Rhodium Group

Pathways to Paris

A Policy Assessment of the 2030 US Climate Target

October 19, 2021

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Prepared for the William and Flora Hewlett Foundation and the Linden Trust for Conservation

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About this Report

The William and Flora Hewlett Foundation and the Linden Trust for Conservation commissioned Rhodium Group to conduct an independent assessment of whether or not the US can achieve its climate target of cutting net GHG emissions by 50-52% below 2005 levels in 2030, and if so, what does a policy pathway to the target look like? The research was performed independently, and the results presented in this report reflect the views of the authors and not necessarily those of the Hewlett Foundation or the Linden Trust.

About Rhodium Group

Rhodium Group is an independent research provider combining economic data and policy insight to analyze global trends. Rhodium's Energy & Climate team analyzes the market impact of energy and climate policy and the economic risks of global climate change. This interdisciplinary group of policy experts, economic analysts, energy modelers, data engineers, and climate scientists supports decision-makers in the public, financial services, corporate, philanthropic and non-profit sectors. More information is available at www.rhg.com.

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Executive Summary

Over the course of this year, the impacts of climate change have become more immediate and tangible. A cascade of natural disasters—floods, hurricanes, wildfires, droughts, and extreme heat—have touched nearly every corner of the US. Meanwhile, it's clearer than ever that the planet is on track for even more intense impacts in the decades ahead if action isn't taken soon to avoid the worst climate damages.

President Biden campaigned on a platform that prioritized action on climate change. Now in office, the Biden administration has taken a whole-of-government approach to the issue, placing staff in key agencies to coordinate federal efforts to cut emissions. As part of this effort, President Biden submitted a nationally determined contribution (NDC) under the Paris Agreement, pledging the US will cut net greenhouse gas (GHG) emissions in the range of 50-52% below 2005 levels by 2030.

Meanwhile, congressional leaders are shepherding a major infrastructure package and a multi-trillion dollar spending bill towards the finish line. The two bills combined have the potential to be the largest action ever taken to abate climate change in US history. In a few weeks, world leaders will meet in Glasgow, Scotland for the UN Climate Change Conference (COP26) to enhance global action and limit warming to 1.5 degrees Celsius. As other countries step to the plate with bold ambition, they will need to be able to trust that the US can deliver on its 2030 promise of a 50-52% reduction.

This report aims to provide an independent, objective, and policy-focused assessment of the US 2030 target. We combine our knowledge of the US economy, energy systems, and policy design with state-of-the-art modeling tools to comprehensively answer two questions: Can the US cut net GHG emissions by 50-52% by 2030 and if so, what does a policy pathway to the target look like?

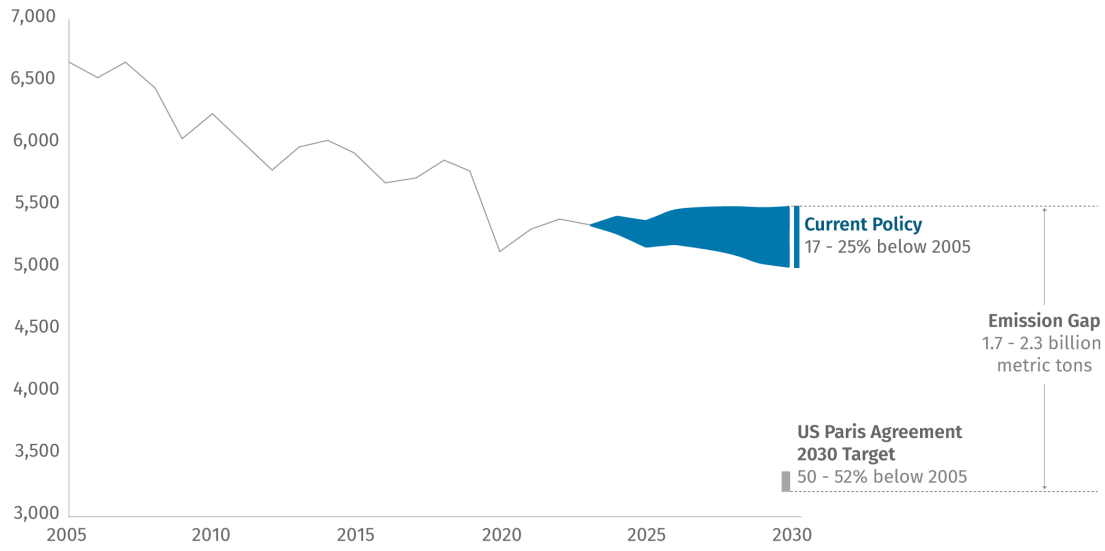
We consider actions by all key actors in the US federal system, including legislation under construction in Congress, regulations and other actions that can be taken by the Biden administration and key departments, as well as actions by climate-leading states and corporations. The suite of policies we consider is not intended to be exhaustive. Instead, it represents a series of actions that can be reasonably expected to occur over the next nine years if leaders in all levels of government work in earnest to address climate change. Based on this analysis, here is a summary of our key findings.

Without new action, the US will not meet its 2030 target

Under current policy as of May 2021, with no new action, the US is on track to reduce GHG emissions 17-25% below 2005 levels in 2030. The range reflects uncertainty around energy markets, clean technology costs and the ability of natural systems to remove carbon from the atmosphere. This leaves a gap of 1.7-2.3 billion metric tons of emission reductions required to achieve the US target in 2030 (Figure ES1). The gap is roughly equal to all 2020 emissions from the transportation sector on the low end and all emissions from electric power and agriculture combined on the high end.

While the challenge of closing the gap is daunting, achieving the target is in line with what's required to avoid the worst impacts of climate change. Not

FIGURE ES1
The US emissions gap, 2005-2030
Million metric tons of CO_2e



Source: Rhodium Group

following through on this commitment risks undermining the credibility of the US and reduces the chances of an ambitious multilateral response to climate change.

Joint action by Congress, the executive branch, and subnational leaders can put the 2030 target within reach, but all must act

Our analysis demonstrates that meeting the US's 2030 target is achievable, if Congress, the executive branch, and subnational leaders all take a series of practical and feasible policy actions—what we refer to as our "joint action" scenario (Figure ES2). This scenario represents passage this year of the infrastructure bill and budget reconciliation package in Congress, coupled with a steady stream of standards and regulations by federal agencies and accelerated action by leading states and companies. Combined, these actions can cut US net GHG emissions to 45-51% below 2005 levels in 2030.

At each level of government, we identify practical policy actions under clearly established authorities (where applicable) that, if pursued on reasonable timelines, can help achieve the target. No one level of government alone can deliver on the target. None of the policies we identify are novel or new, and all federal regulatory action can be implemented with existing legal authority. To close the emissions gap, agencies and states will need to pursue new actions at a pace, scope, and level of ambition that has not been seen to date, but which are also practical and within reach.

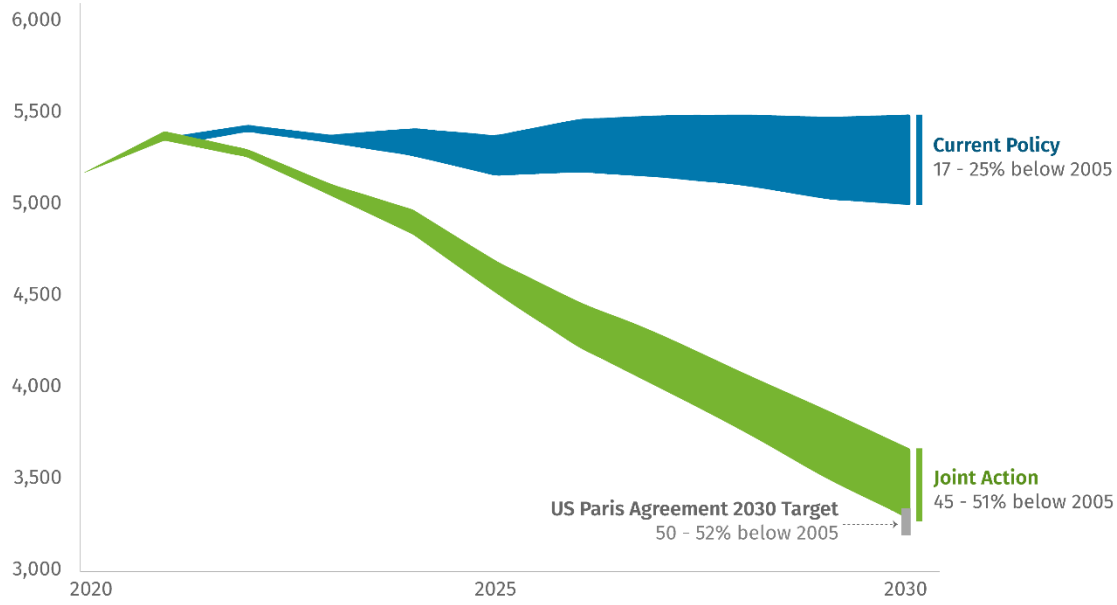
Action across all sectors of the economy is required to achieve the 2030 target

We find that the biggest opportunities for emission reductions in this decade reside in the electric power sector—covering 39-41% of total reductions achieved in the joint action scenario. If actions to cut electric power sector emissions are not successful, then achieving the 2030 target may not be possible. Even so, achieving the target will require successful emission reduction actions across all sectors of the US economy, not just the power sector, as well as increased natural and technological removal of carbon from the atmosphere.

Achieving the 2030 target can also cut harmful air pollutants and consumer bills

Getting US emissions on track to reach the 2030 target can be done with little cost to consumers. Long-term tax credits, investments in energy efficiency and other

FIGURE ES2
US net GHG emissions trajectory, 2020-2030
Million metric tons of CO_2e



Source: Rhodium Group

factors cushion consumers from price increases associated with new standards and regulations. On a national average basis, households save roughly $500 a year in energy costs in 2030 in our joint action scenario. Many policy actions that cut emissions also reduce harmful air pollutants. For example, SO_2 emissions in the electric power sector decline to near zero by 2030.

If Congress fails to act, the 2030 target may be in jeopardy

Congressional action is critical to achieving the 2030 target for two reasons. First, measures in the infrastructure and budget packages can enable and accelerate clean technology deployment and on their own cut emissions significantly. Second, those same programs reduce consumer and compliance costs of federal and state actions that, combined with congressional actions, put the target within reach. Without the cost reduction assistance of congressional actions, federal and state leaders will face higher technical and political hurdles as they pursue the ambitious policies required to get to the 50-52% target. Congressional investments in emerging clean technologies will also drive innovation to enable the next wave of decarbonization after the 2030 target is reached.

Achieving the target will be a historic feat but is only halfway to the net-zero finish line

If all actors successfully pursue all aspects of the joint action scenario and achieve the 2030 target, it will represent one of the most monumental national achievements in recent decades. Even then, achieving the ambitious goal puts the nation just halfway to the longer-term goal of net-zero emissions by mid-century, which is the level required for the US to play its role in a robust global response to the threat of climate change. Getting to net-zero will require new policies and the commercial scale-up of a suite of emerging technologies like clean hydrogen, direct air capture, and advanced zero-emission electric generation, as well as continued electrification of transportation and buildings. Without near-term progress on these fronts in the years ahead, closing the gap to net-zero emissions by 2050 will be even more challenging than getting to the 2030 target.

