Turning point 2020: The transformation of the energy system and the role of nuclear in the light of rapid change

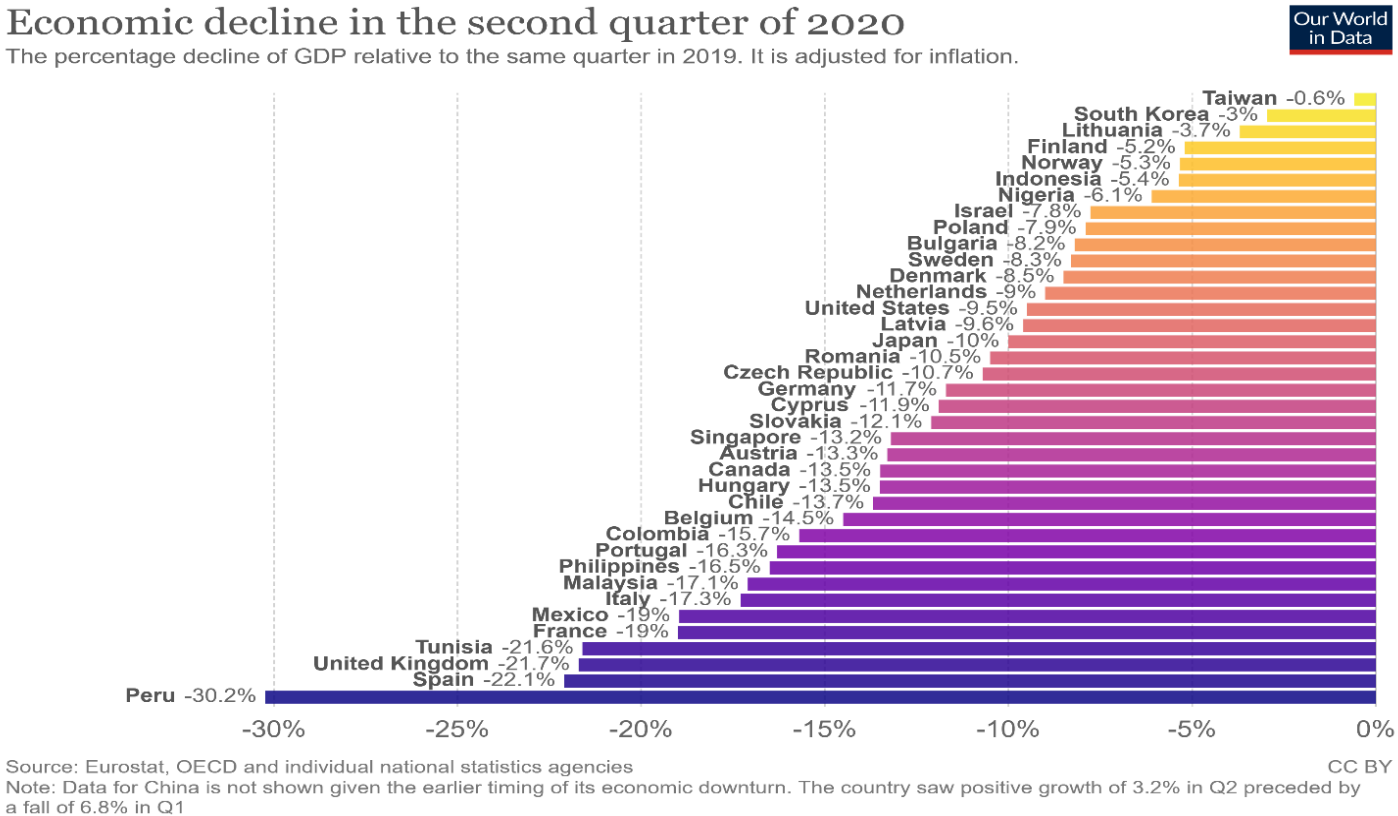
Georg Günsberg, 06 October 2020

Nuclear Power in a Time of Global Climate Change

Content & some sort of structure

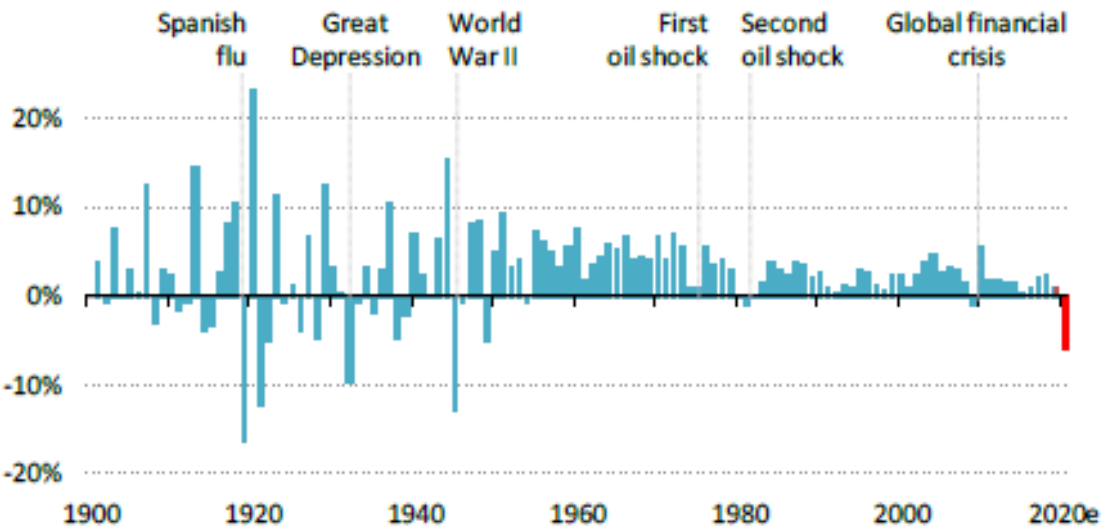
- A disruptive era: 2020 as a year of change.
- Dramatic shifts: COVID-19, climate and the energy system
- Anticipating future developments and possible risks
- Hopes and expectations: looking back at forecasts
- Is nuclear part of the problem or part of the solution? A look at key factors
- Green recovery and the role of climate finace
- Conclusion and some more food for discussion

The pandemic is a major challenge: for our health system, society and our economy.



…and for the energy system

Figure 1.2 ▷ Change in global primary energy demand, 1900 to 2020e

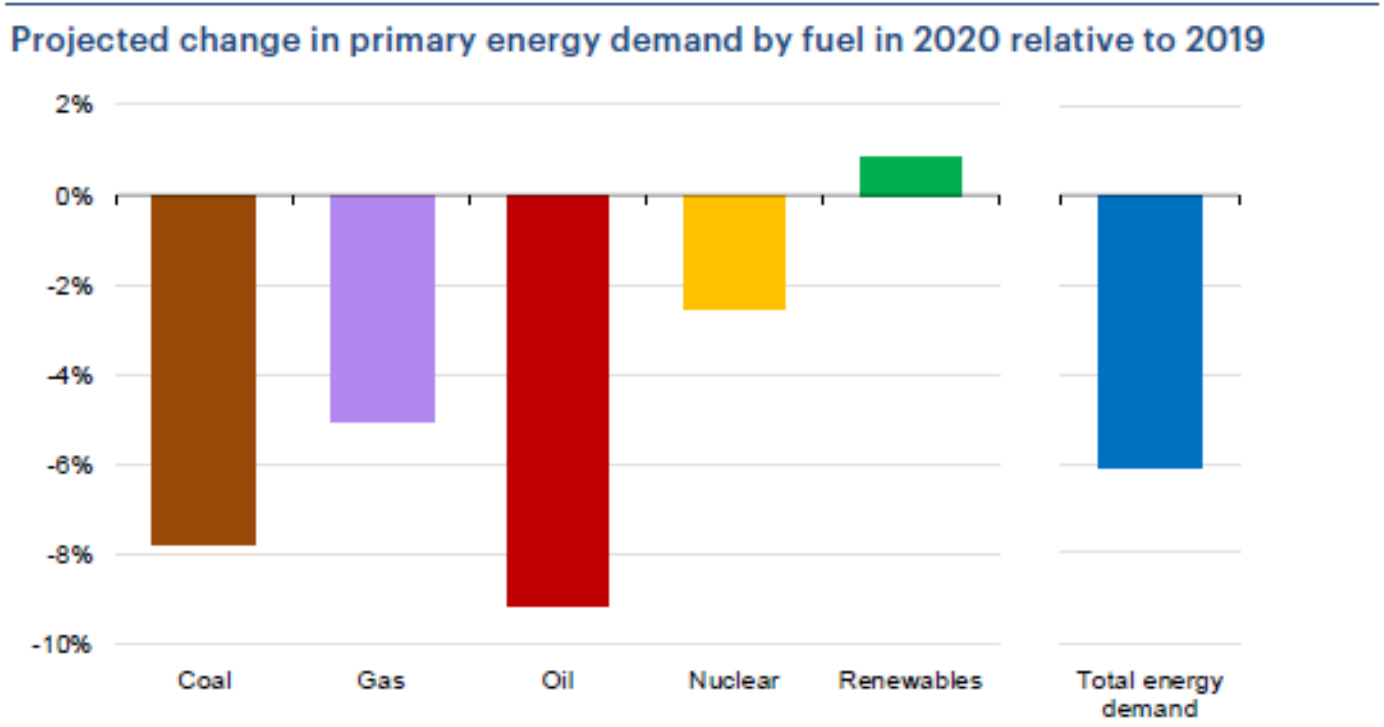


Total primary energy demand is set to drop by 6% in 2020, the largest relative decline in 70 years and the biggest ever decline in absolute terms.

Note: 2020e = estimated values for 2020.

Source: IEA (2020a).

Projected change by fuel in 2020 (provisional data)



2020: Impact on CO2-emissions

With an economic recovery tilted towards green stimulus and reductions in fossil fuel investments, it is possible to avoid future warming of 0.3 °C by 2050.

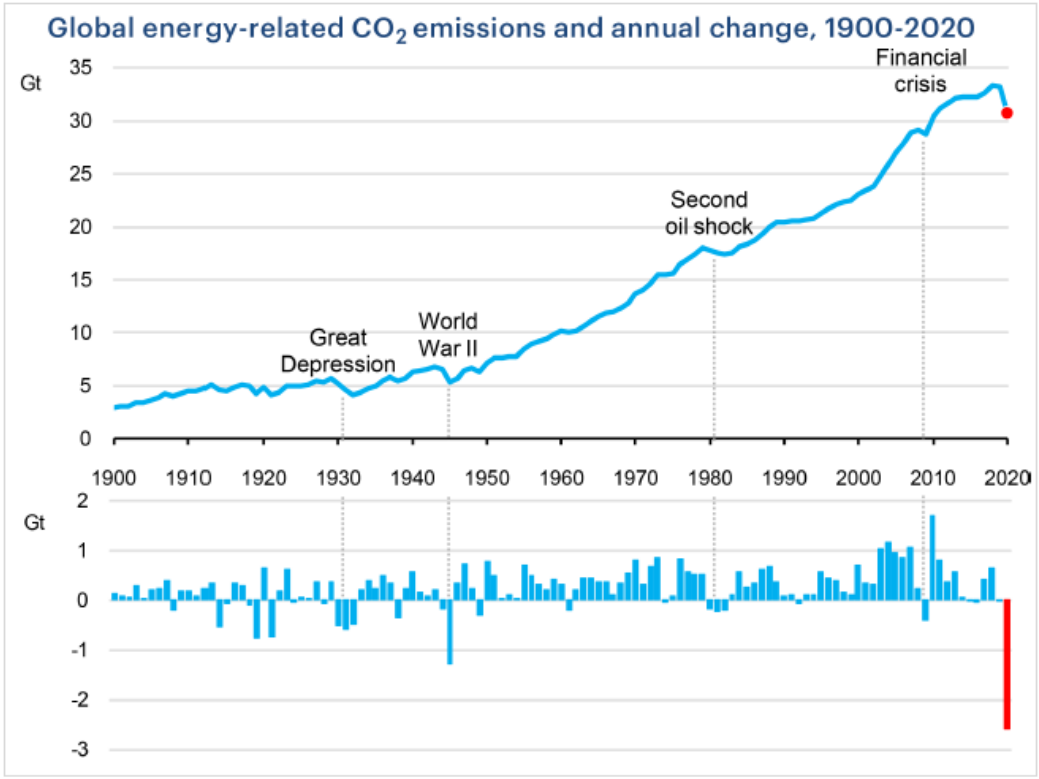
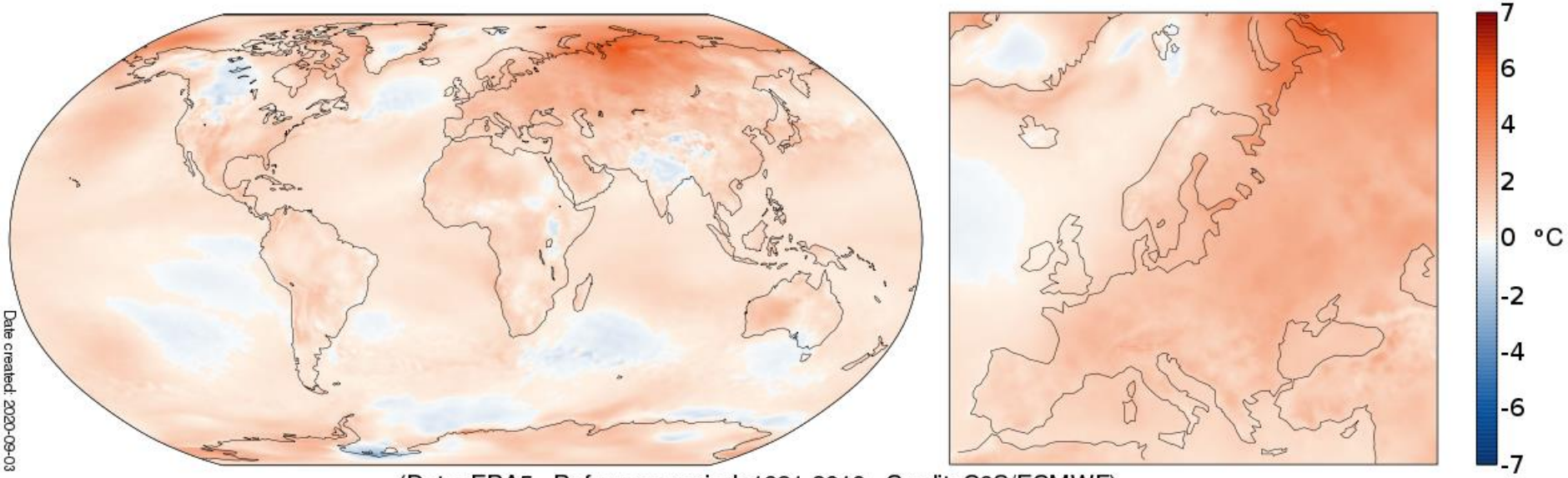


Figure 1: Global energy-related CO_2 emissions and annual changes, 1900-2020 (IEA, 2020a)

Source: New Climate Economy 2020

Climate change: the heat is on

Surface air temperature anomaly for September 2019 to August 2020



(Data: ERA5. Reference period: 1981-2010. Credit: C3S/ECMWF)

Copernicus
Europe's eyes on Earth

IMPLEMENTED BY ECMWF

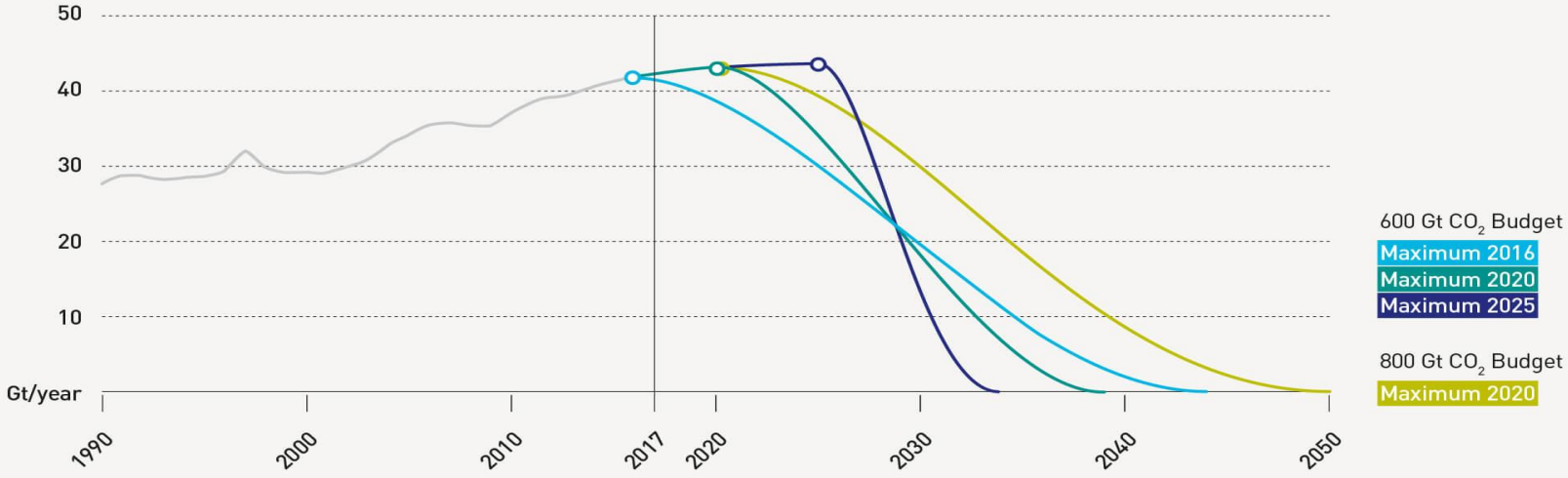
Climate Change Service

Turning point 2020: GHG emissons have to peak

The later greenhouse gas emissions are reduced, the faster they need to drop

Global CO_2 emission scenarios to comply with the 1.5°C and 2°C temperature limit

Faktencheck Energiewende 2017/2018



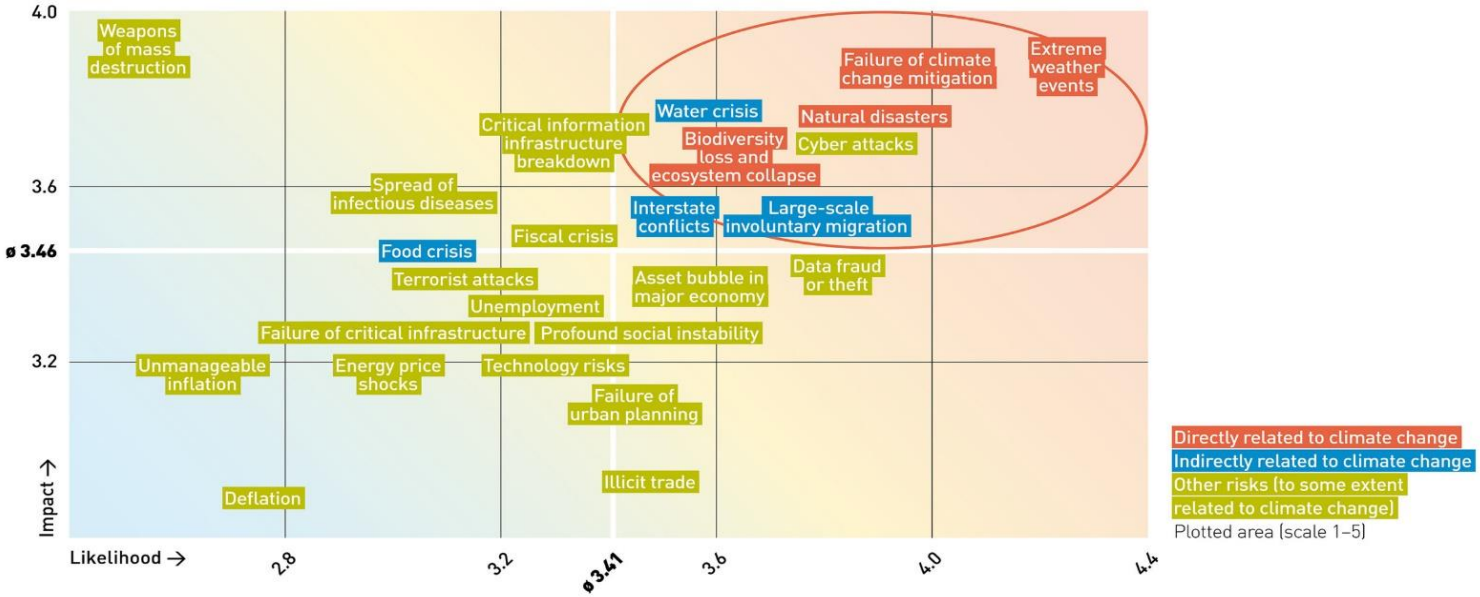
Source: Factcheck Energiewende 2017

Looking back at risk assessments: a pandemic was not seen as likely.

