

The World Nuclear Industry Status Report 2019

(WNISR2019)

www.WorldNuclearReport.org

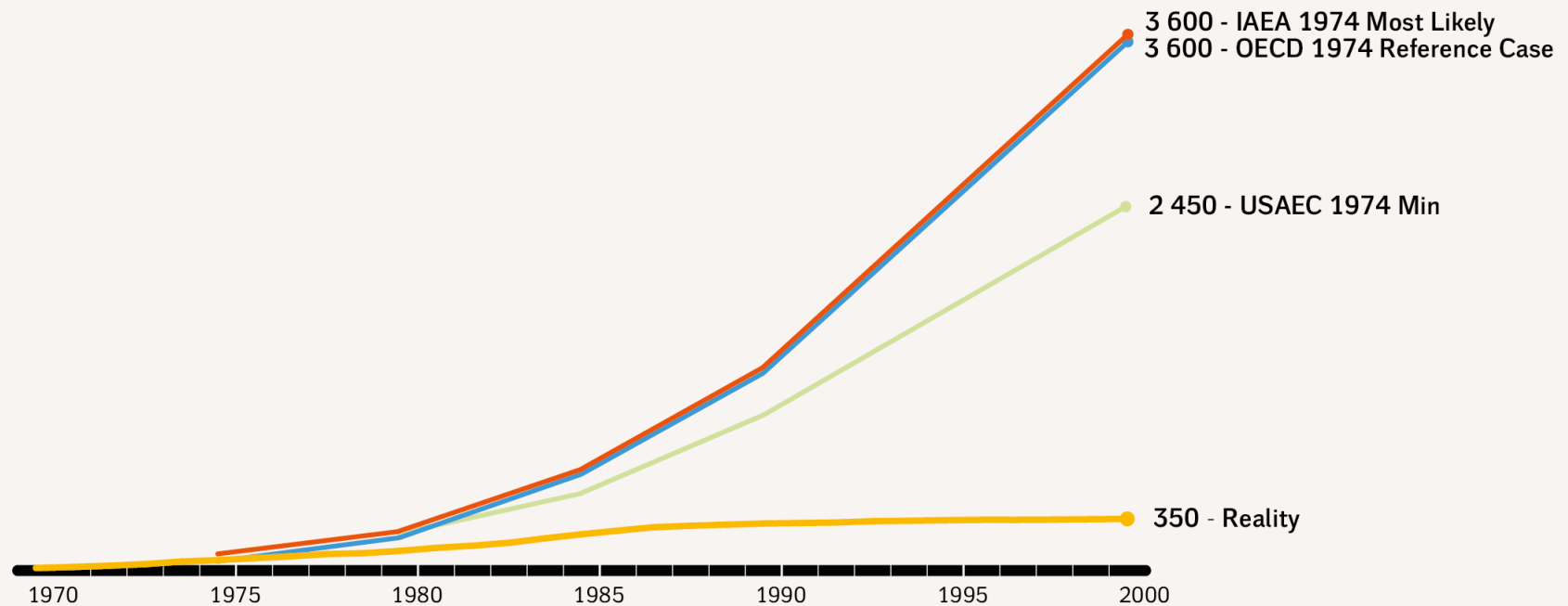
Mycle Schneider

Independent International Consultant on Energy and Nuclear Policy, Paris
WNISR Convening Lead Author and Publisher

Washington D.C./Vienna, 7 October 2019

1970s Projections Nuclear Capacity to 2000 vs. Reality

in GWe, by Organisation and Projection-Year



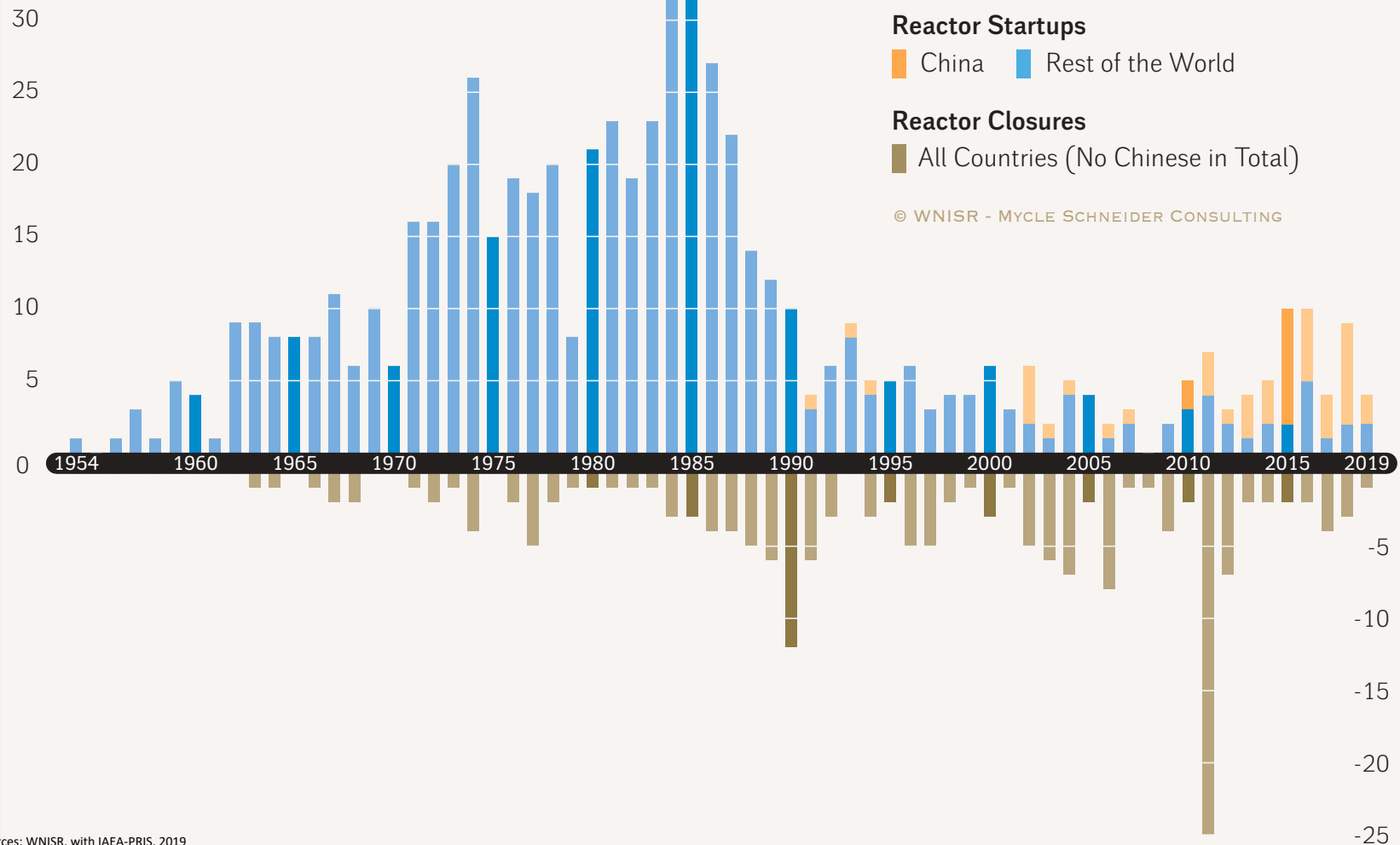
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Sources: Klaus Gufler, "Short and Mid-term Trends of the Development of Nuclear Energy", June 2013

