Czech Republic Launch Event

The World Nuclear Industry Status Report 2021

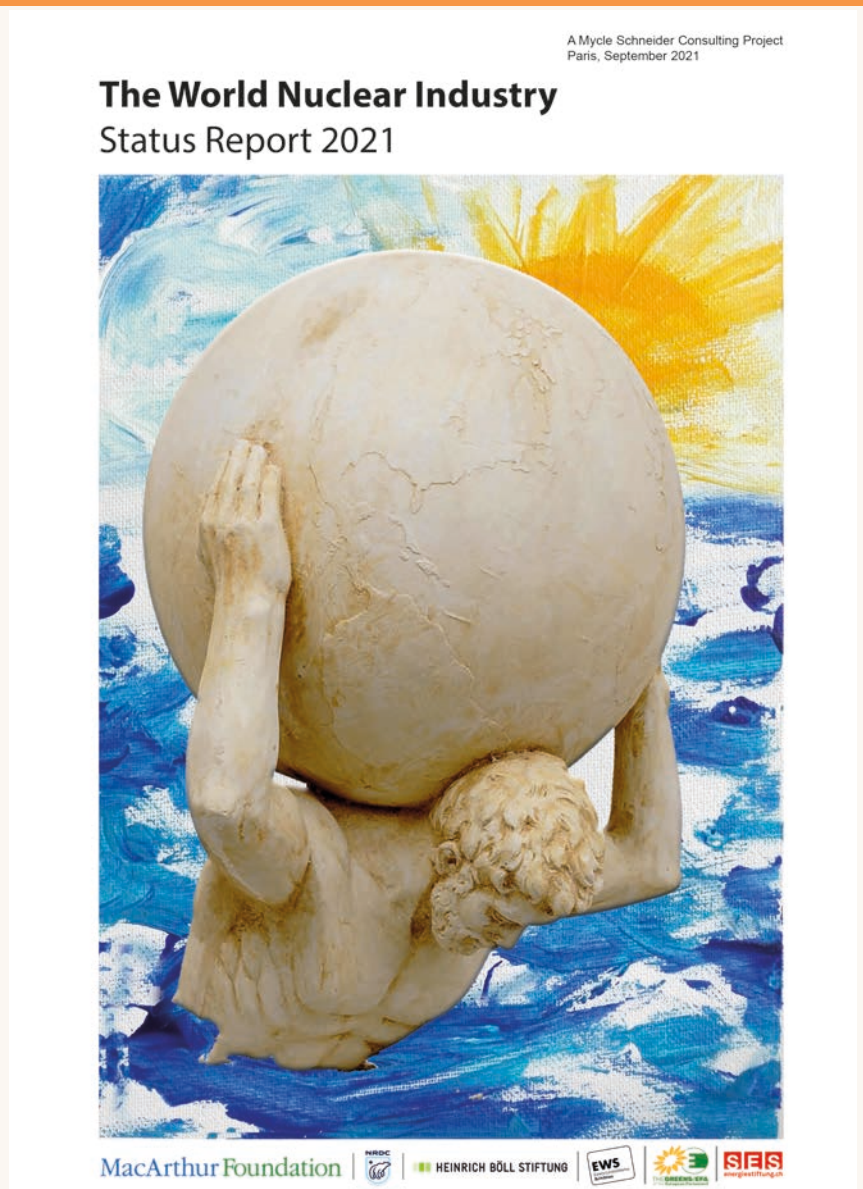
(WNISR2021)

www.WorldNuclearReport.org

Hosted by Hnuti Duha, Calla, and Heinrich Böll Foundation Czech Republic

Prague (Czech Republic), Rockingham (ON, Canada)
19 October 2021

International, Interdisciplinary Team for a Multi-Indicator Analysis



The World Nuclear Industry
Status Report 2021

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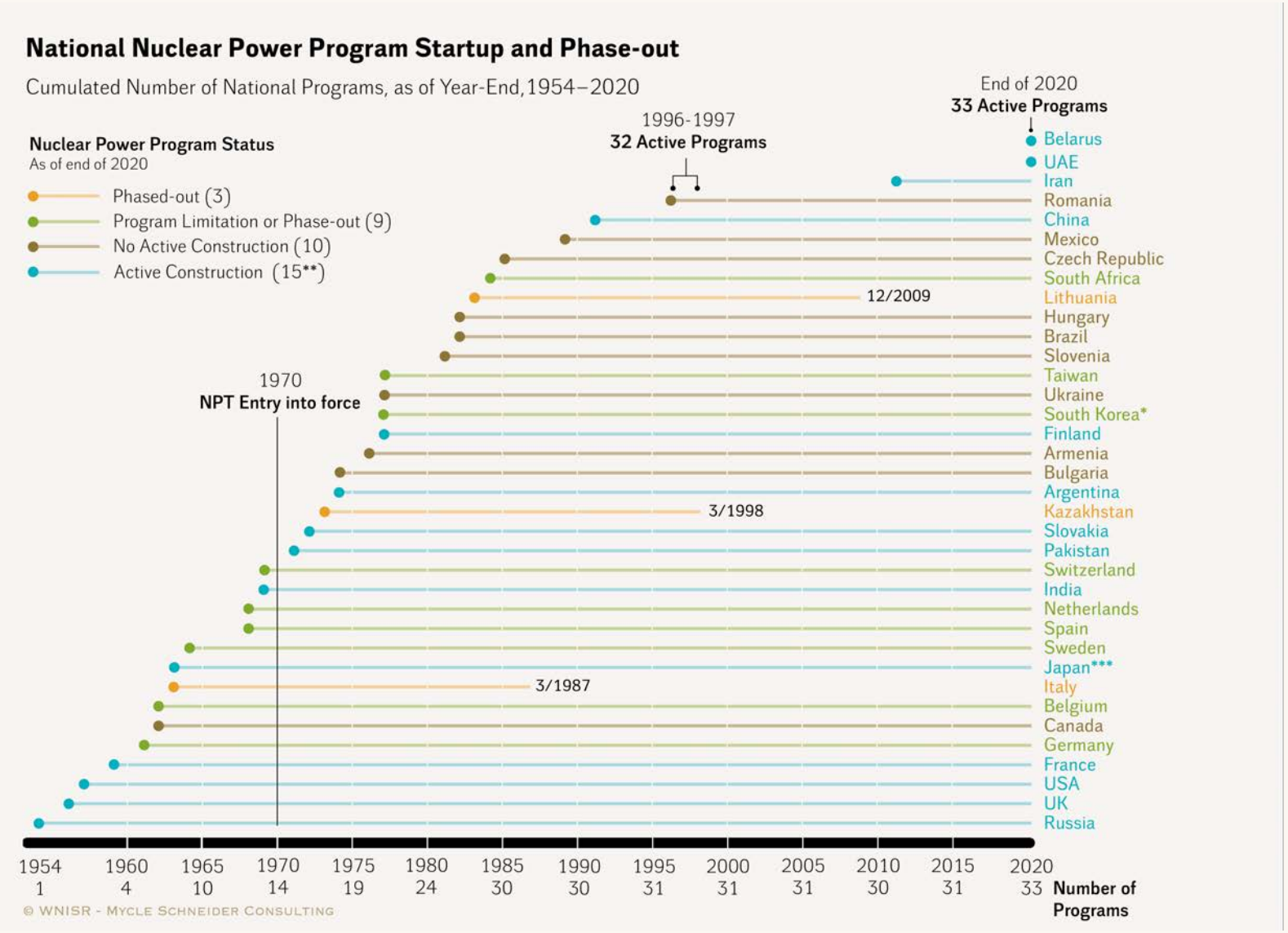
GLOBAL OVERVIEW – PROGRAMS STARTUP AND PHASE-OUT



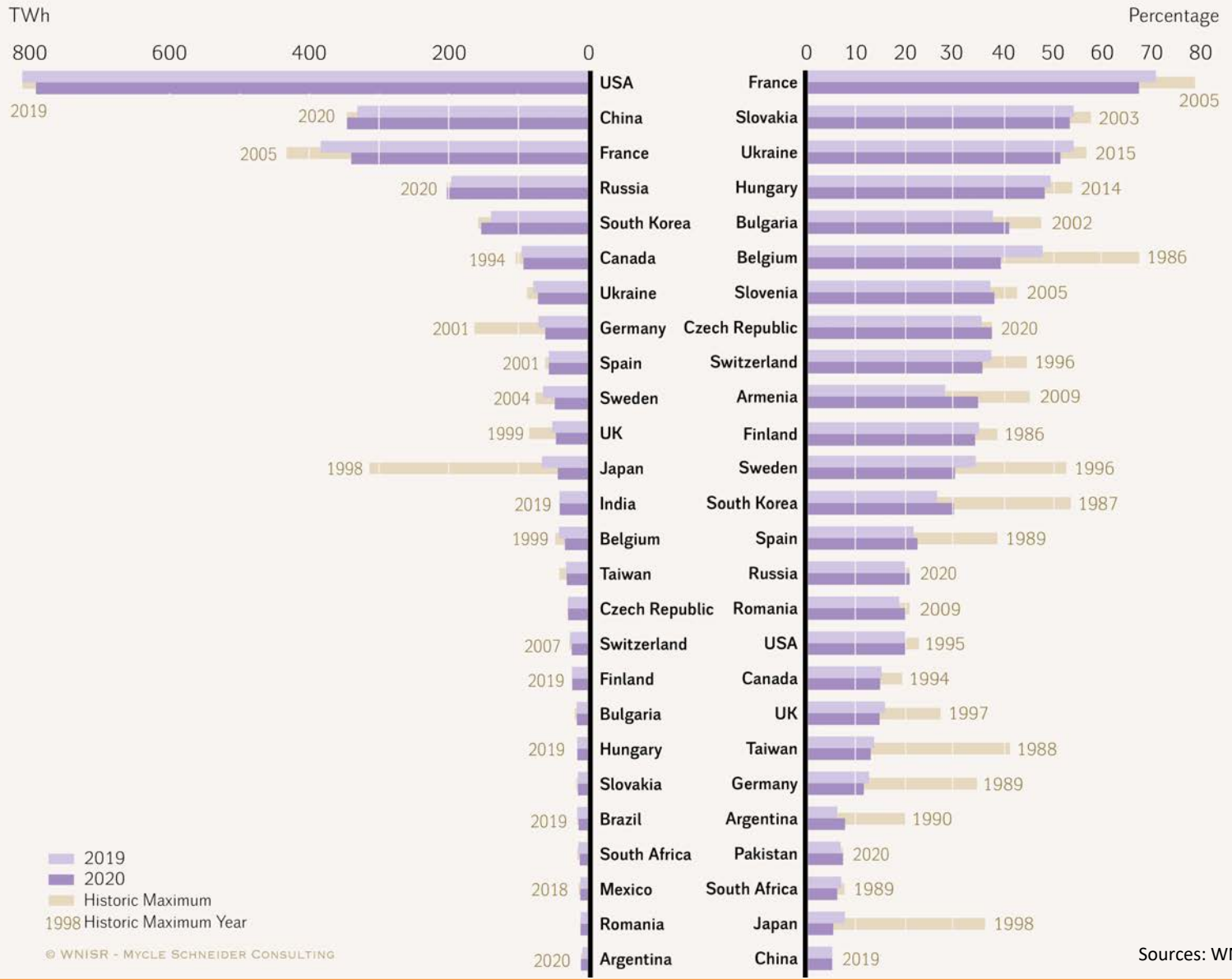
* Although it has a phaseout policy, South Korea has four reactors under construction as of 1 July 2021.
** Including South Korea listed in the category "Program Limitation or Phase-out"
*** Japan is counted here among countries with "active construction"

Sources: WNISR, with BP, IAEA-PRIS, 2021

GLOBAL OVERVIEW – ROLE OF NUCLEAR POWER

Nuclear Production in 2019-2020 and Historic Maximum

in TWh and
% of Electricity Production

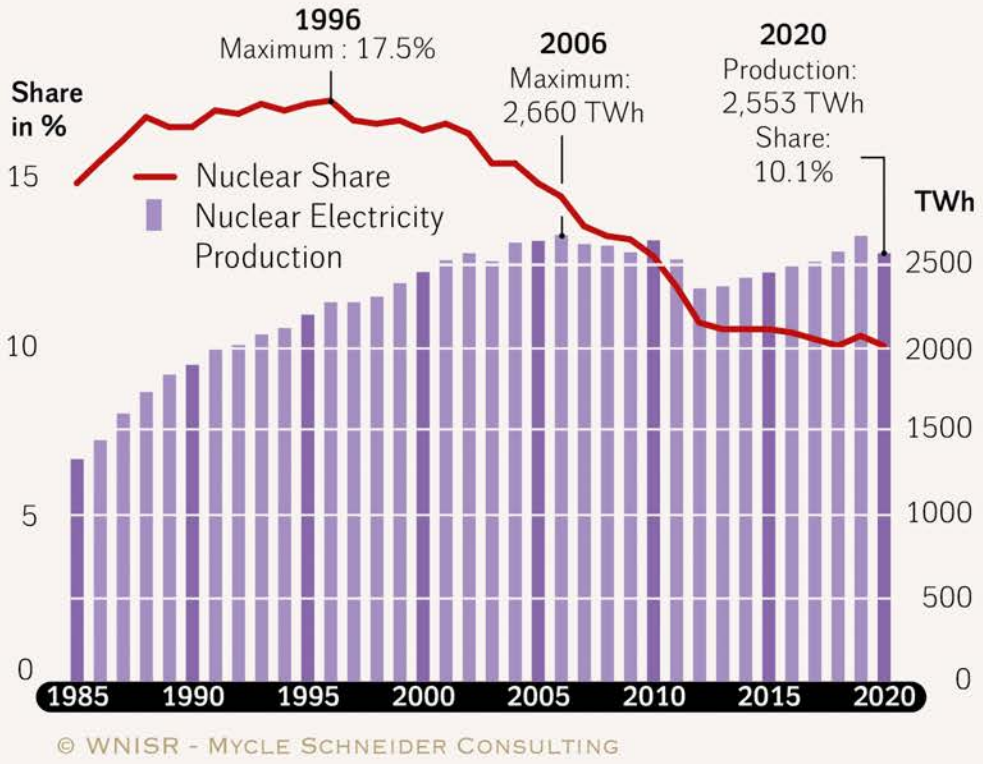


Sources: WNISR, with IAEA-PRIS, RTE and SFOE, 2021

GLOBAL OVERVIEW – ROLE OF NUCLEAR POWER

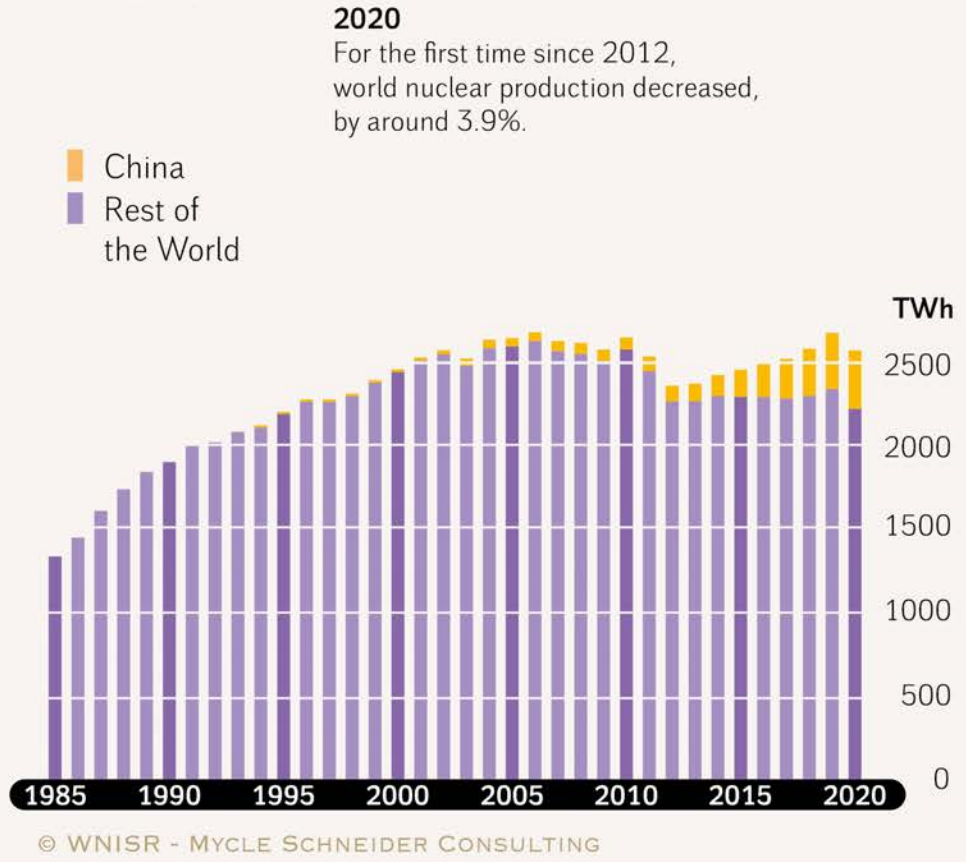
Nuclear Electricity Production 1985–2020 in the World...

