CHAPTER 18

United States Country Report

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CHAPTER 18

United States Country Report[1]

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1. Introduction

The United States (US) is the fourth-largest country in the world by total area, and the third-largest by population. Since 2010, the US population has grown by about 2.3 million people per year, reaching approximately 330 million in 2020 (US Census Bureau, 2020a). Currently, more than 80% of the total US population lives in urban areas (US Census Bureau, 2010).

The US is the world's largest (or second-largest depending on metric) economy, with a gross domestic product (GDP) of US$21.34 trillion and per capita income of US$65,880 as of year-end 2019 (World Bank, 2020f). By sector of origin, 77.4% of US GDP can be linked to services, while 18.2% is linked to industry including construction (World Bank, 2020d). Agriculture, forestry and fishing collectively make up just 0.9% (World Bank, 2020a). More broadly, international trade also plays a crucial role in the overall strength and health of the US economy. As one measure of this, studies have suggested that, in numerous areas of the country, more than one-quarter of state-level GDP can be attributed to international trade, including in Washington, Michigan, Louisiana, Texas and New Jersey (Perry, 2018).

1.1. Energy Situation

The US is the world's second-largest consumer of energy and second-largest emitter of CO2, though by per capita measures it ranks first in both categories. In 1990, US final energy consumption was 1,293.56 million tonnes of oil equivalent (Mtoe). Over the following decade, consumption increased (reaching 1,546.29 Mtoe by 2000), and then experienced a modest

[1] Unless otherwise cited, all data in this report can be attributed to Institute of Energy Economics Japan's economic modelling results for the US, which are included in full as an appendix to this publication.

overall decline from 2000 to 2017 so that consumption was 1,520.46 Mtoe as of the end of 2017. Alongside these trends, US CO2 emissions rose sharply in the 1990s and then declined through the period ending in 2017, so that emissions were 4,760.8 million tonnes of carbon (Mt-C) in 2017 (slightly lower than levels in 1990).

During this period, coal consumption also declined sharply from 55.66 Mtoe to 17.01 Mtoe, but growth in consumption of natural gas and renewables more than offset this decline. A key contributor to this was major shifts in the US domestic energy supply outlook. While the US has long had abundant, diverse resource potential—including substantial natural endowments in fossil fuels such as coal, shale oil, and natural gas; geothermal and hydroelectric potential; and good conditions for wind and solar energy—up until recently, significant portions of this potential were not considered technically or economically viable. However, breakthroughs in technology, declining production costs, and favourable environments for development and investment have contributed to growing accessible domestic resource potential. Between 2008 and 2013, the incremental increase alone of US daily oil production was equivalent to the total daily oil production of Iraq in 2010. Natural gas production also increased 12-fold during a similar period, resulting in the US become a top producer of natural gas (Richardson-Barlow et al., 2014). Meanwhile, between 2008 and 2014, US solar installations grew 35-fold (US Department of Energy, 2014).

Such developments have had a dramatic impact on US energy outlooks. Increased US oil and natural gas production has contributed to reducing or backing out import requirements from Canada and other country sources. Combined with other market and policy factors, these developments have also accelerated the transformation of the US power generation mix. In 2014, for the first time ever, natural gas surpassed coal as the largest share of US power generation. Meanwhile, wind and solar experienced the largest rates of increase of any fuel source during the 1990–2017 period, and the Energy Information Association (EIA) notes that generation costs for these renewables are continuing to decline (US Energy Information Administration, 2020a). In some parts of the US, including Texas and Iowa, wind energy is now considered cost-competitive with traditional fuel sources, which, going forward, may further incentivise consumption (Gillispie, Johnson, and Schwartz, 2017).

