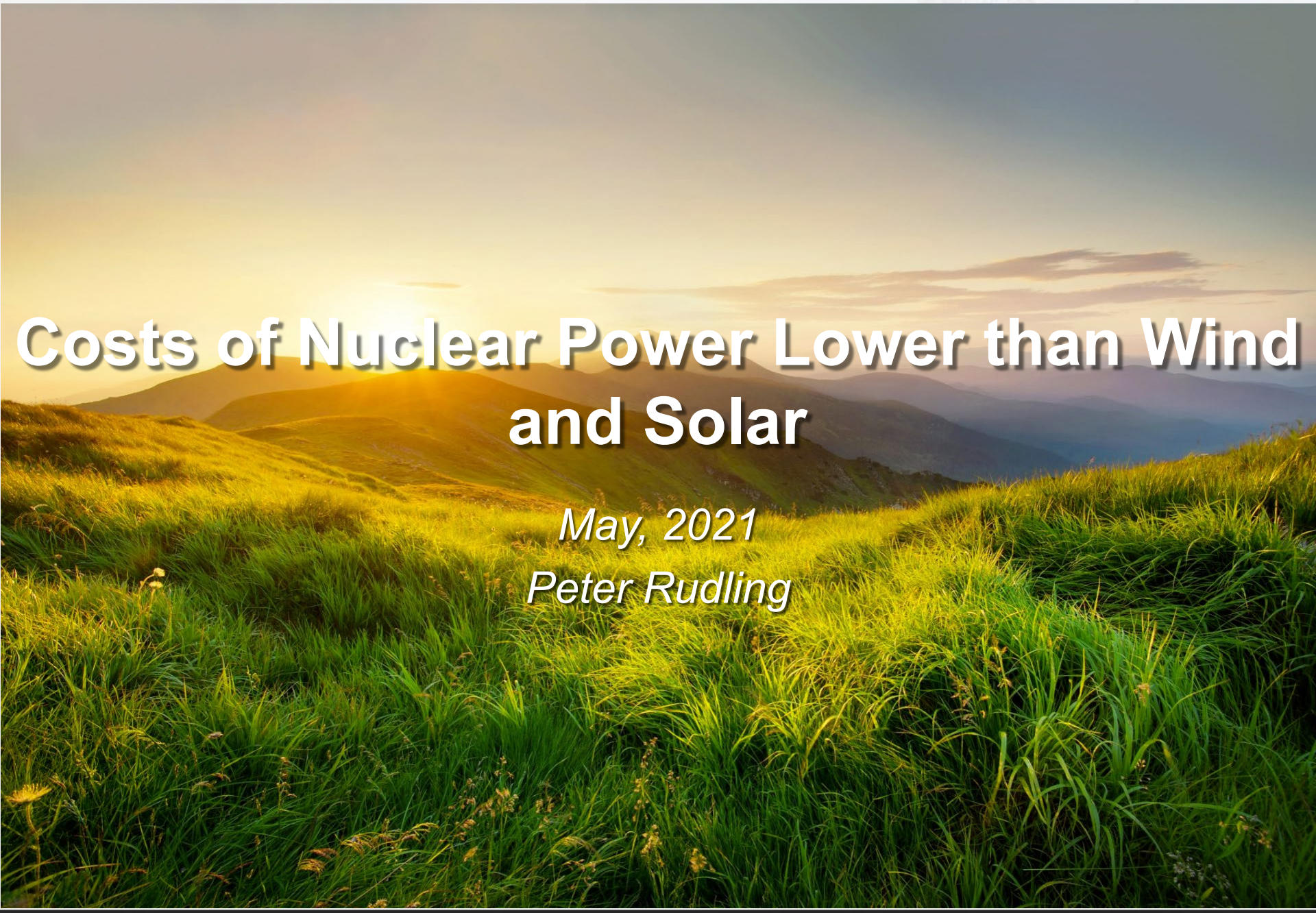