CHAPTER 1

Raising Climate Ambition

The impacts of a changing climate are being felt across the US. Atmospheric concentrations of carbon dioxide (CO_2) have surpassed 410 parts per million (PPM) as world continues to emit more than 50 billion tons of greenhouse gases each year. The resulting increase in global temperatures have made the past seven years the Earth's warmest on record. Ninety-nine percent of the Western US is in a drought, with nearly 60% suffering through a drought that the US government classifies as either extreme or exceptional. A heat wave this summer resulted in hundreds of premature deaths in the Pacific Northwest. As of early October, 2021 had already become the third most active hurricane season in the Atlantic on record. Hurricane Ida delivered record rainfall across the eastern US, with flooding that contributed to nearly 100 deaths. No individual extreme weather event can be attributed entirely to climate change, but there is growing scientific consensus that a warmer climate increases the frequency and severity of a range of extreme events, from heat waves to hurricanes. In its Sixth Assessment Report released in September, the Intergovernmental Panel on Climate Change (IPCC) warned that these increases in frequency and severity will continue unless the world significantly reduces emissions over the next few decades.

In the 2015 Paris Agreement, countries set a collective goal of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change." In a 2018 report, the IPCC estimated that limiting global temperature increase to 1.5°C would require the world reaching net-zero emissions between 2045 and 2055, with a 40-60% reduction below 2010 levels by 2030.

In April 2021, in an effort to both re-establish US credibility on climate and increase global ambition in the hopes of achieving a 1.5°C temperature target, the Biden administration announced a new US target of a 50-52% reduction in US GHG emissions below 2005 levels by 2030 (the equivalent of a 47-49% reduction from 2010 levels). This nationally determined contribution (NDC) announcement came only days before President Biden hosted a Leaders Summit on Climate, where the world's 17 largest economies and GHG emitters gathered to discuss new commitments to ramp up ambition in 2030 under the Paris Agreement.

The Biden administration has indicated it plans to take a whole-of-government approach to reach this target. Within a week of taking office, President Biden released an Executive Order establishing climate change as a core priority in both domestic and international policy and calling on all federal agencies and institutions to integrate climate change across their portfolios. This was followed by a wave of nominations of climate experts to high-level positions at nearly every federal agency.

Congress has also ramped up its climate focus. In 2020, the Senate's Special Committee on the Climate Crisis and the House Select Committee on the Climate Crisis both released roadmaps for prioritizing climate action in Congress over the coming years. In contrast to the focus on comprehensive cap-and-trade legislation that dominated Congress a decade ago, today's vision instead focuses on a more modular approach, targeting key sectors, and ramping up federal spending to support parallel regulatory efforts by federal agencies and US states.

Can the US cut emissions by 50-52%?

Can this renewed focus on climate action both within the executive branch and in Congress deliver on the

Biden administration's new international commitment? The goal of this report is to determine whether a 50-52% reduction is achievable and, if so, what achieving the target might look like. While some studies examine the energy system transformation pathways required to meet a net-zero goal by mid-century, and others demonstrate what may occur when key energy system changes are assumed to materialize in time to contribute to achieving emission targets, we take a different approach. This analysis employs a policy-focused methodology where we model scenarios consisting of actual policies contained in proposed legislation, pursued through well-established executive authorities, or taken by subnational actors, and consider their aggregate impact.

For example, we model fuel economy standards and electric vehicle (EV) tax incentives instead of assuming EVs make up an increasing share of vehicle sales. This policy-focused approach allows for granular representation of possible actions to meet the 2030 target and a clearer picture of what achieving the target might look like.

Climate action in the US is not the domain of any single level or branch of government. With this in mind, we take a wide view of potential policy action. In the legislative arena, we examine the two leading packages under consideration now in Congress: the bipartisan Infrastructure Investment and Jobs Act and key climate and energy components of the $3.5 trillion House budget package. Outside of Congress, the federal executive branch has a host of existing authorities it can use to drive down emissions. Finally, states and the private sector can cut emissions within their jurisdictions, supply chains, and products. We consider the aggregate of these actions and determine if it's enough to put the 2030 target within reach.

For this analysis, we conducted a comprehensive assessment of specific policies being debated in Congress this year, as well as potential policies that can be pursued by the executive branch and subnational actors. We then represented these policies in RHG-NEMS, a detailed economy-wide energy system model with full GHG representation. RHG-NEMS is a version of the National Energy Modeling System created by the Energy Information Administration and modified and maintained by Rhodium Group. We provide additional detail on RHG-NEMS in the Technical Appendix to this report. We analyzed policies for carbon removal policies from forest restoration and agricultural land management outside of RHG-NEMS.

The scale and the stakes

Pathway to 2050

Meeting the 2030 target represents the first, and arguably the easiest, step in the process of completely transforming the US energy system and achieving net-zero emissions by mid-century. Success means that, by 2030, the power grid is much cleaner, the majority of consumers are choosing electric vehicles over gasoline, buildings are increasingly electrified and efficient, and carbon capture is a normal part of the industrial landscape. Shifts in carbon removal, forestry and agriculture, and other sectors will also be underway. Meanwhile, the US will be scaling up emerging technologies like direct air capture, clean hydrogen, long-duration storage, and clean fuels to drive the next wave of decarbonization beyond 2030.

Raising global ambition

There is much more than the future of US emissions at stake. The announcement of an ambitious 50-52% goal was a welcome signal to the rest of the world that the US has serious intentions to be part of a net-zero future. But good intentions only go so far. America's international partners will need to see clear, concrete steps to implement that goal—in the form of policies and funding—for them to trust that the US can walk the talk. As world leaders meet at COP26 in November, the US will need all the leverage it can get to bring countries like India and China on board for more ambitious action.

This report provides a bottom-up assessment of plausible policies that in combination have the potential to achieve the US's 2030 climate target. In the next chapter, we present the US emissions trajectory under current policy with no new action and quantify the amount of emission reductions required to meet the 2030 target. In Chapter 3, we identify the policies we consider across the congressional, executive and subnational arenas and construct a joint action scenario that can potentially achieve the target. In Chapter 4, we present and explore modeling results from our policy scenarios. Chapter 5 considers policies not included in our scenarios that may be important depending on the success of the package we model. Chapter 6 reflects on the long-term challenge of decarbonizing the US economy by mid-century and provides conclusions and recommendations.

CHAPTER 2

The US Emissions Gap

As the starting point for our analysis, we assess the 2030 trajectory of US emissions under current policy, without any additional action. All policies on the books through May 2021—at the federal and state levels—are included in our current policy baselines projections. For decades, leading states have implemented and refined clean energy policies of all kinds. At the federal level, clean energy tax credits, pollution regulations, and standards have driven investment towards cleaner options. We capture all of these efforts to date.

Emissions under current policy

For this analysis, we rely on our Taking Stock 2021 net GHG emissions projections. In Taking Stock 2021, we consider a wide range of energy and macroeconomic scenarios. In this analysis, we narrow our focus to consider uncertainties surrounding energy markets, technology costs, and natural carbon removal from land use practices.

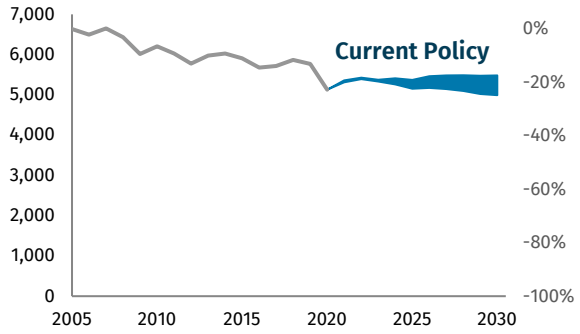
Specifically, we analyze emissions under two bounding scenarios. In our low emissions scenario, we pair low clean energy technology costs, sourced from the National Renewable Energy Laboratory's Annual Technology Baseline as well as Rhodium Group's own research, with our central gas and oil prices (which average $3.05/MMBtu and $59/barrel respectively through 2030). We keep the land use, land-use change, and forestry (LULUCF) assumptions underpinning Taking Stock 2021 in place in our low emissions scenario, which effectively keeps LULUCF negative emissions flat from 2005 levels through 2030.

To bound the impacts of the policies we model, we compare this low emissions scenario with a high emissions scenario where we assume less aggressive cost reductions for clean energy technologies result in achieving central, rather than low, clean energy tech prices. Conversely, we assume that oil and gas prices reach the lower levels we outline in the Taking Stock 2021 low oil and gas price scenario, representing average prices of $51/barrel and $2.60/MMBtu, respectively. Finally, we pair these high emissions energy market characteristics with a low-sequestration pathway for LULUCF, which sees the net carbon sink shrink by nearly 45% over 2005 levels by 2030. We provide greater detail for all energy market assumptions in the Technical Appendix to Taking Stock 2021.

FIGURE 2.1

US net GHG emissions under current policy, 2005-2030

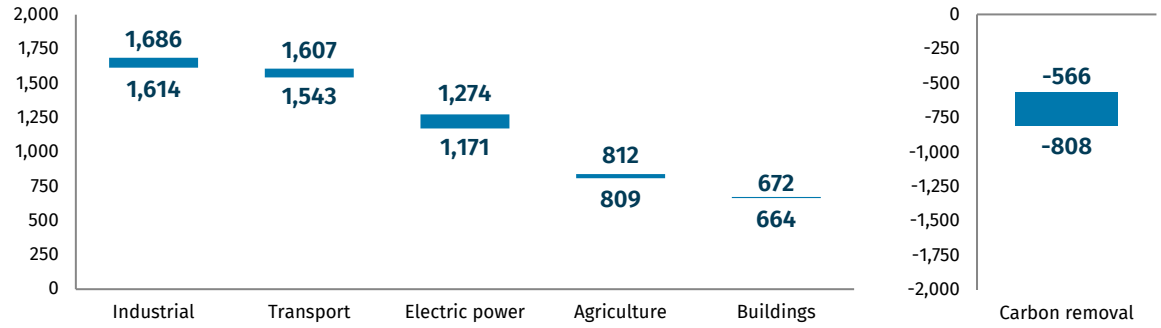
Million metric tons of CO_2e under low and high emissions scenarios



Source: Rhodium Group

Considering just these factors along with state and federal policies on the books as of May 2021, we find that without additional action, the US is on track for net GHG emissions of 5-5.5 billion metric tons in 2030 (Figure 2.1). That's 17-25% below 2005 levels. This means that at best, the US is currently on track to get halfway to the 2030 target with no additional policy action. If fossil fuels are relatively cheap, clean energy technologies are relatively expensive and forest and soil carbon removal declines from 2020 levels, emissions stay roughly flat compared to 2020 levels and the US is only 35% of the way to the 2030 target.

