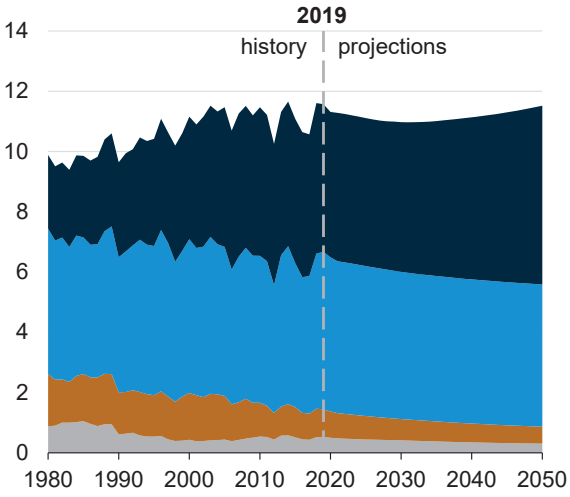
Buildings

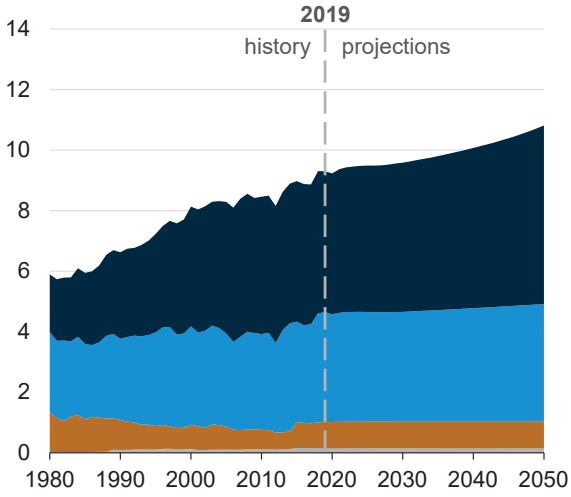
Delivered energy consumption in the U.S. buildings sector grows gradually from 2019 to 2050 in the Reference case, based, in part, on currently established efficiency standards and incentives. EIA anticipates distributed solar capacity to grow throughout the projection period based on near-term incentives, declining costs, and demographic factors.

Residential and commercial energy consumption grows slowly in the AEO2020 Reference case—

Residential sector delivered energy consumption (AEO2020 Reference case)
quadrillion British thermal units



Commercial sector delivered energy consumption (AEO2020 Reference case)
quadrillion British thermal units



electricity natural gas petroleum and other liquids other

—accounting for changes to energy efficiency standards and technological advances

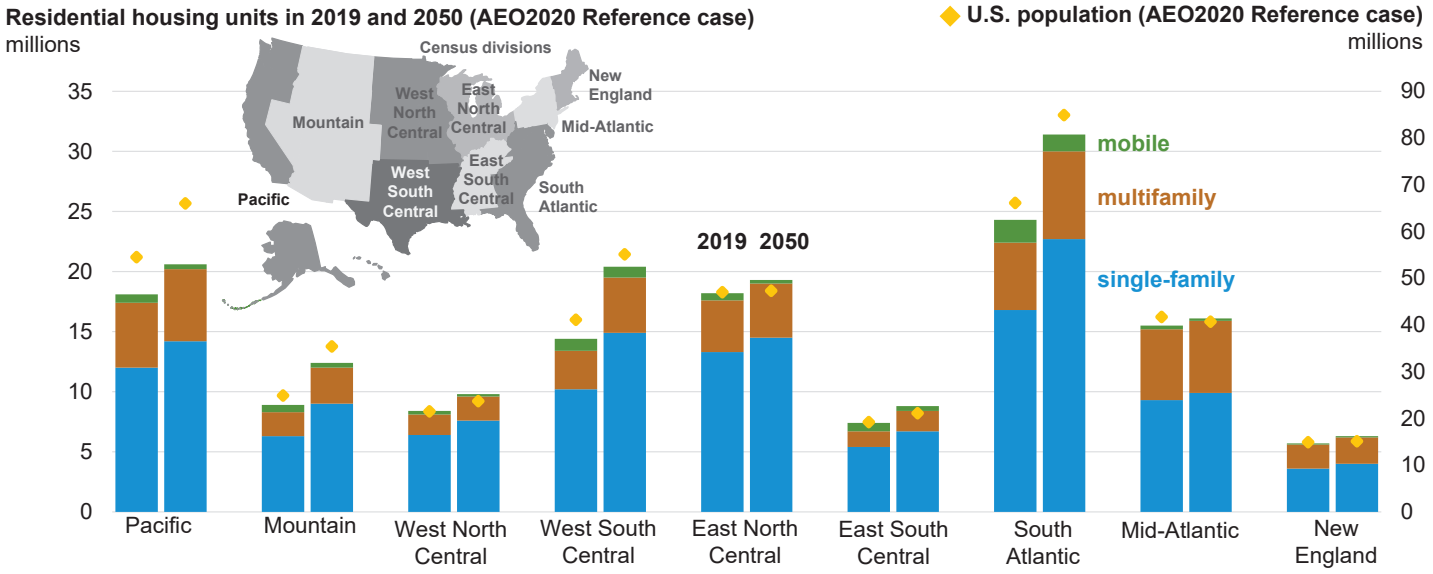
- Total delivered energy consumption in the U.S. buildings sector grows slowly through the AEO2020 Reference case projection period, 2019 to 2050, by 0.2% per year, as energy efficiency improvements, increases in distributed electricity generation, and regional shifts in the population partially offset the impacts of higher growth rates in population, number of households, and commercial floorspace.

