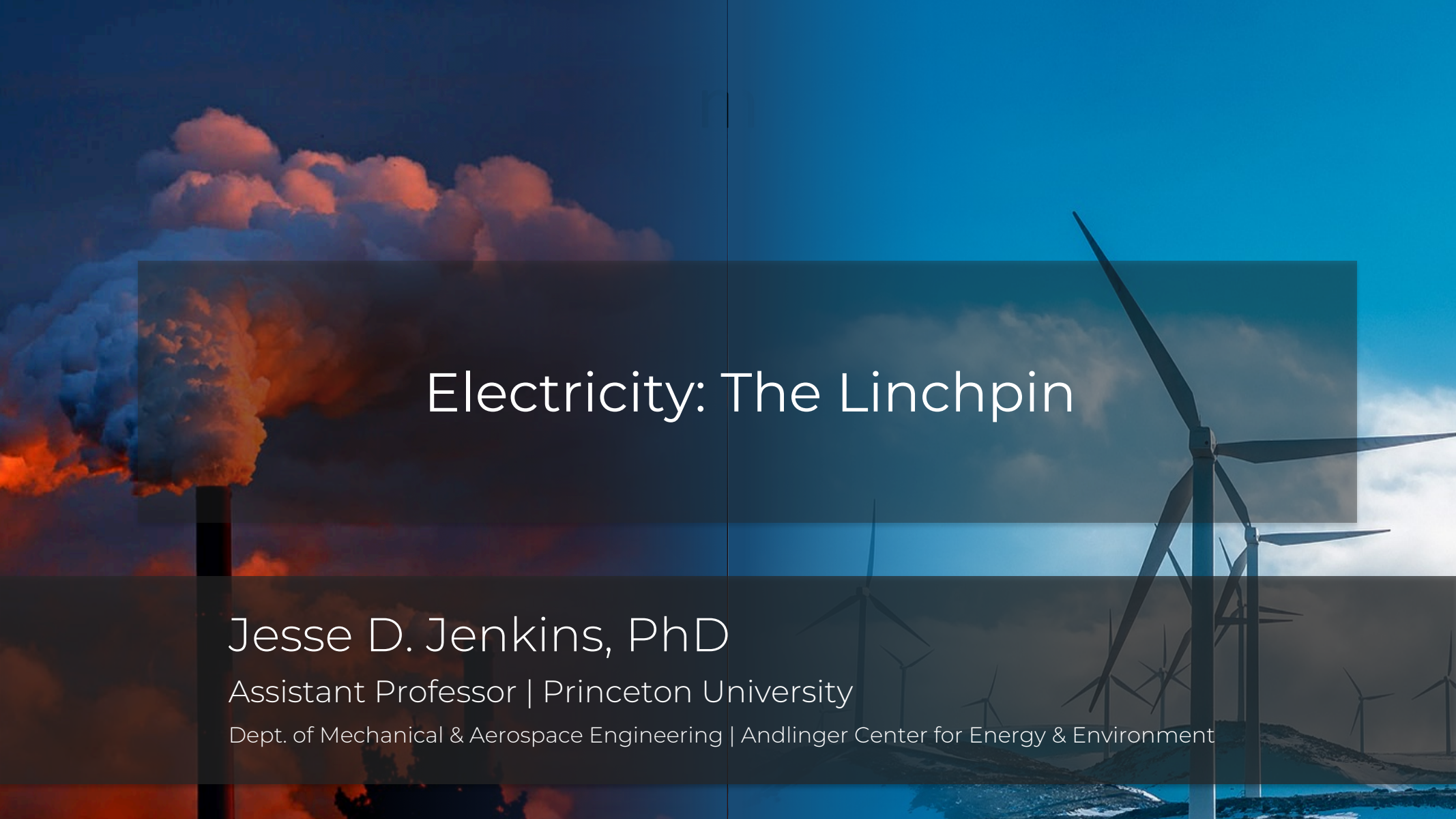

Electricity: The Linchpin