FIGURE 2.2
US GHG emissions by sector under current policy, 2030
Million metric tons of CO_2e under low and high emissions scenarios



Source: Rhodium Group

Looking across the economy in 2030, we find that, absent new policy action, the industrial sector (including emissions from oil and gas production) will be the largest emitting sector at 1.6-1.7 billion tons, followed by transportation at 1.5-1.6 billion tons and electric power at 1.2-1.3 billion tons (Figure 2.2). Taken together, these sectors make up 83-87% of net GHG emissions in 2030; as such, any new actions to cut emissions will have to tackle each of these major emitting sectors. At the same time, there may be cost-effective or politically attractive opportunities across the entire US GHG inventory including agriculture and waste and buildings as well as enhancing carbon removal.

Quantifying the emissions gap

The US 2030 target is to reduce emissions by 50-52% below 2005 levels. Based on our current policy emissions range, the gap between the current policy trajectory and the 2030 target is 1.7-2.3 billion metric tons (Figure 2.3). Focusing on the lower end of the gap range, required reductions from current policy are roughly equal to all transportation sector emissions in the US today. The gap is roughly the same magnitude as 2019 net emissions from Russia or four Californias. The upper end of the gap range is roughly equal to the combined emissions of the electric power and agriculture sectors today, twice the emissions of Japan or three times the emissions of Texas.

Closing the emissions gap will be one of the most challenging things the US has ever attempted. To achieve the 2030 target, the US will need to cut emissions at a pace of 230-240 million metric tons per year every year beginning in 2022.

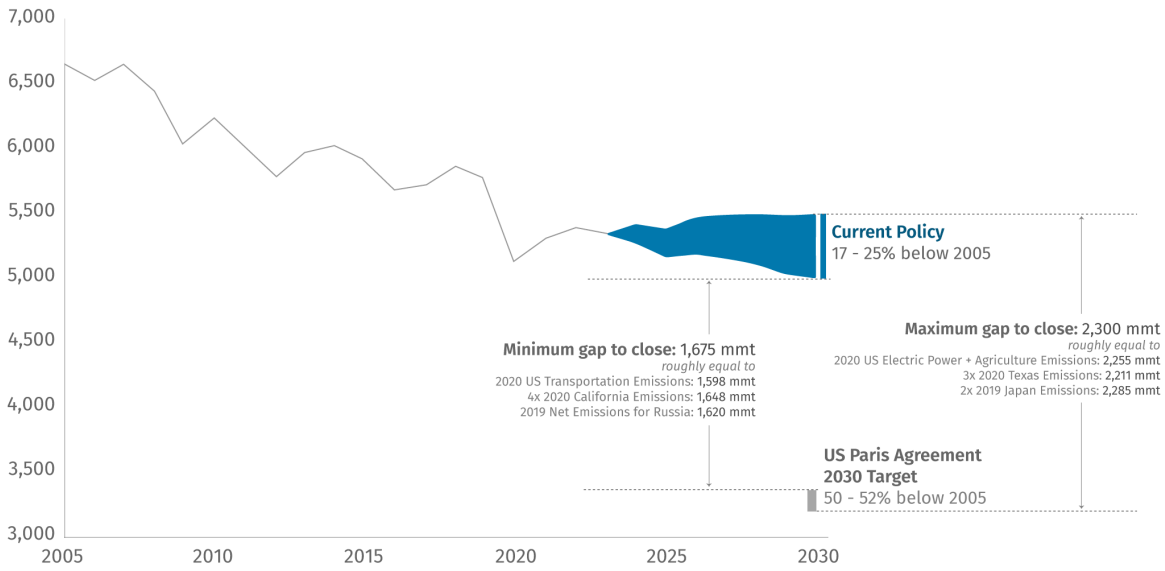
Putting this gap in context, that's the same as zeroing out emissions from the entire state of Florida every year for the next nine years. Since 2005, the US has only cut emissions at that level in absolute terms twice in non-recession years: in 2012 and 2016. Emissions decreased even more during the Great Recession and COVID-19 pandemic, but the pain and suffering involved in those years demonstrate economic contraction is not a sustainable model for achieving decarbonization.

Put differently, the US will have to cut emissions in absolute terms as much as its best non-recession year in recent history every year between now and 2030. On a percentage basis, the US will have to do even better: a path to 50% in 2030 requires a 5.2-5.6% year-on-year cut in emissions every year, compared to a non-recession year best of 4.1% in 2012.

Only new policy action can close the gap

Technology and markets alone will not be enough to help the US achieve the 2030 target. The low end of our current policy emissions range incorporates the most optimistic technology cost assumptions available combined with the most favorable fossil fuel price

FIGURE 2.3
The US emissions gap, 2005-2030
Million metric tons of CO_2e



Source: Rhodium Group

assumptions. A major economic recession could cut emissions for a year or two, but the reductions are short-lived while the pain and suffering hardly make such an event something to wish for. This leaves one primary avenue to meet the target: the rapid enactment and implementation of new decarbonization policies.

Fortunately, Congress is currently considering two major pieces of legislation that together have the potential to be the most significant climate action in US history. On top of that, the Biden administration is taking a whole-of-government approach to tackling climate change and can exercise its considerable existing authorities to regulate key sources of emissions.

Outside of the federal government, many states are leading the charge on cutting emissions, while some major corporations are committing to serious shifts in their emissions and products in an effort to be part of the solution and not the problem.

While the 2030 emissions gap is large and the transition is daunting, there is momentum for new policy action. Next, we catalog the policies under discussion in Congress and potentially on the table in federal agencies, state capitals, and corporate boardrooms, which, when taken together, have a chance of achieving the 2030 target.

CHAPTER 3

A Policy Pathway to 50% by 2030

In this chapter, we examine a joint action scenario where action by the executive branch and subnational actors alongside congressional action can put the 50% 2030 target within reach. We take a bottom-up, policy-by-policy approach to construct this feasible joint action scenario. We start with the budget reconciliation package and infrastructure bill currently under consideration in Congress. We then layer on federal executive branch policies that can reasonably be expected as well as actions from climate-leading states and corporations.

This scenario is not intended to be definitive, prescriptive, or exhaustive—it is not the only way to get to the 2030 target. Instead, it's meant to demonstrate that it is possible for the US to get to 50%. It's also meant to illustrate one possible path to the goal that relies on authorities that have been used previously to cut emissions. There are certainly other pathways that exist and authorities that could be brought to bear beyond those we consider in this analysis.

We include a high-level summary of the policies we model in the following sections, but a detailed breakdown of all policies we include can be found in the Technical Appendix.

Climate action in Congress

Building on the passage of the 2020 year-end stimulus package, which included the the most impactful climate legislation in over a decade, the new Democratic-led Congress has been busy this year shaping two legislative packages that together have the potential to be the most consequential climate and energy legislation in US history. Both packages have a broader focus than just decarbonization, though they also each contain important provisions that can enable or directly catalyze emission reductions. For this analysis, we consider the aggregate impact of both packages combined. Table 1 includes a description of the standout congressional policies we include in our joint action scenario.

A bipartisan foundation

One key legislative vehicle for enacting policies to reduce GHG emissions is the Infrastructure Investment and Jobs Act, the current bipartisan infrastructure bill. This sprawling, 2,700-page piece of legislation passed the Senate on August 10 and is currently scheduled for a vote in the House of Representatives no later than October 31. Though the bulk of the bill's $1 trillion in total spending focuses on infrastructure like roads and bridges, clean water, and broadband, there are a host of provisions that will be critical to decarbonization.

In addition to provisions that directly invest in decarbonization, there are a number of other parts of the bill that are important enablers of future decarbonization. These include a Transmission Facilitation Program at the Department of Energy (DOE) which makes building interstate transmission lines easier, a Carbon Dioxide Transportation Infrastructure Finance and Innovation program to provide low-cost capital for the buildout of CO_2 pipelines and funding for CO_2 storage reservoir characterization and storage permitting. The bill also makes a substantial investment in bringing down future technology costs by funding regional deployment hubs for direct air capture and hydrogen projects and funding RD&D for hydrogen, carbon capture, DAC, energy storage, and other important emerging clean technologies.

Investing in decarbonization

The other main legislative vehicle for investing in decarbonization is through the congressional budget reconciliation bill. On August 11, the Senate approved a $3.5 trillion budget resolution and the House followed

suit on August 24. While it's unclear what precisely will end up in the final budget package, we include the core tax incentive and grant programs contained in the House budget package in this scenario. These include extension and enhancement of clean energy tax credits, EV infrastructure investments, building energy efficiency tax credits as well as carbon removal in forests and soils.

It is important to consider our scenario as one potential representation of the combined infrastructure and budget packages based on the best available information as of mid-October 2021. While the initial budget resolution called for a top-line spending value of $3.5 trillion, President Biden and congressional leaders have made it clear that negotiations will likely lead to a package with a much lower top-line number. Senator Joe Manchin of West Virginia, Chairman of the Senate Energy and Natural Resources Committee, has also signaled he won't support a package that includes measures that he perceives might eliminate fossil fuels, such as a fee on methane emissions, the Clean Electricity Performance Program (CEPP), and the repeal of fossil fuel subsidies. Meanwhile, press reports indicate that other members of the Senate are pushing for the inclusion of a fee on carbon to cut emissions and raise revenue.

In an effort to avoid over reliance on a highly uncertain outcome, we take a conservative approach to congressional action in our joint action scenario. We include tax credit extensions, clean energy grant programs and spending on agricultural programs but do not include a carbon or methane fee or the CEPP. Revisions made during the legislative process have the potential to substantially change the results we'll present in Chapter 4. In that chapter, we also discuss how different outcomes may change our results.

TABLE 1
Congressional policies in the joint action scenario

Policy	Target Sector	Description
Clean electricity tax credits	Electric power	Full-value, long-term, flexible clean energy tax credits for new zero-emitting electric generation and grid improvements with provisions for direct pay
Nuclear support	Electric power	Grants and tax credits available through 2031 for distressed nuclear plants
Rural cooperative incentives	Electric power	Funding for rural electric cooperatives to accelerate decarbonization efforts
Carbon capture tax credits	Electric power and industry	Extension and increase in payout of the section 45Q carbon capture tax credit, including a new credit level for direct air capture
EV tax credits	Transportation	Extension of EV tax credits at $7,500/vehicle with no manufacturer cap and higher credit values for meeting certain labor and domestic production criteria
EV charging infrastructure	Transportation	$7.5 billion in grants for buildout of public charging stations
Clean fuels and hydrogen tax credits	Transportation and industry	New and expanded production tax credits for clean transportation fuels and clean hydrogen
Energy efficiency spending	Buildings	Increased funding for efficiency upgrades through the Weatherization Assistance, State Energy Program, and Energy Efficiency Community Block Grants
Building efficiency tax credits	Buildings	Extension and expansion of energy efficiency tax credits for residential and commercial buildings
Electrification and efficiency grants	Buildings	Funding for grant programs for residential electrification and efficiency upgrades
Well and mine mitigation	Fossil fuel production	Funding for reclamation of abandoned coal mines and remediation of abandoned oil and gas wells
Soil conservation and forest reforestation	Carbon removal	$28 billion in new funds to existing conservation programs at USDA and stepped up funding for reforestation on federal, non-federal public, private, and tribal lands, and urban forests

We assume most revenue raising and social spending components likely to be part of the budget package, such as income tax rate increases and Medicaid expansion, won't have a material impact on emissions.