- Purchased electricity consumption grows in both the residential and commercial sectors as a result of increased demand for appliances, devices, and equipment that use electricity. In the Reference case, purchased electricity increases by 0.6% and 0.8% per year in the residential and commercial sectors, respectively, through 2050.

- Natural gas consumption by commercial buildings grows by 0.2% per year through the projection period, led by increases in water heating and cooking. Consumption of natural gas in the residential sector falls by 0.3% per year as its use for space heating continues to decline.

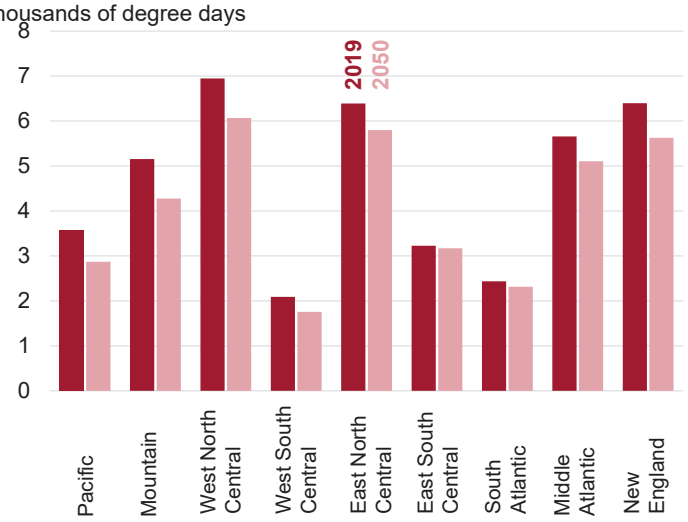
- If not for the contribution of distributed generation sources, particularly rooftop solar, purchased electricity consumption in residential and commercial buildings would be 5% and 3% higher, respectively, by the end of the projection period.

Population and residential housing stocks continue to grow mostly in the South and West between 2019 and 2050

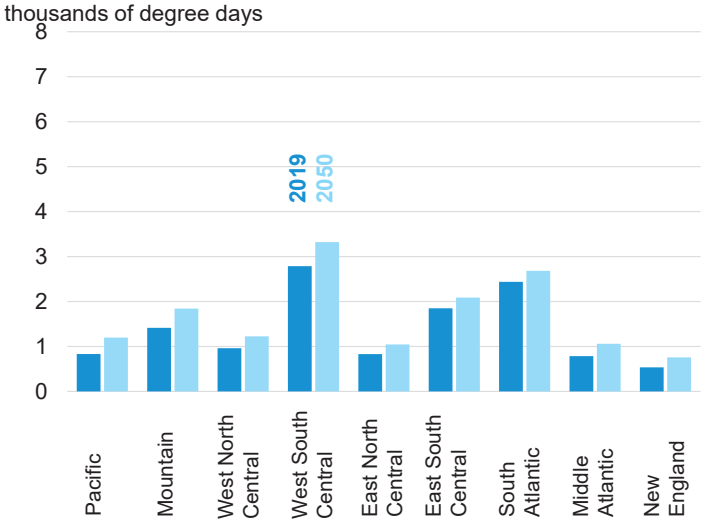


As a result of population shifts, overall U.S. heating needs decrease and cooling needs increase—

