ELECTRICITY MARKETS AND THE ROLE OF NUCLEAR WITH SPECIAL FOCUS ON SMR

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SURVEY

1. Introduction
2. How prices come about (theory)
3. Delays in construction times
4. The economic problems of delays . . .
5. Examples from Western Europe
6. Recent developments of nuclear
7. Some conclusions

ENERGY TRANSITION AUSTRIA: 5.11.1978? 50.5 % VOTE AGAINST NUCLEAR

What are the pro‘s and con‘s of nuclear?

MAJOR PRO-ORGANISATIONS

- NEA (Nuclear energy agency) Paris
- IAEA Vienna
- DOE / USA (How is nuclear regulated in the U.S.?)
- CEA (Commissariat a l'energie atomique) France
- EURATOM

A MAJOR CRITICAL REPORT

A Mycle Schneider Consulting Project
Paris, September 2024

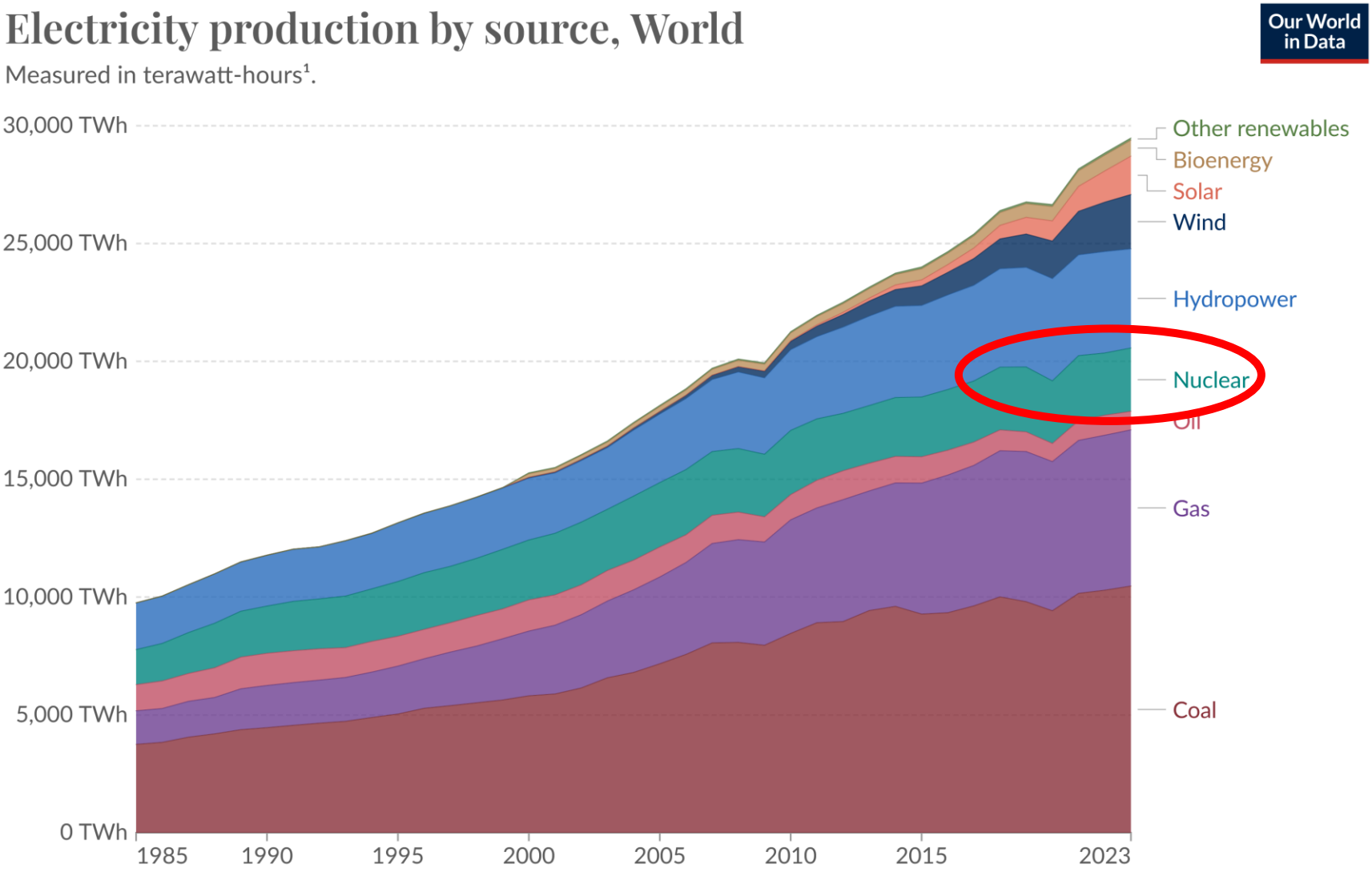
The World Nuclear Industry
Status Report 2024