Executive action to close the emissions gap

Federal agencies have an array of authorities bestowed on them by Congress to regulate emissions from stationary and mobile sources as well as energy consuming products. In addition, existing federal spending programs can sometimes be steered in more climate-beneficial directions within existing authorities. Previous presidents, most notably the Obama administration, used these authorities in a coordinated attempt to cut emissions. To close the emissions gap in 2030, President Biden, as well as his successors, will need to make a similar but far more ambitious and sustained effort.

Key executive authorities and actions

In our joint action scenario, we focus on executive authorities that reinforce and augment congressional actions as well as those that can cut emissions in sectors of the economy where legislation in Congress may make a relatively small dent. While closing the emissions gap will require a whole-of-government approach, the departments with the biggest role to play include the Environmental Protection Agency (EPA), Department of Energy (DOE), and the Department of Agriculture (USDA). A full description of all policies considered in the joint action scenario can be found in the Technical Appendix accompanying this report. We identify key authorities and new policies in Table 2.

We chose these federal executive actions for several reasons. First, all of them are authorities that have been used previously to cut emissions or energy use. Second,

TABLE 2
Executive branch actions in the joint action scenario

Policy	Target Sector	Description
New Source Performance Standards (NSPS) for electric generating units (EGUs)	Electric power	EPA adopts NSPS requiring all new fossil fuel-fired electric generators to meet CO_2 emissions rates equal to 90% carbon capture starting in 2022
Existing Source Performance Standards (ESPS) for EGUs	Electric power	EPA adopts ESPS for CO_2 from all fossil fuel-fired power plants not subject to NSPS, with binding reduction requirements starting in 2026 and requiring an 80% reduction in covered emissions from 2005 levels in 2030
LDV GHG standards	Transportation	EPA adopts mobile source emissions standards that ramp down starting in 2023, achieving a 90 grams of GHG per mile standard for all new light-duty vehicles (LDVs) in 2030
MDV & HDV GHG standards	Transportation	EPA adopts mobile source emissions standards on medium and heavy duty vehicles (MDVs, HDVs) that require a 50% faster annual improvement in new vehicle emissions rates than current standards starting in 2028
NSPS for industrial sources	Industry	EPA adopts NSPS requiring all new chemical factories, liquified natural gas (LNG) import/export terminals, and petroleum refineries to meet CO_2 emissions intensities equal to 90% carbon capture starting in 2022-2023, depending on the source category
ESPS for industrial sources	Industry	EPA adopts ESPS on GHGs from chemical factories, LNG terminals, and refineries not subject to NSPS, with binding carbon capture requirements on certain equipment phased in starting in 2027-2028
ESPS for oil and gas production	Fossil fuel production	EPA adopts ESPS on methane emissions from all existing oil and gas production not subject to EPA's recently reinstated NSPS rules starting in 2025.
Minimum equipment performance standards	Buildings and industry	Exercising Energy Policy and Conservation Act (as amended) authorities to adopt ambitious minimum efficiency standards for covered equipment that prioritize emissions reductions.
Commodities Credit Corporation funding	Carbon removal	Leveraging discretionary spending under the Commodities Credit Corporation to support implementation of climate-smart agriculture and forestry practices on private lands

the authorities can target large emissions sources or large opportunities for carbon sequestration and GHG mitigation in agriculture. Third, technologies exist and have been demonstrated to work that can be used to justify ambitious actions within these policy pathways. Finally, the current administration has stated or signaled that it intends to use these authorities in some fashion.

We don't consider actions that are not likely to yield material amounts of emissions reductions to contribute to closing the 2030 emissions gap, such as banning new fossil fuel leases on federal lands. We also don't include actions that rely on authorities where the current administration has taken steps to not exercise such authority to cut emissions, such as full enforcement of the Renewable Fuels Standard. That said, just because an action is not included in our joint action scenario does not mean it cannot contribute to even more emission reductions at some point in the future.

States and corporations lend a hand

Federal agencies aren't the only actors that can cut emissions alongside Congress. For the joint action scenario, we also consider actions that can be taken by leading states and corporations to cut emissions. We define leadership states as the 25 members of the US Climate Alliance that have committed to reduce collective GHG emissions by at least 50-52% by 2030. We focus on actions that have been implemented by states under existing authority and expand them across all leading states. We also accelerate key corporate clean energy targets. We include detailed policy descriptions in the Technical Appendix, but we outline key leading state and corporate actions by sector in Table 3.

Putting it all together

We aggregate all of the policy actions described above in our joint action scenario and model it in RHG-NEMS. Our approach allows for detailed consideration of each policy and how they interact with each other across the US energy system and economy. This integrated, policy-focused approach allows for a comprehensive view of the GHG emissions impacts of the joint action scenario as well as other energy system and environmental impacts. In the next chapter, we consider the results of our modeling and what it means moving forward.

TABLE 3
Subnational policies in the joint action scenario

Policy	Target Sector	Description
Clean electricity standards (CES)	Electric power	Leadership states set 100% clean electricity standards by 2035
Utility clean power targets	Electric power	Utilities with 100% clean energy targets accelerate targets by 2035
LDV ZEV Mandate	Transportation	Leadership states require 100% zero emission light-duty vehicle sales by 2035
MDV/HDV ZEV Mandate	Transportation	Leadership states require 100% zero emission medium-and heavy-duty vehicle sales by 2045
Low-carbon fuel standards (LCFS)	Transportation	Leadership states adopt a Low Carbon Fuel Standard reducing carbon intensity of fuel by 20% by 2030
VMT management	Transportation	Leadership states direct new congressional funding to reducing vehicle miles traveled (VMT)
Methane abatement	Agriculture and waste	Leadership states take actions to reduce agricultural and waste methane 40% from 2013 levels by 2030
N_2O abatement	Agriculture and waste	Leadership states reduce N_2O via changes to crop management practices
EERS	Buildings	Leadership states adopt and revamp Energy Efficiency Resource Standards (EERS) to achieve 2.5% electricity savings and 1.25% natural gas savings annually

CHAPTER 4

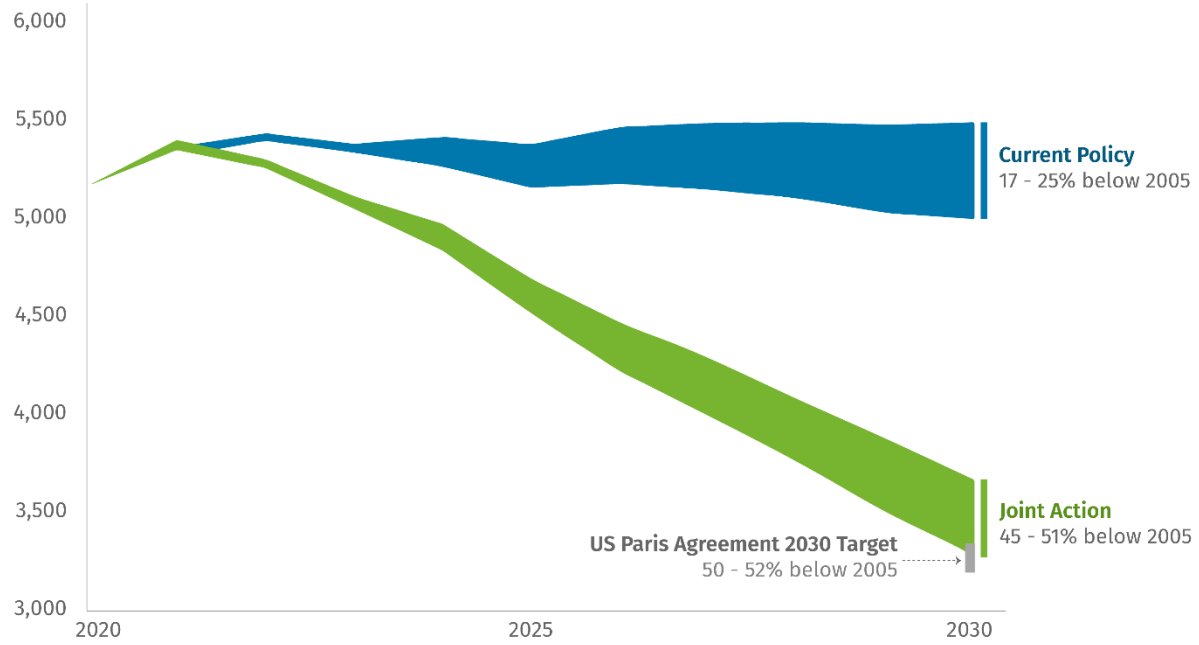
Delivering the 2030 Target

The measures we consider in our joint action scenario represent a step-change in US action on climate change. At the same time, all actions rely on policies and authorities that are well-known with actors who have prior experience in design and implementation. Now it's time to consider what these actions can deliver.

50-52% by 2030 is achievable

Assuming leaders in the White House, key agencies, state capitals, and corner offices have the political will to act ambitiously, *and* both the congressional infrastructure bill and budget package become law, we find that reducing emissions 50% by 2030 is within reach. Under the joint action scenario, US net GHG emissions are 3.3-3.7 billion metric tons in 2030, or 45-51% below 2005 levels (Figure 4.1). The range here and throughout this report reflects uncertainty around fuel prices, technology costs, and land use.

FIGURE 4.1
US net GHG emissions trajectory, 2020-2030
Million metric tons of CO_2e



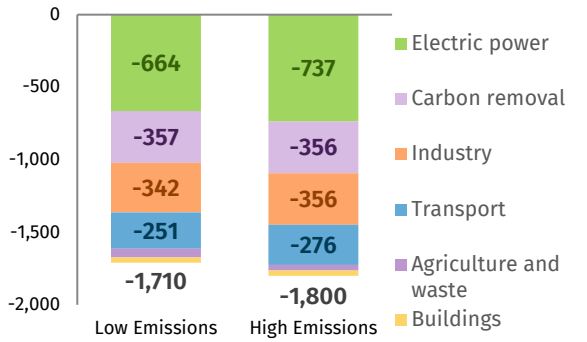
Source: Rhodium Group

Cutting emissions across the economy

Congressional investments complemented by regulations and actions taken by agencies, leading states, and companies push emissions down in every major sector of the economy (Figure 4.2). Some actions, such as EPA's ESPS in the electric power sector, overlap with tax credits, grid and carbon capture investments contained in the budget and infrastructure packages. Such overlap reinforces emission reductions and serves as a hedge to counter market headwinds that may arise if natural gas prices are lower or clean technologies are more expensive than we anticipate in our uncertainty range.

Our results demonstrate that achieving the 2030 target will require substantial emission reductions across the economy. There is no single sector that delivers all the tons needed to meet reduction goals. If one sector is left alone, then the NDC won't be achieved without even more reduction efforts in other sectors.