Population-weighted heating degree days by census division (AEO2020 Reference case)
thousands of degree days



Population-weighted cooling degree days by census division (AEO2020 Reference case)
thousands of degree days

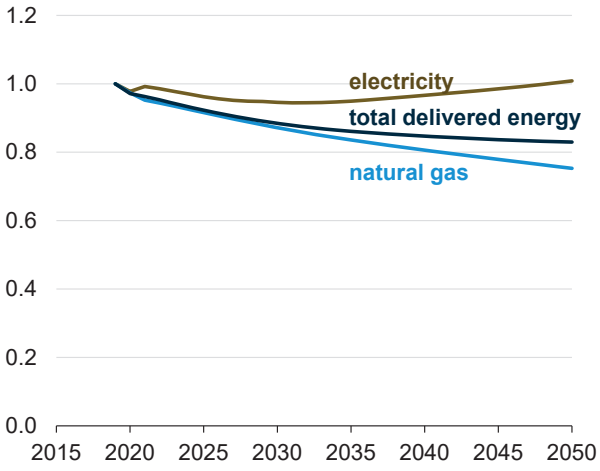


—especially in warmer regions with higher space cooling demand

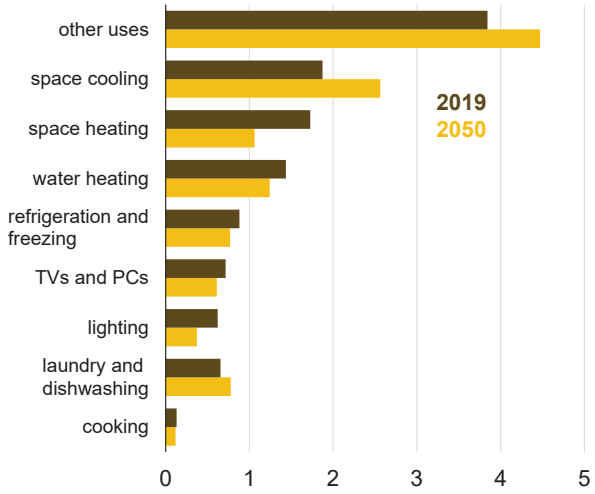
- The number of U.S. households increases by an average of 0.6% per year in the AEO2020 Reference case through 2050, and single-family homes grow the fastest, at 0.7% per year. The stock of multifamily homes grows at a rate of 0.6% per year, while mobile home stocks decrease by 1.2% per year and are the only category EIA does not expect to grow.
- Cooling-dominated West South Central and South Atlantic Census Divisions—as well as the Mountain Census Division—experience average annual housing stock growth that exceeds the national average. 12.2 million housing units are added across these areas by 2050.
- The size of housing units also continues to grow; the national average floorspace per home increases 0.3% per year from 1,786 square feet in 2019 to 1,987 square feet in 2050.
- Demand for space heating from fuels such as natural gas, distillate fuel oil, propane, and electricity decreases through 2050 as a result of fewer heating degree days (HDDs)—a measure of how cold a location is over a time period relative to a base temperature.
- Demand for space cooling from electricity increases through 2050 as a result of more cooling degree days (CDDs)—a measure of how warm a location is over a time period relative to a base temperature.
- EIA uses historical and near-term forecast HDDs and CDDs sourced from the National Oceanic and Atmospheric Administration. EIA uses this historical data and population projections to develop a 30-year linear trend for projecting population-weighted HDDs and CDDs.

