

Buildings Working Group Meeting II



Office of Energy Consumption and Efficiency Analysis

October 3, 2019 | Washington, DC

By

Buildings Energy Analysis Team

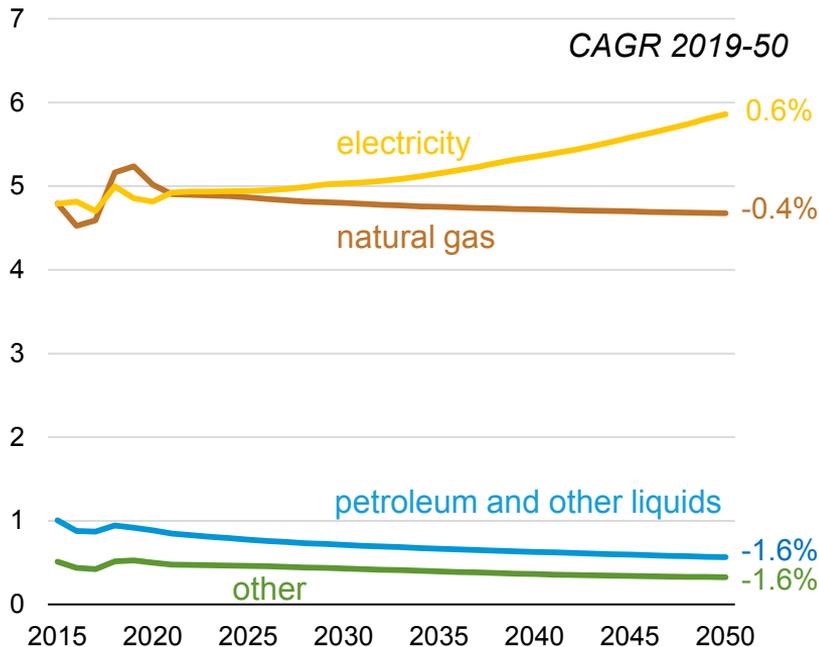
Overview

- AEO2020 results overview—delivered energy by fuel
- Comparison with AEO2019
 - Model drivers
 - Residential and commercial electricity and natural gas consumption
 - General Service Lighting definition change
- Revised distributed generation and combined heat and power (CHP) cost and performance characteristics
- Commercial distributed generation methodology updated
- Commercial minor fuels and other modeling updates

AEO2020 Results Overview

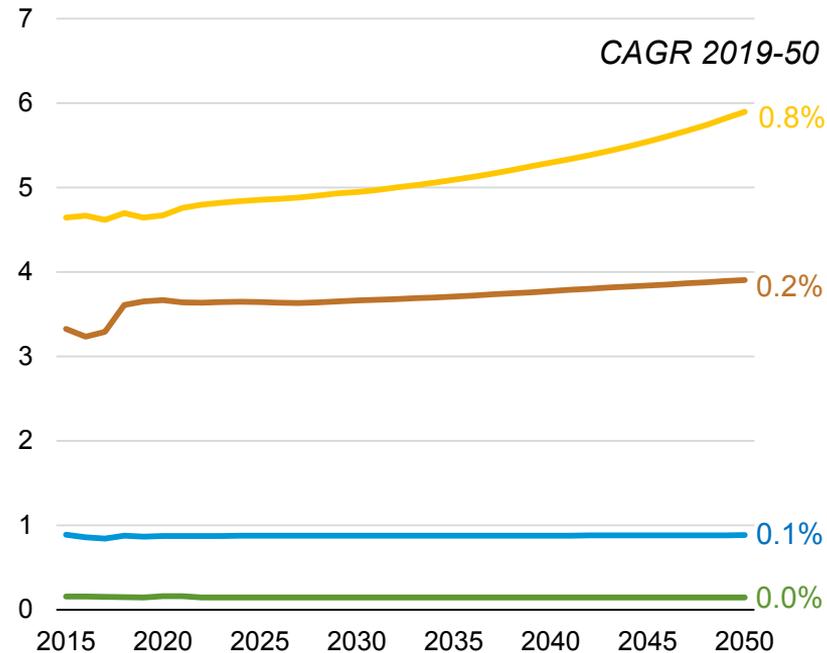
Electricity continues to be the fastest-growing energy source for building use in AEO2020

Residential sector delivered energy consumption
quadrillion British thermal units



Source: AEO2020 preliminary

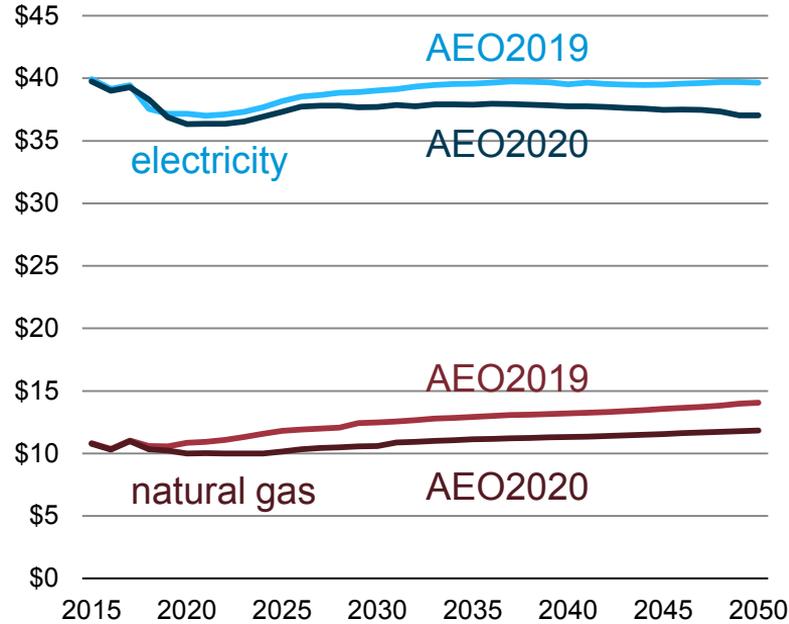
Commercial sector delivered energy consumption
quadrillion British thermal units