https://www.worldnuclearreport.org/
World-Nuclear-Industry-Status-Report-2024-1046

Basic Positions against Nuclear

- Safety / accidents
- What to do with nuclear waste?
- How to decomission nuclear power plants ?
- A heritage for our grand-, grand-, grand children ..

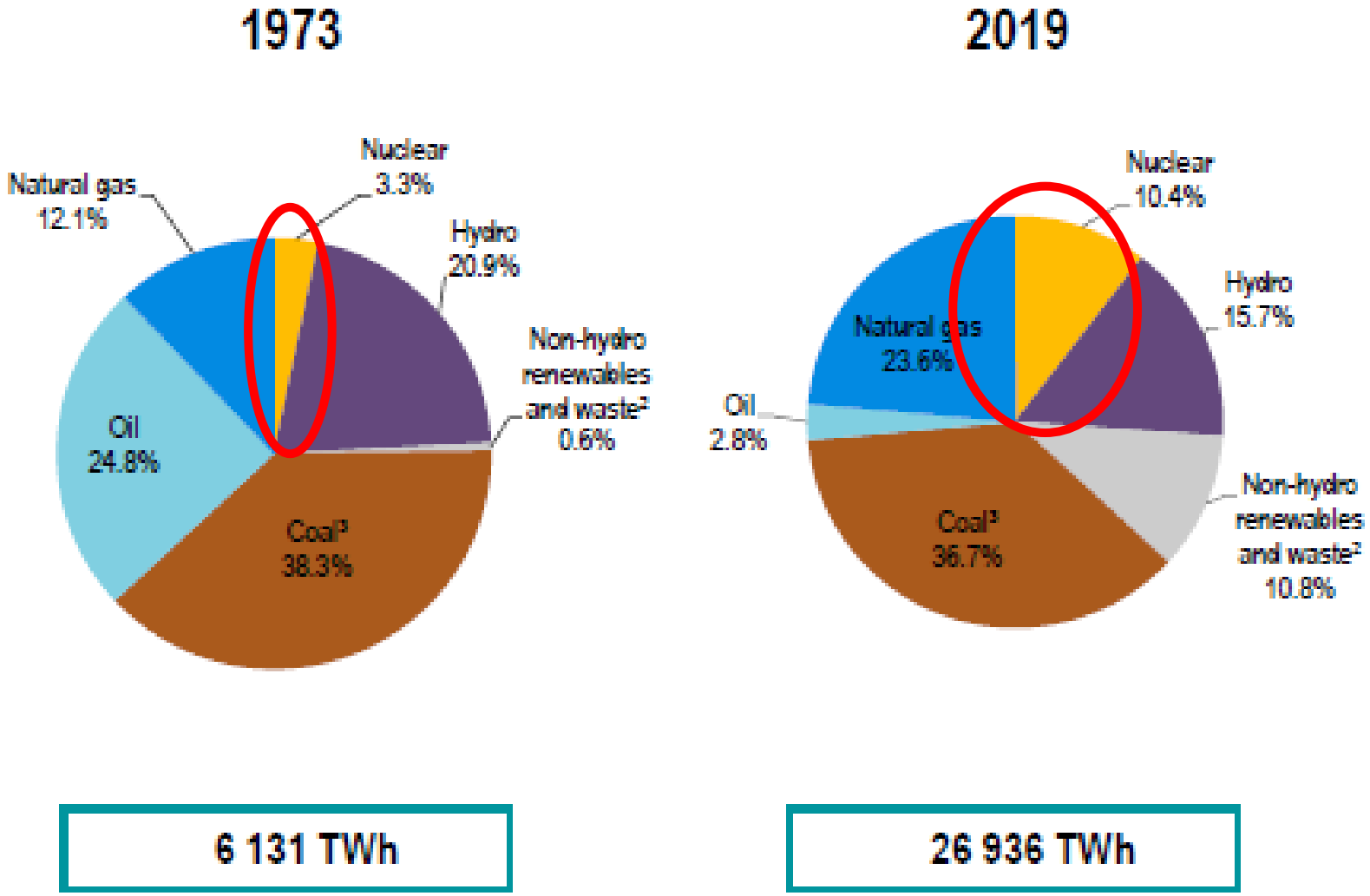
WORLD-WIDE TREND IN ELECTRICITY GENERATION