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



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

in TWh (net)



Sources: WNISR, with BP, IAEA-PRIS, 2021

GLOBAL OVERVIEW – ROLE OF NUCLEAR POWER

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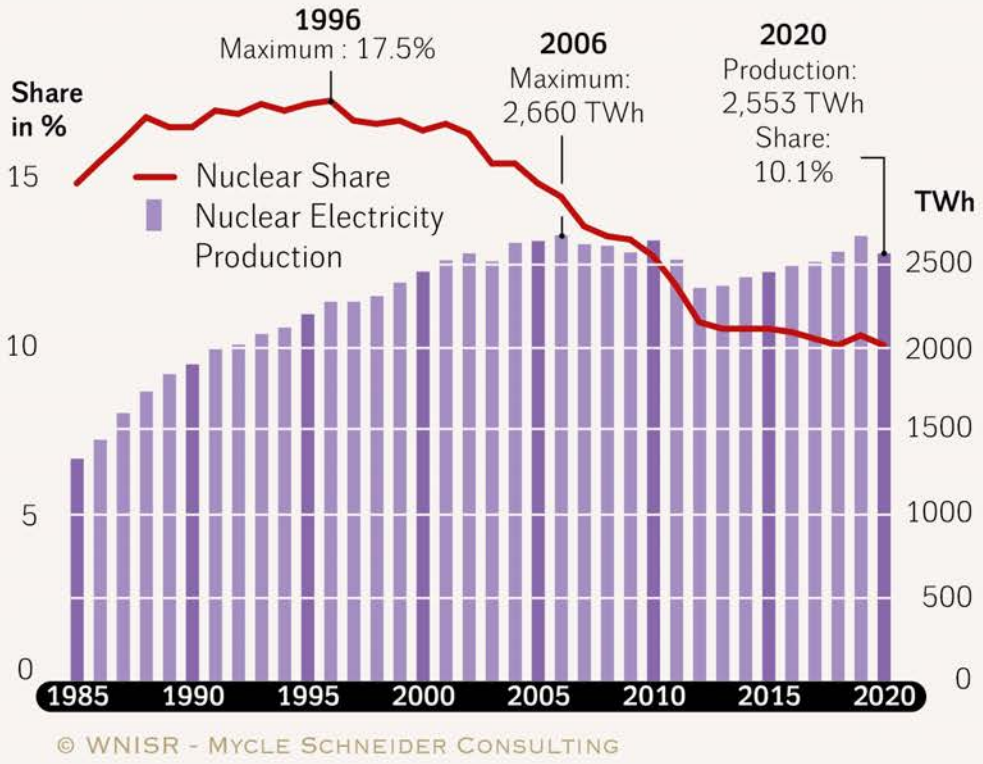
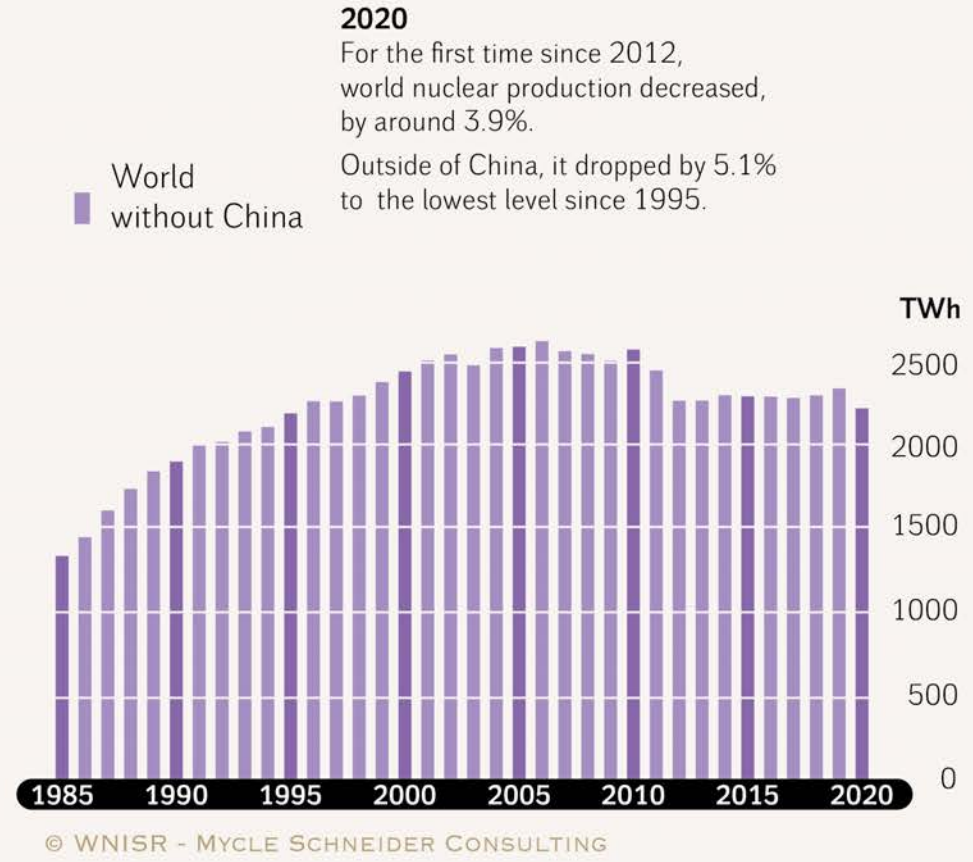


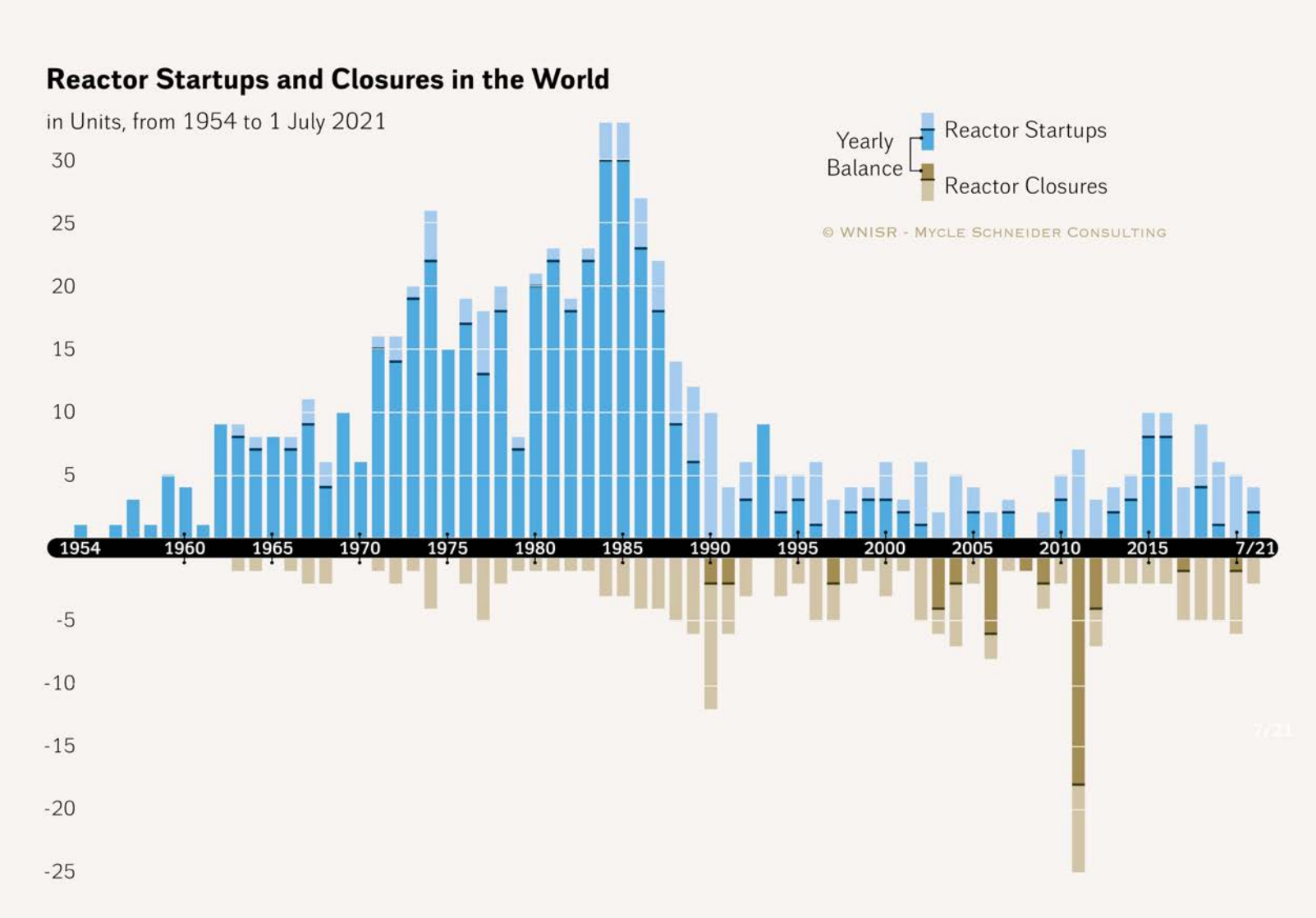
...and in China and the Rest of the World

in TWh (net)



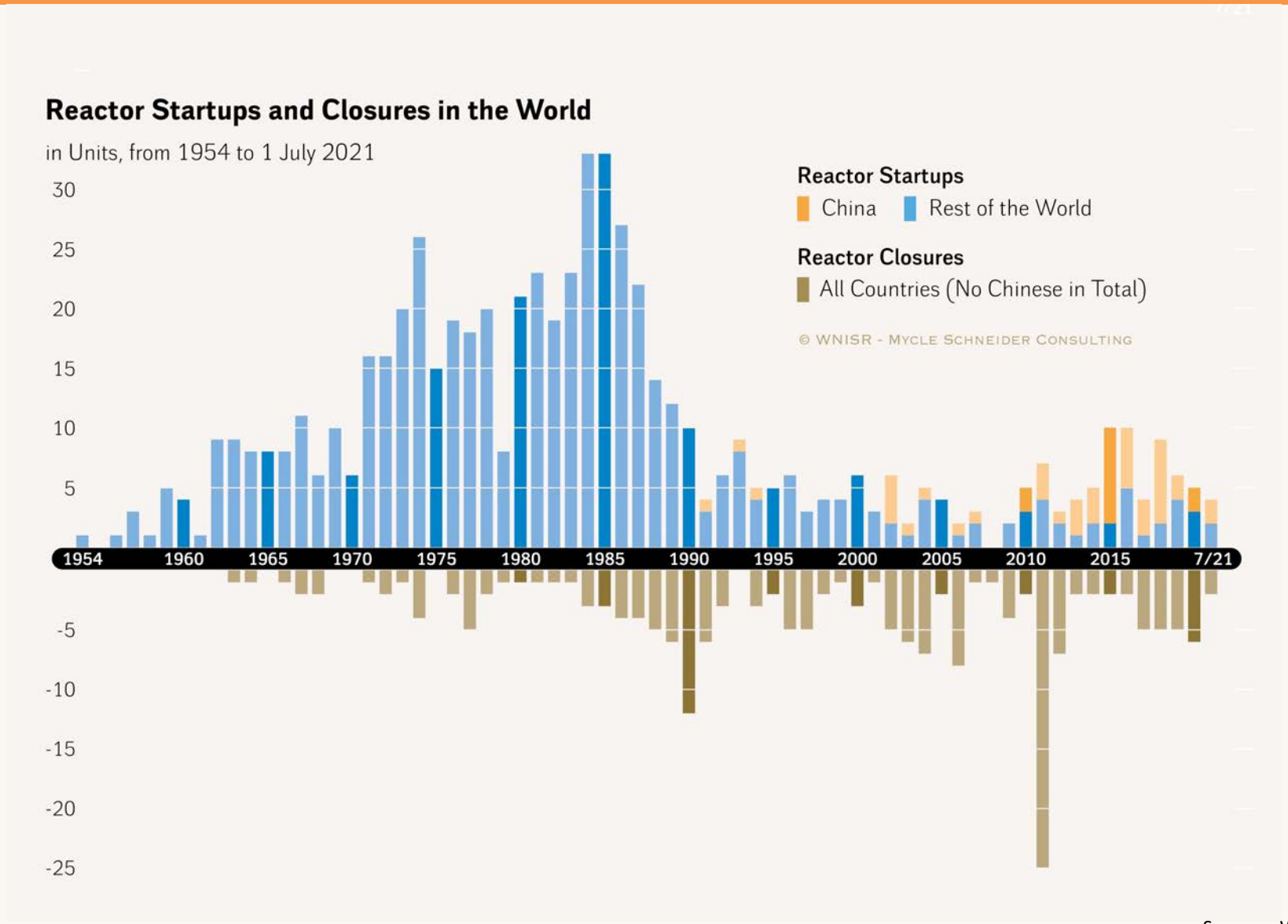
Sources: WNISR, with BP, IAEA-PRIS, 2021