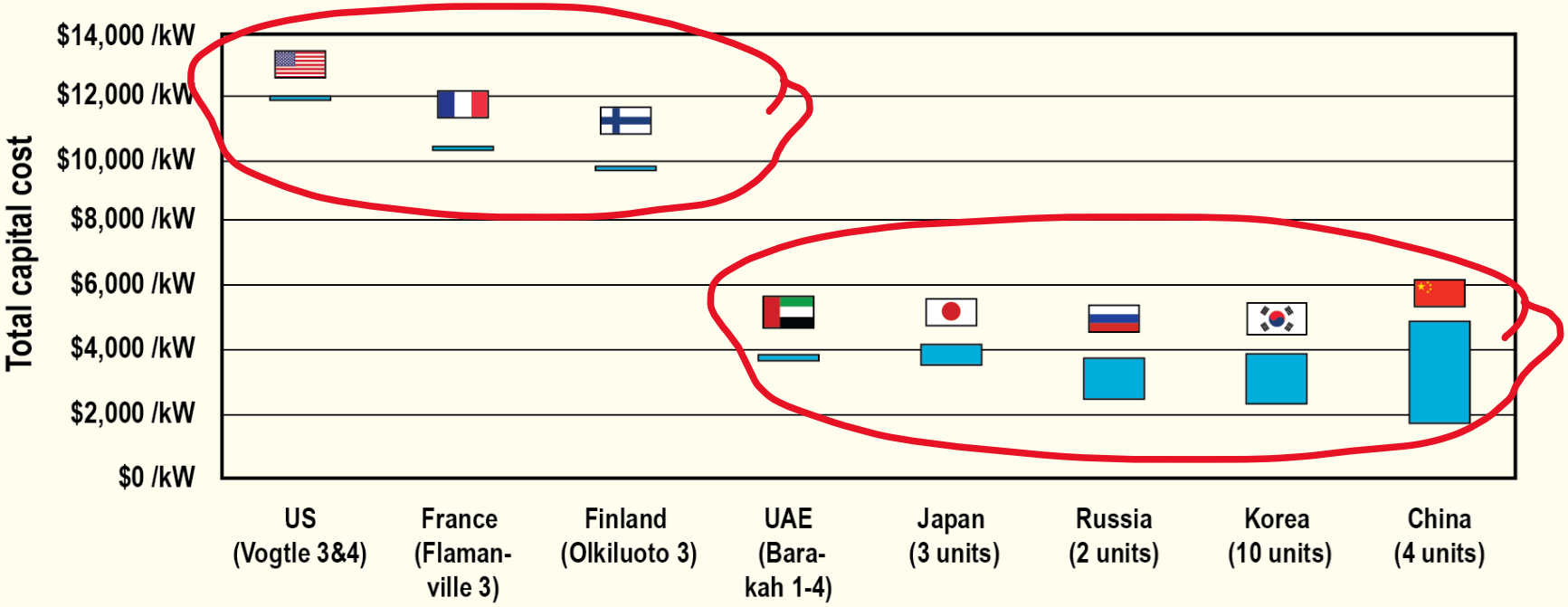