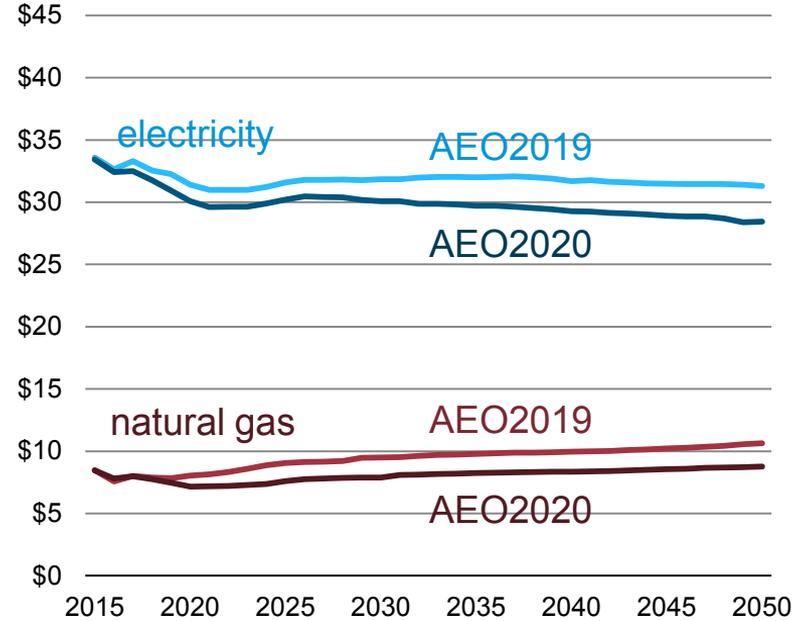
Comparison with AEO2019

End-use fuel prices are lower in AEO2020 than AEO2019

Residential fuel prices
2019 \$/MMBtu

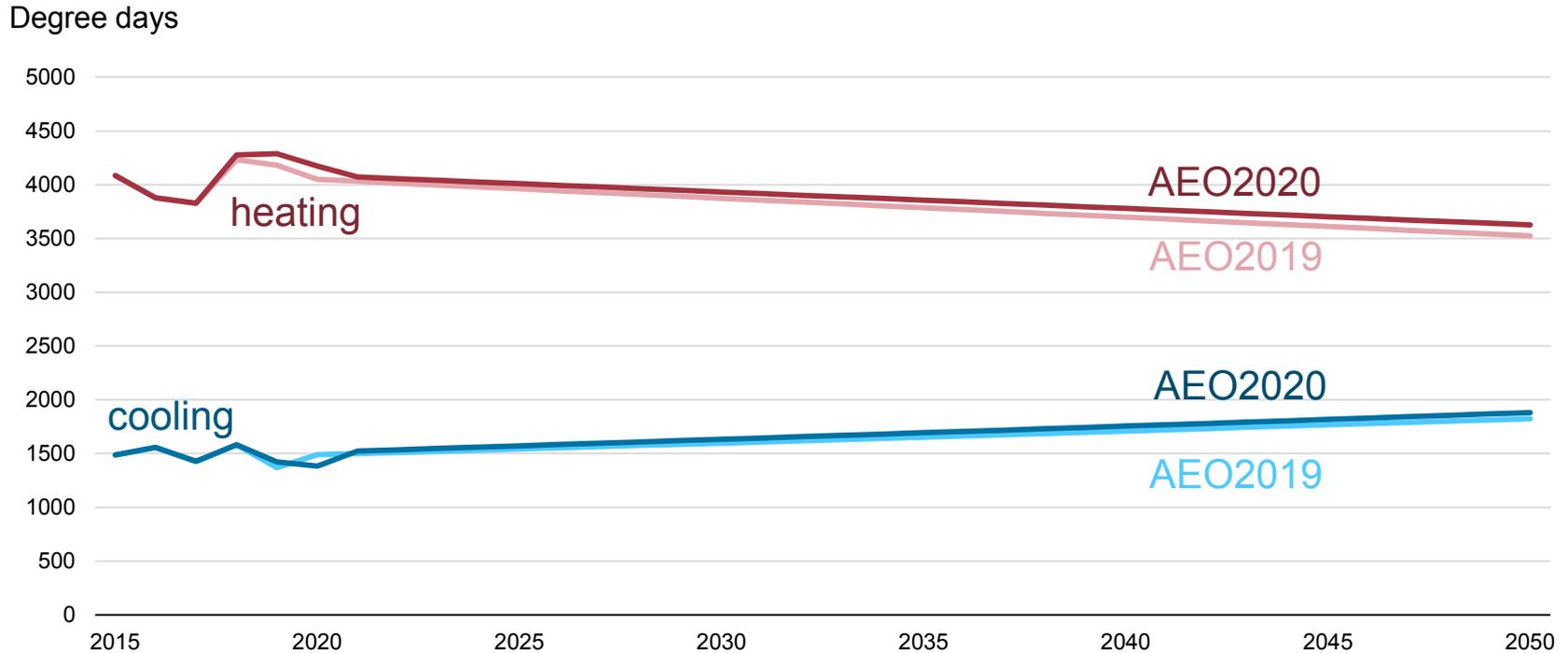


Commercial fuel prices
2019 \$/MMBtu



Sources: AEO2020 preliminary, AEO2019

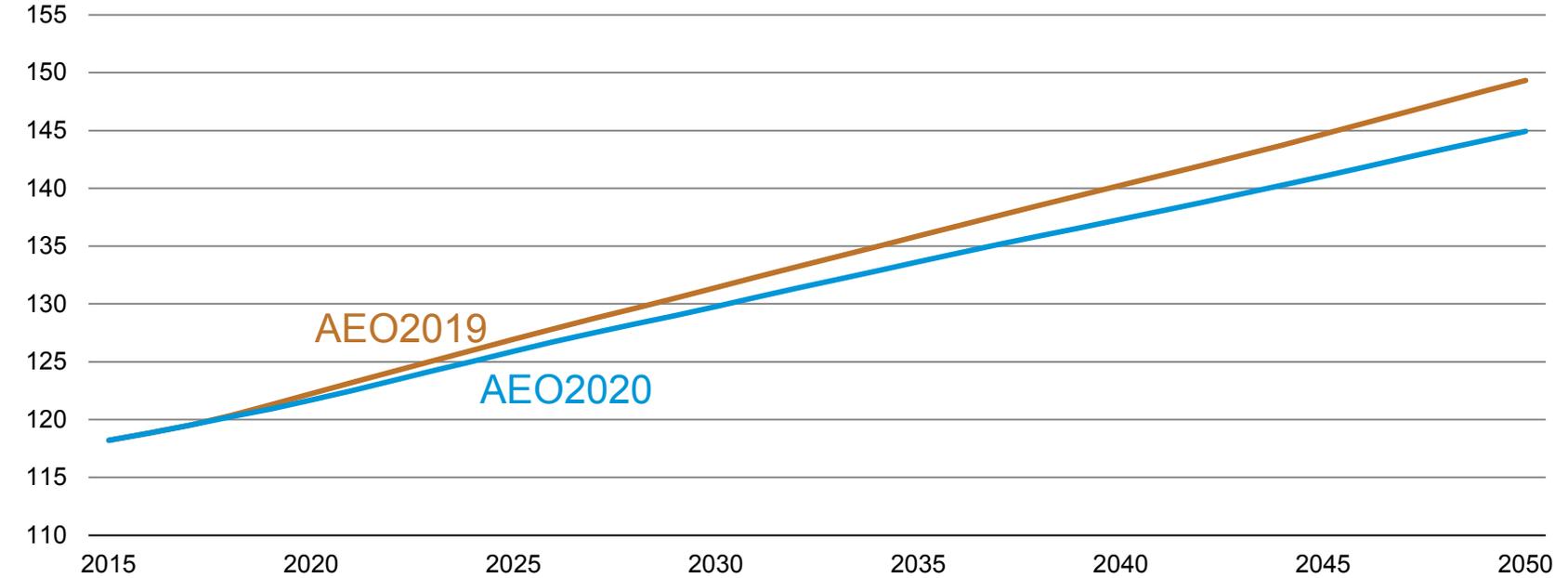
Heating and cooling degree days include NOAA historical data and short-term forecast, along with 30-year trend through projection period



Sources: AEO2020 preliminary, AEO2019. NOAA refers to the National Oceanic and Atmospheric Administration.

