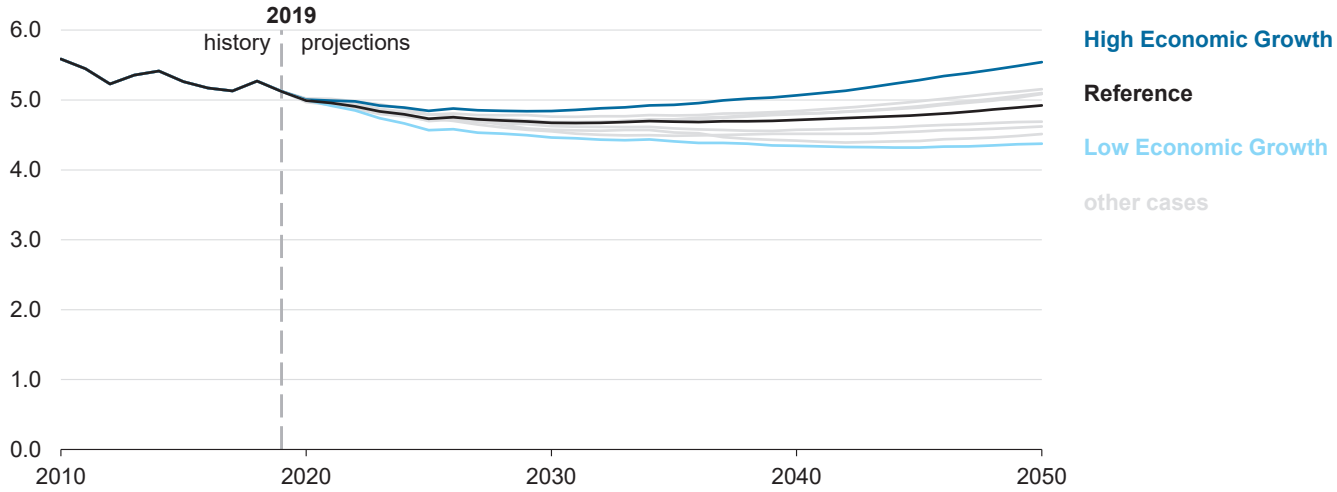
Emissions

Energy-related carbon dioxide emissions decrease until the mid-2020s in the AEO2020 Reference case as a result of changes in the fuel mix consumed by the electric power sector. After 2030, increases in energy demand in the other sectors—predominantly transportation and industrial—cause emissions to increase.

Economic growth is the biggest factor in carbon dioxide (CO2) emissions —

AEO2020 U.S. energy-related CO2 emissions cases
billion metric tons

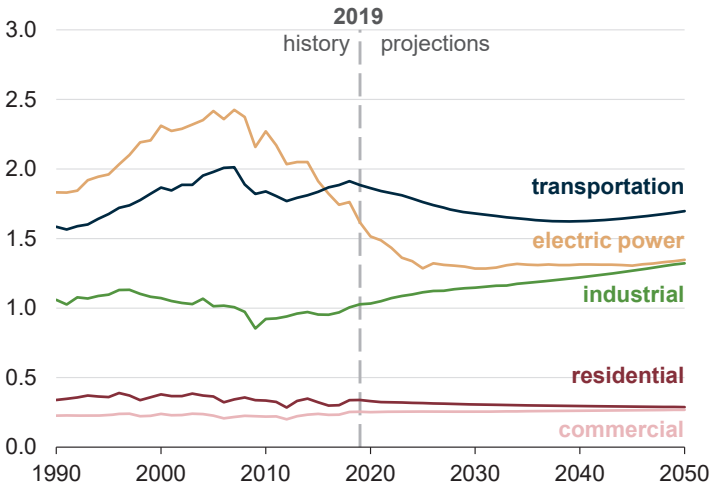


— and emissions in the High Economic Growth case rise faster than the Low Economic Growth case, as rapidly increasing energy demand outweighs improvements in efficiency