Costs of Nuclear Power Lower than Wind and Solar

May, 2021

Peter Rudling

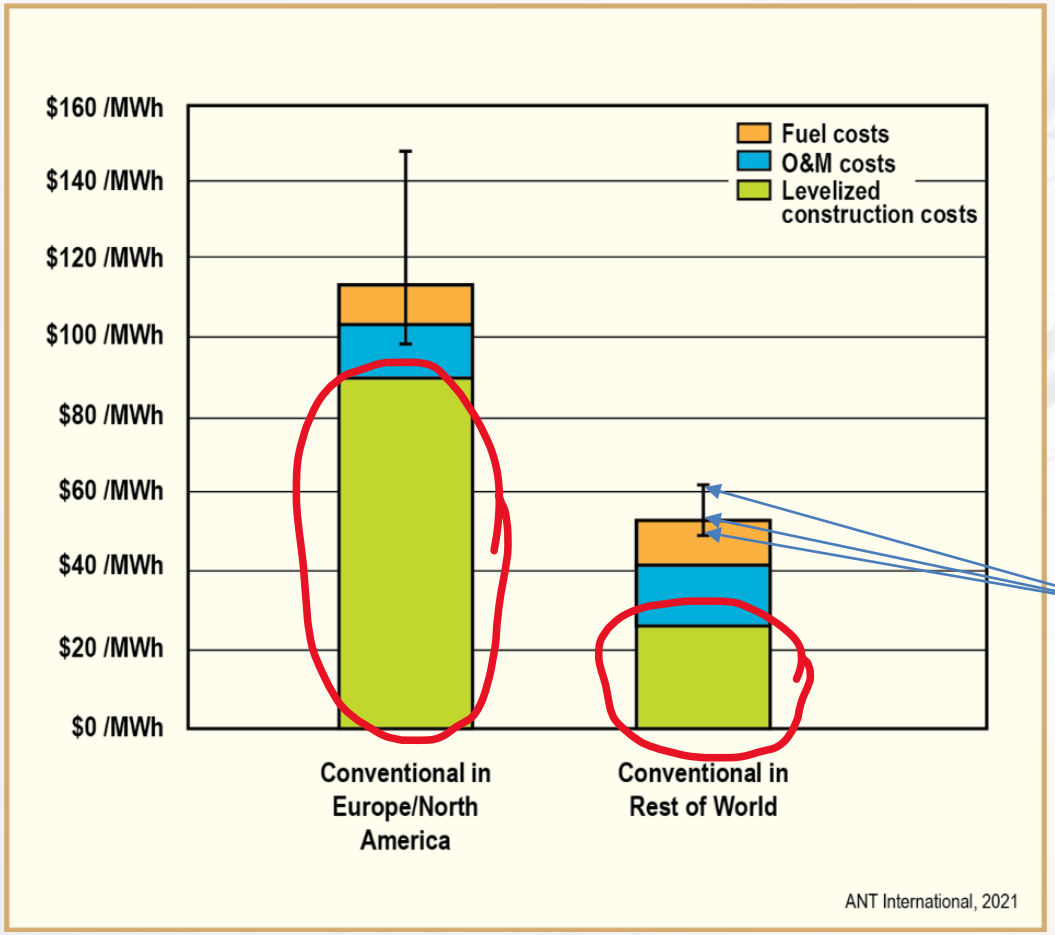
Cost to build new nuclear reactors



Capital costs are fixed, one-time expenses incurred on the purchase of land, buildings, construction, and equipment used to build a reactor

Reference: Modified figure from [D7.3-ETI-Nuclear-Cost-Drivers-Summary-Report_April-20.pdf (d2umxnkyjne36n.cloudfront.net)]