Macroeconomic Activity Module projects fewer housing starts

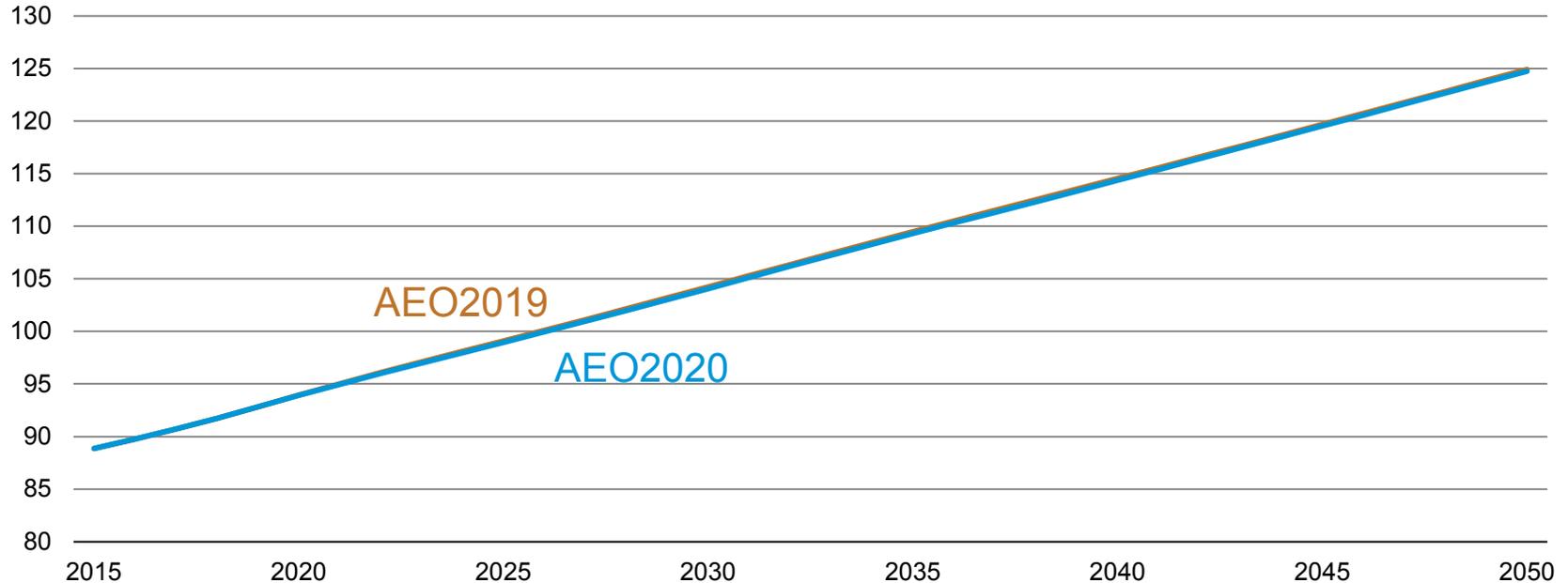
Total households
millions



Sources: AEO2020 preliminary, AEO2019

Commercial floorspace projection closely resembles AEO2019

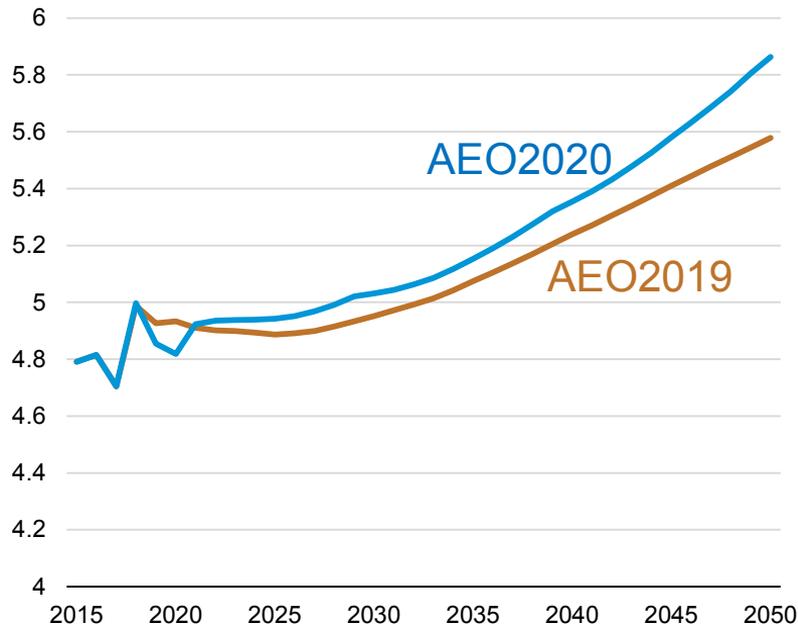
Commercial floorspace
billion square feet



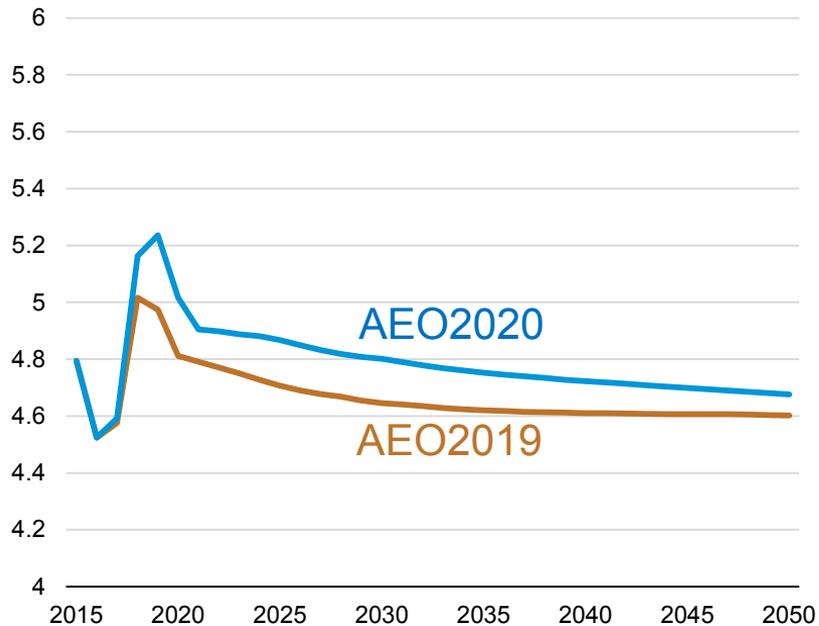
Sources: AEO2020 preliminary, AEO2019

Lower electricity prices and higher heating and cooling degree days drive changes in residential consumption