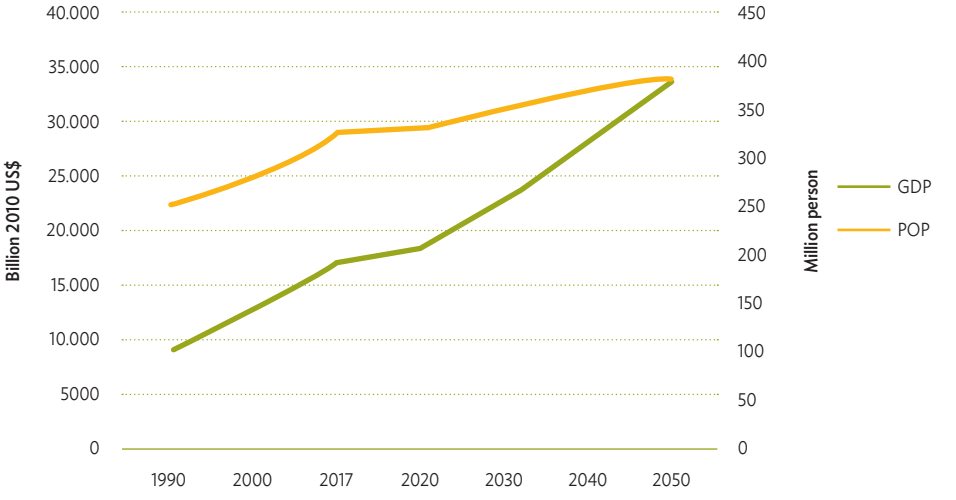
As a result of these transformations, the EIA now projects that the US will become a net energy exporter in 2020. The country is also anticipated to play an increasingly important role as a key exporter to the Asia and the Pacific region. To date, US liquefied natural gas exports have been delivered to several major economies in Asia, including Japan, Taiwan, India, South Korea and China (US Energy Information Administration, 2020c). The US is also an

important global exporter of coal, with India, Japan and South Korea representing three of the top five recipients of US steam coal exports in 2020 (US Energy Information Administration, 2020b). Going forward, while each of these fuel sources has the potential to contribute to regional energy security outlooks, several considerations, such as the overall competitiveness of US supplies, social license considerations and potential infrastructure bottlenecks, may limit overall US exports.

2. Modelling Assumptions

Over this study's outlook period of 2017–50, both overall GDP and population counts are projected to grow, though at markedly different rates, resulting in a trend of an overall rising per capita GDP (Figure 17.1). While US birth rates are projected to remain below replacement levels during the outlook window, the population continues to grow overall due to sustained immigration and improvements in life expectancies. However, at 0.5% per year, the population growth rate for the outlook period is still at a notably slower pace than the 1.0% of the 1990–2017 period.

Figure 18.1. Gross Domestic Product and Population



GDP = gross domestic product, POP = population.

Source: Authors.

Between 1990 and 2017, the US GDP grew at an average annual rate of 2.4%. Despite significant disruption in this overarching trend during the 2007–08 global economic crisis, US economic outlooks had generally recovered and stabilised by 2019. As of this report going to press, the Covid-19 pandemic has injected significant uncertainty into near-term economic

outlooks globally; the effects in the US have been particularly acute. Still, this model projects that GDP growth rates will restabilise over the outlook period at an annual average growth rate of 2.1% per year. This estimate aligns with expectations of continued efficiency and productivity gains coupled with modest yet sustained population growth. It also assumes continued US leadership on innovation in emerging fields alongside global market recovery.

Under the Business-as-Usual (BAU) scenario, oil is anticipated to retain its dominance through the outlook period, reflecting that, by sector, transportation is also anticipated to remain the single largest driver of total final energy consumption. In terms of electricity generation, while coal and nuclear energy remain critical components of the overall US mix, between 2017–50, both are anticipated to decline in terms of their overall share. This is primarily due to unfavourable economics and domestic policy and social license factors when compared with the outlooks for non-hydro renewables and natural gas. Coal in particular is expected to undergo a dramatic decline, given projected retirements of older, inefficient coal-fired plants during the outlook period. Meanwhile, investments in cleaner consumption technologies are anticipated to boost the overall efficiency of generation. However, uncertainties about the pace and scale of retirement of existing nuclear power plants weigh on the overall trajectory of US CO2 emissions.

The Alternative Policy Scenarios (APSs) assume progress toward the full implementation and realisation of a range of established efforts to strengthen a country's energy savings potential. For the US, these include efforts to strengthen efficiency of final energy consumption; improve efficient thermal power generation; sustain a robust role for nuclear energy as a source of baseload power generation; and realise a higher contribution from renewable energy in total supply. Calculations are modelled based on a review and assessment of current laws and policies in place at the national and state level. This study then reviews the results of the APSs to determine their cumulative impact in reducing CO2 emissions and encouraging energy savings beyond BAU.