Cost of energy produced by new nuclear reactors



The LCOE (levelised cost of energy) measures lifetime costs divided by energy production.

The interest rate is determined by assessing the cost of capital, risks involved, opportunity cost investors expect to earn relative to the risk of the investment to build a nuclear power plant (in this case)

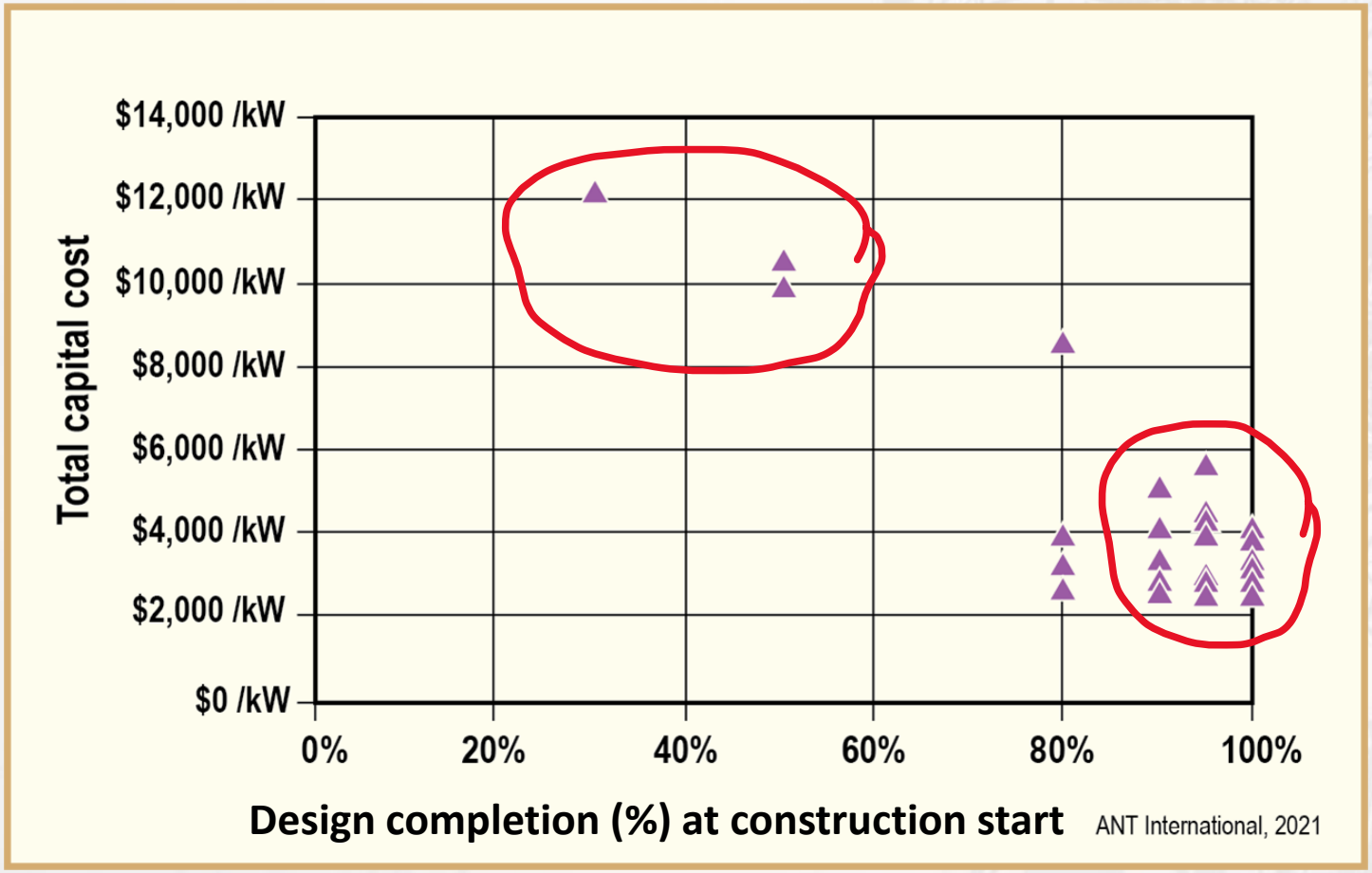
The LCOE (levelised cost of energy) at 6, 7 and 9 % interest rates.

