Management and governance of nuclear power plant projects for ASEAN countries

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@LocaGiorgio

Can we have on time and budget "Nuclear reactors projects"?

UNIVERSITY OF LEEDS

Further delay in commissioning of Finnish EPR

28 August 2020

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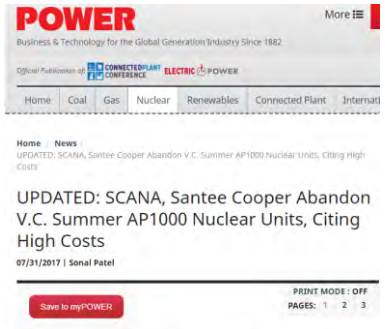
Fuel loading at the Olkiluoto 3 EPR will now not take place until March next year, according to a revised schedule provided to Finnish utility Teollisuuden Voima Oyj (TVO) by the Areva-Siemens consortium. Grid connection is now scheduled for October 2021, with regular electricity production due to start in February 2022.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UPDATED: SCANA, Santee Cooper Abandon V.C. Summer AP1000 Nuclear Units, Citing High Costs

07/31/2017 | Sonal Patel

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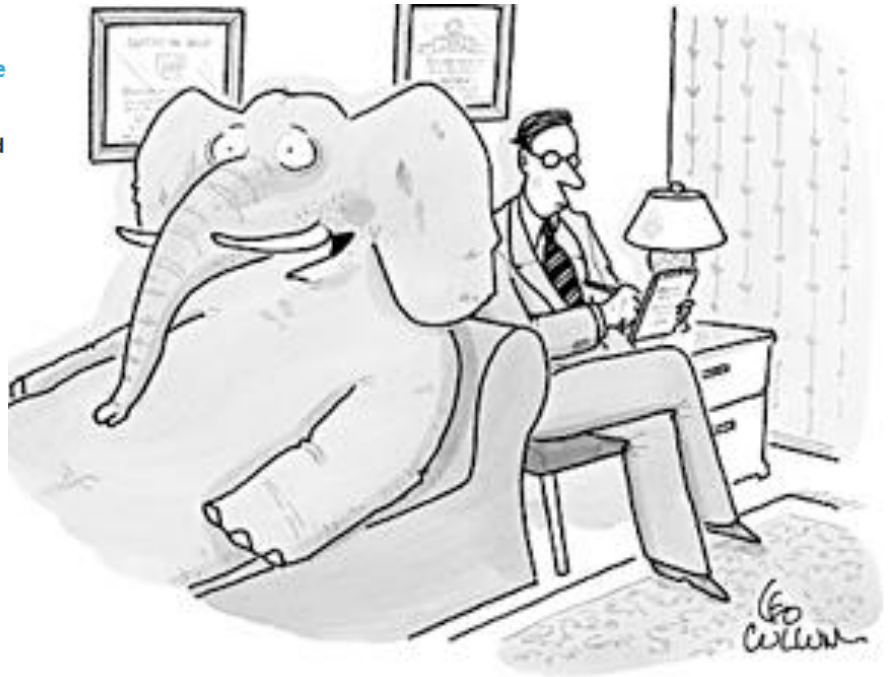
The completion of Mochovce: double the budget and numerous delays

After numerous delays, the third block in Mochovce is expected to be put into operation during the upcoming winter, and the fourth one a year later.

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CHINA NEWS

China's First Advanced Nuclear Reactor Faces More Delays

Start-Up Now Unlikely Until 2016 at the Earliest

EDF warns of added costs of Flamanville EPR weld repairs

09 October 2019

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French utility EDF said its preferred option for repairing the main secondary system penetration welds, using robots, will increase the cost of constructing the Flamanville EPR by EUR1.5 billion (USD1.6 billion). The loading of fuel into the reactor would also be further delayed until the end of 2022.