3. Outlook Results

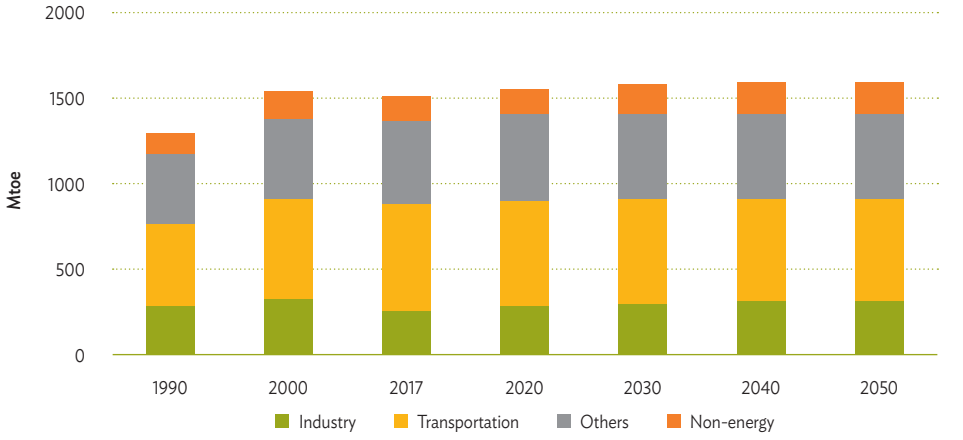
3.1. Business-as-Usual Scenario

3.1.1. Final energy consumption

Under BAU, total final energy consumption is anticipated to rise slightly between 2017

and 2050, at an average annual growth rate of 0.2% (Figure 18.2). The largest growth is experienced in industry, though non-energy sector consumption is not far behind, and also grows at the fastest rate. Meanwhile, the transportation sector is the only sector where consumption is anticipated to decline—albeit by only 0.1%—as efficiency improvements and other structural changes within the sector offset prospects of potential growth from a rise in vehicle ownership and utilisation.

Figure 18.2. Final Energy Consumption by Sector, BAU



BAU = Business as usual.

Source: Authors.

During this same period, electricity consumption is anticipated to grow from 321.42 Mtoe to 445.99 Mtoe. Non-hydropower renewables, primarily wind, solar and geothermal, experience the most dramatic growth during this period. Natural gas consumption grows overall, but shows signs of a potential peak near the end of the outlook period. Coal consumption declines throughout the entire 2017–50 period, although at a much slower pace than the previous 25 years and with most of this decline occurring in the 2020s. Oil consumption also declines, given expectations for continued efficiency gains, as well as switching in the transportation sector to natural gas, biofuels and other sources, as well as increased deployment of electric vehicles. By 2050, oil consumption is anticipated to fall to 686.10 Mtoe (roughly on par with levels in 1990).

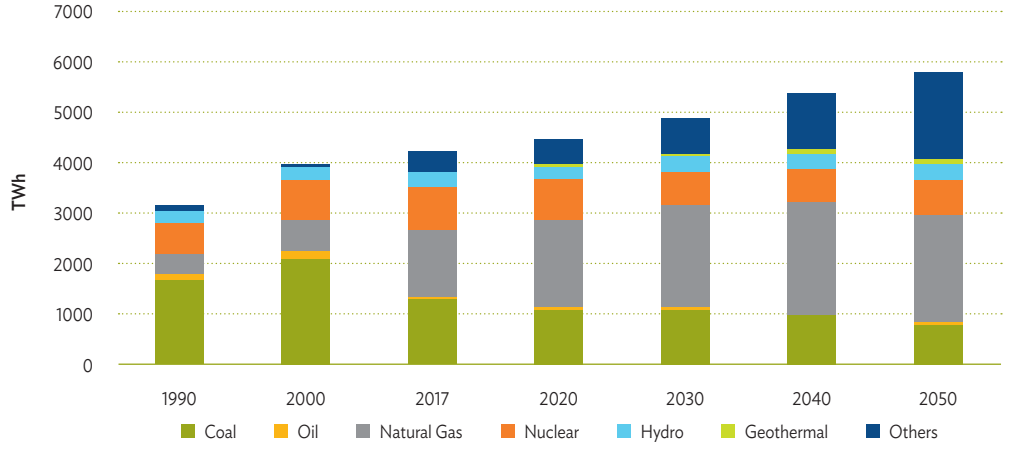
3.1.2 Primary Energy Supply

Under BAU, total primary energy supply is anticipated to rise from 2,155.23 Mtoe in 2017 to 2,254.78 Mtoe in 2050, with an average annual rate of increase of 0.1%. Coal consumption is anticipated to decline at a rate of 1.7% during this period, while nuclear declines by 0.6%. In

contrast, non-hydropower renewables experience the largest growth in consumption at 5.2%, followed by geothermal at 4.3%.