FIGURE 4.2
Emission reductions from the joint action scenario, 2030
Million metric tons of CO_2e from current policy



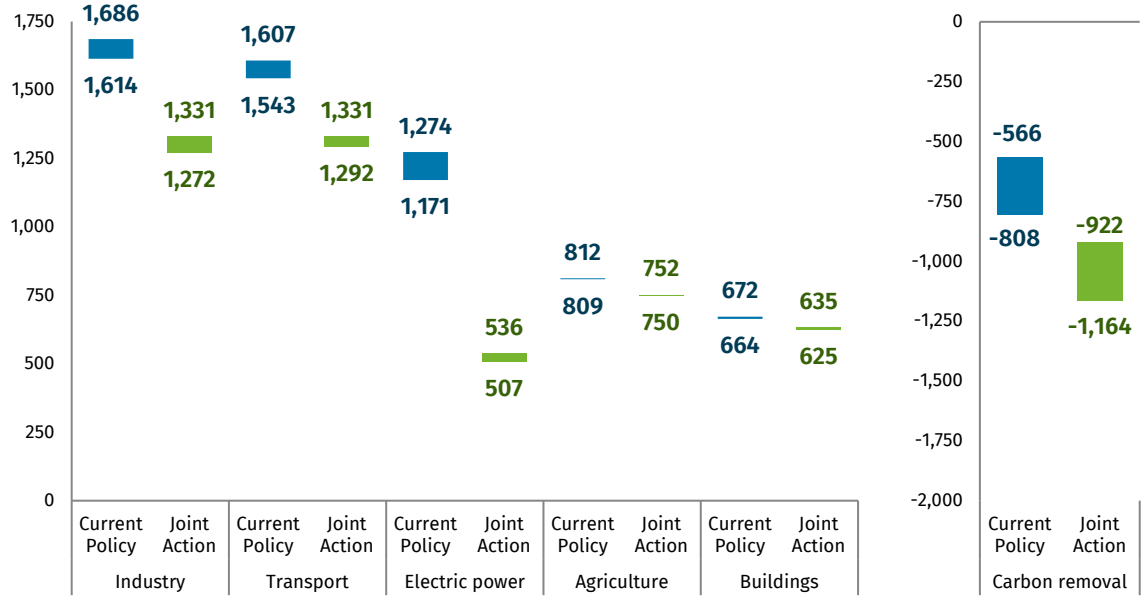
Source: Rhodium Group

This means that some sectors traditionally viewed as hard to abate or politically tough to address, such as the industrial sector, will have to play a role in meeting the target in some fashion.

The power sector delivers the biggest reductions

While every sector needs to play a role in achieving the 2030 target, the electric power sector delivers an outsized share of total emission reductions—roughly double the amount of 2030 abatement than any other sector (Figure 4.2). In the joint action scenario, electric power emissions in 2030 are 507-536 million tons, 57-58% lower than under current policy (Figure 4.3). The executive branch action of prohibiting the construction of new fossil fuel-fired power plants that are not equipped with at least 90% carbon capture substantially reduces the amount of uncontrolled natural gas plants that get built in the 2020s. Meanwhile, ESPS on existing fossil plants drives additional coal capacity off the grid. Our ESPS ambition is set by using EPA's previous "outside the fence line" Best System of Emission Reduction (BSER) framework from the Obama-era Clean Power Plan, updated with current input data, and assumes any new clean generation anywhere in the continental US can displace fossil generation. An alternative "inside the fence line" approach to the same 2030 ambition level could set a schedule for fossil plants to retrofit with carbon capture or retire over a ten-year period starting in 2026, while front-loading the largest, most carbon-intensive plants that are closest to CO_2 storage sites.

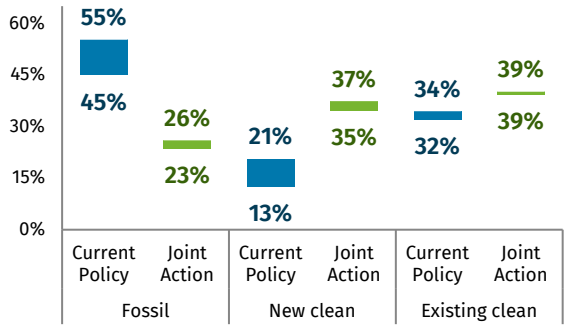
FIGURE 4.3
US GHG emissions and removal by sector, 2030
Million metric tons of CO_2e



Source: Rhodium Group

On the congressional front, enacting a well-designed clean electricity tax credit package this year should make it easier for EPA to pursue ambitious new and existing source regulations. We have previously shown that an enhanced framework that provides long-term incentives at $25/MWh for production of clean electricity or 30% of investment costs for such facilities, flexibility for developers to choose the best credit regardless of technology, direct pay provisions, and incentives to retain existing clean resources can cut emissions substantially on their own before regulations are considered. They can also create hundreds of thousands of jobs. Federal incentives for new and existing clean generation and carbon capture can reduce compliance costs associated with meeting federal rules and may expand the set of cost-effective emission reduction measures EPA considers as it determines what constitutes BSER.

FIGURE 4.4
US electric generation, 2030
% of total electric consumption



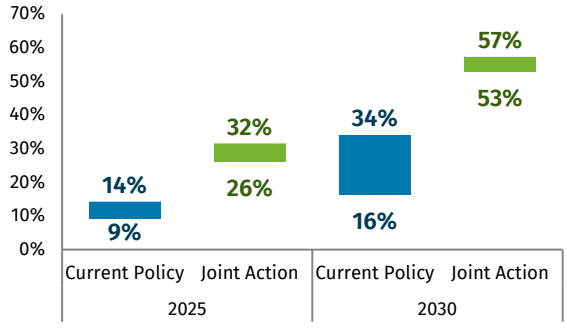
Source: Rhodium Group. Note: totals include distributed PV and new clean includes roughly 1% of total generation coming from fossil plants equipped with carbon capture representing 17-21 GW of fossil capacity with carbon capture

States and corporations can complement tax credits and federal regulations through stepped-up voluntary clean power goals by leading utilities as well as end-use efficiency investments and more ambitious clean electric standards in leadership states. All of these actions combined shift the US electric mix in 2030 towards more clean generation. Electricity from uncontrolled fossil plants declines to 23-26% of total electric generation compared to 45-55% under current policy (Figure 4.4). Meanwhile, new clean generation consisting mainly of wind and solar increases to 35-37% of total generation, roughly double what occurs under current policy. Finally, more existing clean generation stays online in the joint action scenario and contributes 39% of total generation instead of 32-24% under current policy. Altogether, the US achieves 72-74% clean generation in 2030 under the joint action scenario compared to 45-55% under current policy.

On a path to 100% EVs

Looking at transportation, tackling emissions from multiple angles drives results. On the executive front, EPA light-duty vehicle regulations ratchet down GHG emissions from new vehicles at an average rate of 8.5% per year, the most ambitious improvement rate ever pursued by the agency, to meet a 90 grams/mile average in 2030. This is complemented by long-term federal EV tax credits and charging network investment in the congressional budget and infrastructure packages respectively. In 2030, EVs make up 53%-57% of total light-duty vehicle sales (Figure 4.5), a step-change in deployment compared to the 16%-34% EV sales shares under current policy. In the joint action scenario, the US is on a path to 100% light-duty ZEV sales in 2035.

FIGURE 4.5
US EV sales, 2025 and 2030
% of total light-duty sales



Source: Rhodium Group

On top of accelerated electrification of light-duty vehicles, the joint action scenario includes actions by leadership states to leverage federal infrastructure investment to reduce travel demand and broader adoption of low carbon fuel standards. Both actions tackle fuel consumption of internal combustion vehicles on the road in 2030 whereas electrification

takes time as vehicle stock turns over. The end result is US transportation emissions are 1,272-1,331 million tons in 2030—a 16-17% reduction compared to current policy (Figure 4.3).

A push toward decarbonized industry

In the joint action scenario, industrial emissions drop to 1,272-1,331 million metric tons in 2030, a 21% cut compared to current policy. This decarbonization progress hinges on two key policies. The first is executive branch action led by EPA which promulgates new and existing source performance standards on the fastest growing and largest emitting sub-sectors--chemical manufacturers, refineries and LNG terminals. To date, EPA has not taken steps to regulate GHGs from industrial sources other than the oil and gas industry. While politically challenging, we find that EPA will almost certainly have to quickly regulate new and existing source standards in these industrial categories to achieve the 2030 NDC.

EPA does not regulate in a vacuum, and the second key policy change driving large-scale carbon capture deployment is congressional extensions and enhancements to the section 45Q carbon capture tax credit. Incentives for clean hydrogen production and other clean fuels and new programs for carbon capture infrastructure deployment in the infrastructure and budget packages should allow for faster, easier and more affordable compliance by industry. If a border adjustment mechanism is included in the budget package, concerns around international competitiveness may also be allayed. Meanwhile, major oil and petrochemical companies are investing heavily in carbon capture technology and appear ready to meet the challenge.

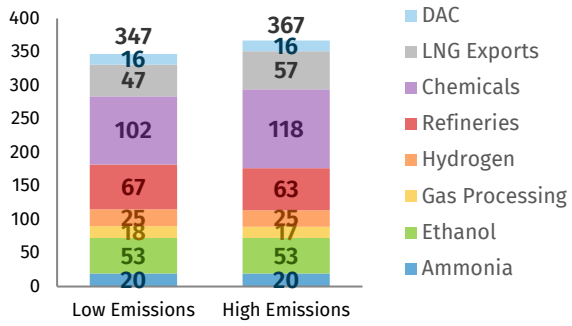
Taken together, these policies can accelerate carbon capture deployment in the US. By 2030, 347-367 million metric tons of industrial carbon capture and direct air capture capacity are installed under our low and high emissions scenarios (Figure 4.6). The rate of scale-up is comparable to US utility-scale solar scale-up in the early part of the last decade or land-based wind in the mid-2000s. Nearly all of this capacity is installed in an array of industrial applications. Enhanced tax credits for direct air capture (DAC) drive initial commercial scale-up of that technology to 16 million tons of capacity. Both investment in industrial carbon capture and DAC have the potential to create thousands of jobs per project.

Achieving such a high level of capture deployment will only be possible if permitting capacity is greatly expanded and investments in pipeline infrastructure and injection sites scale up concurrently. All of these activities are supported by new programs and funding in the infrastructure package. We also expect that the geographic distribution of key industries, especially chemical manufacturing and refineries, will lead to the development of clusters of capture facilities in places like the Gulf Coast, which will further ease infrastructure constraints. These levels of deployment represent important progress for key technologies that we and others have found will be important for achieving net-zero emissions by mid-century.

FIGURE 4.6

Industrial carbon capture and direct air capture capacity, 2030

Million metric tons of capture capacity



Source: Rhodium Group

ESPS on methane from oil and gas production also cuts industrial emissions. GHGs from these sources are 48 to 49% lower than under current policy where current new source standards are already in place.

