Let's decarbonize our energy system!

MIT Alumni/ae

Energy, Environment and Sustainability Network

September 16, 2020

Bruce Biewald ‘81

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Synapse Energy Economics

- Founded in 1996 by CEO Bruce Biewald
- Leader for public interest and government clients in providing rigorous analysis of the electric power sector
- Staff of 36 includes experts in energy and environmental economics and electric system planning and policy
- Develops versatile modeling toolkits to map out deep decarbonization strategies based on good data and realistic assumptions

Pandemic Synapse

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Takeaway ideas from this talk on decarbonization

- We can do it!-- the technologies are available, there's some history of significant transformation, and we're making some progress
- It'd going to be hard! -- regulated utilities are central to everything
- There's work for everyone!

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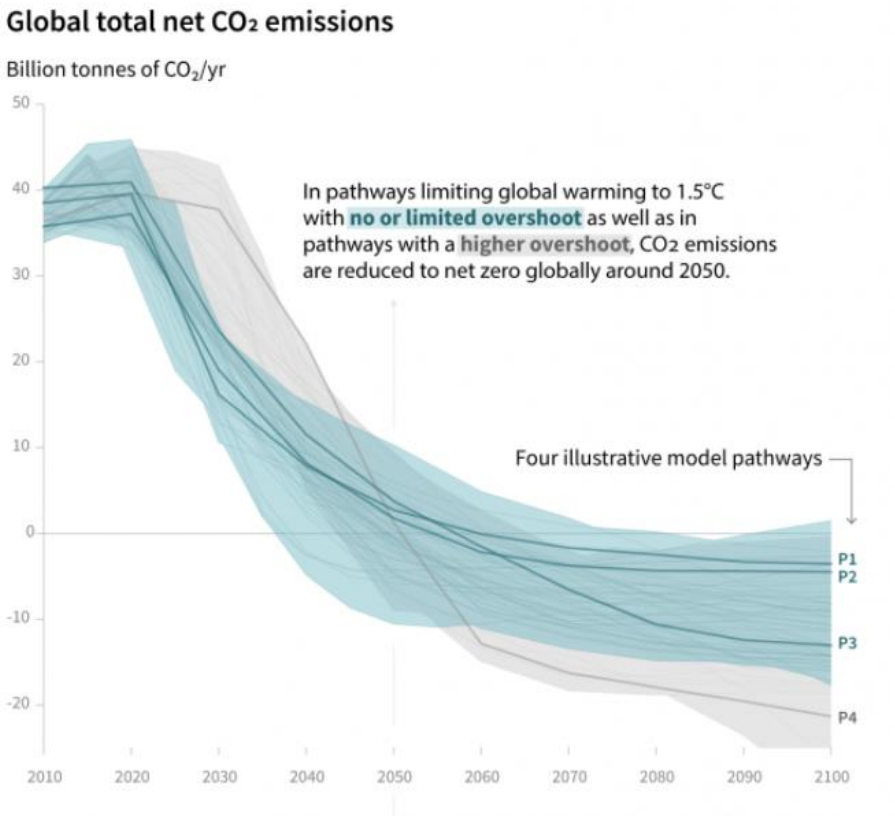
Global CO2 emissions reductions

- CO2 emission reductions to net zero by 2050 are required for 1.5 degree warming scenario



Source: IPCC (https://www.ipcc.ch/sr15/chapter/spm/)

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Electricity is Central to Decarbonization

We have to decarbonize! Starting with electricity

We have to decarbonize transportation

We have to decarbonize buildings

We need more zero carbon electricity

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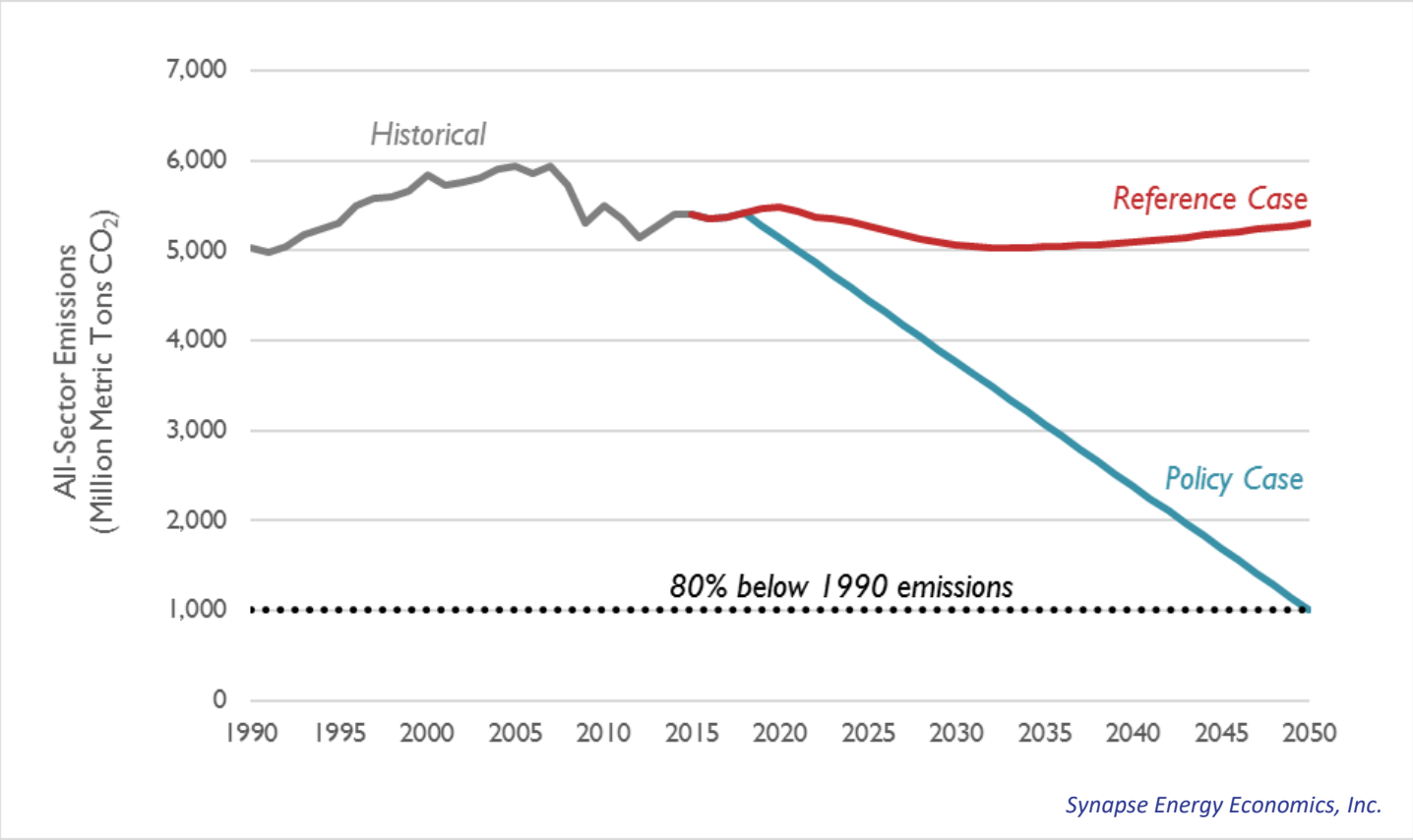
US CO_2 emissions need to decrease



CO_2 emissions from electric power, residential, commercial, industrial, and transportation sectors. Chart developed using Synapse's M-SEM tool.