Fact check
Green Finance

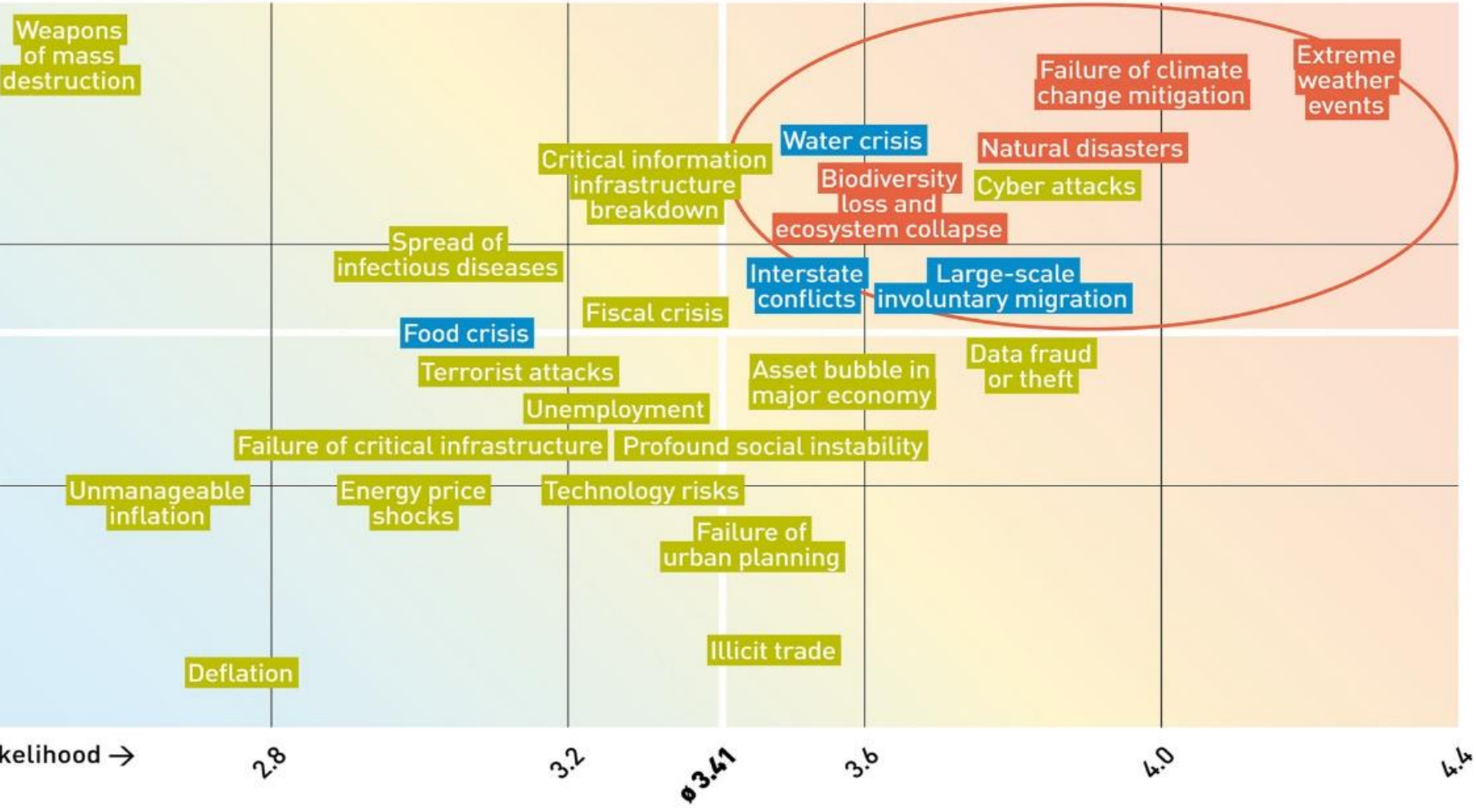
According to decision-makers climate-related risks are seen as gravest threats

Assessment of impact and likelihood of different global risks



klima+ energie fonds

Based on grapic source and data from World Economic Forum 2019


Weapons of mass destruction
Failure of climate change mitigation
Extreme weather events
Water crisis
Natural disasters
Critical information infrastructure breakdown
Biodiversity loss and ecosystem collapse
Cyber attacks
Spread of infectious diseases
Interstate conflicts
Large-scale involuntary migration
Fiscal crisis
Food crisis
Data fraud or theft
Terrorist attacks
Asset bubble in major economy
Unemployment
Failure of critical infrastructure
Profound social instability
Unmanageable inflation
Energy price shocks
Technology risks
Failure of urban planning
Illicit trade
Deflation
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2.8
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Directl
Indirec
Other
related
Plotted

Based

Energy markets in transition: technology – structure - culture

- **Disruption**: breakthrough technologies, innovation and dramatic costs reduction (PV, EV) will change many industries on global scale. Sector coupling, storage, hydrogen. Do conventional energy scenarios reflect the transformation process in a sufficient way?
- **Decarbonisation**: will become a key element for all industries. Electrification (see sector coupling) will be one aspect.
- **Decentralisation**: An energy system based on renewable energy will be more decentralised, requires more flexibility and demand-side management. Current instruments (and institutions) and rules are based on the old, conventional system.
- **Digitalisation and flexibility**: is a key driver for the transformation and creates new business models.
- **Democratization & transparency**: Civil society will play a key element in the transformation. Community power/energy initiatives.
- **Divest-Invest:** finance markets have sent a signal. But policies have to deliver on instruments (carbon tax) and measures. Sustainability will play a role

Will the pandemic: Covid-19 and political decision making

- Economic and employment crisis: recovery and (climate) investment programs in focus
  - EU level
  - National level
- Resilience:
  - Independence (critical infrastructure, basic needs)
  - Supply chain weakness
  - Flexibility; ability to react? (disruption)
  - Social net
- Change of values?
  - Priorities: what is important?
  - Social norms (transport, video conferences)
  - Risk assessment and crisis management: will prevention get more attention?

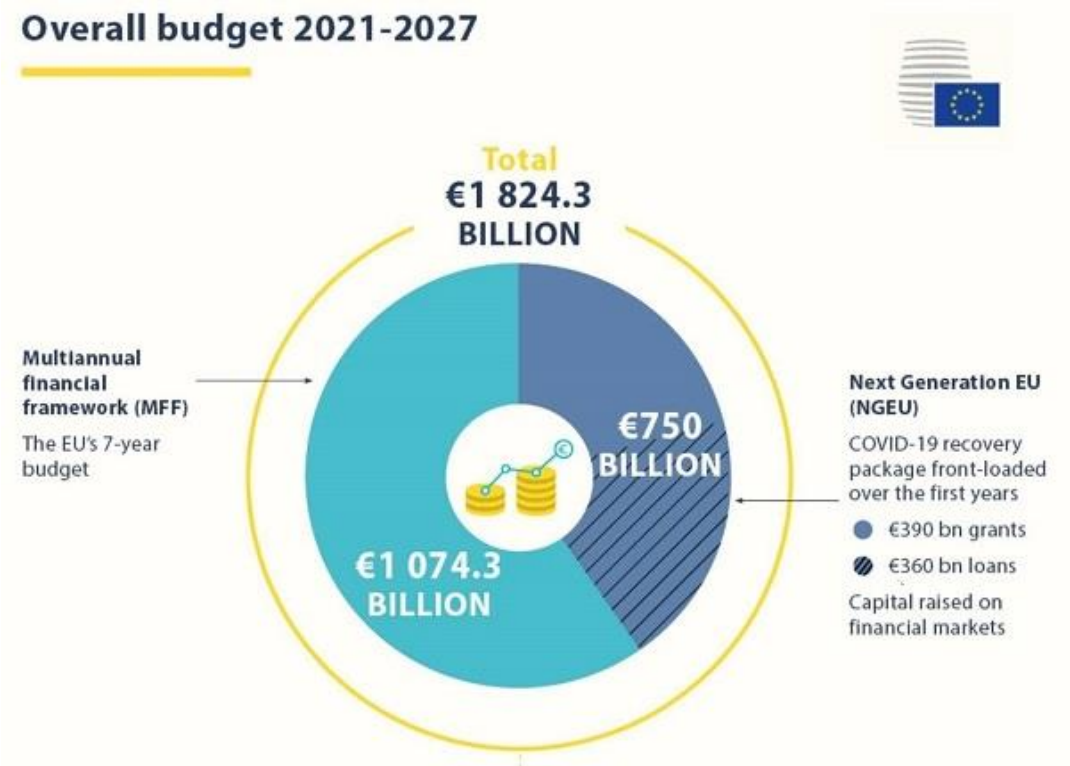
Possible key aspects for decision making in/after Covid-19

- Does a measure/an investment have a positive effect on the economy?
- Does a measure/an investment create regional/local jobs?
- Is it a good investment in terms of profitability?
- Is the measure/investment cost-effective?

Possible key aspects for decision making in/after Covid-19

- Does is make a country/region/society more resilient? (supply chain/globalization)
- Does it contribute to climate change and/or the reduction of GHG emissions?
- Are there any lock-in effects? (carbon & depencency)
- Does the measure/investment create risks (physical risks, financial risks, economic risks) and how do we assess these risks?
- Are there other environmental or social risks?

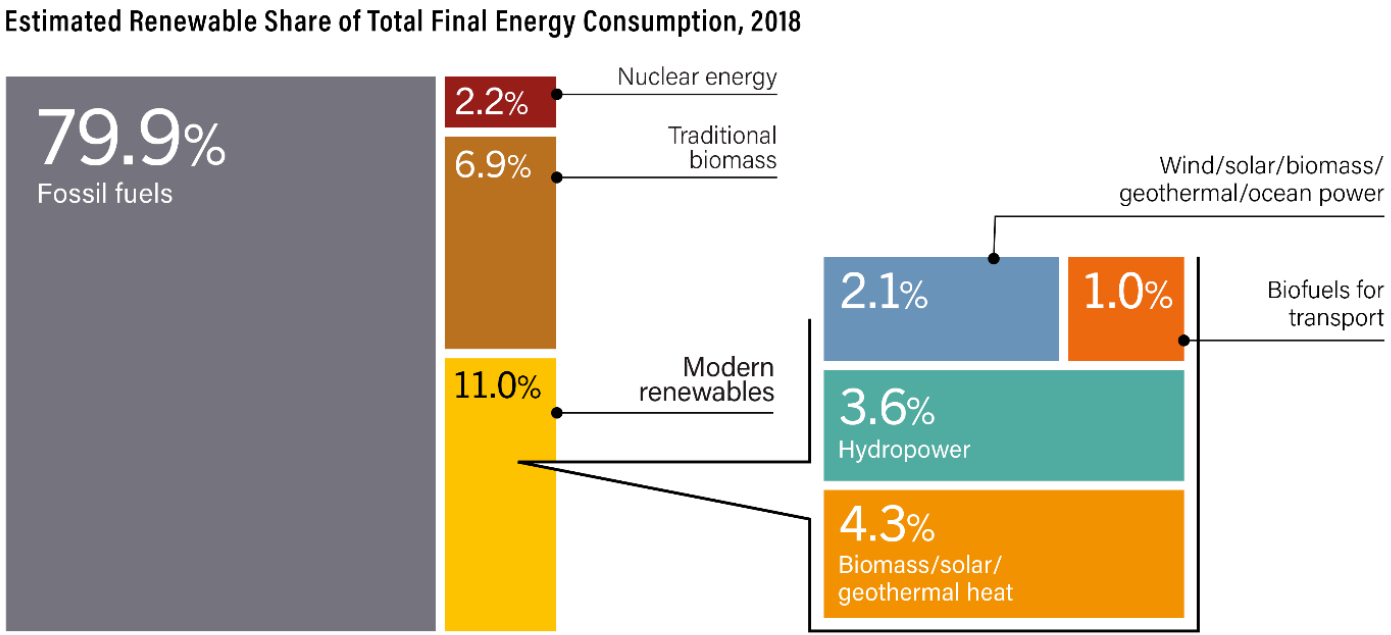
EU program: Next generation EU



Recovery programs (example Austria)

- The Austrian government just recently has started a green recovery program with a specific focus on climate protection and environment.
- Additional budget of 2-billion Euro for the next two years, dedicated to climate friendly investments
- E.g. 750 million fresh money for thermal renovation switch from fossil fuel heating boilers to renewable heating systems (creates/secures 40.000 jobs)
- Additionally 250 mio € in renewable energy for 2020-2022 and addition budget 300 million € for innovative technologies.
- Increased investments for public transport infrastructure and a better public transport offer.
- Investment premium
  - 7% premium for all investments of businesses (ranging vom 5k to 50 mio €) 14% premium for investments in environmental measures (renewable energy, waste management, biodiversity). Exclusion of climate damaging investments.
  - Application for more than1 billion € in less than 3 week, more than one third for explicit environmental measures

What role can nuclear energy play?

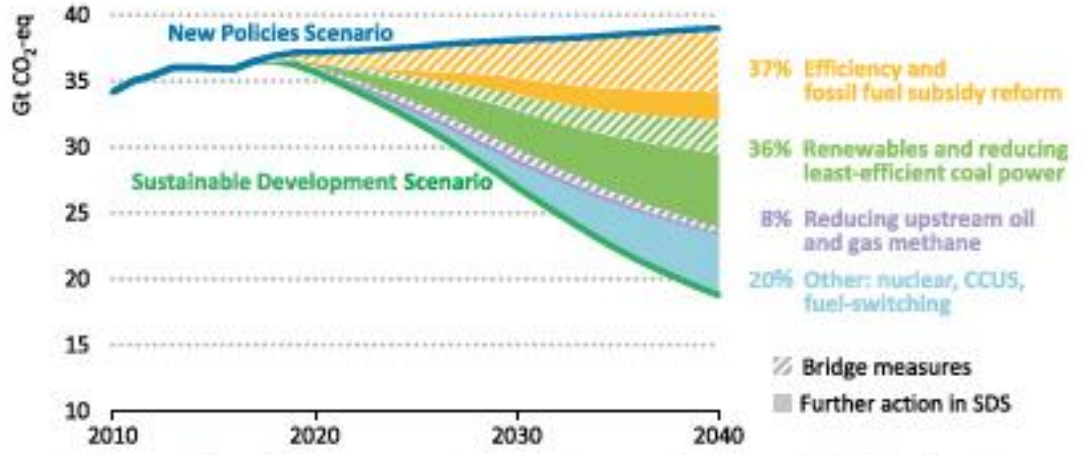


Note: Data should not be compared with previous years because of revisions due to improved or adjusted data or methodology. Totals may not add up due to rounding.

Source: Based on IEA data.

Different pathways for decarbonisation

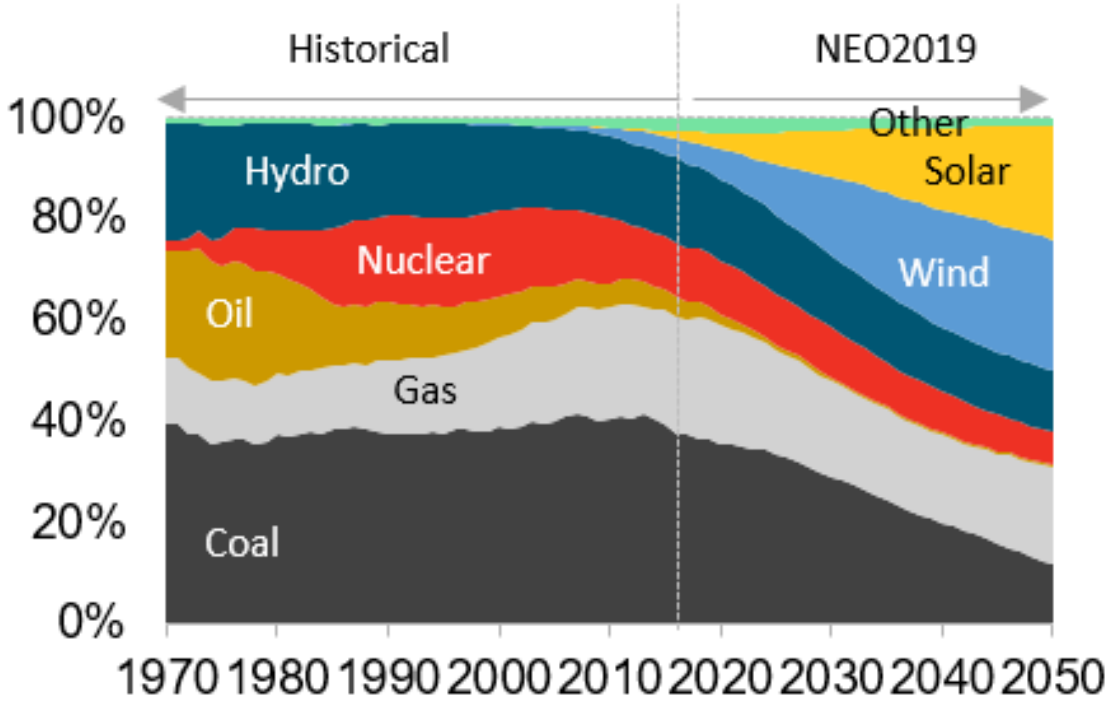
Figure 2.16 ▷ CO_2 and methane emissions reductions by measure in the Sustainable Development Scenario relative to the New Policies Scenario



Notes: Gt CO_2-eq = gigatonnes of CO_2 equivalent; CCUS = Carbon, Capture, Utilisation and Storage; SDS = Sustainable Development Scenario; 100-year global warming potential of methane = 30.