U.S. residential energy intensity decreases in the AEO2020 Reference case—

Residential delivered energy intensity index (AEO2020 Reference case)
indexed annual energy use per household, 2019 = 1.0



Residential purchased electricity intensity (AEO2020 Reference case)
thousand kilowatthours per household



—although changes in electricity consumption vary by end use

- In the AEO2020 Reference case, U.S. total delivered residential energy intensity, defined as annual delivered energy use per household, decreases by 17% between 2019 and 2050 as the number of households grows faster than energy use. The main factors contributing to this decline include gains in appliance efficiency, onsite electricity generation (e.g., solar photovoltaic), utility energy efficiency rebates, rising residential natural gas prices, lower space heating demand, and a continued population shift to warmer regions.

- Lighting electricity consumption per U.S. household declines faster than other electric end uses as a result of compliance with the minimum performance requirements of the Energy Independence and Security Act of 2007. The federal standards effectively eliminate low-efficacy incandescent lamps, replacing them with more energy-efficient light-emitting diodes (LEDs) and compact fluorescent lamps (CFLs) by 2020. Energy efficiency incentives also accelerate LED and CFL penetration before 2020. In 2050, purchased electricity intensity for lighting is 40% lower than in 2019.

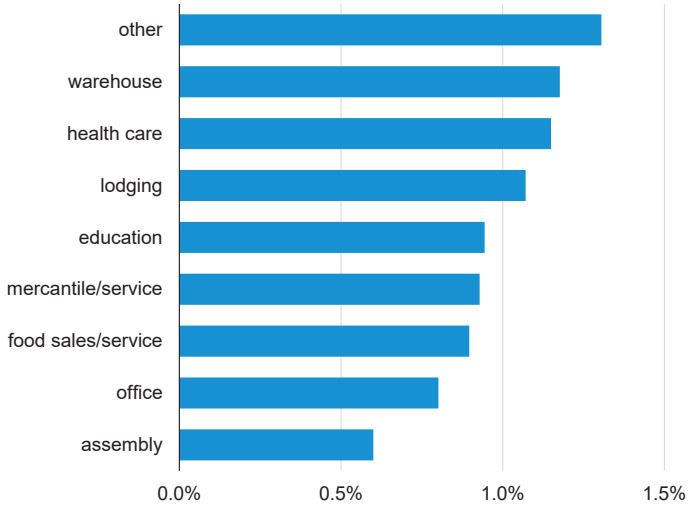
- As near-term appliance standards result in efficiency gains beyond those gains caused by market forces and technological change, electricity intensity declines before 2030 and then increases slightly as sector growth overtakes additional efficiency gains.

- Natural gas and electric equipment increasingly replace distillate fuel oil- and propane-fired equipment.

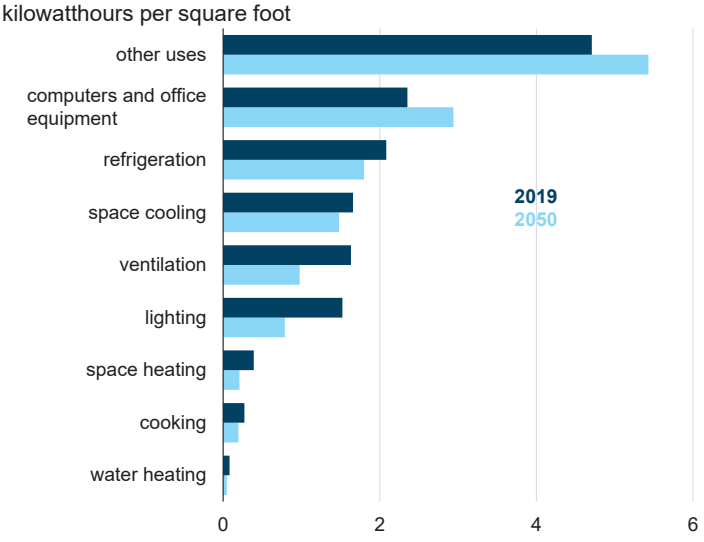
- Electricity intensity of other uses increases throughout the projection period with expected growth in the use of electronic equipment, such as security systems and rechargeable devices.