What is the share of nuclear in electricity generation today world-wide?

Share of world electricity

Share of world electricity generation[1] by source, 1973 and 2019

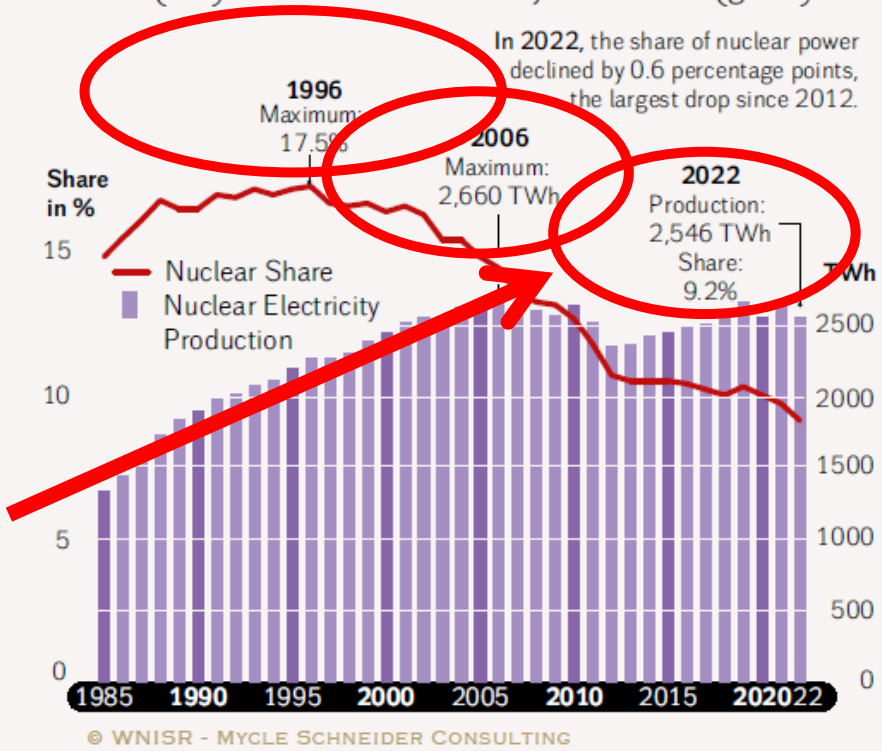


6 131 TWh

26 936 TWh

Nuclear Electricity Production 1985–2022 in the World...

in TWh (net) and Share in Electricity Generation (gross)