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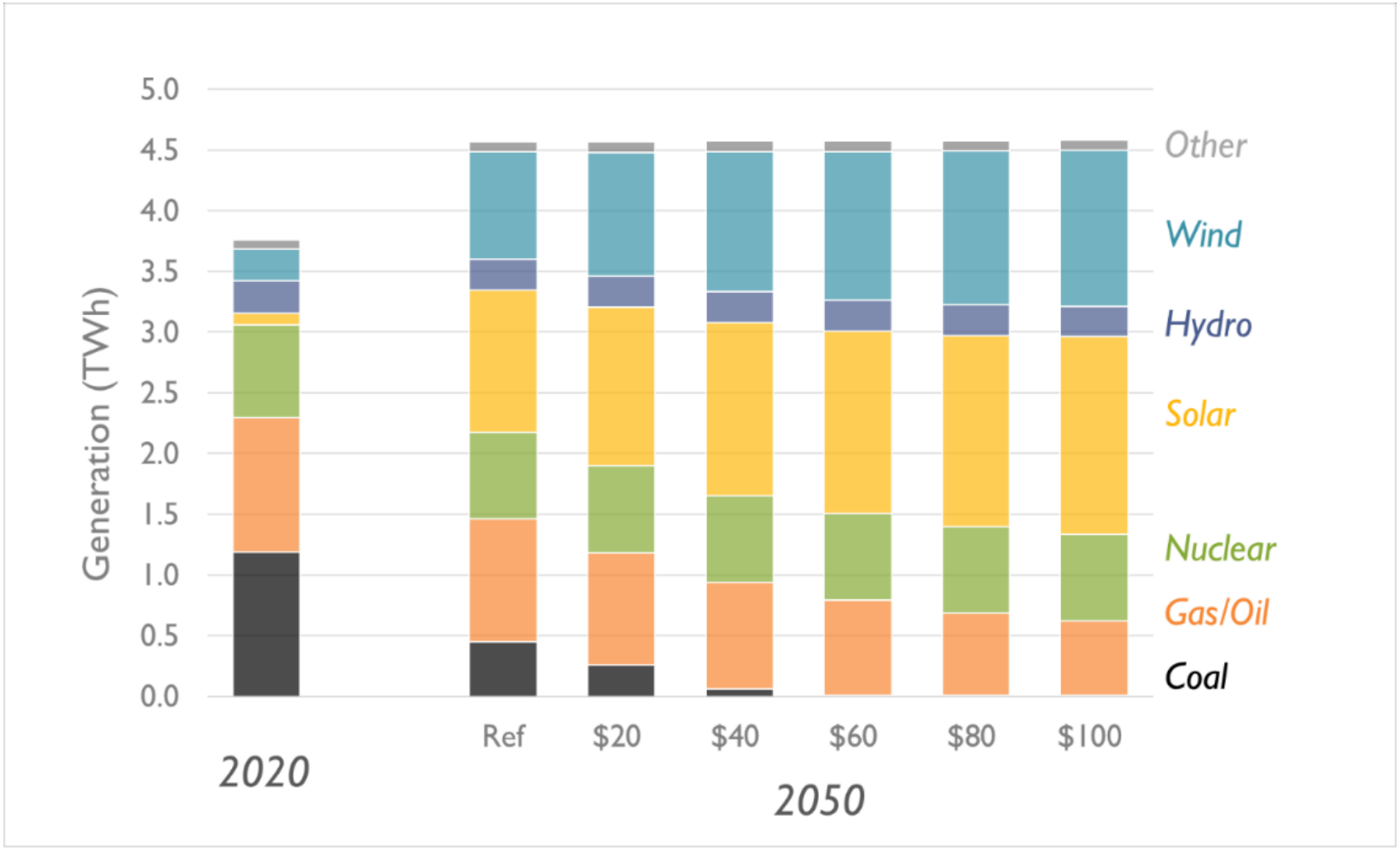
First challenge: Decarbonize Electricity



https://www.synapse-energy.com/about-us/blog/price-emissions-reduction-carbon-price-pathways-through-2050

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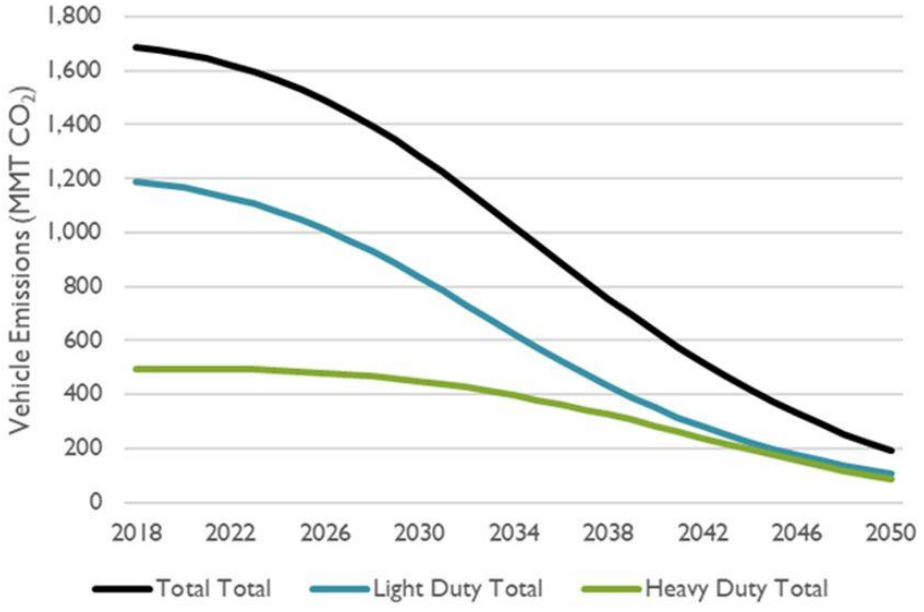
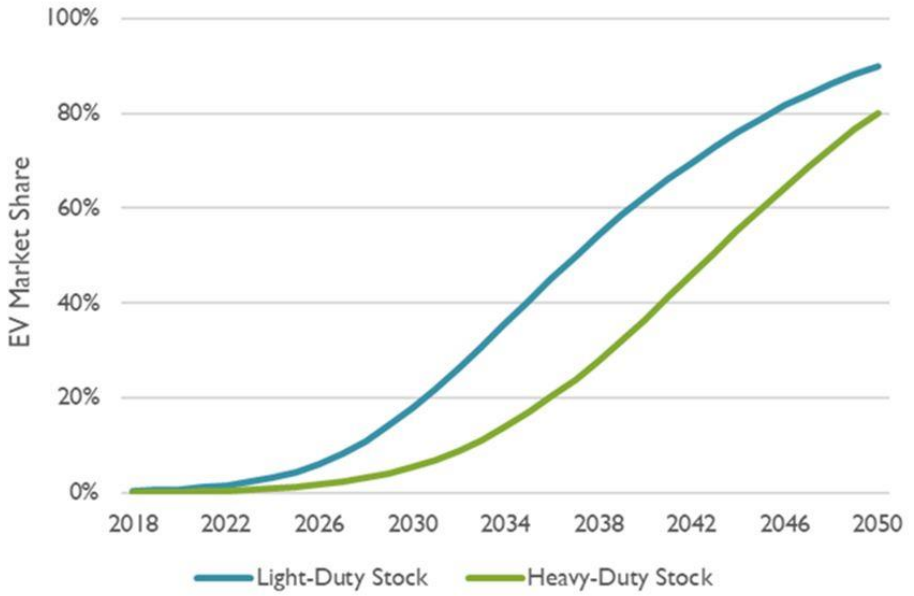
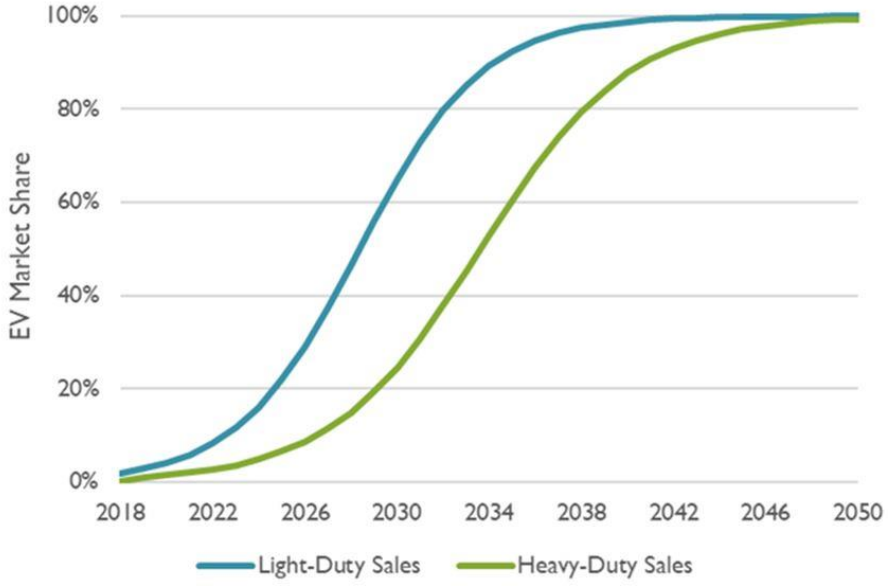
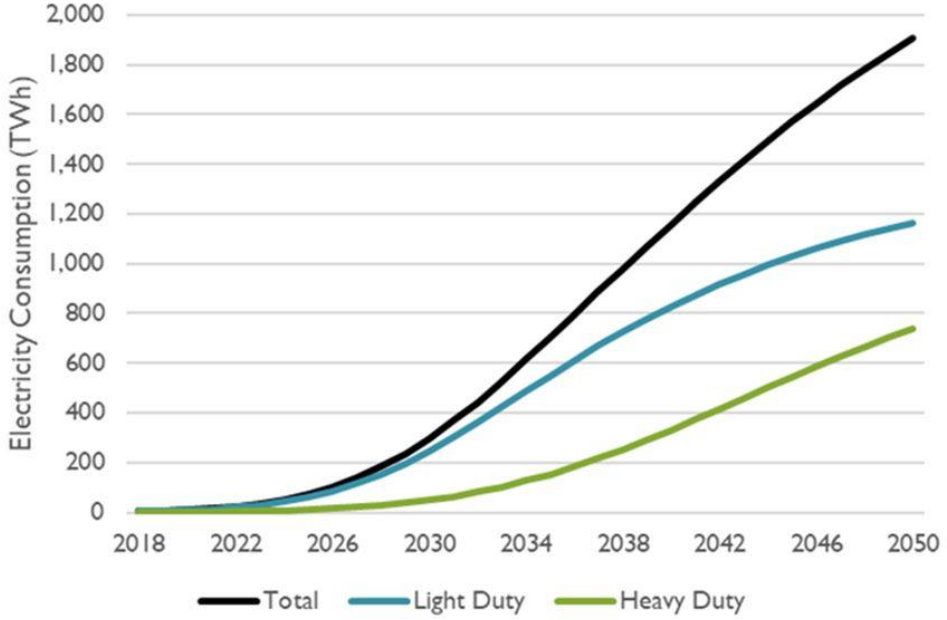
Second challenge: Decarbonize Transportation