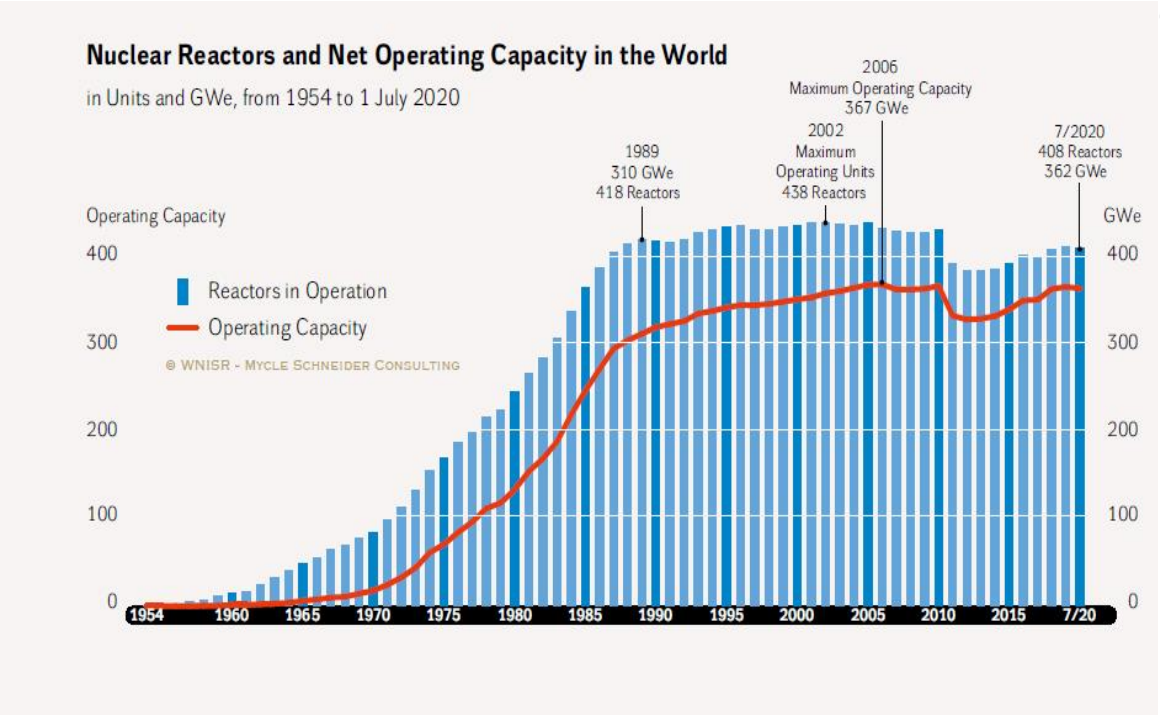
IEA World Energy Outlook 2018

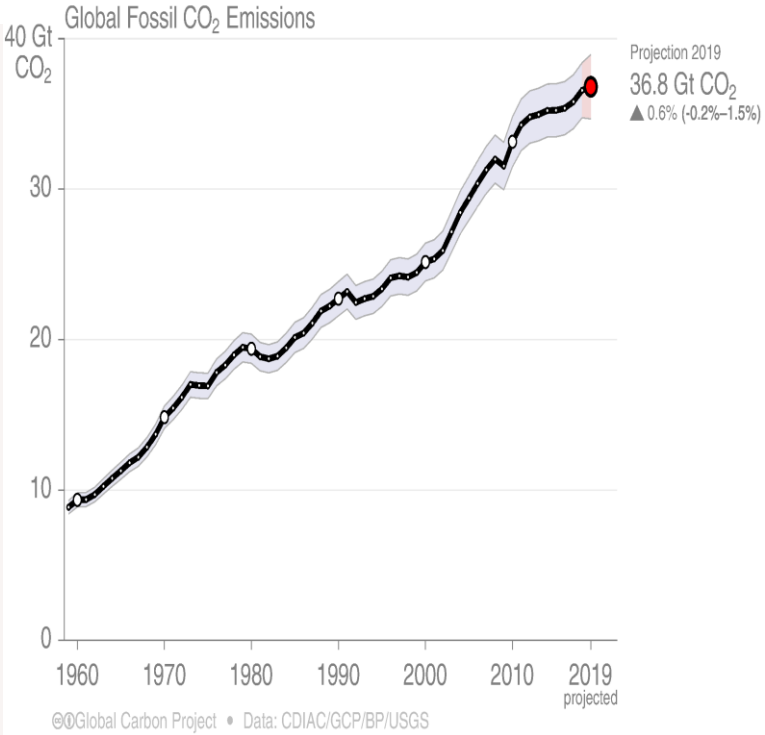
Bloomberg New Energy Finance 2019



Bloomberg New Energy Outlook 2019

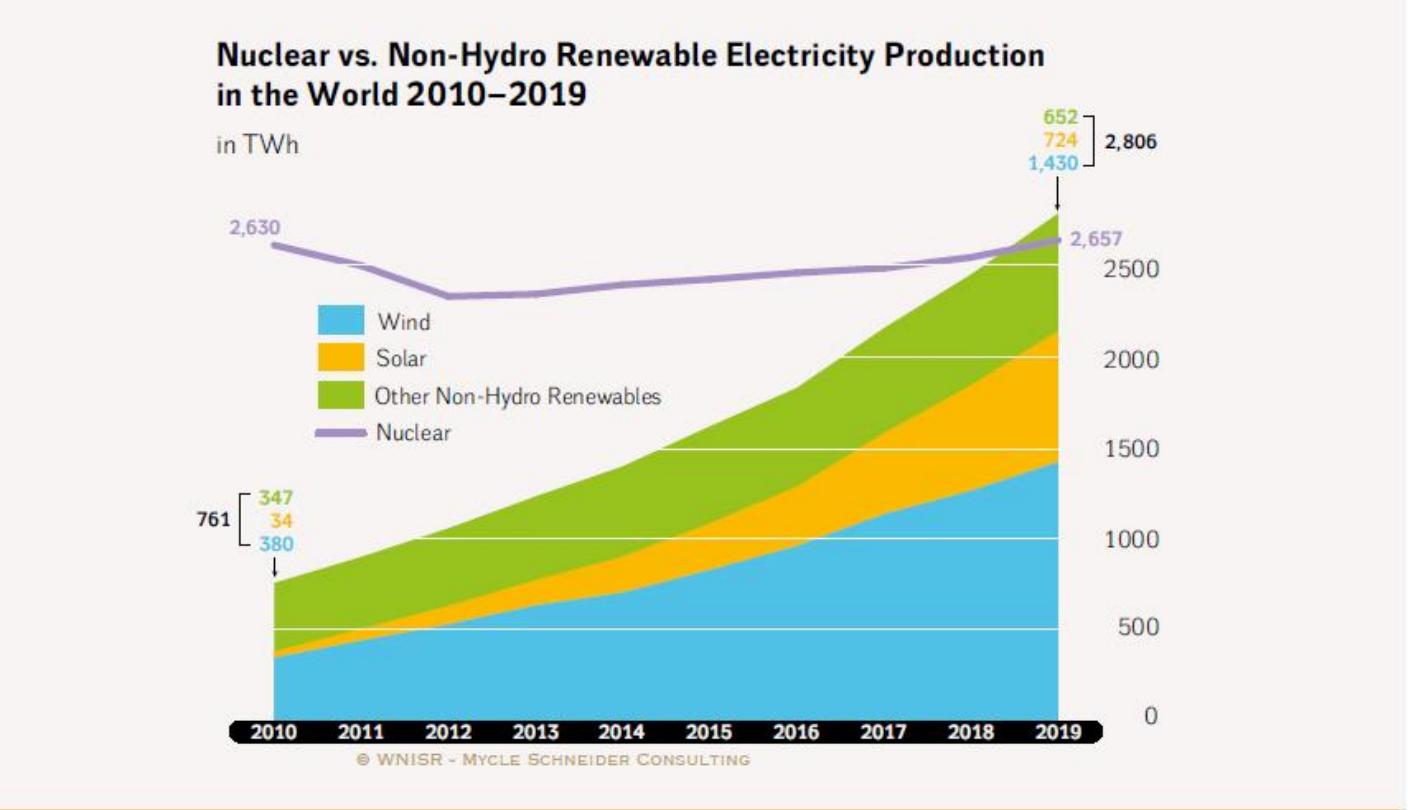
CO2-emissions rising during nuclear energy era





Mycle Schneider et al: World Nuclear Status Report 2020; Global Carbon Project 2019

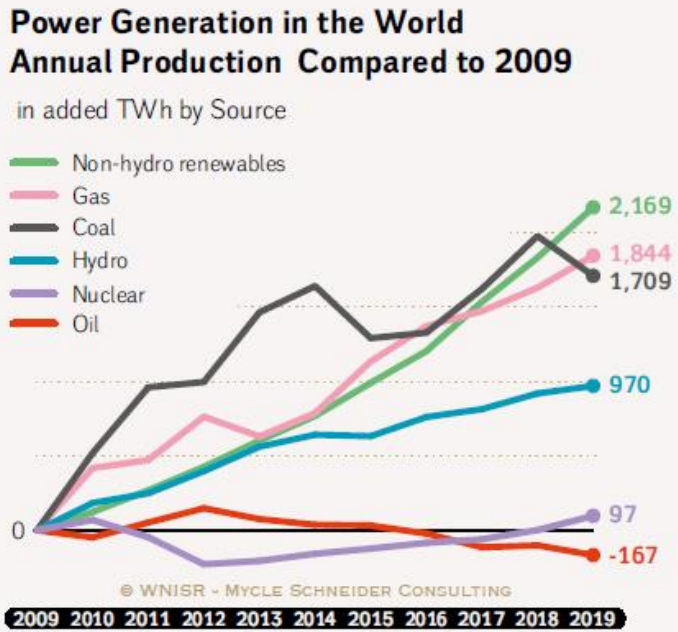
Dramatic shift in the last ten years



World Nuclear Industry Status Report 2020, Mycle Schneider Counsulting

Sources: BP Statistical Review and IAEA-PRIS, 2020

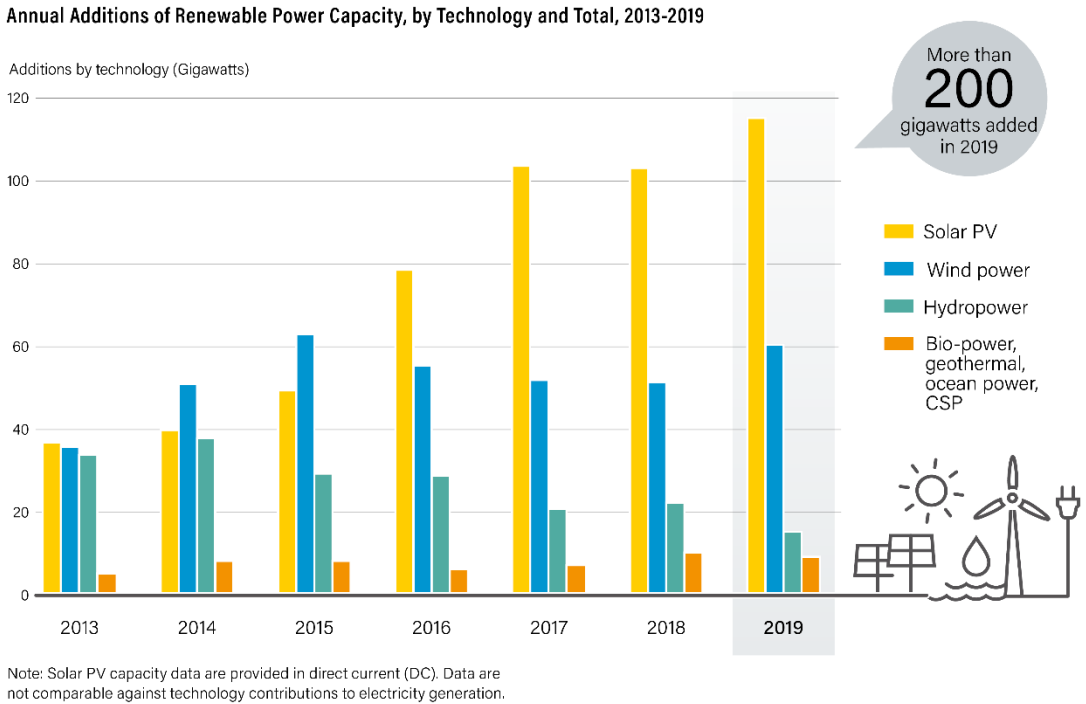
And compared to other sources



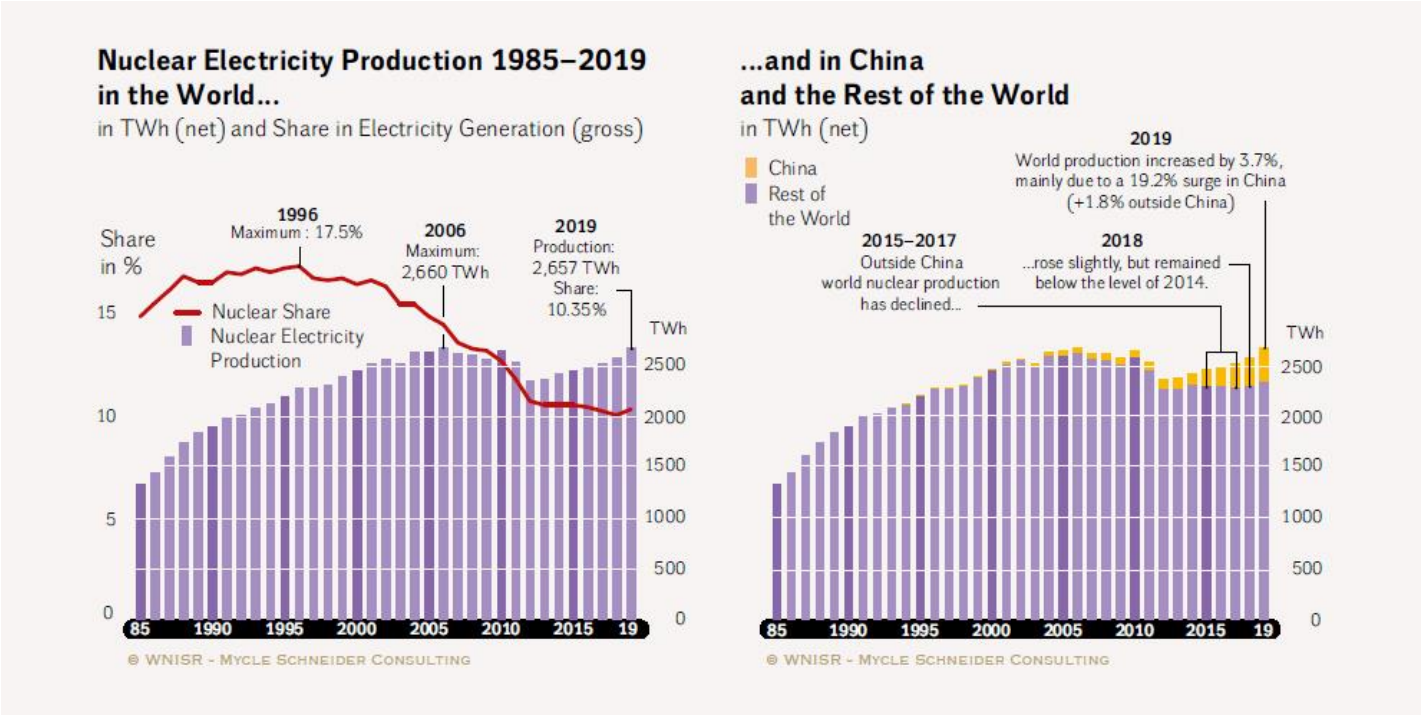
World Nuclear Industry Status Report 2020, Mycle Schneider Counsulting

Source: BP Statistical Review, 2020

Solar PV has taken the lead

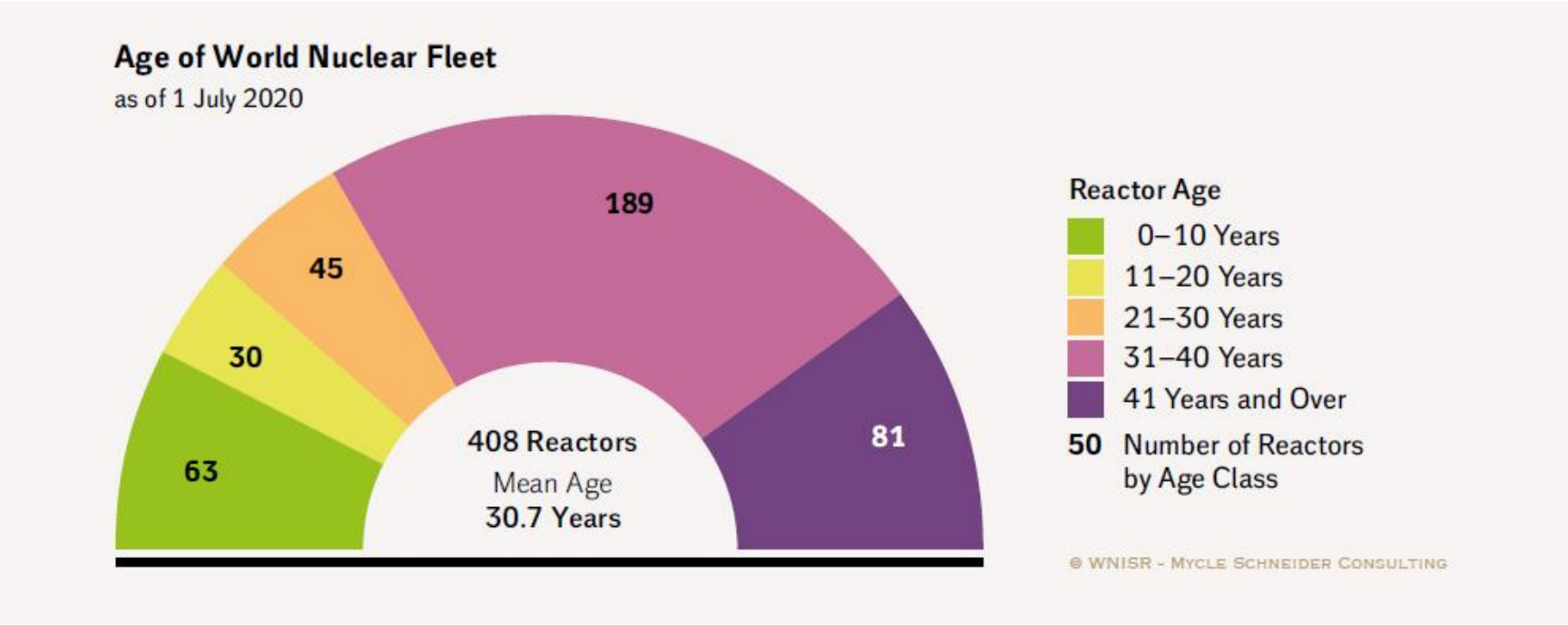


Have we already seen „peak nuclear“?



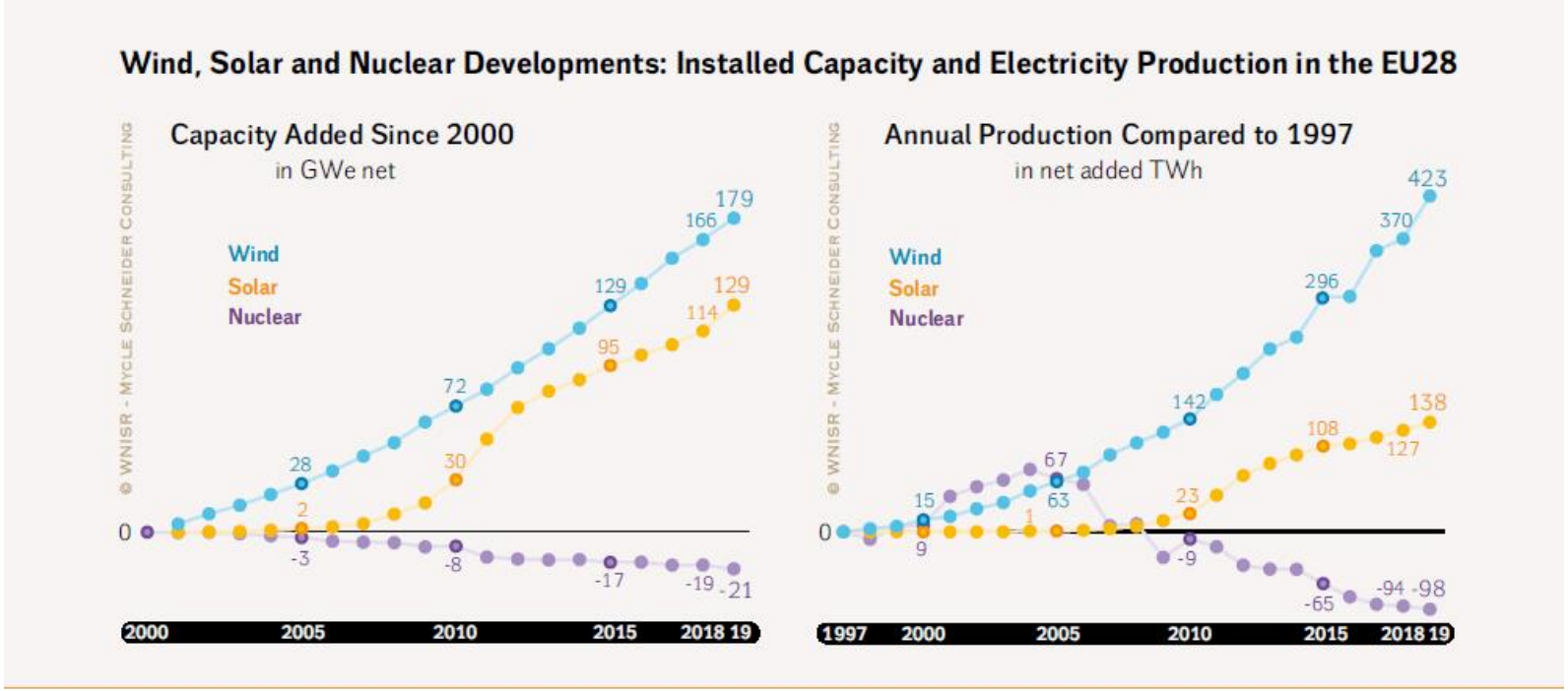
World Nuclear Industry Status Report 2020, Mycle Schneider Counsulting