GLOBAL OVERVIEW – STARTUPS AND CLOSURES WORLD



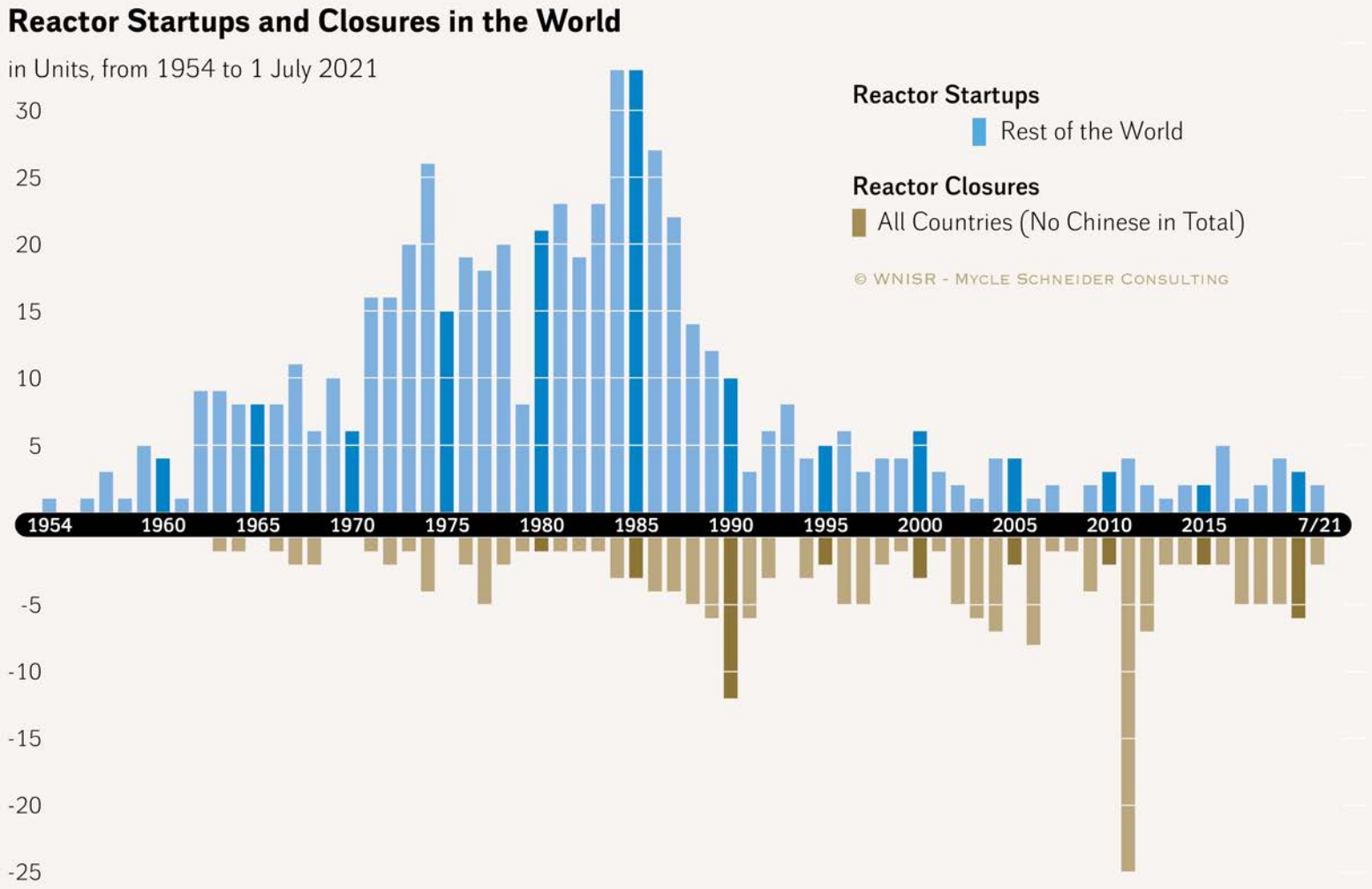
Sources: WNISR, with IAEA-PRIS, 2021

GLOBAL OVERVIEW – STARTUPS AND CLOSURES WORLD AND CHINA



Sources: WNISR, with IAEA-PRIS, 2021

GLOBAL OVERVIEW – STARTUPS AND CLOSURES WORLD OUTSIDE CHINA



2001–2020

World
- 95 Startups,
- 98 Closures

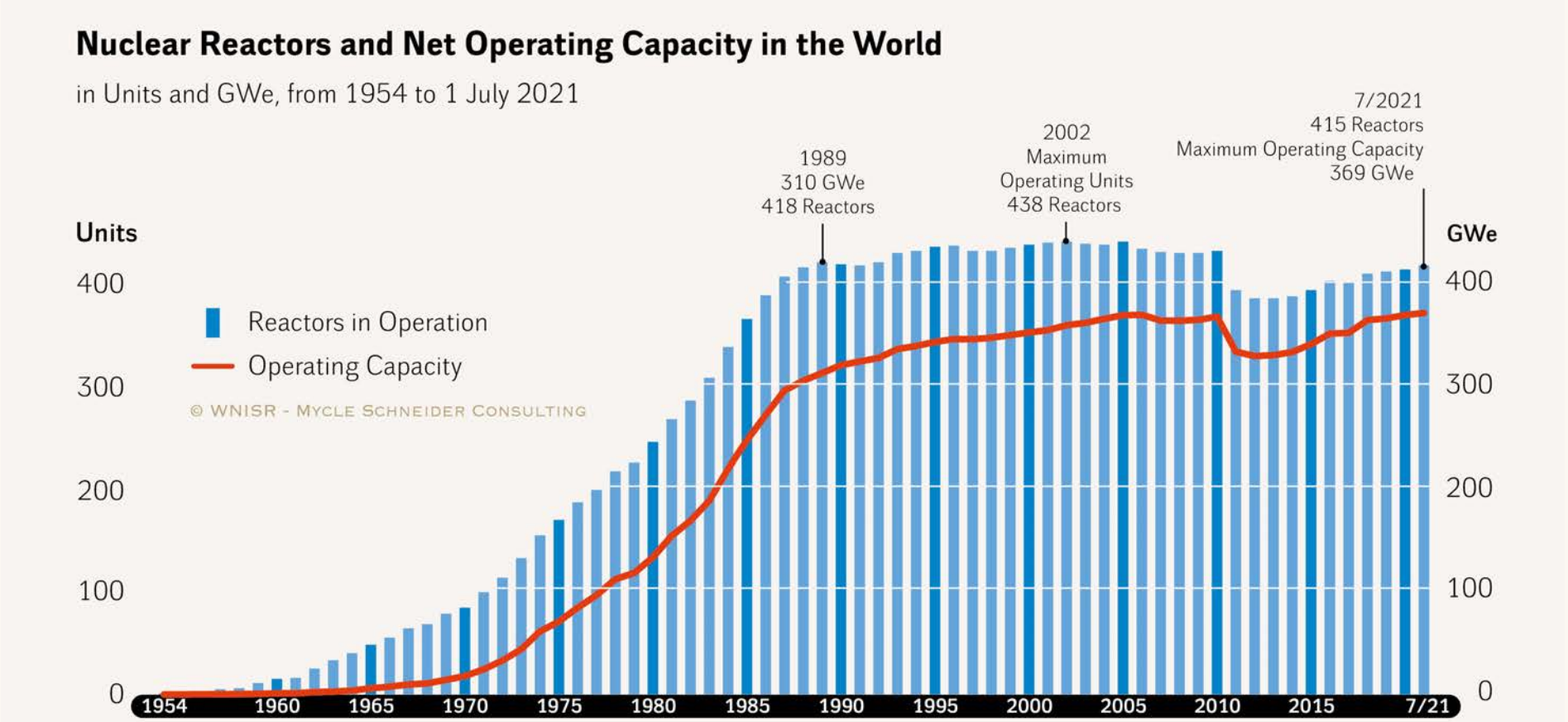
China
- 47 Startups
- No Closure

World Outside China
- 48 Startups,
- 98 Closures

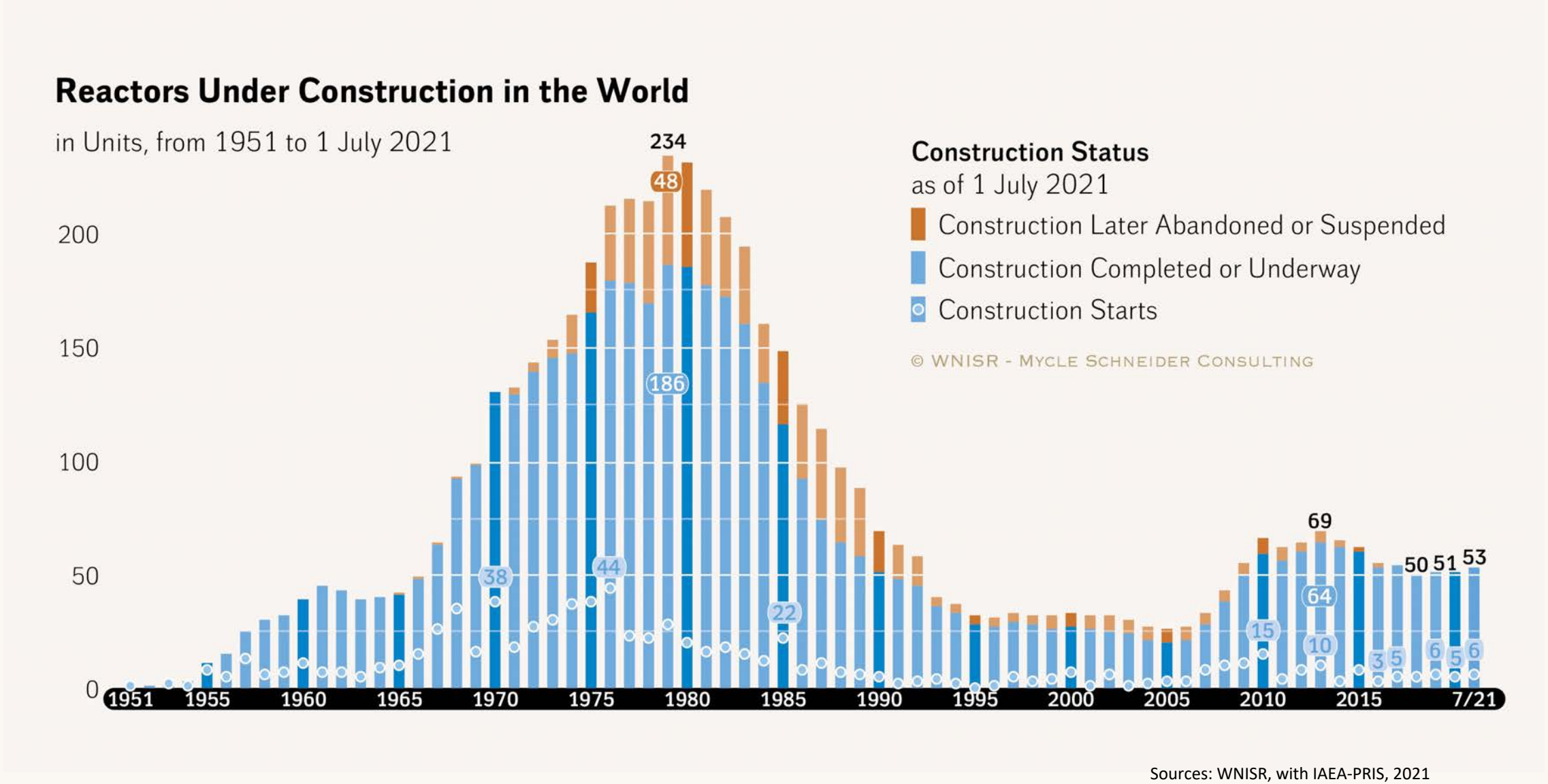
Net Balance –50

Sources: WNISR, with IAEA-PRIS, 2021

GLOBAL OVERVIEW — WORLD FLEET

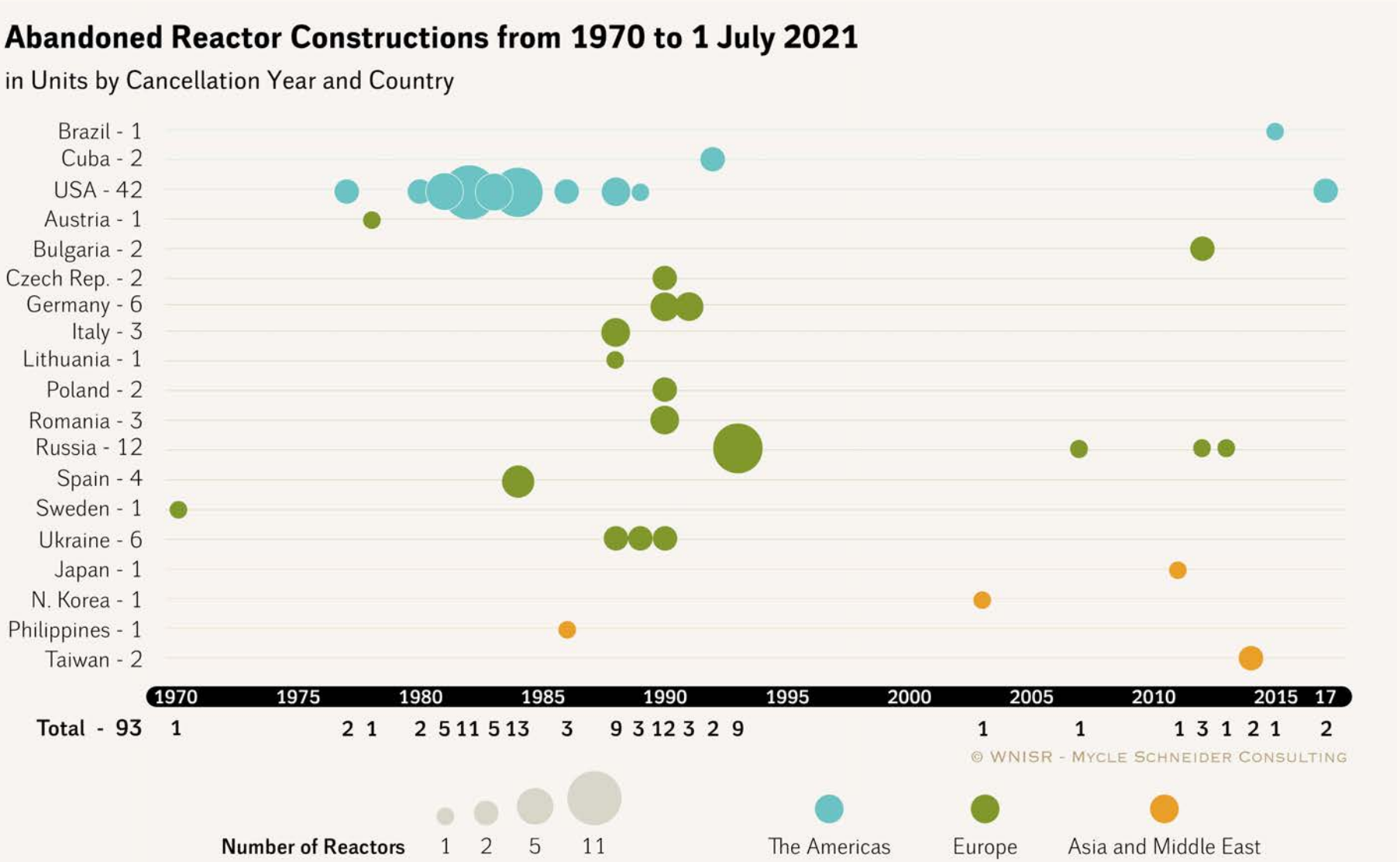


Sources: WNISR, with IAEA-PRIS, 2021



Sources: WNISR, with IAEA-PRIS, 2021

ABANDONED OR SUSPENDED CONSTRUCTIONS



Sources: WNISR, with IAEA-PRIS, 2021

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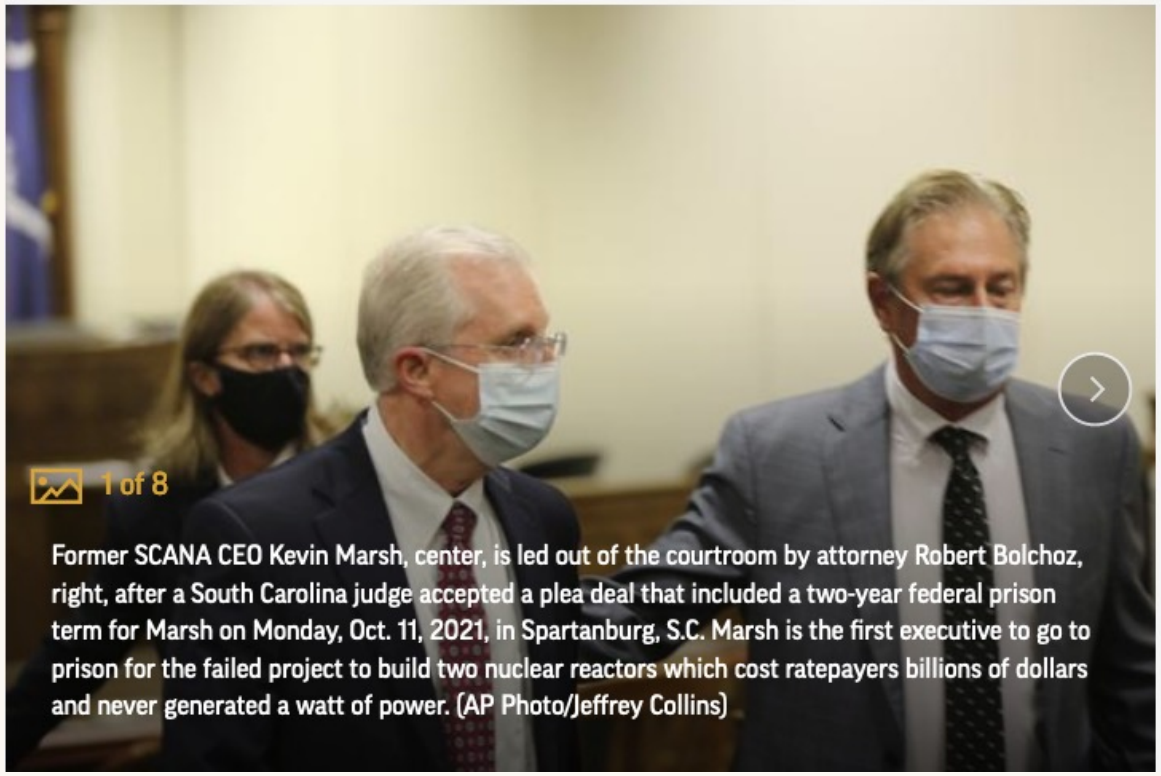
1st executive to head to prison in doomed nuclear project

By JEFFREY COLLINS October 11, 2021

Source: https://apnews.com/article/technology-business-south-carolina-columbia-5069af42b22c134483d4da7837e453ac



Former SCANA CEO Kevin Marsh, center, is led out of the courtroom by attorney Robert Bolchoz, right, after a South Carolina judge accepted a plea deal that included a two-year federal prison term for Marsh on Monday, Oct. 11, 2021, in Spartanburg, S.C. Marsh is the first executive to go to prison for the failed project to build two nuclear reactors which cost ratepayers billions of dollars and never generated a watt of power. (AP Photo/Jeffrey Collins)

- « A former utility executive who lied to ratepayers and regulators costing billions of dollars after he found out a pair of nuclear reactors being built in South Carolina were hopelessly behind schedule will soon be heading to prison for two years. »
- « A second former SCANA executive and an official at Westinghouse Electric Co., the lead contractor to build two new reactors at the V.C. Summer plant north of Columbia, have also pleaded guilty. A second Westinghouse executive has been indicted and is awaiting trial. »

GENERAL OVERVIEW — CONSTRUCTION DELAYS

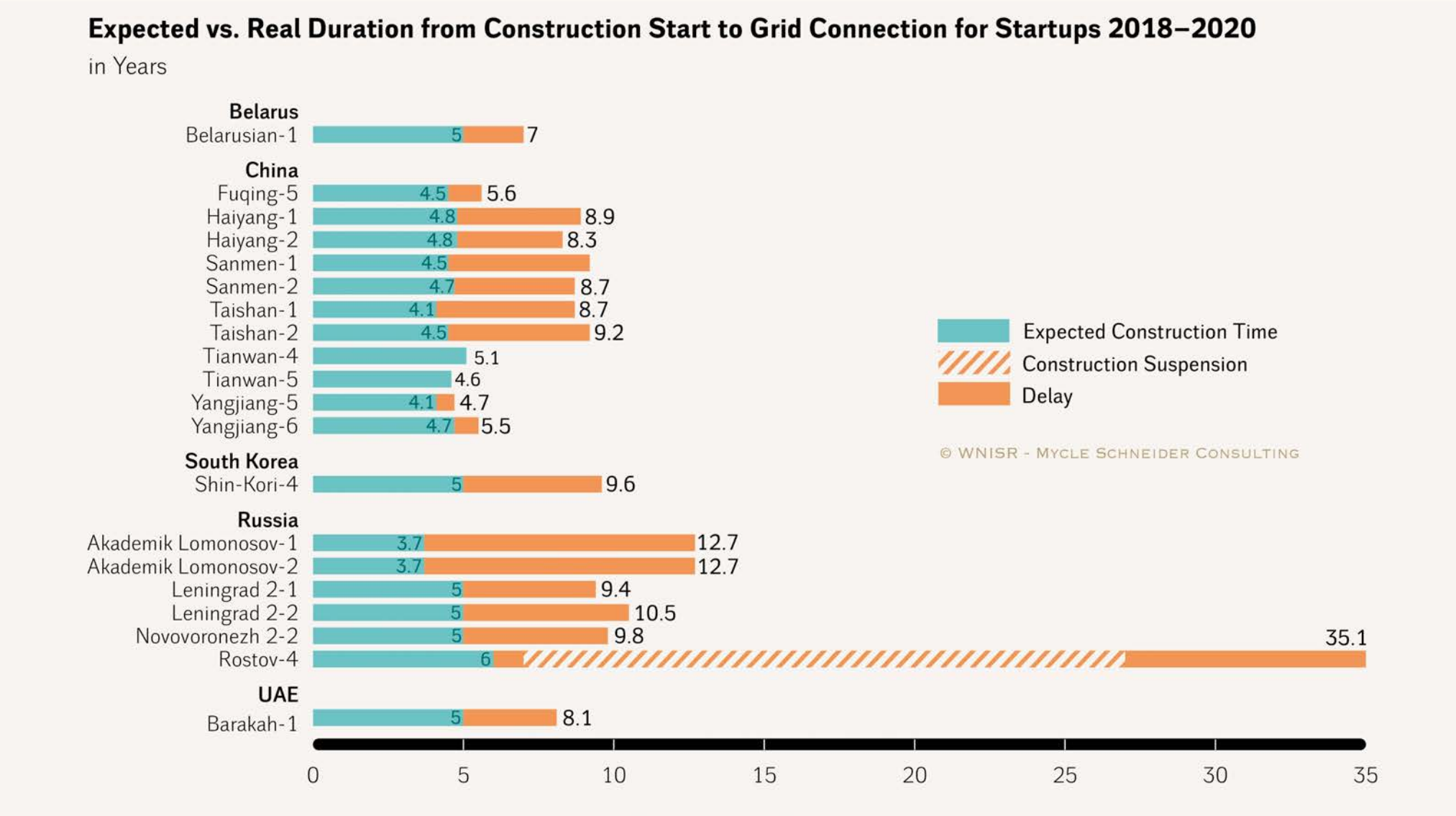
Nuclear Reactors "Under Construction" (as of 1 July 2021)