The same old story…

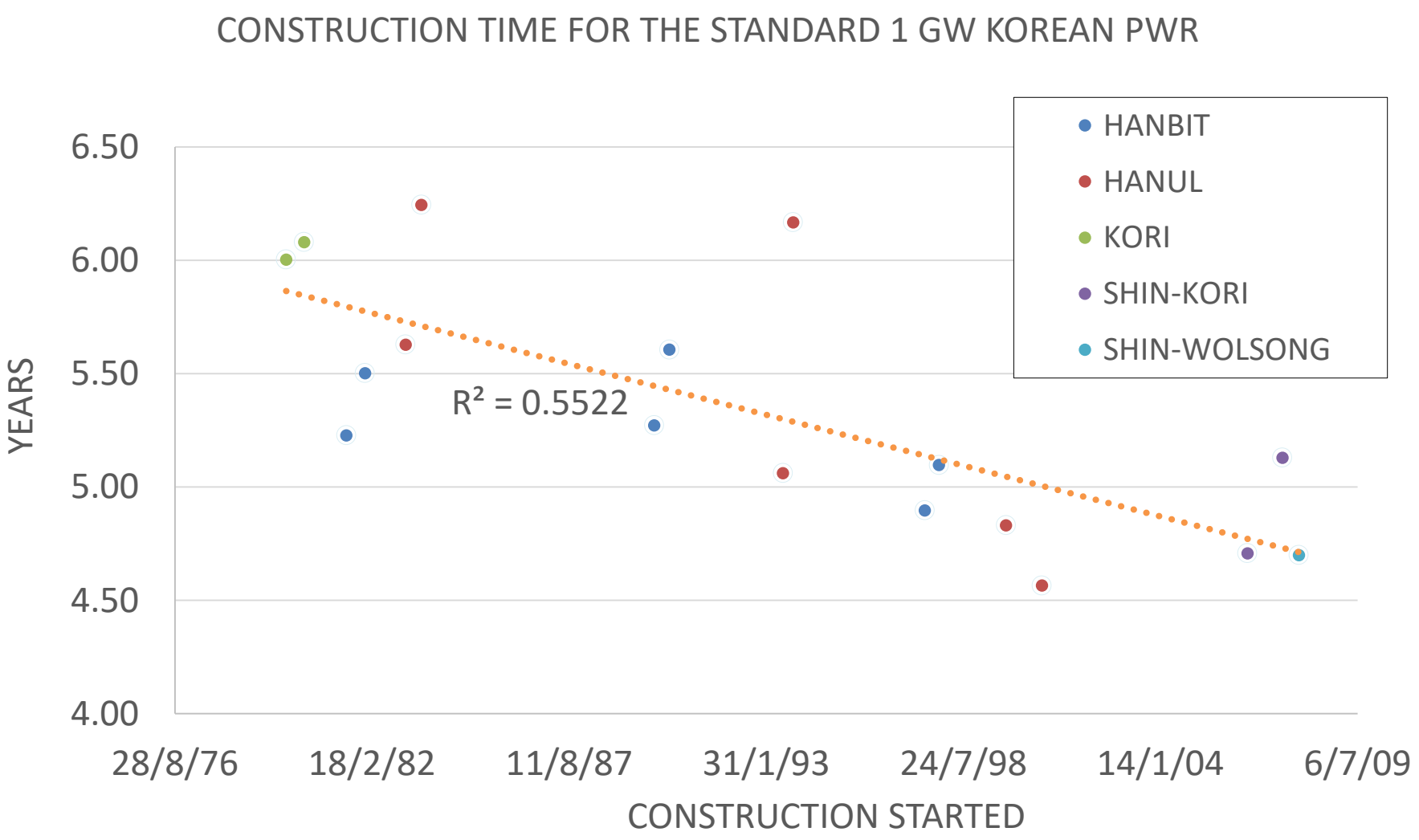
Projected and Actual Construction Costs for Nuclear Power Plants (USA)

Construction Starts		Average Overnight Costs[a]		
Year Initiated	Number of Plants[b]	Utilities' Projections (Thousands of dollars per MW)	Actual (Thousands of dollars per MW)	Overrun (Percent)
1966 to 1967	11	612	1,279	109
1968 to 1969	26	741	2,180	194
1970 to 1971	12	829	2,889	248
1972 to 1973	7	1,220	3,882	218
1974 to 1975	14	1,263	4,817	281
1976 to 1977	5	1,630	4,377	169
Overall Average	**13**	**938**	**2,959**	**207**

Source: Congressional Budget Office (CBO) based on data from Energy In[illegible]nation Administration, *An A[illegible]of Nuclear Power Plant Construction Costs*, Technical Report DOE/EIA-0485 (January 1, 1[illegible]).