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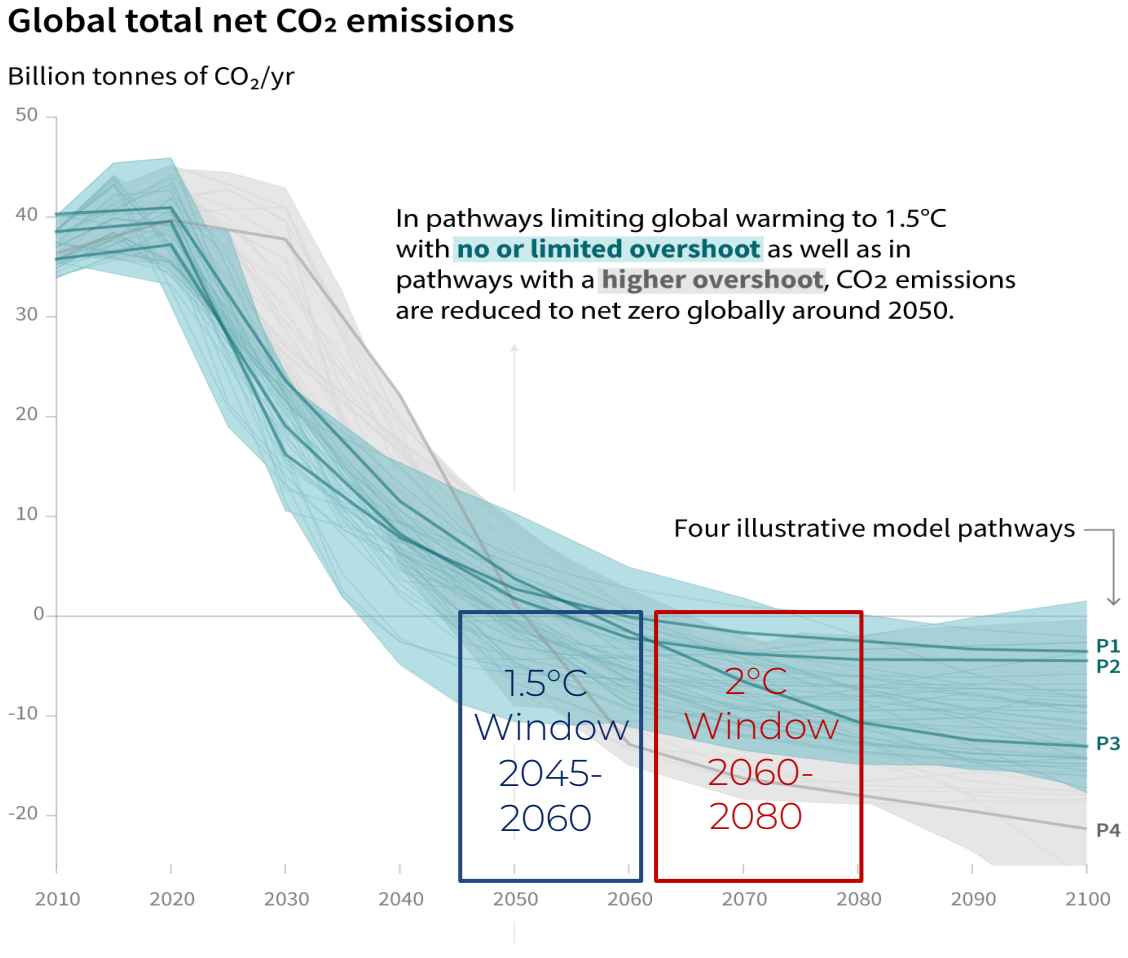