AEO2020 Reference case U.S. commercial energy consumption growth is tempered by increased equipment and lighting efficiencies—

Commercial floorspace growth (AEO2020 Reference case)
percent compound annual growth rate



Commercial purchased electricity intensity (AEO2020 Reference case)
kilowatthours per square foot

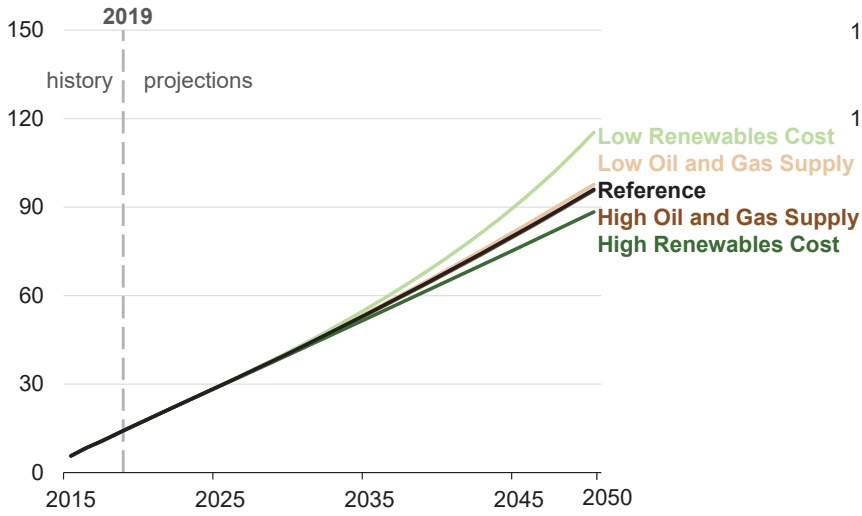


—but growing floorspace, declining electricity prices, and expanding information technology needs drive an overall increase in electricity consumption

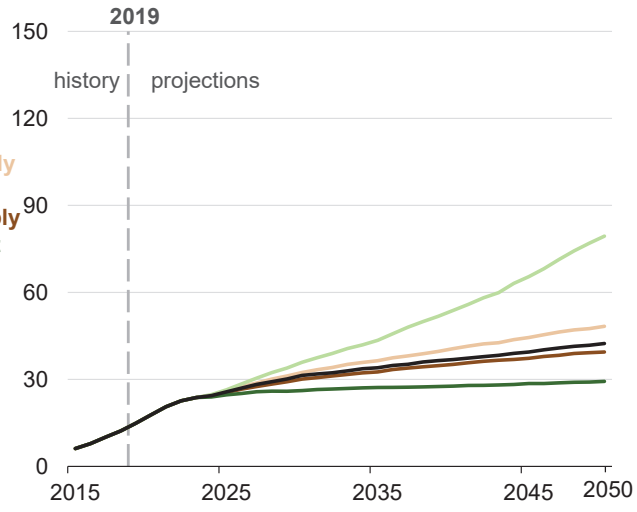
- Commercial floorspace grows by an average 1% per year in the AEO2020 Reference case through the projection period, reflecting rising economic activity. Some of the fastest-growing building types, including health care and lodging, are also among the most energy intensive.
- Commercial electricity intensity, defined as electricity consumption per square foot of commercial floorspace, declines at an average of 0.2% per year through the projection period. Combined with floorspace growth, the decline in intensity results in an overall increase in electricity consumption of 0.8% per year.
- Lighting accounts for the steepest intensity decline among the major end uses, falling by more than 2% per year throughout the projection period. Lower costs and energy efficiency incentives lead efficient LEDs to displace linear fluorescent lighting as the dominant commercial lighting technology by 2030. Similarly, intensities for major end uses such as ventilation, space heating and cooling, and refrigeration decline over time. However, other uses such as office equipment (not including computers), whose electricity intensity increases by 1.6% per year, counterbalance these declines.
- Despite increasing equipment efficiencies, declining electricity prices encourage greater use of energy-consuming appliances and devices.