Actual = budget X 3

Can we have on time and budget "Nuclear reactors projects"? YES!




WHY???
WHY GOD WHY!!!

Megaprojects – Some literature

Sovacool, Benjamin K., Daniel Nugent, and Alex Gilbert. "Construction cost overruns and electricity infrastructure: an unavoidable risk?." *The Electricity Journal* 27.4 (2014): 112-120.

"401 power plant and transmission projects in 57 countries […] with only 39 projects across the entire sample experiencing no cost overrun"

Sovacool, Benjamin K., Alex Gilbert, and Daniel Nugent. "An international comparative assessment of construction cost overruns for electricity infrastructure." Energy Research & Social Science 3 (2014): 152-160.

"Hydroelectric dams and nuclear reactors have the greatest amount and frequency of cost overruns, even when normalized to overrun per installed MW […] solar and wind projects seem to present the least construction risk."

Sovacool, Benjamin K., Alex Gilbert, and Daniel Nugent. "Risk, innovation, electricity infrastructure and construction cost overruns: Testing six hypotheses." Energy 74 (2014): 906-917.

"H1 Bigger is bad
H5 - small is beautiful"

Ansar, Atif, et al. "Big is Fragile: An Attempt at Theorizing Scale." (2016).

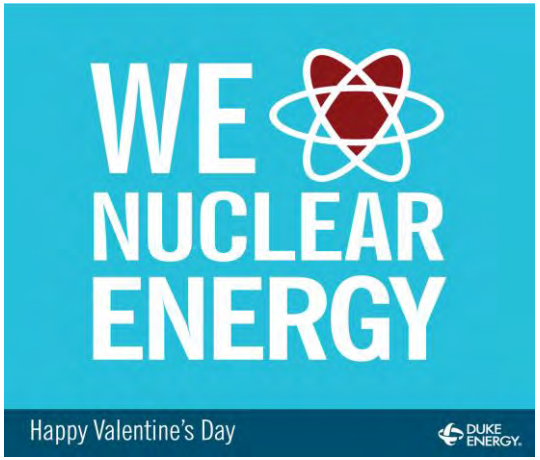
"the propensity of big capital investments to systematically deliver poor outc
easil
unce
and
(non
above and beyond their economies of scale and scope."

Big here is intended as
- Physically Unique, uncommon, expensive, long construction
- With a unique new team of stakeholders

