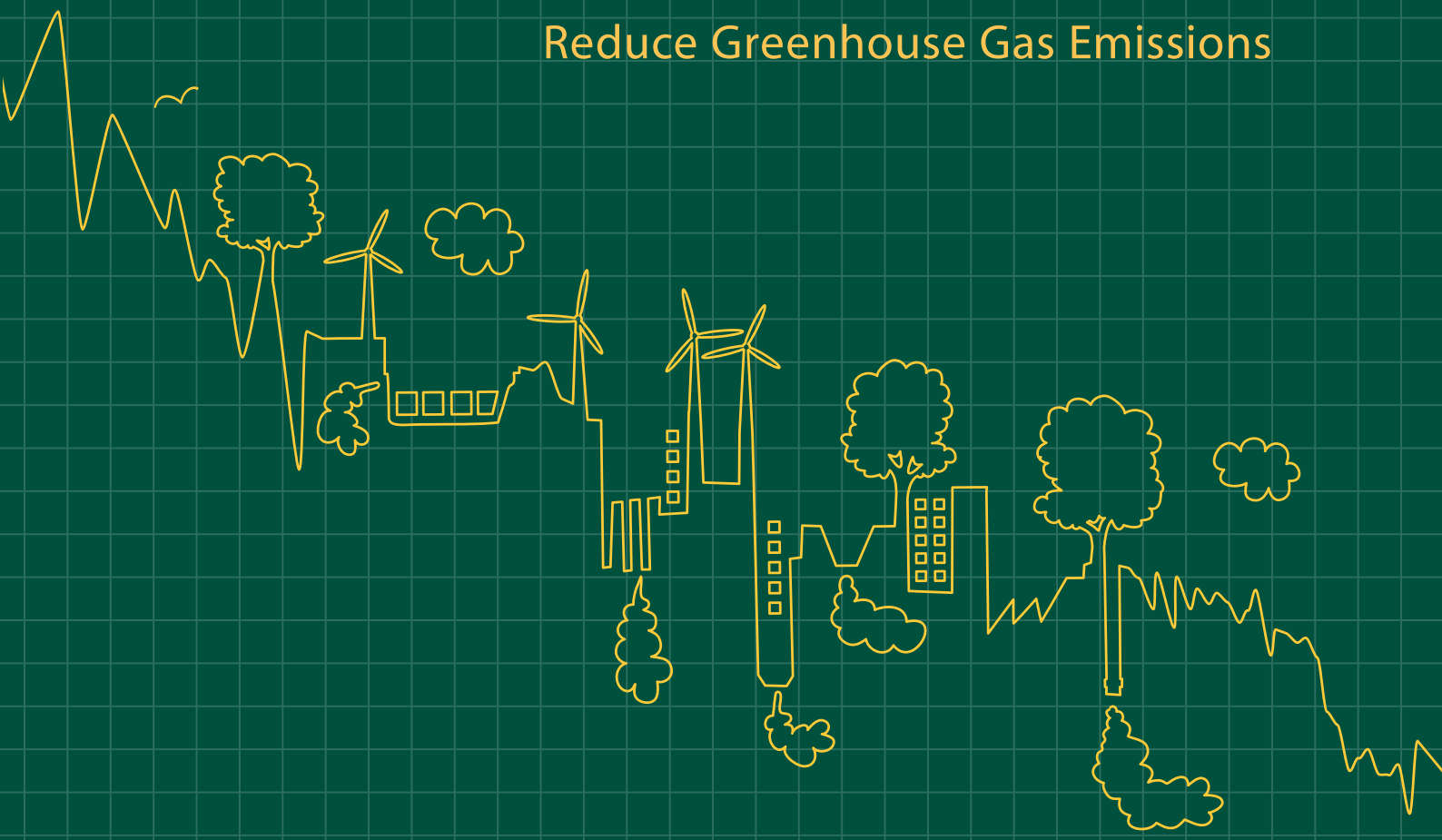
WORLD RESOURCES INSTITUTE

SUMMARY FOR POLICYMAKERS

Can The U.S. Get There From Here?

Using Existing Federal Laws and State Action to Reduce Greenhouse Gas Emissions



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Summary for Policymakers

I. Introduction

CLIMATE CHANGE IMPACTS IN THE UNITED States are increasingly evident and come with steep economic and social costs. The frequency and intensity of extreme weather events has increased in recent years, bringing record-breaking heat, heavy precipitation, coastal flooding, severe droughts, and damaging wildfires.[1] According to the National Oceanic and Atmospheric Administration (NOAA), weather-related damages in the United States were $60 billion in 2011, and are expected to be significantly greater in 2012.[2]

The mounting costs convey an unmistakable urgency to address climate change by reducing greenhouse gas emissions (GHGs). This report examines pathways for GHG reductions in the United States through actions taken at the federal and state levels without the need for new legislation from the U.S. Congress.

This report answers a number of key questions:

- What are current U.S. GHG emissions? Without further action to reduce emissions, what are they projected to be in 2020 and 2035?
- What legal and policy tools exist under current federal law to achieve emissions reductions? What additional actions can states pursue to contribute to emissions reductions?
- Which legal and policy tools at the state and federal levels offer the greatest potential for achieving emissions reductions in the near- and mid-term?
- Can the U.S. meet its international commitment to reduce emissions 17 percent below 2005 levels by 2020 without new federal legislation?
- Can the U.S. put itself on a trajectory to meet or exceed its long-term commitment of reducing emissions by more than 80 percent below 2005 levels by 2050, without new legislation from Congress?

The answers to these questions are set out in detail in the body of this report. Two significant findings stand out. First, it is clear the U.S. is not currently on track to meet its 2020 reduction pledge, however, this target is achievable through implementation of strong new federal measures to reduce emissions using existing legal authorities. Second, the mid-century goal of reducing emissions by 80 percent or more appears unattainable using existing authorities. New legislation will eventually be needed.

BOX 1 Key Conclusions and Recommendations

1. Without new action by the U.S. Administration, greenhouse gas (GHG) emissions will increase over time. The U.S. will fail to make the deep emissions reductions needed in coming decades, and will not meet its international commitment to reduce GHG emissions by 17 percent below 2005 levels by 2020.
2. The U.S. EPA should immediately pursue "go-getter" emissions reductions from power plants and natural gas systems using its authority under the Clean Air Act. These two sectors represent two of the top opportunities for substantial GHG reductions between now and 2035.
3. The U.S. Administration should pursue hydrofluorocarbon (HFC) reductions through both the Montreal Protocol process and under its independent Clean Air Act authority. Eliminating HFCs represents the biggest opportunity for GHG emissions reductions behind power plants.
4. U.S. states should complement federal actions to reduce emissions through state energy efficiency, renewables, transportation, and other actions. States can augment federal reductions.
5. New federal legislation will eventually be needed, because even go-getter action by federal and state governments will probably fail to achieve the more than 80 percent GHG emissions reductions necessary to fend off the most deleterious impacts of climate change.

Potential reductions in the United Stated were assessed in a 2010 WRI Report entitled *Reducing Greenhouse Gas Emissions in the United States Using Existing Federal Authorities and State Action.*[3] This updated report revisits these questions, taking into account the latest GHG emissions information and recent actions taken at the federal and state levels. Since the publication of the last report, notable factors influencing U.S. GHG emissions include:

- Reduced global economic growth, including slower growth of economic output in the United States;
- Increased fuel switching from coal to natural gas in the generation of electricity; and
- Reduced demand for transportation fuel, partly as a result of higher petroleum prices, lower miles traveled, and more efficient vehicles.

These factors and others, including the issuance of new motor vehicle emissions and fuel efficiency standards for cars and trucks, will reduce greenhouse gas emissions. However, even with these factors, we project that total U.S. emissions will experience relatively modest growth over the coming decades.

At the 2009 Conference of the Parties of the United Nations Framework Convention on Climate Change in Copenhagen, Denmark, President Obama made a commitment to reduce U.S. greenhouse gas emissions in the range of 17 percent below 2005 levels by 2020. Despite the inability of Congress to pass comprehensive climate change legislation, the Administration has re-committed to the Copenhagen pledge and taken some steps to reduce emissions using authority under existing laws.[4] While the Administration has reaffirmed its commitment to this target, it has not yet matched that commitment with adequate action. Though significant progress has been made in some areas since our 2010 analysis, most notably with the vehicle rules, key opportunities, such as reductions from power plants, remain untapped. The fact that the U.S. remains far from the "go-getter" emissions trajectory laid out in our 2010 report reinforces the urgency for taking strong action now.

Although the U.S. emissions reduction commitment for 2020 represents an important step toward reducing GHG emissions, much greater reductions are necessary. According to the Intergovernmental Panel on Climate Change, industrialized countries need to collectively reduce emissions between 25 and 40 percent below 1990 levels by 2020 and 80 to 95 percent below 1990 levels by 2050 in order to keep global average temperatures from increasing more than 2 degrees Celsius above preindustrial levels. This report evaluates the potential for meeting the 17 percent commitment and the deeper longer-term reduction pathway necessary to avoid the worst impacts of climate change.

BOX 2 Ambition Matters

Within the bounds of what is legally and technically possible, the single most important factor influencing emissions reductions is political and policy ambition. This analysis considers three levels of ambition:

- **Lackluster.** This is low ambition and represents the results of actions of lowest cost or least optimistic technical achievement.
- **Middle-of-the-Road.** This is mid-level ambition and represents the results of actions of moderate cost and moderately optimistic technical achievement.
- **Go-Getter.** This is the highest ambition achievable without new congressional action. It represents the results of actions of higher cost or most optimistic technical achievement.

The term "go-getter" is not meant to suggest the actions are adequate to achieve U.S. reduction targets or reductions the science suggests are necessary to ward off the worst effects of climate change.

1. *America's Climate Choices: Panel on Advancing the Science of Climate Change.* National Research Council, 2010.ISBN 978-0-309-14588-6. Accessible at: <http://www.nap.edu/catalog.php?record_id=12782>.
2. *Preliminary Info on 2012 U.S. Billion-Dollar Extreme Weather/ Climate Events.* National Oceanic and Atmospheric Administration. Accessible at: <http://www.ncdc.noaa.gov/news/preliminary-info-2012-us-billion-dollar-extreme-weatherclimate-events>. (Last accessed January 15, 2013)
3. Accessible at: <http://www.wri.org/publication/reducing-ghg-emissions-using-existing-federal-authorities-and-state-action>.
4. Most recently, the U.S. delegation to the Conference of the Parties of the UN Framework Convention on Climate Change in Doha, Qatar, made it clear that the 17 percent pledge is not contingent on new legislation from Congress.

Attaining even the 17 percent reduction goal will require new and ambitious action from the U.S. Administration—ambitious action that must survive court challenges. Real progress depends on numerous actions not yet taken by the U.S. Administration—especially for stationary emissions sources like power plants, natural gas systems, and industry. U.S. states may also need to take action to fill any emissions gaps left by the federal government. Achieving the necessary mid-century reductions will almost certainly require the U.S. Congress to act to achieve the needed reductions.

Section II summarizes the report's key findings, including the range of reductions that are possible and a brief description of the analytical approach. An examination of current emissions in the United States and projected emissions without new actions follows in Section III. Section IV summarizes the sector-by-sector actions the federal government might take under existing laws. Section V summarizes potential state actions. Section VI sets out summary conclusions. Two detailed appendixes set out the assumptions and methodologies for the federal and state analyses. The picture revealed is one of significant potential greenhouse gas emissions reductions, provided there is sufficient political will to take strong action.

II. Charting a Path Forward in the U.S.: Summary of Key Findings

This report identifies significant potential for GHG emissions reductions by the U.S. Administration under current laws and through state-level actions, as well as the limitations of current tools. The reductions actually achieved will depend on the level of ambition brought to the effort by the U.S. Administration, including executive agencies such as the U.S. Environmental Protection Agency. At the state level, outcomes will depend on the number of states that choose to support renewable energy, energy efficiency, and transportation measures, and to pursue policies that the federal government opts not to pursue or that go beyond the minimum stringency set by the federal government. Key findings are set out below for federal and state actions.[5]

A. FEDERAL GHG REDUCTIONS POSSIBLE WITHOUT NEW LEGISLATION

- Only with "go-getter" ambition by the U.S. Administration can the United States achieve emissions reductions using current law that meet or exceed the Copenhagen commitment to reduce global warming pollution by at least 17 percent below 2005 levels by 2020.[6] With middle-of-the-road ambition, the United States will fall well short of its 17 percent commitment, unless supplemented by go-getter actions by the states.

- Even with go-getter ambition, long-term emissions reductions fall short of the level of reductions necessary to put the United States on pace to reach its long-term reduction goal of reducing emissions 83 percent below 2005 levels by 2050. New congressional legislation is therefore necessary to achieve reductions in line with what the international scientific community agrees is necessary by mid-century in order to stabilize global average temperatures and avert the worst impacts of climate change.

- After taking action to significantly improve motor vehicle fuel efficiency, the U.S. Administration should now apply similar ambition to reducing emissions from a wider range of sources, such as existing power plants, if it is to achieve the needed reductions.