Rooftop solar PV adoption grows between 2019 and 2050—

Residential solar distributed generation capacity
gigawatts direct current



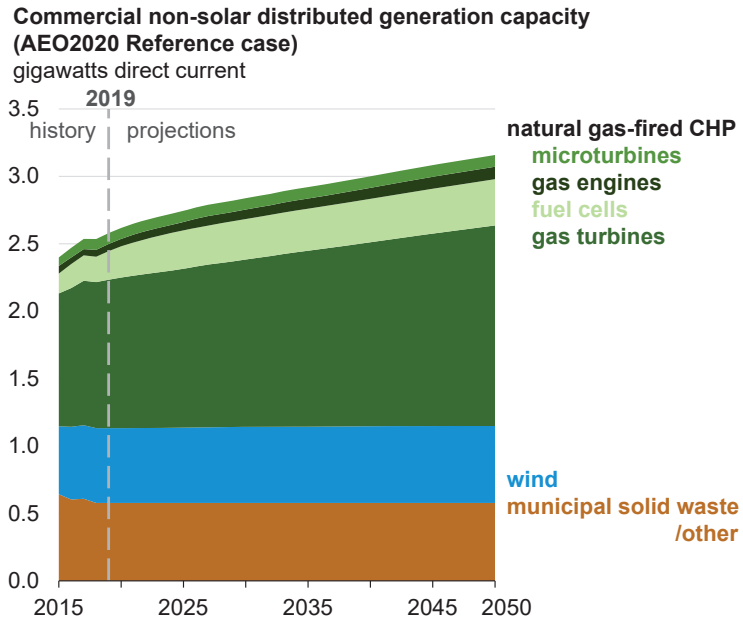
Commercial solar distributed generation capacity
gigawatts direct current

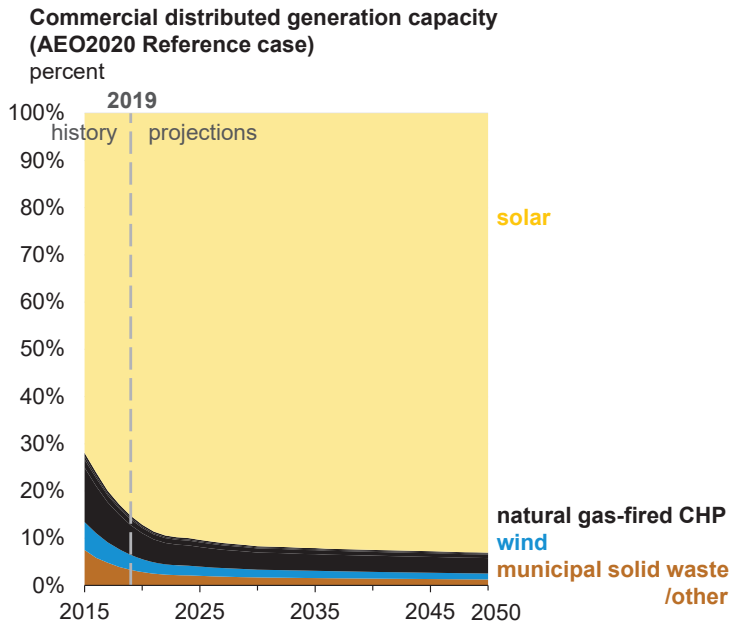


—with residential growth outpacing commercial growth in later years

- Residential solar photovoltaic (PV) capacity increases by an average of 6.1% per year through 2050 in the AEO2020 Reference case, and commercial PV capacity increases by an average of 3.4% per year.
- PV costs decline most rapidly before 2030, despite the phasedown in the federal Energy Investment Tax Credit (ITC) from 30% in 2019 to 10% in 2022 and the four-year Section 201 tariff levied on PV cells and modules in 2018.
- Declining installation costs drive steady commercial PV adoption, although capacity growth slows after 2030. Rising incomes, declining system costs, and social influences accelerate residential PV adoption.
- For both residential and commercial sectors, the High Renewables Cost case and Low Renewables Cost case vary the most from the Reference case. Commercial PV projections are particularly responsive to variations in installed cost; a spread of 50 GW between the Low Renewables Cost case and High Renewables Cost case is projected in 2050.
- PV growth is also sensitive to electricity prices. In 2050, electricity prices vary the most from the AEO2020 Reference case in the Low Oil and Gas Supply case, by 9.7% and 9.2% for the residential and commercial sectors, respectively. In response, residential PV capacity increases by 1.7% and commercial PV capacity increase by 14% relative to the AEO2020 Reference case.