4 Key reasons

All (mega)projects

Optimism Bias



Strategic Misrepresentation

Particularly (large) nuclear

FOAK technology and organisation

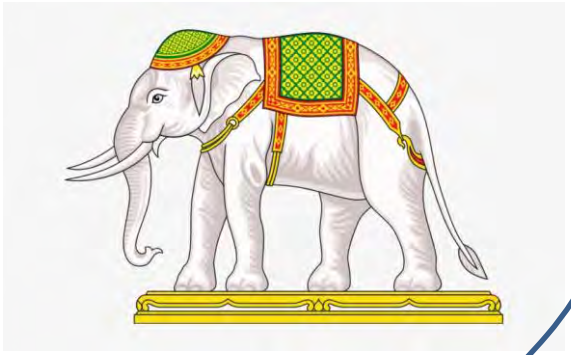
Complexity technology and organisation


FIX IT NOW

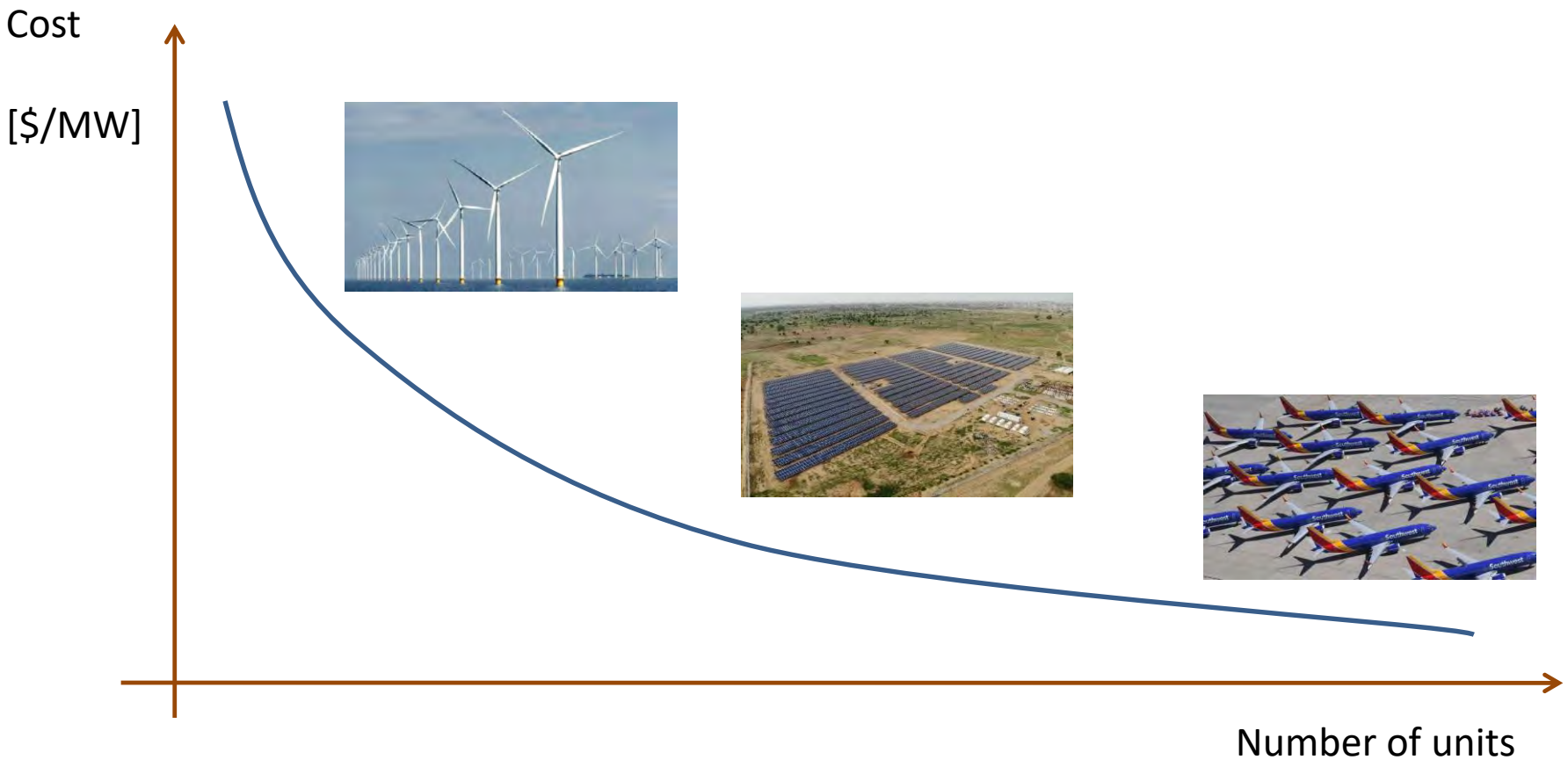
Fix it?

	Stand alone Large	Several "right" SMR
• Benchmark previous projects		
• Start from a completed design! Remember the Rickover Effect – Requires an immense amount of development on apparently trivial items; – Takes a long time to build because of its engineering development problems – Reworks, mistakes in constructions, change requests		
• Develop stakeholders accountability – "you won't get the next projects if you don't perform well on this one" – Create long term collaboration between stakeholders		
• Foster the "economy of multiples" – Learning for all the stakeholders involved – Multiple units in the single site		
• Economy of scale – Don't go to small, don't go to big!	?	?