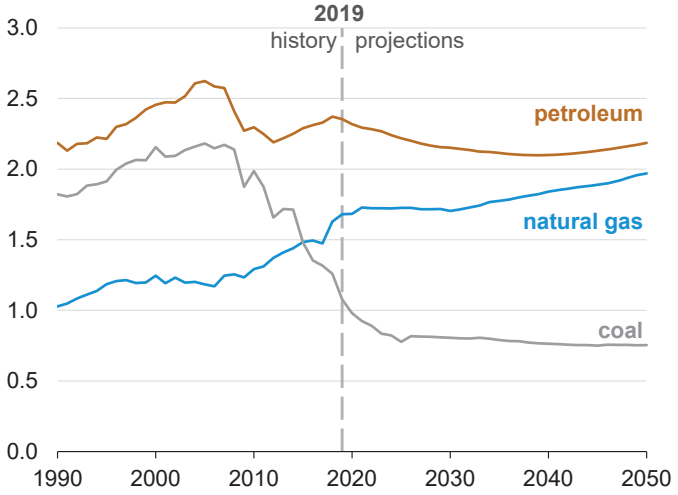
- Economic growth is the primary driver of energy demand and related CO2 emissions.
- Energy-related CO2 emissions in all AEO2020 cases decrease early in the projection period before increasing in the later years through 2050 as economic growth and increasing energy demand outweigh improvements in efficiency.
- In the High Economic Growth case, CO2 emissions decrease through the late 2020s before increasing through 2050 to higher levels than in 2019.
- In the Low Economic Growth case, CO2 emissions decline for most of the projection period and only begin to slowly increase after 2045.
- By 2050, CO2 emissions in the High Economic Growth case are 13% higher than in the Reference case, and those in the Low Economic Growth case are 11% lower than in the Reference case.

AEO2020 energy-related CO2 emissions increase in the industrial sector, increase as a result of natural gas consumption, but remain relatively flat in other sectors and fuel types through 2050

Energy-related CO2 emissions by energy sector (AEO2020 Reference case)
billion metric tons

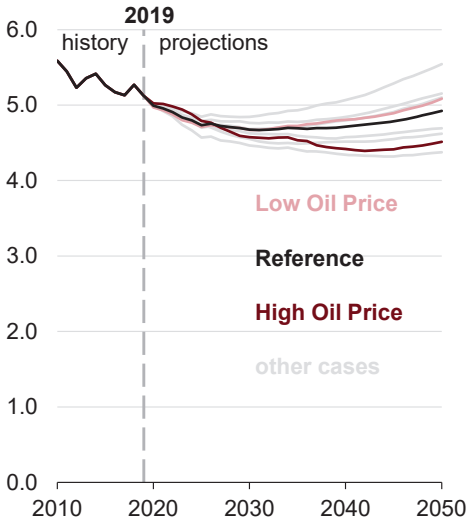


Energy-related CO2 emissions by fuel (AEO2020 Reference case)
billion metric tons

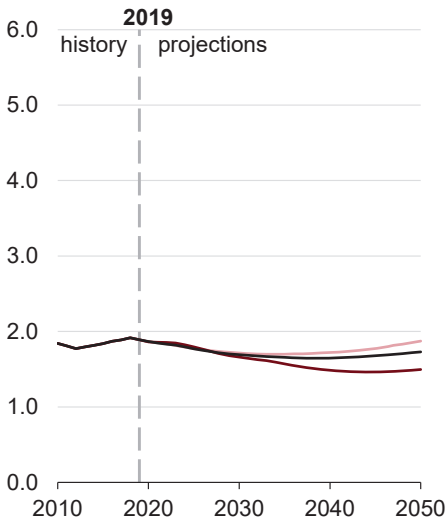


Assumptions regarding crude oil prices affect energy-related CO2 emissions in AEO2020 —

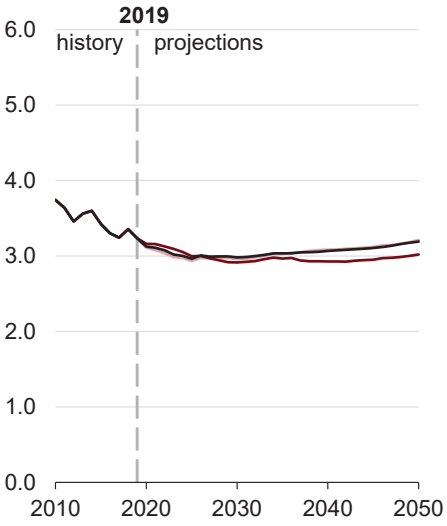
U.S. energy-related CO2 emissions
billion metric tons