3.1.3 Power generation

Figure 18.3. Power Generation, BAU



BAU = Business as usual.

Source: Authors.

Electricity generation in the US, under BAU, is projected to increase over the outlook period, though at a slower pace than the previous 25 years. Generation output increases from 4,263.68 to 5,822.49 between 2017 and 2050, for an average annual growth rate of 0.9%.

After surpassing coal as the largest share of the US power generation mix in 2014, natural gas retains its number one rank through 2050, representing 37.6% of the overall mix. The largest average annual growth rates are seen in non-hydro renewables, most prominently solar and wind, as well as, potentially, geothermal. When combined with shares for nuclear and hydro, these growth rates suggest that, by 2050, close to 50% of US power generation output may come from zero-carbon sources. Improved economics alongside other considerations could also contribute to incentivising higher levels of consumption of wind and solar, though, as aptly noted by the EIA, many existing tax credits begin to expire in the early 2020s, potentially raising questions for the road ahead.

Retirements of older, inefficient coal-fired plants, as well as ongoing technological improvements promoting more efficient consumption, are assumed to play important roles in shaping this outlook, alongside broader market and policy forces that may incentivise switching. Coal is now expected to decline sharply at 1.5% a year, and in 2050 it is anticipated to account for only 13.9% of all US power generation (down from 31.0% in 2017). However,

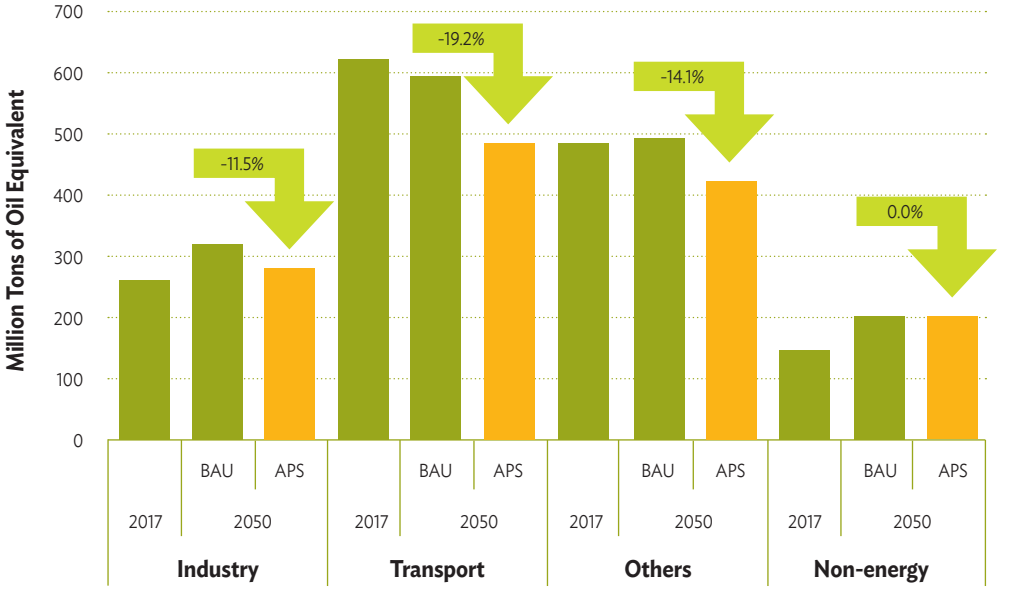
uncertainties in investments and progress toward strengthening existing, aging grid infrastructure may challenge efforts to bring new generation on line in ways that promote energy savings and CO2 reductions.

3.2. Energy Saving and CO2 Reduction Potential

3.2.1. Final energy consumption

This study projects that, rather than continuing to grow, total final energy consumption in the US begins to decline under APS. To that end, under APS, consumption declines from 1,520.46 Mtoe to 1,392.08 Mtoe during 2017–50. When compared with BAU, this shows an energy savings of 221.36 Mtoe, or 13.72% during the period. Transportation realises a saving of 114.78 Mtoe (19.2%), industry saves 36.78 Mtoe (11.53%), and residential and commercial (others) saves 69.8 Mtoe (14.1%). Meanwhile, in contrast to expectations under BAU, both transportation and residential and commercial now realise some level of declining overall consumption.