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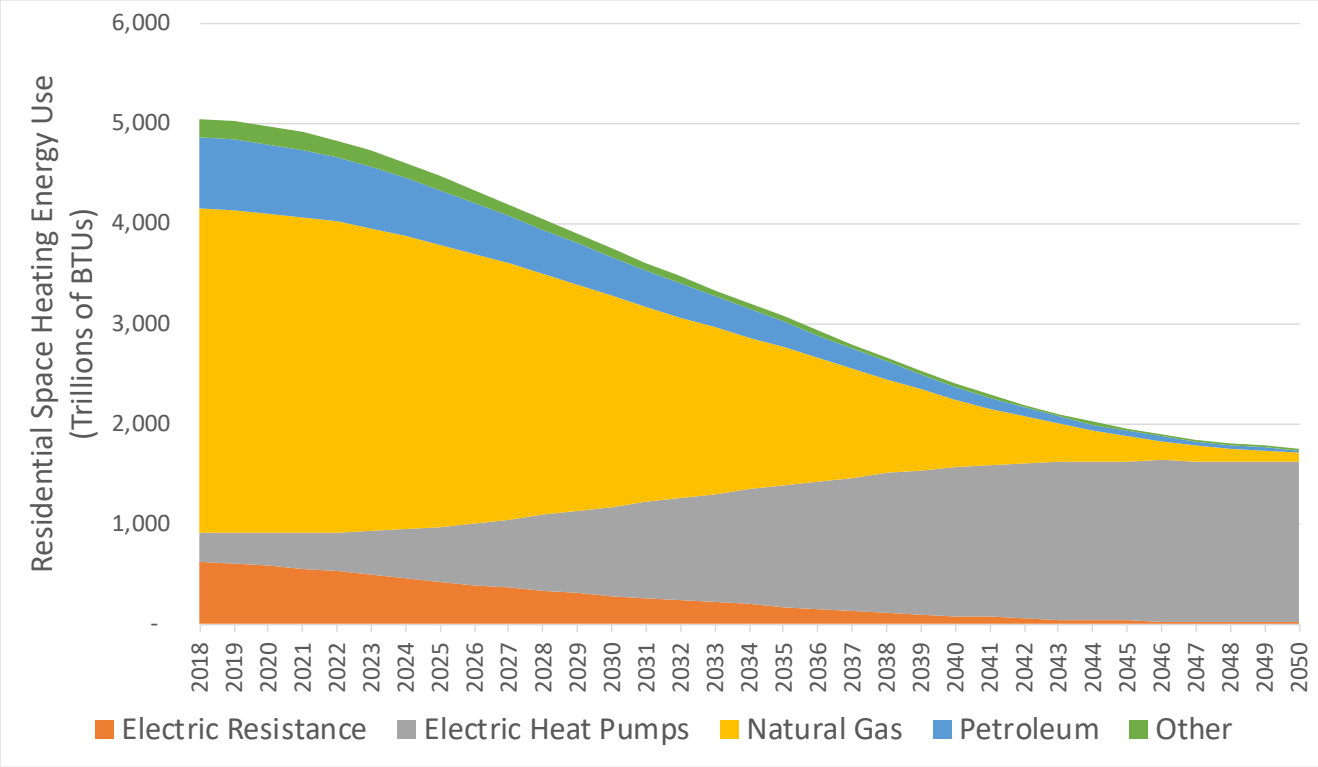
Third Challenge: Decarbonize Buildings

- Heat pumps can replace fossil fuel space and water heat in nearly every building today – but they are only widely adopted in some regions of the country
- Long lifetimes of appliances mean that transformation of sales markets must happen soon in order to achieve stock turnover by 2050.



Source: Synapse modeling of "maximum electric" case of building system turnover

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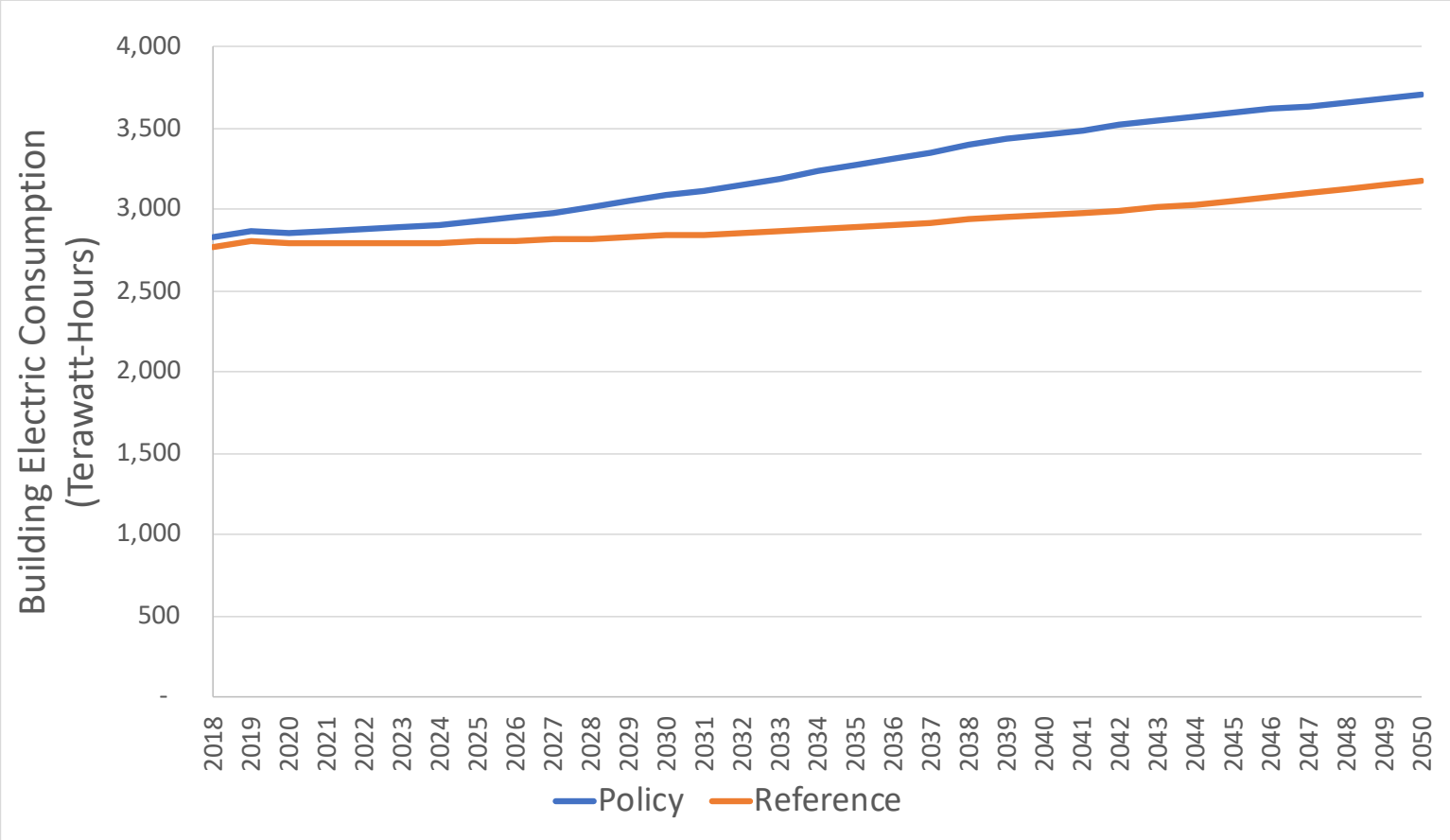
Additional Electricity for Buildings

- Building electrification will require more (low carbon!) electricity



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Decarbonizing the Energy System

- Electric System Transformation
- Transportation System Transformation
- Buildings Transformation
- Electrify everything!

  - - - - - - - - - - we are here - - - - - - - - - - - - -

- Let's look at the past – what can we learn?
- Utility resource planning is terrible: targets vs. plans; sunk costs; bad planning; bad incentives
- Recipe for success

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Clean up successes

We cleaned up SO2 and NOx from the electric sector over 20 years.