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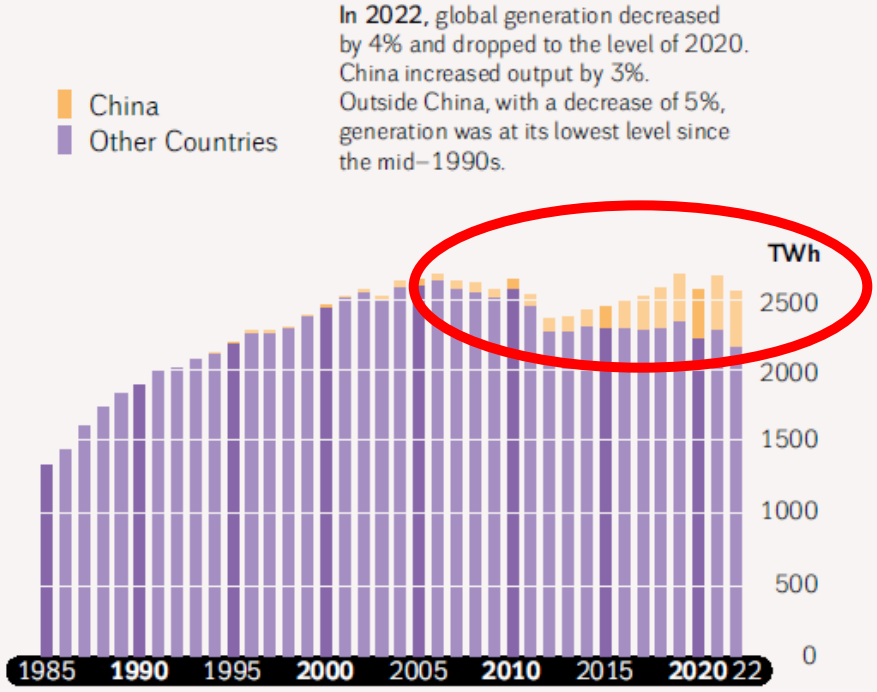
...and in China and the Rest of the World

in TWh (net)



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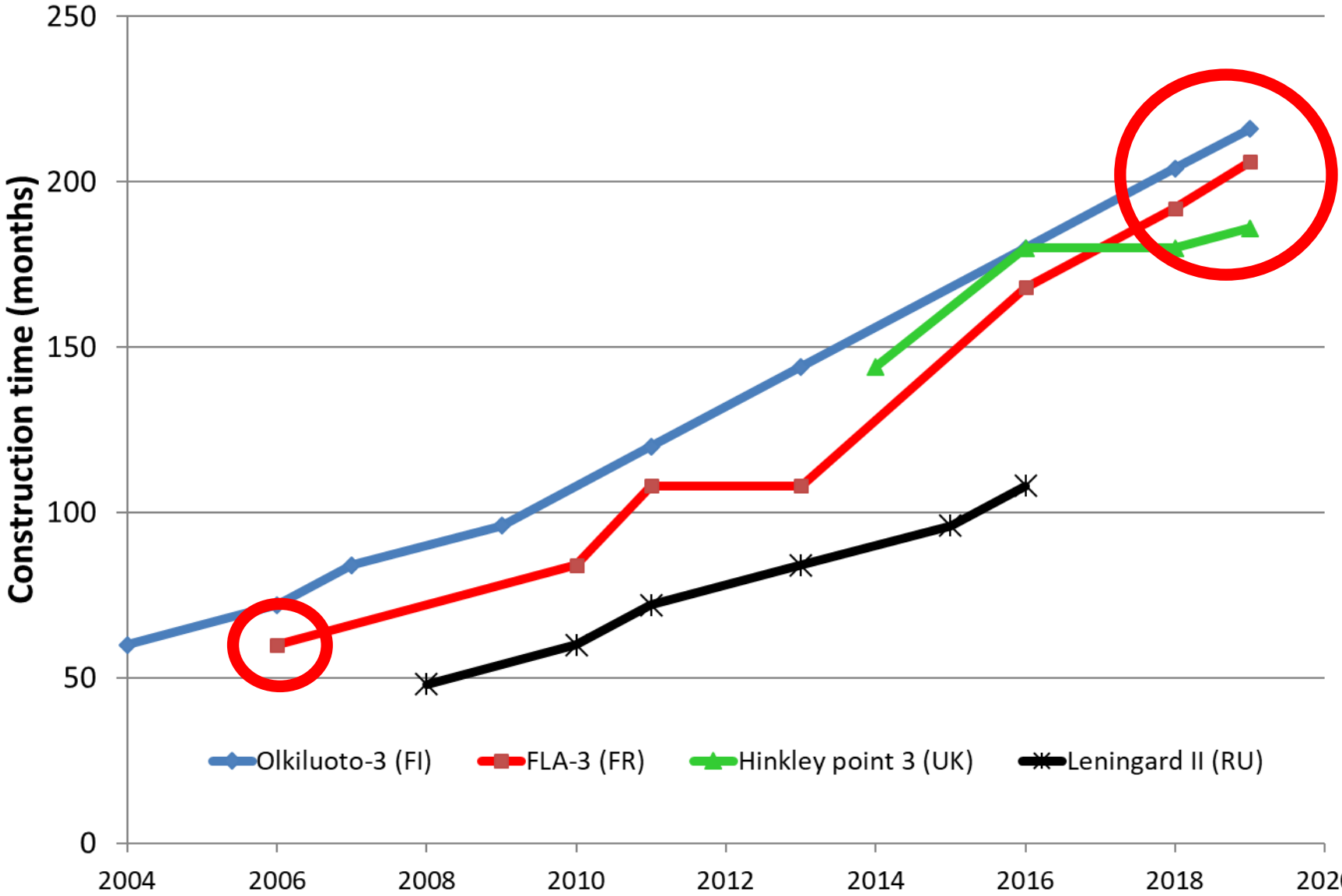
RECENT DEVELOPMENTS