WNISR2019 GLOBAL OVERVIEW – STARTUPS AND CLOSURES

Reactor Startups and Closures in the World

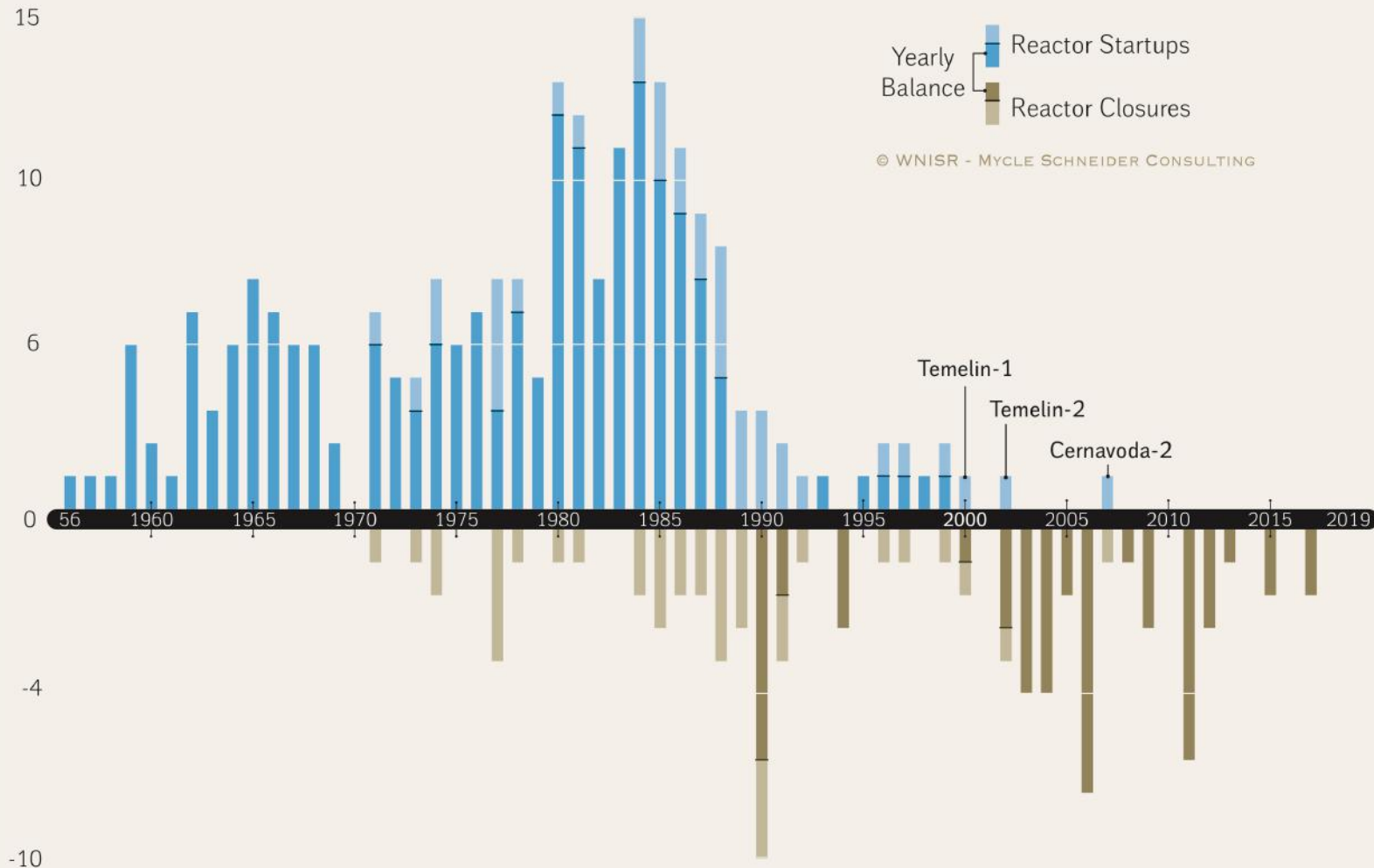
in Units, from 1954 to 1 July 2019



Sources: WNISR, with IAEA-PRIS, 2019

Reactor Startups and Closures in the EU28

in Units, from 1956 to 1 July 2019

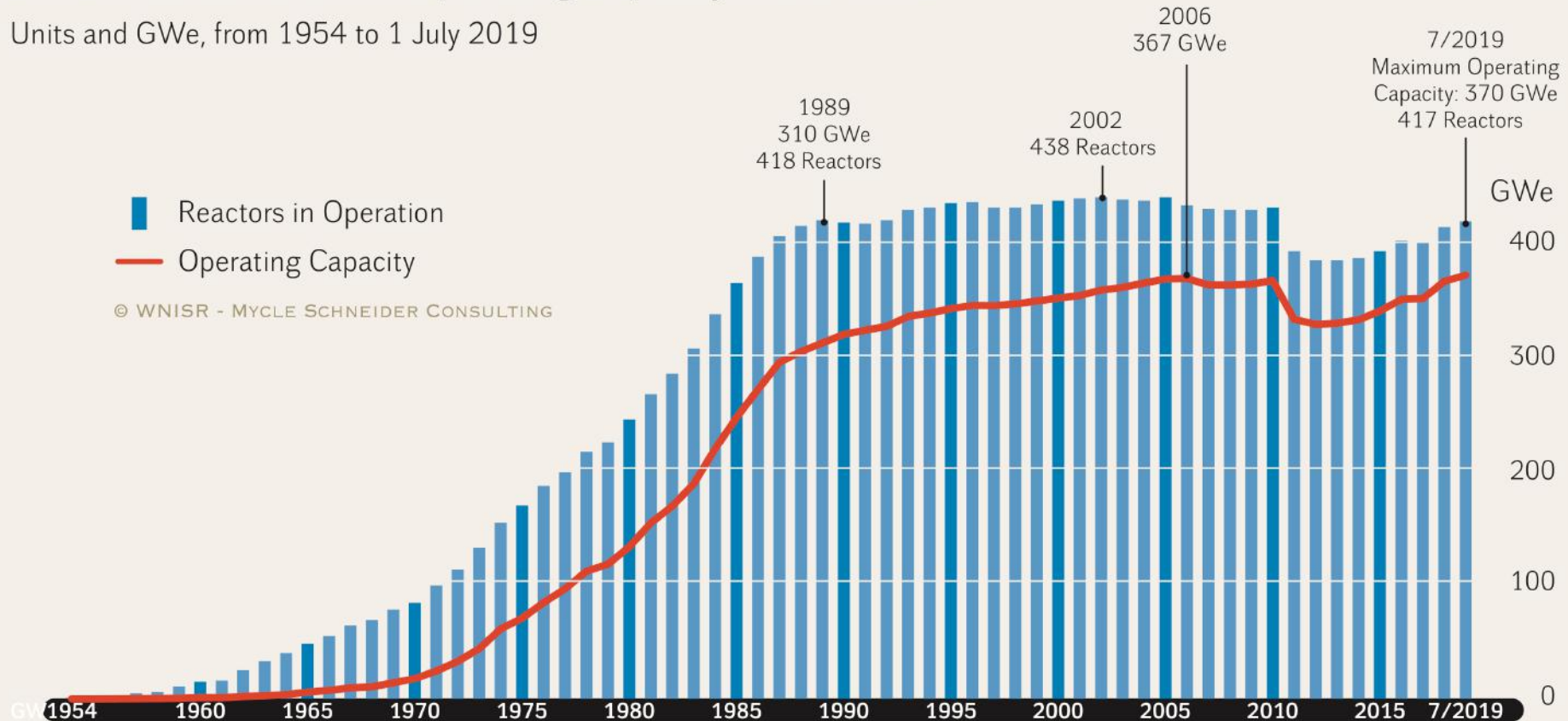


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Sources: WNISR, with IAEA-PRIS, 2019

Nuclear Reactors and Net Operating Capacity in the World

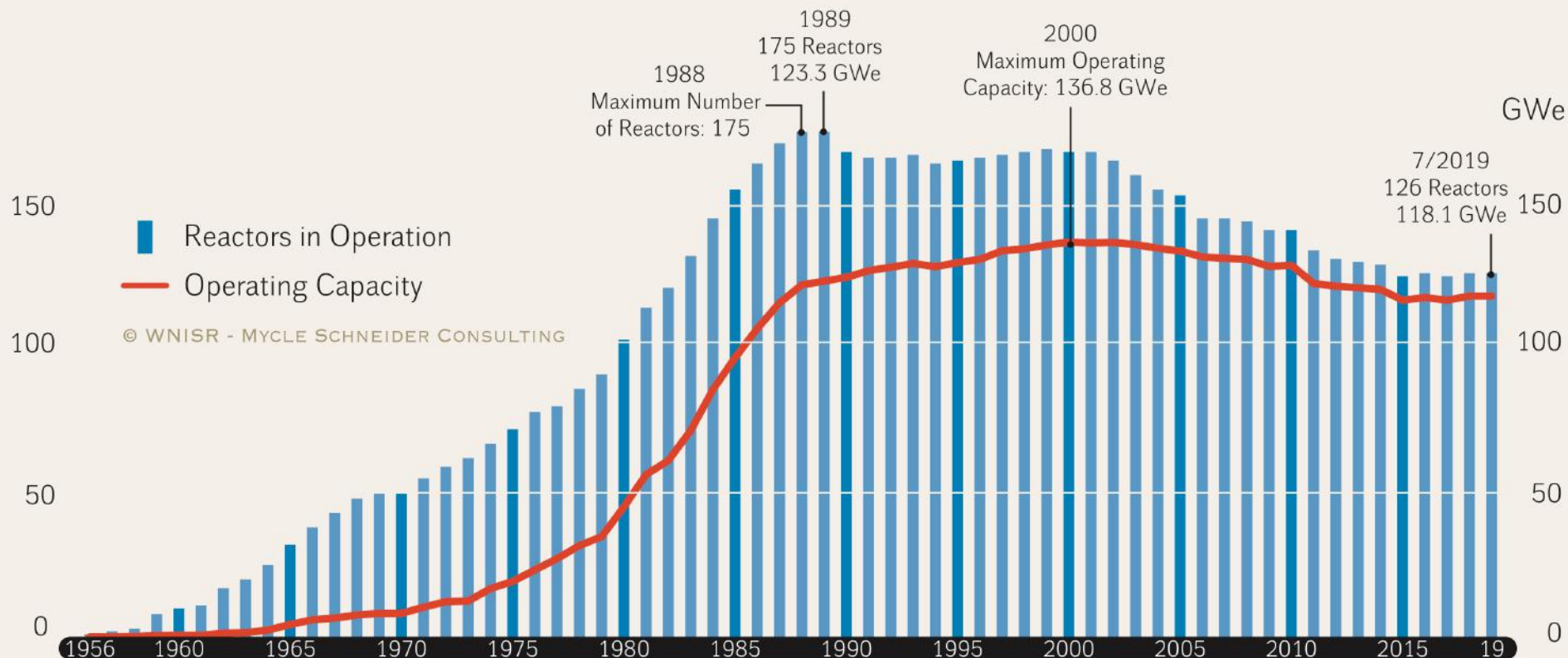
in Units and GWe, from 1954 to 1 July 2019



Sources: WNISR, with IAEA-PRIS, 2019

Nuclear Reactors and Net Operating Capacity in the EU 28

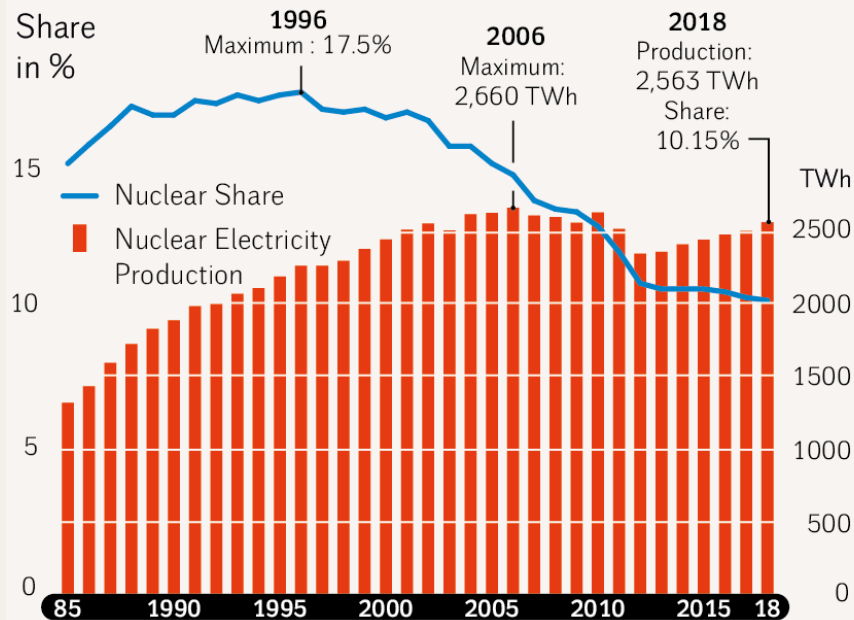
in Units and GWe, from 1956 to 1 July 2019



Sources: WNISR, with IAEA-PRIS, 2019

Nuclear Electricity Production 1985-2018 in the World...