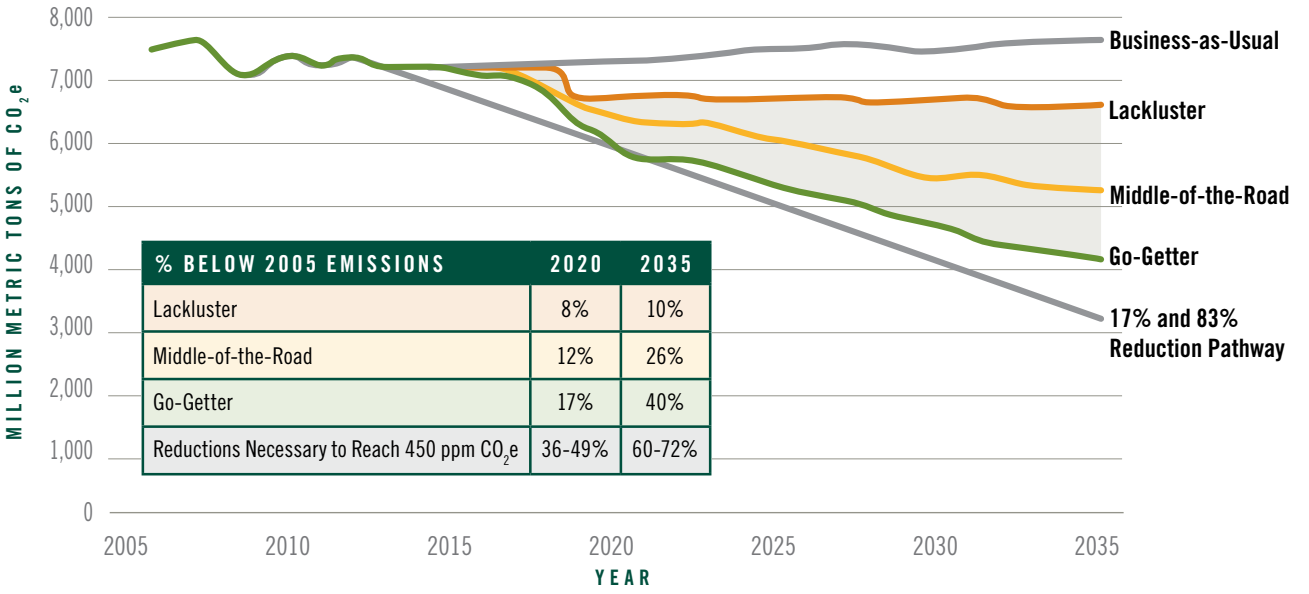
- The greatest projected emissions reduction opportunities by 2020 and beyond come from four federal policy measures. The Administration will need to pursue these opportunities if the United States is to achieve the 17 percent reduction target. Those policies are:

    - standards to reduce carbon pollution from existing power plants (48 percent of total emissions gap between business-as-usual (BAU) and 2020 target);

5. For data sources and an explanation of how expected emissions trends were compiled, please consult the appendixes. For the sake of clarity and brevity, sources are not provided in this summary.

6. The U.S. commitment in Copenhagen calls for reductions in 2020 "in the range of 17 percent [below 2005 levels], in conformity with anticipated U.S. energy and climate legislation." The U.S. submission notes that the ultimate goal of legislation pending at the time was to reduce emissions by 83 percent below 2005 levels in 2050.

FIGURE 1 Projected U.S. Emissions under Different Federal Regulatory Scenarios



% BELOW 2005 EMISSIONS	2020	2035
Lackluster	8%	10%
Middle-of-the-Road	12%	26%
Go-Getter	17%	40%
Reductions Necessary to Reach 450 ppm CO_2e	36-49%	60-72%

Note: The Intergovernmental Panel on Climate Change's (IPCC's) *Fourth Assessment Report* (2007) indicates that industrialized countries need to collectively reduce emissions between 25 and 40 percent below 1990 levels by 2020 and 80 to 95 percent below 1990 levels by 2050 to keep atmospheric concentrations of greenhouse gases from exceeding 450 parts per million of CO_2e and to keep global average temperatures from increasing more than 2 degrees Celsius above pre-industrial levels. This target does not necessarily represent any particular country's share. Due to modeling limitations, this figure depicts HFC consumption, which is generally thought to be equivalent to life-cycle emissions. For this and all other figures, we use the global warming potentials provided in IPCC's *Fourth Assessment Report*. There are some limited exceptions. See Appendix I for more details.

- requirements to phase out the use of certain hydrofluorocarbons (HFCs) (23 percent of total emissions gap between BAU and 2020 target);
- standards to reduce methane emissions from natural gas systems (11 percent of total emissions gap between BAU and 2020 target);[7] and
- actions to improve energy efficiency in the residential, commercial, and industrial sectors (8 percent of total emissions gap between BAU and 2020 target).

B. STATE ACTION COULD HELP THE U.S. MEET NEAR-TERM PLEDGE

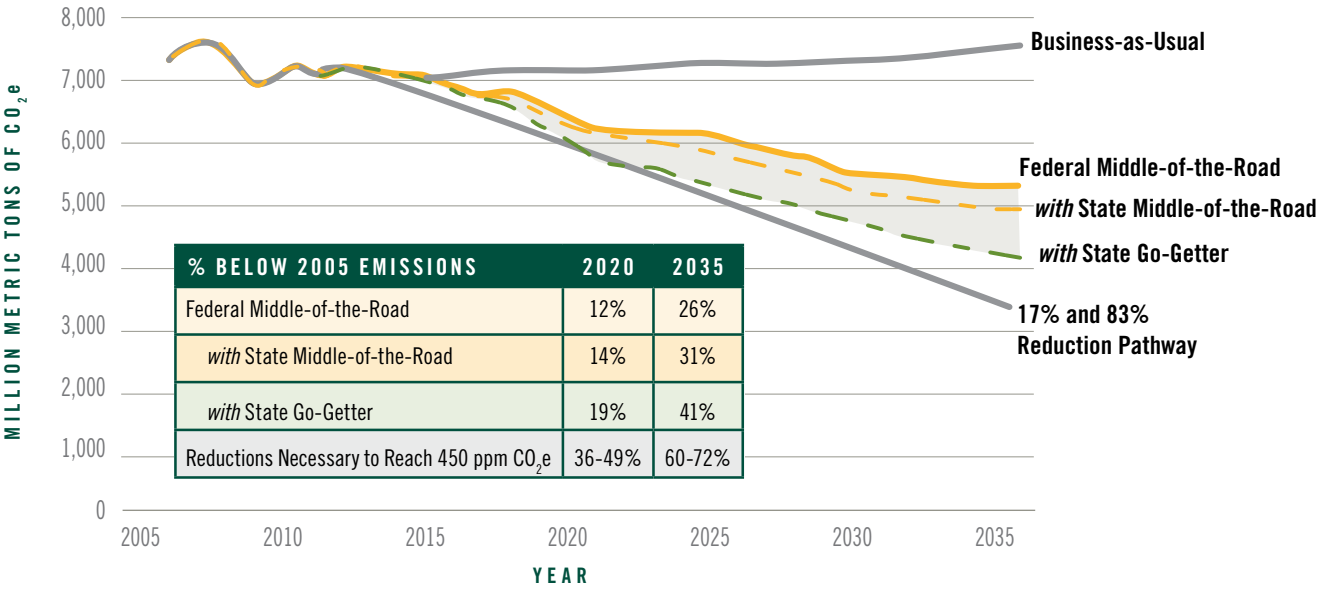
- States can be important contributors to efforts to reduce GHG emissions. If the U.S. Administration were to pursue policies with middle-of-the-road ambition, for example, states could pick up the slack and help the United States reach its goal of reducing emissions 17 percent below 2005 levels by 2020.
- If the federal government pursues a lackluster effort, even a go-getter effort by states is unlikely to achieve the U.S. Administration's 2020 reduction goal.
- Beyond 2020, go-getter state action combined with middle-of-the-road federal action falls short of putting the United States on track to make the mid-century reduction target. This suggests that strong new federal legislative action will be needed.

C. THE STUDY IN BRIEF

This updated report represents the authors' projections of the range of greenhouse gas emissions reductions possible if federal agencies and certain states implement measures to reduce GHG emissions. The report projects the range of reductions possible under current federal law based on a review of published analyses of technical feasibility. The report characterizes three emissions scenarios based on different levels of effort by federal and state actors: "lackluster," "middle-of-the-road," and "go-getter."

7. There is considerable uncertainty with regard to emissions for natural gas systems. The absolute magnitude of abatement opportunities is thus also uncertain. Nevertheless, our analysis suggests that there are important opportunities to reduce emissions from this sector. Those reductions are some of the lowest cost opportunities identified in this analysis.

FIGURE 2 Projected U.S Emissions with State Action Coupled with Middle-of-the-Road Federal Action



% BELOW 2005 EMISSIONS	2020	2035
Federal Middle-of-the-Road	12%	26%
with State Middle-of-the-Road	14%	31%
with State Go-Getter	19%	41%
Reductions Necessary to Reach 450 ppm CO_2e	36-49%	60-72%

Note: Due to modeling limitations, this figure depicts HFC consumption, which is generally thought to be equivalent to life-cycle emissions.

1. Analysis of Federal Actions

The analysis of federal actions is based on a legal assessment of the measures the U.S. Administration, including key federal agencies like EPA, may take under existing federal laws. The federal analysis assumes no new legislation is adopted. Technical studies were used to identify the range of reductions possible within a given sector or subsector. The legally and technically feasible range of reductions was then evaluated based on the level of ambition necessary to achieve a particular point in the range. Where available, we relied more heavily on studies that provided a consideration of the costs needed to achieve a particular outcome to provide a sense of the federal regulatory resolve necessary to achieve those reductions.

Where only a low level of ambition is necessary to achieve a particular technically and legally feasible outcome within a specific sector or subsector, the outcome was judged to be "lackluster." If a high level of ambition is necessary to achieve a particular reduction outcome deemed technically and legally possible, the effort necessary was deemed "go-getter" in our scenarios. "Middle-of-the-road" outcomes were those judged possible with moderate ambition and usually at the middle of the range deemed technically and legally possible.

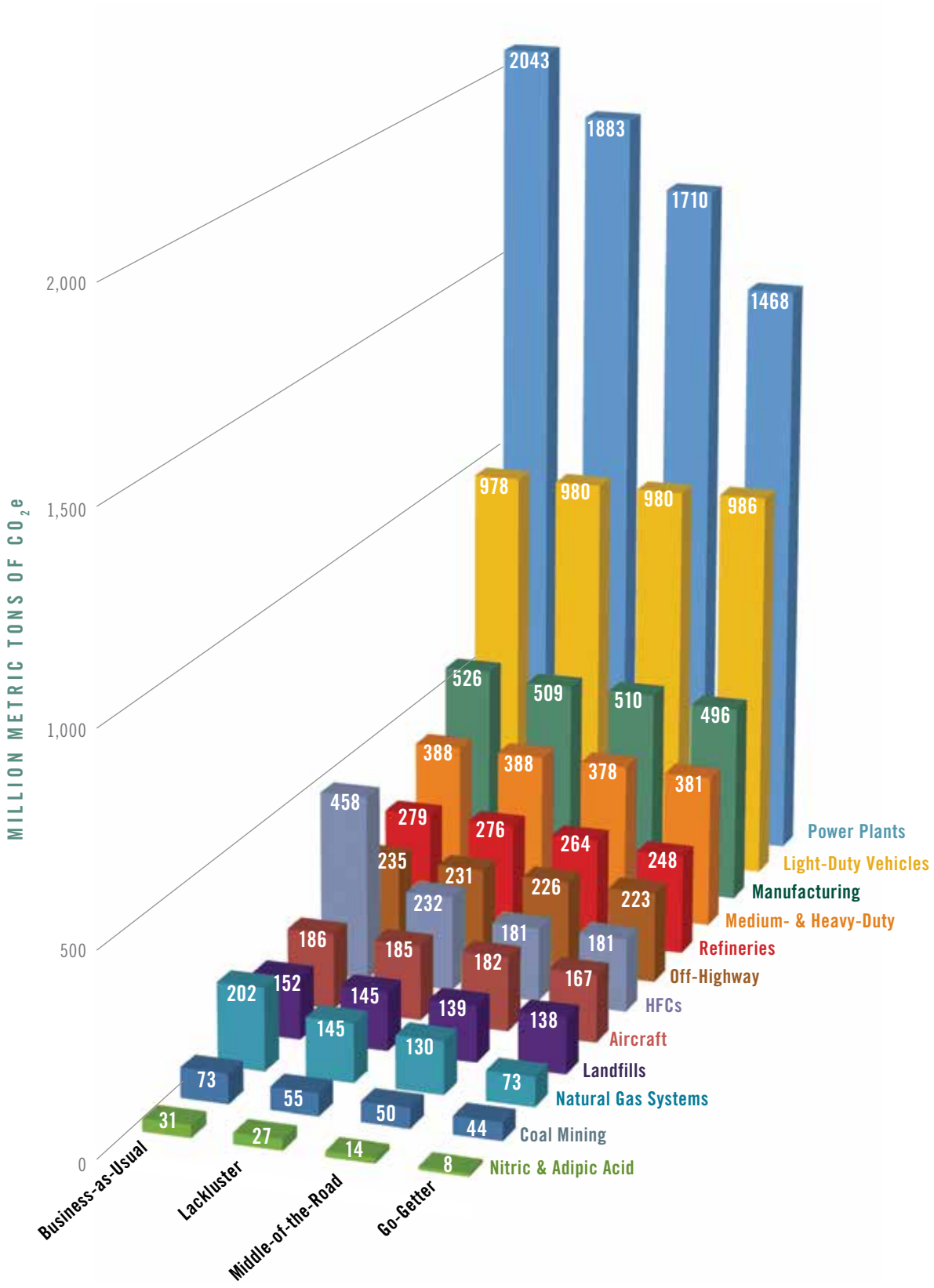
Lackluster emissions reductions from all sectors and subsectors analyzed were aggregated to determine the lackluster emissions pathway through 2035. The same approach was taken for middle-of-the-road and go-getter reductions.

2. Analysis of State Actions

The state analysis has two components: the first considers the impact of states taking action in the absence of federal action; the second considers the impact of states taking action in the presence of varying levels of federal action. In both components we examine the implication of states implementing the same types of policies modeled for the federal government, as well as complementary state-level actions in the transportation, energy efficiency, and renewables areas.