Carbon sequestration in farms and forests

The congressional budget package includes historic investments in forest restoration on private, public, and tribal lands and in urban forests, as well as a $28 billion

influx of funds to climate-smart agriculture through existing programs, refocused on carbon sequestration through 2026. We include these investments in our joint action scenario and assume funding is sustained through 2030. We estimate carbon removal potential from a subset of proposed expenditures across agencies that can be reliably tied to increases in carbon sequestration.

The executive branch can use its authority to focus the Commodity Credit Corporation (CCC) discretionary spending on climate-smart agricultural practices and operational changes that would result in carbon removal and GHG reductions. Our analysis assumes that all of these funds will be directed to increasing carbon removal. In practice, these funds could also support other GHG reductions in the agriculture sector as well. Moreover, the USDA has the discretion to prioritize climate-friendly activities through these payments. In the joint action scenario, we include a steady ramp-up in CCC carbon removal investment from zero today to $9 billion in 2030. The combined impact of all of these investments increases US natural carbon removal to 902-1,144 million tons in 2030 (Figure 4.3), a 42-60% improvement compared to current policy. While this progress is significant, it does not max out the available acreage or biogenic limits of carbon removal from US forests and croplands. Additional actions by leadership states to tackle agricultural GHG emissions can start to drive down emissions from livestock and manure management.

Modest decline in the buildings sector

Finally, we find that direct emissions from buildings change modestly in the joint action scenario. Tax incentives, grants, and appliance standards for more electrified and efficient equipment, stepped-up investments in federal efficiency programs and ramped up energy efficiency spending in leadership states do make buildings more efficient and in turn cut emissions to 625-635 million tons in 2030, a reduction of 6% compared to current policy in 2030. However, most of the actions target new equipment and do little to address emissions from existing furnaces, boilers, water heaters, and stoves.

Moreover, nearly all of these actions do not accelerate the pace of all electric equipment adoption because they are designed to foster energy savings not emission reductions. While the US electric grid gets cleaner, tax incentives and state efficiency programs do nothing to leverage these clean electrons to cut building emissions. Instead, tax incentives and rebates are made available to buyers of new equipment on essentially a fuel-neutral basis. Federal dollars cut the cost of efficient electric equipment and efficient fossil equipment even though the latter may well still be emitting come mid-century. These fossil fuel subsidies embedded in efficiency programs represent a missed opportunity to foster switching from fossil fuel-fired equipment to electric heat pumps and other clean technologies.

DOE has little latitude to eliminate whole fuel classes of equipment from its appliance standards regulations. Meanwhile, municipal and state new building natural gas bans are proving to be contentious and have yet to add up to material national emission reductions. New policy solutions are needed as are revisions to appliance standard authorities and tax incentives to focus on electrification or else risk further fossil lock-in and a harder task of decarbonizing buildings down the road.

Climate action cuts harmful air pollution

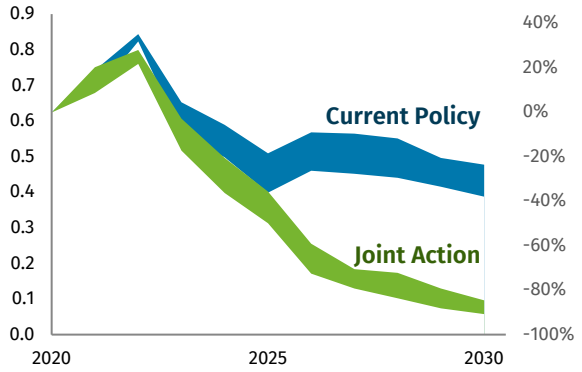
Tackling GHG emissions can also deliver major public health benefits over the next decade. While reductions in uncontrolled fossil fuel combustion across the energy system reduce emissions of conventional pollutants, the biggest reductions occur in the electric power sector. Historically the sector has been the largest source of SO_2 and NO_x. SO_2 pollution causes asthma attacks and other serious health problems, especially for people living near emissions sources. NO_x does the same while also contributing to ground level ozone, a pollutant that leads to unhealthy air in the summertime for over 125 million Americans.

The EPA GHG regulations and the congressional extension of clean energy tax credits in the joint action scenario all but eliminate electric power SO_2 emissions by the end of this decade (Figure 4.7). Under current

policy, SO_2 emissions decline through 2025 but then progress stalls out at 24-38% below 2020 levels in 2030. New clean generation in the joint action scenario displaces fossil and more than doubles this progress, pushing emissions down to 86-89% below 2020 levels. Most of these gains occur by 2025.

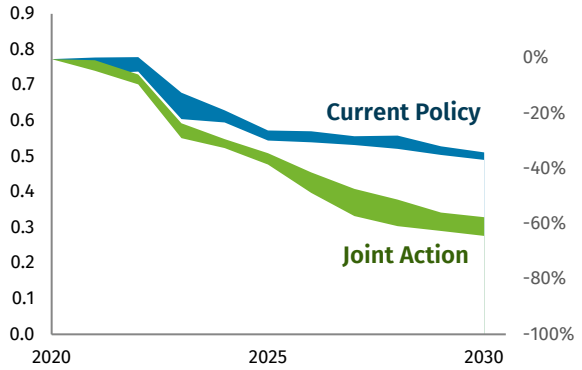
The joint action scenario drives important progress in cutting power-sector NO_x emissions as well. Under current policy NO_x declines by 35% below 2020 levels in 2030 with most of that occurring by 2025. Clean generation pushing out coal and natural gas cuts NO_x emissions down to 59-63% below 2020 levels by the end of the decade (Figure 4.8). These outcomes should help to prevent children from getting sick, costly hospital visits, and premature deaths thanks to a cleaner grid.

FIGURE 4.7
SO_2 pollution from the electric power sector
Million metric short tons (left), change from 2020 (right)



Source: Rhodium Group

FIGURE 4.8
NO_x pollution from the electric power sector
Million metric short tons (left), change from 2020 (right)



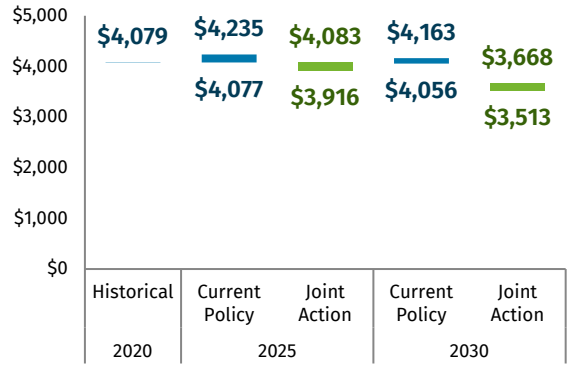
Source: Rhodium Group

Consumers see energy costs drop

Opponents of ambitious climate action often raise the specter of higher consumer energy costs as a way to erode public support. They warn that any new policies that shift consumption away from cheap fossil fuels will inherently hit households with higher heating and electric bills and higher gasoline prices. We find that the opposite is true in our joint action scenario.

There are costs associated with cleaning the grid and regulating GHGs from power plants, vehicles and natural production. But consumers are cushioned from these costs due to three factors. First, tax credits included in the congressional budget package subsidize compliance and reduce the amount of costs passed on to consumers. Instead, these compliance costs are shifted from consumers to the federal treasury. Second, investments in energy efficiency reduce the amount of energy consumers use to heat their homes, get to work, and power office buildings. Finally, as the electric power sector shifts away from fossil fuels, lower natural gas demand leads to lower natural gas prices for all sectors of the economy. The result is that in 2030, national average annual household energy costs are $411-$566 lower than they were in 2020 and roughly $500 lower than under current policy (Figure 4.9).

FIGURE 4.9
Household annual average energy expenditures
2020 US dollars



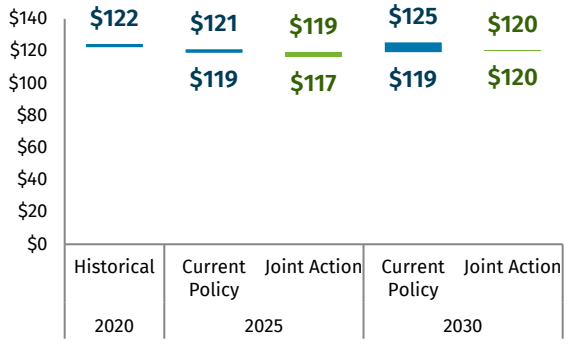
Source: Rhodium Group

In the electric power sector, household bills stay effectively flat in the joint action scenario, despite increased electricity demand from electric vehicles. As the grid gets cleaner thanks to clean energy incentives

and stringent regulations on new and existing power plants, monthly households see bills decline thanks to the same three factors. In 2030, households' electricity bills average $120 a month—$2 lower than today and between $1 more and $5 less than under current policy (Figure 4.10).

Of course, there will be variation in cost impacts across the country given the diverse nature of the energy system. Still, it's clear that substantial gains can be made in decarbonization without a major burden on households. These outcomes are contingent on passage of the congressional budget package. Without the substantial incentives contained in that legislation, our results would be very different.

FIGURE 4.10
Household monthly average electricity bills
2020 US dollars



Source: Rhodium Group

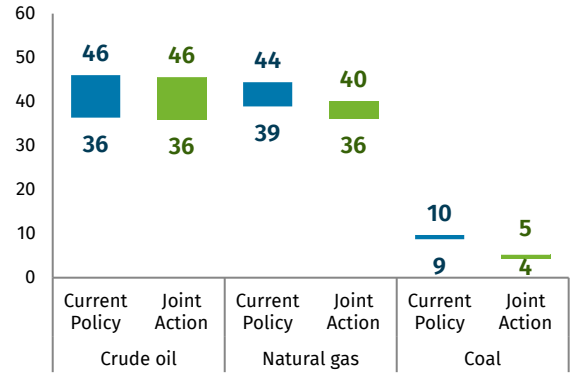
US fossil fuel production

Key members of Congress advocate for a response to climate change that relies on innovation rather than the elimination of fossil fuels. We find that the suite of policies and measures in the joint action scenario put the 2030 target in reach without eliminating the domestic production of coal, oil, or natural gas. Nearly all of the investments, incentives, and regulations we consider in this analysis reduce demand for fossil fuels across the economy. The exception is ESPS on methane from oil and gas production, which marginally increases production costs but not substantially.

Lower fossil fuel demand does not fundamentally alter US production of oil and natural gas. In 2030, crude oil production is essentially the same in both the current policy and joint action scenarios (Figure 4.11). While EVs takeoff through 2030 and displace gasoline, this decline is balanced with modest increases in petroleum exports. The US is also less reliant on oil imports in the joint action scenario.

Cuts in natural gas demand, especially in the electric power sector, do cause natural gas production to decline by roughly 10% compared to current policy, from 39-44 Quads to 36-40 Quads. Even with ambitious electric power sector regulation, 2030 US coal production is 4-5 Quads in 2030, which is a 50-56% decline compared to current policy.

FIGURE 4.11
US fossil fuel primary energy production, 2030
Quads



Source: Rhodium Group. Note: Crude oil includes natural gas plant liquids.