Misunderstanding about economy of scale

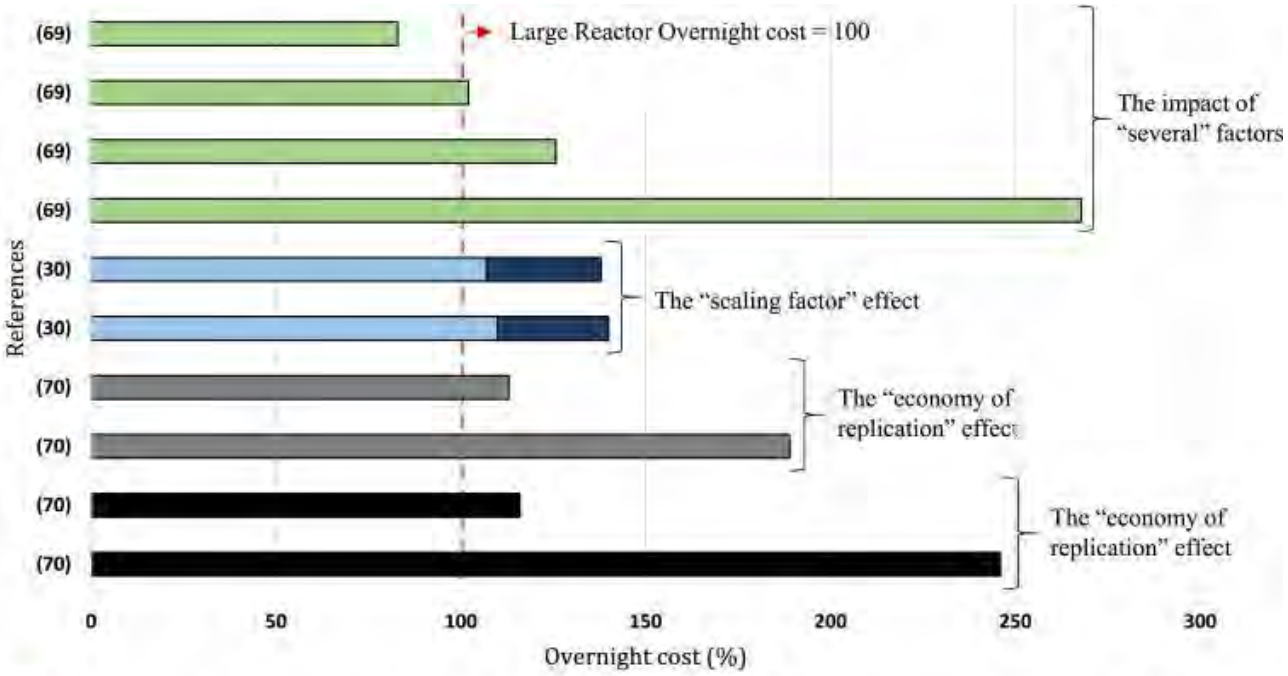


Economy of multiples



For the same power, the smaller the plant, more units are built

SMR OVC Estimations



The highest SMR OVC is obtained scaling up from an estimation of an LR OVC without considering other factors. The following OVCs are obtained including the following factors sequentially in the comparison: design simplification and schedule reduction, additional learning determined by factory fabrication that determines a 40% NOAK cost reduction applied to indirect components, contingency, and owner's cost, and the learning curve applied to all components.