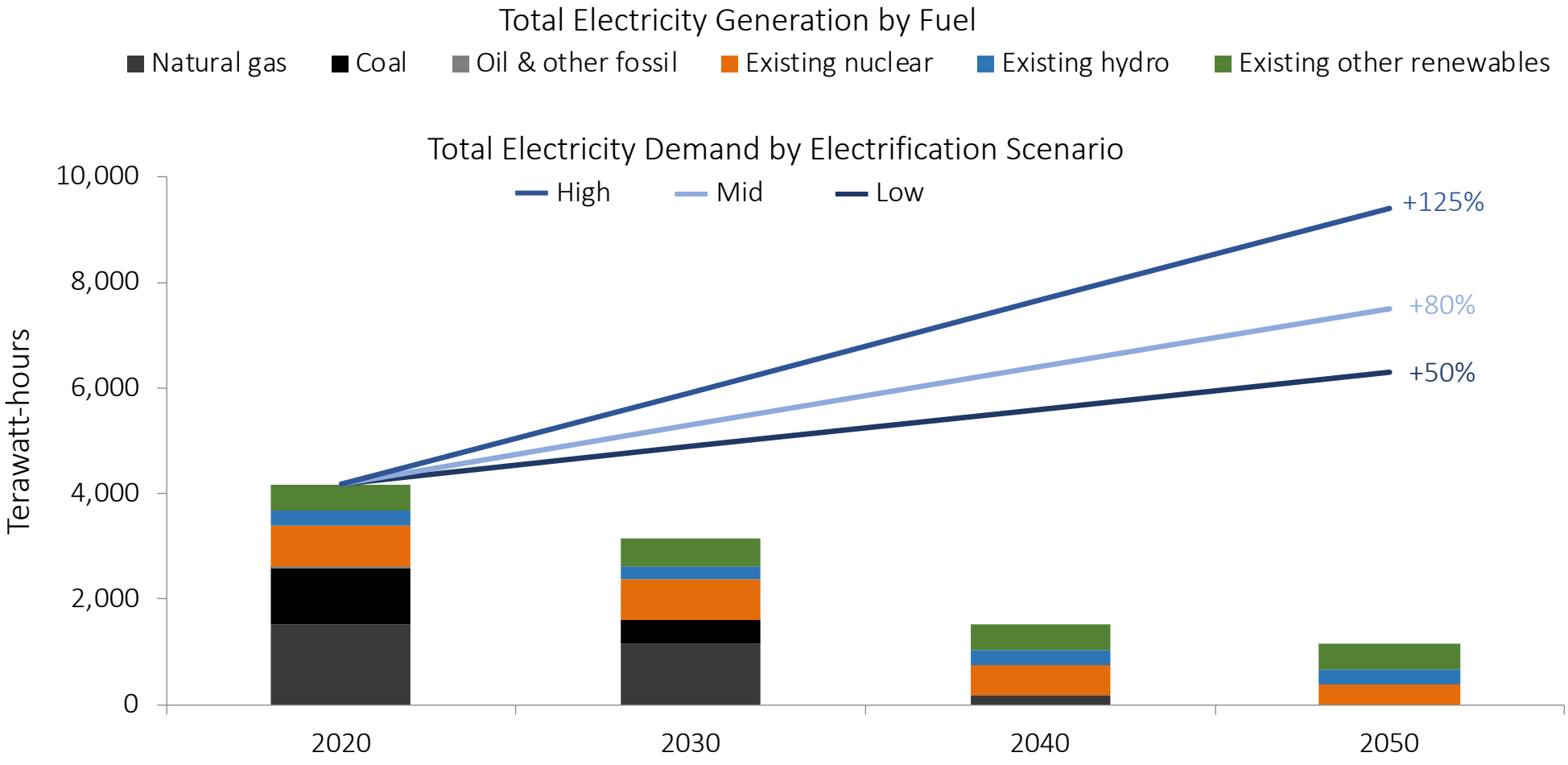
Getting to Zero