…looks like



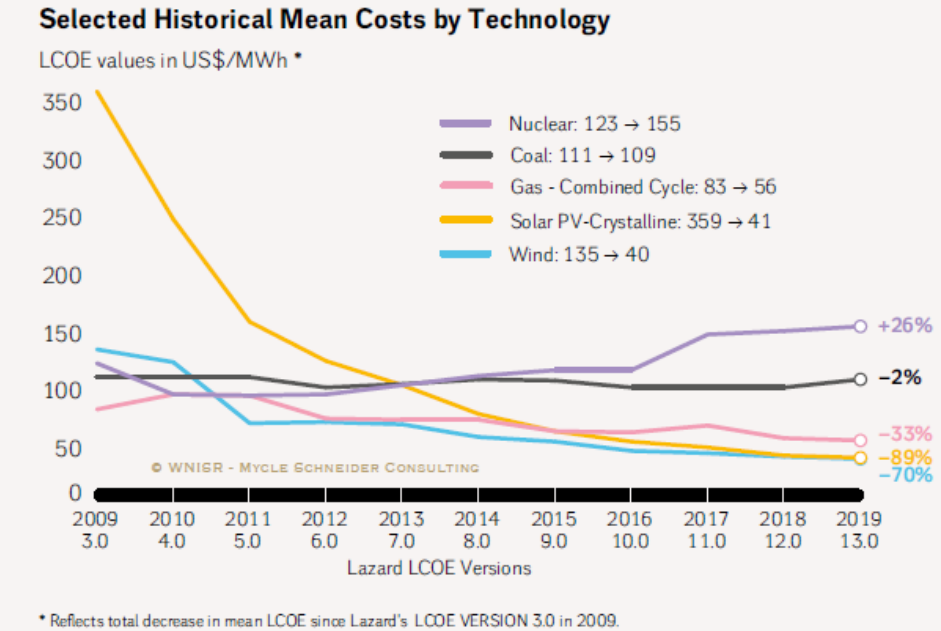
World Nuclear Industry Status Report 2020, Mycle Schneider Counsulting

A shift to RES in the EU



World Nuclear Industry Status Report 2020, Mycle Schneider Counsulting

Costs (chart will be replacey by english language chart)



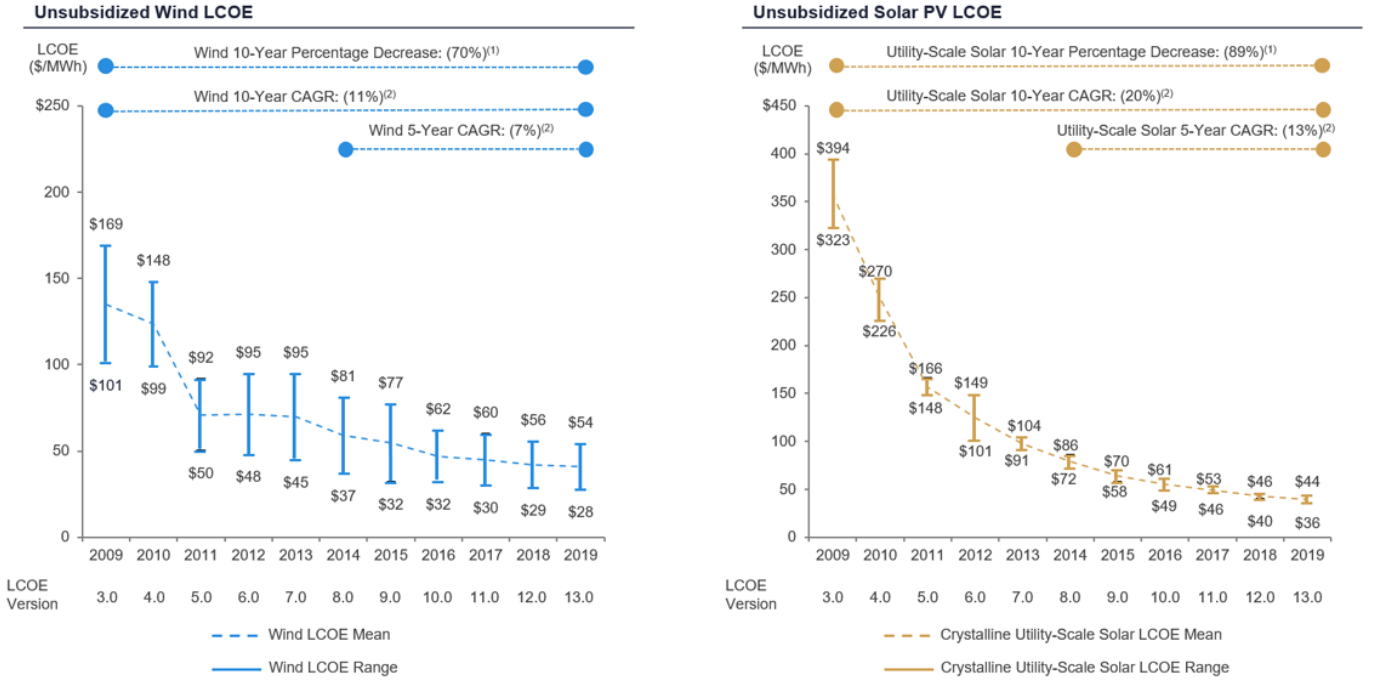
In economic terms renewables continue to pull away from nuclear power, over the past decade the cost estimates for utility-scale solar dropped by 89 percent, wind by 70 percent, while nuclear increased by 26 percent

World Nuclear Industry Status Report 2020, Mycle Schneider Counsulting

Massive decline of costs for solar pv and wind

Levelized Cost of Energy Comparison—Historical Renewable Energy LCOE Declines

In light of material declines in the pricing of system components and improvements in efficiency, among other factors, wind and utility-scale solar PV have exhibited dramatic LCOE declines; however, as these industries mature, the rates of decline have diminished



Source: Lazard estimates.

(1) Represents the average percentage decrease of the high end and low end of the LCOE range.

(2) Represents the average compounded annual rate of decline of the high end and low end of the LCOE range.

Opportunity costs: avoiding most carbon at least cost as fast as possible

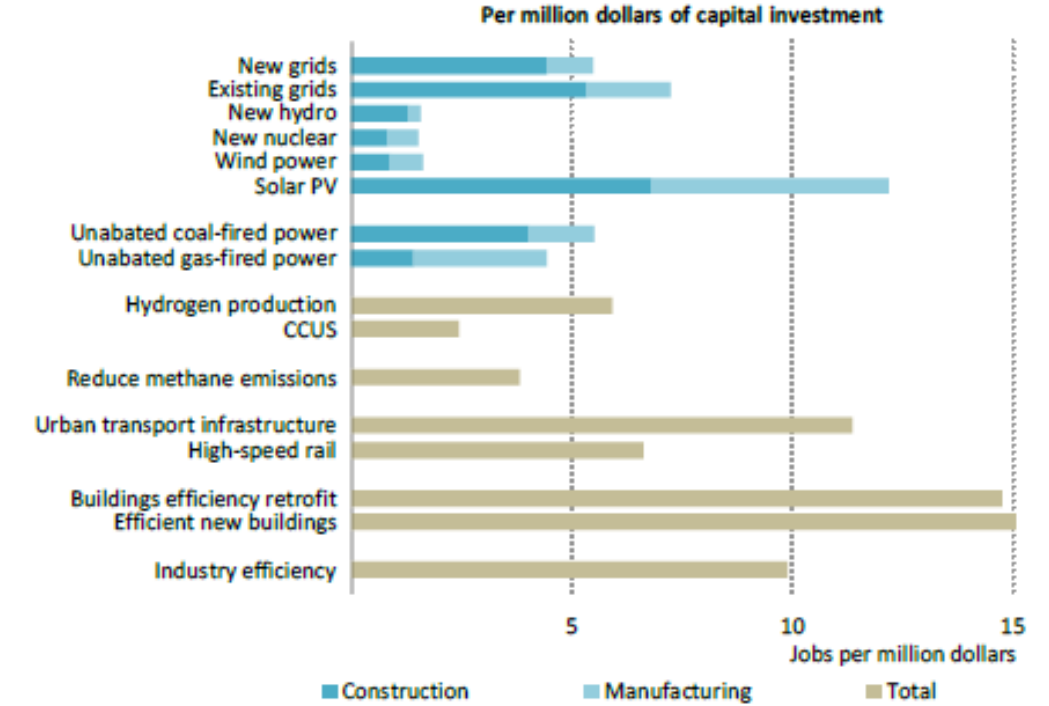
- Thinking in budgets not only target years (2020 is a good example)
- Three pillars: carbon reduction, cost, and time (Lovins et al)
- Costly or slow options will avoid less carbon per € or per year than cheaper or faster options could have done
- Nuclear and fossil-fueled generation compete with other options: renewables, efficiency, services

Climate change putting more stress in the system, also for nuclear energy

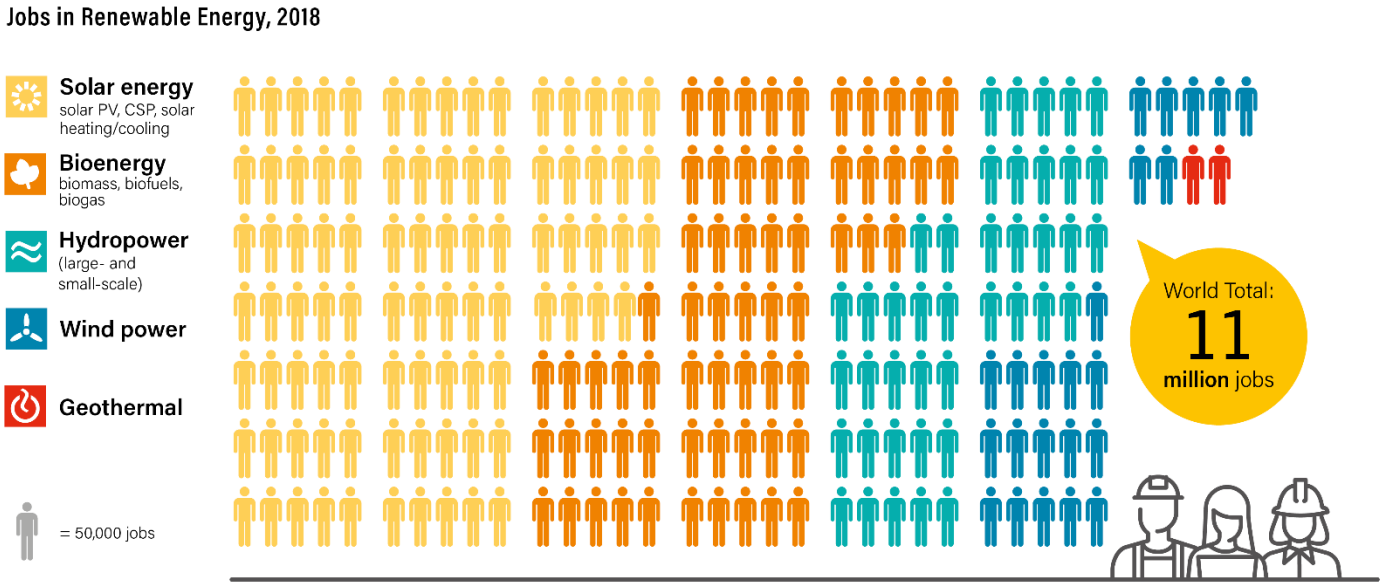
- Climate change poses physical risks the nuclear fleet (e.b. Moody's Investors for the US)
- 2019 Bloomberg review 54 of us facilities weren't designed to handle the flood risk they now face.
- Heat stress, water stress, hurricanes, flooding, and rising sea levels
- Not reflected in scenarios
- France 2019: outages

Job perspective

Figure 2.1 ▷ Construction and manufacturing jobs created per million dollars of capital investment and spending by measure

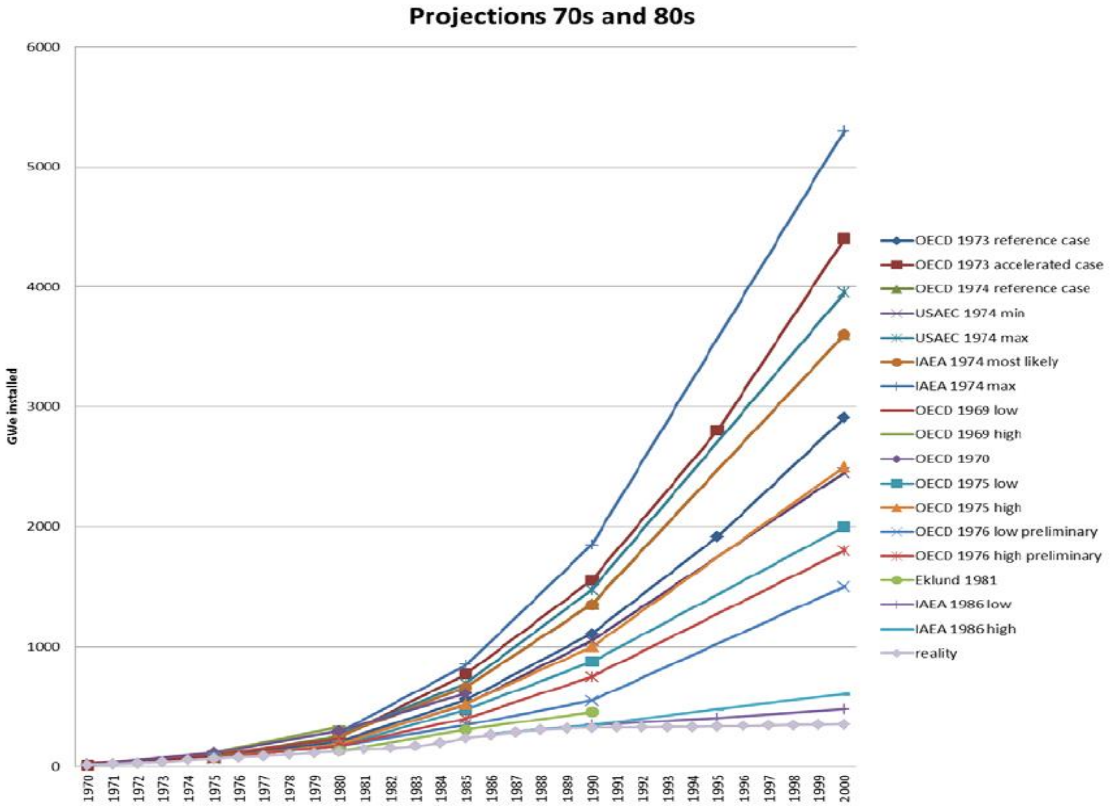


Creating jobs will be a key factor for public investment decisions



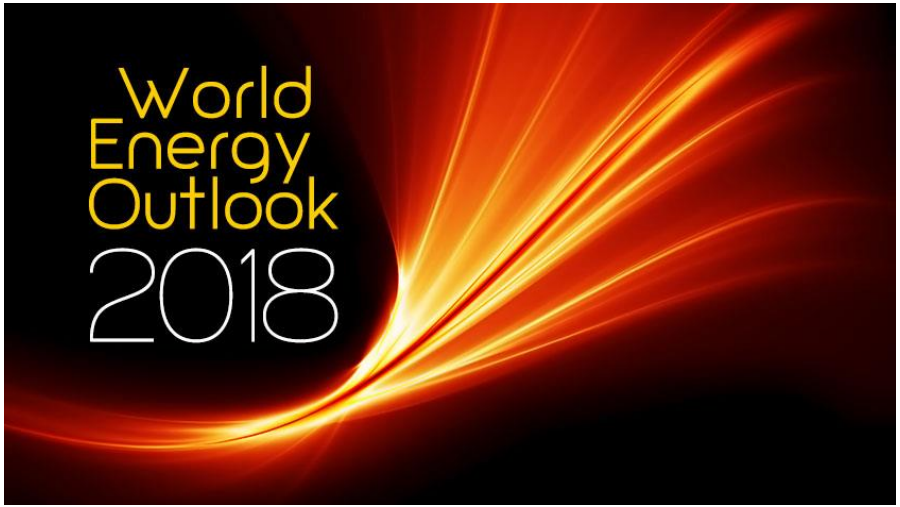
Source: IRENA.

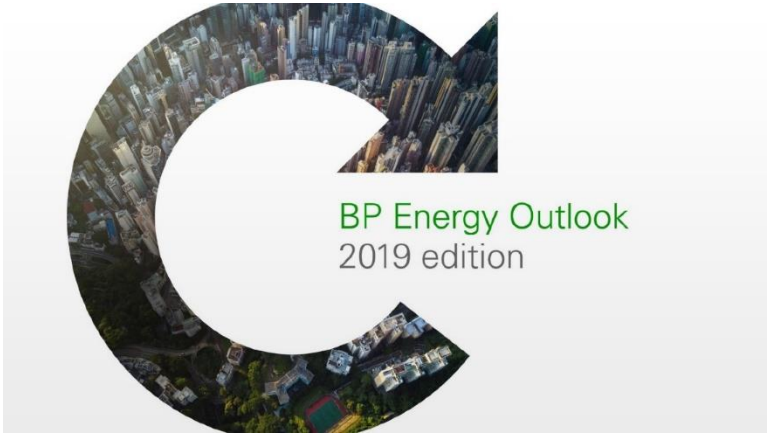
Earlier projections creating (wrong) expectations



Klaus Gufler, “Short and Mid-term Trends of the Development of Nuclear Energy”, 2013

The role of scenarios (forecasts?)





Nuclear:
Declining development vs. projected increase in IEA WEO in TWh

Data from IEA World Energy Outlook, reference scenario/NPS, editions 2010, 2011, 2012, 2013, 2014, 2016, 2017, 2018

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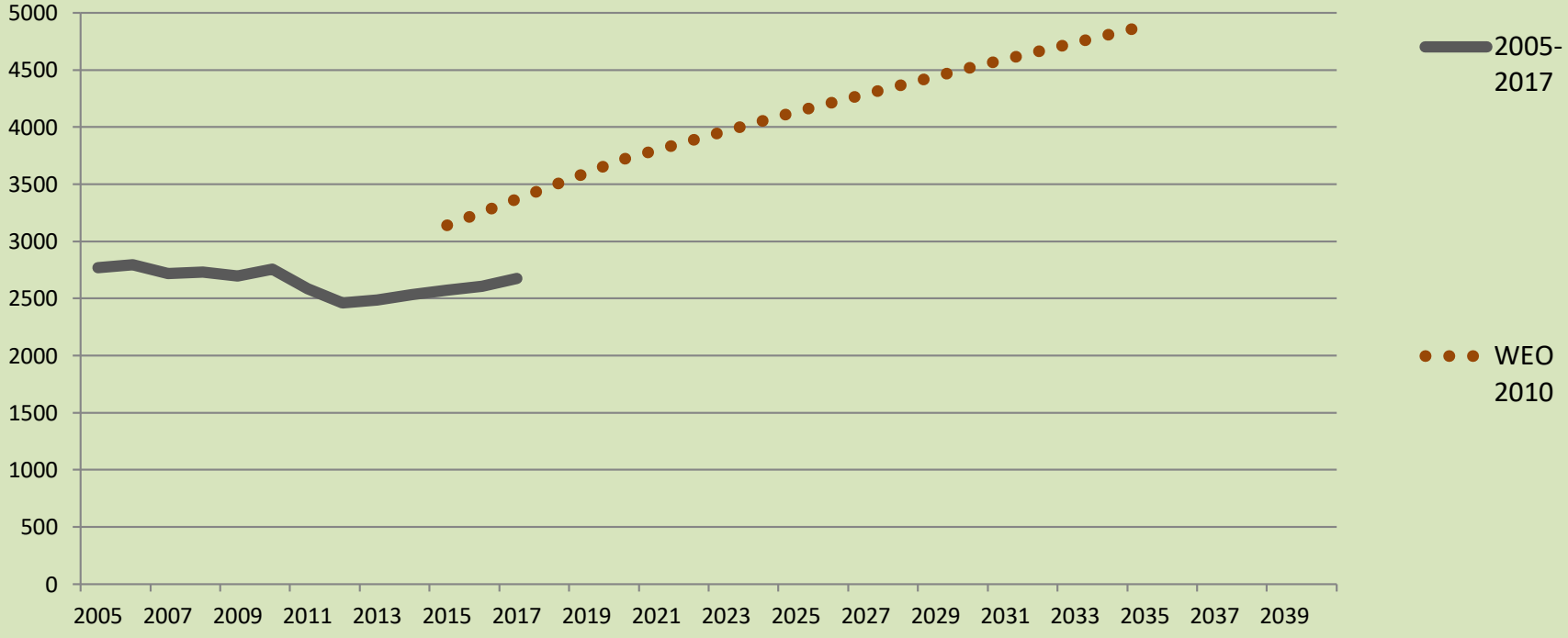