Figure 18.4. Final Energy Consumption by Sector in BAU vs. APS



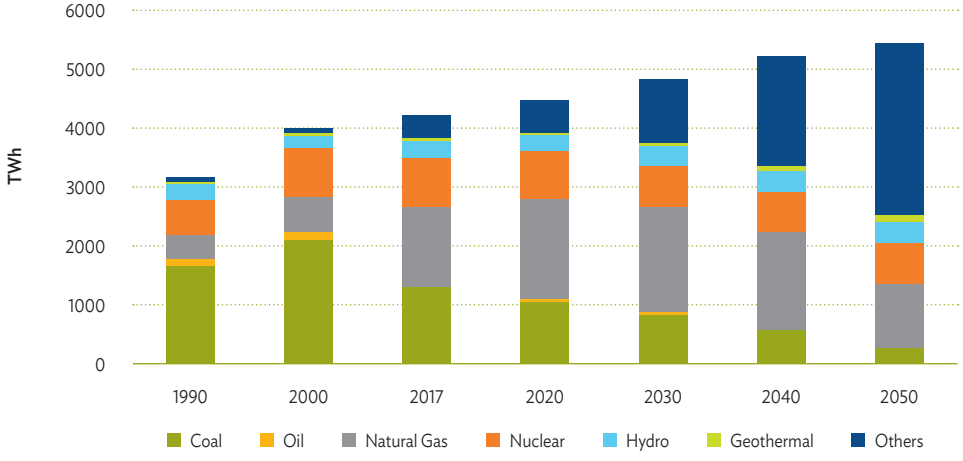
APS = alternative policy scenario, BAU = Business as usual.

Source: Authors.

Under APS, electricity consumption is still anticipated to grow, although at a modestly slower rate than in BAU. Much more dramatic, however, is the overall transformation of the US power generation mix. In line with increasingly favourable economics and this scenario's assumptions around additional technological improvements (including in storage

technologies), non-hydro renewables overtake natural gas as the largest share of the US power generation mix. By 2050, roughly 75% of US power generation output comes from zero-carbon sources; natural gas makes up 20% while coal is responsible for less than 5% (see Figure 18.5).

Figure 18.5. Electricity Generation under APS

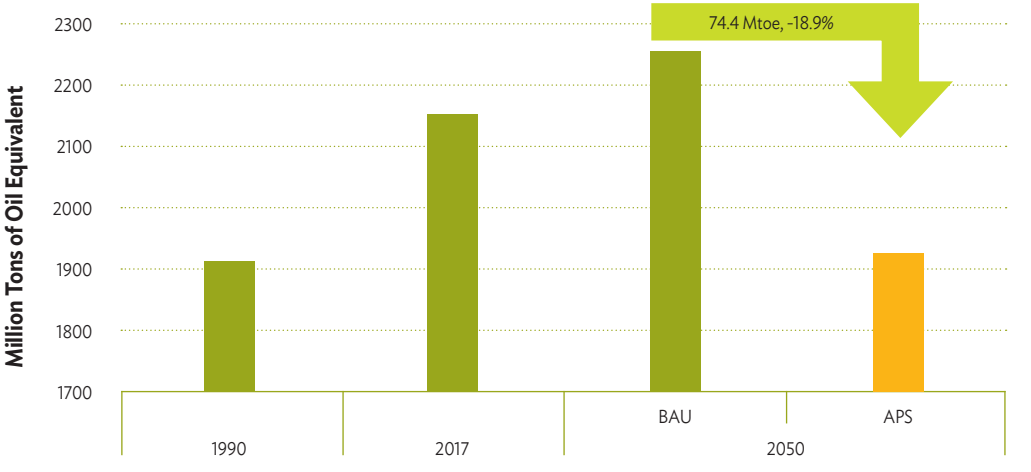


EAS = East Asia Summit, Mtoe = million tons of oil equivalent.

Source: Authors.