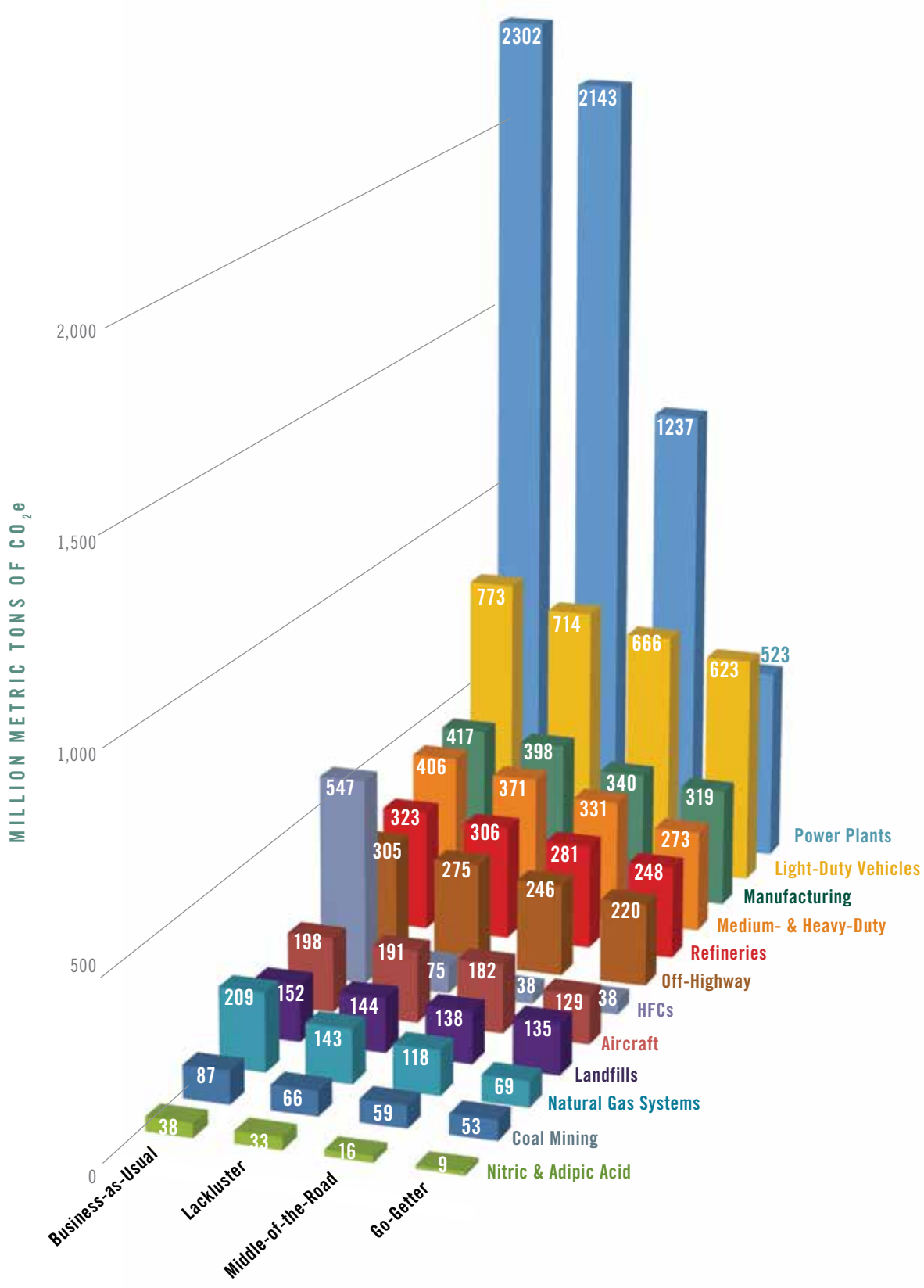
For transportation, the state scenarios consider measures to encourage low carbon fuels and reduce vehicle miles traveled. In the energy efficiency area, measures examined include increased electric end-use energy efficiency, improved building performance, and increased deployment of combined heat and power. For renewables, the analysis adds new and additional renewable energy policies across a certain number of states.

FIGURE 3 Projected U.S. Emissions in 2020 by Sector under Different Federal Regulatory Scenarios



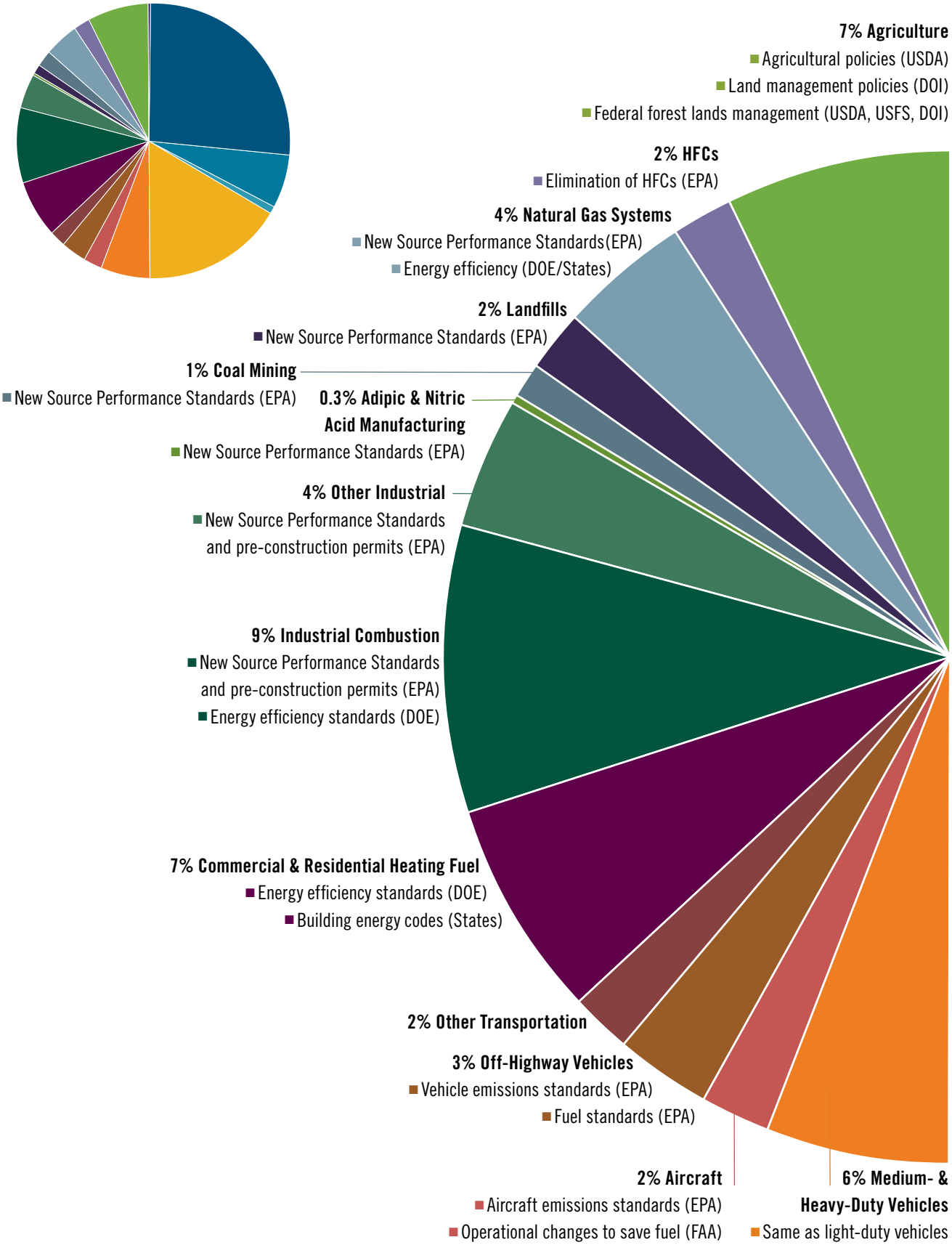
Note: Figure 3 depicts the emissions under the three federal regulatory scenarios by sector or category of sources in 2020. The bars on the left represent business-as-usual emissions. Emissions under the lackluster, middle-of-the-road, and go-getter scenarios are then shown moving from left to right of the business-as-usual emissions. Light-duty vehicle emissions initially increase in our scenarios due to assumptions about vehicle electrification and crediting rates. As shown in Figure 4, these trends reverse in later years. See Appendix I for more information. Due to modeling limitations, this figure depicts HFC consumption, which is generally thought to be equivalent to life-cycle emissions.

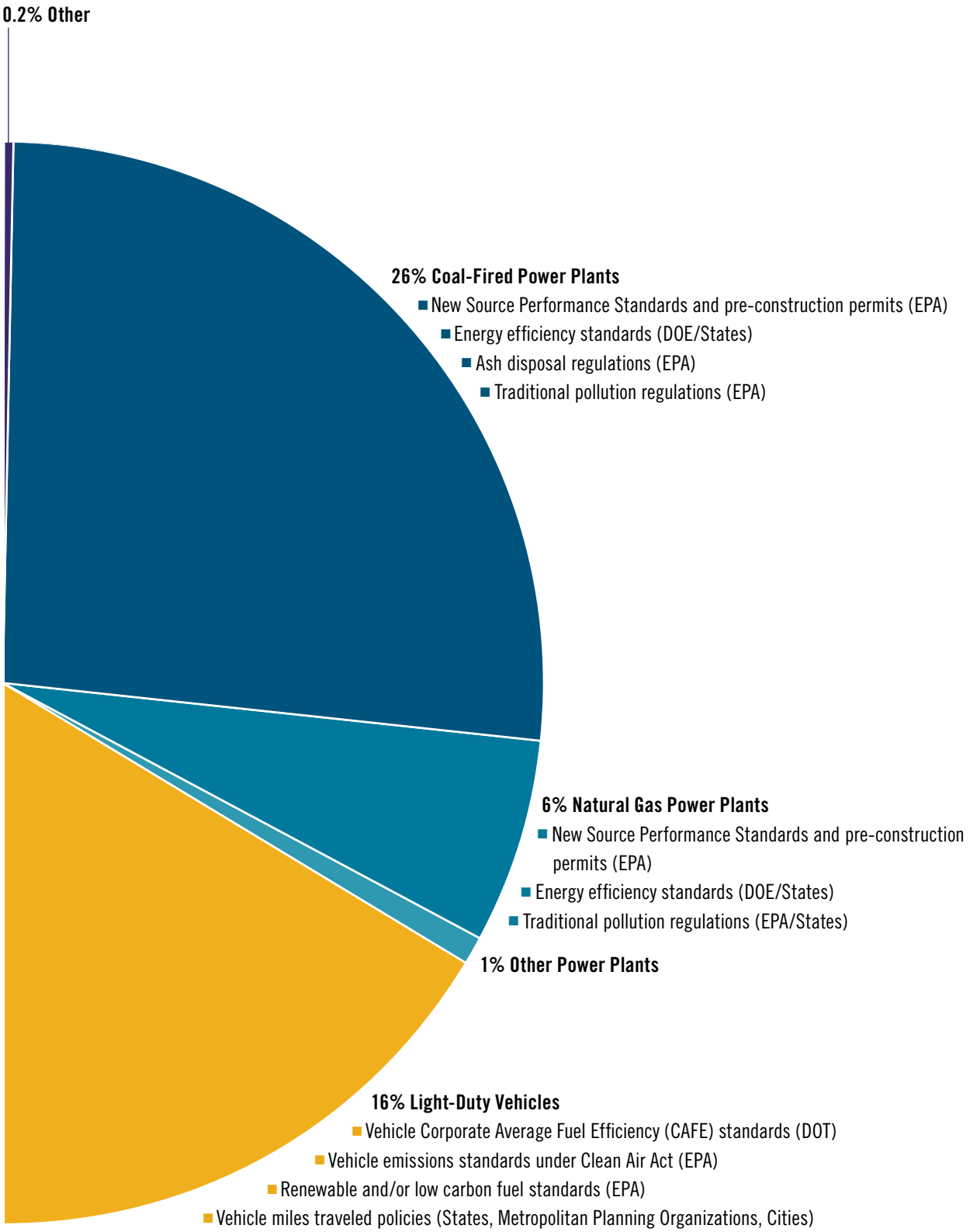
FIGURE 4 Projected U.S. Emissions in 2035 by Sector under Different Federal Regulatory Scenarios



Note: Figure 4 depicts the emissions under the three federal regulatory scenarios by sector or category of sources in 2035. The bars on the left represent the business-as-usual emissions. Emissions under the lackluster, middle-of-the-road, and go-getter scenarios are then shown moving from left to right of the business-as-usual emissions. Due to modeling limitations, this figure depicts HFC consumption, which is generally thought to be equivalent to life-cycle emissions.

FIGURE 5 **U.S. Greenhouse Gas Emissions by Sector and Corresponding Federal Authorities, 2010**





Source: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010.* U.S. Environmental Protection Agency, April 2012. Accessible at: <http://www.epa.gov/climatechange/emissions/usinventoryreport.html>; *Clearing the Air on Shale Gas Emissions: Assessing and Reducing the Carbon Footprint of Natural Gas.* James Bradbury, Michael Obeiter, Laura Draucker, Wen Wang, and Amanda Stevens. World Resources Institute, Working Paper, forthcoming.

Unlike the federal analysis, many of the state measures modeled would require new legislation at the state level. Also unlike the federal scenario, whether state action is "lackluster", "middle-of-the-road" or "go-getter" is a function of how many states adopt the measures modeled, and in some cases the ambition of the policies pursued.

3. Analysis of Federal and State Actions Together

Given that it is unlikely that federal action will occur without state action or that state action will occur without federal action, we analyzed emissions scenarios with both federal and state action. States can be expected to continue to be active in areas of traditional state purview such as energy resource planning and energy efficiency, while also compensating for weak federal action. To capture this dynamic, we modeled varying levels of action for federal and state action.

III. The Road the U.S. is on Now: Business as Usual

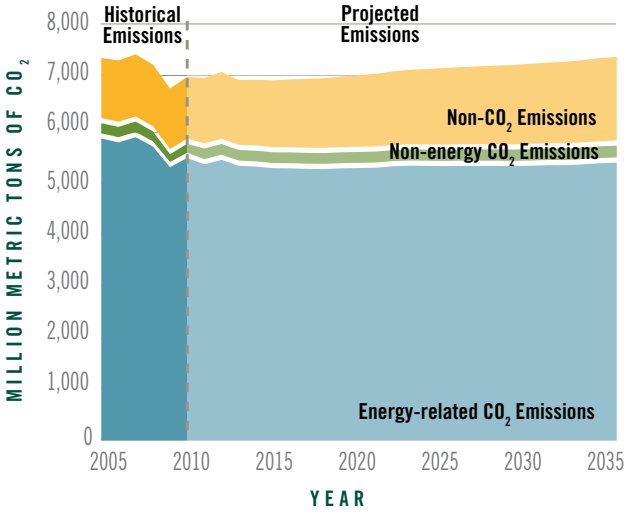
The reduction pathways presented in this report are best considered in light of current U.S. emissions, along with recent and future emissions trends. A snapshot of U.S. emissions using the most recent data available is presented below, together with a summary of U.S. emissions by key sectors and recent actions to reduce them by federal agencies.