Residential purchased electricity consumption
quadrillion British thermal units



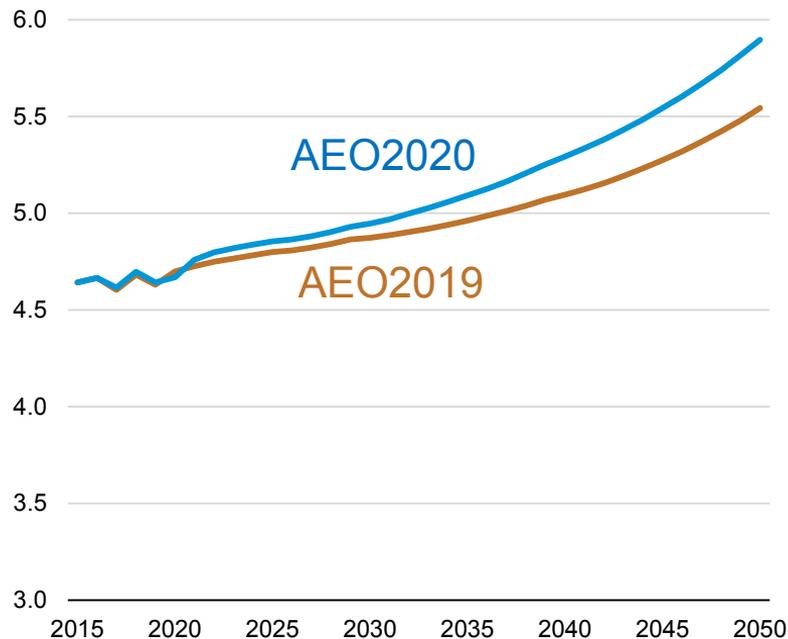
Residential natural gas consumption
quadrillion British thermal units



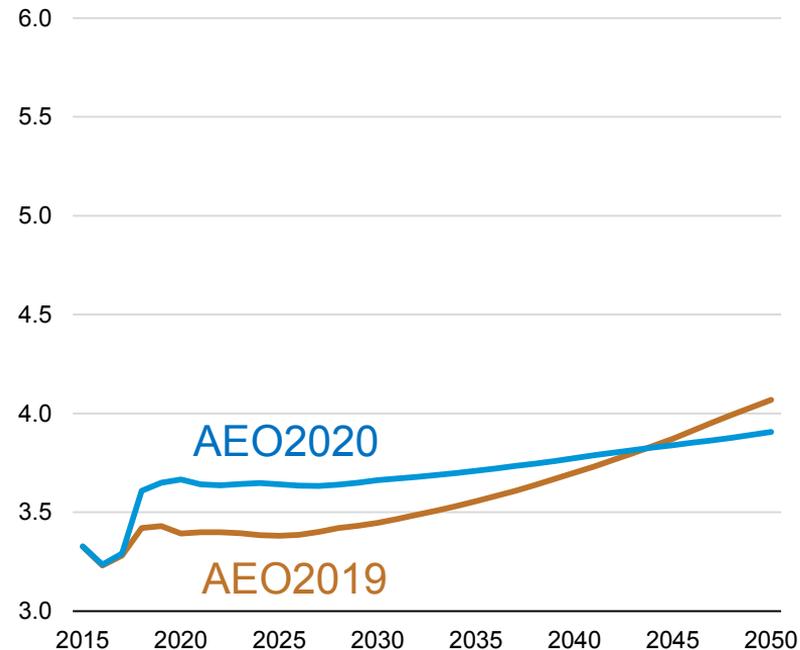
Sources: AEO2020 preliminary, AEO2019

Lower electricity and natural gas prices and lower combined heat and power (CHP) growth drive changes in commercial consumption