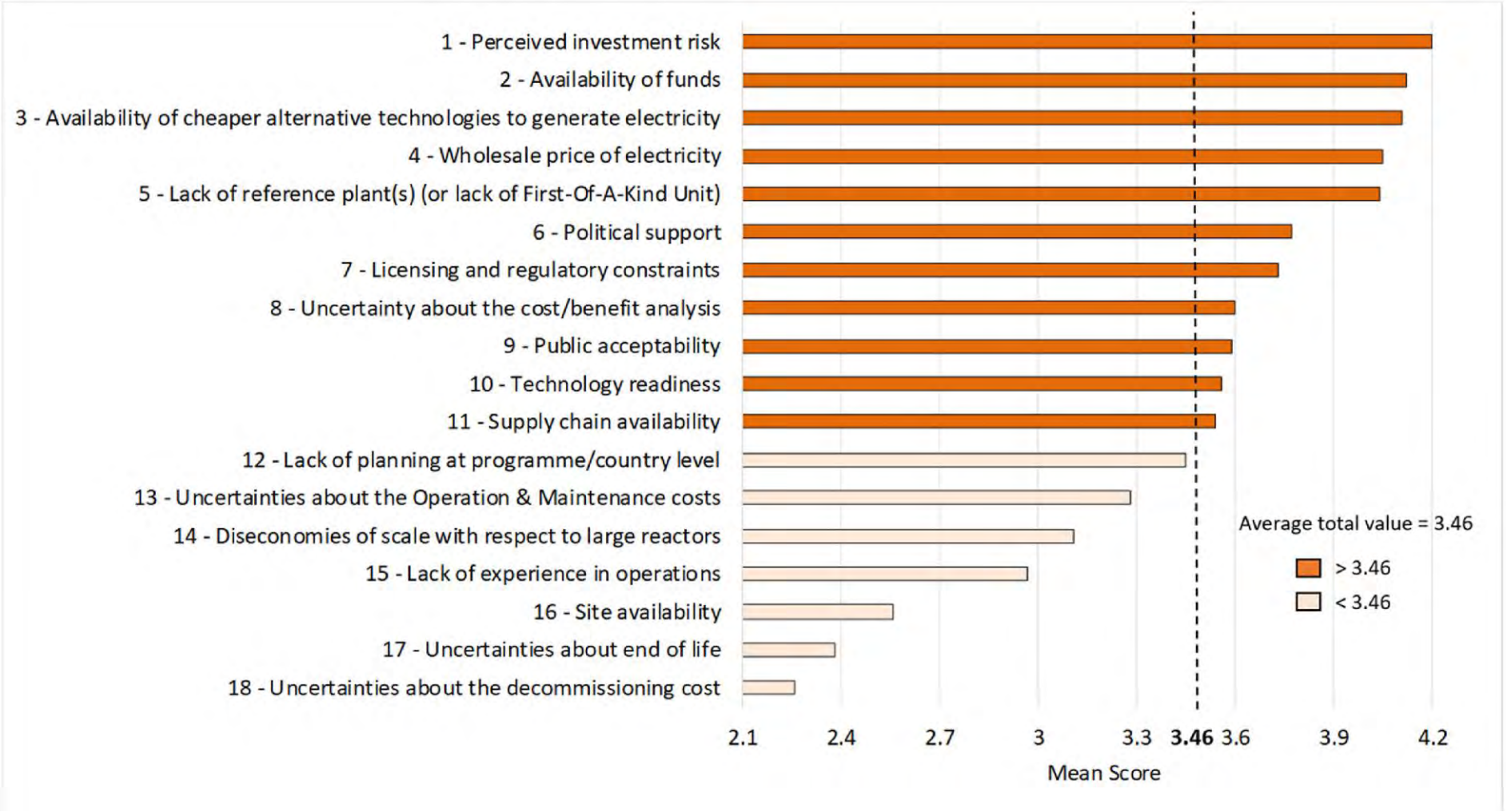
Respectively the minimum and the maximum from (30). The analysis highlights how the SMR OVC cost changes according to the different sizes of LR for the scaling up. The highest OVC is obtained scaling up from a 1500 MWe LR, while the lower value from a 1200 MWe LR.

Results by (70) showing how the economy of replication contribute to the reduction of the SMR OVC. The SMR OVC is 146% higher if it is considered only a 1600 MWe LR and a 150 MWe SMR. Considering more SMRs to reach the same total power, the gap is reduced to 16%.

Results by (70) showing how the economy of replication contributes to the reduction of the SMR OVC. The SMR OVC is 89% higher if it is considered only a 1600 MWe LR and a 300 MWe SMR. Considering more SMRs to reach the same total power the gap is reduced to 13%.

Mignacca, B., & Locatelli, G. (2020). Economics and finance of Small Modular Reactors: A systematic review and research agenda. *Renewable and Sustainable Energy Reviews*, *118*, 109519.

What are the most important elements hindering the construction of SMRs?



Mignacca, B., Locatelli, G., & Sainati, T. (2020). Deeds not words: Barriers and remedies for Small Modular nuclear Reactors. *Energy*, 118137.

What's about risk?

- FOAK cost unknown → True for LR and SMR, but the scale is dramatically different