A. CURRENT U.S. EMISSIONS

In 2010 the United States emitted almost 7 billion metric tons of carbon dioxide equivalents (CO_2e), which represents a decrease of about 6 percent below 2005 levels and a 10 percent increase over 1990 levels. Fossil-fuel combustion was responsible for nearly 80 percent of U.S. emissions, with power plants accounting for about 40 percent of combustion emissions, or one-third of the total U.S. GHG inventory, according to EPA. The second largest contributor to total GHG emissions is the transportation sector, with approximately 30 percent of U.S. emissions. Non-CO_2 emissions and CO_2 emissions that result from industrial processes (as opposed to combustion) represented approximately 22 percent of U.S. total GHG emissions.

Figure 5 shows the 2010 U.S. emissions inventory by sector and subsector, together with the corresponding federal regulatory tools available to achieve reductions in the sector.

FIGURE 6 Projected U.S. Greenhouse Gas Emissions if no New State or Federal Action is Taken



Source: See sources listed under Figures 7 and 8 below.

B. WHAT HAPPENS WITH NO NEW POLICIES? UNDERSTANDING CURRENT U.S. EMISSIONS TRENDS

Before discussing the reduction pathways projected for this report, it is important to describe the major emissions trends that are part of the business-as-usual projections. Business-as-usual emissions trends have shifted downward since the 2010 version of this report. While energy-related CO_2 emissions are projected to rise slowly but remain below 2010 levels through 2035, non-CO_2 emissions are projected to steadily increase over the same time period. The primary trends are noted here:

- **Current Energy-related Carbon Dioxide Emissions Down from 2005 Levels.** In 2011 carbon dioxide emissions from energy sources, which account for nearly 80 percent of U.S. GHG emissions, were 8.7 percent below 2005 levels. Nearly half of those reductions (48 percent) came from the power sector. The rest of the reductions came from transportation (28 percent), industry (18 percent), and buildings (6 percent).[8]

- **Future Energy-CO_2 Emissions Expected to be Relatively Flat.** Our projections suggest that if no future policy actions are taken, then energy-CO_2 emissions will remain approximately 10 percent

8. *Closer than You Think: Latest U.S. CO_2 Pollution Data and Forecasts Show Target Within Reach.* NRDC Issue Brief. Dan Lashof. July 2012.

below 2005 levels in 2020, and will increase slightly through 2035 to levels that are about 8 percent below 2005 levels (Figure 7).

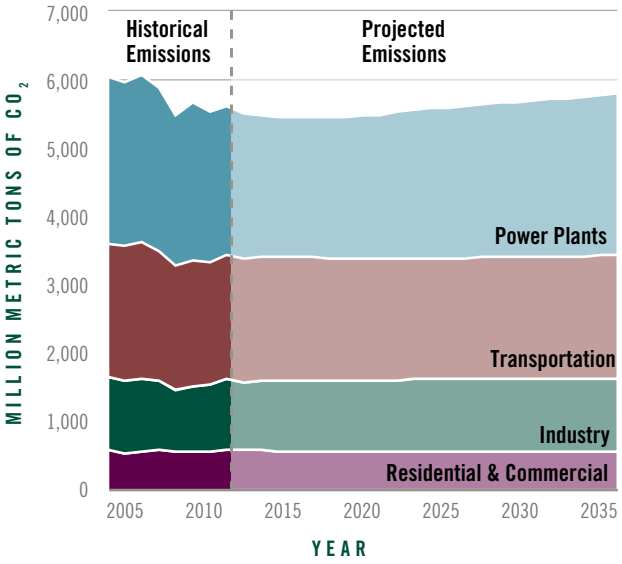
- Those trends are driven by a number of factors, including:

  - **Falling Energy Demand.** The economic slowdown experienced by the United States and other parts of the world over the period from 2008 to 2012 has led to decreased demand for goods and services and reduced energy consumption.[9] Over time, this trend is expected to reverse as economic growth picks up. In addition, the industrial sector was affected significantly by the recent economic turndown and saw a decrease in both production and emissions. This decline is projected to be temporary. Manufacturing output is expected to accelerate from 2010 through 2020, and emissions are projected to increase by 4 percent over this time.[10]

  - **Rise of Natural Gas and Renewables.** The power sector is shifting from coal-fired generation toward natural gas-fired and renewable generation. This trend is driven in part by increases in natural gas extraction, low natural gas prices, increasing coal prices, and new (non-GHG) regulations for the power sector. Increases in renewable generation are driven by state renewable standards, voluntary purchases of "green" energy, and decreasing renewable energy costs. However, gas prices are expected to slowly rise from current levels and demand for electricity is expected to rise 18 percent by 2035 from 2010 levels.[11]

  - **New Vehicle Rules.** The transportation sector is expected to become less carbon-intensive, due in large part to high petroleum prices and new federal GHG emissions and fuel efficiency standards covering light-, medium- and heavy-duty vehicles. These gains will be partially offset by continued increases in vehicle miles traveled.[12] Transportation emissions are projected to increase 1 percent below 2011 levels by 2035.

FIGURE 7 Projected U.S. Energy-Related Carbon Dioxide Emissions if no New State or Federal Action is Taken



Source: U.S. Energy Information Administration, Annual Energy Review (Years 2005-2011); U.S. Energy Information Administration, Annual Energy Outlook (Years 2012-2035)

- **Non-Energy Emissions on the Rise.** Trends for non-energy and non-CO_2 emissions, such as natural gas systems, refrigerants, and landfills, show a likely rise. In 2010, non-energy and non-CO_2 sources accounted for about 22 percent of total U.S. emissions. We project that these emissions will increase roughly 18 percent above 2005 levels by 2020 and 36 percent above 2005 levels by 2035, even after accounting for 2012 regulations that affect portions of natural gas systems and HFCs from vehicles. Those trends are driven by several factors, including:

  - **CFCs Phased Out, HFCs Phased In.** HFC emissions are increasing due to the phaseout of chlorofluorocarbons (CFCs) and other ozone-depleting substances under the Montreal Protocol, which is intended to

9. *Annual Energy Review 2012.* Figure 1.1, Primary Energy Overview (Consumption). EIA, September 2012. Accessible at: <http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf>.
10. *Annual Energy Outlook 2012 with Projections to 2035. EIA, June 2012.* Accessible at: <http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf>.
11. *Annual Energy Outlook 2012 with Projections to 2035.* EIA, June 2012. Accessible at: <http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf>.
12. *Annual Energy Outlook 2012 with Projections to 2035.* EIA, June 2012.

BOX 3 Recent Federal Action 2010–12

Since the 2010 report, federal agencies have taken a number of actions that are reducing GHG emissions. The most significant actions from a GHG reduction perspective are summarized below. These are all incorporated into our new business-as-usual projections.

- **Passenger cars and light-duty trucks.** In August 2012 EPA and the National Highway Traffic Safety Administration (NHTSA) finalized new fuel economy and GHG standards for passenger cars and light-duty trucks for model years 2017–2025. These standards equate to a fleet-wide average of 54.5 mpg (101 g CO_2e/km) if they are met solely through fuel economy improvements (as opposed to reductions in HFC emissions from air conditioners). This is approximately double the fuel economy of vehicles sold in 2010. EPA estimates that the rule will save nearly 2 billion tons of CO_2e over the life of the program. This is in addition to the estimated 960 million tons of CO_2e over the life of the prior regulations for model years 2012–2016.

- **Heavy-duty vehicles.** In August 2011 EPA and NHTSA finalized the first-ever fuel efficiency and GHG emission standards for model year 2014 through 2018 medium- and heavy-duty vehicles. EPA estimates that this rule will reduce CO_2 emissions by approximately 270 million metric tons over the life of vehicles sold during the 2014–2018 model years.

- **Natural gas systems.** In April 2012 EPA finalized four regulations that will reduce emissions of volatile organic compounds, sulfur dioxide (SO_2), and air toxics from oil and natural gas systems. EPA estimates that the new standards will have the co-benefit of reducing annual methane emissions by an estimated 19–33 million metric tons of CO_2e.

- **Energy efficiency standards for new appliances.** Between 2009 and 2011, the Department of Energy established 17 new standards. According to analysis by the Appliance Standards Awareness Project and the American Council for an Energy-Efficiency Economy, these standards are expected to save 126.2 TWh in 2025 and 146.8 TWh in 2035.

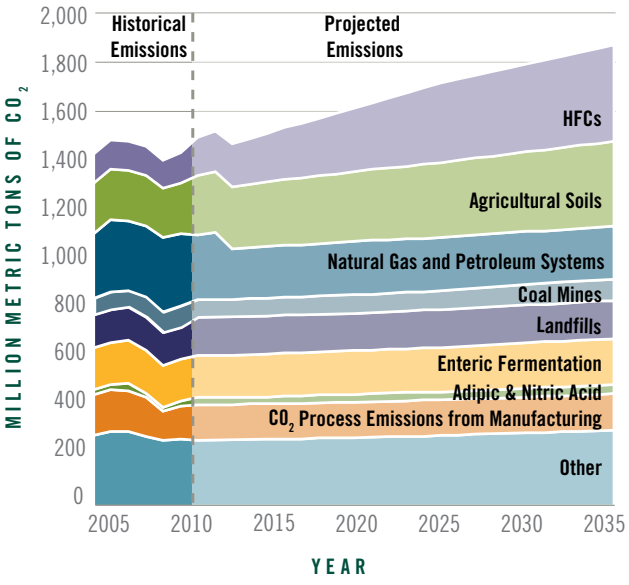
- **Non-GHG regulations for power plants.** EPA has also finalized several other non-GHG-related environmental regulations for power plants, most notably those for mercury and other air toxics. Some modeling has suggested that these rules could lead to the retirement of old, inefficient, coal-fired power plants.

protect and restore the ozone layer in the upper atmosphere, and the Clean Air Act. This trend is expected to continue as the interim substitutes, HCFCs, are also phased out as they are currently being replaced with gases that have a high global warming potential.

- **With the Natural Gas Boon, More Methane Leaks.** Extraction of natural gas in the United States has increased by over 25 percent over the period of 2005 to 2011 due to rapid development of shale gas resources.[13] Increases in natural gas extraction lead to larger fugitive methane emissions from natural gas systems. Fugitive methane emissions are expected to fall significantly, however, due to 2012 EPA regulations that reduce emissions of volatile organic

13. *Monthly Energy Review.* Table 1.2, Primary Energy Production by Source. EIA, December 2012. Accessible at: <http://www.eia.gov/totalenergy/data/monthly/pdf/sec1_5.pdf>.

FIGURE 8 Projected U.S. Non-CO_2 and Non-Energy Emissions if no New State or Federal Action is Taken



Source: U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010 (Years 2005-2010)*; U.S. Environmental Protection Agency, *Draft Global Non-CO_2 Emissions Projections Report 1990-2030 (Non-CO_2 Years 2011-2035)*; RTI, *Applied Dynamic Analysis of the Global Economy Model (Non-energy CO_2 Years 2011-2035)*; *Clearing the Air on Shale Gas Emissions: Assessing and Reducing the Carbon Footprint of Natural Gas.* World Resources Institute. Working Paper. James Bradbury, Michael Obeiter, Laura Draucker, Wen Wang, and Amanda Stevens.

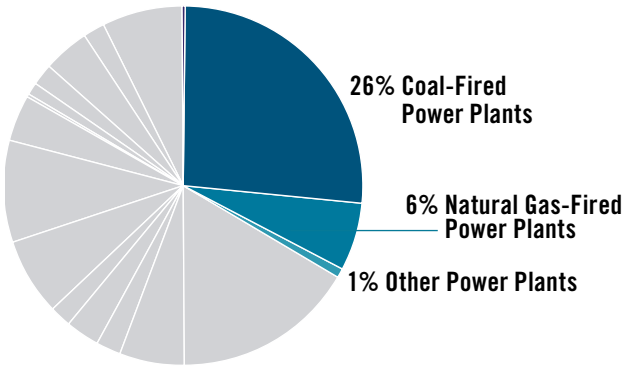
compounds, sulfur dioxide, and air toxics from natural gas systems. Actions to reduce those emissions will also reduce methane emissions (see Box 3 for more details).

IV. Understanding the Federal Reduction Pathways

A. ABOUT THE SECTOR-BY-SECTOR APPROACH

This analysis is a bottom-up assessment of the policies and regulatory tools available to the U.S. Administration, through the federal executive agencies tasked with implementing such regulations—to reduce GHG emissions. The analysis began with an examination of the makeup of U.S. emissions in 2010, followed by research and analysis into existing laws on authority to reduce emissions. We reviewed available literature to determine the range of emissions reductions technically feasible for each sector or subsector. Lastly, we considered legal authority, technical feasibility, cost and political will in constructing lackluster, middle-of-the-road, and go-getter scenarios for each sector or subsector. We briefly describe the scenarios for each sector or subsector below, beginning with the sectors that our analysis indicates offer the greatest potential for reductions. A more detailed discussion of our federal methods is provided in Appendix I.

FIGURE 9 Power Plant Emissions



As a Share of U.S. Emissions in 2010

B. ELECTRIC POWER

The electric sector is the largest single source of GHG emissions in the United States. In 2010 it made up 33 percent of total U.S. GHG emissions, and about 40 percent of all carbon pollution from the combustion of fossil fuels. This sector also represents the single biggest opportunity for emissions reductions using existing legal and regulatory tools.