Congress's role in achieving the 2030 target

As of the time of publication in mid-October, we do not know if the budget package and infrastructure bill will get over the finish line. While the infrastructure bill contains important investments in RD&D and enabling policies for accelerating decarbonization, the budget package contains the lion's share of Congress's contributions to getting to the 2030 target.

It's reasonable to expect that if Congress fails to act, reaching the 2030 target will be far more challenging for two reasons. First, Congress will leave a considerable amount of potential emission reductions on the table that will have to be made up through the pursuit of even more ambitious policies by agencies and subnational

actors. For example, every emission ton lost due to the absence of long-term renewable tax credits will need to be made up in the ambition of electric power NSPS and ESPS. This also raises the stakes associated with such regulations, as there are fewer backstops and risk hedges from policy overlap.

We previously found that six big ticket items currently under consideration for inclusion in the budget package could cut emissions by nearly a gigaton in 2030—roughly half of the emissions gap. These six items are clean electricity and electric vehicle tax credits, rural cooperative clean energy investments, a Clean Electricity Performance Program, a methane fee, and investments in soil and forest carbon removal. If Congress does succeed in passing the budget package and all of these programs or other programs are included, reductions from legislation could be far greater than we show here. Analyses published by Senator Schumer's office and others find that to be the case. If Congress passes an even smaller budget package where, for example, the duration of tax credits is less than ten years or the incentive values are lower than we consider, then reductions could be smaller. We do not estimate the impacts of the congressional components of the joint action scenario alone due to the uncertainty around what a final package might contain. When Congress does pass the budget package, we will publish estimates of what the final package will deliver.

The other reason why a lack of congressional action could jeopardize achievement of the 2030 target is the fact that tax credits and other incentives in the budget package lower the compliance and consumer costs associated with policy actions taken by agencies and states. Without these incentives, it's reasonable to expect that federal regulators and state officials will be less enthusiastic about pursuing all of the regulations we include in our joint action scenario at the levels of ambition necessary to put the 2030 target within reach. EPA, DOE, and leading states may choose to pursue fewer regulations and lower ambition for the actions they do pursue compared to what we consider in the joint action scenario. It's much easier to envision EPA regulating GHG emissions from refineries when entities can get an $85/ton tax credit for employing carbon capture for compliance than without that support. Likewise, it's easier to envision more states adopting 100% zero-emission vehicle (ZEV) targets if every EV buyer can get $7,500 or more in federal subsidies.

Long-term incentives provided by congressional action also create a fundamentally different political landscape for agencies and states to pursue regulations that are far more ambitious than previous efforts. It should be politically and economically easier to justify more ambitious GHG regulations if the federal government is subsidizing the technologies needed for compliance through tax credits and grant programs. This is the case for nearly all EPA and DOE regulations and some state programs considered in the joint action scenario.

How certain can we be about reaching the 2030 target?

Now that we have demonstrated that a combination of congressional legislation, executive branch regulations, and subnational leadership can put the 2030 target within reach, it is worth considering what can change our estimates. Our emissions ranges reflect technology, energy market, and land-use uncertainty. If the US ends up on the pessimistic (more expensive clean technologies, lower fossil fuel prices, declining land-use sequestration) end of this range, then additional actions beyond the ones we consider in the joint action scenario will be necessary to make sure the 50% target is reached. At the same time, if the US is on the more optimistic (cheaper technologies, more expensive fossil fuel prices, and static land-use sequestration) end of this range, then pursuit of all the components of the joint action scenario should be enough to put the target within reach. There are other important factors that can influence the trajectory of US emissions under the joint action scenario.

Legislative risk

As of the time of publication in mid-October, we do not know the final text of the budget package while the

infrastructure bill is set in stone. The White House as well as House and Senate leadership are now negotiating top-line spending levels and determining what programs will make it into the budget package. If the final budget package does not contain a full spectrum of investments and programs like what we consider in our scenario, then the contribution towards meeting the 2030 target will be smaller. The reverse is also true—Congress could include more ambitious policies than we consider here that could potentially lead to even greater emission reductions than what we've shown.

Beyond political uncertainty, there's the possibility that some programs in either package do not work as intended. There are almost no mandates or regulations in either package. The nature of the budget process means the package consists mostly of incentives, direct funding, and other investments that can drive decarbonization, but outcomes are not guaranteed. In this analysis, we account for much of this uncertainty through a range of market and technology cost assumptions. Still, the future will always be uncertain to some degree.

It's important that beyond drafting effective legislative text, the Biden administration implements both bills as quickly and carefully as possible to make the most of the opportunity and to flag course corrections for Congress if needed. The quicker these policies are in place, the higher the chance of success in cutting emissions.

Ambition risk

Just because an agency has the authority to regulate or political leaders in a state have the will to put in place new policies, that doesn't mean those policies will be sufficiently ambitious to help get the US to its 50% target. The cost and performance of commercial and emerging clean technologies is improving so fast that regulators may not take such developments into account when setting new rules, missing important opportunities to cut more emissions. Moreover, agencies and states have rarely acted in an environment where long-term, substantial tax credits and grant programs can subsidize the costs of compliance. Regulators will need to recalibrate for this new landscape and rewrite the ambition playbook for the decade ahead. As a case in point, the original Clean Power Plan was intended to cut electric power sector emissions by 32% below 2005 in 2030. The ESPS we include in the joint action scenario achieves an 80% cut in electric power sector emissions, with little impact on national average household electric bills, thanks in part to congressional investments in clean energy. If regulators instead set rules based on stale historical data and no regard for the new long-term incentives in place, then there is a real risk that new rules will not be sufficiently ambitious to close the emissions gap.

Legal risks

Nearly every time a federal agency promulgates a new regulation, a concerned party launches a legal challenge. This is the case even when the authorities used by the agency rest on settled law backed by numerous precedents. Some lawsuits delay regulations while others have little impact. Some of the regulatory actions contained in the joint action scenario rely on authorities that have been used infrequently over the 40+ years that the Clean Air Act has been in place. This presents more legal uncertainty around the boundaries of what's possible for EPA in constructing regulations such as ESPS under section 111d. We constructed our assumptions based on current technology costs and performance data and constrained interpretations of what is required under 111d. While we believe our scenarios are reasonable, we are not legal experts nor are we Supreme Court justices that may have the final say on whether a regulation will stand or not.

If a regulation incurs a substantial legal challenge, there is a risk that implementation may be delayed, reducing the chance of achieving 50% in 2030. Worse, a rule could be remanded back to the originating agency where it will need to start the process over again from scratch. Any actions by agencies to promulgate rules in line with achieving the 50% target will need to be on solid legal footing.

Election risks

If recent history tells us anything, it's that elections matter and their outcomes can lead to big shifts in the political landscape. 2020 ushered in a new unified federal government that is prioritizing climate action. There is no reason to assume a repeat in 2022 or 2024. Many of the executive branch actions in the joint action scenario will require sustained implementation after the end of President Biden's current term. If the White House changes hands and a new president chooses to roll back new climate rules, that alone could delay action enough to put the 2030 target out of reach. There will be almost no time left to make up for lost progress.

This same risk applies at the state level. Leadership states are driven by climate-conscious governors and legislatures. If an election shifts control to new leaders who don't make climate a priority, then the emission reductions we estimate from subnational action may be lower. The reverse is also true. If a large emitting state not considered a leadership state in our analysis were to make climate change a priority, then there is a chance of more emission reductions materializing from subnational action.

Technology risks

Finally, some of the emission reductions in the joint action scenario hinge on the rapid scale-up of key clean energy technologies and their underlying infrastructure. If carbon capture, batteries, renewables, or other technologies do not scale as fast as they do in our modeling, other actions will need to be pursued to make up the difference. The investments and programs in the infrastructure and budget packages should reduce this risk to a large degree.

An achievable, but challenging, race ahead

Our joint action scenario demonstrates that a series of policy actions by Congress, agencies, and subnational actors can put the US within reach of its 2030 climate target. It shows how a combination of actions across all levels of government can get to the goal. What it can't show is the level of sustained political will and effort required to make sure everything goes the right way at every point in the process from here to 2030. Achieving the 2030 target will require a long-term, coherent, and ambitious series of actions reinforced by civil society pressure and acceptance by reluctant actors in the private sector. Without a continuous, sustained push, achievement of the target may not happen.

CHAPTER 5

Additional Policy Opportunities

In the event that not all policies considered in our joint action scenario are pursued, or if they are pursued but they come up short due to legal challenges or implementation delays, there are other policies we do not model that have the potential to help achieve the 2030 target. For the most part we did not include these policies because they either are not firmly part of the legislative debate or they present more challenges and complexities for agencies and states than the policies we do consider. Still, a qualitative assessment of options is useful should additional ideas be needed to get to 50% or opportunities arise to push past it.

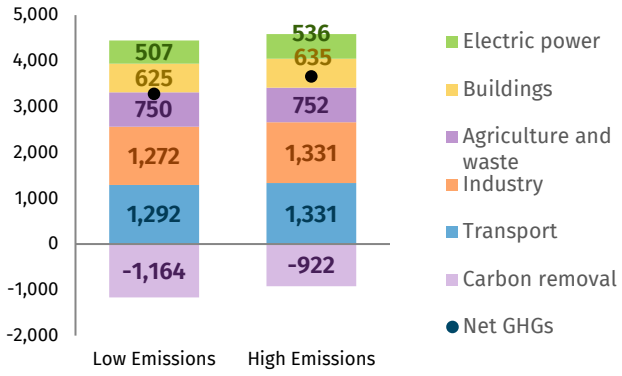
We break down policy options based on where they interact with the economy and energy system and then discuss what they could look like if pursued by different actors. Before we do, it's worth reflecting on where emissions are across sectors in our joint action sensitivity scenarios. Over the next decade, we find that the electric power sector becomes the smallest emitting sector behind buildings and agriculture. Industrial and transportation emissions are neck and neck in 2030, and combined account for 58% of US emissions (Figure 5.1). Climate action beyond our joint action scenario must focus on these highest emitting sectors.

Economy-wide

A carbon price, applied to key sectors or across the entire economy, has been seen as the most efficient and straight-forward way to tackle climate change. A carbon price can amplify the impact of clean energy incentives included in our joint action scenario and sends a long-term signal for investors to shift towards a net-zero economy.

A carbon price is not a new idea. The European Union's program and the power sector focused Regional Greenhouse Gas Initiative (RGGI) in the Northeast have both been in operation over a decade, and California's program is the foundation of its approach to climate action. Despite a plethora of legislative proposals in Congress, a carbon price has not gained political traction at the federal level.

FIGURE 5.1
US net GHG emissions, 2030
Million metric tons of CO_2e



Source: Rhodium Group

EPA does have authority under section 115 of the Clean Air Act to require states to implement pollution reduction plans in line with international commitments. EPA may be able to use this authority to impose a federal cap-and-trade program as part of its efforts to meet the 2030 target, which is a commitment under the UN Framework Convention on Climate Change. While some have found that using this authority could drive deep emission reductions, the process, potential ambition and timing associated with pursuing this path is not clear as section 115 has rarely been used. This also means that what constitutes a legal use of section 115 has not been tested in the courts.