Combined heat and power (CHP) and other non-solar sources of electric generation account for 15% of commercial onsite capacity in 2019 in the AEO2020 Reference case—



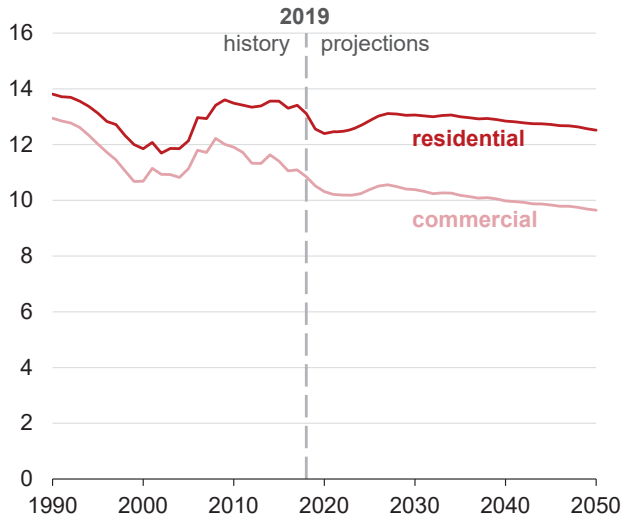


—but this share declines during the projection period as growth lags behind solar photovoltaic generation

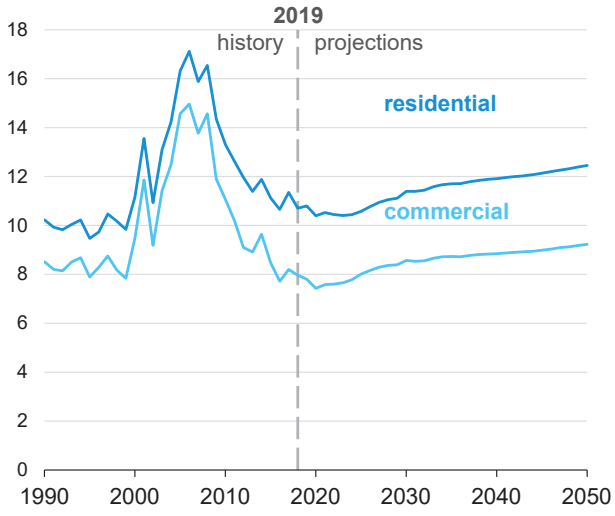
- Non-photovoltaic technologies, such as combined heat and power (CHP) and distributed wind, account for 15% of commercial distributed generation capacity in 2019 but only 7% by 2050 in the AEO2020 Reference case.
- Of the non-solar technologies, natural gas-fired CHP (namely, microturbine, reciprocating engine, fuel cell, and conventional turbine) capacity expands the fastest at an average of 1.1% per year. Incremental installed cost declines and performance improvements drive this growth, despite rising commercial natural gas prices, which increase by 0.5% per year through the projection period.
- The 2018 Bipartisan Budget Act extends the ITC provisions for qualifying CHP beginning construction before January 1, 2022. These tax credits contribute to growth in CHP in the short term.
- Wind generation capacity projections remain flat in AEO2020, in part, because of a lack of commercial mid-scale turbines (101 kilowatts to 1 megawatt) available in the U.S. market. The majority of recent commercial wind installations use large-scale turbines—the average in 2018 was 2.1 megawatts—but the commercial sector market potential for these larger turbines is limited.

Residential and commercial electricity prices decline slightly in the AEO2020 Reference case through 2050