1. Power plants

Carbon pollution from power plants can be reduced through the following federal regulatory authorities:

TABLE 1 Projecting New Source Performance Standards for Power Plants

	LACKLUSTER	MIDDLE-OF-THE-ROAD	GO-GETTER
Existing plants	Emissions reductions consistent with a 5 percent improvement in efficiency starting in 2018.	Aggregate emissions reductions across all electric generators equal to an 18 percent reduction in emissions in 2021 compared to 2012 emission levels, and a 33 percent reduction in 2035.	Aggregate emissions reduction across all electric generators equal to a 38 percent reduction in emissions in 2021 compared to 2012 emission levels, and a 74 percent reduction in 2035.
New plants	Standards initially consistent with EPA's proposal (1,000 pounds of CO_2 per megawatt-hour of output). Beginning in 2020, new unit performance improves to 570 pounds of CO_2 per megawatt-hour by 2030.	Standards initially consistent with the lackluster scenario. Beginning in 2028, new units achieve emissions rates equivalent to carbon capture and storage (CCS) with a 90 percent capture rate.	Standards initially consistent with the lackluster scenario. Beginning in 2020, new units achieve emissions rates equivalent to CCS with a 90 percent capture rate.

TABLE 2 Appliance and Equipment Efficiency Standards (Electric)

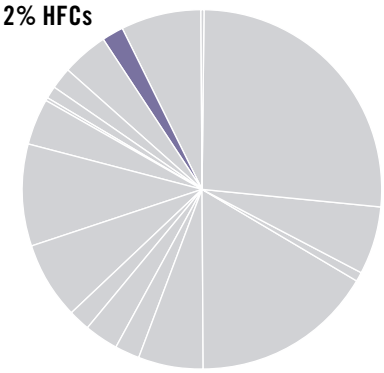
LACKLUSTER	MIDDLE-OF-THE-ROAD	GO-GETTER
192 TWh savings in 2025 from the residential and commercial sectors, plus additional savings from the industrial sector. Annual savings remain constant through 2035.	212 TWh savings in 2025 and 306 TWh savings in 2035 from the residential and commercial sectors, plus additional savings from the industrial sector.	364 TWh savings in 2025 and 525 TWh savings in 2035 from the residential and commercial sectors, plus additional savings from the industrial sector.

a. **Performance standards for new and existing sources under section 111 of the federal Clean Air Act**
Under section 111 of the Clean Air Act, EPA may prescribe emissions limitations based on the "best system of emission reduction" for new and modified existing sources within source categories EPA determines cause or contribute significantly to air pollution that may reasonably be anticipated to endanger human health or welfare.[14] To determine the "best system of emission reduction," EPA considers technological feasibility, cost, lead time, and energy and non-air environmental impacts.[15] In the spring of 2012 EPA proposed new source performance standards (NSPS) for new power plants.

In addition, for any source category EPA regulates on the federal level, EPA must also promulgate guidelines to states to use in developing requirements for existing sources under section 111(d). In regulating existing sources, states must determine the "best system of emission reduction" for existing sources while taking into account the same factors EPA uses to set limitations for new sources, and also the remaining useful life of existing sources.[16] The form of regulations imposed on existing sources is not tightly prescribed in the statute, and EPA has previously taken the position that states could implement flexible, market-based approaches in setting standards from existing sources. Table I specifies our three scenarios for new and existing power plants under section 111.

b. **Appliance and equipment efficiency standards under Department of Energy authority**
The Department of Energy (DOE) may promulgate efficiency standards for consumer appliances and non-consumer equipment under authority already granted DOE in current law. Based on available studies, the three scenarios analyzed assume progressively greater reductions through appliance and equipment standards, ranging up to 364 TWh of annual savings from residential and commercial consumers in 2025 and 525 TWh annual savings in 2035, with additional savings from industrial consumers.

FIGURE 10 HFC Emissions



As a Share of U.S. Emissions in 2010

C. HYDROFLUOROCARBONS

Hydrofluorocarbons (HFCs), used primarily for refrigeration and air conditioning, represented only 2 percent of all U.S. global warming pollution in 2010. Despite their relatively small share of the U.S. emissions picture today, our analysis finds HFCs can provide some of the greatest reductions by 2020 and through 2035. EPA has existing authority to regulate HFC consumption under Title VI of the Clean Air Act. EPA can phase down the use of HFCs under

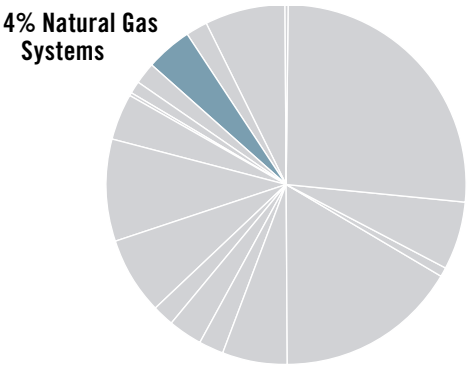
14. 42 U.S.C. §§ 7411(a)(1) & 7411(b)(1)(A).). U.S. Environmental Protection Agency. "Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act." Accessible at: <http://www.gpo.gov/fdsys/pkg/FR-2009-12-15/pdf/E9-29537.pdf>.
15. 42 U.S.C. §§ 7411(a)(1).
16. 42 U.S.C. §§ 7411(d)(1)(B).

TABLE 3 Emissions Reduction Schedule for Hydrofluorocarbons

LACKLUSTER	MIDDLE-OF-THE-ROAD	GO-GETTER
Consumption ramp-down occurs three years later than the schedule detailed in the joint North American Proposal.	Consumption is ramped-down in a manner consistent with the joint North American Proposal, which calls for an 85 percent reduction below 2005–2008 levels by 2033.	Consumption is ramped-down more rapidly than in the joint North American Proposal, achieving the 85 percent reduction target in 2028, five years earlier than detailed in the joint North American Proposal.

its Significant New Alternatives Program (SNAP), implementing section 612 of the Clean Air Act. The U.S. Administration has proposed an international ramp-down schedule to achieve reductions worldwide under the Montreal Protocol. Our middle-of-the-road scenarios for HFCs assume this proposed ramp-down schedule is met in the United States. The lackluster scenario assumes that the same ramp-down schedule is implemented, but on a delayed timeline, commencing in 2019 instead of 2016. Meanwhile, the go-getter scenario assumes a more ambitious reduction schedule.[17]

FIGURE 11 Emissions from Natural Gas Systems



As a Share of U.S. Emissions in 2010

D. NATURAL GAS SYSTEMS

Global warming pollution from natural gas systems accounts for approximately 4 percent of U.S. emissions. Yet like HFCs, our analysis suggests that natural gas systems may be among the top emissions reduction opportunities in the near term. Similar to power plants, EPA can regulate natural gas systems by implementing emissions performance standards for methane under section 111 of the Clean Air Act for new and existing natural gas systems. They may also be able to achieve additional GHG emissions reductions

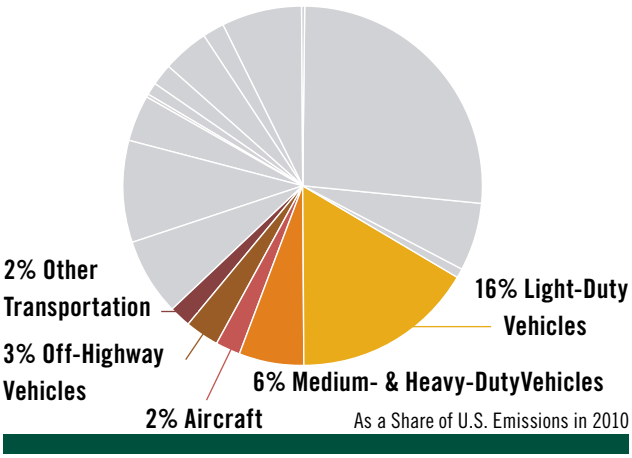
17. Due to modeling limitations, our analysis examines changes in HFC consumption. In the United States, HFC consumption is roughly equivalent to life-cycle emissions due to low rates of capture and destruction. See Appendix I for a more detailed discussion.

TABLE 4 Performance Standards to Reduce Emissions from Natural Gas Systems

LACKLUSTER	MIDDLE-OF-THE-ROAD	GO-GETTER
Emissions reductions of 26 percent from business-as-usual starting in 2019. Assumes implementation of plunger lift systems to reduce emissions from liquids unloading at new and existing wells, and leak monitoring and repair to reduce fugitive emissions from production, processing, and compressor stations.	Emissions reductions of 37 percent from business-as-usual starting in 2019. Assumes implementation of measures in lackluster scenario and conversion of existing high-bleed pneumatic controllers to low-bleed or no-bleed controllers to reduce emissions from production, processing, and transmission.	Emissions reductions of 67 percent from business-as-usual starting in 2019. Assumes implementation of measures in middle-of-the-road scenario, as well as desiccant dehydrators to reduce emissions during dehydration of wet gas; improved compressor maintenance to reduce emissions during processing; hot taps in maintenance of pipelines during transmission; and vapor recovery units to reduce emissions during storage.

by tightening standards for other air pollutants, such as volatile organic compounds and air toxics, as they recently did with respect to new equipment in the U.S. oil and gas sector. Through one or more of these regulatory paths, EPA could require equipment changes, upgrades, changes to operational practices, and inspection and leak prevention. Table 4 details the three scenarios analyzed. However, there is a great deal of uncertainty with regard to emissions for natural gas systems. This means that the absolute magnitude of abatement opportunities is uncertain. Nevertheless, our analysis identifies important opportunities to reduce emissions from this sector. Those reductions are some of the lowest cost opportunities identified in this analysis. See the appendix for a more detailed discussion of uncertainties and opportunities.

FIGURE 12 Transportation Emissions



E. TRANSPORT VEHICLES

Transportation is one of the largest sources of global warming pollution in the United States, accounting for 30 percent of the 2010 inventory. Improving the efficiency of motor vehicles has been a priority for the Obama Administration, which promulgated new standards to reduce emissions and raise the fuel efficiency of light-, medium- and heavy-duty vehicles. Our analysis finds that it is possible to achieve additional reductions from light-, medium-, and heavy-duty vehicles. In addition, there are opportunities to reduce emissions of global warming pollution from aircraft and off-highway vehicles.

1. Passenger vehicles

Under Title II of the Clean Air Act, EPA has the authority to regulate greenhouse gas emissions from new light-duty cars and trucks, and has done so already in two consecutive rulemakings covering vehicles sold through model year 2025. In conjunction with EPA's rulemaking, the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) may promulgate corporate average fuel economy (CAFE) standards regulating the average fuel efficiency of new vehicles. Because standards have already been issued covering light-duty vehicles through model year 2025, our analysis focuses on the time period after 2025. Table 5 outlines the three scenarios, with the lackluster scenario projecting improvements at half the rate of the previous standards, middle-of-the-road projecting continuation of the same rate of improvement, and go-getter increasing the rate of improvement significantly.

2. Medium- and heavy-duty vehicles

For medium- and heavy-duty vehicles, EPA has established emissions standards and NHTSA has established fuel economy standards for model years 2014 through 2018. These standards are included in our business-as-usual emissions trajectory. Our emissions reduction scenarios pick up in model year 2020 using the same legal authority, but making different assumptions about the stringency of the next set of standards. As shown in Table 5, our lackluster scenario assumes a rate of improvement that is just half that of the current standards through 2035, middle-of-the-road projects a continuation of the current standards through 2035, and the go-getter scenario considerably increases new standards to meet the maximum level of efficiency currently thought to be technically achievable in that time frame.

3. Off-Highway engines

EPA may also regulate off-highway sources of global warming pollution under Title II of the Clean Air Act. For the lackluster, middle-of-the-road, and go-getter scenarios, respectively, the analysis assumes new standards can achieve 0.9 percent, 1.8 percent, and 2.4 percent annual improvement in the emissions rate for new equipment and engines from 2018 to 2035.

4. Aviation and aircraft

The Federal Aviation Administration (FAA) may make operational improvements in the air traffic control system that could achieve significant carbon pollution reductions over time. We draw our assumptions about operational improvements from an EPA analysis of the reductions possible and the FAA's comments on that analysis. Our scenarios, shown in Table 5, bound the range of reductions estimated by EPA and FAA.

TABLE 5 Vehicle Emissions Standards, Efficiency Standards, and Operational Improvements

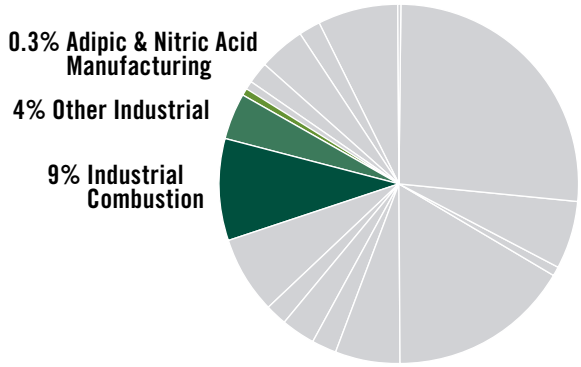
	LACKLUSTER	MIDDLE-OF-THE-ROAD	GO-GETTER
Light-duty vehicles	Vehicle standards continue to improve from 2026–2035 at roughly half the rate of the 2017–2025 standards (2 percent per year). This results in a 131 grams per mile emissions standard and a 61 mpg CAFE standard in 2035.	Vehicle standards continue to improve from 2026–2035 at roughly the same rate as the 2017–2025 standards (4 percent per year). This results in a 104 gram per mile emissions standard and a 75 mpg CAFE standard in 2035.	Vehicle standards continue to improve from 2026–2035 at 6 percent annually. This results in a 81 grams per mile and a 92 mpg CAFE standard in 2035.
Medium- & heavy-duty vehicles	Standards continue to improve through 2035 at half the rate of the 2013–2018 standards by vehicle category—about a 1.3 percent annual improvement.	Standards continue to improve through 2035 at the same rate as the 2013–2018 standards by vehicle category—about a 2.6 percent annual improvement.	By 2020–2022, the medium- and heavy-duty fleet reduces its emissions rate by an average 26 percent and by 42 percent in 2023–2025 compared to 2010. Standards continue to improve annually by 1 percent through 2035.
Off-highway	From 2018 to 2035, a 0.9 percent annual improvement in the emissions rate for new equipment and engines.	From 2018 to 2035, a 1.8 percent annual improvement in the emissions rate for new equipment and engines.	From 2018 to 2035, a 2.4 percent annual improvement in the emissions rate for new equipment and engines.
Aviation	Through 2035, a 0.17 percent annual emissions reduction from operational improvements via FAA's NextGen Program.	Through 2035, a 0.4 percent annual emissions reduction from operational improvements via FAA's NextGen Program.	Through 2035, a 1.4 percent annual emissions reduction from operational improvements via FAA's NextGen Program, plus a 2.3 percent annual improvement in the performance of new aircraft and engines.