Transportation sector CO2 emissions
billion metric tons



Non-transportation sectors CO2 emissions
billion metric tons

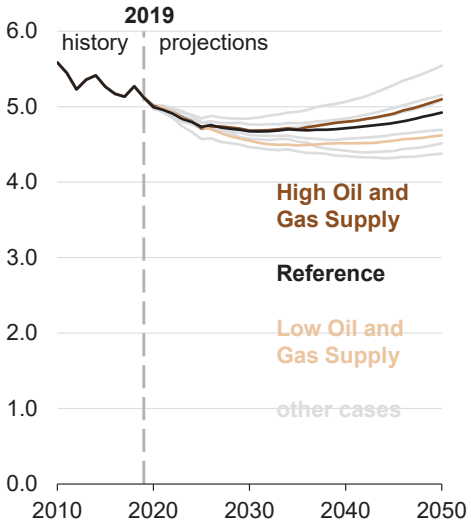


— and the oil price assumptions have the greatest effect on CO2 emissions from the transportation sector

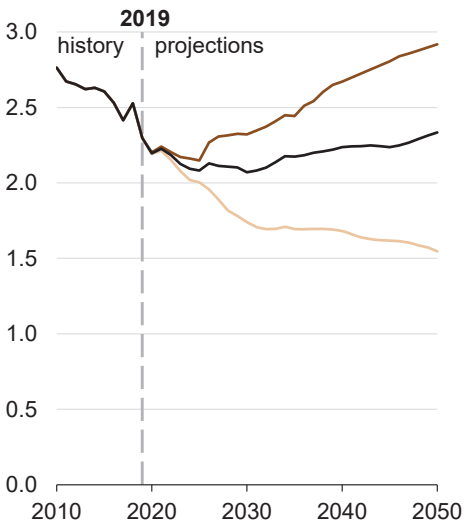
- Transportation sector emissions vary the most in the AEO2020 price cases because petroleum-related emissions dominate the transportation sector.
- In the Low Oil Price case, after an early decline, emissions increase to almost 2019 levels by 2050. Low-priced petroleum products trigger increased demand that results in greater CO2 emissions than in the Reference case.
- In the High Oil Price case, emissions decrease compared with the Reference case. Higher petroleum product prices reduce demand for petroleum products, leading to lower CO2 emissions.
- In the Low Oil Price case, transportation CO2 emissions are 1,874 million metric tons (MMmt) by 2050. In the High Oil Price case, transportation-related CO2 emissions are 1,495 MMmt.
- The industrial sector is the next most responsive sector to petroleum prices. In the Low Oil Price case, CO2 emissions from the industrial sector are 1,683 MMmt by 2050, and in the High Oil Price case, they are 1,589 MMmt.

The AEO2020 High Oil and Gas Supply and Low Oil and Gas Supply cases have different electricity generation fuel mixes than the Reference case—

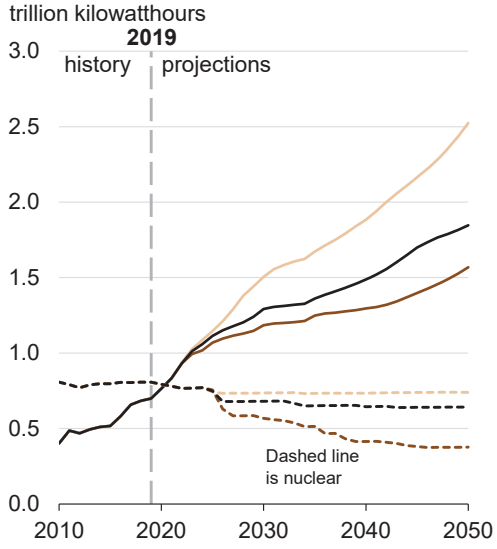
AEO2020 U.S. energy-related CO2 emissions
billion metric tons