Sulfur Dioxide

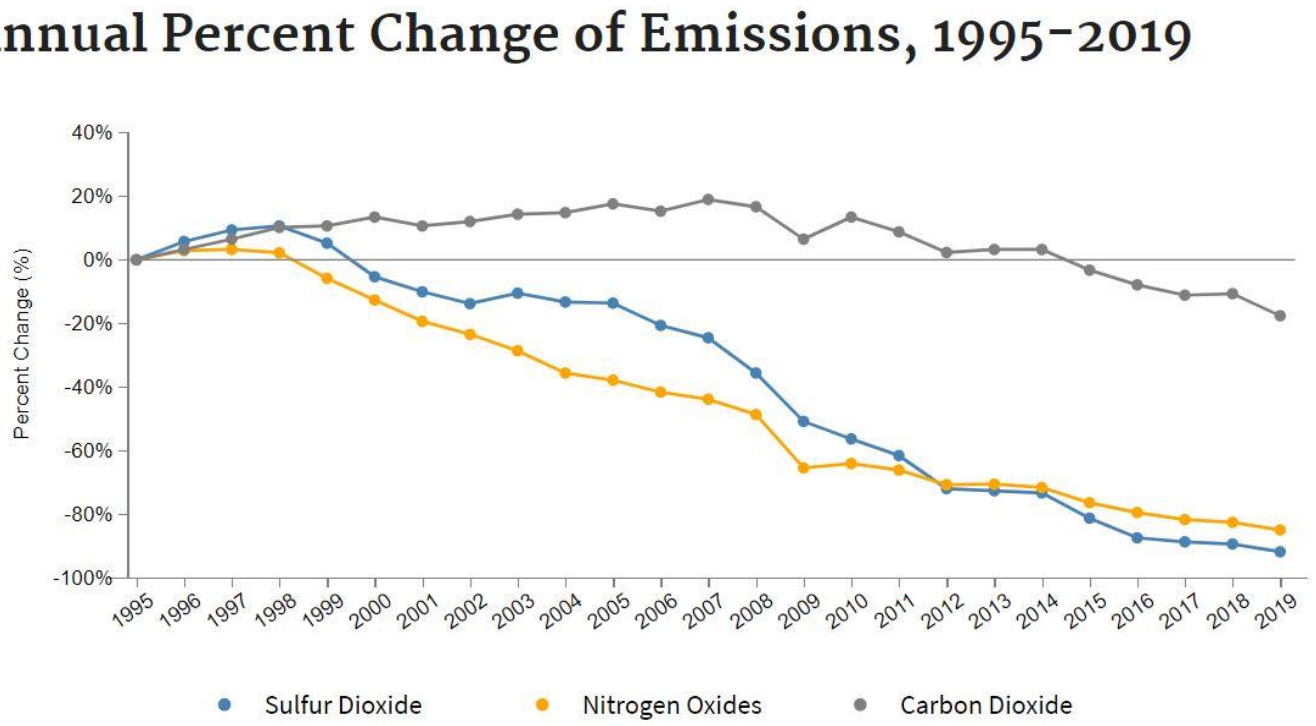
-92%

Nitrogen Oxides

-85%

Carbon Dioxide

-18%



Source: https://www.epa.gov/airmarkets/power-plant-emission-trends

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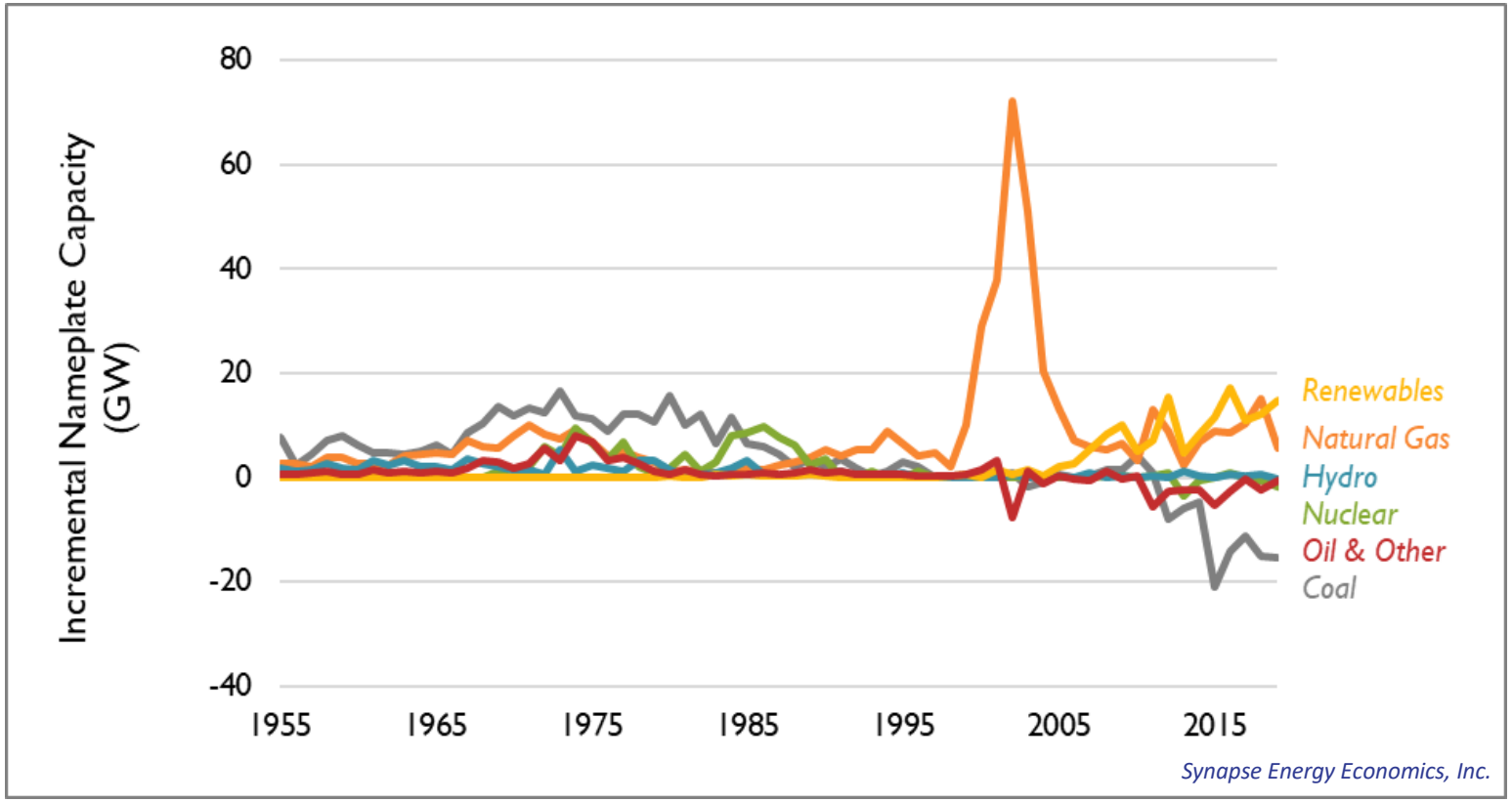
Electric System Capacity Additions and Retirements



Note: This figure displays net nameplate values for utility-scale generators; annual capacity retirements are subtracted from annual capacity additions.

In this and all other figures, "Renewables" contains wind, solar, geothermal, and storage. "Oil and Other" contains oil, biomass, and other misc. fuel types.

While coal capacity and oil capacity are in decline, renewable and natural gas capacity grow every year.

2019 was the third-highest year in history for renewable capacity additions.