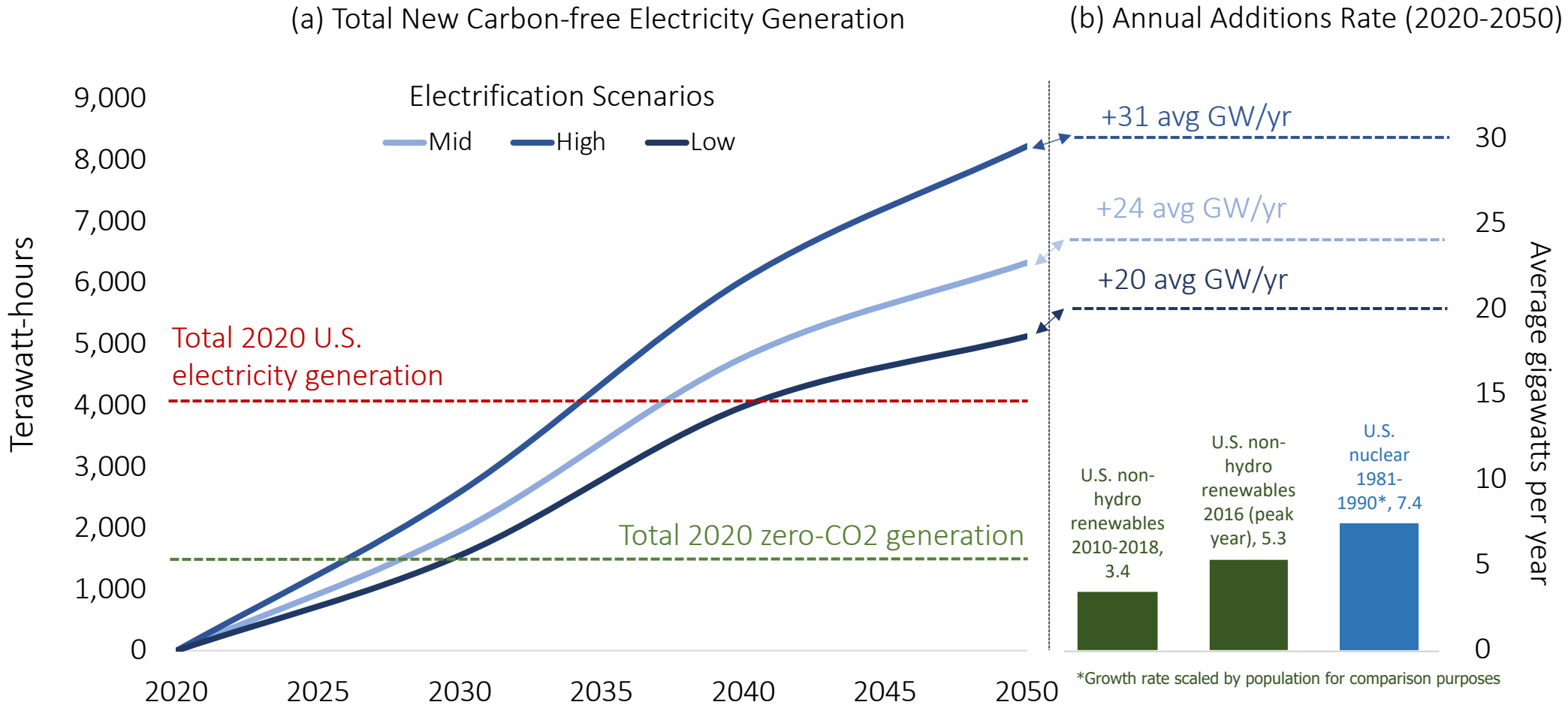
Source: IPCC (2018) Special Report on Global Warming 1.5°C