Reference: Modified figure from [D7.3-ETI-Nuclear-Cost-Drivers-Summary-Report April-20.pdf (d2umxnkyjne36n.cloudfront.net)]

Cost to build new nuclear reactors

- Why do Chinese, Russians and Koreans build reactors at 1/3 of the cost and 1/3 of the contruction time compared to reactors built in Europe and US?
  - Experience
  - Reactor design completion before start of construction, see next slide

Reactor design completion percentage and total capital cost



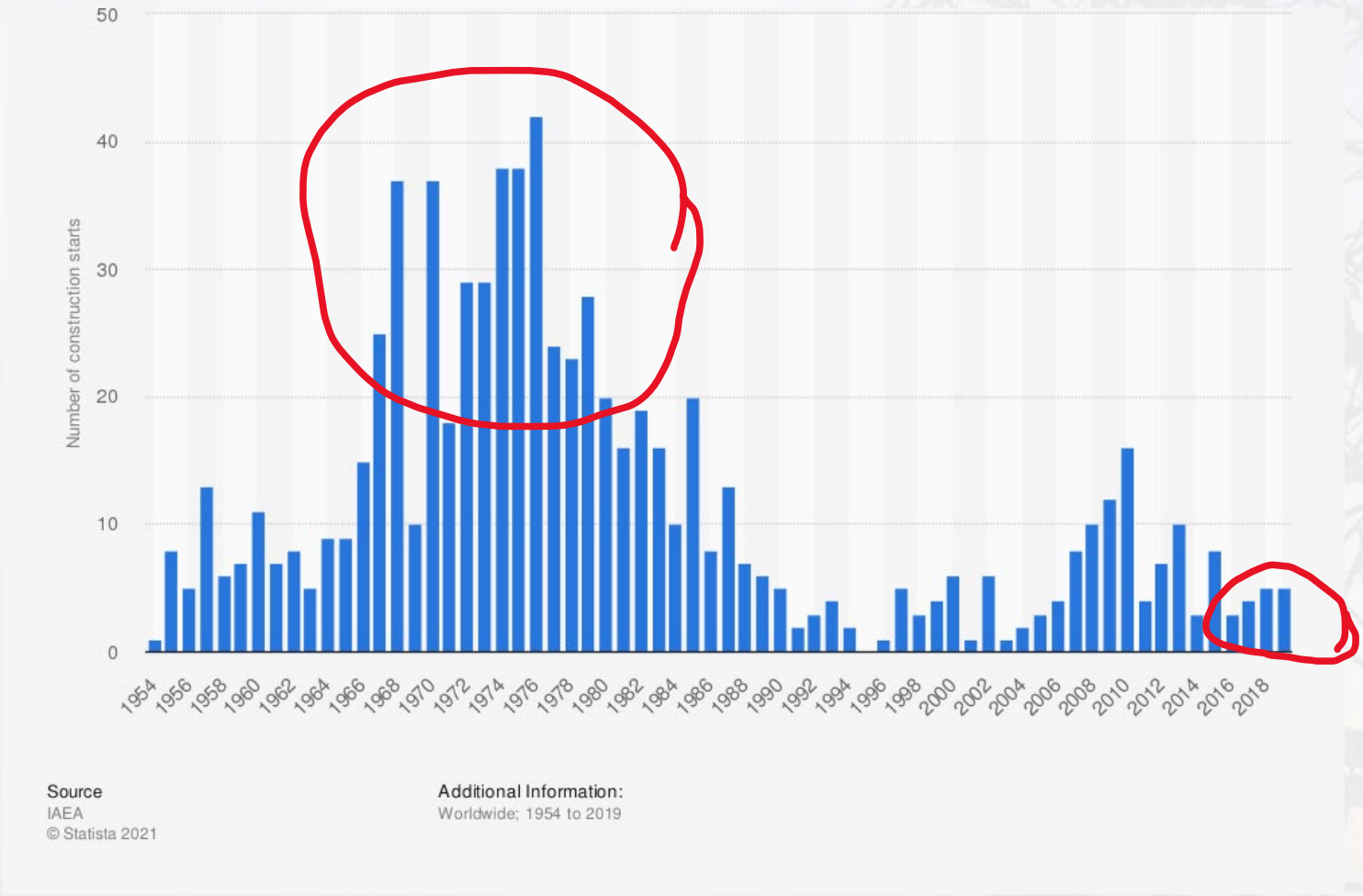
Reference: Modified figure from [D7.3-ETI-Nuclear-Cost-Drivers-Summary-Report_April-20.pdf (d2umxnkyjne36n.cloudfront.net)]

Larger costs related to longer reactor construction times

- Typical reactor contruction time in US/Europe
  - US
    - Vogtle 3-4,
      - Expected construction time – 8 years
  - Finland/France
    - Flammanville 3 and Olkiluoto 3
      - Expected construction time – 15-17 years
  - UAE
    - Barakah 1
      - Construction time – 6 years
  - China
    - Fuqing-5
      - Construction time – 5.5 years