EPA has statutory authority under Title II of the Clean Air Act to promulgate standards to reduce emissions from new and existing aircraft engines. To date, EPA has never exercised that authority to require aircraft engine manufacturers to meet standards that the industry association has not previously adopted voluntarily. Nevertheless, our go-getter scenario, shown in Table 5, projects the emissions reductions that could be achieved if EPA were to pursue this regulatory course of action.

F. INDUSTRY

Emissions from industrial facilities comprised 13 percent of U.S. global warming pollution in 2010. Fossil fuel combustion at industrial facilities accounts for 9 percent of U.S. emissions, while non-combustion industrial processes account for 4 percent of emissions. When accounting for upstream, indirect CO_2 emissions from power plants, the industrial sector is responsible for 23 percent of total U.S. GHG emissions. EPA may regulate industrial stationary sources of emissions through performance standards under section 111 of the Clean Air Act. As with power

FIGURE 13 Industrial Emissions



As a Share of U.S. Emissions in 2010

TABLE 6 Performance Standards to Reduce Industry Emissions

	LACKLUSTER	MIDDLE-OF-THE-ROAD	GO-GETTER
Fossil-fuel combustion in manufacturing and cement kilns	Emissions reductions consistent with a 10 percent improvement in combustion efficiency by boilers.	Emissions reductions consistent with harnessing all cost-effective energy efficiency across all processes and energy uses at manufacturing facilities. Emissions standards also drive reductions in process emissions from cement kilns.	Emissions reductions consistent with harnessing all cost-effective energy efficiency across the entire manufacturing facility. All new units must meet emissions rate equivalent to natural gas combustion. Emissions standards also drive reductions in process emissions from cement kilns.
Refineries	Emissions reductions consistent with a 1 percent improvement in efficiency beyond business-as-usual projections.	Emissions reductions consistent with a 5 percent improvement in efficiency beyond business-as-usual projections.	Emissions reductions consistent with a 10 percent improvement in efficiency beyond business-as-usual projections.
Nitric and adipic acid manufacturing	A 13 percent reduction in emissions.	A 56 percent reduction in emissions.	A 75 percent reduction in emissions.

plants, this is accomplished through EPA's setting of standards for new sources and issuing regulations that provide states with guidelines for covering existing sources. New source requirements typically take the form of a simple emissions rate, while regulation of existing sources can be more flexible.

1. Fossil fuel combustion in manufacturing and cement kilns

As with fossil-fuel burning power plants, reducing the GHG emissions profile of the industrial sector can be accomplished through improvements to the efficiency of boilers, fuel switching, and use of renewable energy such as biomass or geothermal, among other methods. Additional reductions are possible if regulations require a manufacturing facility to capture all cost-effective process efficiencies across an entire operation, beyond the boiler. Table 6 details the three scenarios analyzed for projecting possible reductions from the industrial sector. In addition, for the middle-of-the-road and go-getter scenarios for cement kilns, we assume emissions standards are used to drive reductions in process emissions through greater use of blended cements, and potentially carbon capture and storage, achieving reductions in process emissions of 2 percent in 2020 and 13 percent in 2035.

2. Petroleum refineries

EPA's advanced notice of proposed rulemaking, *Regulating Greenhouse Gas Emissions Under the Clean Air Act,* indicated that efficiency improvements in refineries are possible in the range of 10 to 20 percent. Some efficiency improvements are included in our business-as-usual projections, however. Therefore, in order to generate conservative estimates of emissions reductions, starting in 2018 we model lackluster, middle-of-the-road, and go-getter scenarios with reductions in annual GHG emissions of 1, 5, and 10 percent reductions beyond business-as-usual projections, respectively.

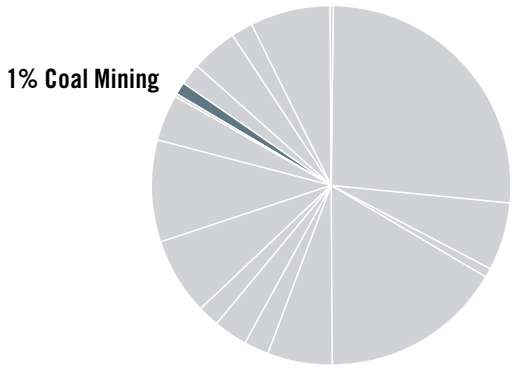
3. Nitric and adipic acid manufacturing

Nitric acid is primarily used as a feedstock for synthetic fertilizer, and also used to produce adipic acid and explosives. Adipic acid is used in the production of nylon and is a flavor enhancer in foods. The production of both compounds leads to emissions of nitrous oxide, a potent greenhouse gas. Though nitric and adipic acid manufacturing makes up less than 0.5 percent of total U.S. global warming pollution, there are opportunities to achieve dramatic reductions at low cost, making it a good target for policy.

To reduce emissions from acid manufacturing, EPA can use its authority under section 111 of the Clean Air Act to set standards for new manufacturing plants and issue guidelines to states to cover existing sources. Our

lackluster, middle-of-the-road and go-getter scenarios project reductions of annual GHG emissions of 13 percent, 56 percent, and 75 percent, respectively, compared to the business-as-usual projections.

FIGURE 14 Coal Mine Emissions

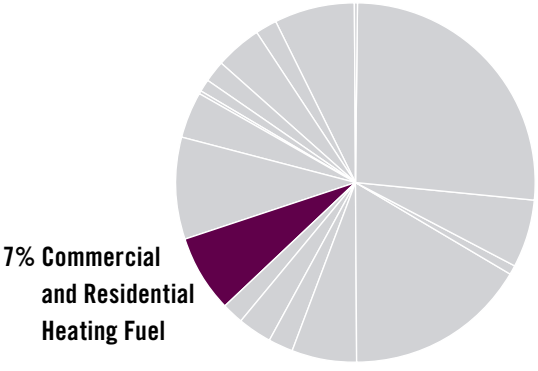


As a Share of U.S. Emissions in 2010

G. COAL MINES

Methane emissions from coal mines represented 1 percent of total U.S. global warming pollution in 2010. EPA may regulate coal mines as a source category under section 111 of the Clean Air Act. As discussed above for power plants and industry, this would entail EPA issuing performance standards for new coal mines and regulations to guide states in their regulation of existing coal mines. The statute does not prescribe the specific form of regulations applied to existing sources. For the lackluster, middle-of-the-road, and go-getter scenarios, we projected reductions from coal mines of 24 percent, 32 percent, and 39 percent, respectively, compared to business-as-usual projections.

FIGURE 15 Commercial & Residential Heating Emissions

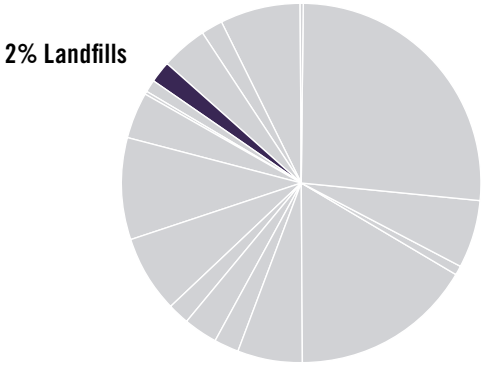


As a Share of U.S. Emissions in 2010

H. COMMERCIAL AND RESIDENTIAL HEATING

Carbon pollution from commercial and residential heating, mostly through natural gas combustion, accounted for 7 percent of U.S. emissions in 2010. This includes things such as home heating, cooking, and water heating. The most effective way to decrease emissions in this sector is to improve the building envelope—a path traditionally the province of state and local governments in the United States. However, the federal government can promulgate efficiency standards for appliances and equipment used to heat buildings. Based on our survey of the available literature, we conclude that efficiency standards implemented in 2015 could reduce natural gas demand by 126 Trillion British thermal units (TBtu) in 2025 and 235 TBtu in 2035, reducing GHG emissions by 6.7 million tons of CO_2 in 2025 and 12.5 million tons CO_2 in 2035 compared to business-as-usual projections. Due to limitations in the available literature, we project the same reductions level for all three scenarios.

FIGURE 16 Landfill Emissions



As a Share of U.S. Emissions in 2010

I. LANDFILLS

Methane emissions from landfills represented 2 percent of total U.S. global warming pollution in 2010. EPA already regulates emissions of volatile organic compounds from landfills under section 111 of the Clean Air Act. These standards provide the co-benefit of reducing methane emissions. EPA could either strengthen those standards or establish new standards for GHG emissions. The statute does not prescribe the form of regulations applied to existing sources. For the lackluster, middle-of-the-road, and go-getter scenarios, we projected reductions of 5 percent, 9 percent, and 9 percent, respectively, compared to our business-as-usual projections. The reductions we

project for landfills in this report are substantially smaller than the reductions projected in the 2010 report. These differences are attributable to changes in the EPA data used in the analysis.

V. Understanding the State Reduction Pathways

Policy action to address environmental challenges frequently begins at the state level, and greenhouse gases are no exception. States were the first to push ambitious emissions standards for vehicles, adopt greenhouse gas regulations for the power sector, and establish economy-wide reduction targets. Many states already have programs that reduce emissions from transportation, improve energy efficiency, and promote renewable generation. In the state scenarios, we examine what would happen if states continue to adopt policies that reduce their GHG footprint.

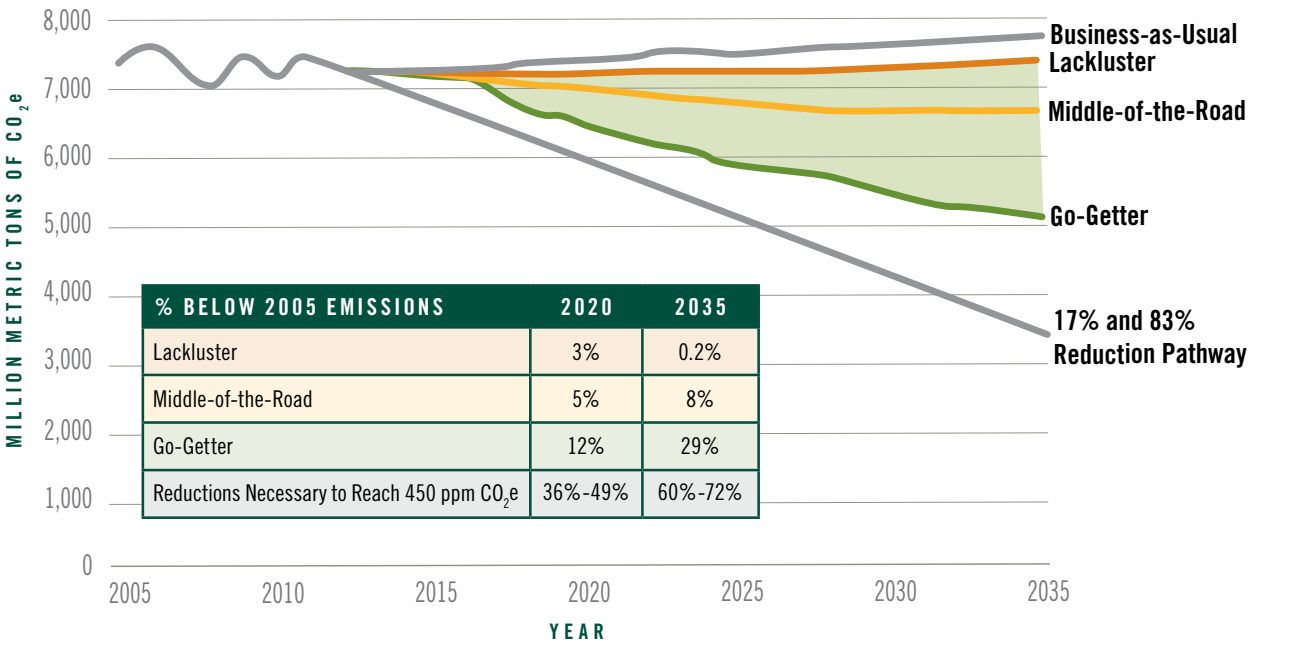
A. ABOUT THE STATES APPROACH

The state analysis takes a two-pronged approach. First, we project the potential greenhouse gas emissions reductions from transportation, end-use energy efficiency, and renewable electricity policies typically undertaken by states. Second, we consider the potential for state action in areas we also consider for the federal government, such as emissions standards for power plants and industry. This is based on the observation that the Constitution grants states broad authority to regulate their energy sources and emissions. States thus have the ability to implement many of the same policies as federal agencies.

In this analysis, the difference between lackluster and go-getter action at the state level is a function of the number and size of the states that adopt the measures modeled, and in some cases the ambition of the policies pursued. Unlike the federal analysis, in some cases state action would require new state legislation. However, we did not attempt to determine which states would require new legislation to implement the state measures and which states could implement without new legislation. A detailed discussion of our state methods is provided in Appendix II.

In addition to the direct emission reduction opportunities modeled here, state-level action can help trigger more ambitious action at the federal level. In the words of Justice Brandeis, states can serve as "laboratories of democracy," testing out approaches that provide possible models for federal action. Action at the state level can also lead to broader support for federal action, with the most ambitious states helping establish a floor for federal ambition.