3.2.2. Primary energy supply

Figure 18.6 . Total Primary Energy Supply in BAU vs. APS



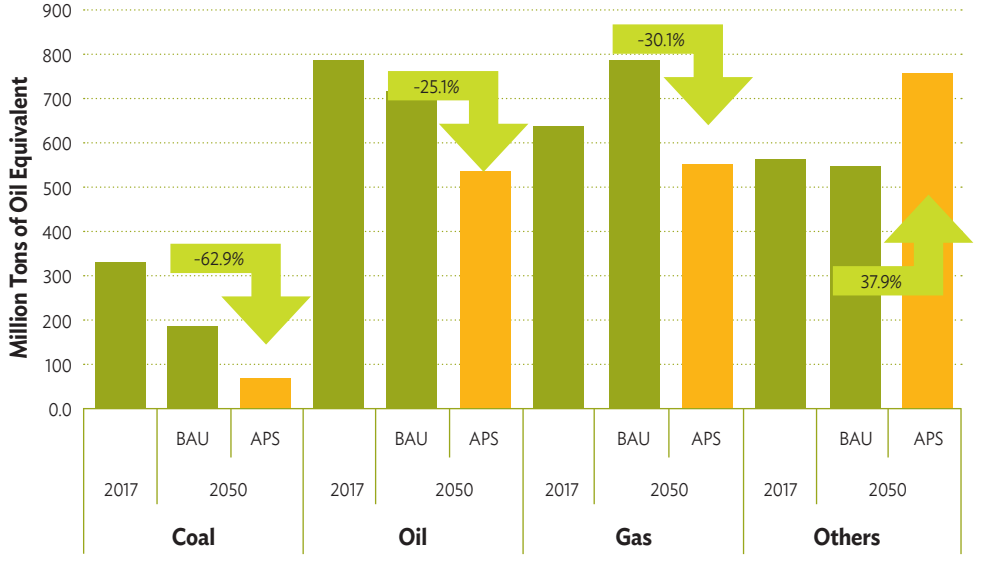
APS = alternative policy scenario, BAU = Business as usual.

Source: Authors.

Under the APS, the US primary energy supply is anticipated to decrease from 2,155.23 in 2017 to 1,924.39 in 2050. This implies that, in 2050, under APS, savings of primary energy supplies will be around 330.39 Mtoe, or 14.65% lower compared with BAU (Figure 18.6).

Primary energy demand in the APS is expected to decline for coal to 70.36 Mtoe. This represents a total energy savings of 119.33 Mtoe in 2050 compared with BAU. Oil consumption is also anticipated to decline compared to BAU, with a potential saving of 180.91 Mtoe (or 25.09%) by 2050, while natural gas is also anticipated to see an even more pronounced level of decline (30.11%). In contrast, the combined demand for all others is anticipated to increase about 208.82 Mtoe (37.92%) compared to BAU in 2050.

Figure 18.7. Total Primary Energy Supply by Fuel in BAU vs. APS



APS = alternative policy scenario, BAU = Business as usual.

Source: Authors.

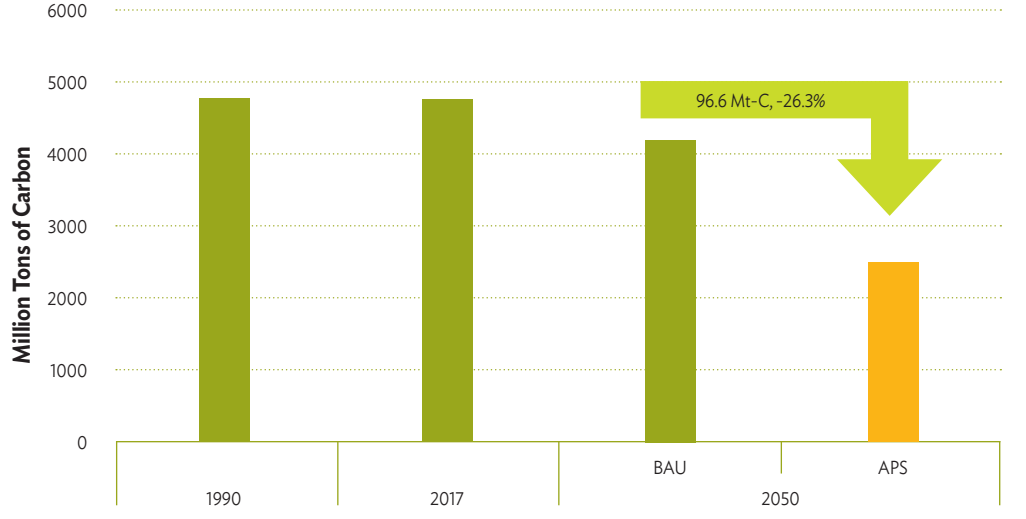
3.3. CO2 Emissions

CO2 emissions from energy consumption, under the BAU, are anticipated to decline modestly from 4,760.8 Mt-C in 2017 to 4,191.7 Mt-C in 2050. This is equivalent to an annual average rate of decrease of 0.4%. Key drivers of this shift include that, while energy consumption overall continues to grow in the BAU scenario, continued switching in the US electricity mix—particularly decreases in coal consumption and increased consumption of non-fossil sources—contributes to modest improvements in the country's overall emission profile, as does a decrease in oil consumption.