Country	Units	Capacity (MW net)	Construction Start	Grid Connection	Units Behind Schedule
China	18	17 062	2012 - 2021	2021 - 2027	4
India	7	5 194	2004 - 2021	2022 - 2026	6
South Korea	4	5 360	2012 - 2018	2022 - 2025	4
Russia	3	2 650	2018 - 2021	2022 - 2026	0
Turkey	3	3 342	2018 - 2021	2024 - 2026	1
UAE	3	4 035	2013 - 2015	2021 - 2023	3
Bangladesh	2	2 160	2017 - 2018	2023 - 2024	0
Slovakia	2	880	1985 - 1985	2021 - 2023	2
UK	2	3 260	2018 - 2019	2026 - 2027	2
USA	2	2 234	2013	2022 -2023	2
Argentina	1	25	2014	2024	1
Belarus	1	1 110	2014	2022	1
Finland	1	1 600	2005	2022	1
France	1	1 600	2007	2023	1
Iran	1	1 196	1976	2024	1
Japan	1	1 325	2007	2025	1
Pakistan	1	1 014	2016	2022	1
Total	**53**	**54 047**	**1976 - 2021**	**2021 - 2027**	**31**

Sources: WNISR, with IAEA-PRIS, 2021

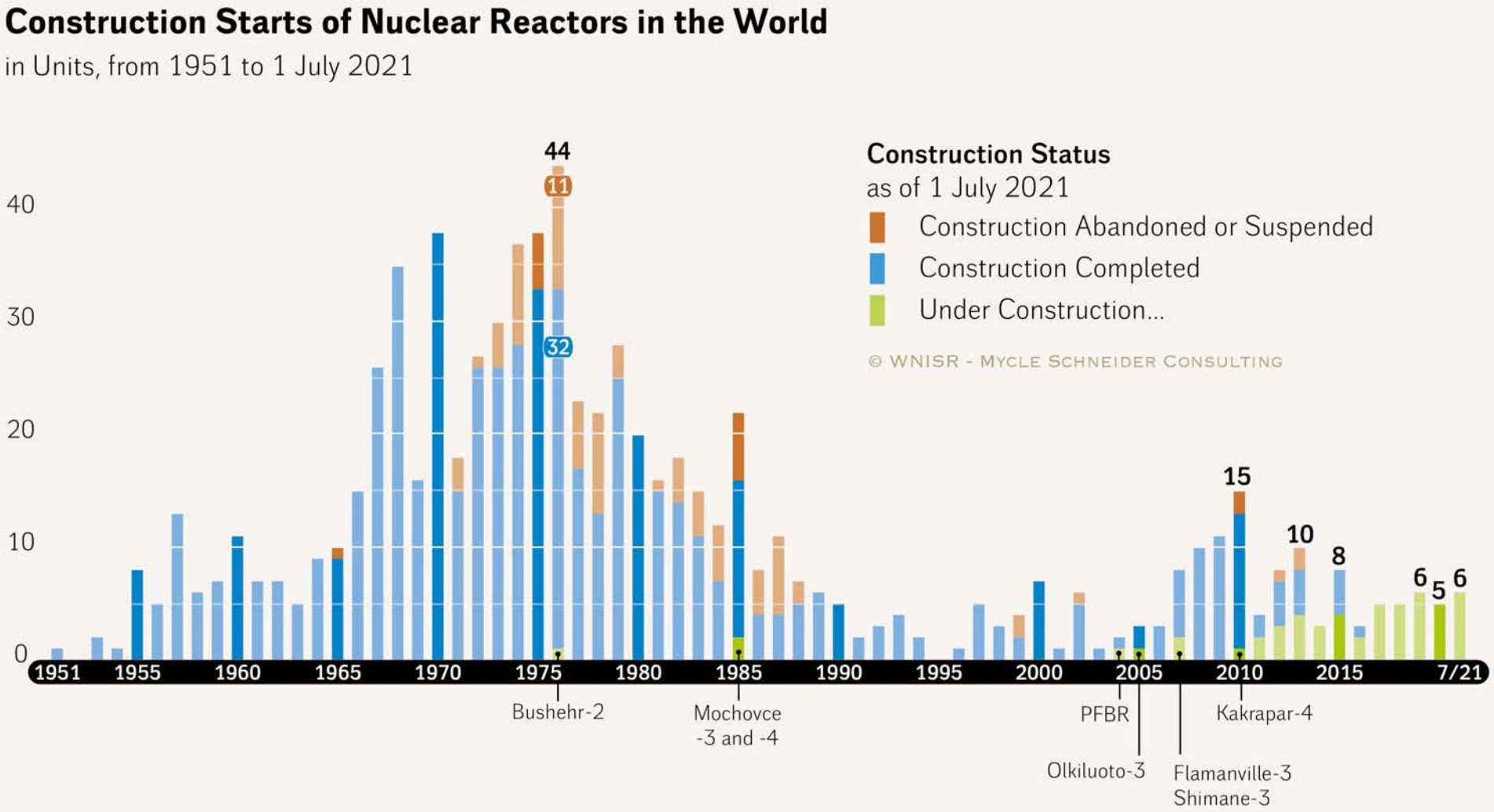
Construction Times of 63 Units Started-up 2011–2020				
Country	Units	Construction Time (in Years)		
		Mean Time	Minimum	Maximum
China	37	6.1	4.1	11.2
Russia	10	18.7	8.1	35.1
South Korea	5	6.4	4.2	9.6
India	3	11.5	8.7	14.2
Pakistan	3	5.4	5.2	5.6
Argentina	1	33.0	33.0	
Belarus	1	7.0	7.0	
Iran	1	36.3	36.3	
UAE	1	8.1	8.1	
USA	1	42.8	42.8	
World	63	9.9	4.1	42.8