AEO2020 fossil fuel-fired electric generation
trillion kilowatthours



AEO2020 renewables and nuclear electric generation
trillion kilowatthours



—resulting in different CO2 emissions profiles

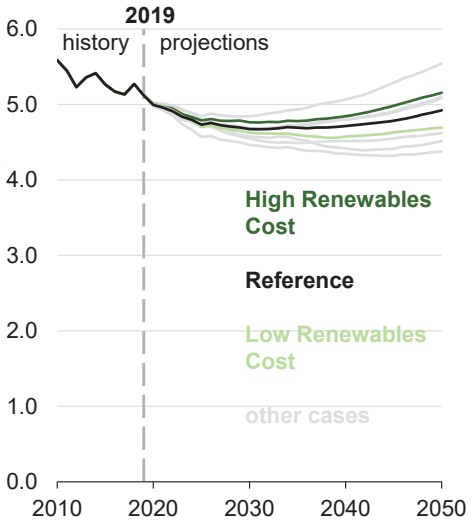
- In the AEO2020 High Oil and Gas Supply case, energy-related CO2 emissions are higher overall compared with the Reference case, as a result of increased use of natural gas consumption, primarily in the electric power sector—and to a lesser extent, the industrial sector. The relatively low natural gas prices in this case allows natural gas to compete with renewables for new electricity generation capacity. Relatively inexpensive natural gas also accelerates nuclear retirements.

- In the Low Oil and Gas Supply case, CO2 emissions are lower overall, compared with the Reference case. Energy-related CO2 emissions decrease until about 2035 as a result of retiring coal-fired power plants, and although they increase after 2035, they remain 10% lower than 2019 levels. The relatively high natural gas prices in this case lead to greater renewables penetration and fewer nuclear retirements.

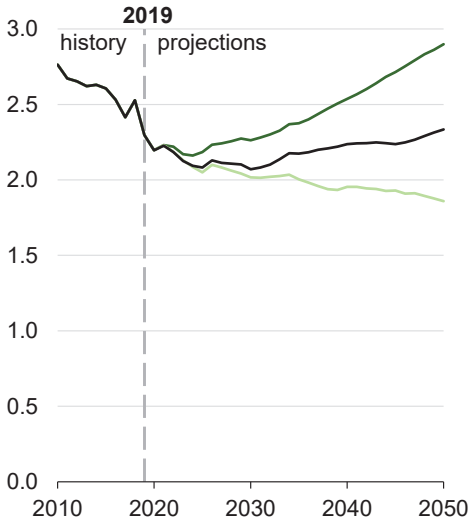
- By 2050, in the High Oil and Gas Supply case, fossil fuel-fired electric power generation is 25% higher than in the Reference case. In the Low Oil and Gas Supply case it is 34% lower than in the Reference case. The High Oil and Gas Supply case emits 5,099 MMmt CO2, and the Low Oil and Gas Supply case emits 4,620 MMmt CO2, creating a range of about 478 MMmt in CO2 emissions.

Changes in AEO2020 cost assumptions for new wind and solar projects also result in different electricity generation fuel mixes—

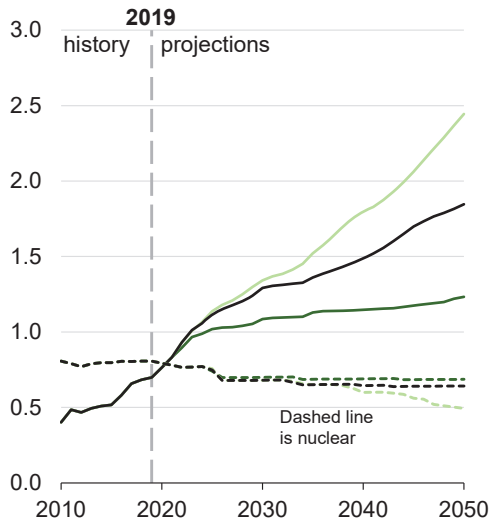
AEO2020 U.S. energy-related CO2 emissions
billion metric tons