Electricity prices (AEO2020 Reference case)
2019 cents per kilowatthour



Natural gas prices (AEO2020 Reference case)
2019 dollars per thousand cubic feet



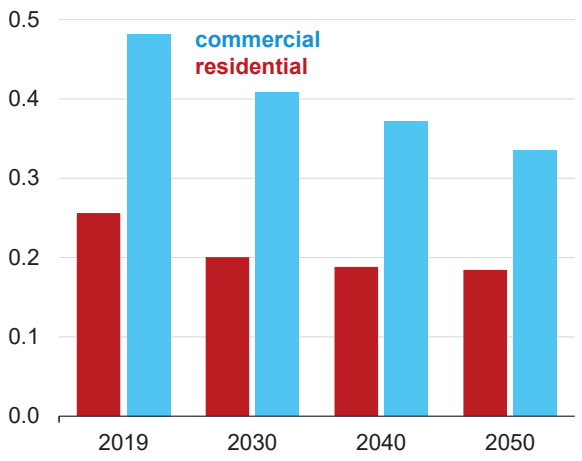
—while natural gas prices rise, moderating natural gas consumption

- AEO2020 Reference case electricity prices fall in the near term, primarily because utilities pass along savings from lower taxes under the Tax Cuts and Jobs Act of 2017. In addition, utilities are replacing more costly power plants with new plants that are less expensive to construct and operate, which also contributes to lower prices. Lower prices encourage more consumption in the near term in both sectors, although near-term efficiency standards and population shifts to warmer areas of the country moderate this trend.

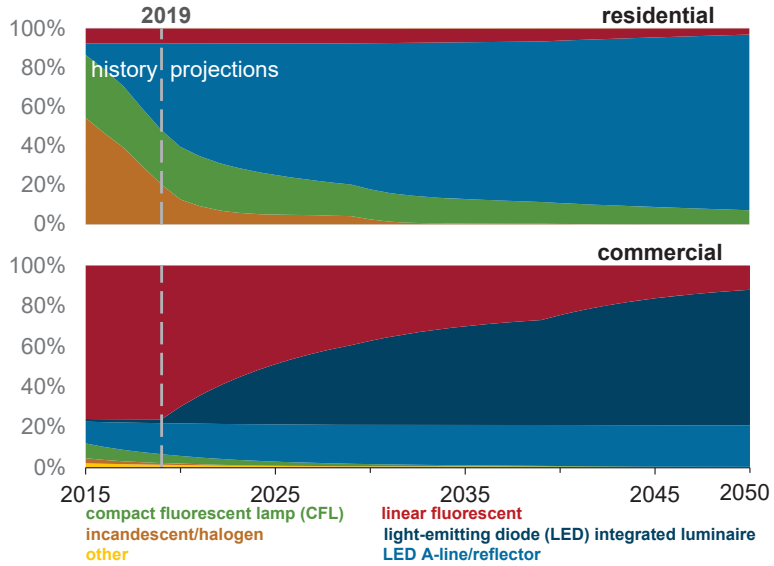
- Natural gas prices in both the residential and commercial sectors increase steadily, by an average of 0.5% per year, in the Reference case through 2050. Increasing natural gas prices decrease consumption in the residential sector and moderate consumption growth in the commercial sector.

Energy consumed to meet lighting needs decreases in the AEO2020 Reference case –

Delivered electricity consumed to meet lighting demand (AEO2020 Reference case)
quadrillion British thermal units



Lighting shares (AEO2020 Reference case)
percent



—driven by federal efficiency standards, declining upfront costs, and utility and state energy efficiency program incentives

- In 2019, 44% of residential light bulbs were LEDs, currently the most efficient light bulb technology available, and 17% of commercial lighting service demand was met by LED bulbs and fixtures. By 2050, these shares increase to 90% and 88%, respectively.
- Utility energy efficiency program incentives drive LED adoption in the AEO2020 Reference case during the short to medium term, reducing the upfront cost of purchasing LEDs by up to 40% until 2019. EIA assumes residential lighting subsidies will fall to 0% in 2020, but efficiency incentives continue to drive commercial adoption of LED lighting through 2029.
- Efficiency requirements under the Energy Independence and Security Act of 2007 eliminate inefficient incandescent bulbs from general service lighting (GSL) use after 2020, causing homes and businesses to switch to more efficient LED and CFL bulbs. Although we incorporate a U.S. Department of Energy final rule that narrows the definition of GSLs, about two-thirds of residential lighting falls under the revised definition.
- Cost declines in LEDs drive expanded market share throughout the projection period. During the projection period, the AEO2020 shows the installed cost of residential GSL LEDs declines by 33% and the cost of commercial LED luminaires declines by up to 74%.