In the APS, CO2 emissions are projected to decrease at an average annual rate of 2% from 4,760.8 Mt-C in 2017 to 2,485.1 Mt-C in 2050. Emissions savings in the APS are thus 40.71% compared to the BAU in 2050. The most dramatic shifts between BAU and APS link to absolute reductions in emissions from natural gas (681 Mt-C) and oil (517.6 Mt-C), though coal undergoes the most substantial relative reduction, down 66.51%.

In its official Intended Nationally Determined Contribution submission, the US pledged to reduce CO2 emissions by 26%–28% from 2005 levels by 2025. Although the current US administration has announced that it intends to formally withdraw from the Paris Climate Accord in November 2020, thus abandoning its current Intended Nationally Determined Contribution pledge, this study suggests that the US has already made substantial progress toward this goal. However, even under APS more robust action may be necessary to fully achieve this target by 2025.

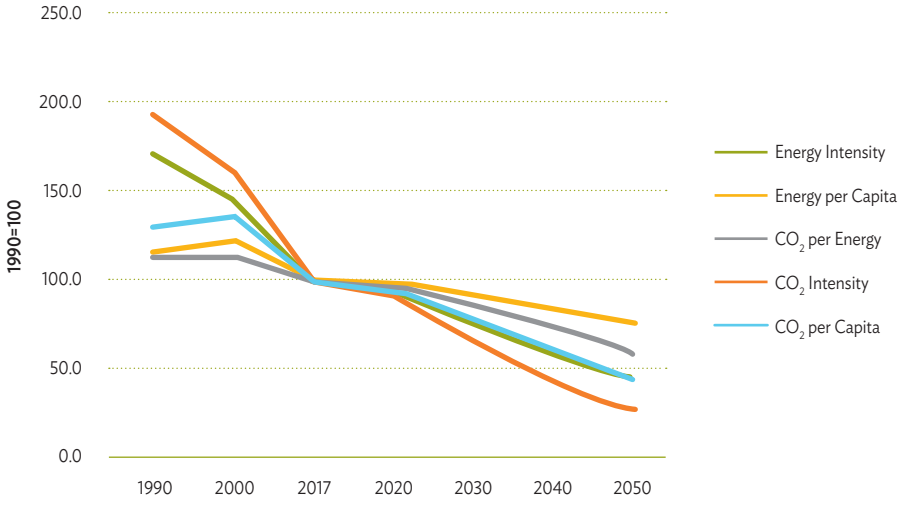
Figure 18.8. CO_2 Emission Trends in BAU vs. APS



APS = alternative policy scenario, BAU = Business as usual.

Source: Authors.

Figure 18.9. Energy Indicators under APS



APS = alternative policy scenario.

Source: Authors.

4. Implications

- Oil and natural gas will continue to dominate the US energy mix in both BAU and APS. However, demand for coal will continue to steadily decline in both scenarios, with an even more dramatic reduction projected under APS.

- While natural gas will remain the single greatest share of the US electricity generation mix over the period to 2050 under BAU, non-hydro renewables such as wind and solar are anticipated to experience the largest growth rates. Moreover, under APS, zero-carbon sources overtake natural gas as the greatest share of the US electricity generation mix. However, as aptly noted by the EIA, substantial uncertainties lie ahead, including determining the implications and desirable responses to expiring tax credits and fiscal incentives for renewable energy in the 2020s. Greater attention to addressing aging infrastructure as well as new breakthroughs in storage technologies are also critical to maintaining the overall pace and trajectory of additional gains.

- Continued efforts to strengthen the transportation sector are envisioning as a critical opportunity for energy saving under both BAU and APS. In addition to accelerated deployment of electric vehicles, greater attention to fuel efficiency and technologies for overall cleaner consumption will be critical given expectations of a continued

prominent role for oil.

- US energy exports to Asia could contribute immensely to strengthening regional energy security outlooks. However, factors such as overall competitiveness, social license considerations on both sides of the Pacific, and the need to overcome infrastructure bottlenecks may limit overall US export growth potential.

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