AEO2020 fossil fuel-fired electric generation
trillion kilowatthours



AEO2020 renewables and nuclear electric generation
trillion kilowatthours



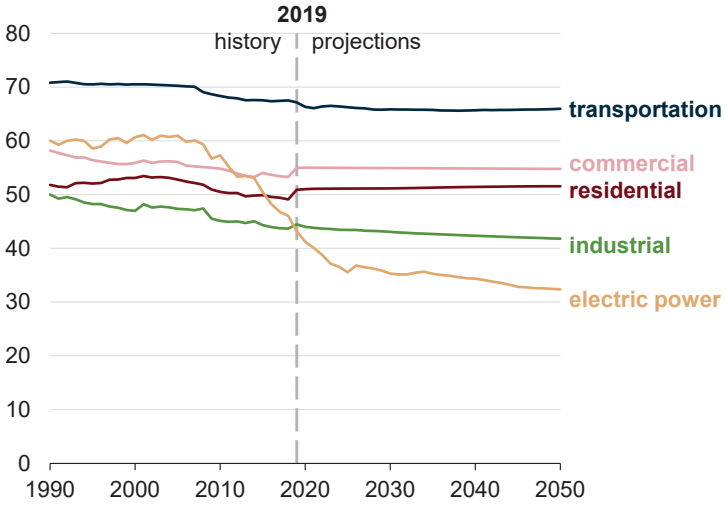
—and consequently, different energy-related carbon dioxide emission profiles

- The AEO2020 High Renewables Cost case, which assumes no further cost reductions for renewables, results in more energy-related CO2 emissions overall compared with the Reference case throughout the projection period. Until about 2030, emissions decrease as a result of retiring coal-fired generation capacity. After 2030, less penetration of renewables, increased natural gas-fired generation, and slightly fewer nuclear retirements (compared with the Reference case) lead CO2 emissions to return to nearly 2019 levels by 2050.

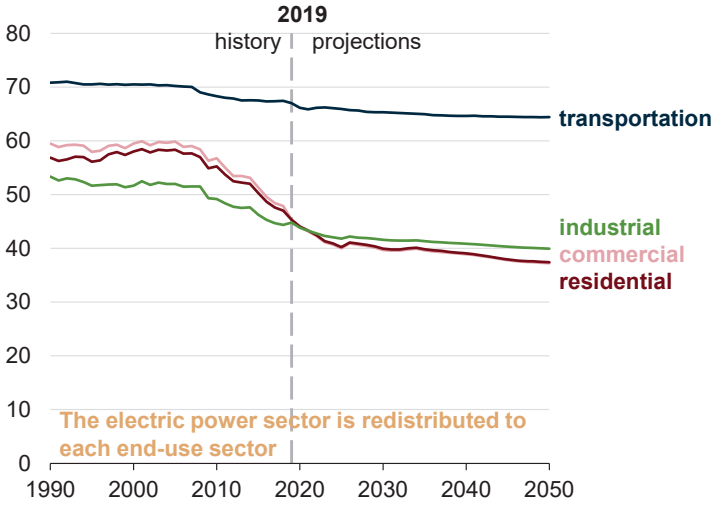
- The Low Renewables Cost case, which has sustained cost reductions for renewables through 2050, results in lower energy-related CO2 emissions overall compared with the Reference case. Increasing electricity generation from renewables leads to decreasing emissions; after 2040, total emissions increase as a result of increased energy demand in the transportation and industrial sectors that are less dependent upon electricity. However, in 2050, emissions remain 8% lower than 2019 levels.

Across end-use sectors, carbon intensity declines with changes in the fuel mix in the AEO2020 Reference case—

Carbon intensity by energy sector (AEO2020 Reference case)
metric tons of carbon dioxide per billion British thermal units



Carbon intensity by end-use sector (AEO2020 Reference case)
metric tons of carbon dioxide per billion British thermal units



—despite overall increases in energy consumption

- Carbon intensity can vary greatly depending on the mix of fuels the end-use sectors consume. Historically, the industrial sector has had the lowest carbon intensity, as measured by CO2 emissions per British thermal unit. The transportation sector historically has had the highest carbon intensity, which continues in the projection because carbon-intensive petroleum remains the dominant fuel used in vehicles throughout the projection period.

- The generation fuel mix in the electric power sector has changed since the mid-2000s; less generation is coming from high-carbon-intensive coal, and more generation is coming from natural gas and carbon-free renewables, such as wind and solar. Because of this change, the overall carbon intensity of the electric power sector declined by 30% from the mid-2000s to 2019 and is expected to continue to decline through 2050.

- If the CO2 emissions from the electricity sector in the end-use sectors that consume electricity are accounted for, carbon intensity declines to a greater degree across those sectors for all AEO2020 cases. In the Reference case, the carbon intensities of the residential and commercial sectors show no decline when their direct carbon intensities are counted from 2019 to 2050. When the electric power sector energy is distributed to the end-use sectors, the residential and commercial sectors decline by 17% and 18%, respectively, during the projection period, and the industrial sector declines by 11%. Transportation carbon intensity declines by 4%.