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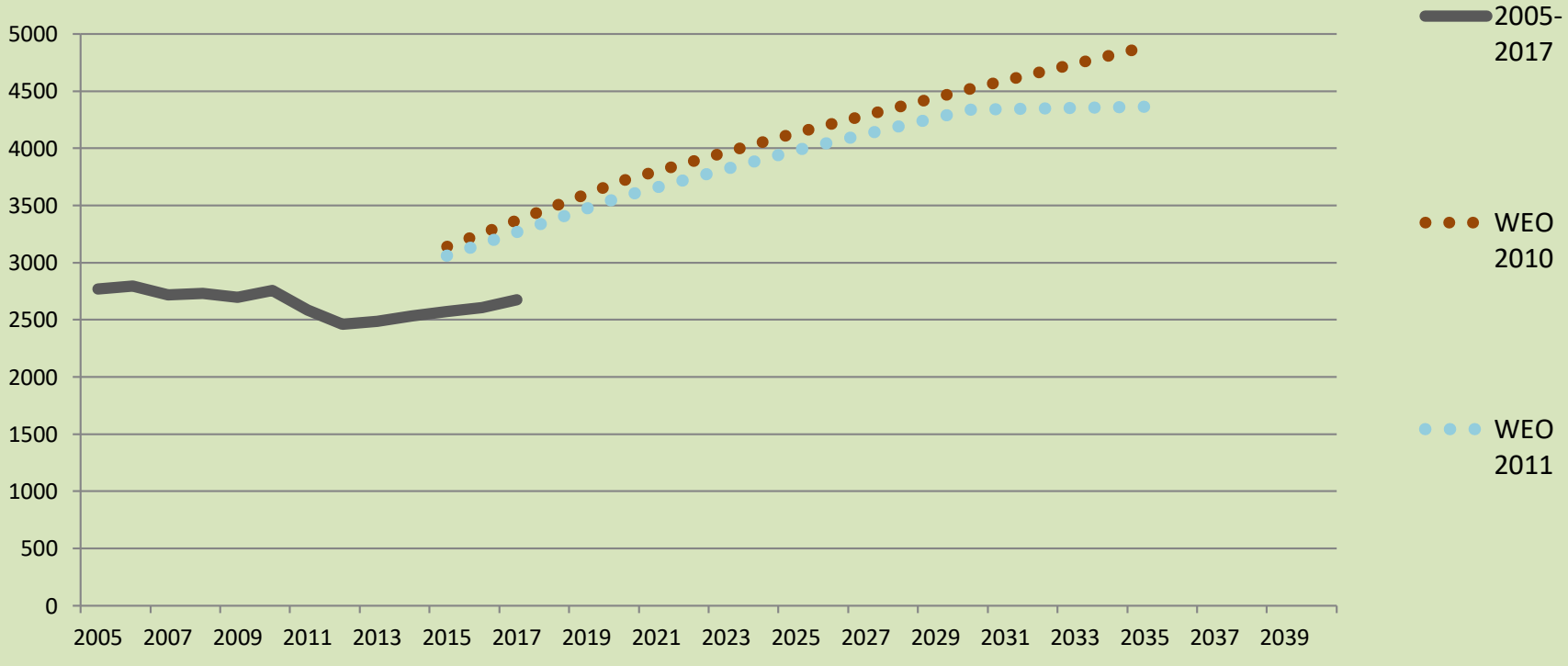

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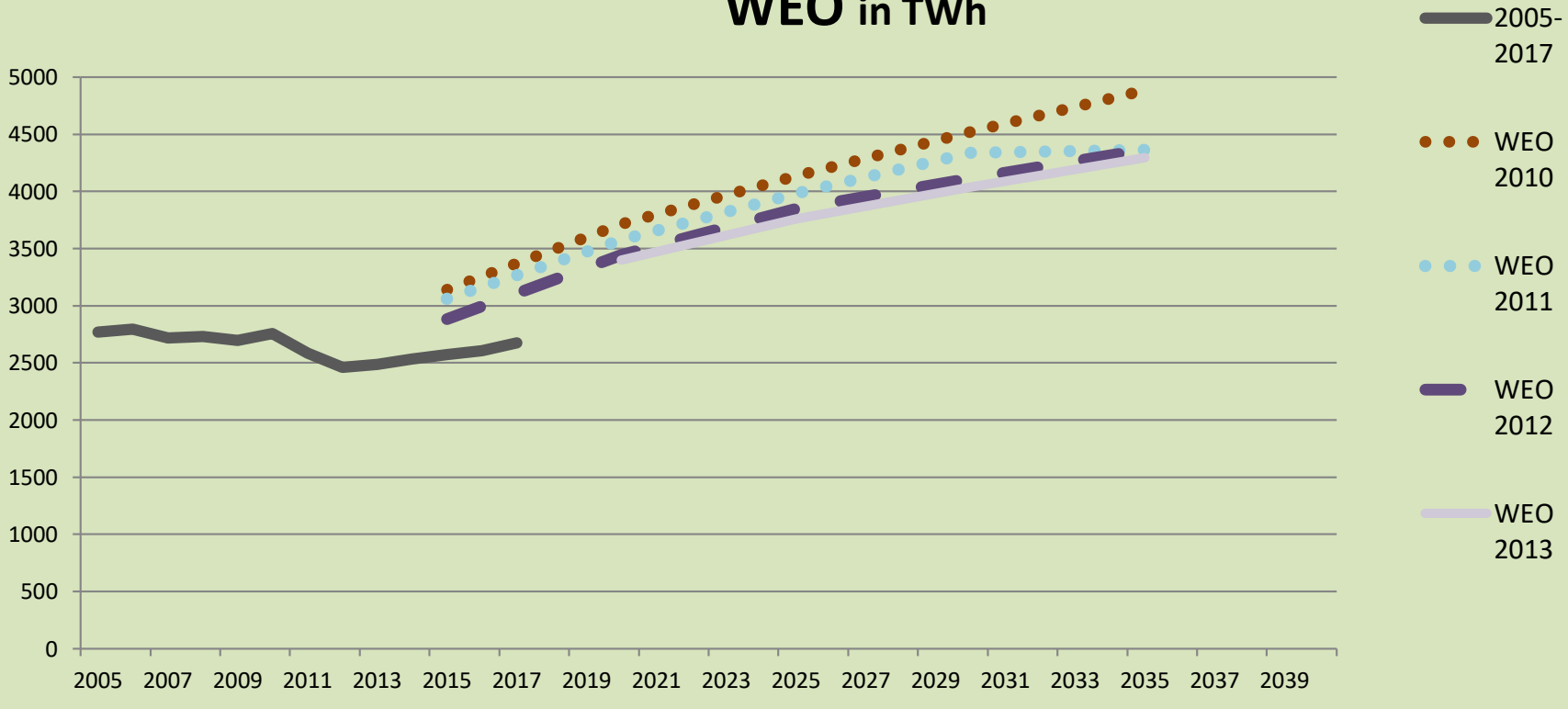

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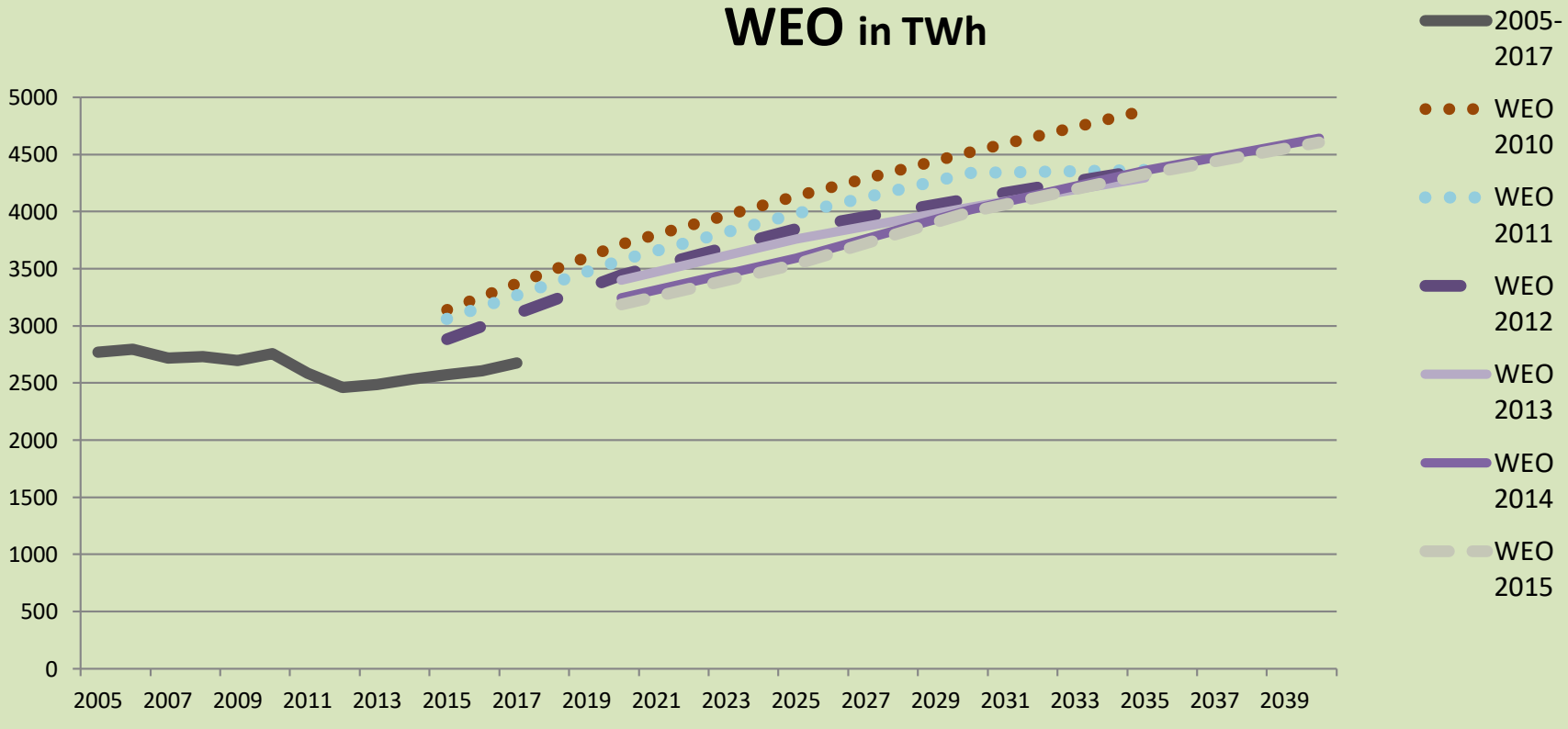

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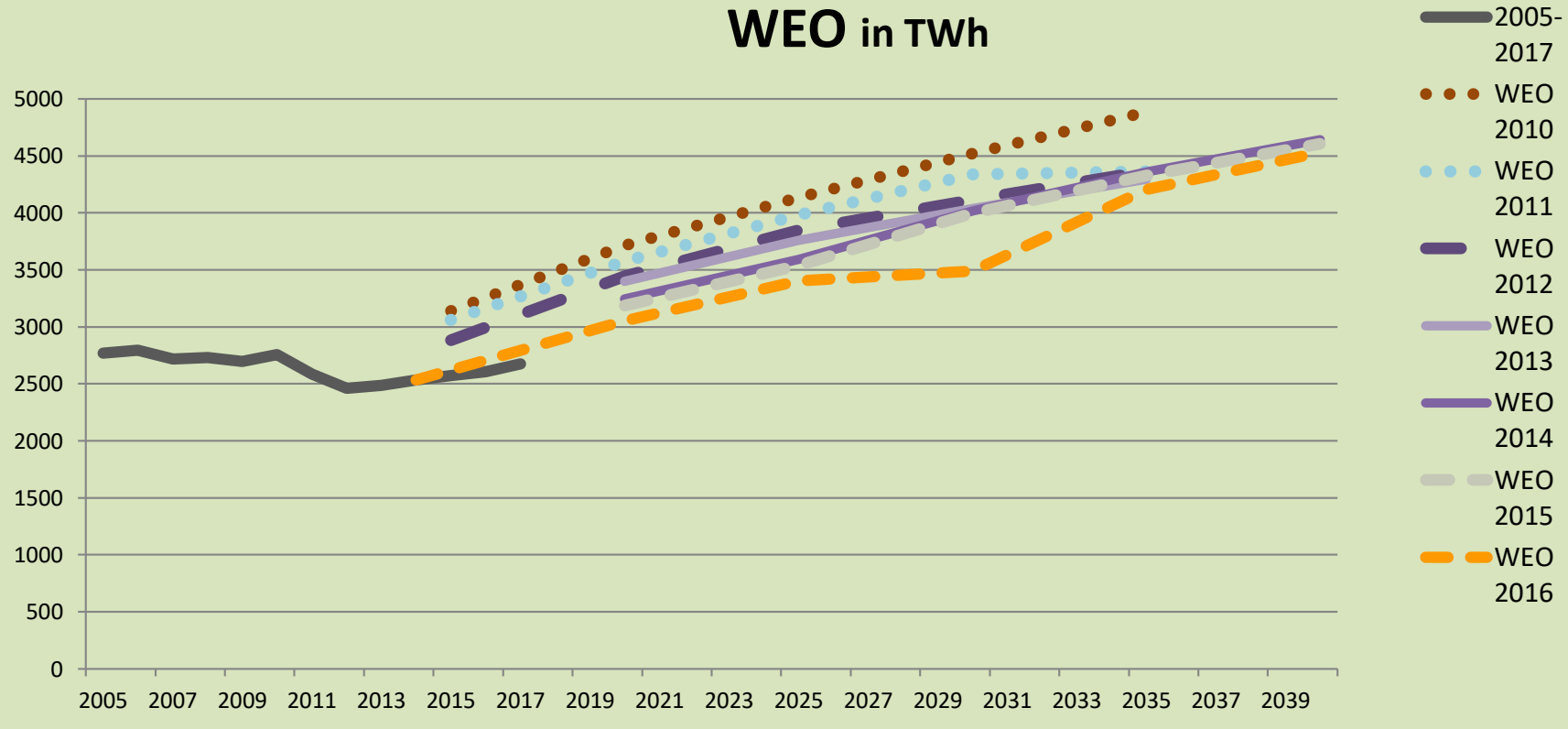

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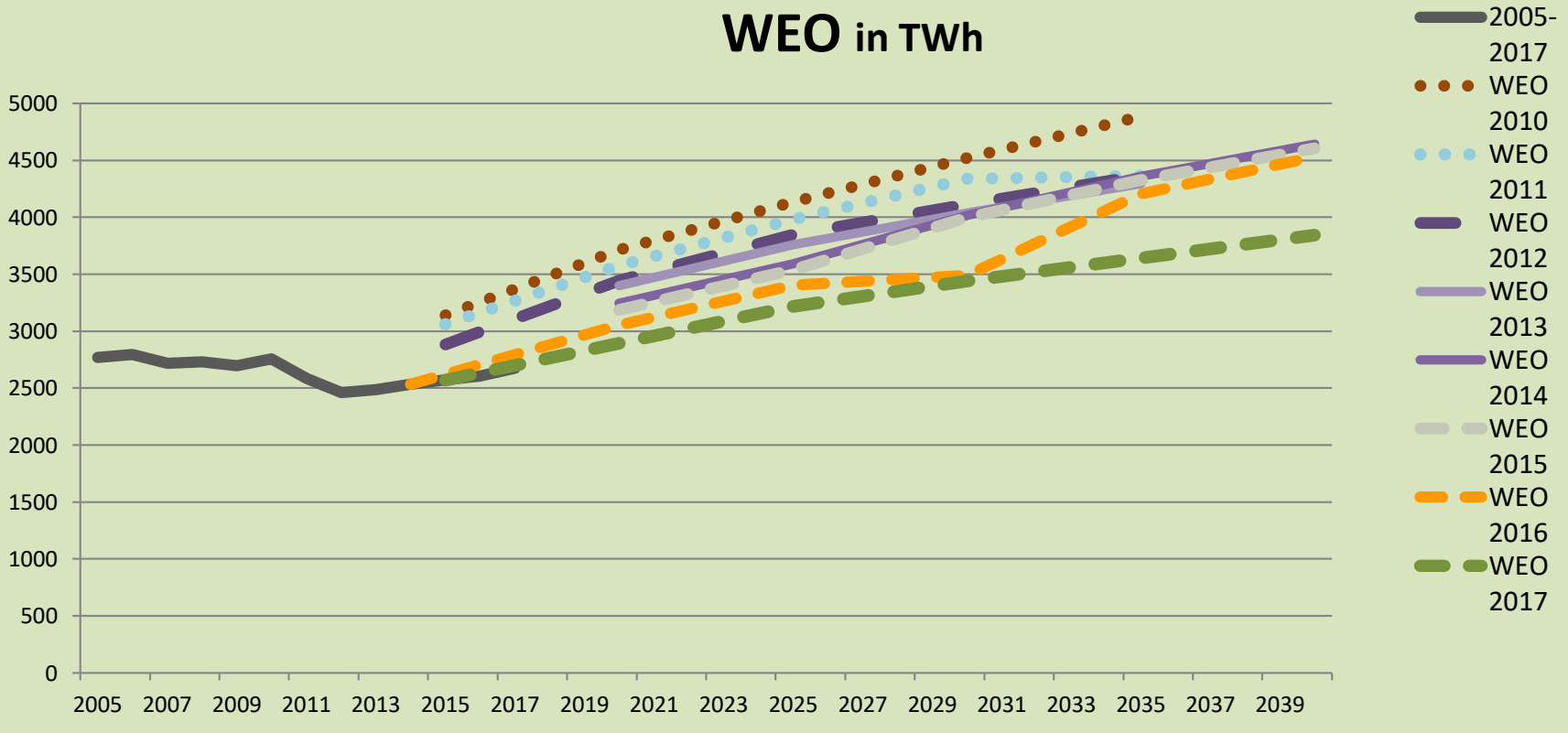

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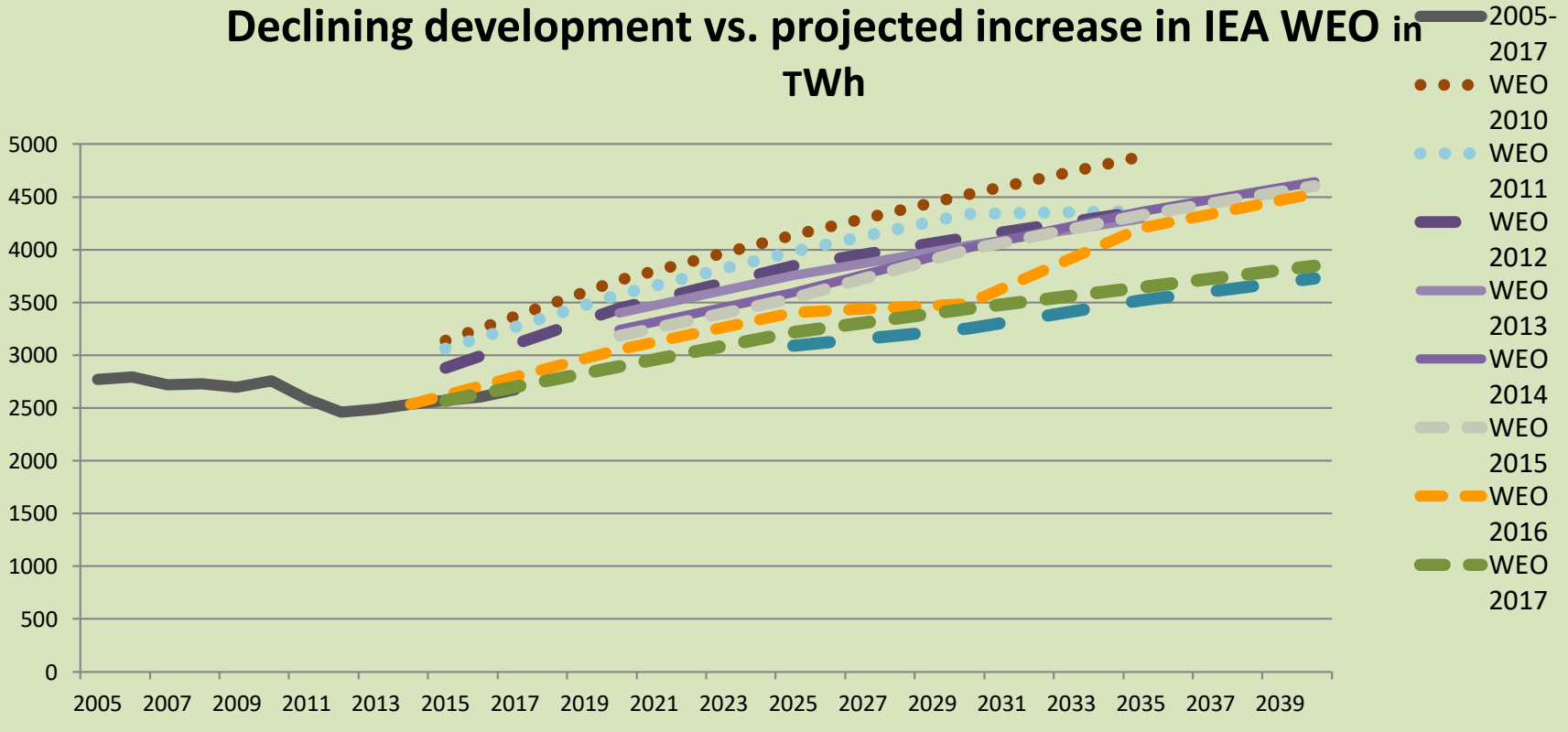
Nuclear: each year IEA WEO has lowered future projection