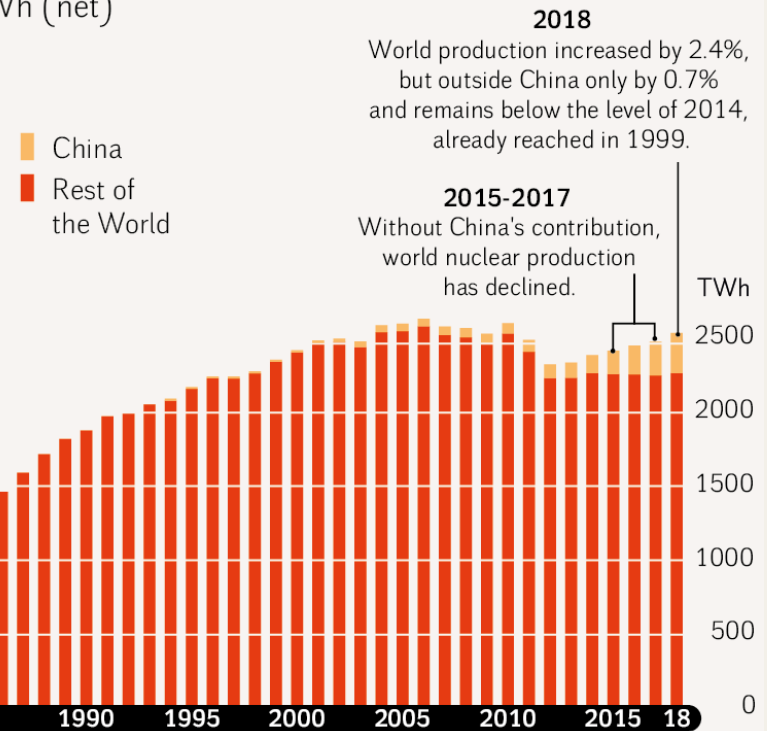
in TWh (net) and Share in Electricity Generation (gross)



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

in TWh (net)

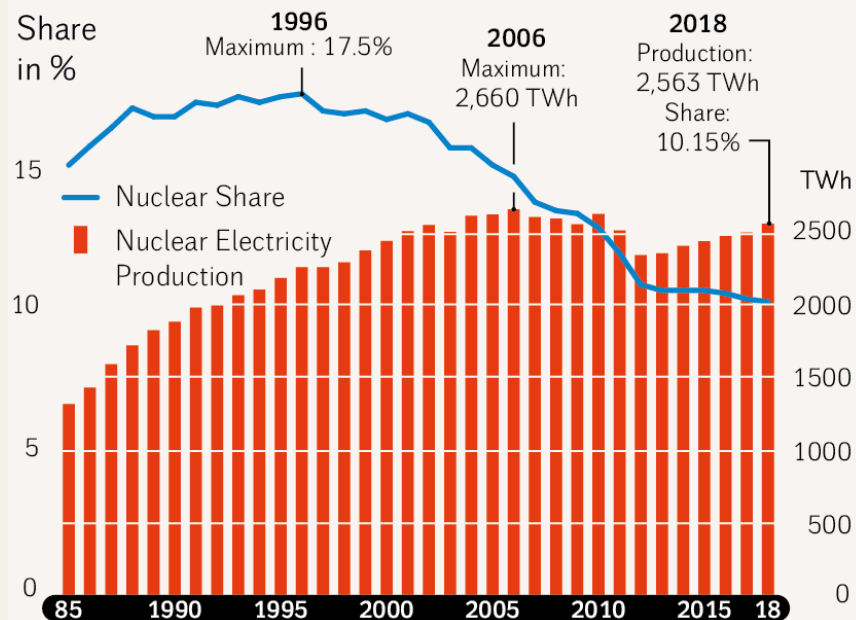


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Sources: IAEA-PRIS, BP, 2019

Nuclear Electricity Production 1985-2018 in the World...

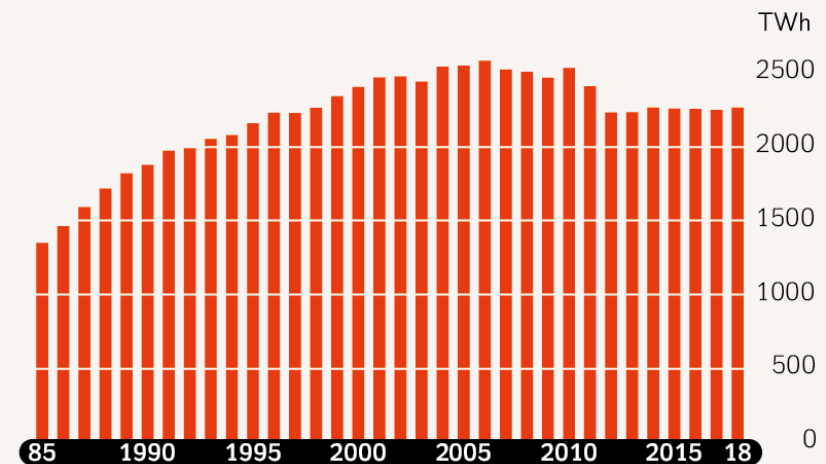
in TWh (net) and Share in Electricity Generation (gross)



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

in TWh (net)



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Sources: IAEA-PRIS, BP, 2019

WNISR2019 GLOBAL OVERVIEW - NUCLEAR ELECTRICITY GENERATION

Nuclear Production in 2017/2018 and Historic Maximum (Top 21)

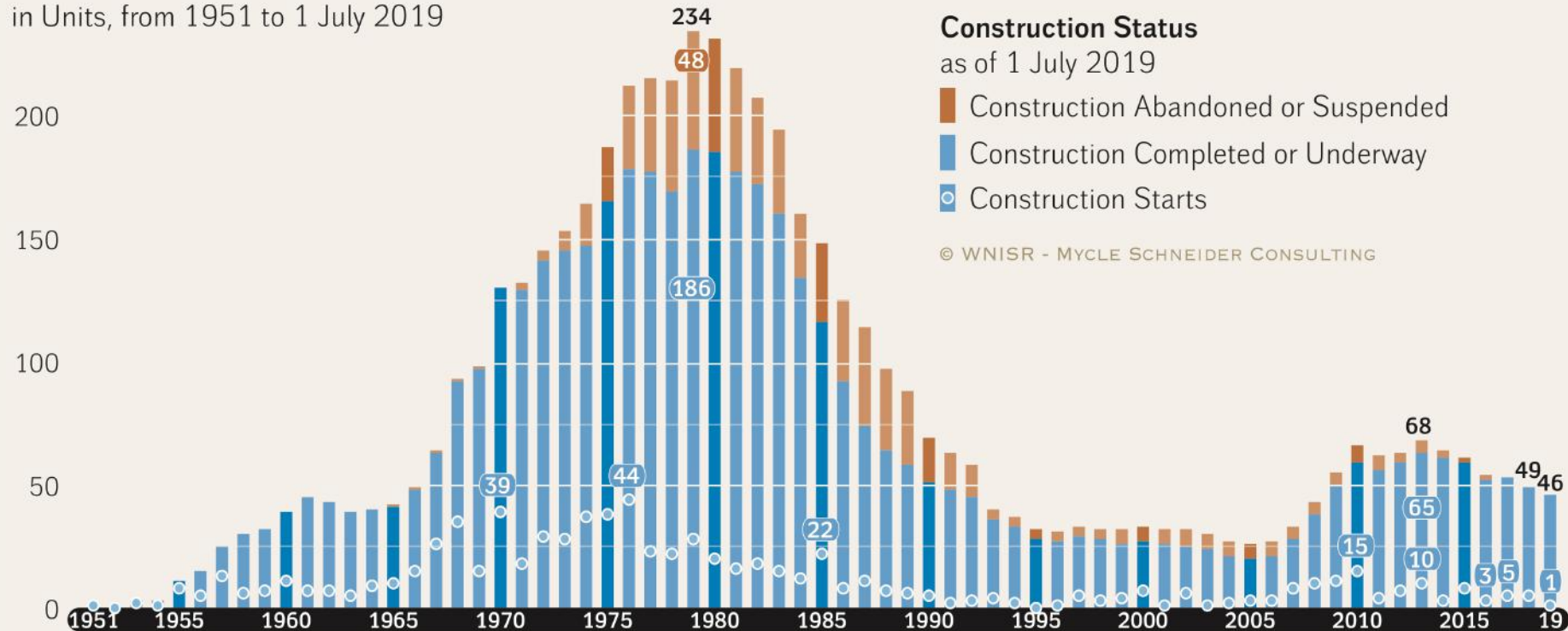
in TWh and Share In Electricity Production



Sources: IAEA-PRIS, BP, 2019

Reactors Under Construction in the World

in Units, from 1951 to 1 July 2019



Sources: WNISR, with IAEA-PRIS, 2019

WNISR2019 GENERAL OVERVIEW — CONSTRUCTIONS

Country	Units	Capacity (MW net)	Construction Starts	Grid Connection	Units Behind Schedule
China	10	8 800	2012 - 2017	2020 - 2023	2-3
India	7	4 824	2004 - 2017	2019 - 2023	5
Russia	5	3 379	2007 - 2019	2019 - 2023	3
UAE	4	5 380	2012 - 2015	2020 - 2023	4
South Korea	4	5 360	2012 - 2018	2019 - 2024	4
Belarus	2	2 218	2013 - 2014	2019 - 2020	1-2
Bangladesh	2	2 160	2017 - 2018	2023 - 2024	0
Slovakia	2	880	1985	2020 - 2021	2
USA	2	2 234	2013	2021 - 2022	2
Pakistan	2	2 028	2015 - 2016	2020 - 2021	0
Japan	1	1 325	2007	?	1
Argentina	1	25	2014	2021	1
UK	1	1 630	2018	2025	0
Finland	1	1 600	2005	2020	1
France	1	1 600	2007	2022	1
Turkey	1	1 114	2018	2024	0
Total	46	44 557	1985 - 2019	2019 - 2025	27-29

Sources: Compiled by WNISR, 2019

WNISR2019 GENERAL OVERVIEW — CONSTRUCTIONS

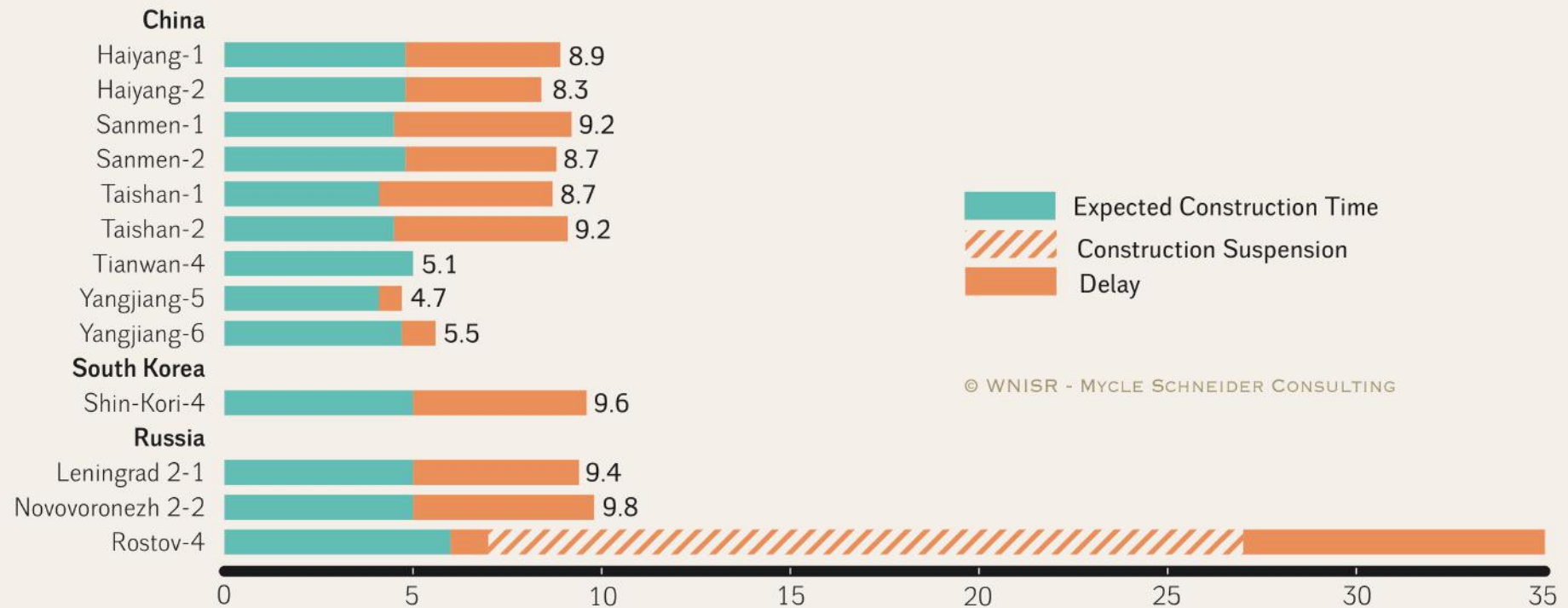
Construction Times of 63 Units Started-up 2009-7/2019				
Country	Units	Construction Time (in Years)		
		Mean Time	Minimum	Maximum
China	37	6.0	4.1	11.2
Russia	8	22.2	8.1	35.0
South Korea	6	6.0	4.1	9.6
India	5	9.8	7.2	14.2
Pakistan	3	5.4	5.2	5.6
Argentina	1	33.0	33.0	
Iran	1	36.3	36.3	
Japan	1	5.1	5.1	
USA	1	43.5	43.5	
World	63	9.8	4.1	43.5