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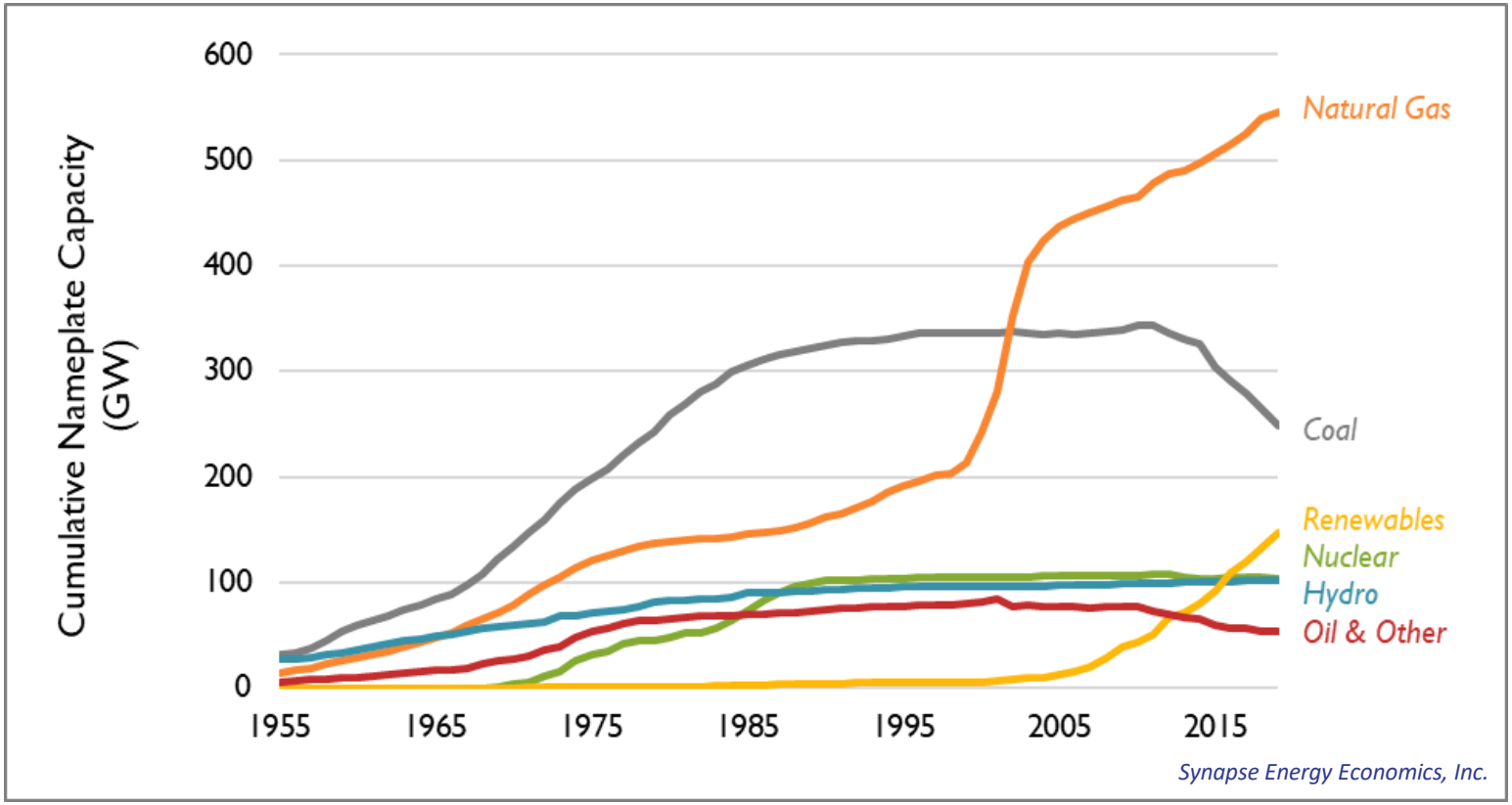
Electric System Capacity by Type



Note: This figure displays net nameplate values for utility-scale generators; annual capacity retirements are subtracted from annual capacity additions.

In 2019, renewable resources reached 12 percent of total U.S. generating capacity. In the 10 years since 2010, renewables have increased by 103 GW, compared to an 80 GW increase in natural gas over the same period. 94 GW of coal was retired over this same 10-year period.

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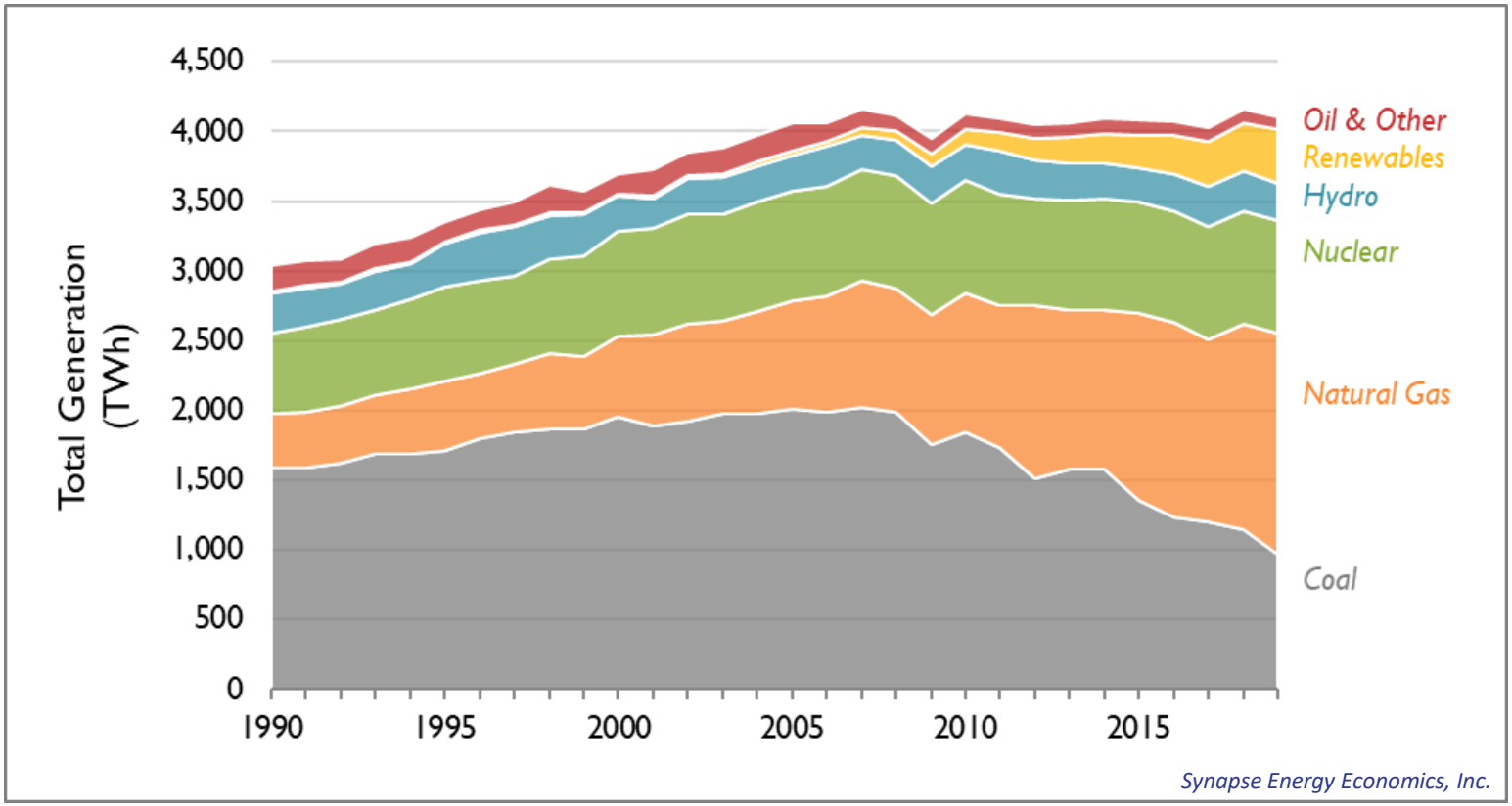
Coal generation is at its lowest level since 1976



In 2019, the amount of electricity generated from natural gas exceeded that from coal by 64 percent, up from 29 percent in 2018.

Since 2010, total annual U.S. generation has increased by less than 0.4 percent per year.

For the first time since the late 1970s, coal generation dropped below 1,000 TWh per year.

For the first time since at least the 1940s, coal made up less than 25% of nationwide electricity generation.