Declining development vs. projected increase in IEA WEO in TWh



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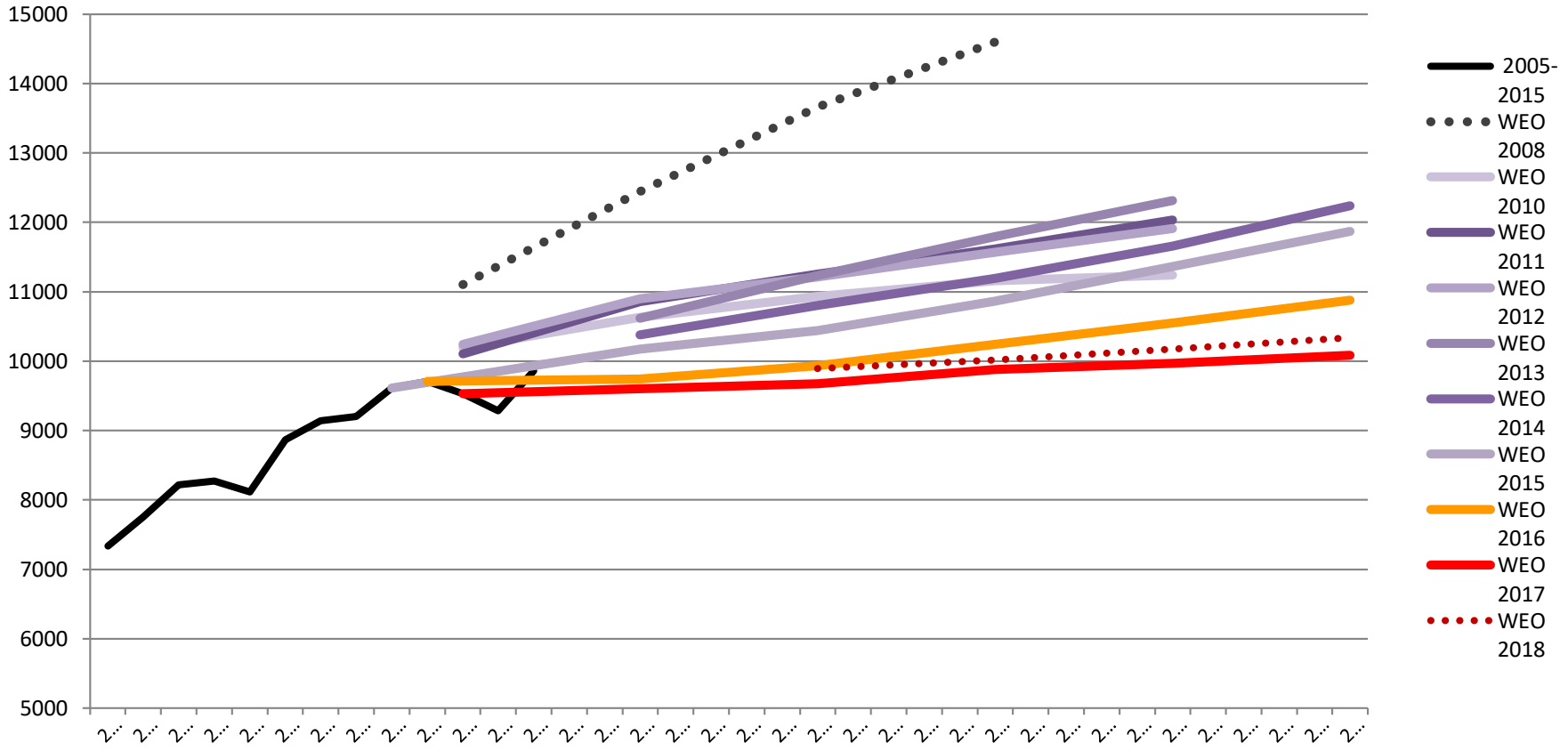
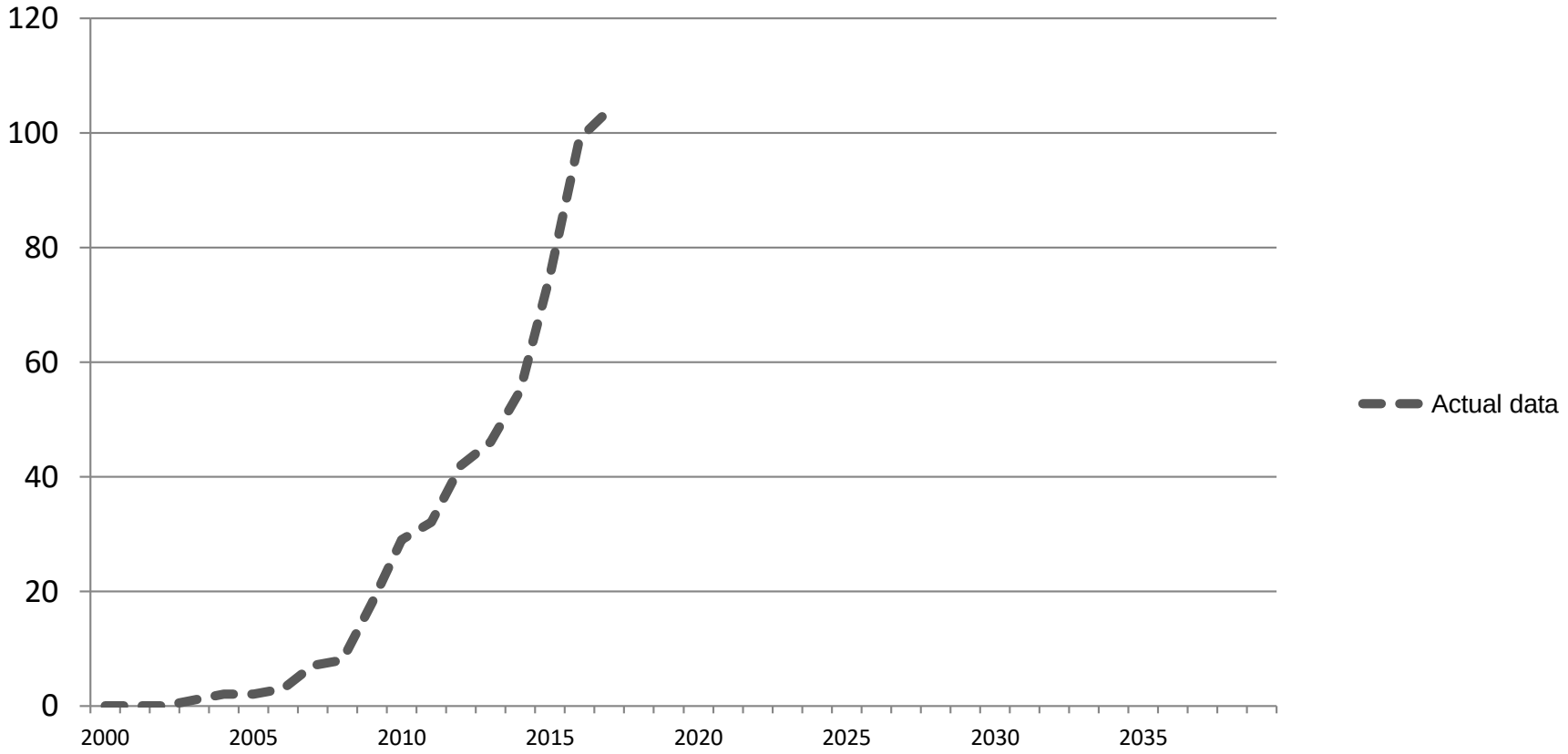
IEA WEO central scenarios were not only wrong on nuclear:

Coal-fired electricity development and IEA WEO main scenario in TWh



Data from IEA World Energy Outlook, reference scenario/NPS, editions 2004, 2006, 2008, 2010 2011, 2012, 2013, 2014, 2016, 2017, 2018

On the other hand: Solar power new capacity added per year: IEA-WEO main scenarios and actual development (in GW)



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Solar power: new capacity added per year
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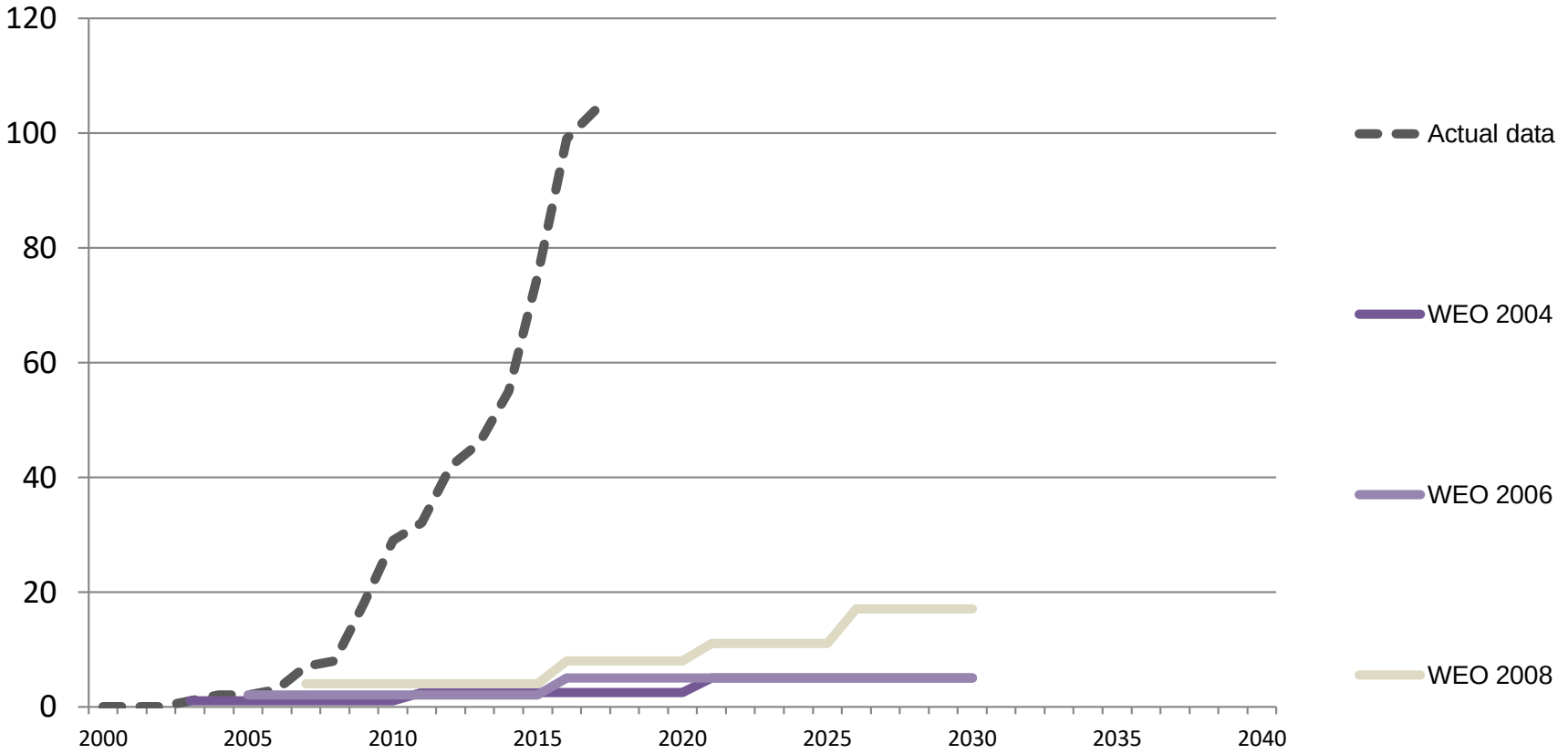

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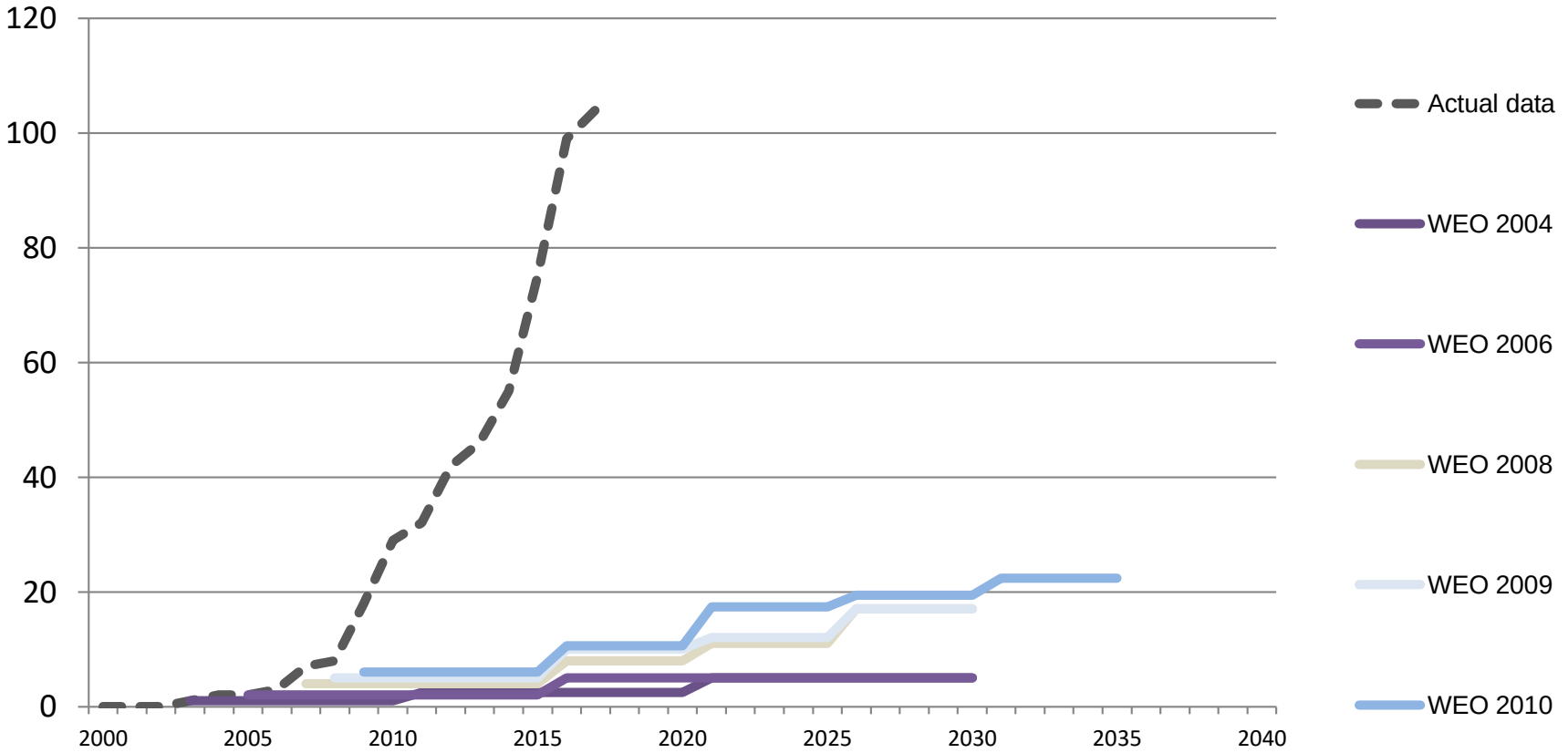

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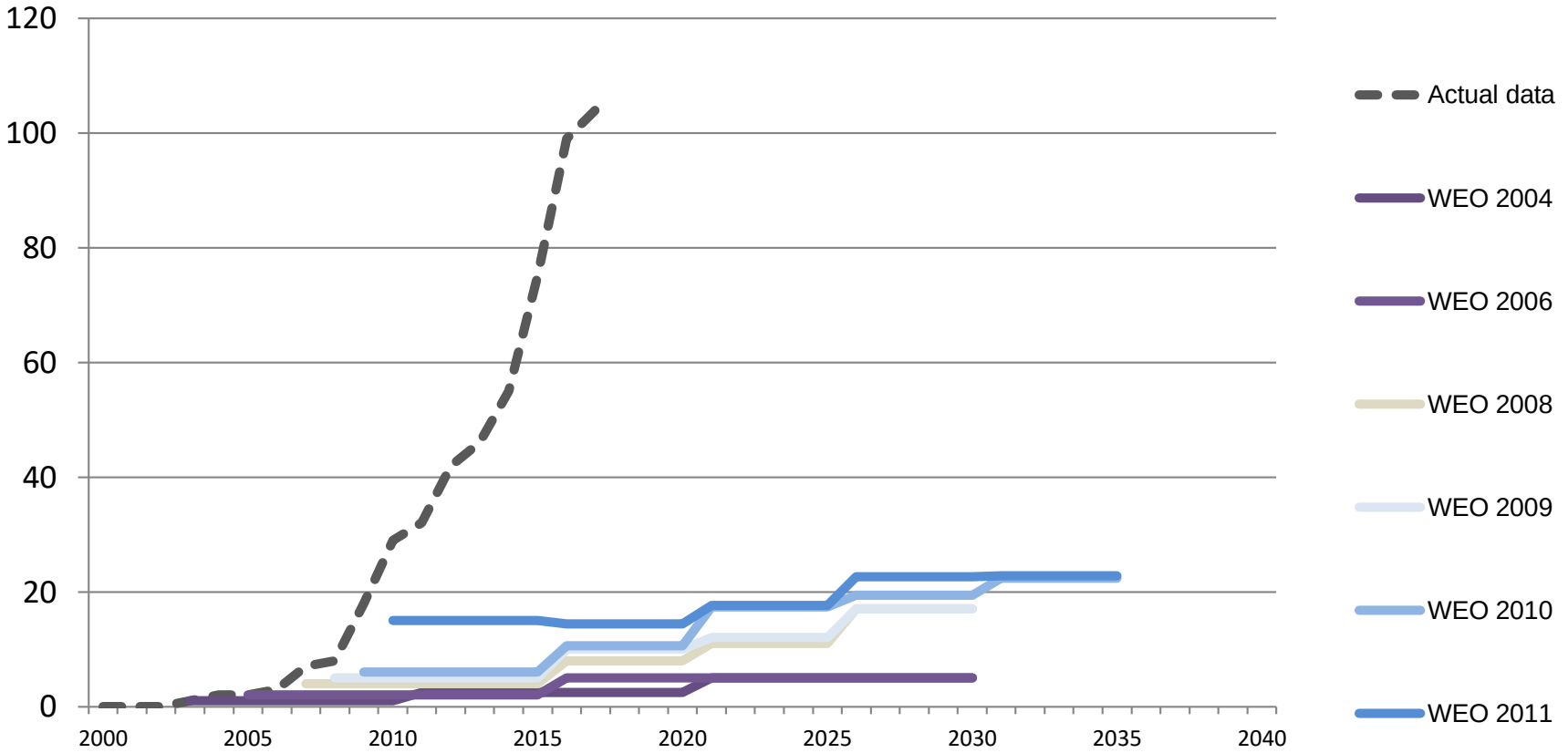
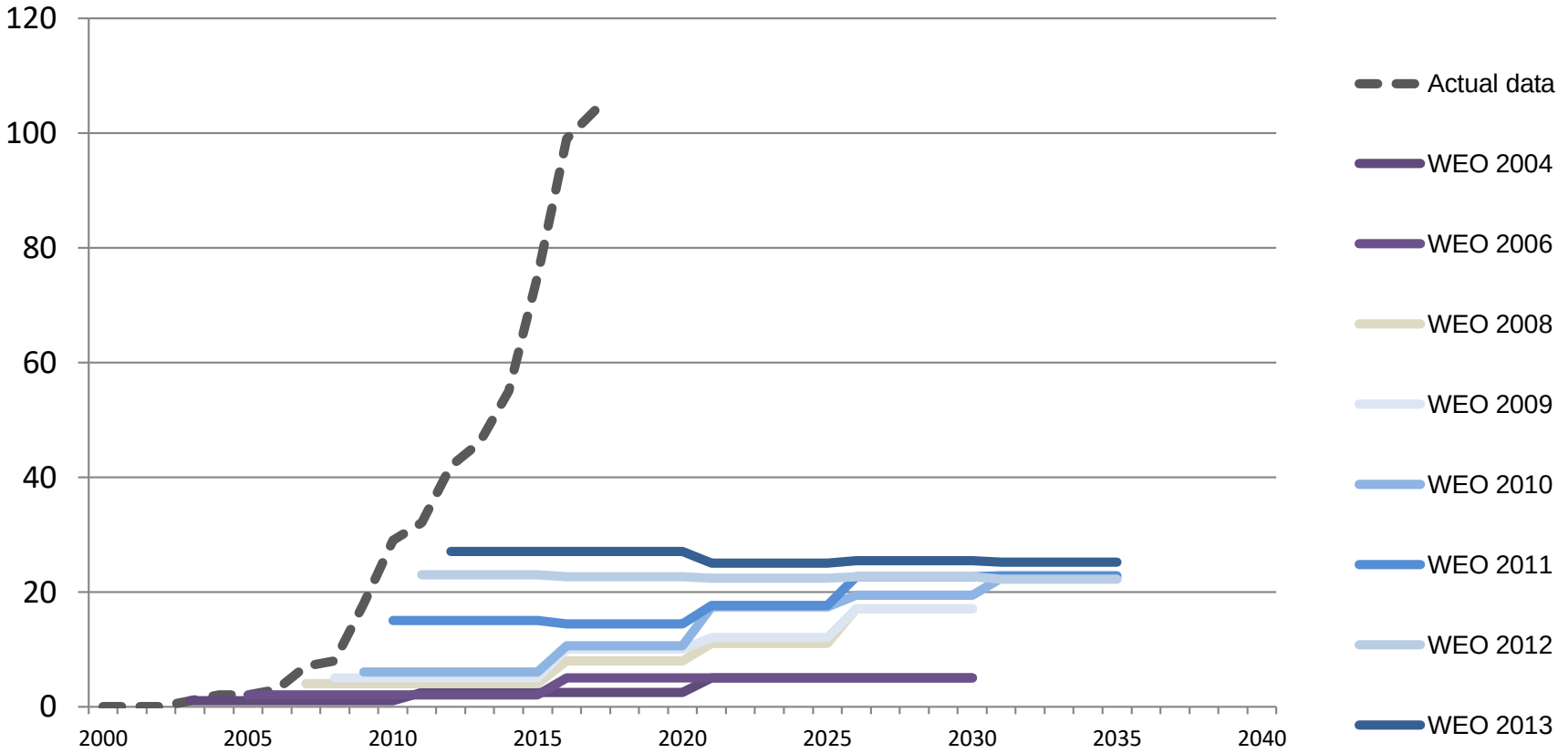
IEA-WEO main scenarios and actual development (in GW)