Sources: WNISR, with IAEA-PRIS, 2021



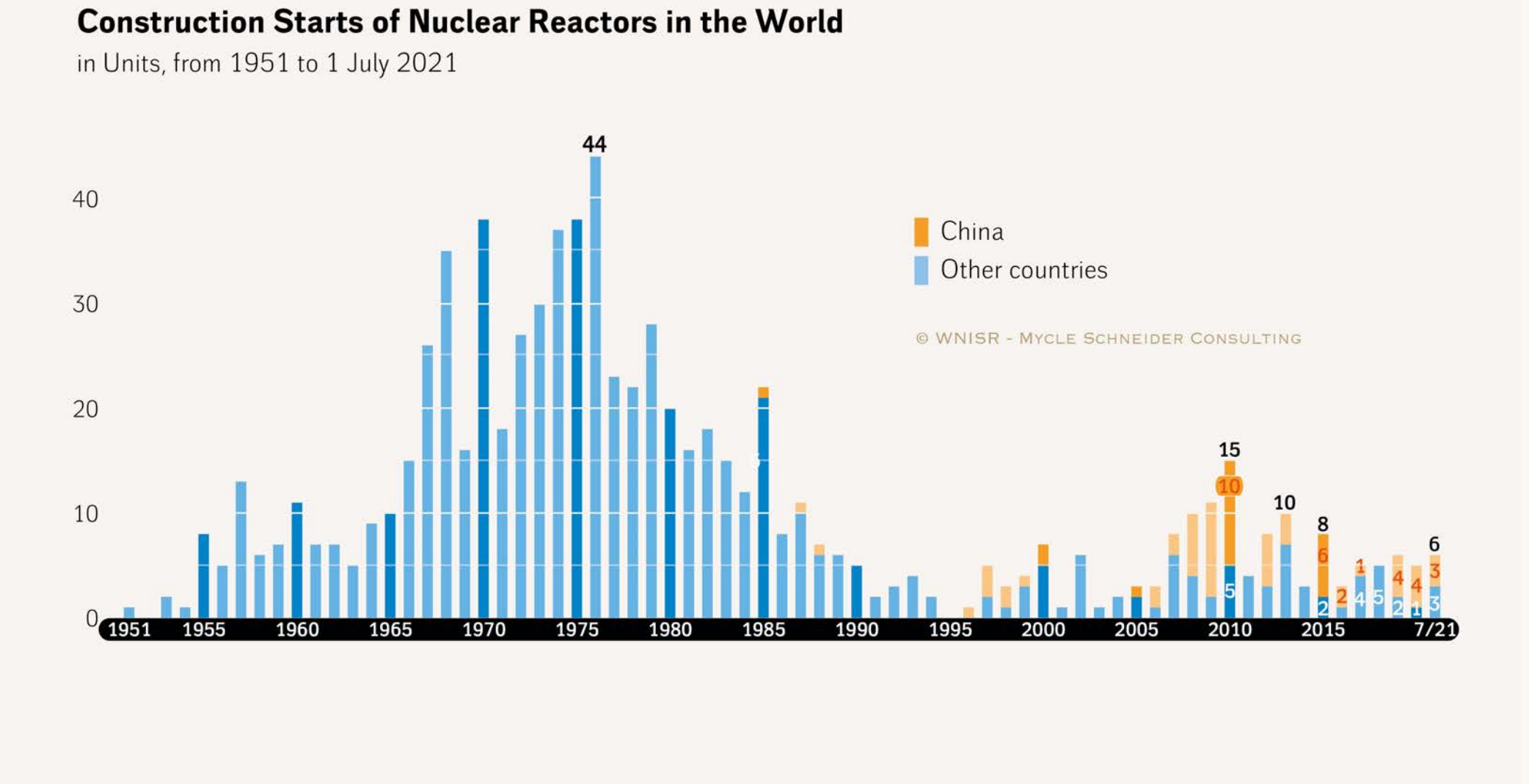
Sources: WNISR, with IAEA-PRIS, 2021

GENERAL OVERVIEW — CONSTRUCTION STARTS WORLD



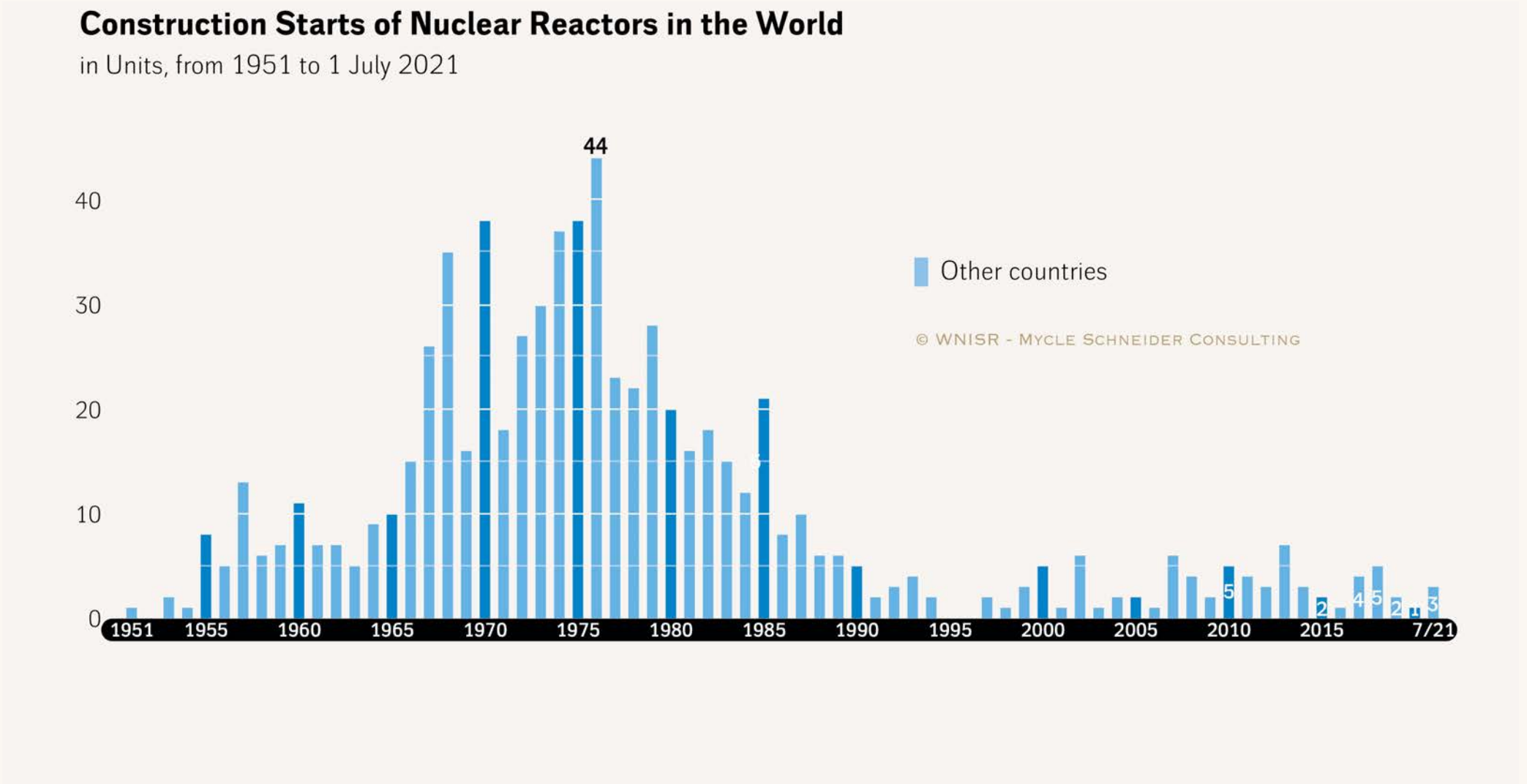
Sources: WNISR, with IAEA-PRIS, 2021

GENERAL OVERVIEW — CONSTRUCTION STARTS WORLD AND CHINA



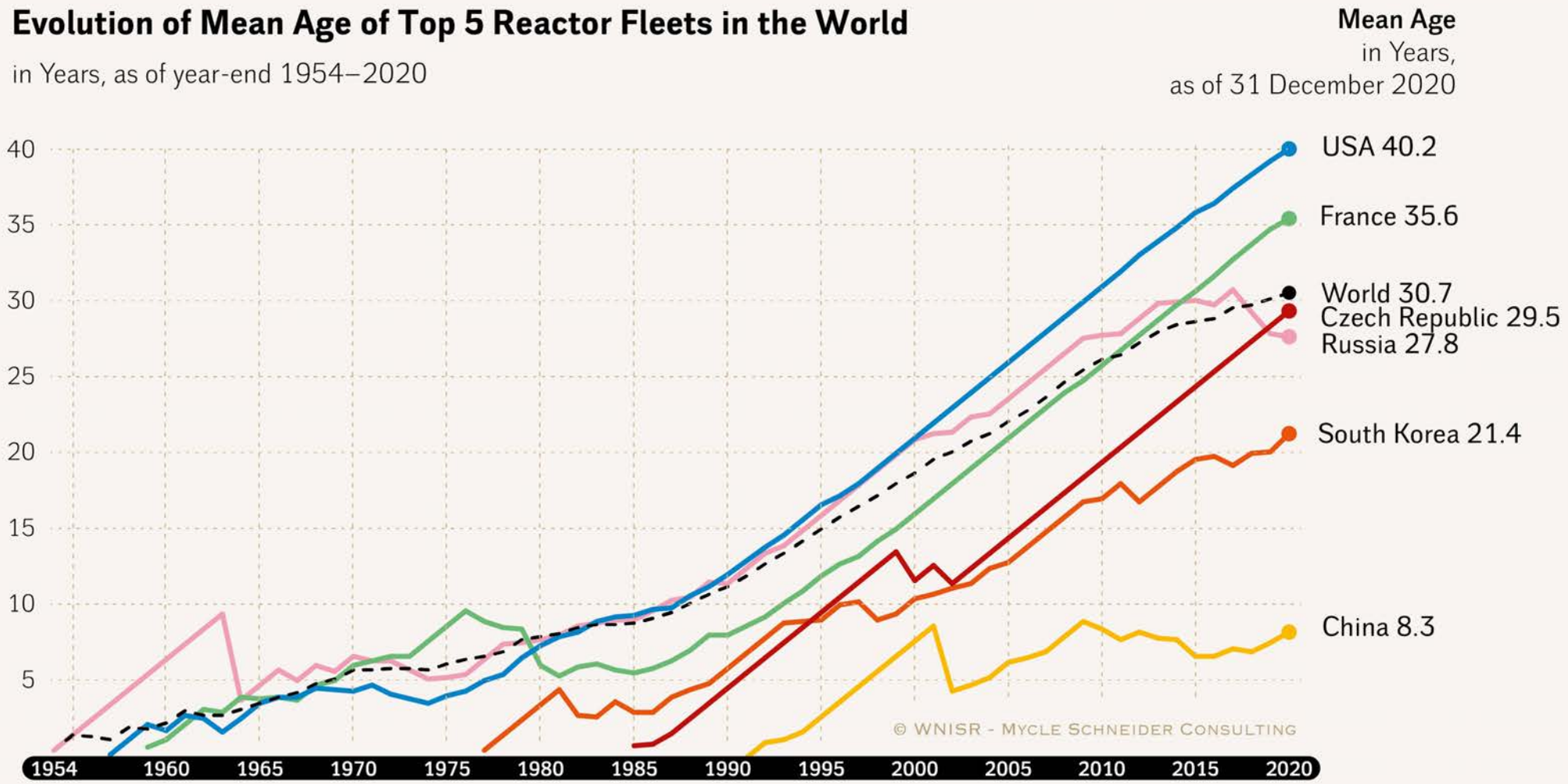
Sources: WNISR, with IAEA-PRIS, 2021

GENERAL OVERVIEW — CONSTRUCTION STARTS WORLD OUTSIDE CHINA



Sources: WNISR, with IAEA-PRIS, 2021

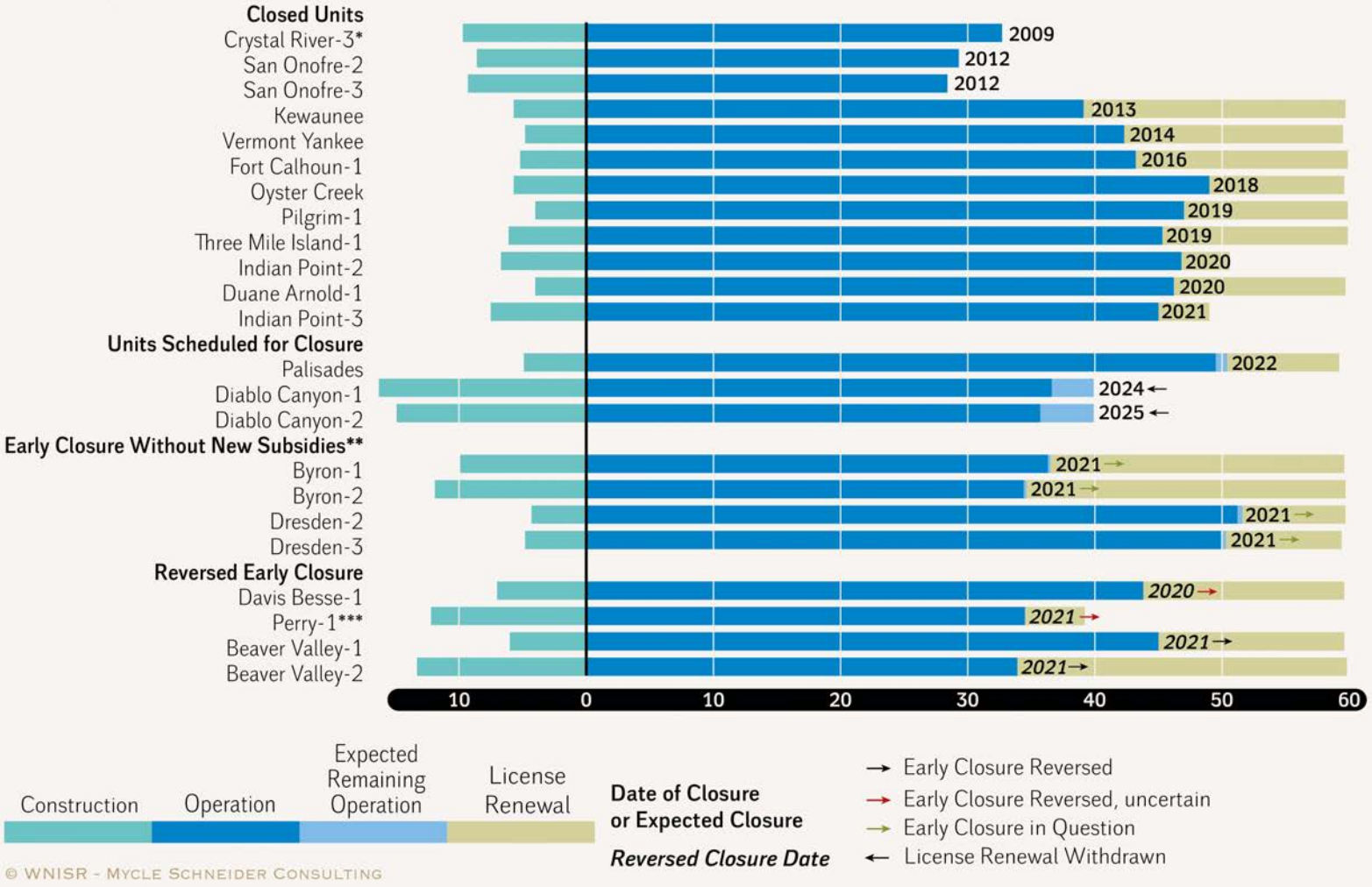
GENERAL OVERVIEW — AGE EVOLUTION OF TOP 5 REACTOR FLEETS



Sources: WNISR, with IAEA-PRIS, 2021

Timelines of 23 U.S. Reactors Subject to Early-Retirement 2009–2025

as of 1 July 2021



Sources: Various, compiled by WNISR, 2021

The New York Times

Powerful Ohio Republican Is Arrested in $60 Million Corruption Scheme

The House speaker was connected with a conspiracy to enact a $1.3 billion bailout of an energy company, the F.B.I. said.

Larry Householder, the Republican speaker of Ohio's House of Representatives. John Minchillo/Associated Press

Source: NYT, 21 July 2020, see https://www.nytimes.com/2020/07/21/us/larry-householder-ohio-speaker-arrested.html

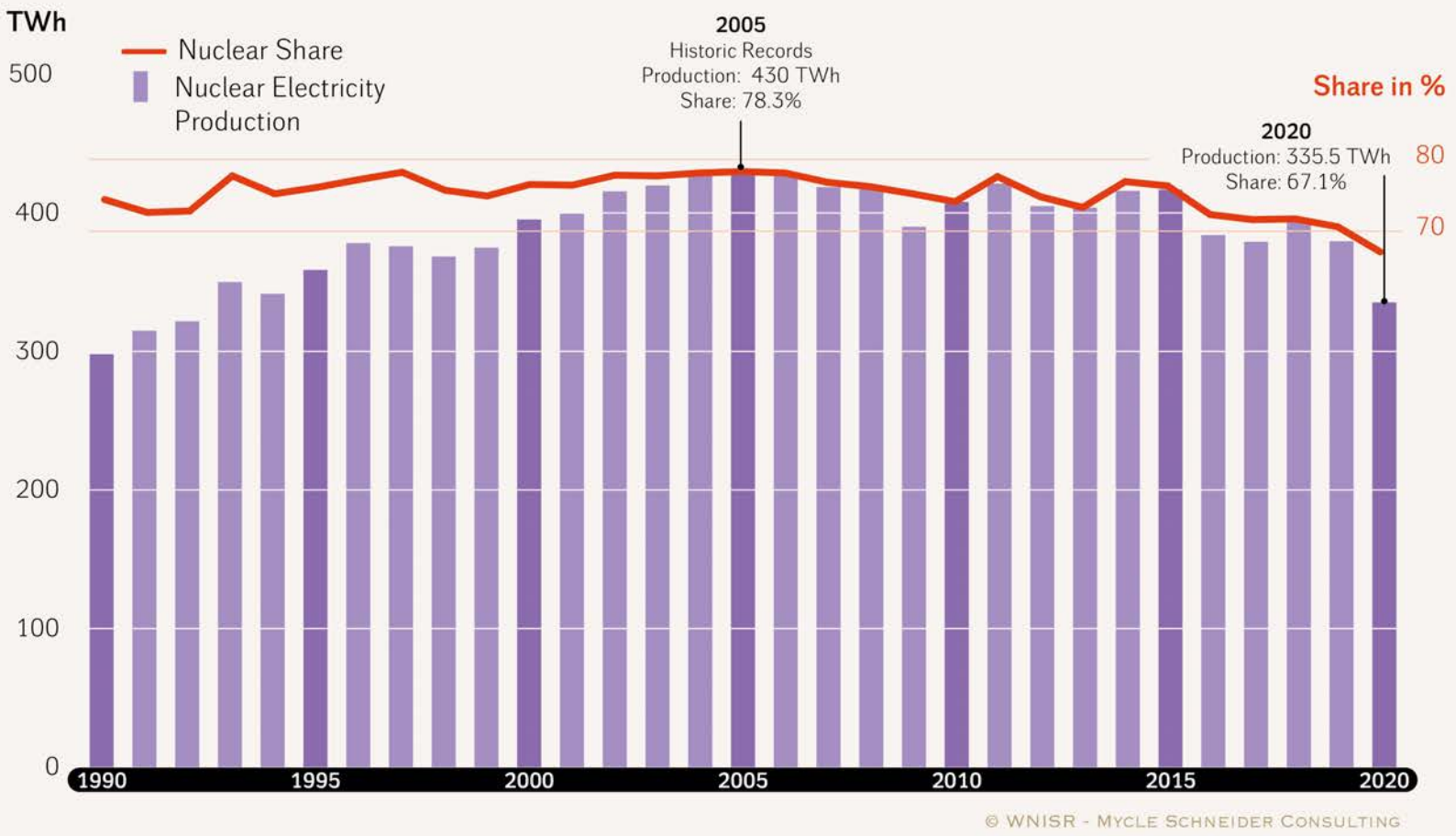
FirstEnergy had admitted that

« it conspired with public officials and other individuals and entities to pay millions of dollars to public officials in exchange for specific official action for FirstEnergy Corp.'s benefit. (...)

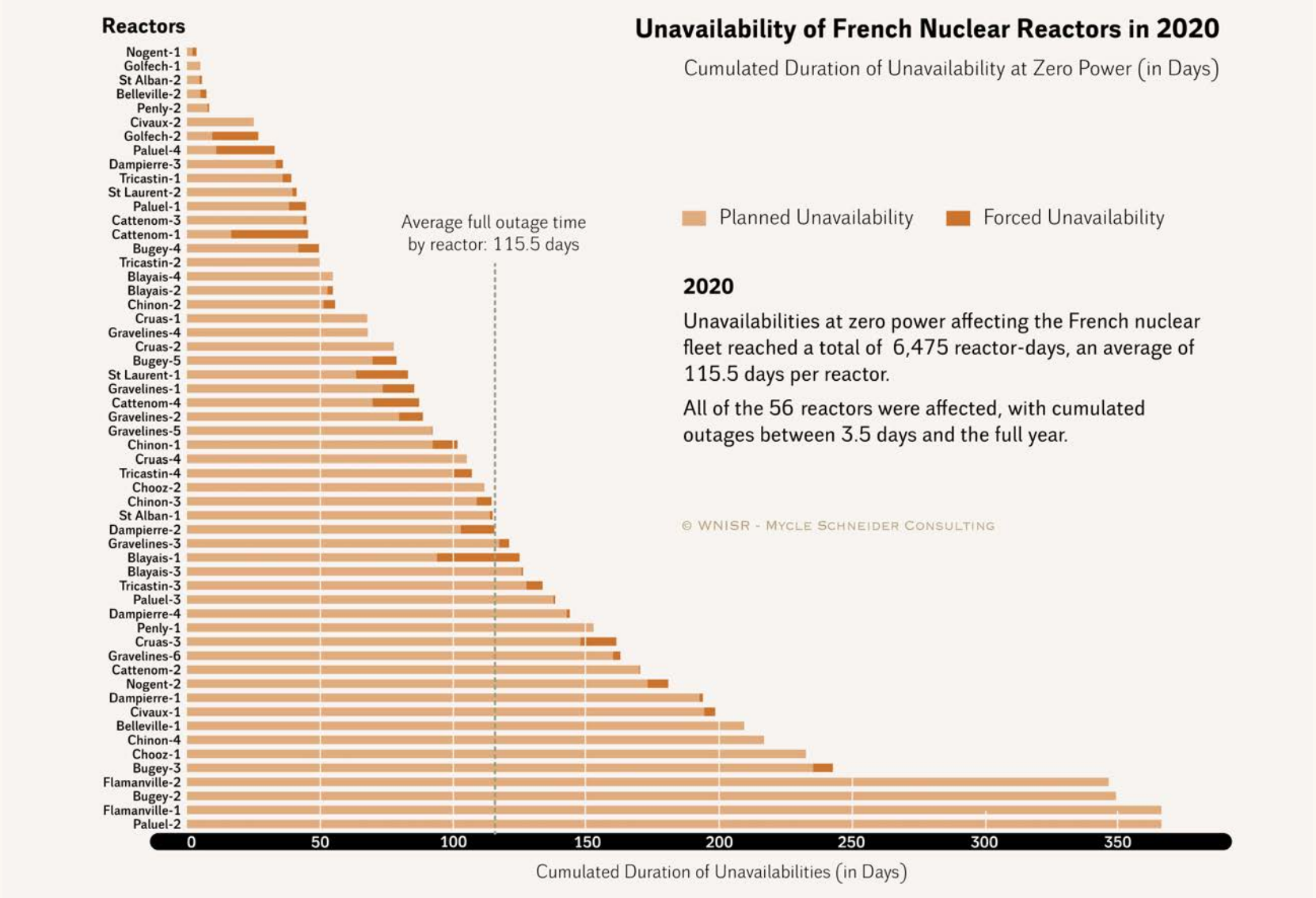
« ...it paid $4.3 million dollars to a second public official. In return, the individual acted in their official capacity to further First Energy Corp.'s interests related to passage of nuclear legislation and other company priorities. »

FirstEnergy agreed to pay a US$230 million fine for bribing key Ohio officials.

Source: United States Attorney Office, Southern District of Ohio, 22 July 2020

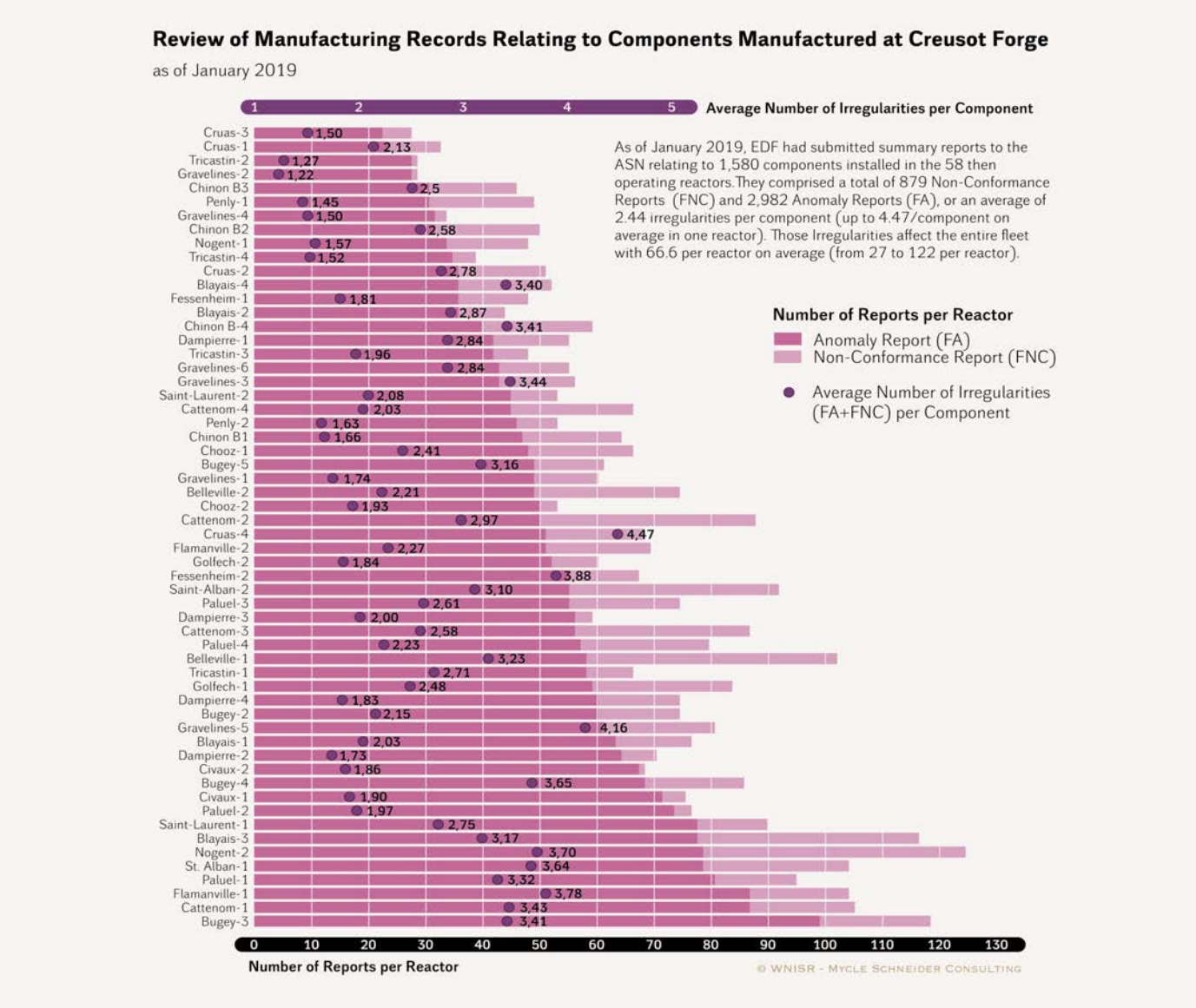


Sources: RTE, 2000–2021



Sources: RTE and EDF, 2021

CRIMINAL ENERGY AND OPERATING REACTORS: FRANCE



Sources: EDF, “Dossiers de fabrication”, 2019

world nuclear news

Energy & Environment | New Nuclear | Regulation & Safety | Nuclear Policies | Corporate | Uranium & Fuel |

New component issues idle Korean reactors

28 May 2013

Share

Two South Korean power reactors have been ordered offline and another two must remain out of operation until uncertified cabling has been replaced. The government is worried about possible power shortages over the coming months as a result.