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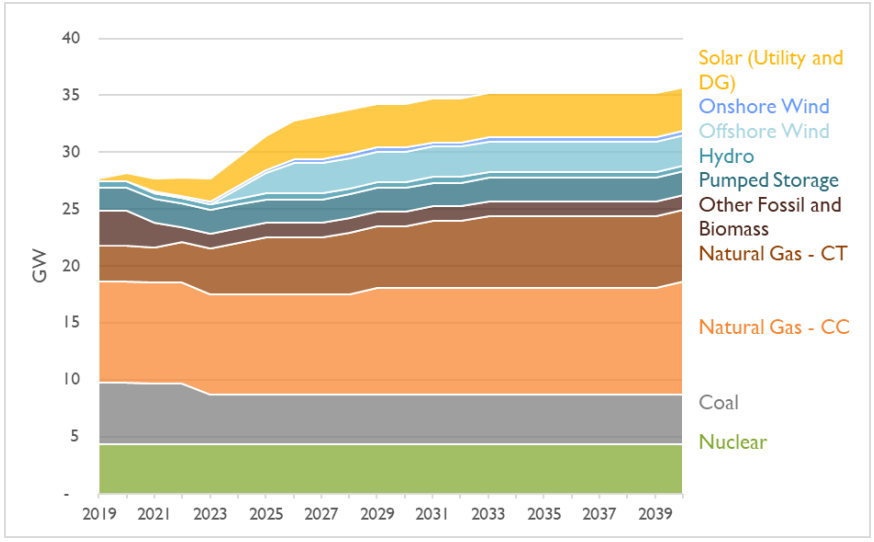
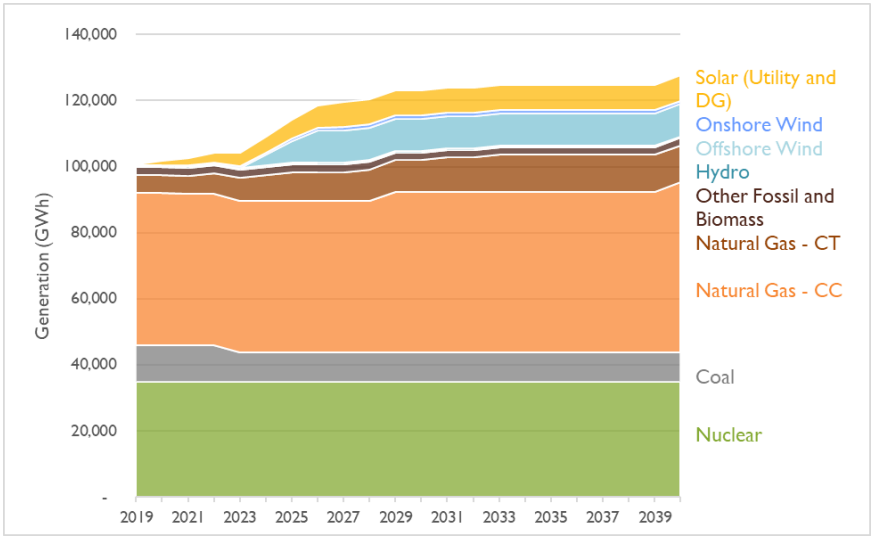
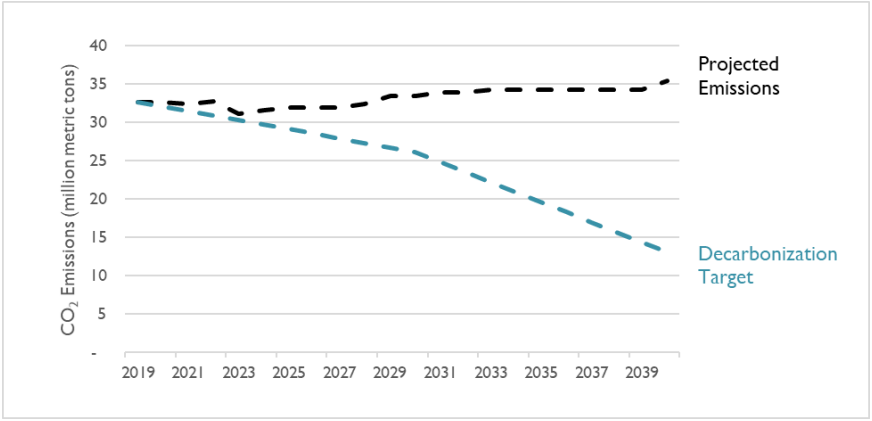
Utility Plans Don't Achieve CO2 Targets: Dominion Energy



Dominion Energy nameplate capacity of future resource plans (2019–2040)



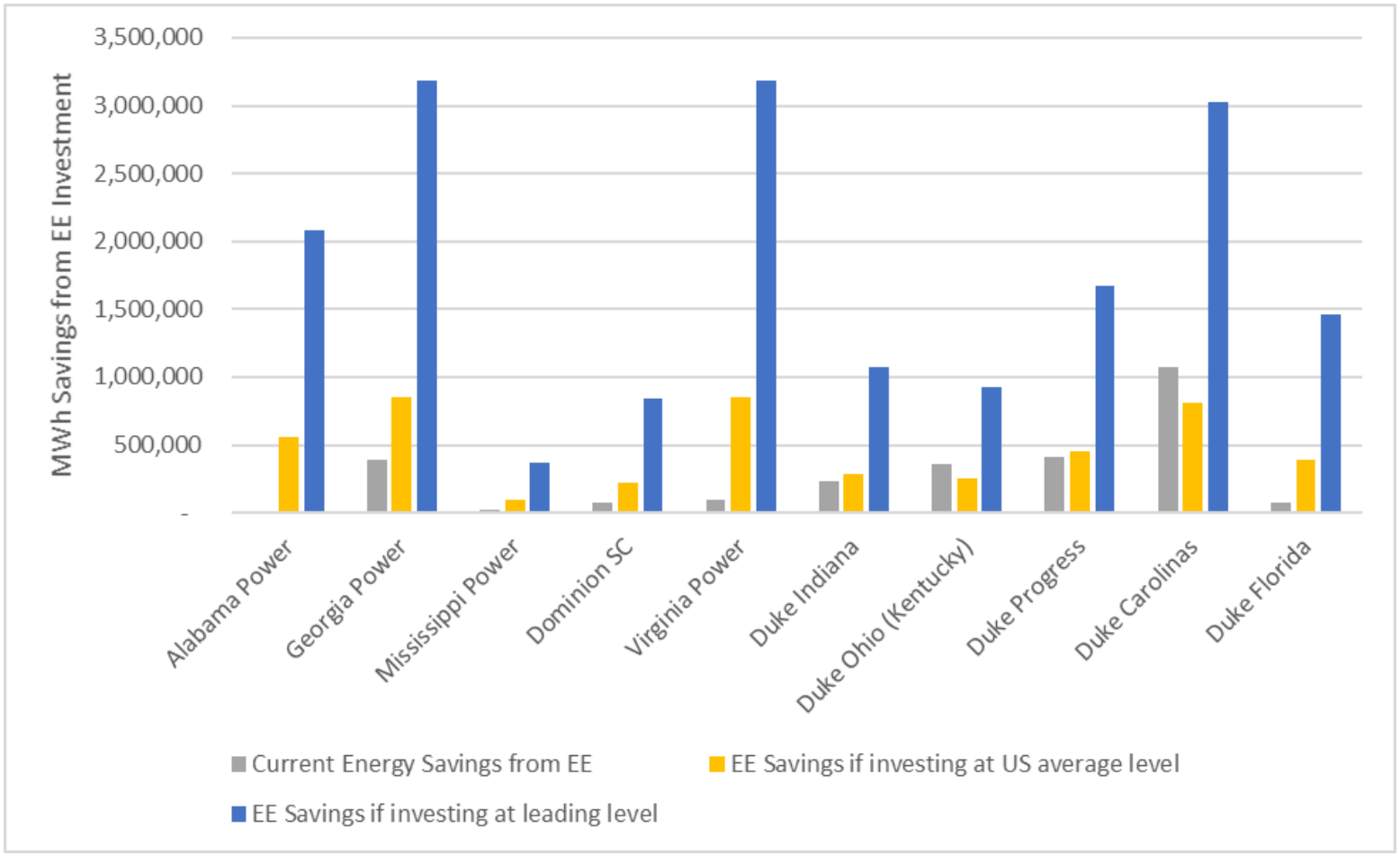
Dominion Energy projected generation (2019–2040)



Dominion Energy projected emissions (2019–2040)

Source: EIA form 860m, November 2019, EIA 923m November 2019, EIA Carbon Dioxide Emissions at Electric Power Plants supplemented by Virginia Power's 2018 IRP and Update to the 2018 IRP, and SCE&G's 2019 IRP. *©2020 Synapse Energy Economics Inc. All rights reserved.*

Energy Efficiency Potential Targets



Energy efficiency savings equivalents for national average and leading utility savings levels

*Source: EIA f861, 2018 Sales and EE tables, *ACEEE 2020 Utility Energy Efficiency Scorecard.* *©2020 Synapse Energy Economics Inc. All rights reserved.*

Types of problems in utility resource plans

- Plain old errors
- Outdated assumptions
- Biased cost inputs
- Unrealistic resource limits
- Technical details (e.g., “end effects”)
- Myopia (e.g., “piecemealing”)
- Unrealistic representation of programs, policies, laws, and regulations
- Geographic boundaries
- Unreasonable approaches to risk and uncertainty
- Considering sunk costs
- Inadequate documentation
- Lack of transparency
- Hostility to stakeholder input

(any of these could be willful negligence or inadvertent)

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Why is utility planning so bad?

Regular Business	Regulated Monopoly Utility Business
Prices determined by strategy and markets	Prices set by regulators
Cost overruns decrease profits	Cost overruns can increase profits
Manage risk	Manage regulatory risk
Ignore sunk cost	Significant concern about sunk cost recovery

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Regulated Utilities are Terrible at Planning and Innovation

Sunk costs should not matter but they do.
A lot.