Sources: Compiled by WNISR, 2019

WNISR2019 GLOBAL OVERVIEW – CONSTRUCTIONS & DELAYS

Expected Construction Time vs. Real Construction Time for Startups 2018-2019

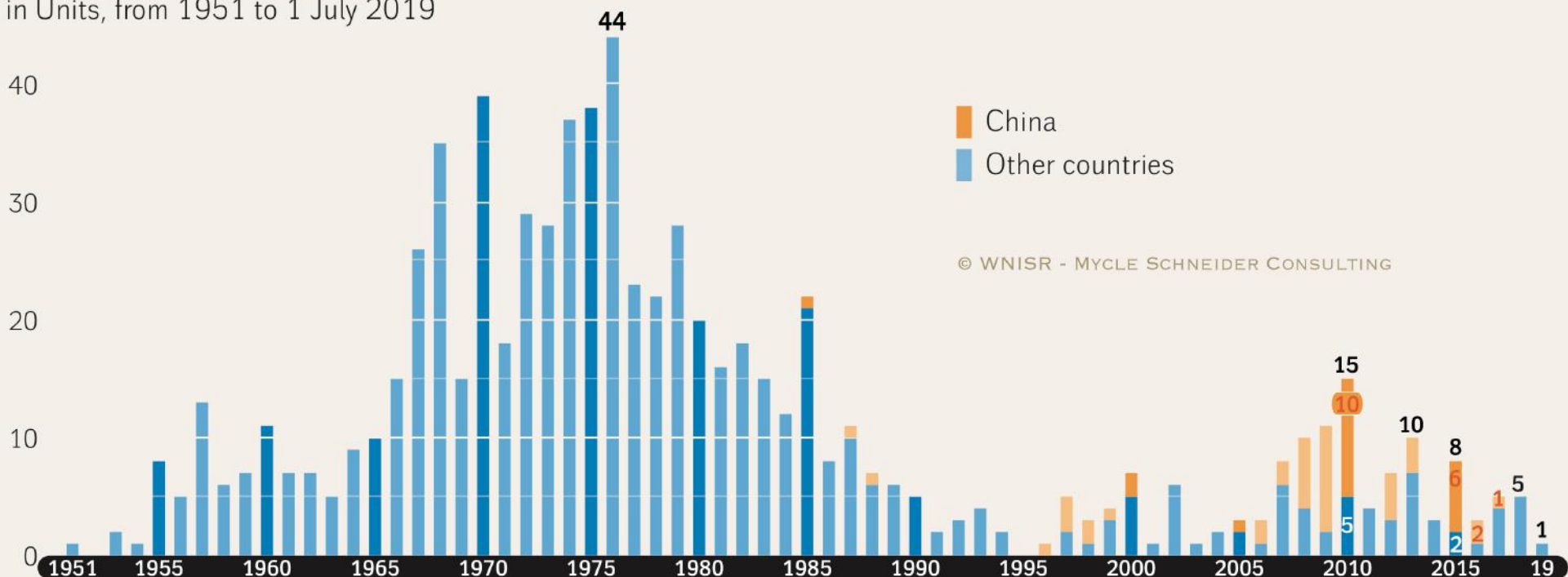
in Years



Sources: WNISR, with IAEA-PRIS, 2019

Construction Starts of Nuclear Reactors in the World

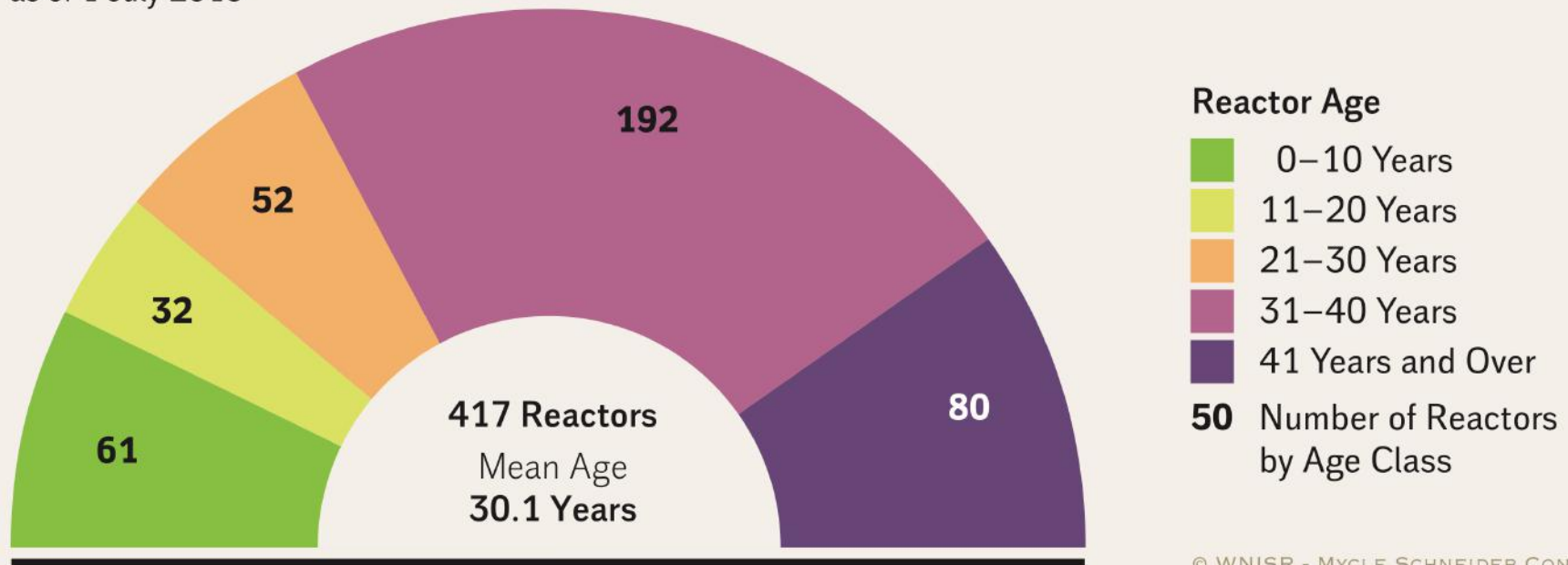
in Units, from 1951 to 1 July 2019



Sources: WNISR, with IAEA-PRIS, 2019

Age of World Nuclear Fleet

as of 1 July 2019

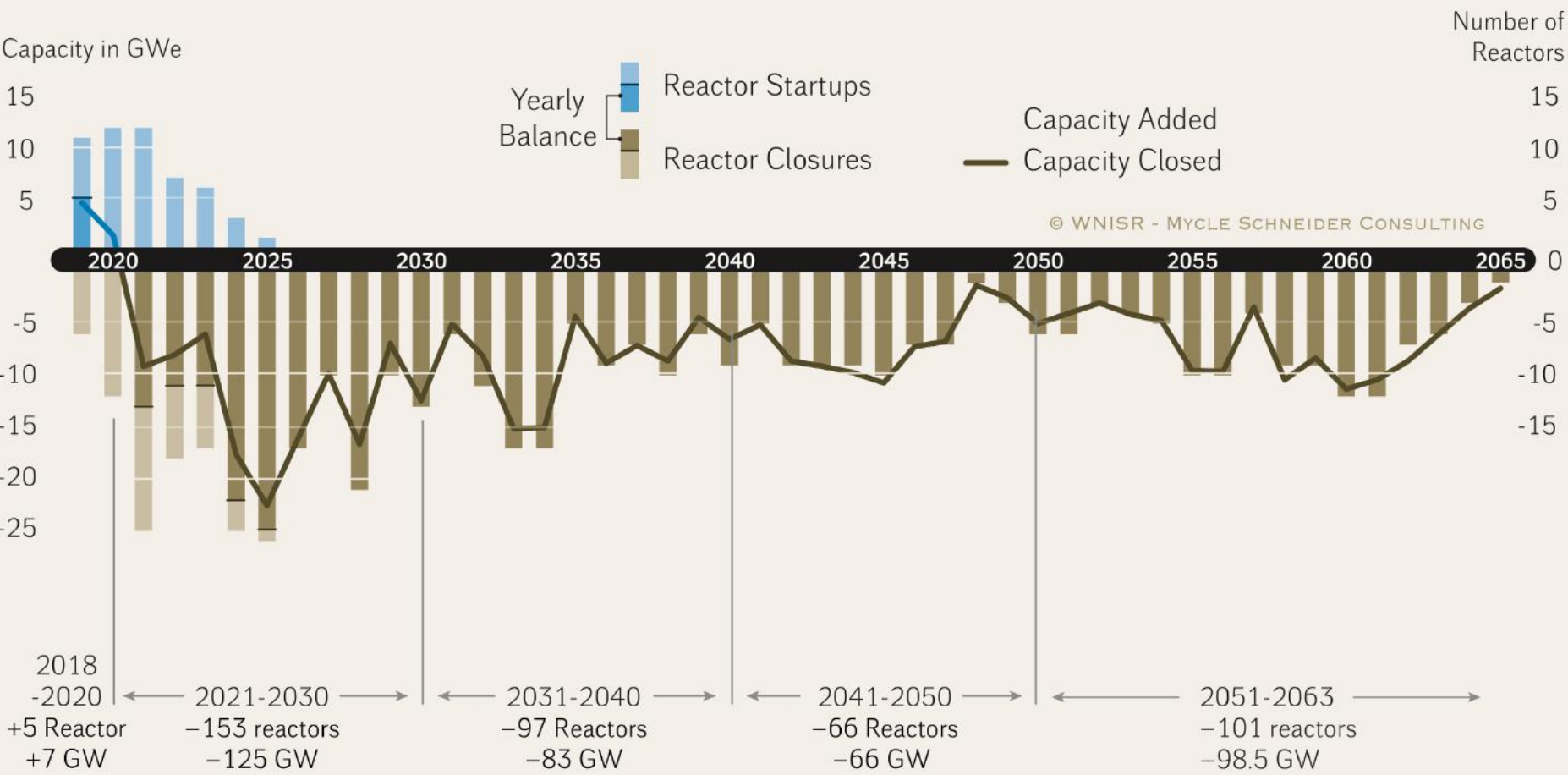


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Sources: WNISR, with IAEA-PRIS, 2019