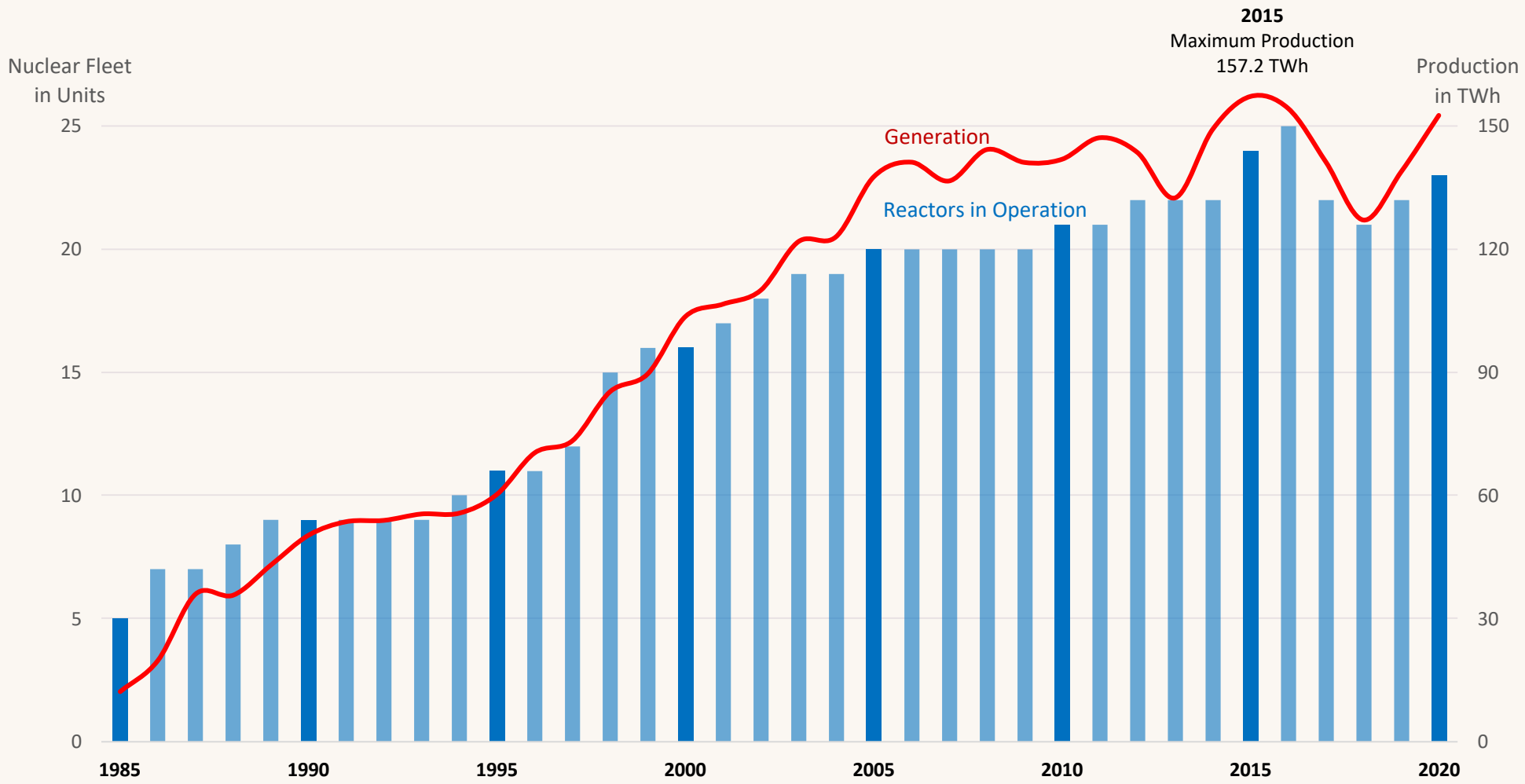
Shin Kori units 1 and 2 (Image: KHNP)

« In an investigation unrelated to the falsely-certified parts discovered last year, safety-related control cabling with forged documentation was found to have been installed at the four reactors. In the event of an accident, the cables send signals from the reactor operating systems, such as cooling, to the control room. (...)

« The latest discovery of forged quality documentation is said to be unrelated to the case announced last November in which KHNP had allegedly been supplied with falsely-certified non-safety-critical parts for at least five power reactors. The utility told the ministry that eight unnamed suppliers - reportedly seven domestic companies and one US company - forged some 60 quality control certificates covering 7682 components delivered between 2003 and 2012. »

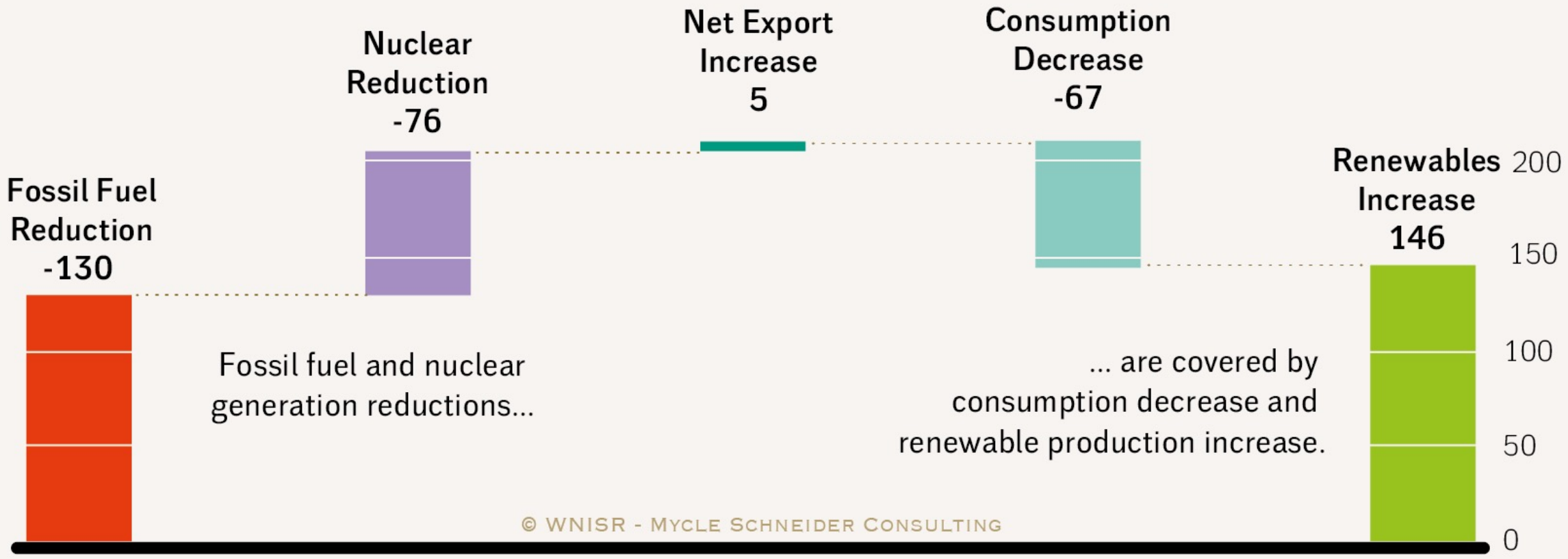
SOUTH KOREA FOCUS: REACTORS AND POWER GENERATION

Evolution of Nuclear Fleet and Production in South Korea 1985–2020



Main Evolution of the German Power System Between 2010 and 2020

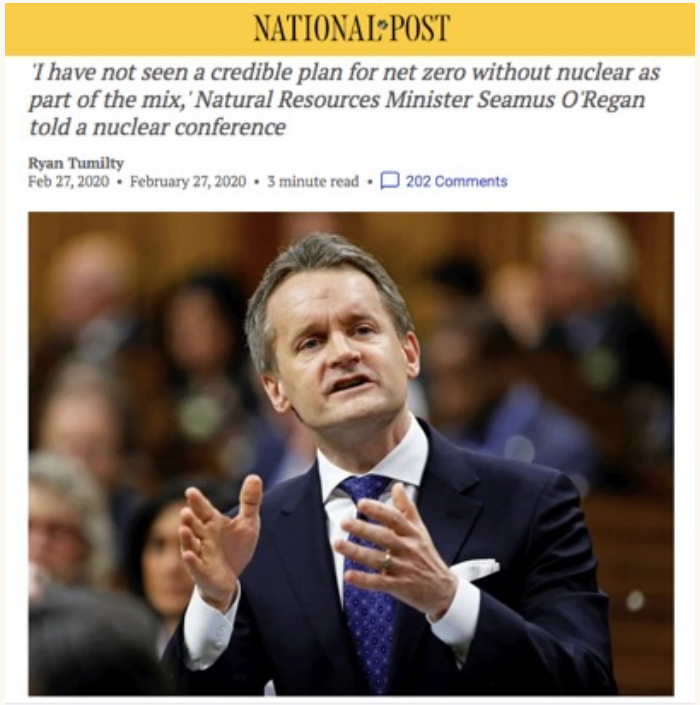
in TWh



Sources: AG Energiebilanzen, 2021

SMALL MODULAR REACTORS (SMRs) – PUBLIC ATTENTION

- **Lots of media coverage**
- **Some public funding**
- **Favourable regulation**



NATIONAL POST

'I have not seen a credible plan for net zero without nuclear as part of the mix,' Natural Resources Minister Seamus O'Regan told a nuclear conference

Ryan Tumilty
Feb 27, 2020 • February 27, 2020 • 3 minute read • 202 Comments

Example Canada

- 2018: Federal funding for SMR roadmap
- 2020: Federal government released action plan
- October 2020: CAD20 million (US$16 million) in federal funding to Terrestrial Energy
- March 2021: CAD50 million (US$40 million) in federal funding to Moltex
- October 2020: Ontario Power Generation announced agreements with GE Hitachi, Terrestrial Energy and X-energy

SMRs – PROJECT DELAYS AND POOR PERFORMANCE

- **Argentina**

  Carem-25 construction start 2014; November 2020 report: “physical completion of Carem 25 is at 70%”; No completion date.

- **China**

  HTR-PM construction start 2012; projected to generate electricity in 2017; recently became critical (four years late).

- **Russia**

  KLT-40S construction start 2007; projected to start operations in October 2010; commissioned in May 2020; load factors in 2020 just 29 and 16 percent.

SMRs – REACTOR DESIGN DELAYS

India

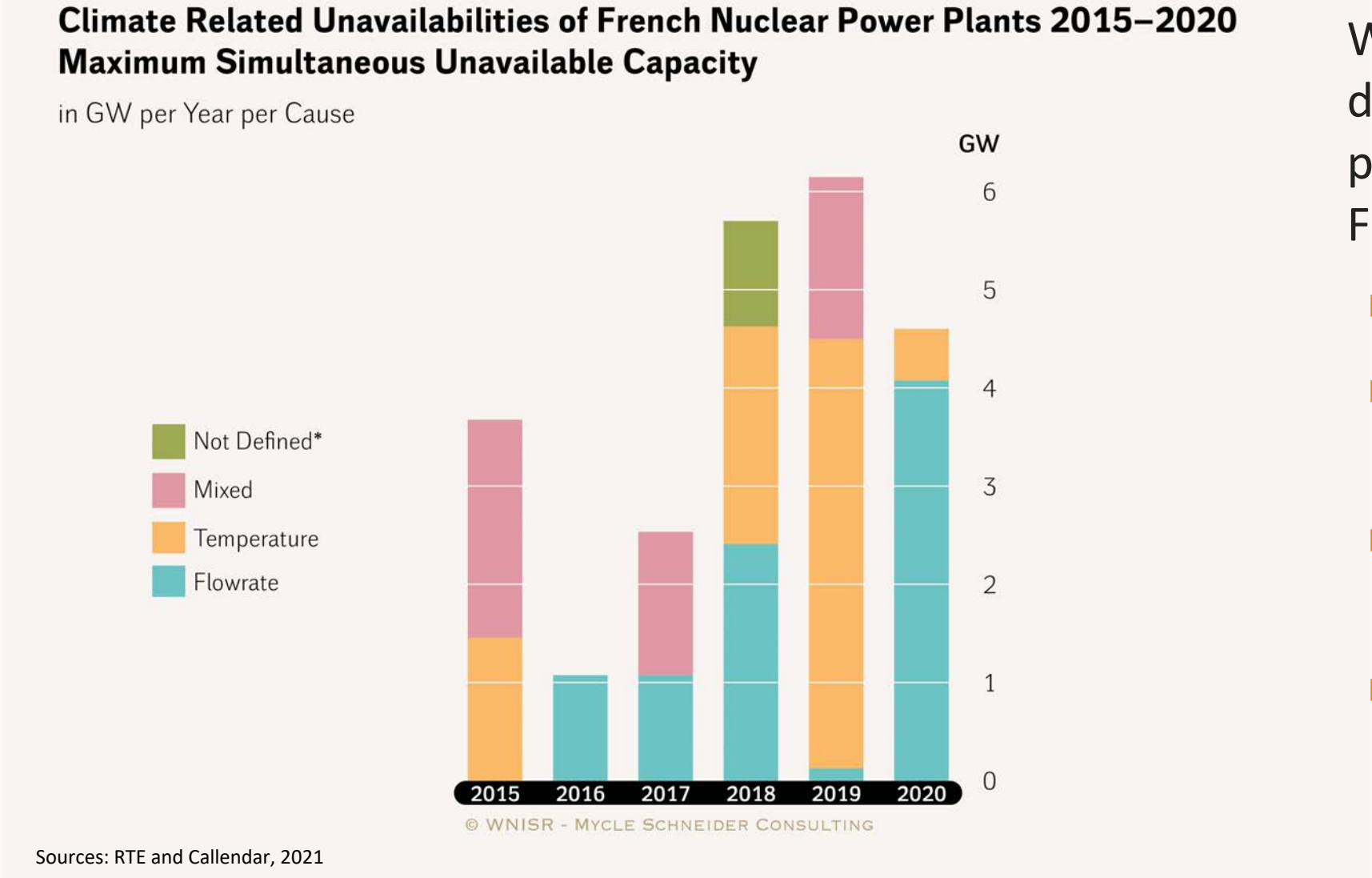
AHWR 2000 projection: operating by 2011; no current construction plans.

USA

NuScale 2008 projection: electricity generation by 2015-16; current: 2029-30?

Russia

"Federal Program for Advanced Nuclear Technologies" in 2012: three commercial fast neutron reactors by 2020, including the BREST-300, as well as the lead-bismuth cooled SVBR-100, and the sodium-cooled BN-1200; BREST construction start in June 2021.



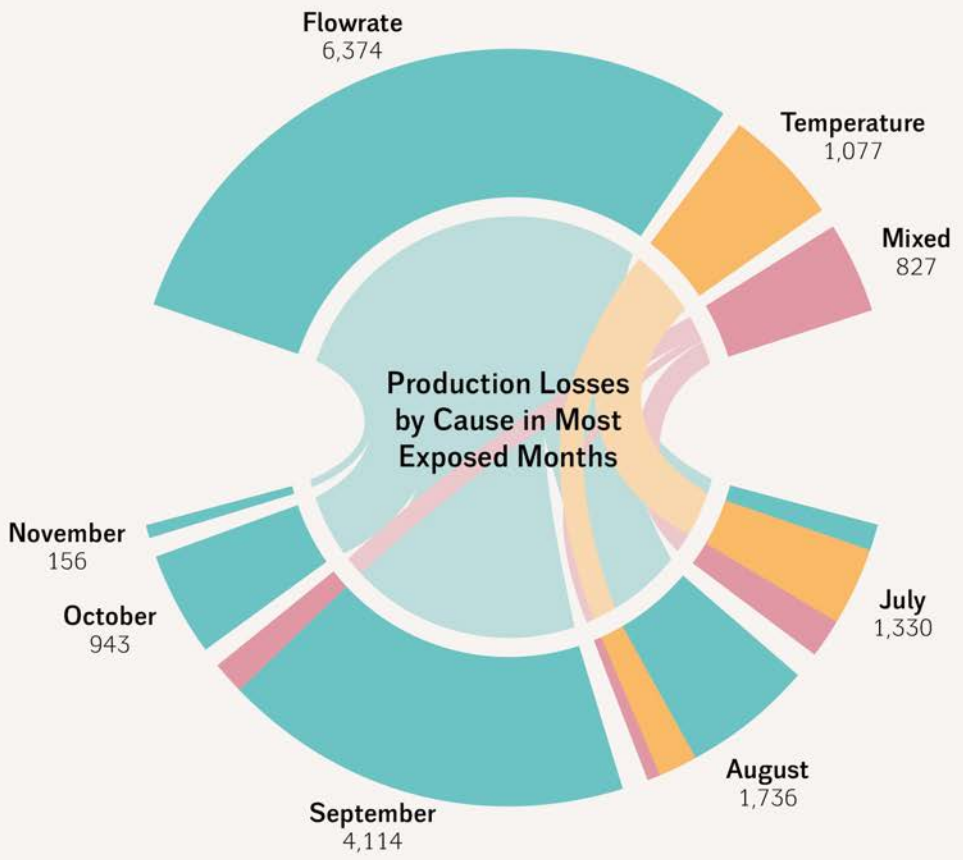
Sources: RTE and Callendar, 2021

Weather-related disruptions of nuclear power production in France 2015–2020:

- **357 outages** identified
- At least several dozen disruptions a year
- Up to **100 reactor-days** lost in a year
- Up to **6.2 GW** unavailable