FIGURE 17 Projected U.S Emissions when States Pursue the Full Range of Policies within their Authority (No Federal Action)



% BELOW 2005 EMISSIONS	2020	2035
Lackluster	3%	0.2%
Middle-of-the-Road	5%	8%
Go-Getter	12%	29%
Reductions Necessary to Reach 450 ppm CO_2e	36%-49%	60%-72%

Note: Due to modeling limitations, this figure depicts HFC consumption, which is generally thought to be equivalent to life-cycle emissions.

B. TRANSPORTATION

As noted above, the transport sector is responsible for about 30 percent of GHG emissions in the United States, making it the second largest emitting sector behind power plants. State and local policies have traditionally played a significant role in transportation, and as a result we project reductions that states might be able to achieve in this area, including through policies to encourage the use of lower carbon fuels and reduce vehicle miles traveled.

1. Lower Carbon Fuels

States may establish requirements for the fuels delivered in their jurisdictions to reduce the carbon profile of those fuels. To project potential reductions through state policies that reduce the life-cycle emissions of transportation fuels, we do not select specific policies in specific states. Rather, we model percent improvements in the carbon profile of fuels generally. These general improvements in the carbon profile of fuels are a proxy for what is likely to be a diverse set of measures across numerous states.

For modeling purposes, we assume that those policies further reduce the average life-cycle carbon intensity of transportation fuels by 1 percent per year between 2015 and 2035. In the lackluster scenario, we assume this annual reduction is achieved by states accounting for 15 percent of total energy consumption from U.S. transportation fuels. In the middle-of-the-road and go-getter scenarios, we assume that these policies are pursued by states accounting for 25 percent and 35 percent of total U.S. transportation fuel consumption, respectively.[18]

2. Reducing Vehicle Miles Traveled

States play a big role in designing and implementing policies that directly impact the number of vehicle miles traveled. These include smart growth strategies, such as targeting new development near public transportation, favoring infill, limiting sprawl, mixed-use development, and provision of smartly located affordable housing options. These strategies can be complemented by a variety of strategies, including improving and expanding public transportation options, bike and pedestrian pathways, car sharing, and HOV lanes, as well as through speed limit restrictions, intercity tolls, and strategies to limit driving within urban centers (e.g., parking restrictions).

In our lackluster and middle-of-the-road scenarios, we assume that states that implement policies and programs achieve VMT reductions of 0.5 percent per year beginning in 2016, leading to a 10 percent reduction below business-as-usual projections in 2035.

18. See Appendix II for context about what it would take to achieve the state uptake in this and the other state scenarios.

TABLE 7 State Transportation Measures

ACTION	POLICIES AND PROGRAMS DRIVING ACTION	LACKLUSTER	MIDDLE-OF-THE-ROAD	GO-GETTER
Reduce carbon content of fuels by 1 percent per year from 2015 to 2035	■ Low-carbon fuel standard ■ Clean fuel standard ■ Advanced biofuels standard ■ Infrastructure incentives	States accounting for 15 percent of transportation fuel consumption implement measures to achieve a reduction.	States accounting for 25 percent of transportation fuel consumption implement measures to achieve a reduction.	States accounting for 35 percent of transportation fuel consumption implement measures to achieve a reduction.
Vehicle miles traveled reductions of 0.5 or 1 percent per year from 2016 to 2035	■ Smart growth ■ Improved public transit ■ Pedestrian and biking infrastructure ■ Improved traffic systems operations	States accounting for 15 percent of GHG emissions from light-duty vehicles implement measures to achieve a reduction of 0.5 percent per year.	States accounting for 25 percent of GHG emissions from light-duty vehicles implement measures to achieve a reduction of 0.5 percent per year.	States accounting for 35 percent of GHG emissions from light-duty vehicles implement measures to achieve a reduction of 1 percent per year.

This is on the conservative end of the range found in the state programs under way. Therefore, in our go-getter scenario we assume that states reduce VMT 1 percent per year. We assume that these policies and programs are implemented by states accounting for 15, 25, and 35 percent of GHG emissions from light-duty vehicles in our lackluster, middle-of-the-road, and go-getter scenarios, respectively.

C. ENERGY EFFICIENCY

Energy efficiency measures avoid the need to use fossil fuels and save consumers money, creating significant economic benefits.[19] States are on the front lines in designing and implementing programs to enhance energy efficiency, both for end-use electricity and heating fuels. Our analysis projects the emissions reductions states may achieve implementing energy efficiency programs, building codes, and the increased penetration of combined heat and power. Each type of measure is outlined below.

1. Electricity Savings

States have been the primary drivers of end-use energy efficiency within their borders. Many states have implemented energy efficiency portfolio standards and/or other ratepayer-funded programs to fund energy efficiency investments. Other states have sought to integrate energy efficiency into the process for procuring new generation resources (e.g., in the context of long-term resource planning), so that energy efficiency can compete as a viable alternative to more traditional generating resources.

To project potential emissions reductions from increased state-level energy efficiency policies, we made different assumptions about states with and without such policies. We assume that some states with and without existing energy efficiency targets adopt policies and programs that lead to electricity savings beginning in 2015. Both the rate of savings and the number of states covered varies across the scenarios, as shown in Table 8.

2. Natural Gas Savings

A number of states have also begun to implement energy efficiency programs targeted at natural gas consumption. These programs can resemble those for electricity savings, taking the form of energy efficiency portfolio standards or system benefit charges. As with the electricity savings scenarios, we assume that some states with targets increase those targets, and that some states without targets implement those targets. The scenarios are shown in Table 8.

3. Improving Building Performance

States and municipalities are generally responsible for adopting and updating state and local building energy codes, which apply to new construction and major renovations. Responsibility for enforcing these codes is part of the states' police powers. In our lackluster scenario, we assume that states accounting for 10 percent of the energy consumed by the building sector implement more ambitious building codes. In our middle-of-the-road and go-getter scenarios, we assume that states accounting for 30 and 50 percent of the energy consumed by the building sector implement more ambitious building codes, respectively.

4. Increased Penetration of Combined Heat and Power

The U.S. electricity system is designed to accommodate large central station power plants located away from the electricity customers. Fossil-fuel generating plants operate at 30 to 60 percent efficiency, wasting significant energy in unused heat from the combustion process. Combined heat and power (CHP), or cogeneration, is a form of distributed generation located at or very near end-use customers that captures and puts waste heat to beneficial use.

States have been at the forefront in driving the spread of CHP. They have done so through a variety of policies, including standard interconnection rules, reduced standby rates, net metering policies, friendly air quality regulations (such as output-based emissions regulations), technical assistance programs, and various financial incentives.[20] In our lackluster, middle-of-the-road, and go-getter scenarios, we assume that state action results in deployment of an additional 10, 20, and 40 GW of new CHP by 2025, respectively, beyond business-as-usual projections.[21]

19. *The Long-Term Energy Efficiency Potential: What the Evidence Suggests.* American Council for an Energy Efficient Economy, Research Report E121, January 2012. Accessible at: < http://www.aceee.org/research-report/e121>.
20. *Challenges Facing Combined Heat and Power Today: A State-by-State Assessment.* ACEEE Report Number IE111, September 2011.
21. In the go-getter scenario, we assume that state action results in deployment of 27 GW of CHP in 2020, in addition to the 13 GW built into our business-as-usual projections. Combined, they result in CHP deployment consistent with the executive order target of 40 GW of new CHP by 2020.

TABLE 8 State Energy Efficiency Measures

ACTION	POLICIES AND PROGRAMS DRIVING ACTION	LACKLUSTER	MIDDLE-OF-THE-ROAD	GO-GETTER
Electricity savings from states with EE targets	■ Energy efficiency resource standards ■ System benefit charge funds or other funds ■ Least-cost procurement requirements	States responsible for 75 percent of electricity consumption that have annual energy efficiency targets below 1.5 percent increase their annual target to 1.5 percent from 2015 to 2035.	States responsible for 75 percent of electricity consumption that have annual energy efficiency targets below 2 percent increase their annual targets to 2 percent from 2015 to 2035.	States responsible for 75 percent of electricity consumption that have annual energy efficiency targets below 2.5 percent increase their annual targets to 2.5 percent from 2015 to 2035.
Electricity savings from states without EE targets		States responsible for 25 percent of electricity consumption achieve electricity savings of 1 percent of total demand per year from 2015 to 2035.	States responsible for 25 percent of electricity consumption achieve electricity savings of 1.5 percent of total demand per year from 2015 to 2035.	States responsible for 50 percent of electricity consumption achieve electricity savings of 1.5 percent of total demand per year from 2015 to 2035.
Natural gas savings from states with EE targets	■ Energy efficiency resource standards ■ System benefit charge funds or other funds	States responsible for 25 percent of natural gas consumption that have energy efficiency targets below 1 percent achieve savings of 1 percent of total demand per year from 2015 to 2035.	States responsible for 50 percent of natural gas consumption that have energy efficiency targets below 1 percent achieve savings of 1 percent of total demand per year from 2015 to 2035.	States responsible for 75 percent of natural gas consumption that have energy efficiency targets below 1.5 percent achieve savings of 1.5 percent of total demand per year from 2015 to 2035.
Natural gas savings from states without EE targets		States responsible for 10 percent of natural gas consumption achieve natural gas savings of 1 percent of total demand per year from 2015 to 2035.	States responsible for 25 percent of natural gas consumption achieve natural gas savings of 1 percent of total demand per year from 2015 to 2035.	States responsible for 50 percent of natural gas consumption achieve natural gas savings of 1.5 percent of total demand per year from 2015 to 2035.
Reduced energy consumption in buildings	■ Commercial and residential building codes ■ Financial incentives	States accounting for 10 percent of the energy consumed by the building sector implement more ambitious building codes.	States accounting for 30 percent of the energy consumed by the building sector implement more ambitious building codes.	States accounting for 50 percent of the energy consumed by the building sector implement more ambitious building codes.
Increased penetration of combined heat and power	■ Standard interconnection rules ■ Reduced standby rates ■ Net metering policies ■ Output-based emissions regulations	State action results in deployment of an additional 10 GW of new CHP beyond business-as-usual projections by 2025.	State action results in deployment of an additional 20 GW of new CHP beyond business-as-usual projections by 2025.	State action results in deployment of an additional 40 GW of new CHP beyond business-as-usual projections by 2025.

TABLE 9 State Renewable Energy Policies

	LACKLUSTER	MIDDLE-OF-THE-ROAD	GO-GETTER
Increased renewables from states with renewables targets	States responsible for 25 percent of electricity consumption increase their renewable generation by 1 percent annually after the last year for which a standard is set.	States responsible for 50 percent of electricity consumption increase their renewable generation by 1 percent annually after the last year for which a standard is set.	States responsible for 75 percent of electricity consumption increase their renewable generation by 1 percent annually after the last year for which a standard is set.
Increased renewables from states without renewables targets	States responsible for 10 percent of electricity consumption increase their renewable generation 0.5 percent annually beginning in 2015.	States responsible for 25 percent of electricity consumption increase their renewable generation 0.5 percent annually beginning in 2015.	States responsible for 50 percent of electricity consumption increase their renewable generation 0.5 percent annually beginning in 2015.

D. RENEWABLE ELECTRICITY GENERATION

Similar to energy efficiency, state policies have been major drivers of renewable electricity generation in the United States. Twenty-nine states and the District of Columbia have renewable energy portfolio standards or advanced energy standards. Numerous states also support distributed or customer-sited renewables as part of their RPS or through other ratepayer-funded programs. In order to capture the reductions possible from states taking new or additional action to increase renewable generation serving their residents, we assumed that a certain number of states without renewable energy targets add 0.5 percent renewables per year beginning in 2015. For those states that already have renewables targets, we assumed they continued to add 1 percent a year to those targets after the target is achieved. Table 9 provides details on differences across the scenarios.

E. WHEN STATES TAKE A MORE EXPANSIVE TACK

States have broad authority to regulate energy sources and emissions within their boundaries. They may therefore implement many of the same policies that we ascribe to the federal government in the federal analysis. In determining what reductions states might make in the future, the analysis considers not only traditional state energy policies, but also scenarios in which states decide to approach carbon pollution more expansively. For example, the states participating in the Northeast and Mid-Atlantic Regional Greenhouse Gas Initiative (RGGI) have chosen to design and implement a multistate cap-and-trade program to reduce carbon pollution from power plants in their states. Other states could join them, or take alternative approaches to reducing carbon pollution from power plants. The most significant example of this is California, which has taken an expansive approach to reducing GHGs in its Global Warming Solutions Act of 2006 and the regulations adopted under that law.

Because it is hard to predict which other states, if any, will pursue ambitious standards for greenhouse gases, we modeled more broad-based action by assuming a portion of total national emissions within each sector would be covered by the reduction measures analyzed for the federal government in section IV above. In the lackluster, middle-of-the-road, and go-getter scenarios, we assume these measures are adopted by states accounting for 10, 25, and 50 percent of GHG emissions from a given sector, respectively.

These approaches include state action for all sectors discussed in the federal action section, except for those policies that are ill-suited for state implementation. We deemed policies that eliminate HFCs, regulate off-highway vehicles, adopt appliance and equipment efficiency standards where federal standards already exist, or regulate aviation to be ill-suited to state implementation because they are preempted by federal law.

It is important to note that we vary both the number of states taking action and the level of ambition they each pursue. In all sectors, the level of ambition pursued is the same as the ambition defined in the federal scenario described in Section IV. Therefore, in our lackluster scenario for power plants, we assume states accounting for 10 percent of GHG emissions from the power sector

implement policies equivalent to the lackluster scenario for federal action. In our go-getter scenario, we assume states accounting for 50 percent of GHG emissions from the power sector implement policies equivalent to the go-getter scenario for federal action.

VI. Conclusion: Finding Our Way to a Low-Carbon Future

The enormous economic and social costs of climate disruption are increasingly evident in the United States. Yet the urgency conveyed by the mounting evidence is not yet reflected in U.S. federal and state actions or climate policies. The United States is not currently on path to meet its international pledge to reduce GHG emissions to 17 percent below 2005 levels by 2020, though it could meet this goal with go-getter action by the U.S. Administration under current laws. In order to achieve adequate mid-century reductions, it appears almost certain that the U.S. Congress will eventually have to enact new legislation aimed at getting deep reductions. Ultimately, a cooperative approach bringing together Congress, states, and the executive branch will be necessary for the United States to do its part.