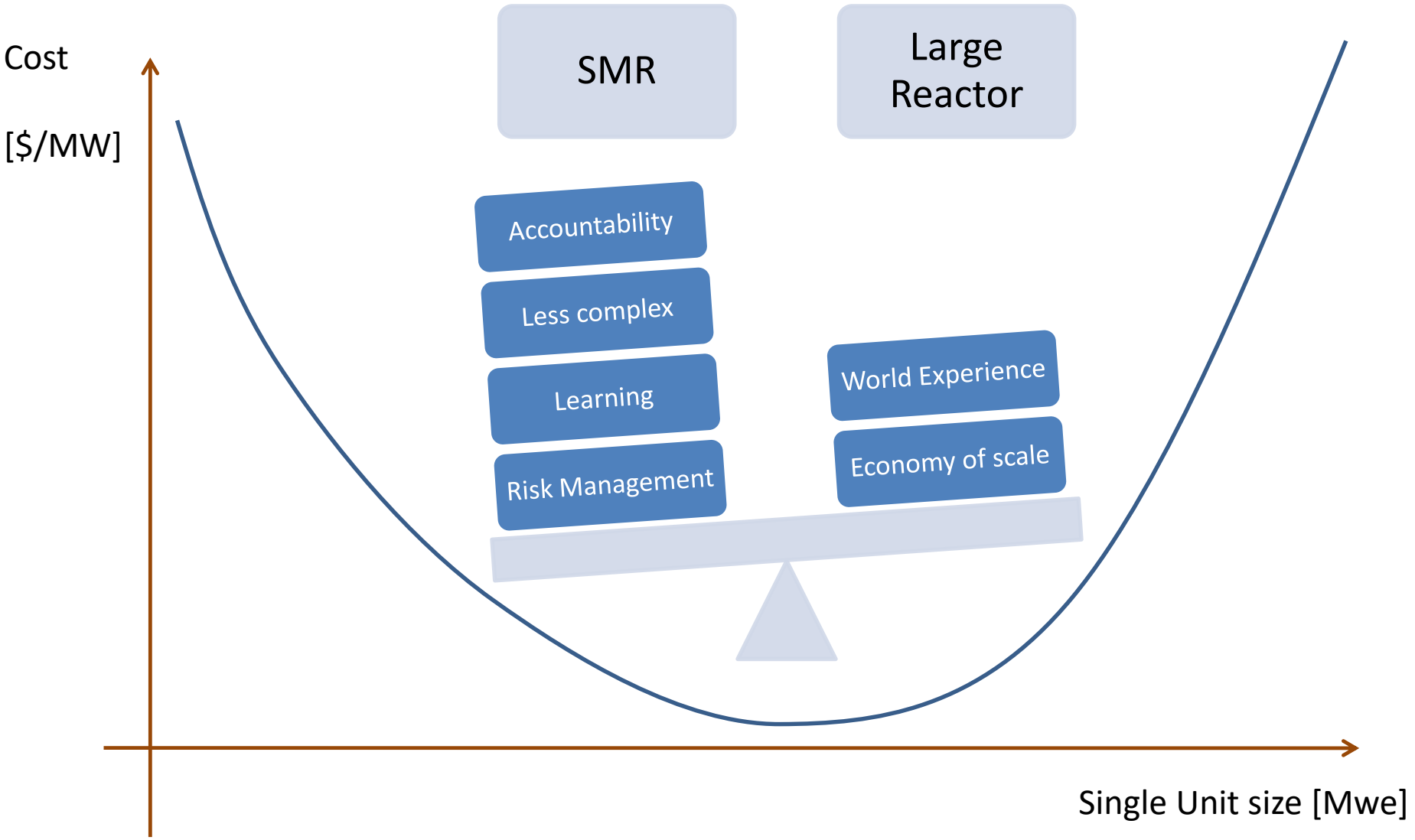
- Exogenous (construction time related)
  - Exchange rates
  - Interests escalation
  - Legislation changes (Chernobyl / Fukushima events)
  - COVID
  - …

SMR shorter construction time

- Endogenous
  - Design mistakes/uncertainties
  - Suppliers mistakes
  - Mistakes in the construction
  - …

Fostered industrial learning (Korean Like)

Which project?



Key messages

- Large engineering projects are often delivered overbudget and late (tons of literature here!)
- Larger the projects more likely to have issues with its delivery
- Investment risk (size and uncertainty) is a key barrier for building nuclear power plants
- SMR can exploit the economy of multiples
  - Start with a complete design (at least after the FOAK)
  - Standardisation of design and supply chain (learning, complete design)
  - Stakeholders Accountability
  - Reduced complexity
  - "Making a Megaproject less mega"
- The "right size" of the SMR (or LR) is also influenced by your country situation
- The delivery of several standardised SMR project might be the key to achieving good project management performances

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