Climate Related Unavailabilities of French Nuclear Power Plants 2015–2020

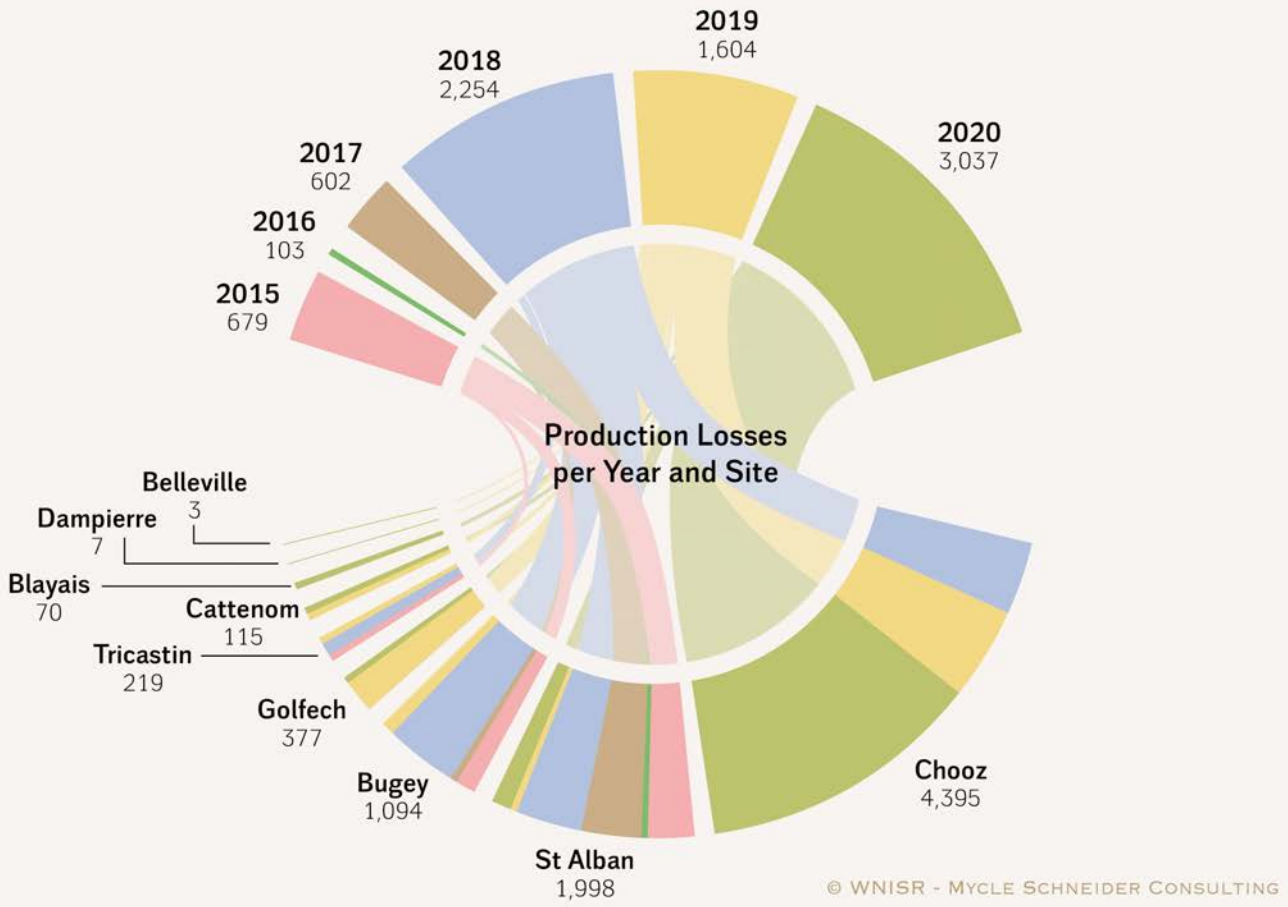
in GWh by Most Probable Cause and Month



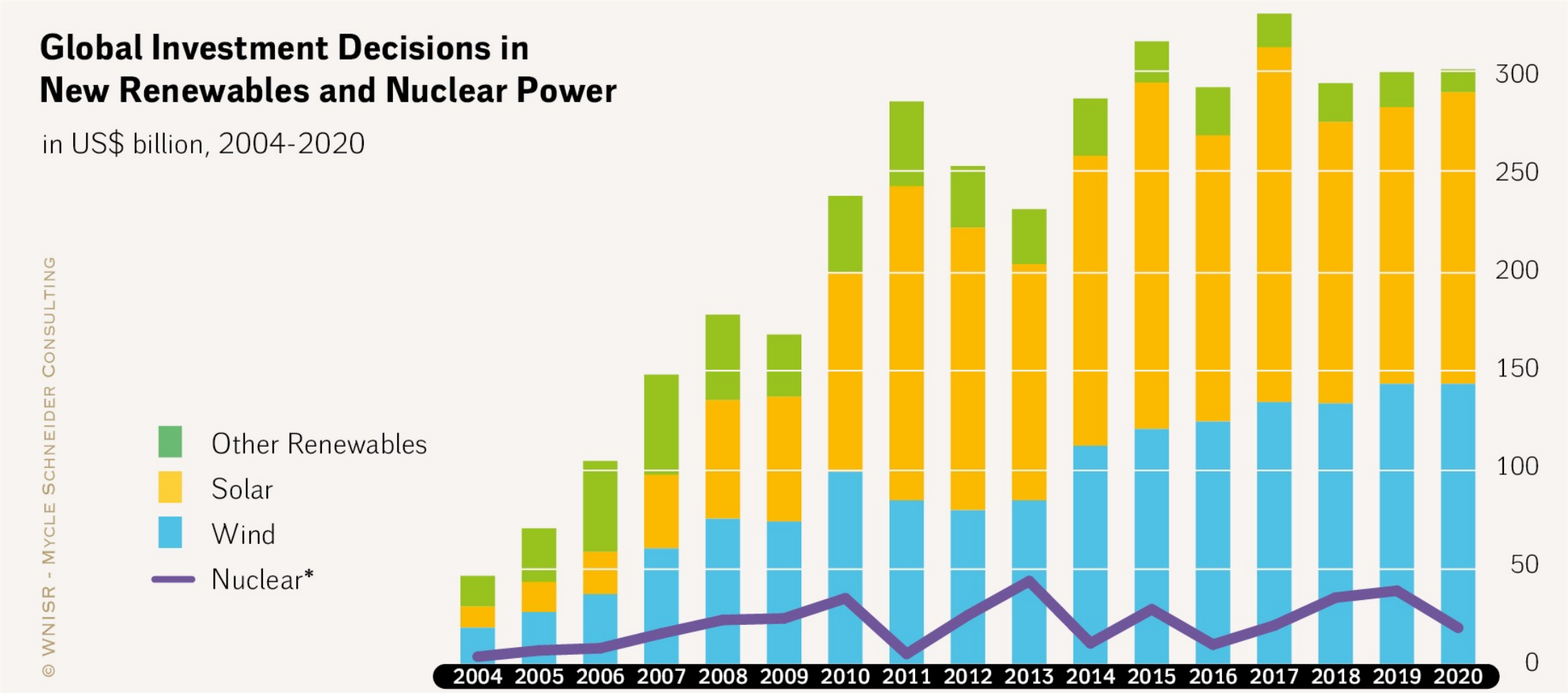
Sources: REMIT, compiled by Callendar 2021

Climate Related Unavailabilities of French Nuclear Power Plants 2015–2020

in GWh per Year and Site

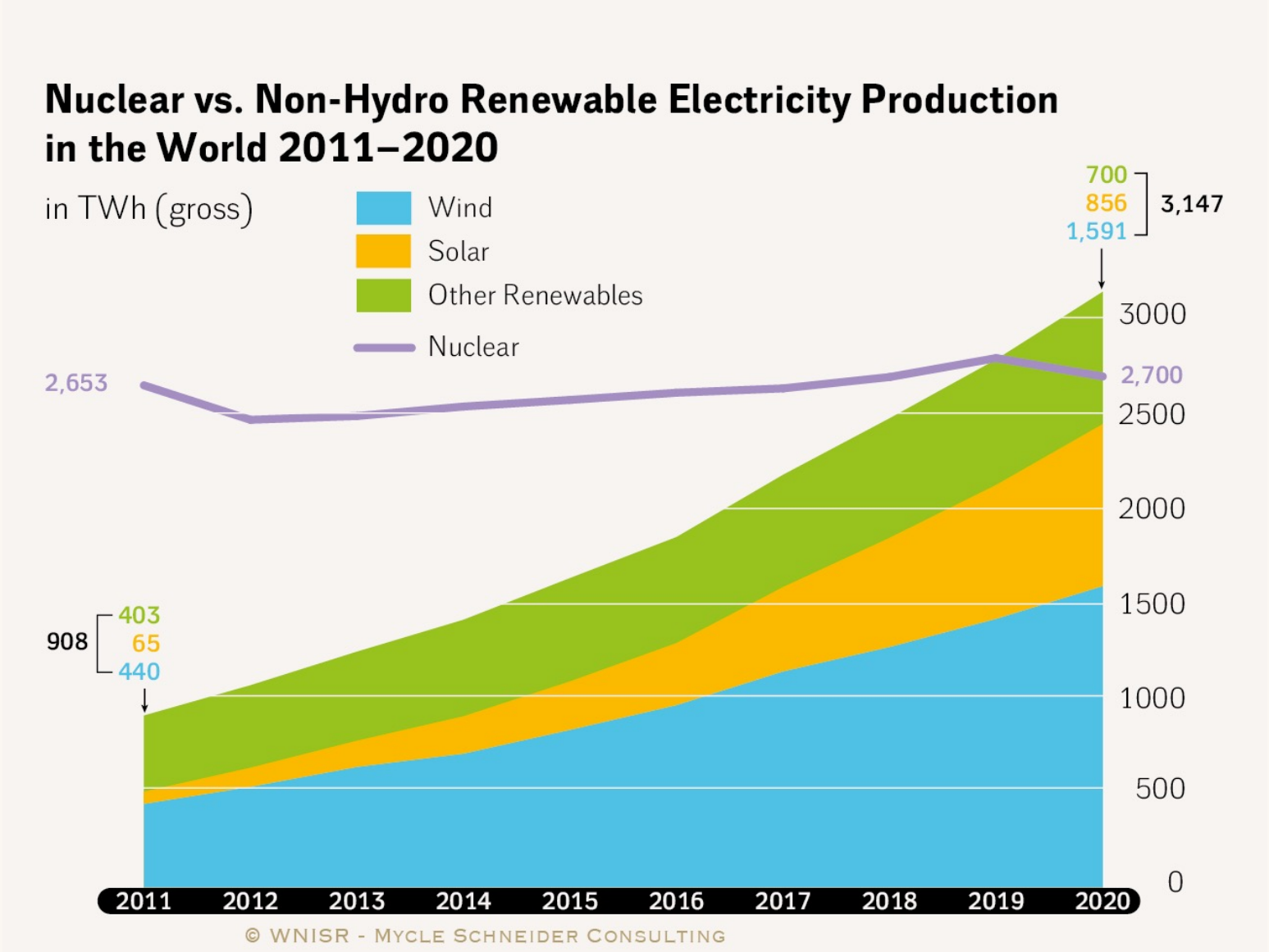


Sources: REMIT, compiled by Callendar 2021



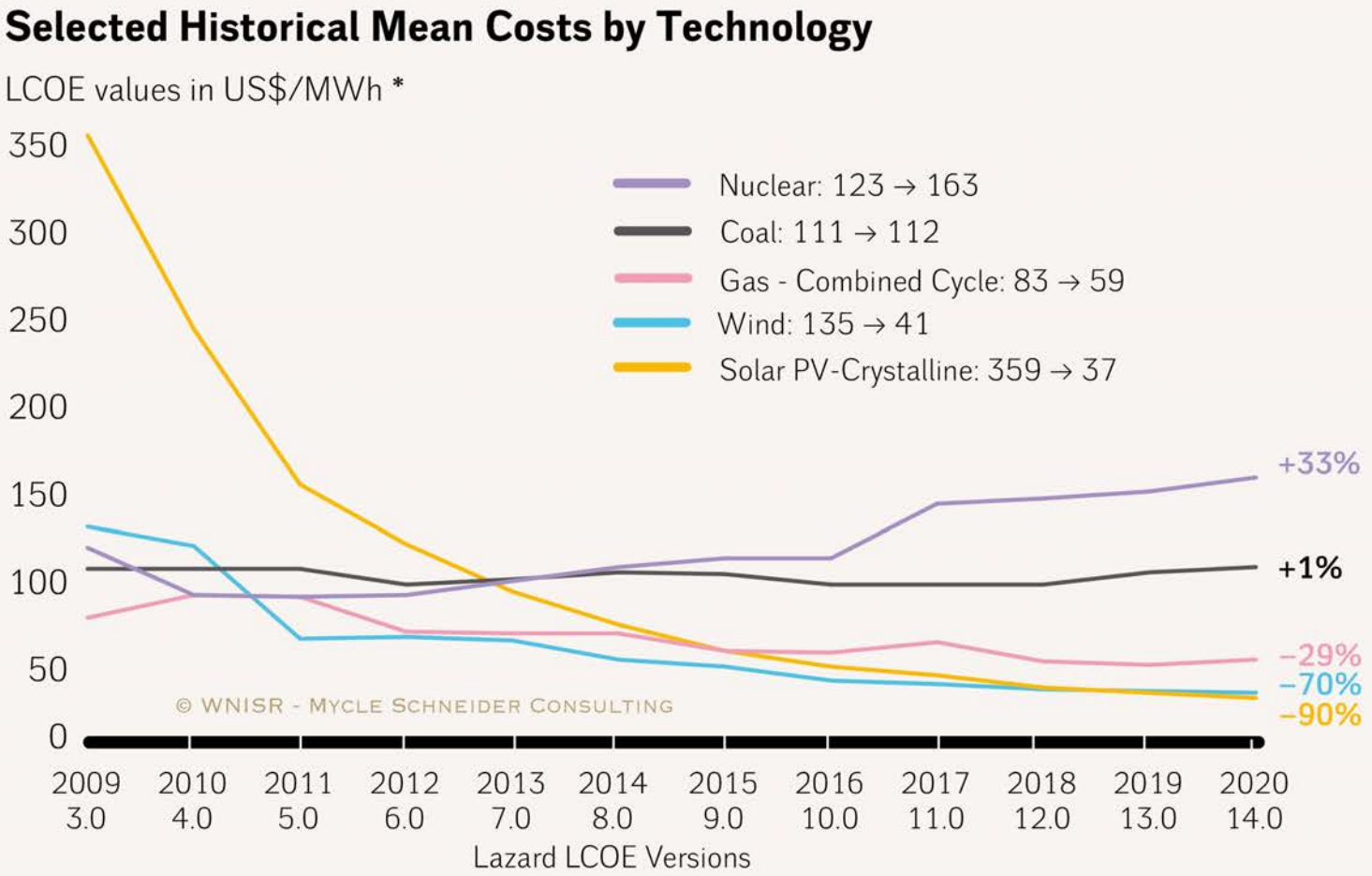
Sources: FS-UNEP/BNEF 2018, 2020, REN21 2019, BNEF 2021 and WNISR Original Research, 2021