Twin Challenges: Zero Carbon, (approx.) Double Demand



Data source: Iyer et al. 2017, GGCAM USA Analysis of U.S. Electric Power Sector Transitions (performed for the United States Mid-Century Strategy for Deep Decarbonization), Pacific Northwest National Laboratory; 2020 zero-carbon electricity supply from EIA Annual Energy Outlook 2019. For nuclear retirements: 8 GW of planned nuclear retirements through 2030, half of the fleet assumed to operate through 2050 (requiring 80 year licenses); 2040 a linear interpolation of 2030 and 2050.

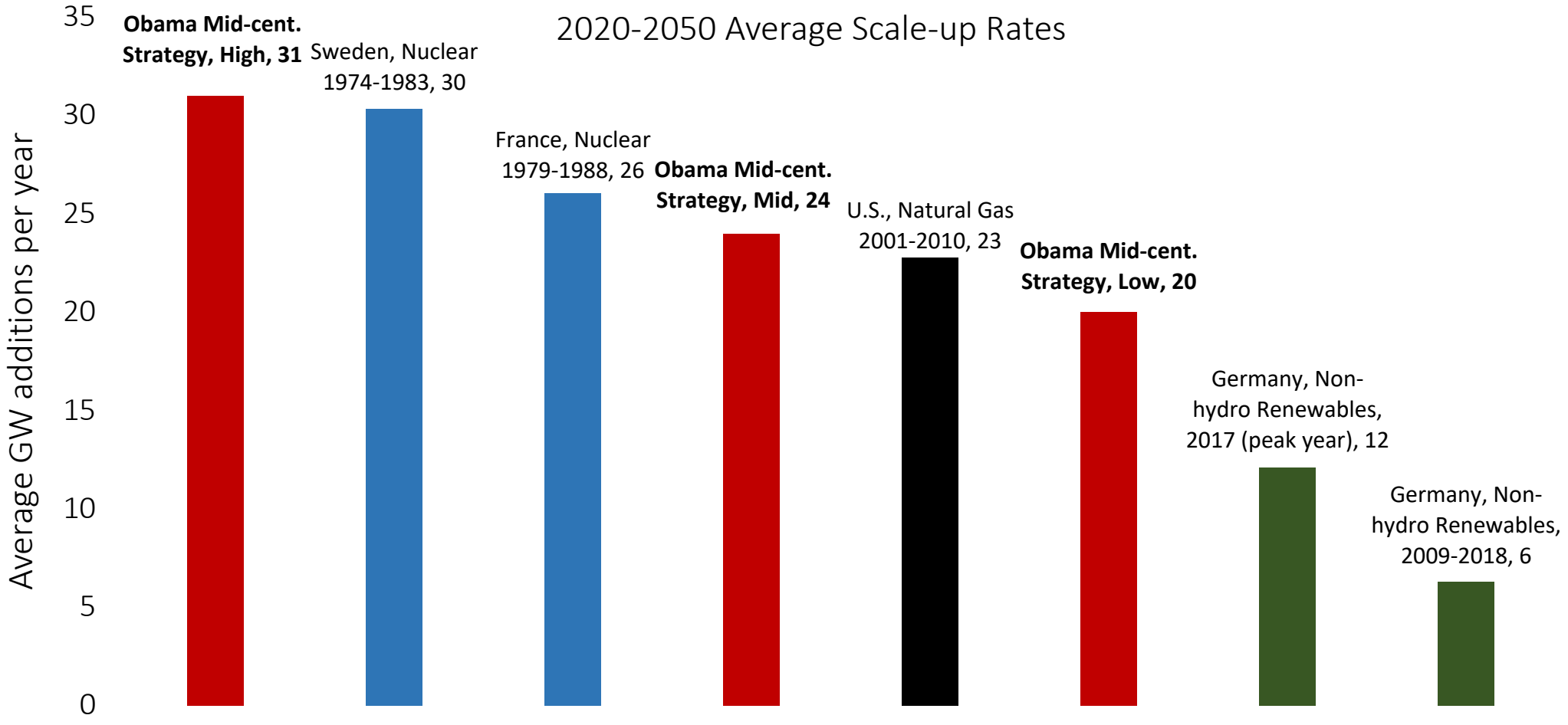
New Clean Electricity Needed: Obama Mid-Century Strategy



(a) Data source: Difference between projected electricity demand in Iyer et al. 2017 and 2020 zero-carbon electricity supply from EIA Annual Energy Outlook 2019. Assumes all 2020 renewable generation can be sustained through 2050 while half of U.S. nuclear fleet retires by 2050. Retirement & replacement of existing capacity would increase new zero-carbon generation needed.