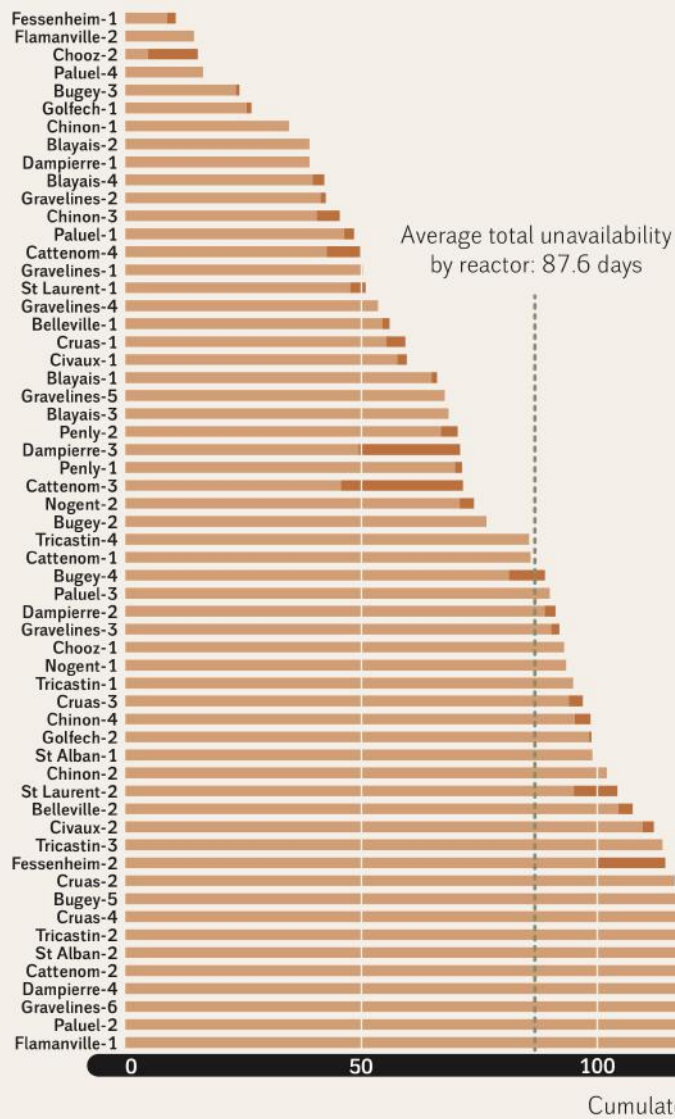
Projection 2019-2065 of Nuclear Reactor/Capacity in the World

General assumption of 40-year mean lifetime + Authorized Lifetime Extensions
 Operating and Under Construction as of 1 July 2019, in GWe and Units



Sources: Various sources, compiled by WNISR, 2019

Reactors



Unavailability of French Nuclear Reactors in 2018

Cumulated Duration of Unavailability at Zero Power (in Days)

Planned Unavailability Forced Unavailability

In 2018, unavailabilities at zero power affecting the French nuclear fleet reached a total of 5,080 reactor-days, or an average of 87.6 days per reactor. All of the 58 reactors were affected, with cumulated outages between 11 and 289 days.

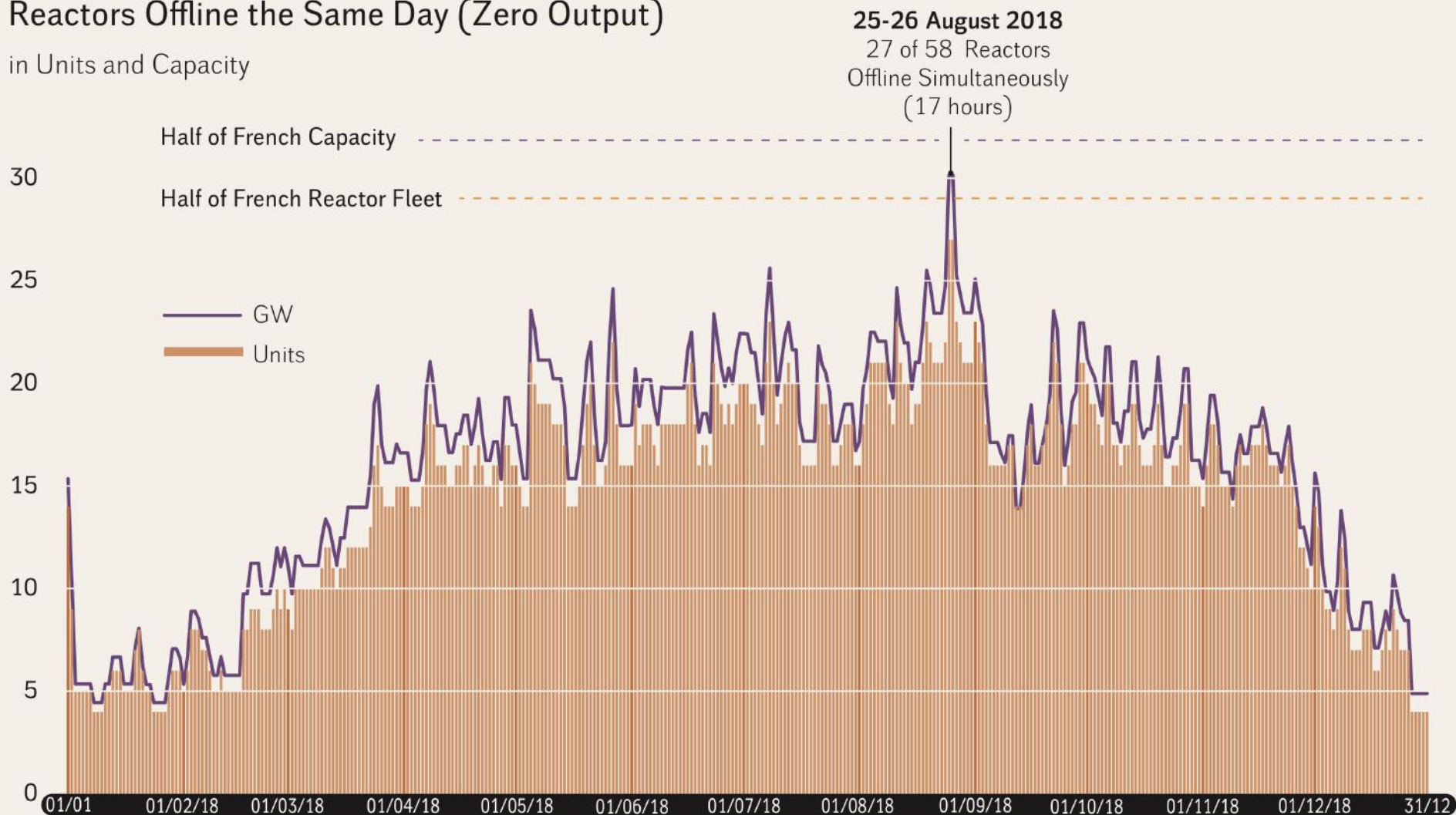
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Sources: Compilation from RTE, 2019

Unavailability of French Nuclear Reactors in 2018

Reactors Offline the Same Day (Zero Output)

in Units and Capacity



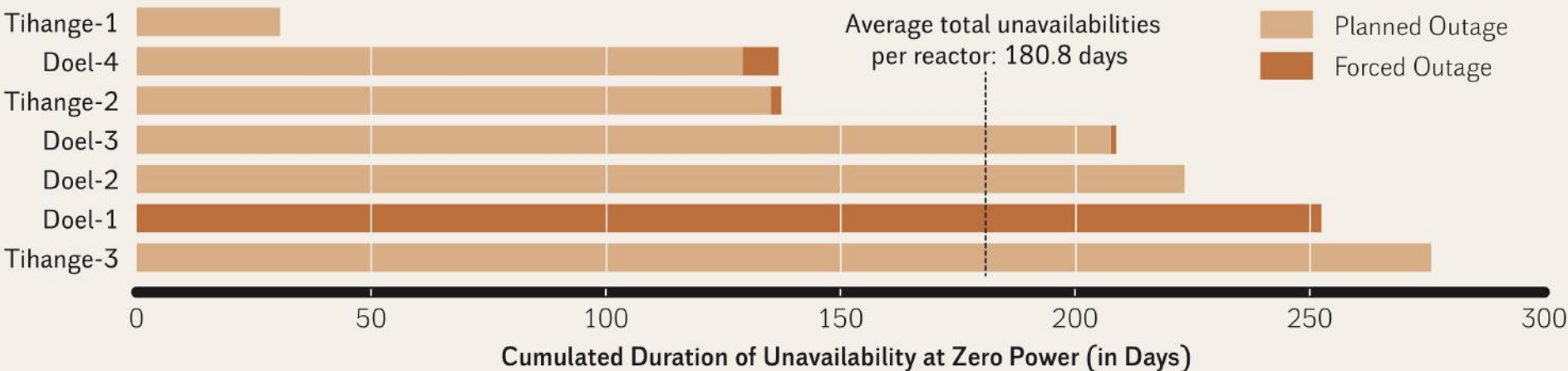
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Sources: Compilation from RTE, 2019

Unavailability of Belgian Nuclear Reactors in 2018

Total Unavailabilities in Days per Reactor

In 2018, unavailabilities at zero power affecting the Belgian nuclear fleet reached a total of 1,265 reactor-days, or an average of 180.8 days per reactor. All of the 7 reactors were affected, with cumulated outages between 31 and 276 days.