- Olkiluoto-3 (Finland): Construction started in 2004, now completed 2023 (originally: 2009); 1600 MW

- Flamanville-3 (France): Construction started in 2006, now expected fully operating 2025 (originally: 2011); 1600 MW

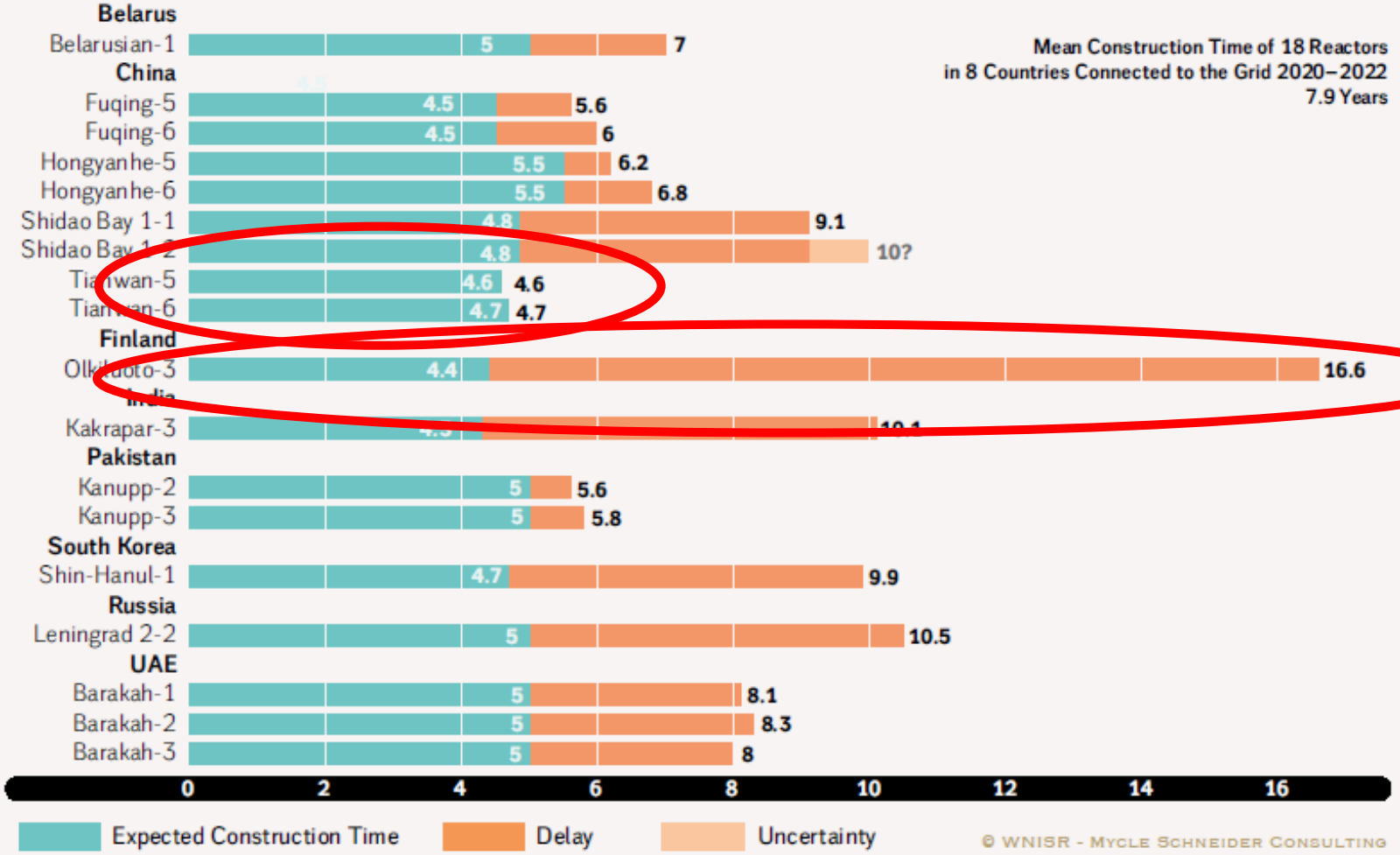
- Hinkley point (UK): Construction started in 2022, 1600 MW