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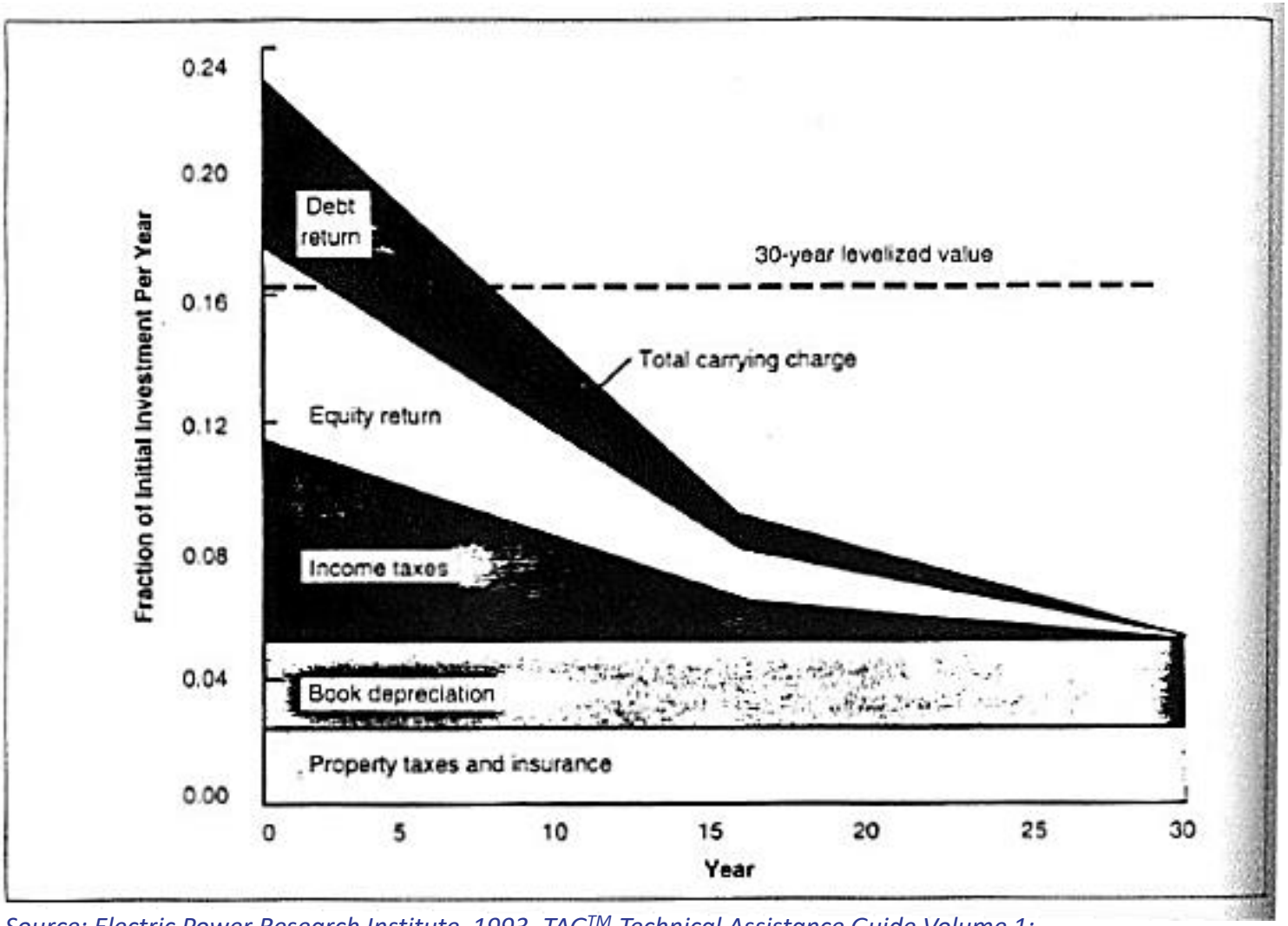
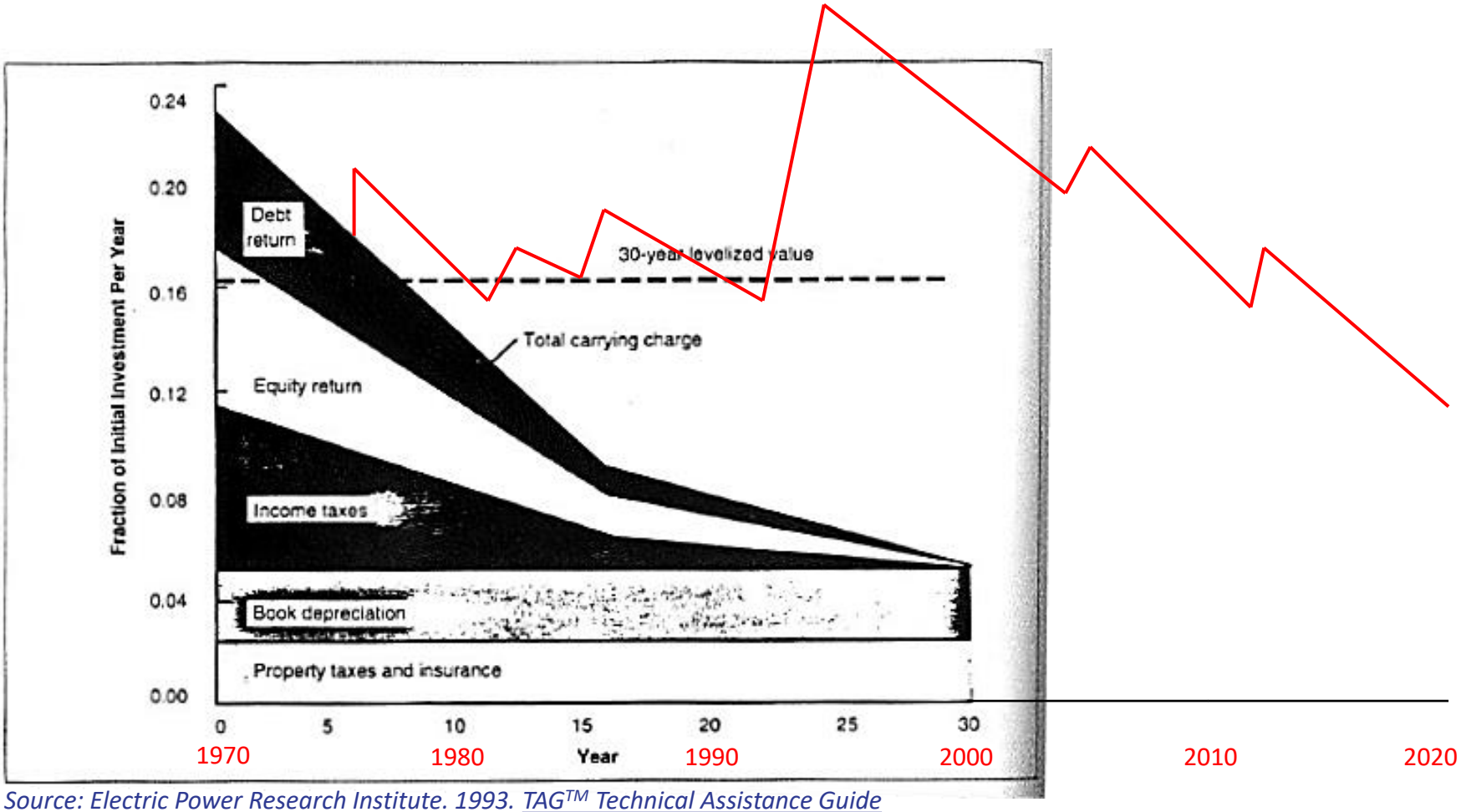
Coal plant revenue requirement 30 year depreciation



Source: Electric Power Research Institute. 1993. TAG™ Technical Assistance Guide Volume 1: Electricity Supply—1993 (Revision 7). Page 6-4.

Coal plant revenue requirement with life extension and capital additions



Source: Electric Power Research Institute. 1993. TAG™ Technical Assistance Guide Volume 1: Electricity Supply—1993 (Revision 7). Page 6-4.

Utility ratemaking

- Regulated Monopoly Economics
- Electric utility prices are not set by “the market.” They are set by state public utility commissions in “rate cases.”
- Fuel, O&M, purchased power, and administrative costs are passed through as expenses
- Power plant investments are put into “ratebase” and recovered over time with an allowed administratively determined return on equity
- Plant investment that is not prudently incurred should be removed from rates
- Plant investment that is not “used and useful” should be removed from rates