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Source: ENTSO-E and Engie Transparency Platforms, 2019

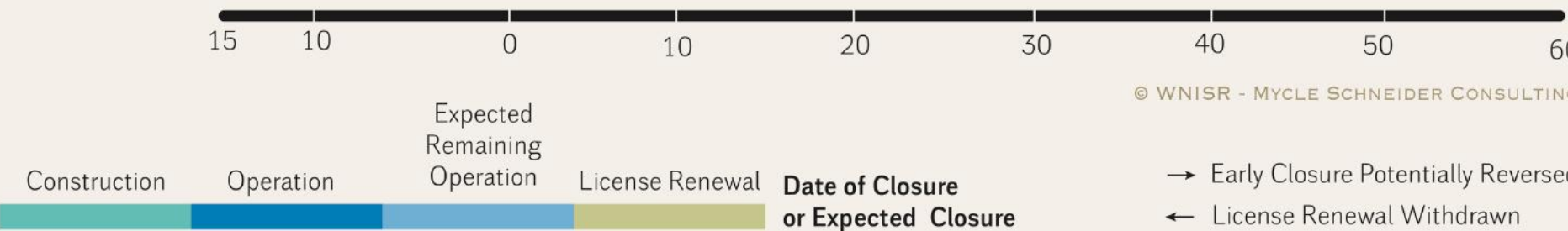
Timelines of 18 U.S. Reactors Subject to Early-Retirement 2009–2025

as of 1 July 2019

Closed Units

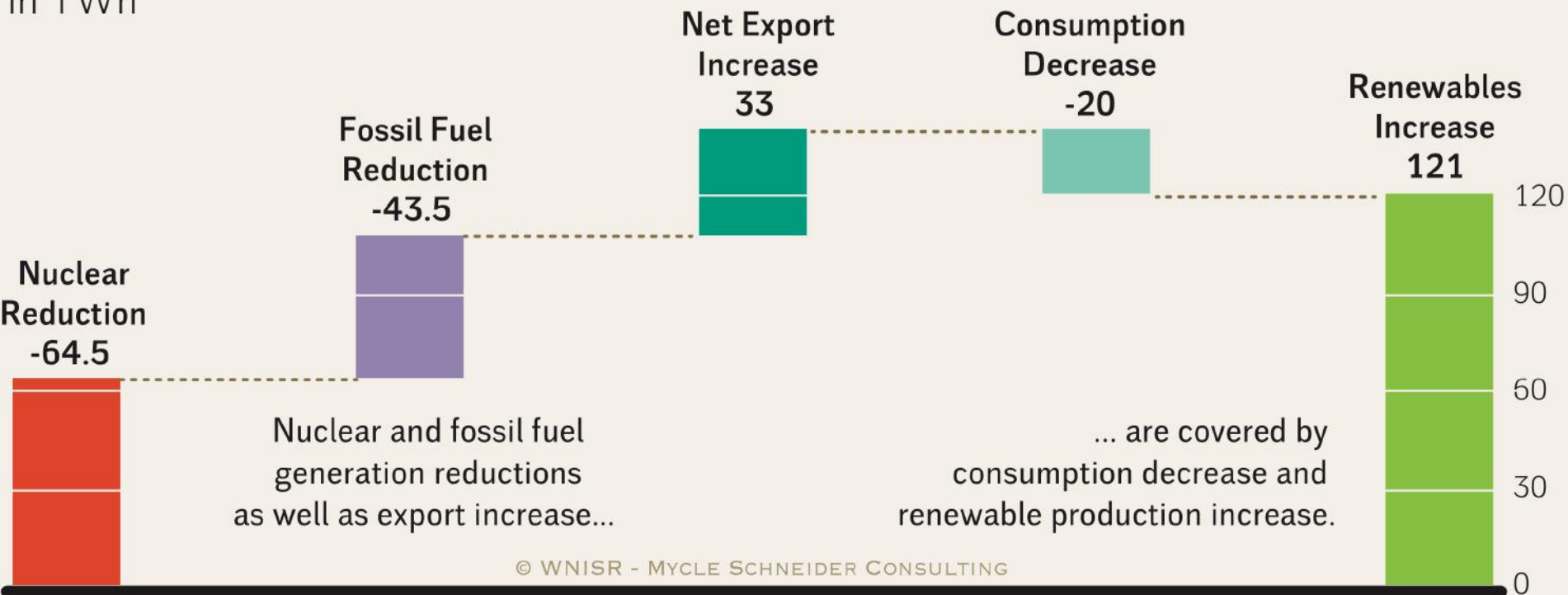


Units Scheduled for Closure



Main Evolution of the German Power System Between 2010 and 2018

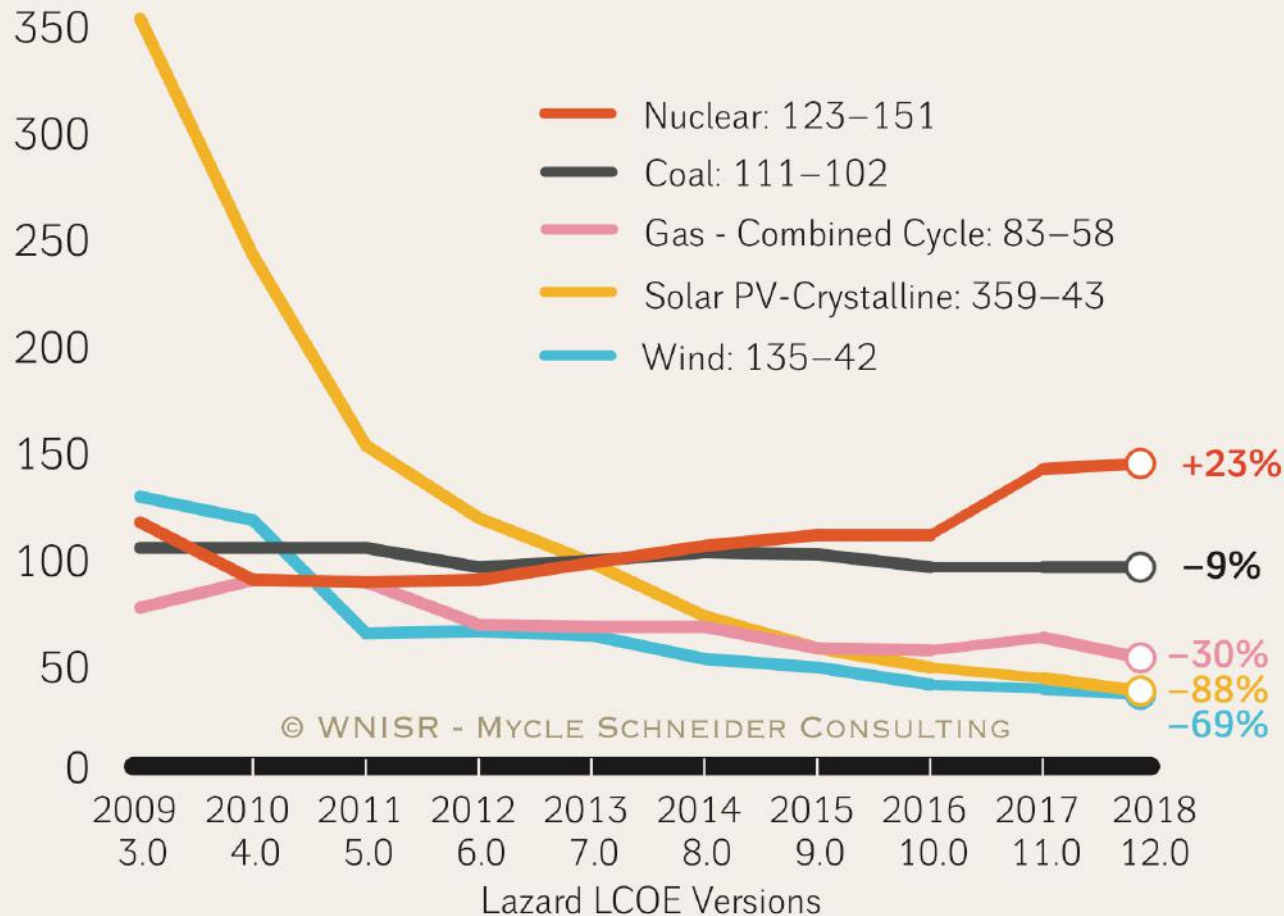
in TWh



Sources WNISR, based on AGEB 2019

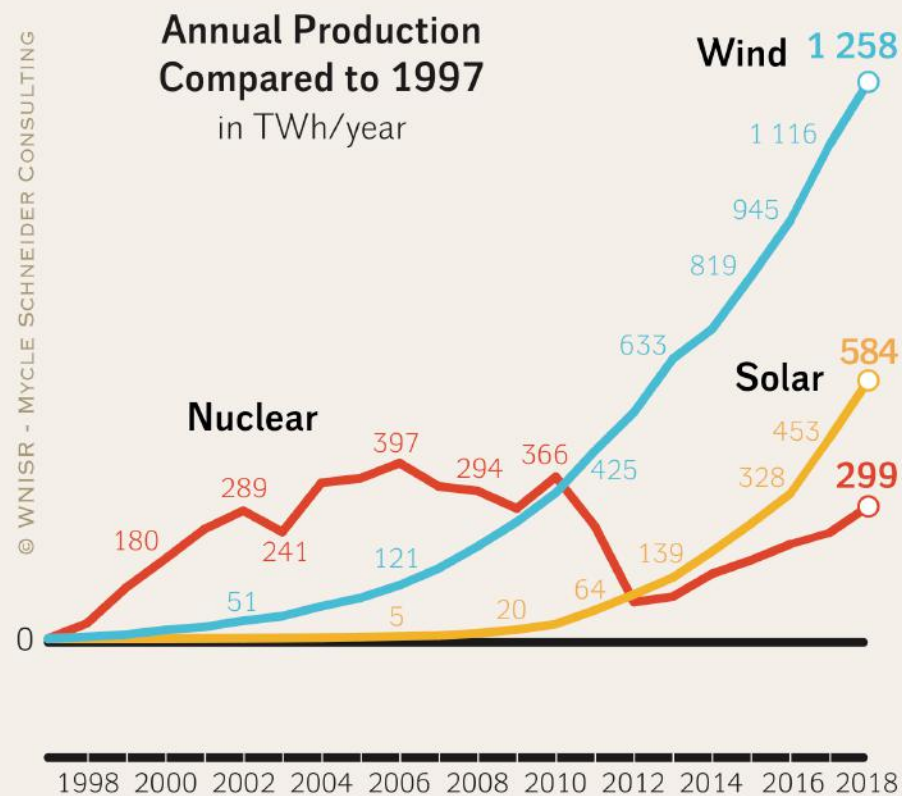
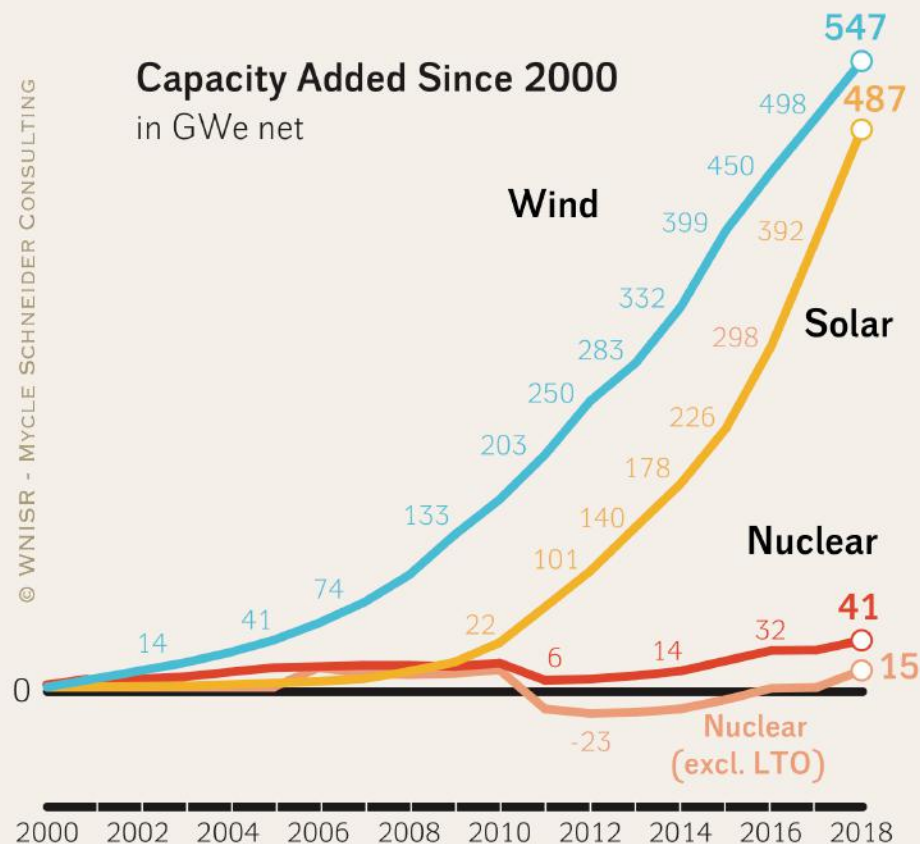
Selected Historical Mean Costs by Technology