Construction times

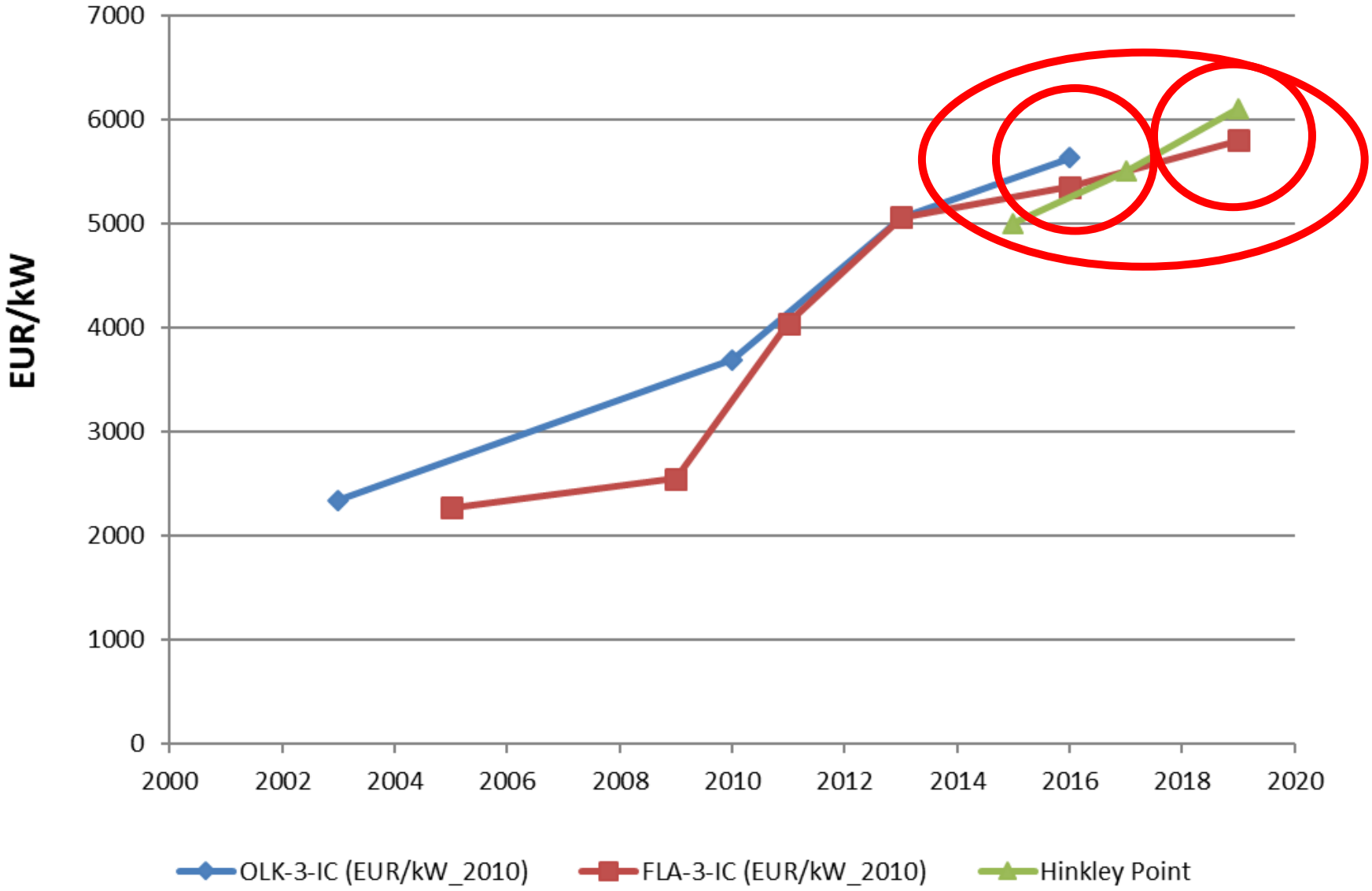


Expected vs. Real Duration from Construction Start to Grid Connection for Startups 2020–2022

in Years

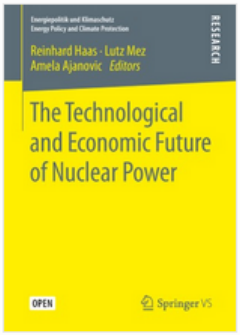


Investment cost development Olkiluoto 3 vs Flamanville 3 vs HP



CONCLUSIONS 1:

- **Nuclear will come to late for reducing GHG emissions**
- **Nuclear is expensive (Hinkley Point: 12 cent/kWh)**
- **The money invested in nuclear power is not available for RES and energy efficiency**



The Technological and Economic Future of Nuclear Power

Editors (view affiliations)

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Small modular reactors (SMRs)

- SMRs … defined as reactors with a capacity of 300 MW or less with ´serial factory production´ of reactor components (or 'modules').
- 300 MW instead of 1200 MW ? → Small?

- So far **no real** SMRs have been built, but dozens of small (<300 MW) power reactors without factory production of reactor components.

Bill Gates : Terra-Power → Traveling—Wave Reactors → was „built“ only in computer simulations (Gates called for „public cooperation“ to put it into practice)

France

- The Nuward project was first revealed in September 2019.
- The Nuward SMR design by EdF expects to build the first prototype by 2030.
- In 2022, President Macron announced €500 million would be made available for SMR projects “carried by EDF NUWARD”
- same sum for other “innovative reactors which allow to close the fuel cycle”.

- Nuward design changes announced in 2024 were a result of feedback from “prospective clients”
- electricity cost projections for the SMRs would be in the range of 70 to 100 euros per megawatt-hour..

Russia

- First SMR design is the “floating” KLT-40S design → Two reactors commissioned in May 2020 in the eastern part of the country.