States can contribute to U.S. emissions reductions, both through state-level transportation, energy efficiency, and renewables programs, as well as through new legislative efforts to initiate a wide array of other policies aimed at reducing GHGs. It appears unlikely that state actions alone will put the United States on the necessary course. However, they can help complement federal action, and can enable the United States to meet its 17 percent target if federal agencies fail to pursue go-getter-level action.

KEY RECOMMENDATIONS

- In the short term, federal agencies and the states should aggressively move forward with a "go-getter" emissions reduction scenario. This will necessitate taking action in the following key areas that present the greatest opportunities for GHG emissions reductions through 2020:
  - EPA and the states should focus on achieving significant reductions in carbon pollution from power plants and natural gas systems.
    - For power plants, EPA should finalize its proposed greenhouse gas emissions standards for new power plants and should move ahead with flexible and ambitious standards for existing power plants. States should move ahead with measures to reduce emissions from the power sector, such as increasing the use of renewable power and cogeneration and reducing electricity demand.
    - For natural gas systems, EPA and the states should propose rules that address methane as a greenhouse gas pollutant, which can result in significant reduction of methane leakage throughout the natural gas life cycle. Such rules would complement the volatile organic compound and air toxics rules established in 2012 for natural gas systems that have the co-benefit of reducing methane leakage.
  - The State Department should continue to seek reductions in hydrofluorocarbons through amendments to the Montreal Protocol. But, in the meantime, EPA should begin reducing consumption in the United States using its authority under the Clean Air Act.
  - EPA and the states should also work to improve energy efficiency in the residential, commercial, and industrial sectors.
- Over time, we will need to see reductions from all sectors, and the Administration should use its existing authorities to achieve go-getter-level reductions across the economy.
- Even with go-getter-level action, however, reductions will fall short of the long-term targets necessary to avoid the worst impacts of climate disruption. As a result, congressional action will be necessary.

BOX 4 Risks and Uncertainties

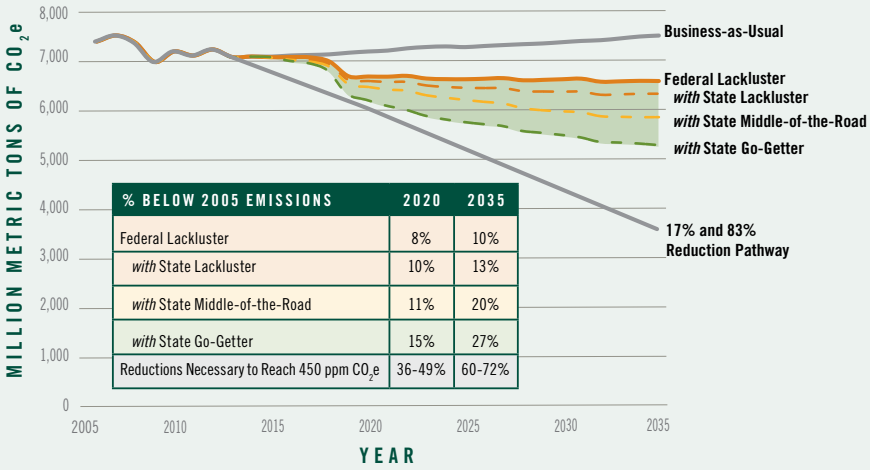
Uncertainties associated with the methods and results of this analysis include:

- **Uncertainties inherent in the models.** As with any modeling analysis of this sort, there is significant uncertainty in projecting the future. The analysis relies heavily on the Energy Information Administration's *Annual Energy Outlook 2012*, which attempts to project energy and emissions trends into the future based on a number of assumptions, including likely fuel costs, economic activity, and source turnover rates. There are also considerable uncertainties in the estimates of fugitive emissions from natural gas systems. All projections are only as good as the assumptions that go into them and the quality of the data modeled.
- **Regulatory impetus.** As the different scenarios suggest, a major uncertainty in the analysis is whether the federal administration will carry out the regulatory actions in a manner sufficient to achieve the reductions that available studies suggest are technically feasible. The lackluster, middle-of-the-road, and go-getter scenarios stand for different levels of regulatory ambition. The go-getter scenario, it should be emphasized, will require steadfast resolve on the part of the Administration and the states.
- **Congressional action.** Federal agencies depend on the U.S. Congress for their budgets. In order to carry out a series of new regulatory actions, federal agencies will require sufficient resources through the annual budget process. In addition, it should be noted that existing authorities can be curtailed through new legislation.
- **Legal risk.** The assumptions made in this analysis were informed by sound legal analysis and vetted with legal experts in the field. Nevertheless, when federal agencies take new actions under existing statutes, the new actions are often challenged in federal court on the grounds that the agency has exceeded the authority originally granted to it in the statute. It is impossible to predict with any precision whether the challenges will be successful.
- **Technological development.** The results modeled depend in part on the development and deployment of new technologies over time. Indeed, many of the regulatory policies are technology-based and must be revised by federal agencies as technology progresses. If technologies emerge rapidly, emissions reductions are more likely. Conversely, if technologies are slow to appear, emissions reductions will slow. This uncertainty is especially important further out into the future.

Supplemental Figures

BOX S-1 Greenhouse Gas Emissions Reductions from State Action Coupled with Lackluster Federal Action

FIGURE S-1 Projected U.S Emissions with State Action Coupled with Lackluster Federal Action



% BELOW 2005 EMISSIONS	2020	2035
Federal Lackluster	8%	10%
with State Lackluster	10%	13%
with State Middle-of-the-Road	11%	20%
with State Go-Getter	15%	27%
Reductions Necessary to Reach 450 ppm CO_2e	36-49%	60-72%

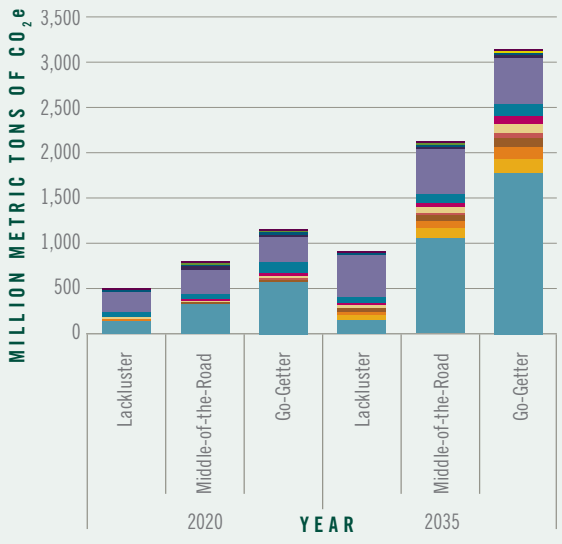
Note: Figure depicts changes in consumption of HFCs.

If the U.S. Administration pursues a lackluster effort, go-getter state action will not be sufficient to make up the emissions gap and reduce GHG emissions 17 percent below 2005 levels by 2020. However, as shown in Figure 2, the 17 percent GHG reduction goal can be achieved with a state go-getter effort along with middle-of-the-road federal action. State action with go-getter federal action is not shown, as it does not provide significant reductions above and beyond other combinations of state and federal action that were considered as a result of the way the scenarios are defined.

BOX S-2 Greenhouse Gas Emissions Reductions from Federal Action

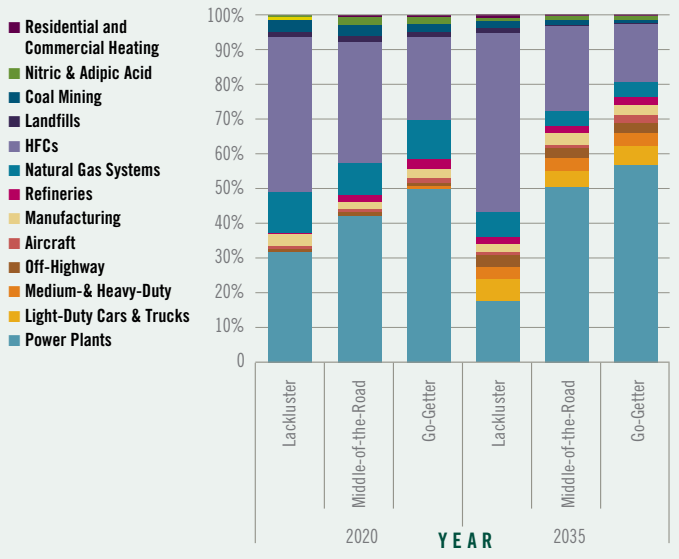
The majority of potential GHG benefits come from actions taken in the power sector, energy efficiency improvements, reducing HFC consumption, and reducing methane emissions from natural gas systems. These actions represent between 80 and 93 percent of potential GHG reductions across all scenarios in 2020 and 2035, and are necessary to achieve a 17 percent reduction below 2005 GHG emissions levels.

FIGURE S-2 Greenhouse Gas Emissions Reductions from Federal Action, in million metric tons



Note: Figure depicts changes in consumption of HFCs.

FIGURE S-3 Greenhouse Gas Emissions Reductions from Federal Action, as a percent of total reductions



Note: Figure depicts changes in consumption of HFCs.

BOX S-3 Greenhouse Gas Emissions Reductions from State Action Only

Improvements in the power sector largely drive reductions in all of the scenarios that examine the impact of state actions without any new federal actions. This is accomplished through a combination of GHG performance standards, renewable and energy efficiency standards, building codes, and policies to promote combined heat and power. In our scenarios those actions can alleviate the demand for up to 1,280 terra watt-hours of conventional sources of electricity in 2035. This is offset to a limited extent through increased vehicle electrification, which increases demand by up to 66 terra watt-hours of electricity in 2035.

States can implement many of the same types of policies as federal agencies. They can also take additional actions that increase electric efficiency, renewable electricity generation, building performance, and combined heat and power penetration.

However, states are less well-equipped to reduce HFC consumption, adopt appliance and equipment efficiency standards where federal standards already exist, and to drive reductions in GHG emissions from off-highway vehicles and aviation. As a result, under our scenarios, state action alone is insufficient to achieve the near-term and long-term GHG reduction targets.

FIGURE S-4 State Actions that Affect Electricity Supply and Demand

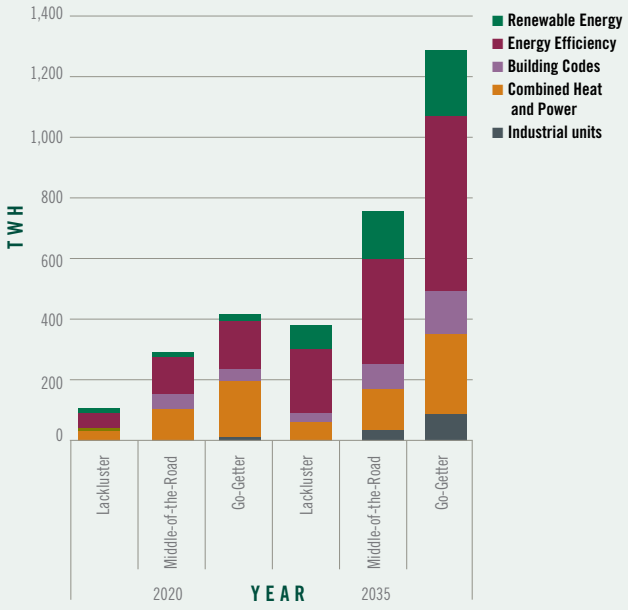


FIGURE S-5 Greenhouse Gas Emissions Reductions from State Action, in million metric tons

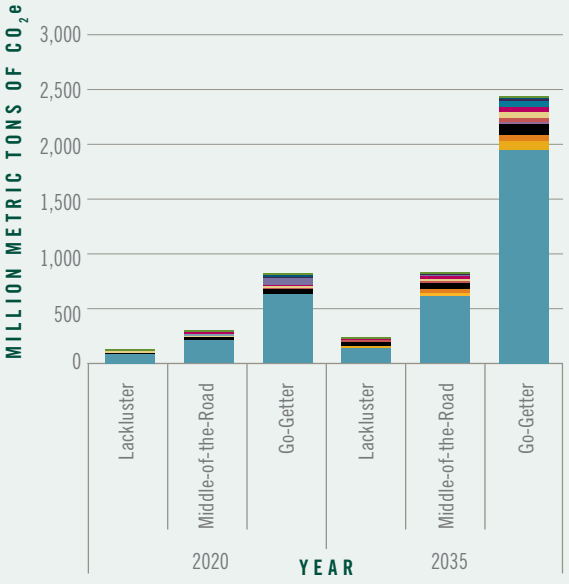
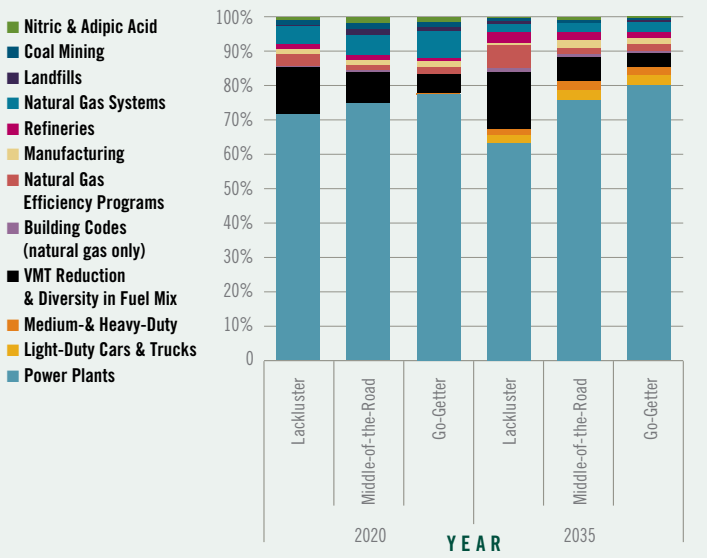


FIGURE S-6 Greenhouse Gas Emissions Reductions from State Action, as a percent of total reductions from state actions



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