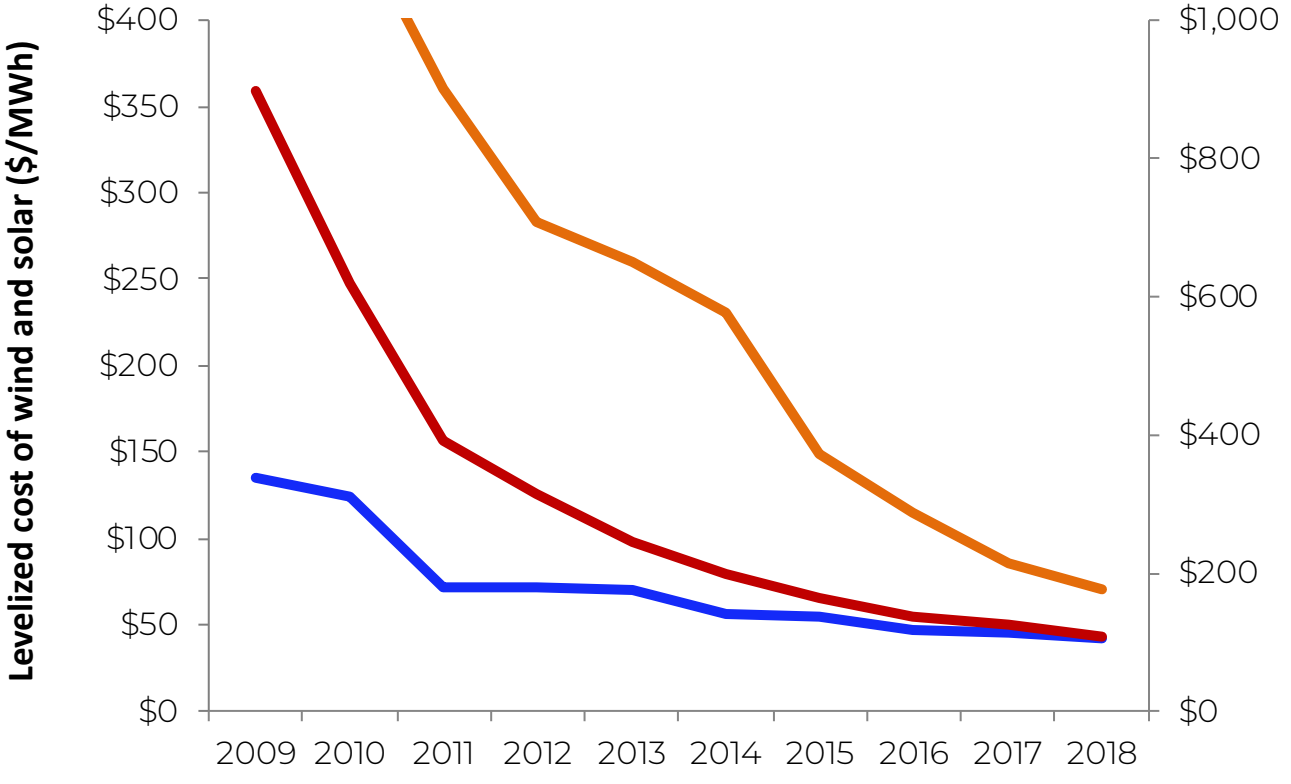
(b) Data source: U.S. EIA for renewables growth rate. MIT *Future of Nuclear in a Carbon Constrained World* study for historic nuclear growth rate (rescaled by population for comparison)

Other Historical Precedents (Scaled To U.S. Population)



Data sources: U.S. renewables from Historical per capita deployment rates from MIT 2018, The Future of Nuclear in a Carbon Constrained World, scaled to based on projected 2035 U.S. population of 364 million from U.S. Census Bureau.

The Good News: Wind, Solar, Battery Costs Plummet



Total cost declines (2009-2018)