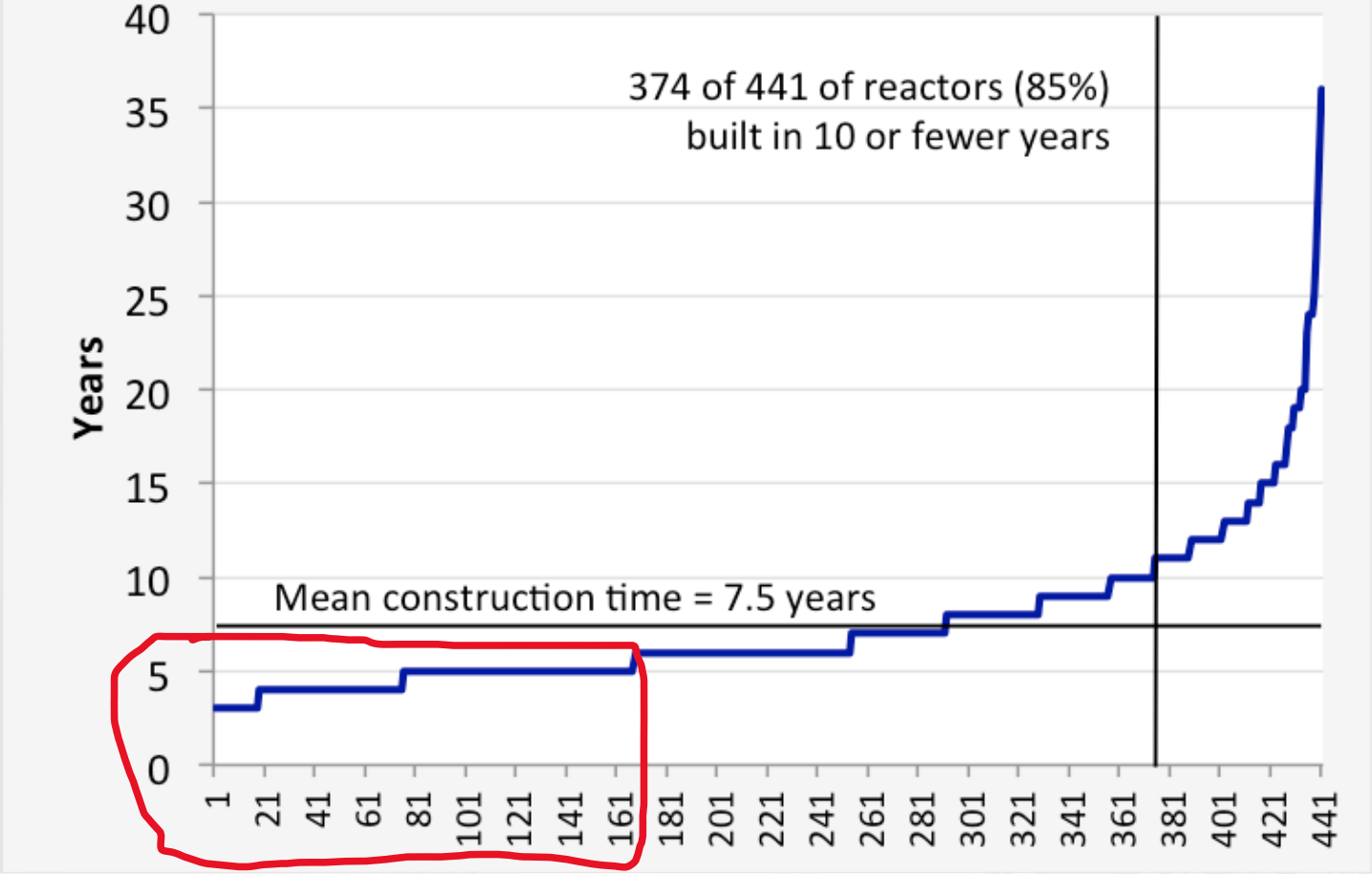
References: Vogtle Electric Generating Plant – Wikipedia
TVO awaits revised schedule for OL3 commissioning : New Nuclear - World Nuclear News (world-nuclear-news.org)
Barakah Nuclear Power Plant - Power Technology | Energy News and Market Analysis (power-technology.com)
Hualong One Reactor Now Operating in China (powermag.com)