Commercial purchased electricity consumption
quadrillion British thermal units



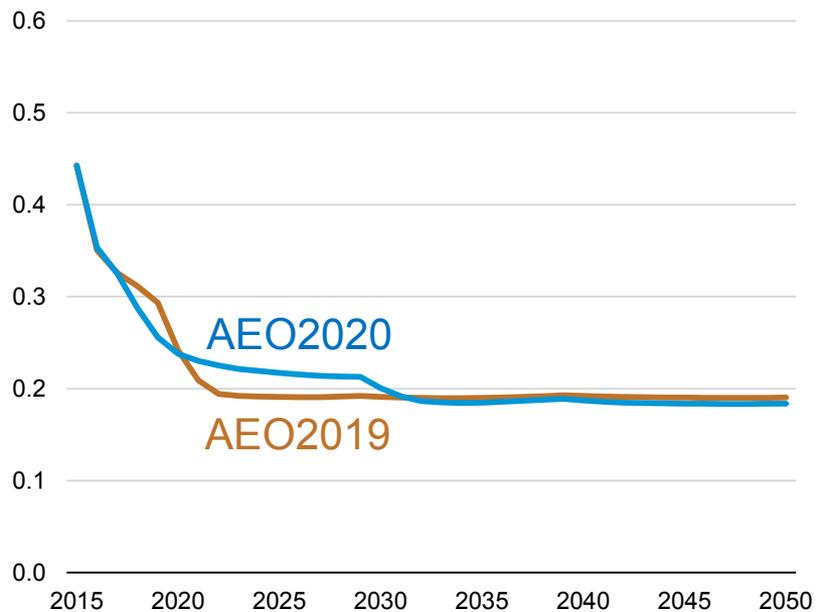
Commercial natural gas consumption
quadrillion British thermal units



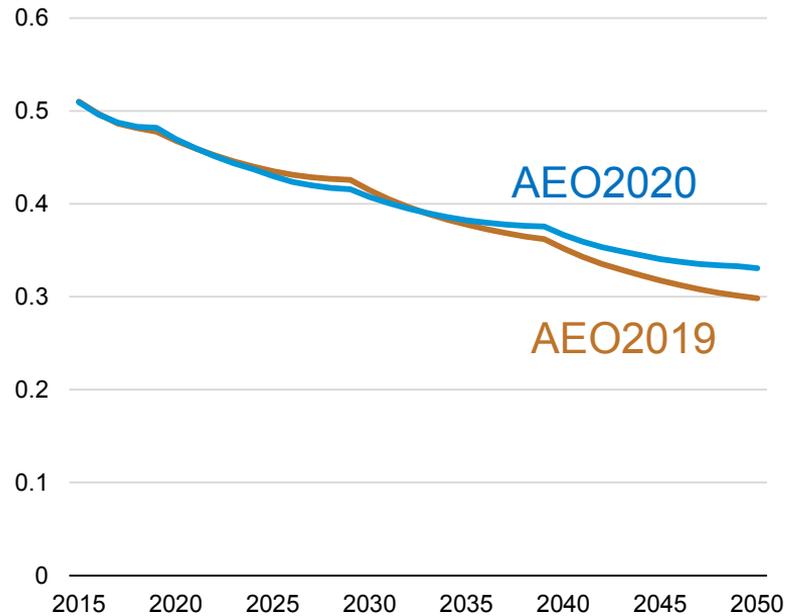
Sources: AEO2020 preliminary, AEO2019

Definition of General Service Lighting narrowed to exclude technology types such as reflector lamps

Residential delivered lighting energy consumption
quadrillion British thermal units



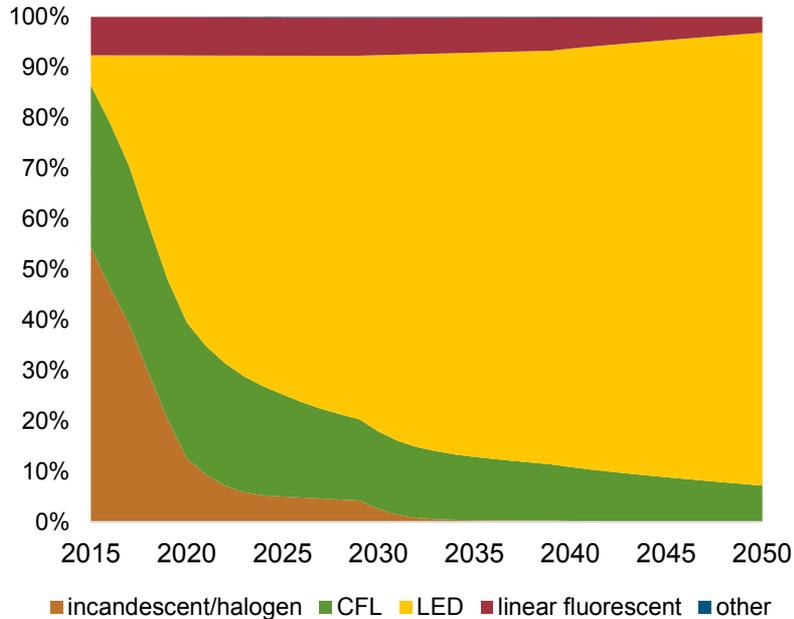
Commercial delivered lighting energy consumption
quadrillion British thermal units