LCOE values in US\$/MWh ⁽¹⁾



Sources: Lazard Estimates, 2018

Wind, Solar and Nuclear Developments: Installed Capacity and Electricity Production in the World

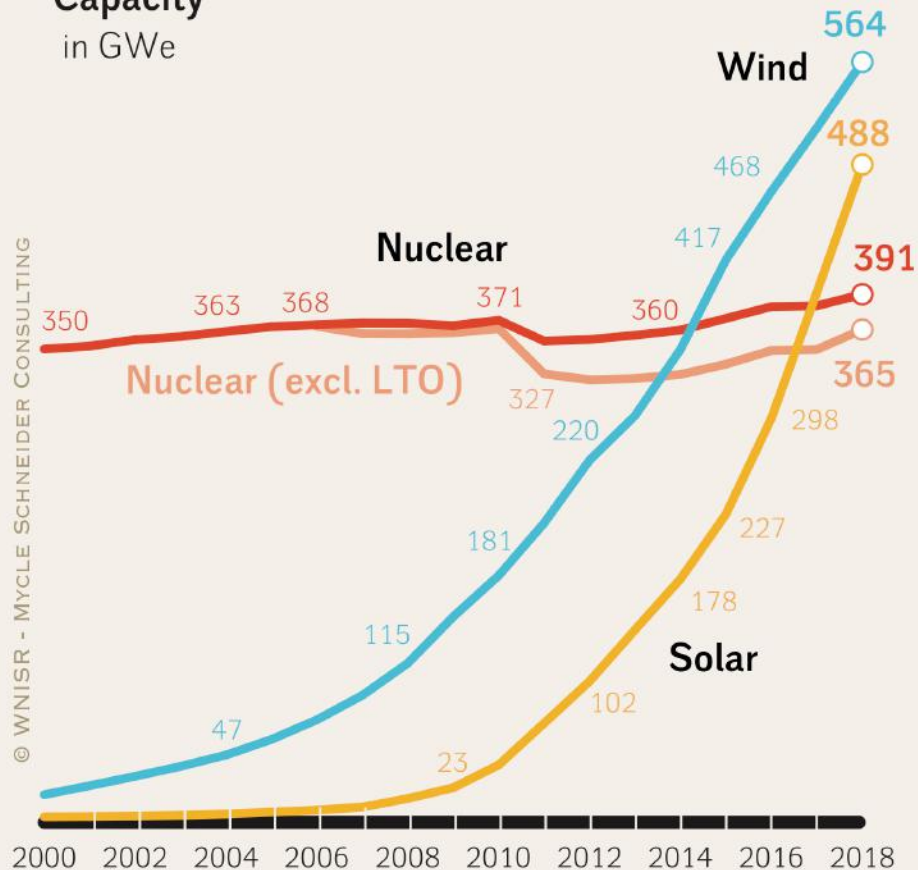


Sources: WNISR, IAEA-PRIS, BP Statistical Review 2019

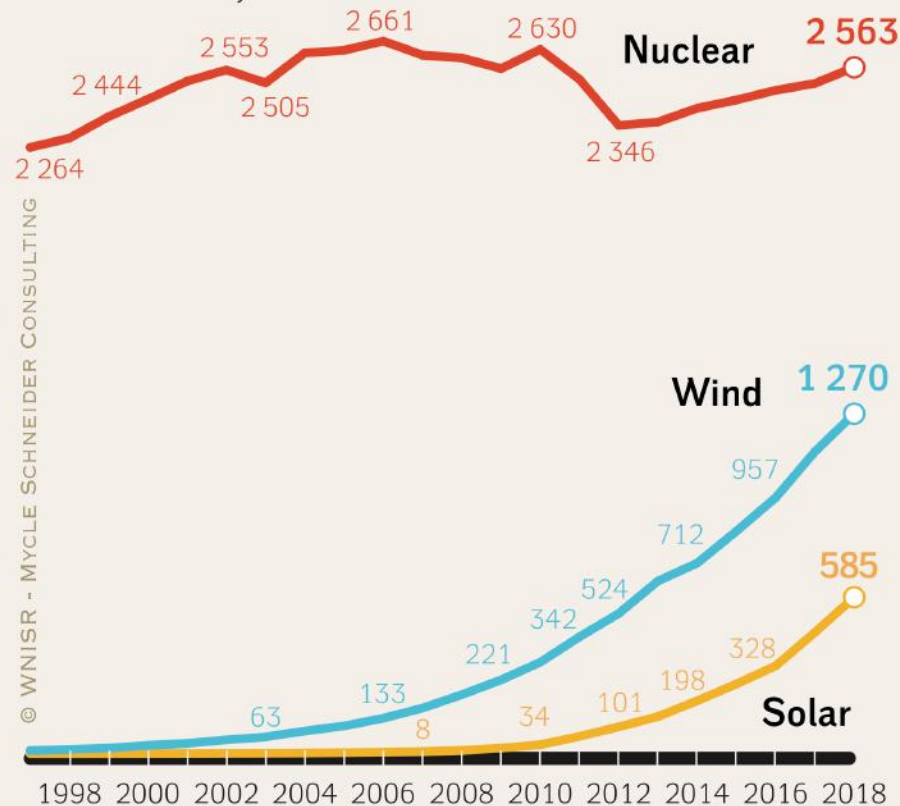
WNISR2019 NUCLEAR POWER VS. RENEWABLES DEPLOYMENT

Wind, Solar and Nuclear Installed Capacity and Electricity Production in the World