NUCLEAR POWER VS. RENEWABLES DEPLOYMENT – ELECTRICITY GENERATION



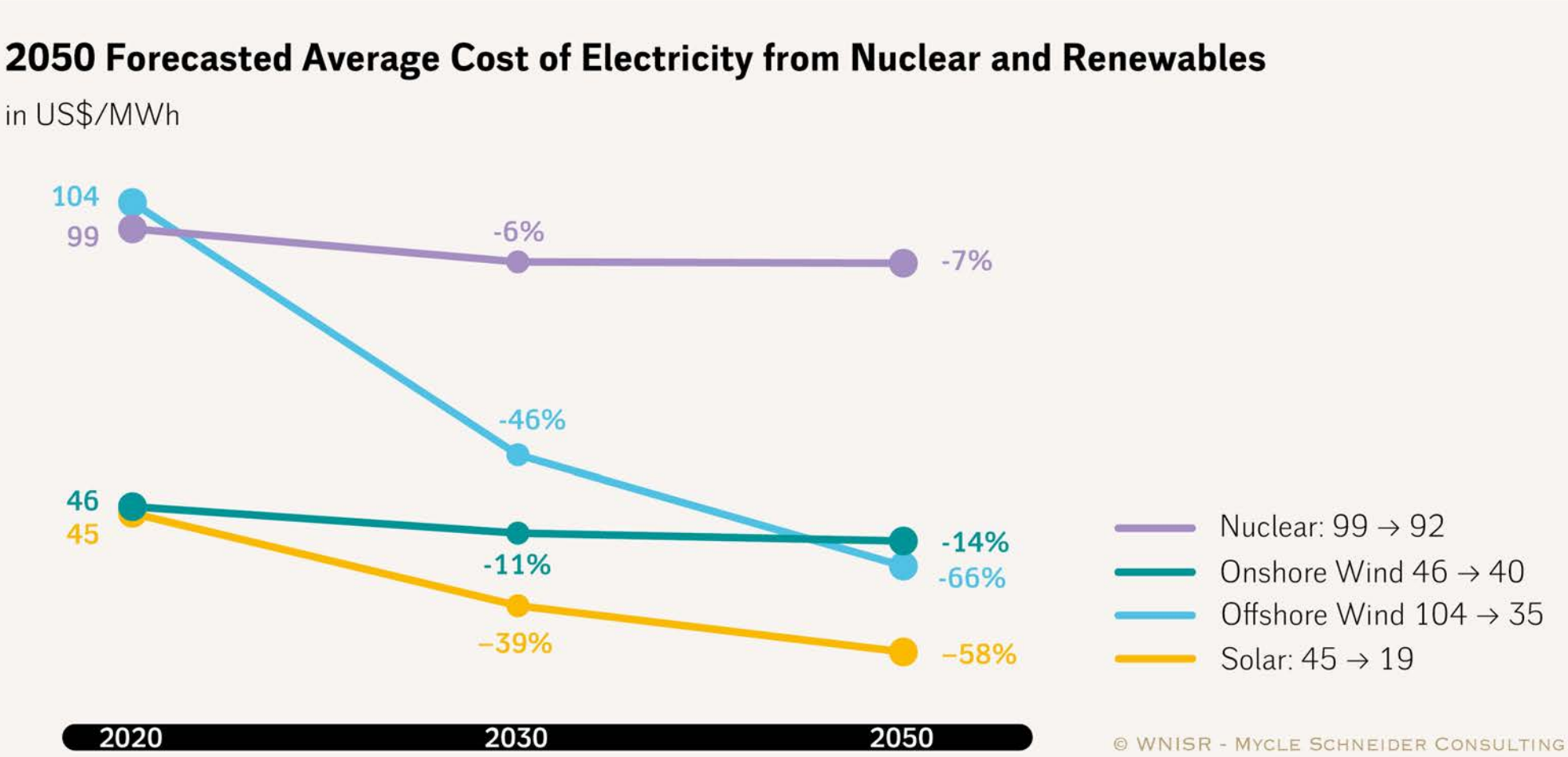
Sources: BP Statistical Review, 2021

NUCLEAR POWER VS. RENEWABLES DEPLOYMENT – GENERATION COSTS 1



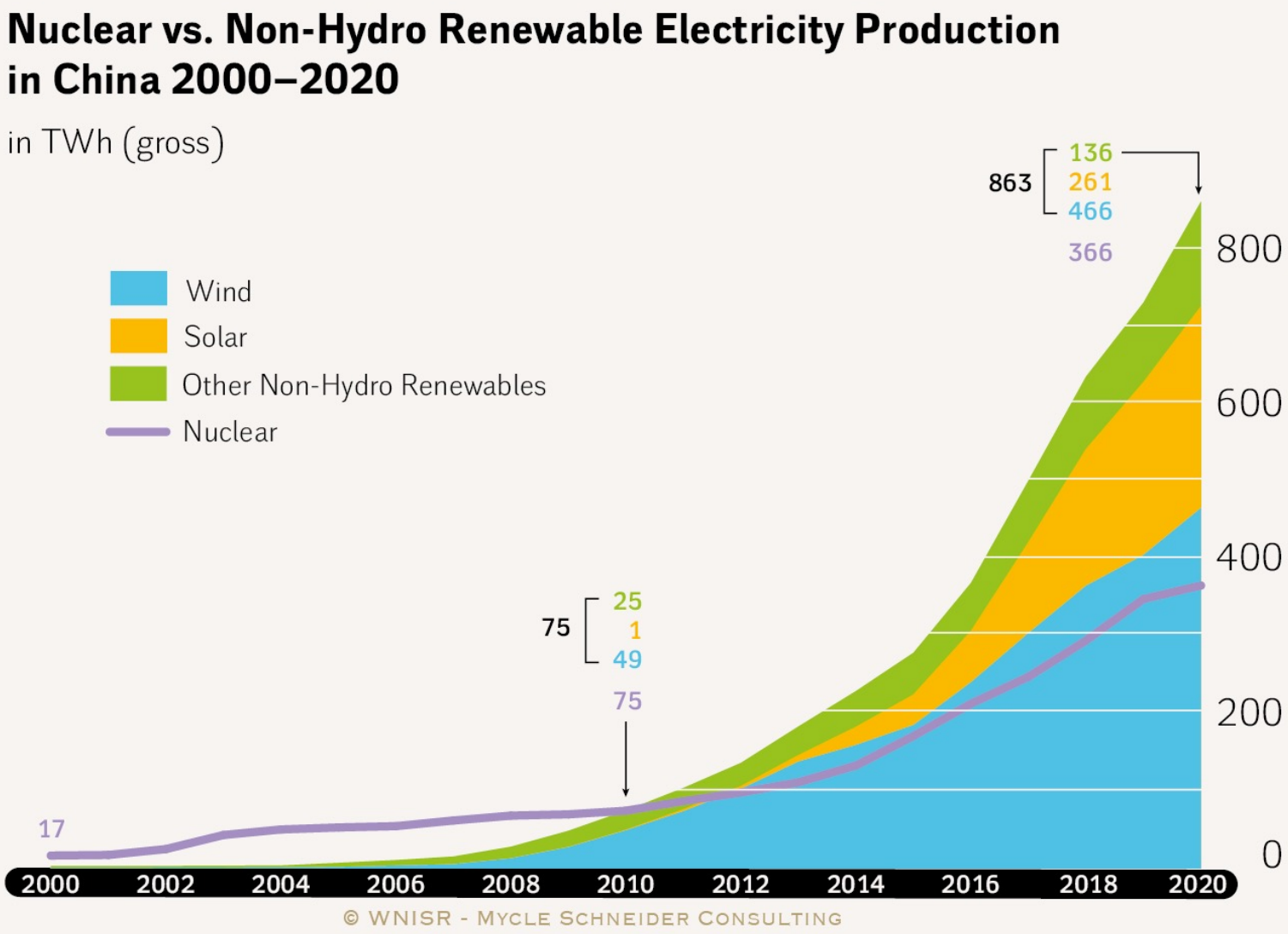
Source: Lazard Estimates, 2020

NUCLEAR POWER VS. RENEWABLES DEPLOYMENT – GENERATION COSTS 2



Source: IEA, 2021

NUCLEAR POWER VS. RENEWABLES DEPLOYMENT - CHINA

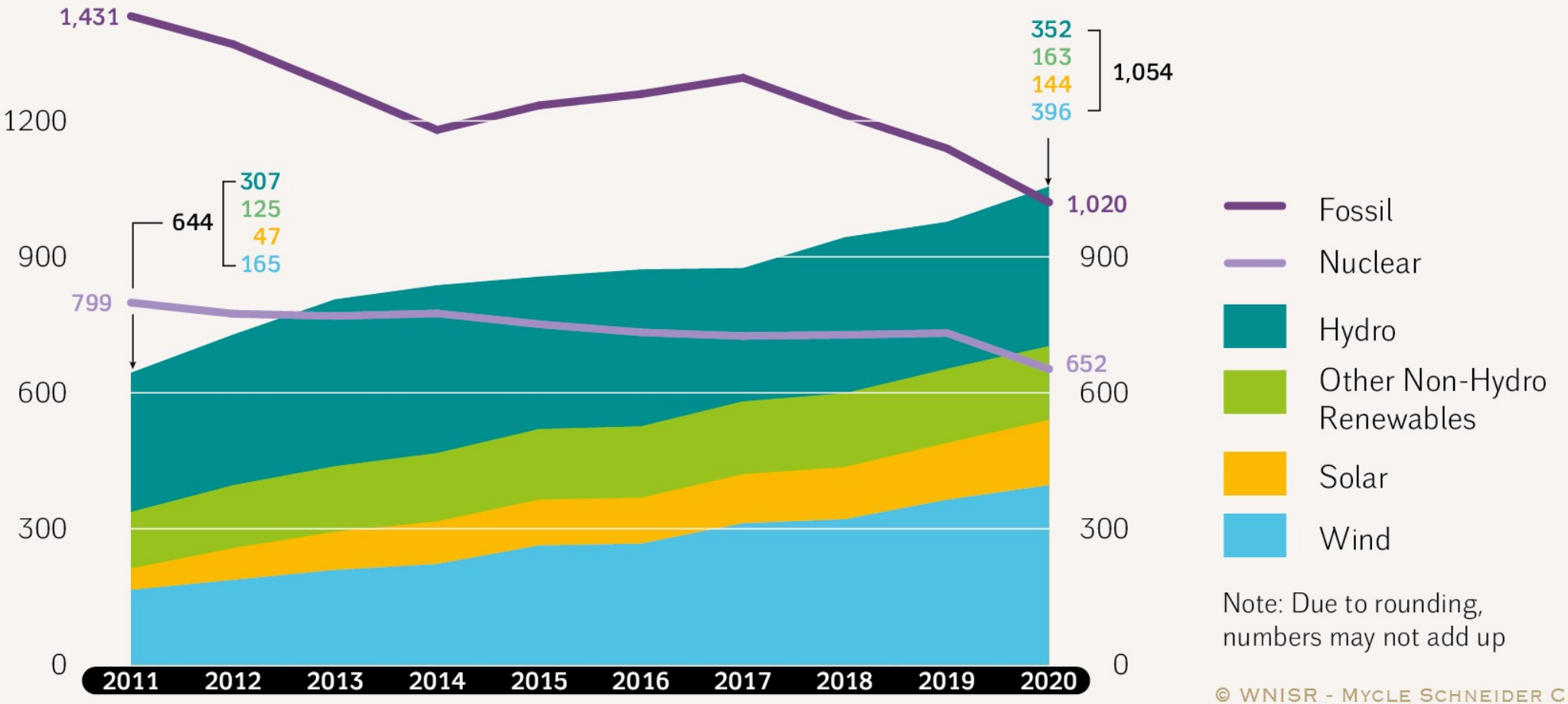


Sources: BP Statistical Review, 2021

NUCLEAR POWER VS. RENEWABLES DEPLOYMENT – EUROPEAN UNION

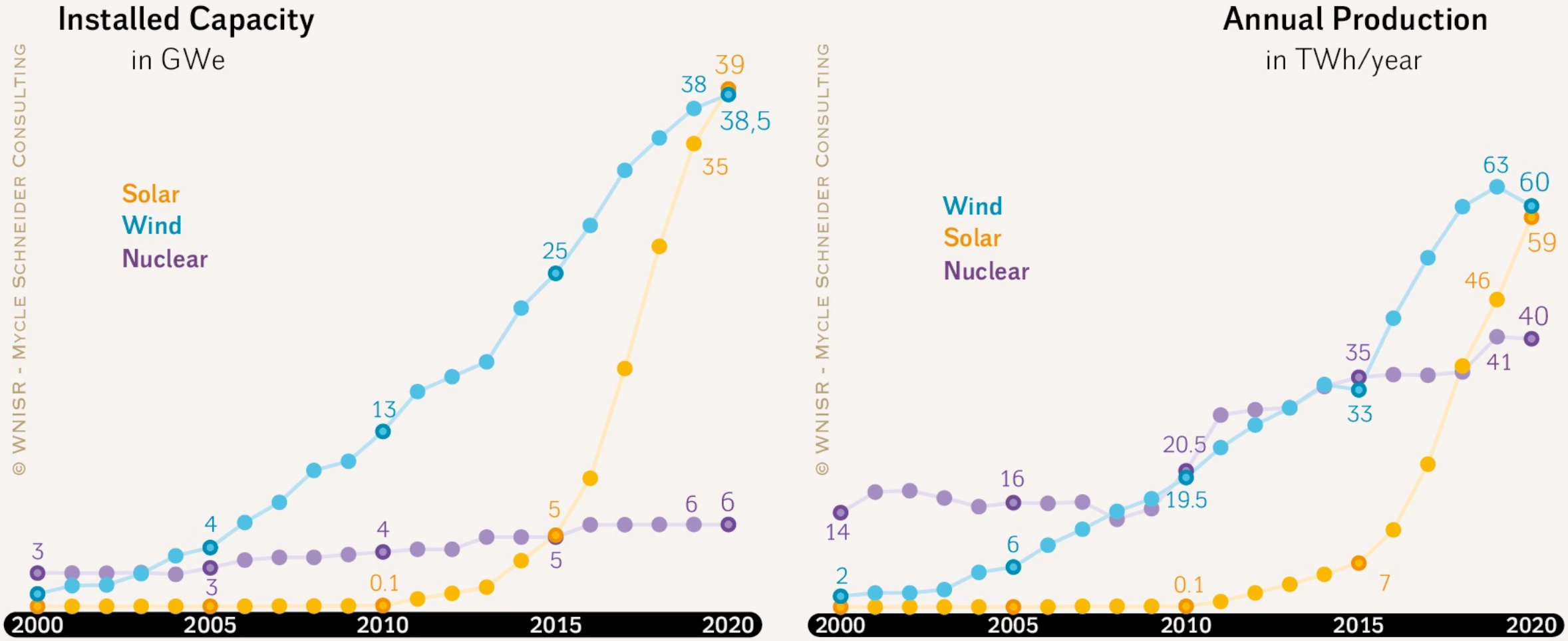
Electricity Production in the EU27 2011–2020

in TWh/year



Sources: IAEA-PRIS, Agora Energiewende and Ember, 2021

Wind, Solar and Nuclear Capacity and Electricity Production in India 2000–2020

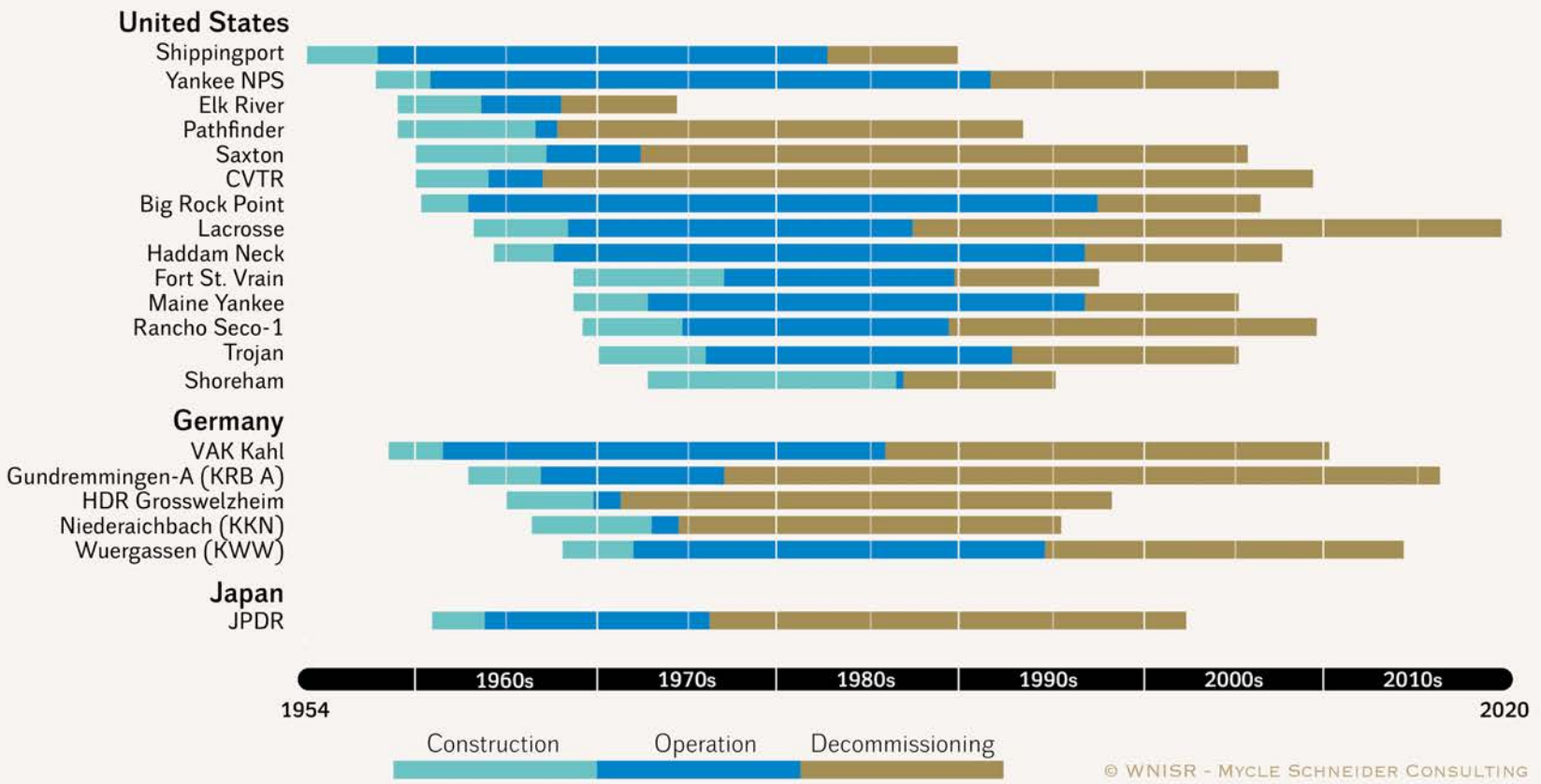


Sources: WNISR with IAEA-PRIS, IRENA, BP Statistical Review, 2021

CONCLUSIONS

- In 2020, nuclear power generation plunged by un an unprecedented margin except for the aftermath of 3/11 (2011–12), while operational nuclear capacity has reached a new peak in mid-2021. More capacity, less output.
- Non-hydro renewables—mainly wind, solar and biomass—have out-performed nuclear power on a global scale. Hydro alone has been generating more power than nuclear for most of the past three decades.
- For the first time, *non-hydro* renewables generated more power in the European Union than nuclear, and renewables *including hydro* generated more power than all fossil fuels combined.
- Net nuclear capacity addition—new startups minus closures—declined to 0.4 GW, compared to >150 GW for renewables alone. Nuclear is irrelevant in today's electricity capacity newbuild market.
- Small Modular Reactors (SMRs) get a lot of media coverage, some public money, but are so far unavailable commercially and will not be—if ever—for another 10–15 years. Pilot projects in Argentina, China, and Russia have been disappointing.
- The situation at Fukushima, onsite/offsite, remains unstable. Effects on health and well-being are significant. Cost estimates have risen, currently range from US$223.1 billion (Gov.) to US$322–758 billion (independent). Japanese courts have acquitted Government/TEPCO officials over disaster responsibility but ruled against reactor operation in some cases.
- Nuclear power demonstrated a high sensibility to the COVID-19 pandemic. A first analysis shows that it has a low resilience against the most common climate change effects. Nuclear's resilience will likely further decline.
- There is a real question about the exposure of the nuclear power sector to criminal activities including bribery and corruption, counterfeiting and other falsification, as well as infiltration by organized crime.

ANNEXES



Sources: Various, compiled by WNISR, 2021

Progress and Status of Reactor Decommissioning in Selected Countries

in Units, June 2018 – June 2021

Sources: Various, compiled by WNISR, 2021


Photo: ©Nina Schneider

Mycle Schneider works as independent international consultant on energy and nuclear policy. He is the initiator, coordinator and publisher of the World Nuclear Industry Status Reports. He is a Founding Board Member and the Spokesperson for the International Energy Advisory Council (IEAC). He is a Founding Member of the International Nuclear Risk Assessment Group (INRAG) and a member of the International Nuclear Security Forum (INSF), based at the Stimson Center, USA. Since 2007, he is a member of the International Panel on Fissile Materials (IPFM), based at Princeton University, USA.
Between 2004 and 2009, he has been in charge of the Environment and Energy Strategies Lecture of the International Master of Science for Project Management for Environmental and Energy Engineering at the *Ecole des Mines* in Nantes, France.

From 2000 to 2010, he was an occasional advisor to the German Environment Ministry. 1998–2003, he was an advisor to the French Environment Minister's Office and to the Belgian Minister for Energy and Sustainable Development. Mycle Schneider has given evidence or held briefings at national Parliaments in 16 countries and at the European Parliament. He has advised Members of the European Parliament from four different groups over the past 30+ years. He has given lectures or had teaching appointments at over 20 universities and engineering schools in 10 countries.