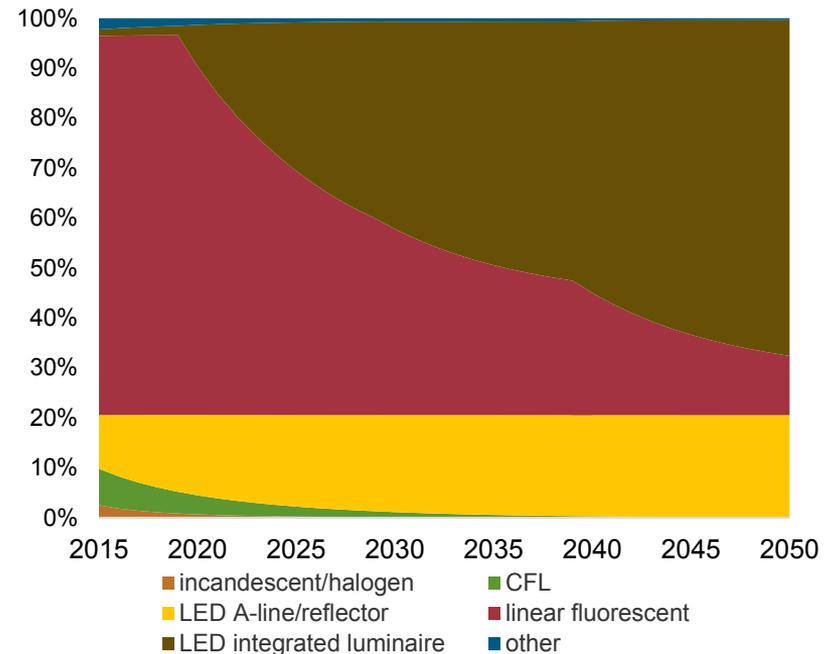
Sources: AEO2020 preliminary, AEO2019

Definition of General Service Lighting narrowed to exclude technology types such as reflector lamps

Residential lighting shares by bulb type
percent of lightbulb stock



Commercial lighting shares by bulb type
percent of lighting service demand met



Source: AEO2020 preliminary

Revised residential distributed generation and combined heat and power (CHP) cost and performance characteristics

Technology type	Year of introduction	Average generating capacity (kW _{DC})		Electrical efficiency		Combined efficiency (elec. + thermal)		Installed capital cost (2018\$ per kW _{DC})		Service life (years)	
		AEO2019	AEO2020	AEO2019	AEO2020	AEO2019	AEO2020	AEO2019	AEO2020	AEO2019	AEO2020
Solar photovoltaic	2015	6.2	6.0	0.17	0.17	N/A	N/A	\$4,156	\$4,020	30	25
	2020	6.7	7.3	0.20	0.20	N/A	N/A	\$2,998	\$2,782	30	25
	2030	7.4	9.3	0.26	0.26	N/A	N/A	\$2,030	\$1,896	30	30
	2040	8.0	10.0	0.28	0.28	N/A	N/A	\$1,701	\$1,627	30	30
	2050	8.4	10.1	0.28	0.28	N/A	N/A	\$1,577	\$1,547	30	30
Fuel cell	2015	5.0	5.0	0.40	0.40	0.86	0.83	\$12,604	\$10,576	30	10
	2020	5.0	5.0	0.40	0.43	0.85	0.86	\$10,849	\$9,739	30	10
	2030	5.0	5.0	0.41	0.44	0.83	0.86	\$8,442	\$9,539	30	10
	2040	5.0	5.0	0.42	0.45	0.83	0.87	\$7,197	\$9,347	30	10
	2050	5.0	5.0	0.42	0.46	0.83	0.88	\$7,197	\$9,162	30	10
Wind	2015	5.0	10.0	0.13	0.13	N/A	N/A	\$8,831	\$8,400	30	20
	2020	5.0	10.0	0.13	0.13	N/A	N/A	\$8,805	\$8,400	30	20
	2030	5.0	10.0	0.13	0.13	N/A	N/A	\$8,261	\$8,400	30	20
	2040	5.0	10.0	0.13	0.13	N/A	N/A	\$7,776	\$8,400	30	20
	2050	5.0	10.0	0.13	0.13	N/A	N/A	\$7,776	\$8,400	30	20

Updated report data will be available at: www.eia.gov/analysis/studies/buildings/distrigen

Revised commercial distributed generation and combined heat and power (CHP) cost and performance characteristics

Technology type	Year of introduction	Average generating capacity (kW _{DC})		Electrical efficiency		Combined efficiency (elec. + thermal)		Installed capital cost (2018\$ per kW _{DC})		Service life (years)	
		AEO2019	AEO2020	AEO2019	AEO2020	AEO2019	AEO2020	AEO2019	AEO2020	AEO2019	AEO2020
Solar photovoltaic	2015	28	35	0.17	0.17	N/A	N/A	\$3,681	\$3,348	30	25
	2020	37	42	0.20	0.20	N/A	N/A	\$2,732	\$2,532	30	25
	2030	38	53	0.26	0.26	N/A	N/A	\$1,881	\$2,007	30	30
	2040	40	58	0.28	0.28	N/A	N/A	\$1,711	\$1,833	30	30
	2050	41	62	0.28	0.30	N/A	N/A	\$1,631	\$1,716	30	30
Fuel cell	2015	200	250	0.36	0.56	0.58	0.59	\$5,738	\$5,757	20	10
	2020	200	250	0.36	0.56	0.58	0.61	\$5,037	\$5,297	20	10
	2030	200	250	0.37	0.57	0.58	0.62	\$3,867	\$5,196	20	10
	2040	200	250	0.38	0.59	0.60	0.64	\$2,961	\$5,068	20	10
	2050	200	250	0.38	0.60	0.60	0.65	\$2,961	\$4,967	20	10
Natural gas engine	2015	373	373	0.33	0.29	0.85	0.83	\$2,288	\$2,406	20	30
	2020	373	373	0.33	0.29	0.85	0.82	\$2,298	\$2,396	20	30
	2030	373	373	0.33	0.29	0.85	0.82	\$2,189	\$2,390	20	30
	2040	373	373	0.33	0.30	0.85	0.82	\$2,091	\$2,377	20	30
	2050	373	373	0.33	0.30	0.85	0.85	\$2,091	\$2,371	20	30
Oil-fired engine	2015	340	350	0.33	0.34	0.77	0.93	\$2,119	\$2,500	20	30
	2020	340	350	0.33	0.34	0.77	0.93	\$2,130	\$2,486	20	30
	2030	340	350	0.33	0.34	0.77	0.94	\$2,028	\$2,468	20	30
	2040	340	350	0.33	0.35	0.77	0.96	\$1,937	\$2,449	20	30
	2050	340	350	0.33	0.35	0.77	0.96	\$1,937	\$2,440	20	30