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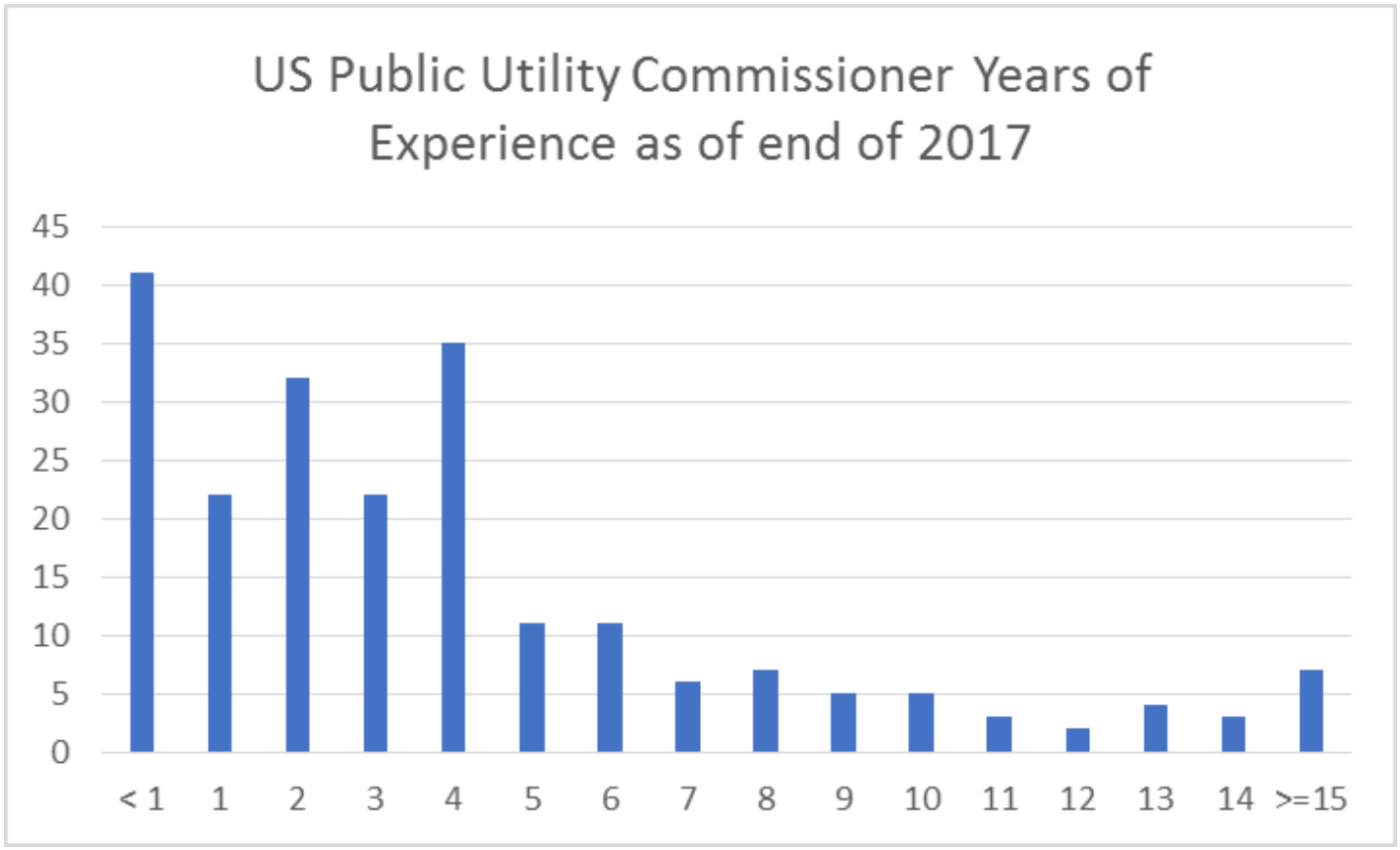
Most state regulators have only a few years in the job



Source: National Association of Regulatory Utility Commissioners, 2017 Membership Directory (Condensed Edition)

- Median experience of a state utility commissioner is about 3.5 years.
- 70 percent of commissioners have less than 5 years of experience.

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Use competitive RFPs

RFP Responses by Technology

Generation Technology	# of Bids	Bid MW	# of Projects	Project MW	Median Bid Price or Equivalent	Pricing Units
Combustion Turbine/IC Engines	30	7,141	13	2,466	$ 4.80	$/kW-mo
Combustion Turbine with Battery Storage	7	804	3	476	6.20	$/kW-mo
Gas-Fired Combined Cycles	2	451	2	451	[redacted]	$/kW-mo
Stand-alone Battery Storage	28	2,143	21	1,614	11.30	$/kW-mo
Compressed Air Energy Storage	1	317	1	317	[redacted]	$/kW-mo
Wind	96	42,278	42	17,380	$ 18.10	$/MWh
Wind and Solar	5	2,612	4	2,162	19.90	$/MWh
Wind with Battery Storage	11	5,700	8	5,097	21.00	$/MWh
Solar (PV)	152	29,710	75	13,435	29.50	$/MWh
Wind and Solar and Battery Storage	7	4,048	7	4,048	30.60	$/MWh
Solar (PV) with Battery Storage	87	16,725	59	10,813	36.00	$/MWh
IC Engine with Solar	1	5	1	5	[redacted]	$/MWh
Waste Heat	2	21	1	11	[redacted]	$/MWh
Biomass	1	9	1	9	[redacted]	$/MWh
Total	430	111,963	238	58,283		

Source: Xcel Energy. 2016 Electric Resource Plan, 2017 All Source Solicitation 30-Day Report. Attachment A, p. 9. December 28, 2017.

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Recipe for Success

- Support decision-making and energy investment that is in the public interest
- Funding for intervenors
- Open source models for planning
- Education and support for regulators
- Use competition where reasonably feasible
- Ratemaking to incentivize desired performance
- Broad policies (carbon price/cap) and targeted policies
- There's work for everyone: the public; government; utilities; private sector; engineers and planners.

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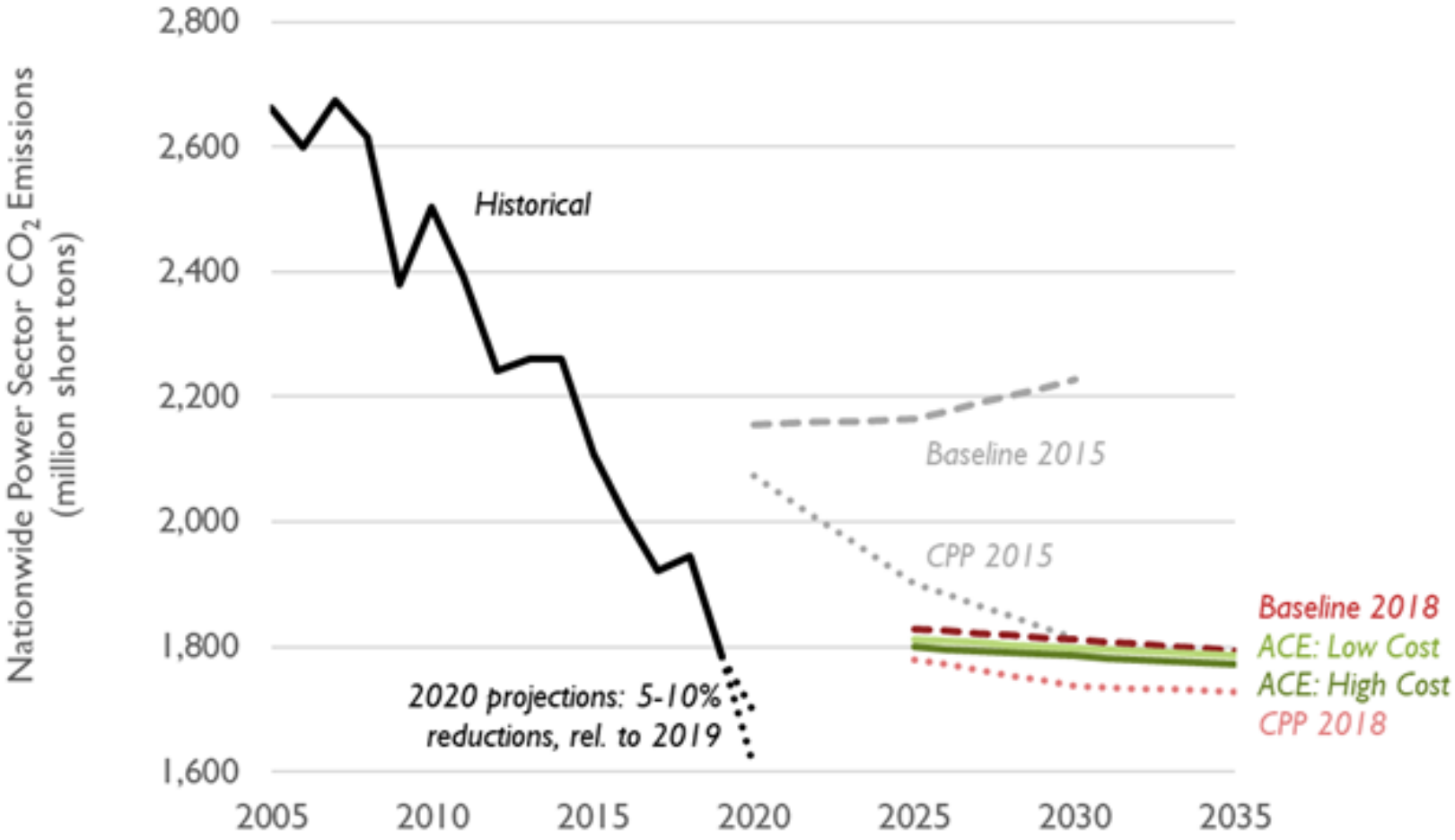
Electric Sector CO2 Trends



Source: EIA data and Synapse Energy Economics

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Resources

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Key takeaway: Utility planning can and should be improved!

Contact info: Bruce Biewald, Synapse Energy Economics
Cambridge, Massachusetts
617.453.7022 & bbiewald@synapse-energy.com

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