Capacity
in GWe



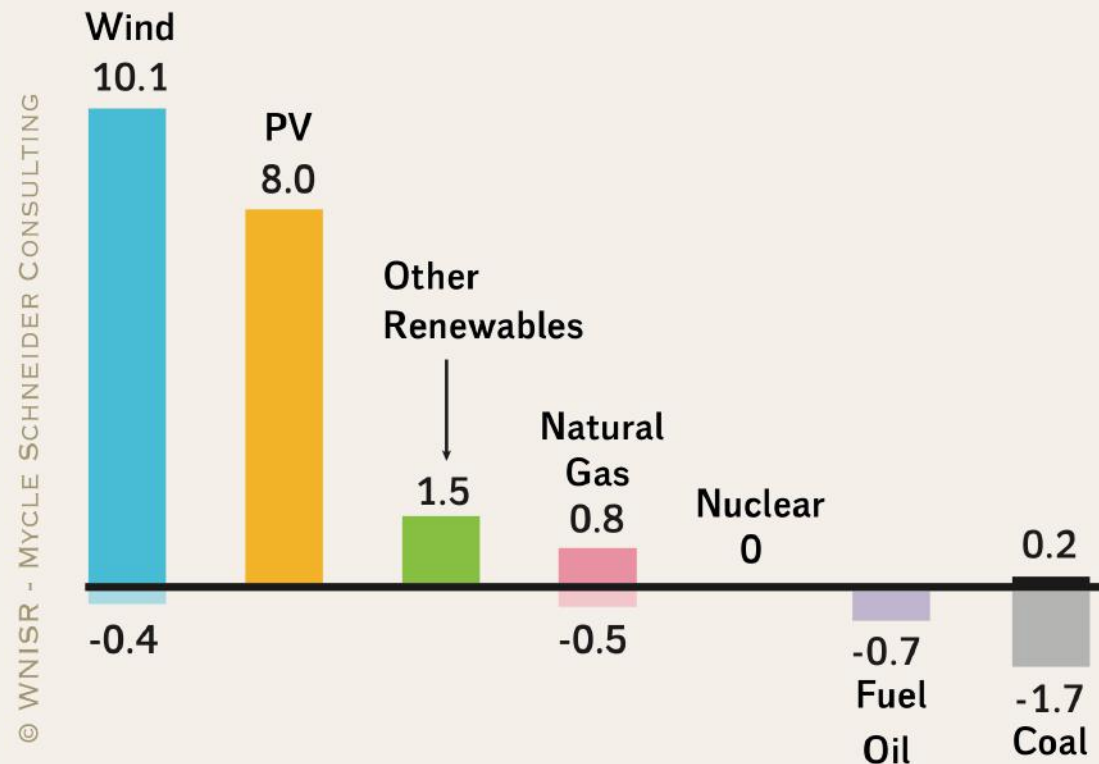
Electricity Production
in TWh/year



Sources: WNISR, IAEA-PRIS, BP Statistical Review 2019

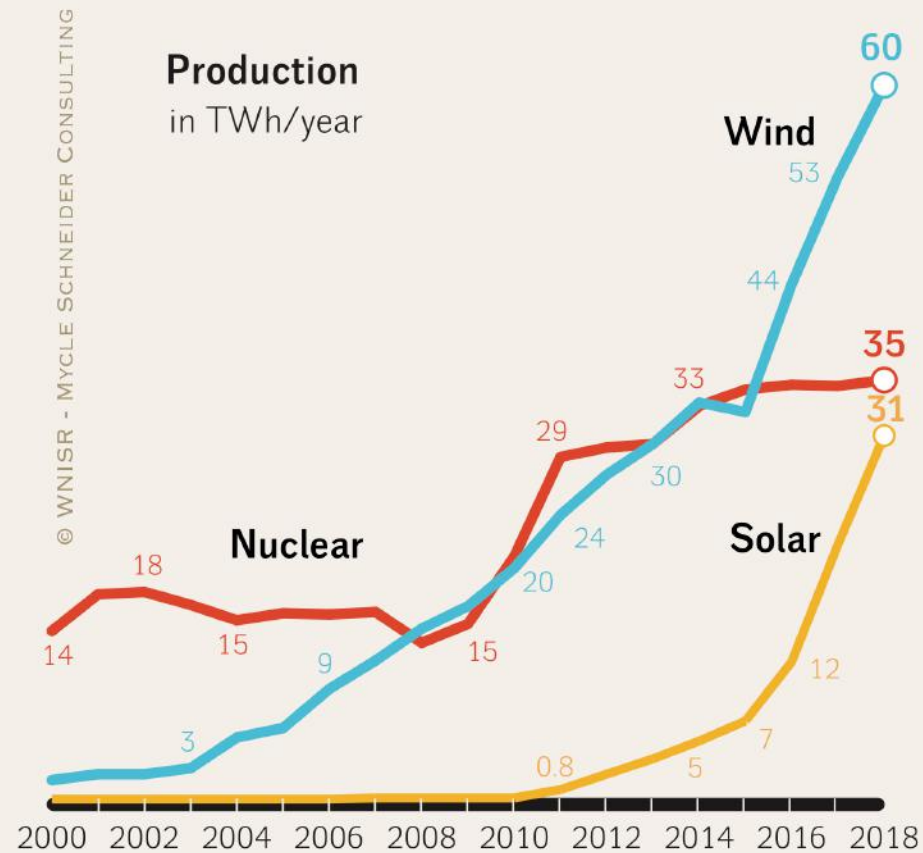
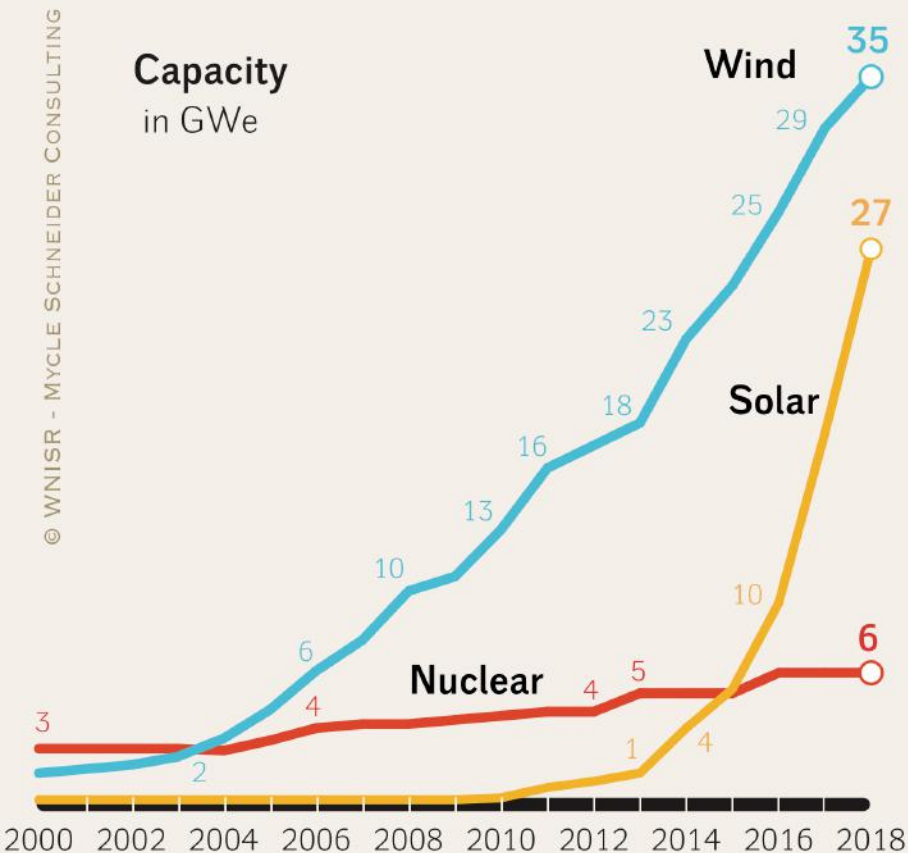
Startup and Closure of Electricity Generating Capacity in the EU in 2018

by Energy Source in GWe



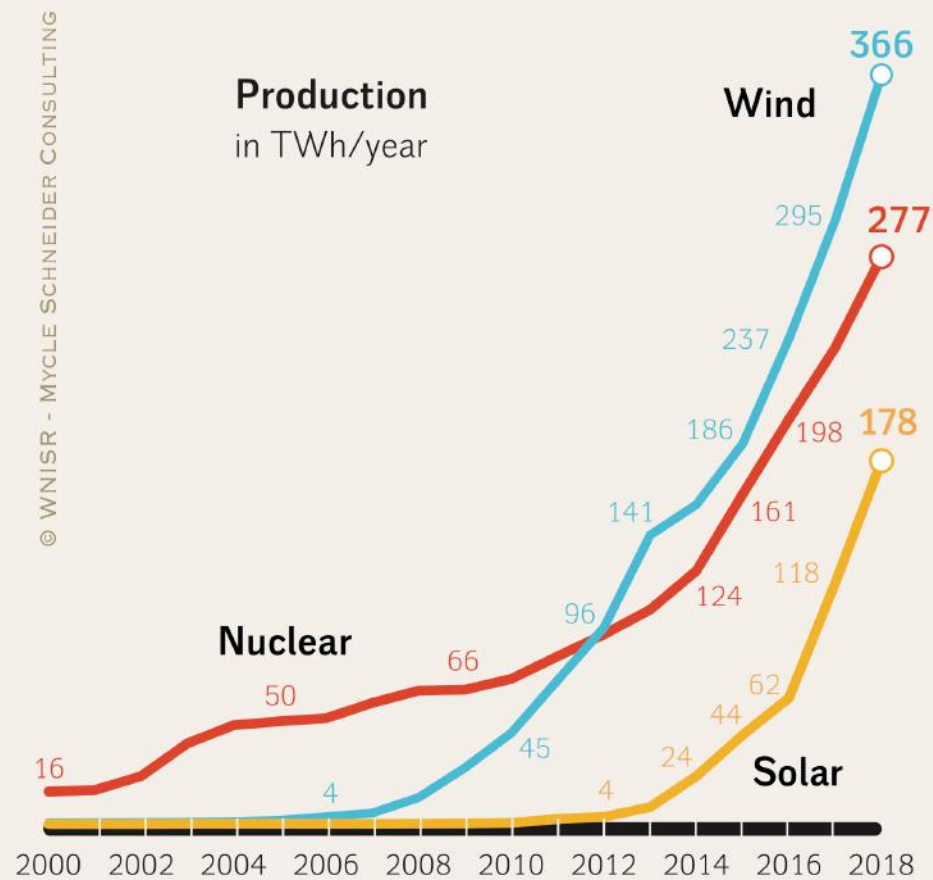
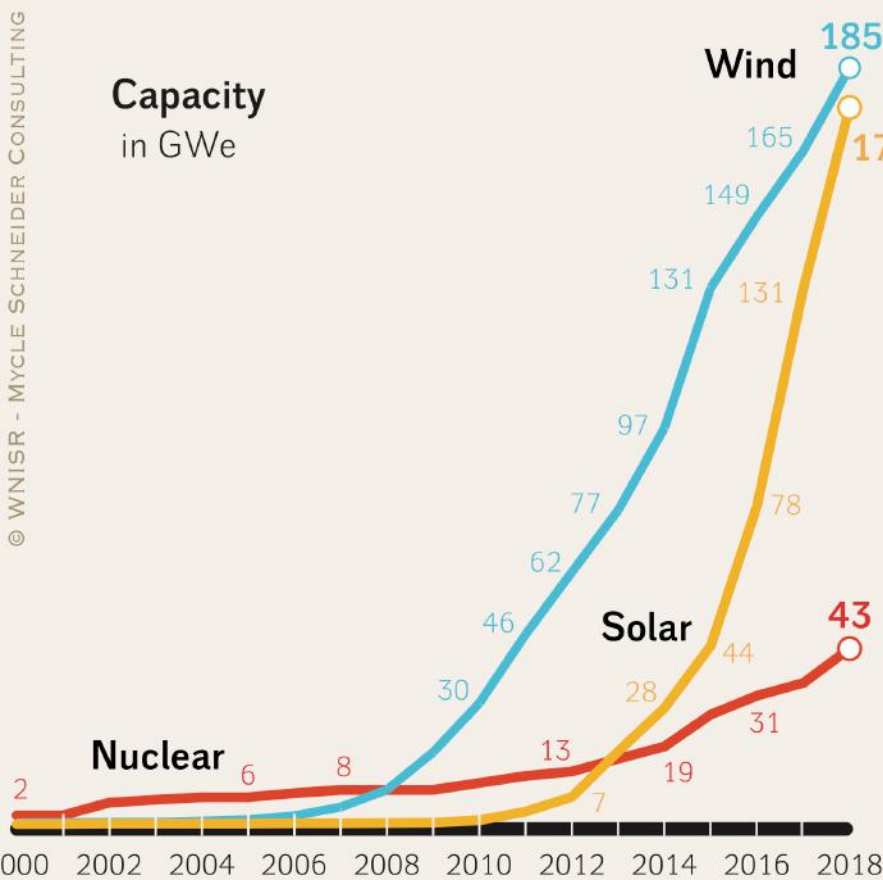
Sources: WindEurope, WNISR, 2019

Installed Wind, Solar and Nuclear Capacity and Production in India 2000-2018



Sources: WNISR, IAEA-PRIS, BP Statistical Review 2019

Installed Wind, Solar and Nuclear Capacity and Production in China 2000-2018



Sources: WNISR, IAEA-PRIS, BP Statistical Review 2019

- For the first time the average age of world nuclear fleet exceeds 30 years.

In 2018,

- nuclear power added 9 GW to the world's power grids to reach a record 370 GW, while renewables added a record 165 GW (wind and solar cumulate >1,000 GW total);
 - nuclear power generation increased by 2.4%, wind by 29%, solar by 13%;
 - nuclear construction down to a trickle with 5 starts vs. 15 in 2010 (1 so far in 2019);
 - 10 of 31 nuclear countries generate more power with renewables than with nuclear.
-
- Construction times average 10 years over the past decade.
 - The costs of new nuclear have *increased* by 23%, while solar costs *decreased* by 88% and wind by 69%.
-
- Fighting the climate emergency requires to invest into effective strategies combining *speed* and *competitive cost* to drastically reduce emissions. Nuclear power turns out not only the most expensive, but the slowest option to generate “low-carbon” electricity and to provide essential energy services.

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www.WorldNuclearReport.org

About the Author



Photo: ©Nina Schneider

Mycle Schneider works as independent international consultant on energy and nuclear policy. He is the initiator and Convening Lead Author of the [World Nuclear Industry Status Reports](#) and Founding Board Member and Spokesperson of the International Energy Advisory Council ([IEAC](#)). He is a member of the International Panel on Fissile Materials ([IPFM](#)), based at Princeton University, USA. In 2010-2011, he acted as Lead Consultant for the Asia Clean Energy Policy Exchange, implemented by [IRG](#), funded by [USAID](#), with the focus of developing a policy framework to boost energy efficiency and renewable energies. 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 15 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 more than 10 countries.

Mycle Schneider has provided information and consulting services to a large variety of clients including international institutions and organizations, think tanks and NGOs.

In 1997 he was honoured with the [Right Livelihood Award](#) ("Alternative Nobel Prize").

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