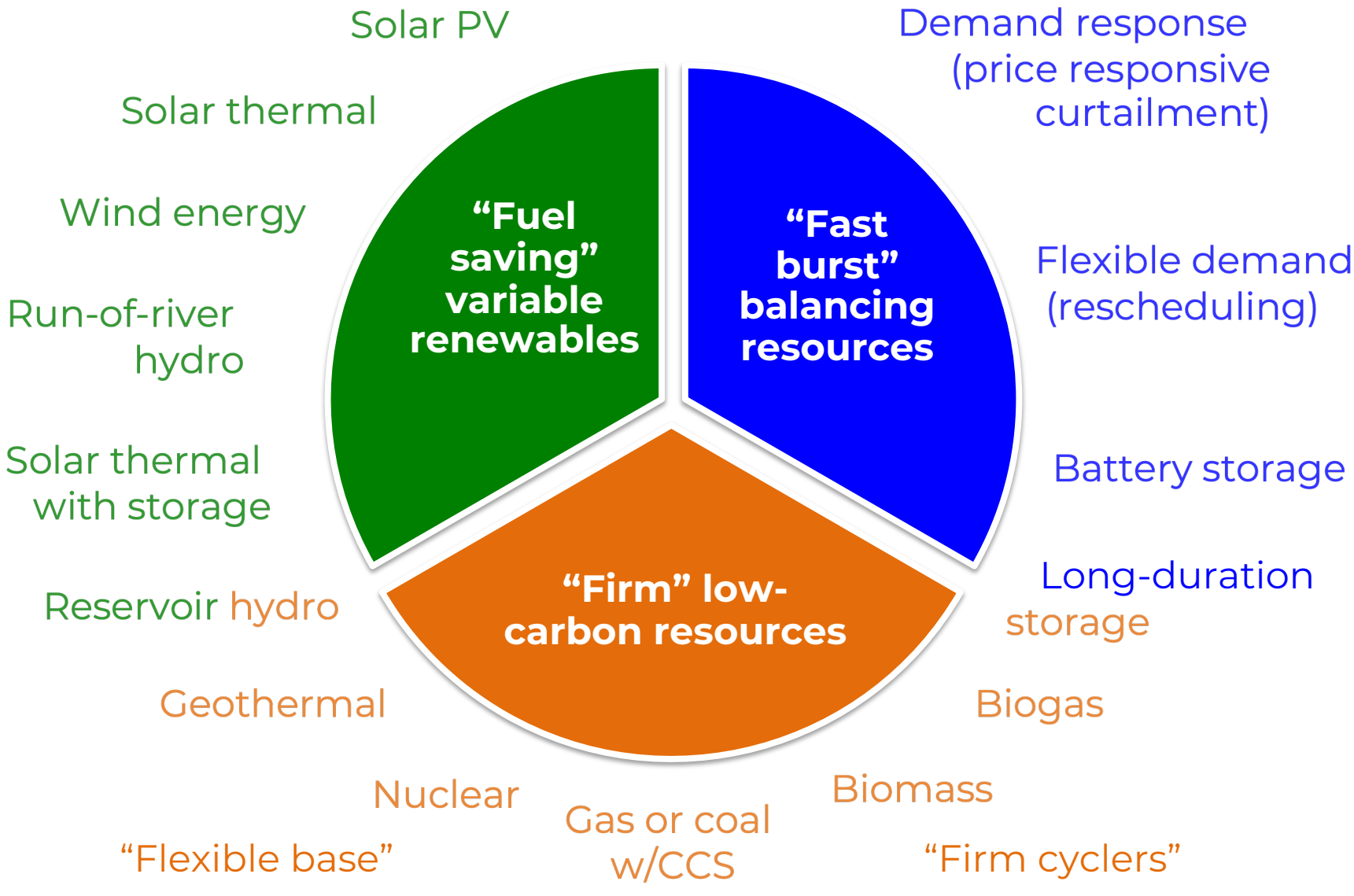
Solar $/MWh -88%

Li-ion packs $/KWh -85%

Wind $/MWh -69%

Data Sources: Wind & solar costs from Lazard (2018), Lazard's Levelized Cost of Energy Analysis – Version 12.0, https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf/. Battery pack costs from Bloomberg New Energy Finance (2018), Battery Price Survey, https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/


15
3
GEORGETOWN
5
GEORGETOWN
Wilson
NCAA


Solar PV
Solar thermal
Wind energy
Run-of-river hydro
Solar thermal with storage
Reservoir hydro
Geothermal
Nuclear
"Flexible base"
Gas or coal w/CCS
Biomass
"Firm cyclers"
Biogas
Long-duration storage
Battery storage
Flexible demand (rescheduling)
Demand response (price responsive curtailment)
"Fuel saving" variable renewables
"Fast burst" balancing resources
"Firm" low-carbon resources

Make Clean Energy Cheap: Scalable Solutions for the World

Image: IEA

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