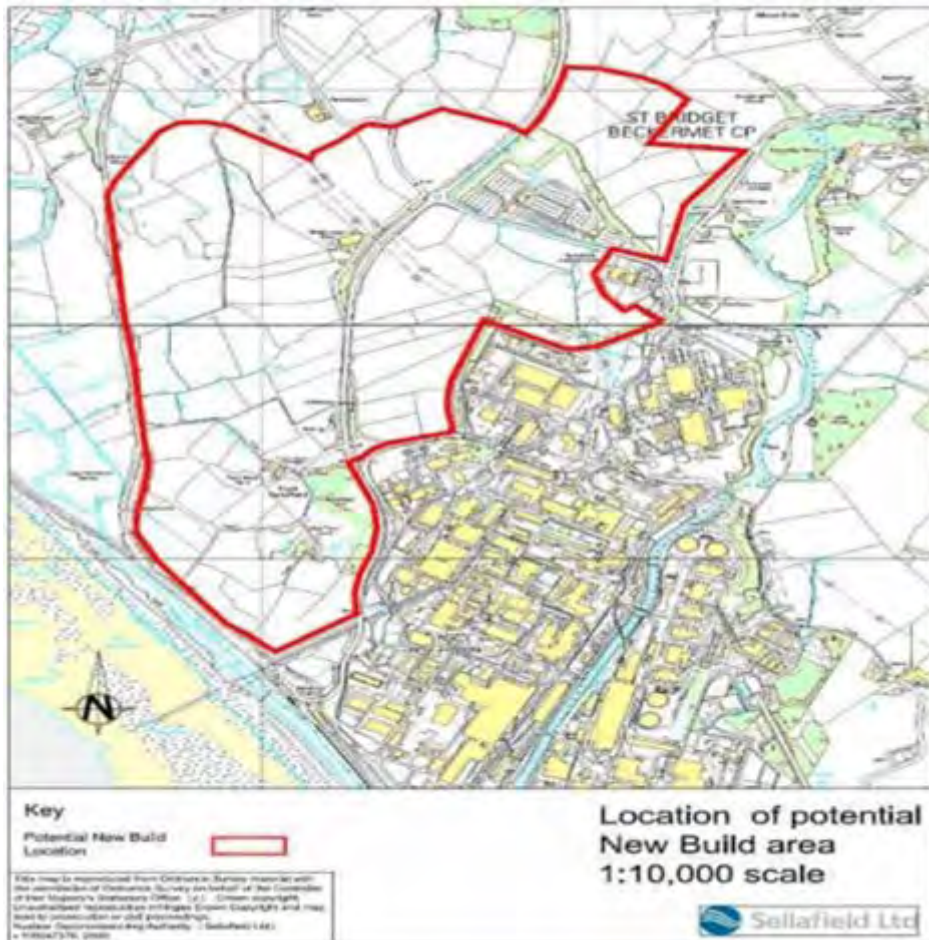
Comparisons of risk bearing among current and likely new nuclear projects

Reactor	Country	Status	Construction risk	Power price risk	Debt guarantee?
Olkilotuo 3	Finland	Under construction	Contractor (Areva)	Customers	None
Flamanville 3	France	Under construction	Sponsor (EDF)	Customers (via regulation)	No
Vogtle	USA	Under construction	Customers	Customers (via regulation)	Federal US government
Hinkley Point C	UK	Awaiting final decision	Sponsor (EDF and CGN)	Customers (mediated by government)	UK government

Source: Taylor, S. in R. Heffron, G. Little (2016) *Delivering Energy Law and Policy in the EU and the US - A Reader* <https://edinburghuniversitypress.com/book-delivering-energy-law-and-policy-in-the-eu-and-the-us.html>

Risk management in a “private project”

Moorside, Cumbria



3.4-3.8GW AP1000

Toshiba (60%) and ENGIE (40%)

Projected sources of funding:

UK state debt guarantee

Japanese Bank for International Cooperation

US Ex-Im Bank

Korea

Source and ©: NuGen

China and nuclear





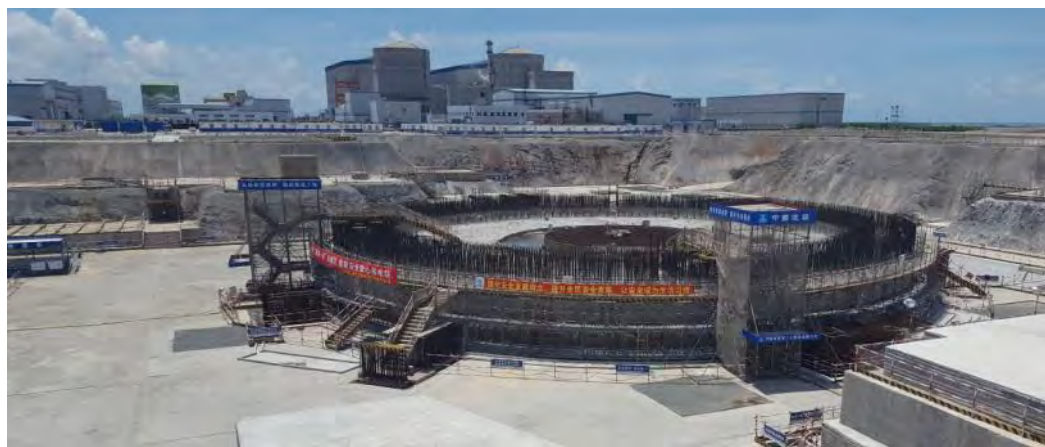
A brief history of Chinese nuclear



French PWR, Daya Bay, Guangdong



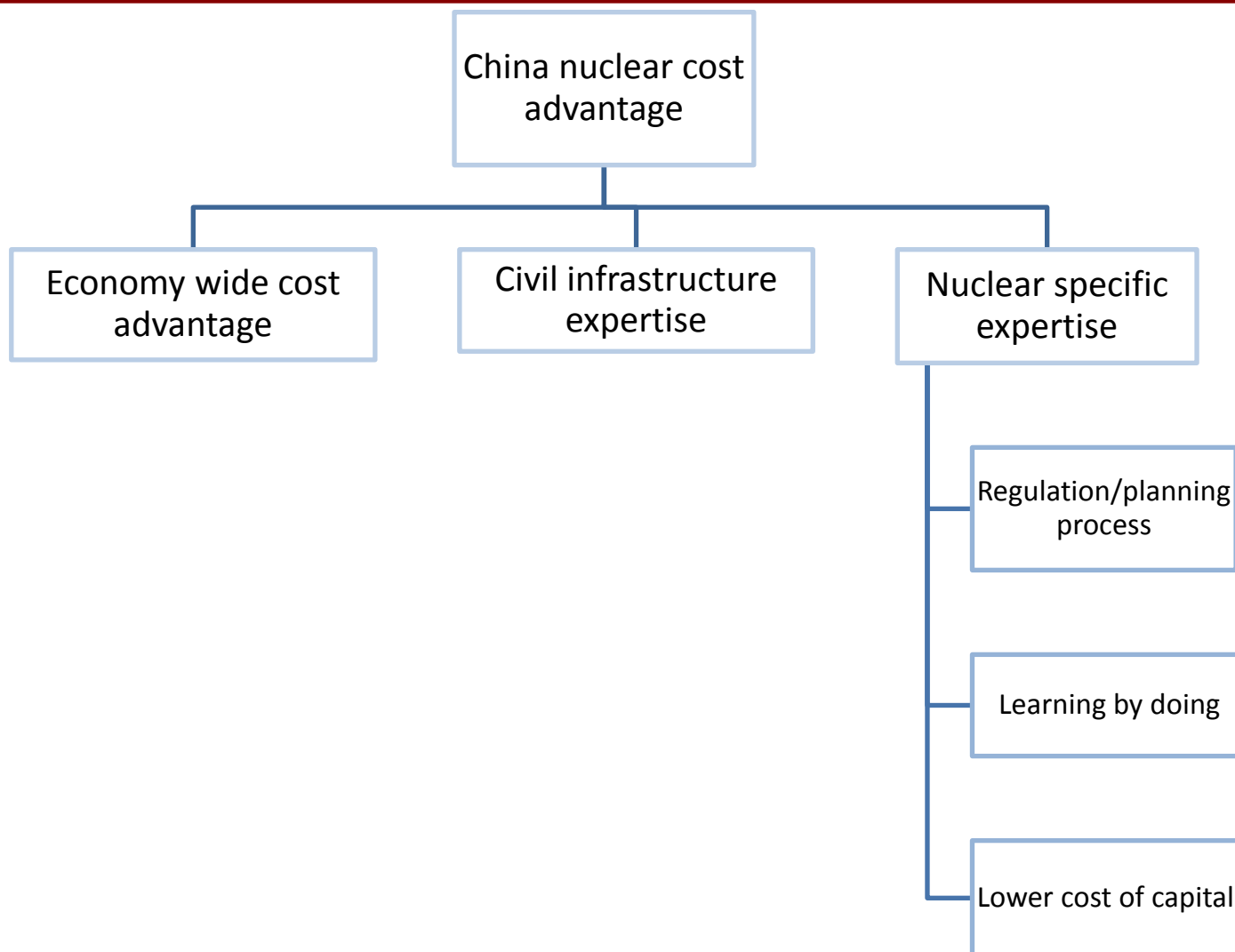
Russian PWR, Tianwan, Jiangsu



Chinese Hualong One PWR, Fengcheng, Guangxi



Sources of China's nuclear cost advantage



Small Modular Reactors

Table 4: Examples of small modular reactor designs
(under construction or with near-term deployment potential)

<i>Vendor</i>	<i>Country</i>	<i>Design</i>	<i>Type</i>	<i>Net capacity (MW)</i>	<i>In operation*</i>	<i>Under construction*</i>
Babcock & Wilcox	United States	mPower	PWR	180	0	0
CNEA	Argentina	CAREM-25	PWR	25	0	1
CNEC	China	HTR-PM	HTR	210	0	Twin units
CNNC	China	ACP-100	PWR	100	0	0
KAERI	Korea	SMART	PWR	110	0	0
NuScale	United States	NuScale SMR	PWR	45	0	0
OKBM	Russia	KLT-40S	Floating PWR	2x35	0	Twin units (one barge)

*: As of 31 December 2014.

“However, the economics of SMRs have yet to be proven.”

Source: IEA http://www.iea.org/publications/freepublications/publication/Nuclear_RM_2015_FINAL_WEB_Sept_2015_V3.pdf

Thank you