Updated report data will be available at: www.eia.gov/analysis/studies/buildings/distrigen

Revised commercial distributed generation and combined heat and power (CHP) cost and performance characteristics (continued)

Technology type	Year of introduction	Average generating capacity (kW _{DC})		Electrical efficiency		Combined efficiency (elec. + thermal)		Installed capital cost (2018\$ per kW _{DC})		Service life (years)	
		AEO2019	AEO2020	AEO2019	AEO2020	AEO2019	AEO2020	AEO2019	AEO2020	AEO2019	AEO2020
Natural gas turbine	2015	1210	1210	0.24	0.30	0.86	0.77	\$2,338	\$1,977	20	30
	2020	1222	1210	0.25	0.30	0.86	0.75	\$2,350	\$1,964	20	30
	2030	1247	1210	0.25	0.30	0.87	0.78	\$2,237	\$1,937	20	30
	2040	1272	1210	0.26	0.31	0.87	0.79	\$2,137	\$1,912	20	30
	2050	1272	1210	0.26	0.31	0.87	0.78	\$2,137	\$1,899	20	30
Natural gas microturbine	2015	250	200	0.26	0.30	0.62	0.63	\$3,579	\$3,203	20	10
	2020	253	200	0.26	0.30	0.62	0.62	\$3,579	\$3,178	20	10
	2030	258	200	0.27	0.31	0.63	0.64	\$3,425	\$3,127	20	10
	2040	263	200	0.27	0.31	0.64	0.62	\$3,271	\$3,078	20	10
	2050	263	200	0.27	0.32	0.64	0.65	\$3,271	\$3,054	20	10
Wind	2015	100	2000	0.13	0.13	N/A	N/A	\$6,203	\$2,803	30	20
	2020	100	2000	0.13	0.13	N/A	N/A	\$5,756	\$2,738	30	25
	2030	100	2000	0.13	0.13	N/A	N/A	\$4,877	\$2,738	30	25
	2040	100	2000	0.13	0.13	N/A	N/A	\$4,142	\$2,738	30	25
	2050	100	2000	0.13	0.13	N/A	N/A	\$4,142	\$2,738	30	25

Updated report data will be available at: www.eia.gov/analysis/studies/buildings/distrigen

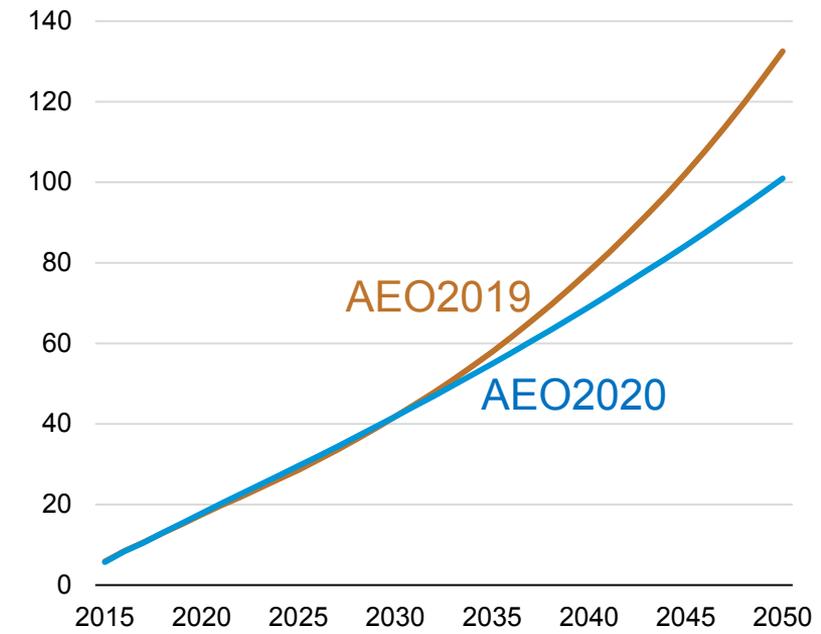
Commercial distributed generation methodology updated

- Technologies modeled include solar PV, CHP, and wind
- Re-estimated parameters for the shape, speed, and maximum levels of distributed generation diffusion to calibrate distributed generation model builds to recent historical data
- More electricity rate variation into niches for internal rate of return calculations
- Revised assumptions, such as diffusion start year, treatment of existing and new buildings, and PV-eligible roof space by building size