Data from IEA World Energy Outlook, reference scenario/NPS, editions 2004, 2006, 2008, 2010 2011, 2012, 2013, 2014, 2016, 2017, 2018

Solar power:
IEA-WEO main scenarios and actual development (in GW)



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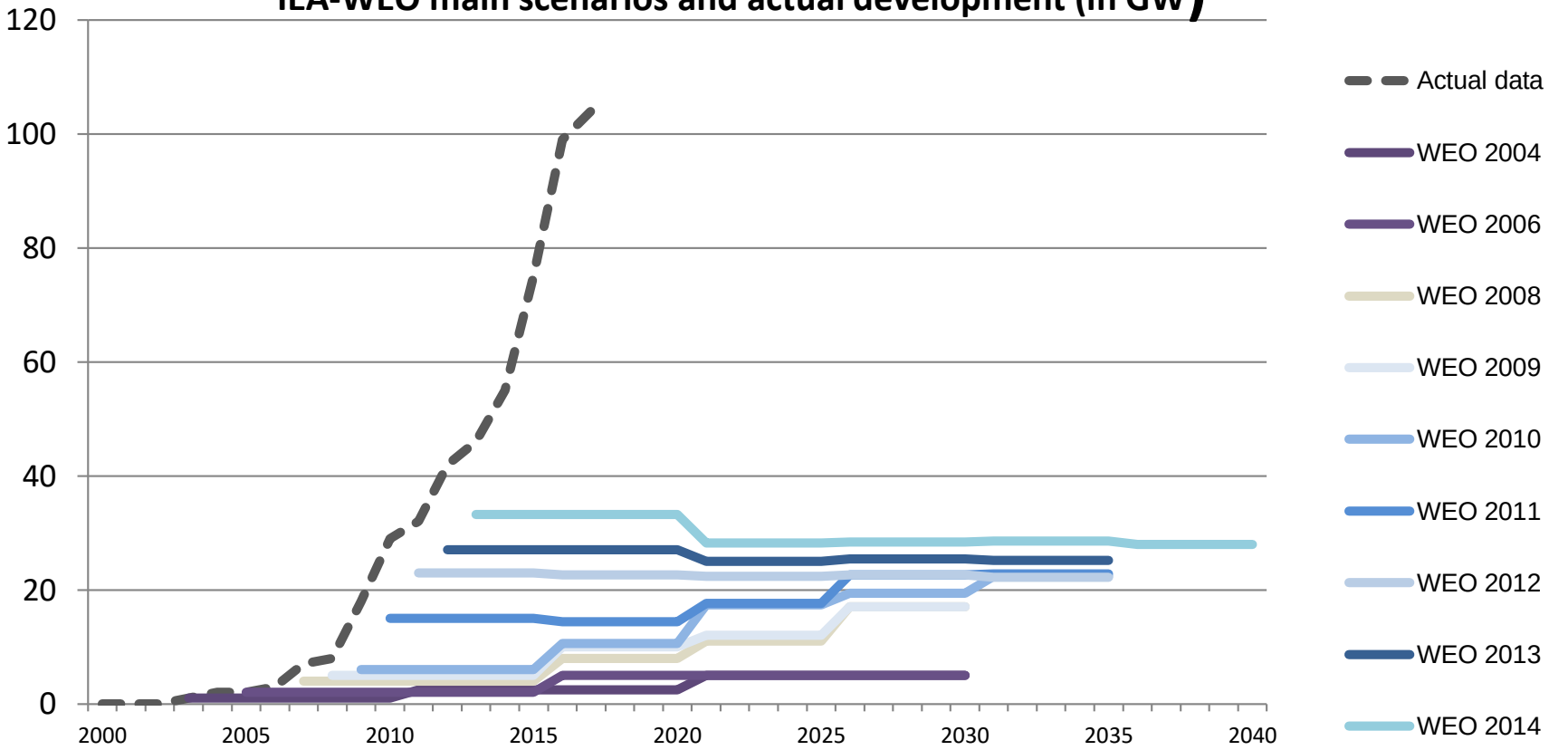
Solar power:

IEA-WEO main scenarios and actual development (in GW)



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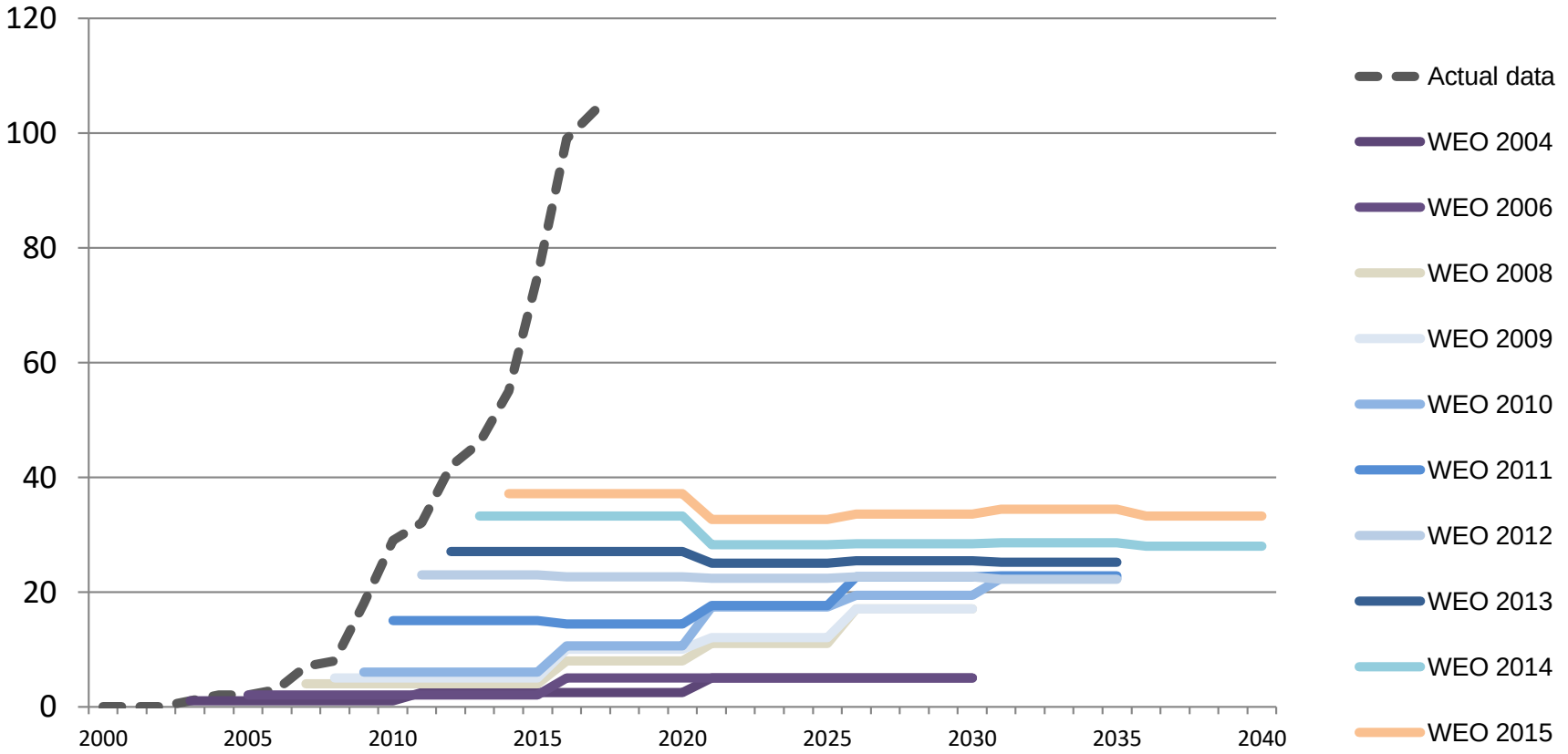
Solar power:
IEA-WEO main scenarios and actual development (in GW)



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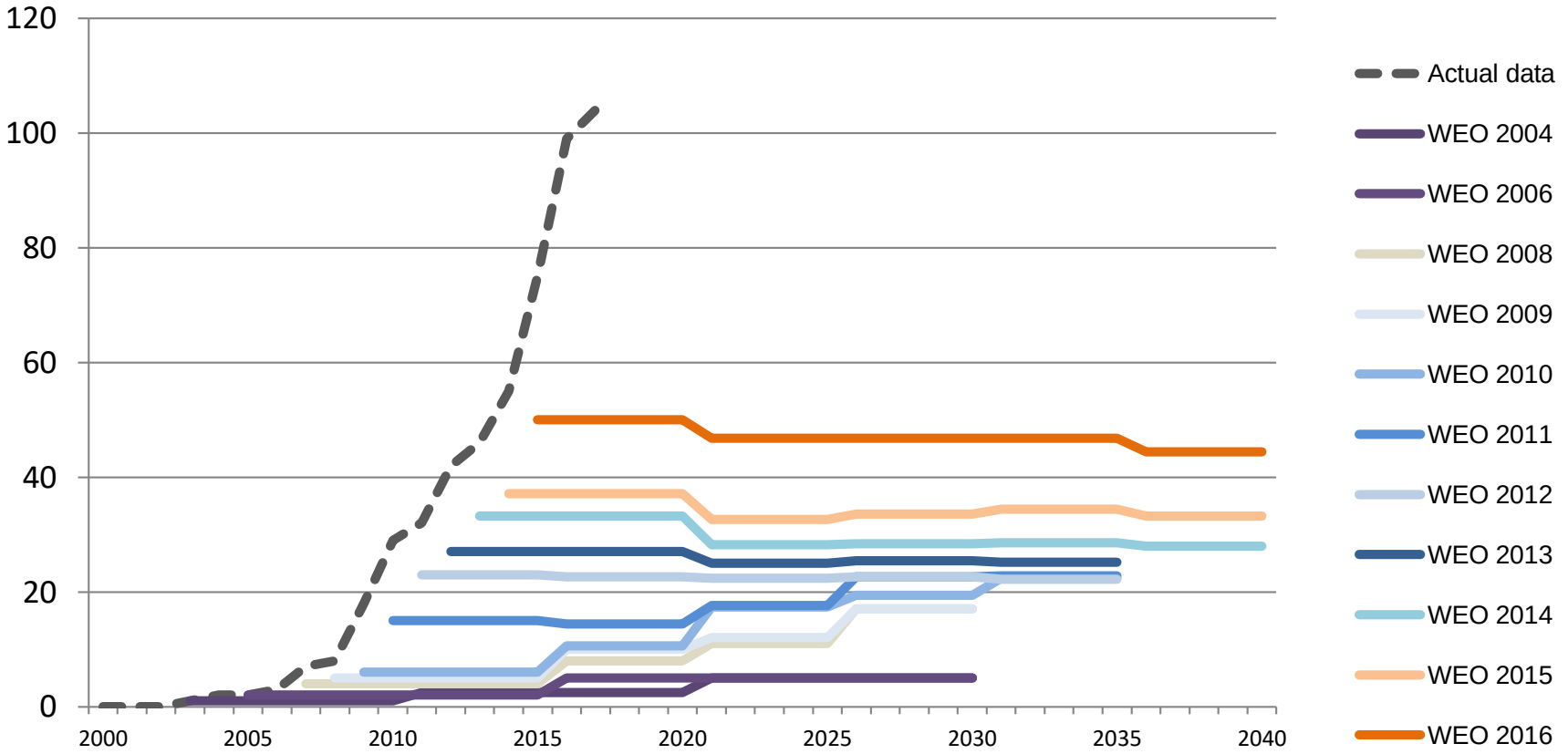
Solar power:
IEA-WEO main scenarios and actual development (in GW)



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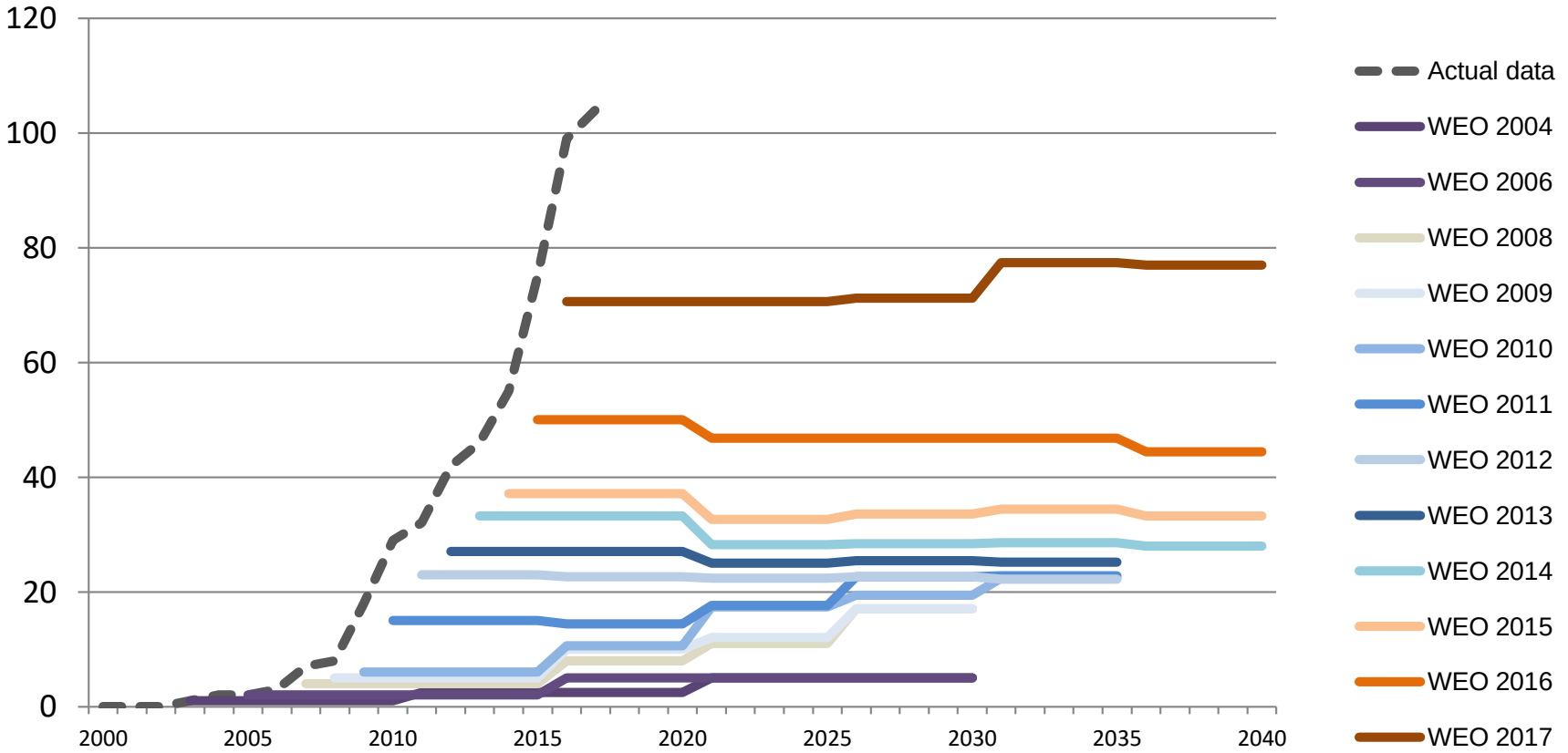
IEA-WEO main scenarios and actual development (in GW)



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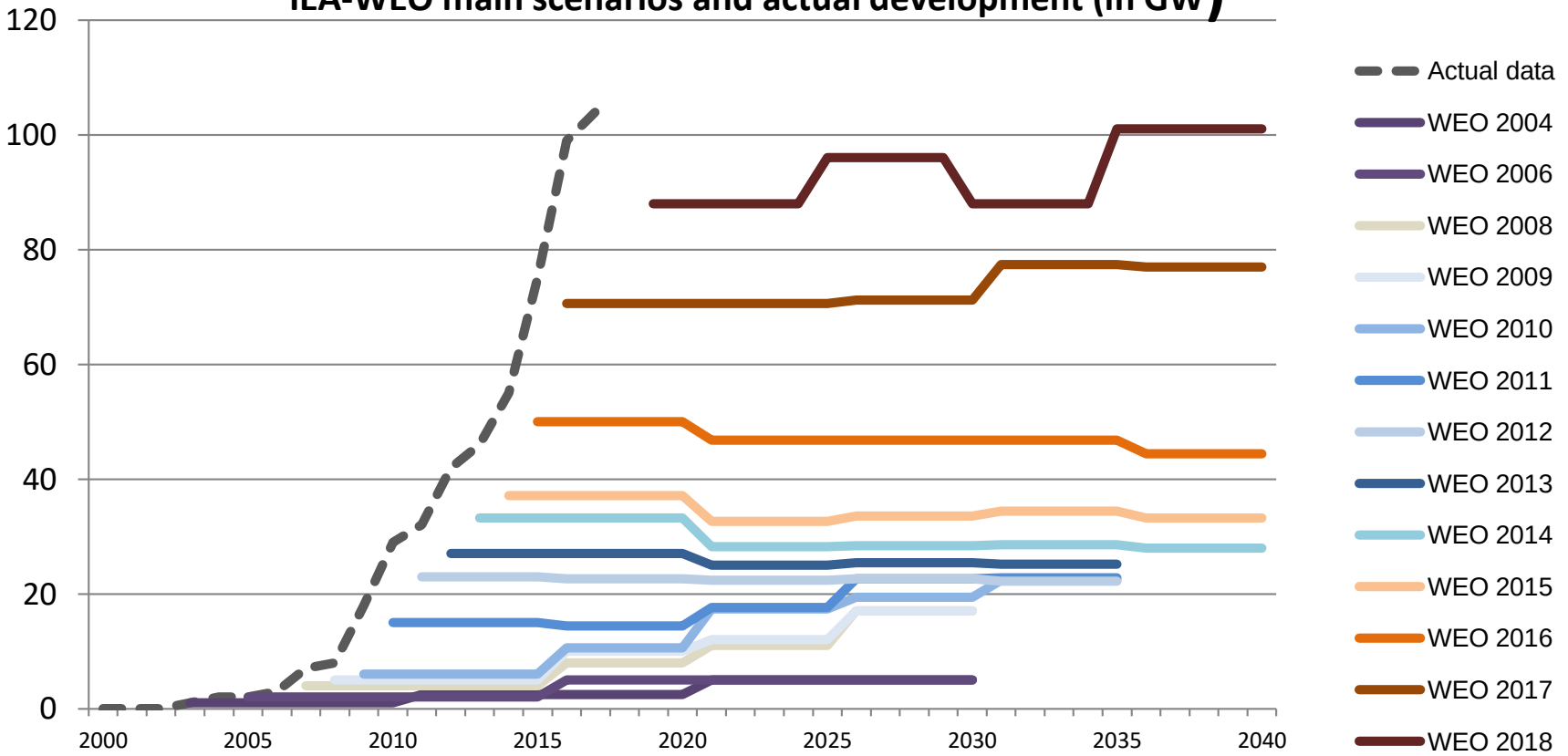
Solar power:

IEA-WEO main scenarios and actual development (in GW)



Data from IEA World Energy Outlook, reference scenario/NPS, editions 2004, 2006, 2008, 2010 2011, 2012, 2013, 2014, 2016, 2017, 2018

Technology costs (+ another factor is intensity)

Power generation technology costs

Table B.6 ▷ Technology costs by selected region in the New Policies Scenario

		Capital costs ($/kW)		Capacity factor (%)		Fuel and O&M ($/MWh)		LCOE ($/MWh)		VALCOE ($/MWh)	
		2017	2040	2017	2040	2017	2040	2017	2040	2017	2040
United States	Nuclear	5 000	4 500	90	90	30	30	105	100	105	100
	Coal	2 100	2 100	60	60	30	35	75	75	75	75
	Gas CCGT	1 000	1 000	50	50	30	40	50	65	45	60
	Solar PV	1 560	860	20	23	10	5	105	50	105	55
	Wind onshore	1 620	1 480	42	44	10	10	60	50	70	60
	Wind offshore	4 720	2 960	45	49	40	25	180	105	190	115
European Union	Nuclear	6 600	4 500	75	75	35	35	150	110	150	110
	Coal	2 000	2 000	40	40	45	45	120	145	105	120
	Gas CCGT	1 000	1 000	40	40	55	75	90	120	80	95
	Solar PV	1 300	760	12	13	20	15	160	85	165	105
	Wind onshore	1 820	1 700	28	30	20	15	100	90	105	105
	Wind offshore	4 260	2 820	50	55	35	25	150	90	160	105
China	Nuclear	2 320	2 500	75	75	25	25	60	65	60	65
	Coal	800	800	70	70	35	30	50	70	50	65
	Gas CCGT	560	560	50	50	70	90	85	115	80	105
	Solar PV	1 120	640	17	19	10	10	90	45	90	65
	Wind onshore	1 200	1 180	25	27	15	15	70	65	70	70
	Wind offshore	4 120	2 740	46	50	35	25	145	90	150	95
India	Nuclear	2 800	2 800	80	80	30	30	70	70	70	70
	Coal	1 200	1 200	60	60	35	35	60	55	60	50
	Gas CCGT	700	700	50	50	80	90	95	105	90	80
	Solar PV	1 120	620	19	22	10	10	80	40	80	65
	Wind onshore	1 080	1 040	25	30	10	10	60	50	65	55
	Wind offshore	3 320	2 220	40	44	40	25	155	95	160	100

Notes: O&M = operation and maintenance; LCOE = levelised cost of electricity; VALCOE = value-adjusted LCOE; kW = kilowatt; MWh = megawatt-hour; CCGT = combined-cycle gas turbine. LCOE and VALCOE figures are rounded. Lower figures for VALCOE indicate improved competitiveness. Coal refers to supercritical, except China that refers to ultra-supercritical.

Sources: IEA analysis; IRENA Renewable Cost Database; Bolinger and Seel (2018).

IEA WEO central scenario (NPS) means growth for everyone

Table 1.1 ▷ World primary energy demand by fuel and scenario (Mtoe)

			New Policies		Current Policies		Sustainable Development	
	2000	2017	2025	2040	2025	2040	2025	2040
Coal	2 308	3 750	3 768	3 809	3 998	4 769	3 045	1 597
Oil	3 665	4 435	4 754	4 894	4 902	5 570	4 334	3 156
Gas	2 071	3 107	3 539	4 436	3 616	4 804	3 454	3 433
Nuclear	675	688	805	971	803	951	861	1 293
Renewables	662	1 334	1 855	3 014	1 798	2 642	2 056	4 159
Hydro	225	353	415	531	413	514	431	601
Modern bioenergy	377	727	924	1 260	906	1 181	976	1 427
Other	60	254	516	1 223	479	948	648	2 132
Solid biomass	646	658	666	591	666	591	396	77
Total	10 027	13 972	15 388	17 715	15 782	19 328	14 146	13 715
Fossil fuel share	*80%*	*81%*	*78%*	*74%*	*79%*	*78%*	*77%*	*60%*
CO_2 emissions (Gt)	23.1	32.6	33.9	35.9	35.5	42.5	29.5	17.6

Notes: Mtoe = million tonnes of oil equivalent; Gt = gigatonnes. Solid biomass includes its traditional use in three-stone fires and in improved cookstoves.

IEA WEO central scenario (NPS) means growth for everyone (political context)

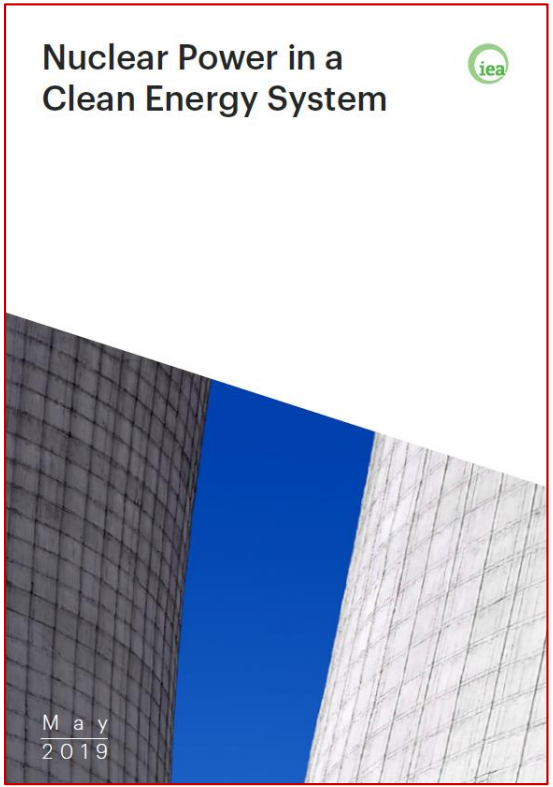
1.4 Power generation and energy supply

Table 1.4 ▷ World electricity generation by fuel, technology and scenario (TWh)

			New Policies		Current Policies		Sustainable Development	
	2000	2017	2025	2040	2025	2040	2025	2040
Coal	6 001	9 858	9 896	10 335	10 694	13 910	7 193	1 982
Oil	1 212	940	763	527	779	610	605	197
Gas	2 747	5 855	6 829	9 071	7 072	10 295	6 810	5 358
Nuclear	2 591	2 637	3 089	3 726	3 079	3 648	3 303	4 960
Hydro	2 618	4 109	4 821	6 179	4 801	5 973	5 012	6 990
Wind and solar PV	32	1 519	3 766	8 529	3 485	6 635	4 647	14 139
Other renewables	217	722	1 057	2 044	1 031	1 653	1 259	3 456
Total generation	15 441	25 679	30 253	40 443	30 971	42 755	28 859	37 114
Electricity demand	*13 156*	*22 209*	*26 417*	*35 526*	*26 950*	*37 258*	*25 336*	*33 176*

Notes: TWh = terawatt-hours. Electricity demand equals total generation minus own use (for generation) and transmission and distribution losses. Total generation includes other sources.

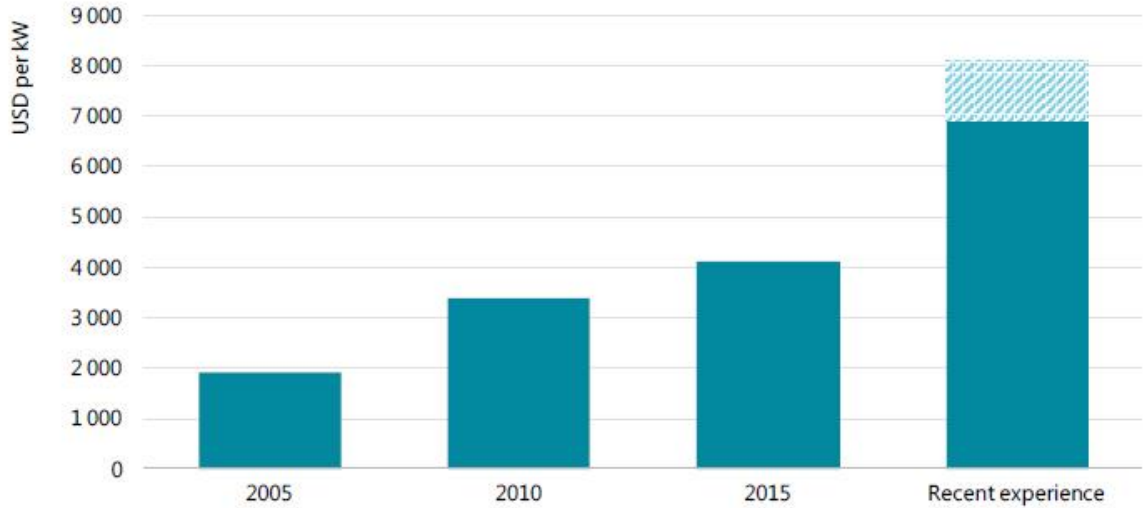
IEA Nuclear report May 2019 (messages)



- The biggest barrier to new nuclear construction is mobilising investment.
- Plants face concerns about competitiveness with other power generation technologies and the very large
- Size of nuclear projects that require billions of dollars in upfront investment. Those doubts are especially strong in countries that have introduced competitive wholesale markets.
- A number of challenges specific to the nature of nuclear power technology may prevent investment
- The main obstacles relate to the sheer scale of investment and long lead times; the risk of construction problems, delays and cost overruns; and the possibility of future changes in policy or the electricity system itself. There have been long delays in completing advanced reactors. They have turned out to cost far more than originally expected and dampened investor interest in new projects.

Even IEA Nuclear report identifies some trouble

Figure 9. Projected overnight construction cost of nuclear power capacity and recent United States and Western European experience

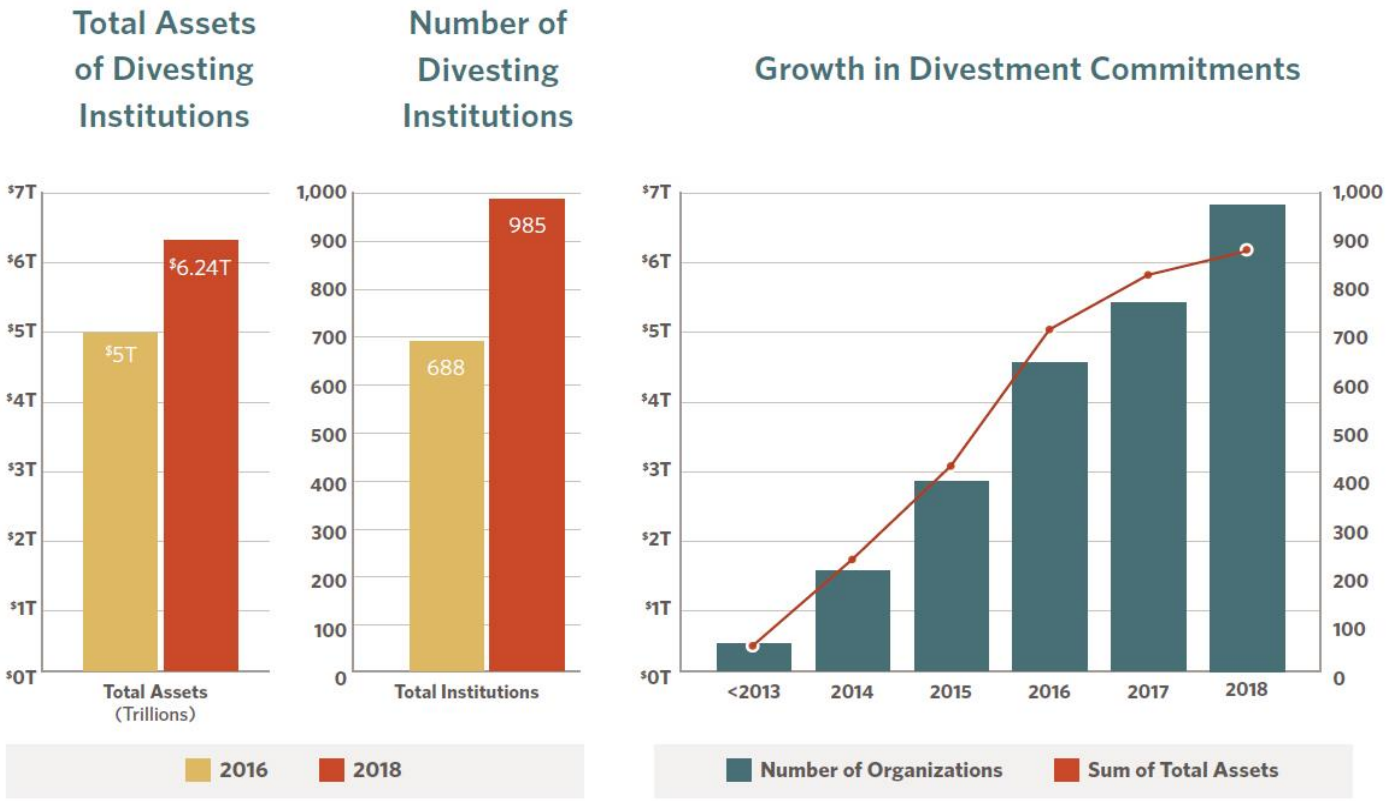


Source: IEA analysis based on IEA/NEA (2005, 2010 and 2015 editions), Projected Costs of Generating Electricity.

Construction costs of new nuclear power plants in the United States and Western Europe have turned out to be much higher than projected.

IEA Nuclear Power in a Clean Energy System, May 2019

Growing awareness in finance sector:
Commitments to fossil fuel divestment: what about nuclear?



Data accurate as of September 5, 2018.

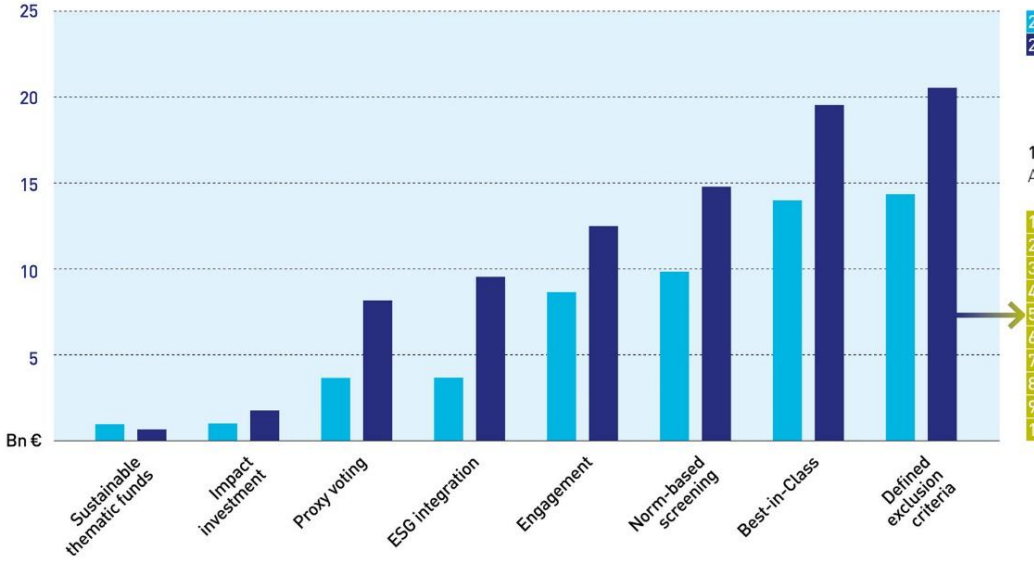
Arabelle Advisory
Sept 2018

Exclusion of nuclear at least in some areas (e.g. Austria)

Fact check
Green Finance

Sustainable investment strategies in Austria

Development of investments according to different investor strategies, comparing 2017 and 2018



10 most common exclusion criteria
Austria, 2018

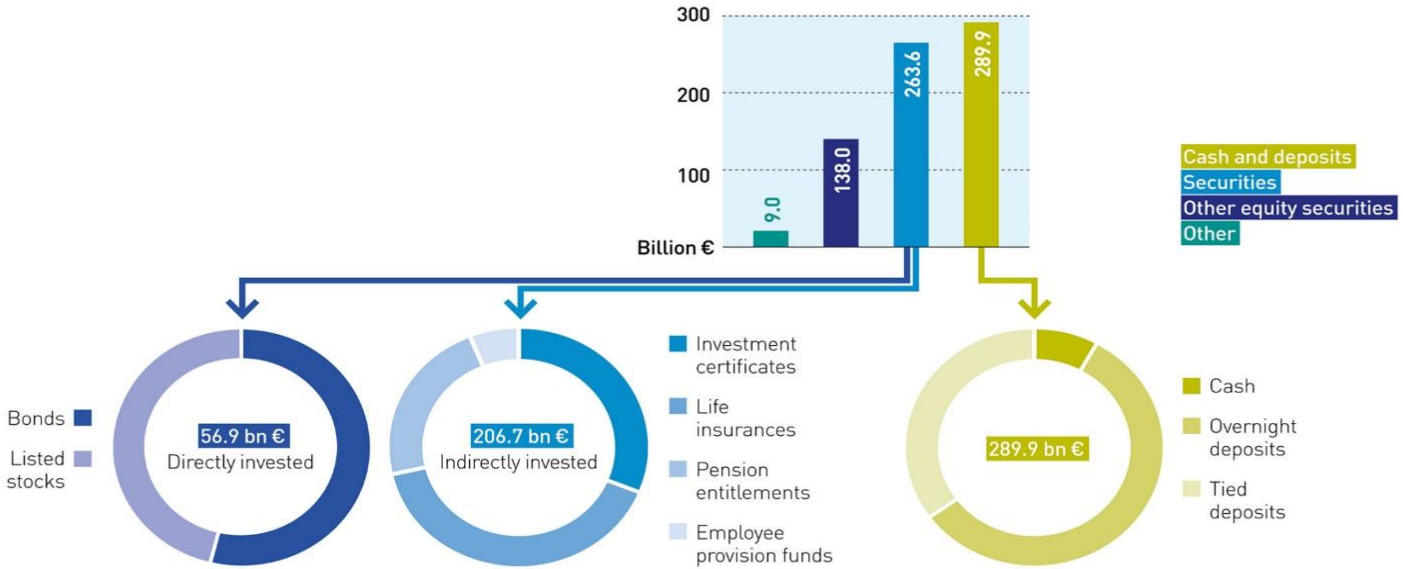
1 coal
2 arms and weapons industry
3 nuclear power
4 human rights violation
5 labor rights violations
6 genetic technology
7 gambling
8 pornography
9 tobacco
10 corruption and bribery

Data source graphic:
Forum Nachhaltige Geldanlagen 2019

How Austrian household´s money is invested

More than 700 billion € are directly or indirectly invested

Fact check
Green Finance



klima+ energie fonds

Data source:
Austrian National Bank 2019

Is nuclear a good option?

- Does a measure/an investment have a positive effect on the economy?
- Does a measure/an investment create regional/local jobs?
- Is it a good investment in terms of profitability?
- Is the measure/investment cost-effective?

- -> better options in the transformation of the energy system

Is nuclear a good option?

- Does is make a country/region/society more resilient? (supply chain)
- Does it contribute to climate change and GHG emissions?
- Are there any lock-in effects?
- Does the measure/investment create risks (physical risks, financial risks, economic risks) and how do we assess these risks?
- Are there other environmental or social risks?

- -> better options in the transformation of the energy system

Résumé

- Crucial moment for economic stimulus and recovery programs
- It will be about

  - Jobs and economic development
  - Combating climate change
  - Time! Short term and long term effects
  - Costs and Opportunity costs
  - Geopolitical aspects
  - Systemic risk analysis and the definition of what is sustainable