- This Project suffered lengthy delays and cost overruns … load factors of just 30 % in 2022. Reasons for poor performance unclear.
- The second is the 55 MW RITM-200S, which is based on design in nuclear-powered icebreaker ships. (Two RITM-200S reactors commenced in August 2022.

China

in China, two SMR designs are currently under construction.

- Earlier design is a high temperature gas cooled reactor (HTGR) called the HTR-PM.
- The latter is an integral pressurized water reactor named ACP100.
- An earlier plan to build floating nuclear reactors appears to have been suspended

Other countries discussing the construction of SMRs

- South Korea: SMART, a 100-MW pressurized water reactor design.
- United Kingdom: Since 2014, Rolls Royce has been developing the “UK SMR”
- India,
- Argentina

SMR CONCLUSIONS (1)

- Small Modular Reactors, will face **greater economic challenges** compared to large reactors, SMRs will be more expensive per unit of installed capacity (discussed up to 20000 US$/kW) and produce more costly power.

- Trend of SMR designers to move **towards larger power outputs**—South Korea from 100 MW design to 170 MW design, Rolls-Royce proposing a 470 MW design—offers evidence for the continued importance of **economies-of-scale**.

- SMRs are developed with large amounts of public money. The puzzle remains why and how long will governments continue to invest in technologies that appear doomed **to commercial failure**.

SMR CONCLUSIONS (2)

- Since many years there is a lot of talking and discussion on SMRs , but so far no concept has been put into practice successfully.

- The NEA lists about 56 models in its SMR Dashboard —impressive really.
- But what about achievements?
- The NEA informs on its webpage that “the first SMRs are expected to be built this decade, followed by accelerated deployment around the world in the 2030s.”