Number of reactor construction starts



Reference: • Nuclear energy: power plant construction 2019 | Statista

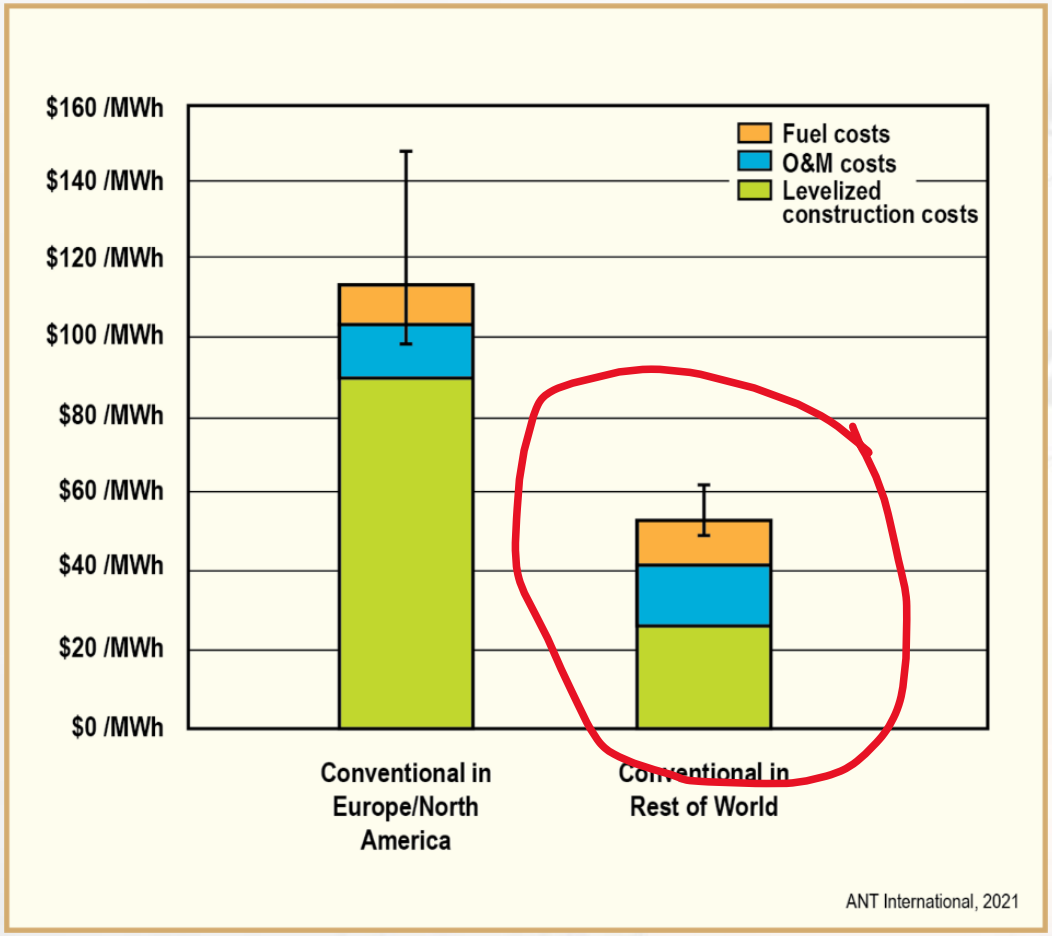
Construction time



18 reactors were completed in 3 years, 12 of those in Japan, 3 in the USA, 2 in Russia and 1 in Switzerland

Reference: [How long does it take to build a nuclear power plant? | Energy Matters (euanmearns.com)]

Cost of energy produced by new nuclear reactors



The LCOE (levelised cost of energy) is the income per unit energy (MWh) needed to recover the costs to build and operate the nuclear power plant during its life.

The LCOE (levelised cost of energy) at 6, 7 and 9 % interest rates.

Reference: Modified figure from [D7.3-ETI-Nuclear-Cost-Drivers-Summary-Report April-20.pdf (d2umxnkyjne36n.cloudfront.net)]

Cost comparision of nuclear, wind and solar energy

Parameter	Onshore wind	Offshore wind	Solar	Nuclear
Capital cost USD/MWh	43	72		
Capital Cost Parameters				
Windturbine	60-65%	30-40%		
Turbine foundation	5-10%	15-20%		
Transmission	10-15%	20-30%		
Access roads	5-10%	0%		
Other costs	5-10%	10-20%		
O&M cost USD/MWh	16	21		
Production cost USD/MWh	59	93	86*	50**

*The study by T. Karlsson and L. Torfgård indicated a production cost of 70 USD/MWh with any additional cost of transmission cost. The value of 86 USD/MWh assumes a 20 % transmission cost.

**From slide 3

References in Swedish: FULLTEXT01.pdf (diva-portal.se) , FULLTEXT01.pdf (diva-portal.se)

Conclusions

- The ”greens” refer to the latest nuclear reactor builds in Europe and US showing that new nuclear reactors are very expensive and take up to 17 years to build a new reactor.
  - However, these examples are not representive since these reactors were built by companies that had not build reactors for 30+ years and the design was not approved before construction start.
  - The Chinese, Russians, Koreans, Japanese reactors builders are building reactors continously at 1/3 of the cost and construction time compared to that of the European and US reactor construction companies.
  - If there is a renaissance of nuclear power in the world, the representative time and cost to build nuclear reactors for all reactor vendors will be similar that that of Chinese, Russians, Koreans, Japanese reactors builders.
  - The production cost of wind and solar is at least 20- 85% more expensive than that of new nuclear reactors

About Peter Rudling

- Mr. Peter Rudling was a senior consulting specialist at Vattenfall, the largest Swedish nuclear power company. Earlier he has also been a Specialist of Nuclear Fuel Materials at ABB Atom (now Westinghouse) and a Project Manager at Electric Power Research Institute (EPRI) in CA, USA.
- More information about Peter, please click here.

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- D7.3-ETI-Nuclear-Cost-Drivers-Summary-Report April-20.pdf (d2umxnkyjne36n.cloudfront.net)
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- How long does it take to build a nuclear power plant? | Energy Matters (euanmearns.com)
- FULLTEXT01.pdf (diva-portal.se) , FULLTEXT01.pdf (diva-portal.se)