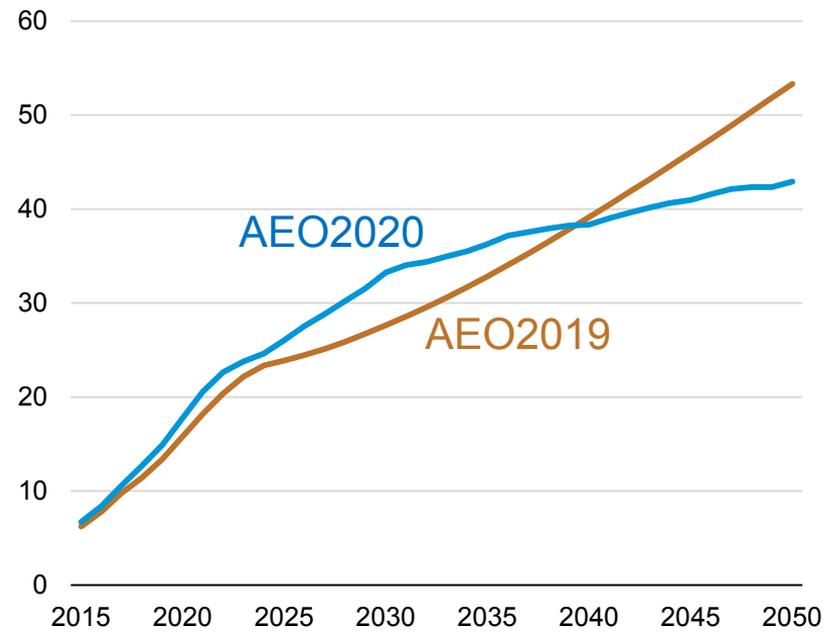
As a result of the update, PV grows more quickly in the short term, but growth levels off in the long term. Wind and CHP grow more slowly.

Revised cost and performance characteristics, lower electricity prices, and model updates affect buildings PV projections

Residential PV capacity
gigawatts-direct current (GW-DC)



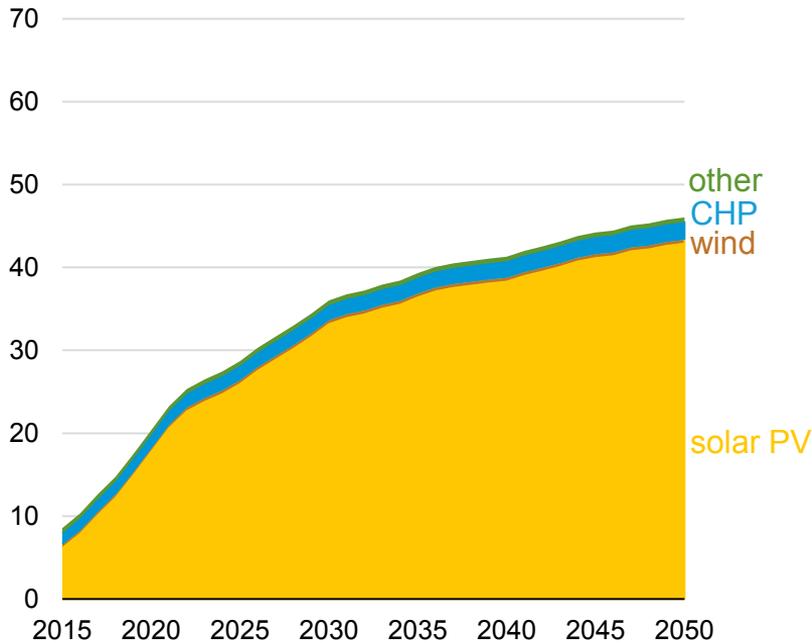
Commercial PV capacity
gigawatts-direct current (GW-DC)



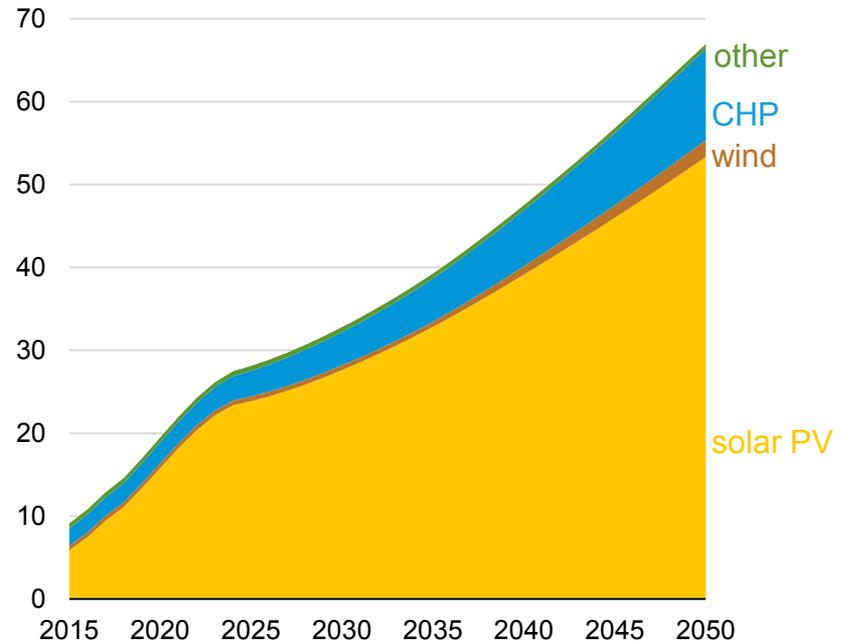
Sources: AEO2020 preliminary, AEO2019

Commercial combined heat and power (CHP) grows more slowly, and PV assumes a larger share of distributed generation growth

AEO2020 commercial distributed generation capacity
gigawatts-direct current (GW-DC)



AEO2019 commercial distributed generation capacity
gigawatts-direct current (GW-DC)



Source: AEO2020 preliminary, AEO2019

Commercial minor fuels and other updates

- Updated commercial minor fuel parameters based on latest State Energy Data System (SEDS) historical consumption data and other historical data
- Revised base-year heat pump stocks and unit energy consumption (UEC) using U.S. Census Bureau split of air-source versus ground-source equipment
- Incorporated final Residential Energy Consumption Survey (RECS) wood consumption published after AEO2019 modeling
- Revised sub-census division distributed generation niches (based on average RECS electricity rates) and distributed generation interconnection limitations
- Updated equipment-level energy efficiency rebate assumptions based on incentives data from the Consortium for Energy Efficiency, ENERGY STAR, NEEP, and past contractor reports

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For more information

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International Energy Outlook | <https://www.eia.gov/outlooks/ieo/>

State Energy Data System | <http://www.eia.gov/state/seds/>

Monthly Energy Review | www.eia.gov/mer

Residential Energy Consumption Survey | <http://www.eia.gov/consumption/residential/>

Commercial Building Energy Consumption Survey | <http://www.eia.gov/consumption/commercial/>