States can also expand their use of carbon pricing to help cut US emissions. RGGI could expand to include more states or sectors. More states could adopt California's approach. Some states are contemplating a regional cap on road fuel emissions through the Transportation Climate Initiative. Thoughtful expansion of the use of carbon pricing should yield

incremental emission reductions beyond our results or reduce the need for other measures.

Congress can also enact a carbon price as part of the budget package or in future legislation. Previous Rhodium Group research found that the lowest and highest carbon tax rates contained in recent congressional proposals could cut energy CO_2 emissions by 33-41% below 2005 levels before any other additional measures are pursued.

Resource restrictions

For at least the last few decades, environmental advocates have continuously advocated for restricting fossil fuel leasing on public lands and blocking new fossil fuel infrastructure. The Biden administration heeded their call in freezing new leases of oil and gas on public lands during its first 100 days in power. Fights continue on permitting oil and gas infrastructure across the country.

As we note in the previous chapter, with the exception of coal, US fossil fuel production is little changed in the joint action scenario. While lease restrictions may constrain fossil fuel supplies over multi-decade timeframes, they will do little in the next ten years to change market dynamics and reduce GHG emissions. This is because of the fact that the vast majority of fossil fuel production in the US is not on public lands, and it will take at least a decade to unwind currently held leases. Any public land restrictions will shift production to private lands with little change in the supply or price of fossil fuels. Restricting infrastructure build-out may cause local fossil fuel price increases, but it is unlikely to be big enough to shift emissions in the right direction.

That's not to say that either action has no environmental benefits. Reduction in fossil fuel production on public lands limits land and water impacts associated with drilling and mining. Infrastructure has its own land and water impacts. Both have legacies of undue impacts on disadvantaged communities. For these reasons and others, such policies may be worth pursuing but neither is likely to lead to GHG emission reductions anywhere close to the magnitude of the policies considered in our joint action scenario.

Clean fuels

Transportation remains a leading source of emissions under our joint action scenario in 2030, with electric vehicles making up 53-57% of new vehicle sales. Clean fuels policies can accelerate emission reductions and improve air quality where electrification will take time to deliver because of the slow turnover of vehicle stock or where electrification may not be feasible.

Existing state and federal clean fuel policies have garnered bipartisan support and driven investment in low carbon technology and innovation. Since 2005, the Renewable Fuel Standard (RFS) requires the sale of a set volume of renewable transportation fuel to reduce fossil transportation fuel use. RFS fuel volumes are currently set through 2022. Enforcement of RFS volumes through the 2020s may lead to more biofuels displacing fossil and reduce GHG emissions. To date, the Biden administration has not taken actions to do so.

California, Washington, and Oregon have implemented technology-neutral Low Carbon Fuel Standards (LCFS) that reduce the carbon intensity of each state's transportation fuel. These clean fuel policies are part of the states' climate action portfolios and work in coordination with carbon pricing, vehicle standards, and incentives to achieve state climate targets.

EPA implements the RFS through section 211 of the Clean Air Act. EPA may be able to use this same authority to modify the RFS into a clean fuel standard (CFS)—a technology-neutral fuels program modeled on state LCFS programs that could also apply to aircraft and marine vessels. A CFS could accelerate development and deployment of low carbon fuels and support the Biden administration's goal of reducing aviation emissions.

In lieu of a federal CFS, additional states—beyond the leadership states considered in our joint scenario—could adopt LCFS programs. LCFS programs can also

be extended beyond the transportation sector to cover fuels used in the industrial, agriculture, and building sectors.

The expansion of technology-neutral clean fuels policy would complement our joint action scenario and provide additional emission reductions in 2030 and strong price signals for clean fuel deployment through mid-century.

Clean products

Industrial emissions also remain stubbornly high in our joint action scenarios. Though carbon capture and clean hydrogen help make a dent in the sector's emissions, industrial facilities remain heavily dependent on gas and, to a lesser extent, coal as both fuels and feedstocks in 2030. Electrification, novel low-carbon production processes, increased use of clean fuels, and amped-up carbon capture deployment are all technological solutions that can drive still greater GHG reductions in the industrial sector, but they will require policy support above and beyond what we've modeled here.

One such idea is low-carbon government procurement requirements, often called "Buy Clean." In such policies, government agencies are required to procure less GHG-intensive versions of products, often raw materials like steel and cement, and are permitted to pay a premium for such goods. The federal government is the single largest consumer of goods and services, and all levels of government taken together represent huge markets for materials used in building roads, bridges, public housing, and other large-scale infrastructure. By being early adopters and helping buy down some of the current increased cost of low-GHG products, governments can help to open wider markets for clean products.

The state of California currently has a Buy Clean requirement in place for key construction materials; other states could adopt such a policy, and all states could expand the list of covered products to be more comprehensive. At the federal level, the Senate budget instructions enumerated federal investment in green materials procurement as a priority for the $37 billion in spending allocated to the Homeland Security and Governmental Affairs committee.

To further drive industrial decarbonization, the federal government or states could implement clean product standards (CPS). In this policy, a government would establish a maximum level of GHGs that could be emitted in the production of a given product and ban the sales of products over that threshold. Over time, governments can lower these maximum levels. Though this novel and potentially ambitious policy hasn't yet been adopted, and there are numerous trade and administrative questions to iron out, it can provide the technology-neutral impetus required to achieve deep decarbonization in the industrial sector. A CPS will almost certainly require an act of Congress to authorize a federal program. Legislation will also be needed if a state decides to pursue the same.

Clean buildings

We find the least GHG abatement in our joint action scenarios in the residential and commercial buildings sector. Quite simply, policies in place today and being discussed in Washington and state capitals are largely insufficient in scope and design to make meaningful impacts. Clean energy in buildings has, for the most part, been focused on improving energy efficiency. But with an ever-cleaner grid, energy efficiency is no longer an unmitigated climate good—especially if investments support new, long-lived assets that will perpetuate the burning of fossil fuels for decades to come.

Congress can start to take action by adopting the electrification grants proposed as part of the House Energy and Commerce budget reconciliation bill. But these grants only provide $3.5 billion in total (with an additional $8.5 billion in grants provided for whole home efficiency retrofits, which could feasibly be leveraged in part for electrification as well), while the Center for American Progress and Rewiring America have estimated a federal government price tag of $265 billion between now and 2031 to fully replace key electric appliances in residential homes. State funding can help fill this gap as well, but more than an order of

magnitude increase is necessary to drive large-scale residential electrification. Similar programs are also necessary on the commercial building side.

Federal and state governments can also refocus existing programs to improve their climate impacts. Current tax provisions incent the deployment of both efficient gas and electric appliances, and 18% of annual state energy efficiency spending goes to lock in new gas-burning heaters, water heaters, and cooktops. To achieve deep decarbonization in the buildings sector, policymakers can redirect all funding to efficient electric appliances only. Smart electric efficiency investments can not only reduce overall electric demand, reducing the build-out of new clean generation required, but also support greater penetration of variable renewables by shifting load to periods of plentiful wind and solar.

Finally, municipalities, states, and the federal government can consider regulatory approaches to building decarbonization. One option for doing so is for EPA to use its authority under the Clean Air Act to restrict the sale of new fossil fuel furnaces and water heaters. Other options include bans on the sale of new fossil-fired appliances and on hooking up fossil fuel infrastructure for new residential and commercial buildings.

Conventional pollutant controls

Before climate change was identified as the global threat that it is, environmental policy was primarily focused on cutting emissions of harmful pollutants such as particulate matter, SO_2, and NO_x, as well as water pollutants and toxic wastes. Actions that drive further reductions in these pollutants can deliver major public health benefits, especially for disadvantaged groups. The same actions have the potential to cut GHG emissions.

Regulations that reign in pollution from new vehicles as well as new and existing power plants and factories can help accelerate demand for clean fuels and electric alternatives. They can also shift the economics for some sources where it makes more sense to retire instead of retrofit. For example, the Obama administration's Mercury Air Toxics Standards set stringent new emissions standards for coal and oil-fired power plants. Of the nearly 114 GW of plants subject to the standards that weren't already in compliance, 77% installed pollution controls while the remainder switched to natural gas or retired. The result was lower toxic pollutants and GHG emissions.

Active pursuit of new public health-focused regulations by federal and state agencies may help have the co-benefit of cutting GHG emissions and getting the US closer to achieving the 2030 target.

More ideas are welcome

When it comes to decarbonization, there will never be a shortage of demand for new policy ideas. Creative thinking on how to use existing authorities to accelerate emission reductions and on new approaches that can garner a broad enough base of support for passage and implementation will expand the toolkit available to current and future policymakers across the nation. Advocates, investors, academics, think tank scholars, and others should redouble their efforts to construct the next wave of base hit and home run policies. Doing so will increase the likelihood of accelerated action.

CHAPTER 6

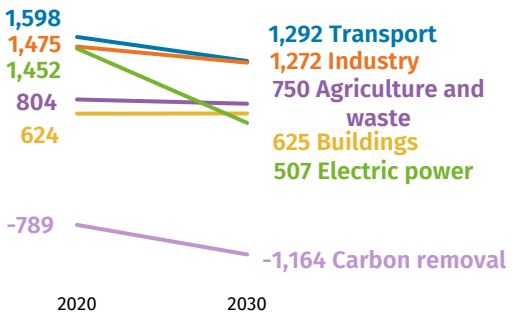
The Road Ahead

While doable, getting to the 2030 target will be a challenge. Success will set the US up for the even greater hurdle of achieving net-zero emissions by mid-century. Failure will make the next round of effort to reach net-zero over the subsequent 20 years even harder. In addition, it will make it more difficult to rally the international community to also do its share.

Beyond 2030 is a whole new ballgame

Assuming the US does achieve the 2030 target through policy actions that look similar to the joint action scenario, the opportunities for the next set of emission reductions will look very different from today.

FIGURE 6.1
Change in US sectoral emissions, 2020 and 2030
Million metric tons of CO_2e



Source: Rhodium Group

As we show in Chapter 4, getting to the 2030 target relies on harnessing cheap and fast emission reductions in the electric power sector supplemented by smaller contributions across the rest of the economy. In 2030, the largest emitting sectors, industry, and transportation, will make up more than half of total emissions (Figure 6.1). These two sectors also prove to be much harder to decarbonize than electric power. Tackling these emissions will require new strategies and technologies not commercially available today.

In the transportation sector, while light-duty vehicles may be on a path to near full electrification by 2050, batteries are unlikely to be enough to decarbonize heavy-duty trucking, marine shipping, and aviation. Wide-spread availability of clean fuels including synthetic fuels and advanced biofuels will be needed.

In the industrial sector, while it's already highly energy efficient and has plentiful opportunities for carbon capture deployment, industrial demand is expected to grow through mid-century. Meeting this demand sans emissions will usher in new low-carbon production processes including a role for clean hydrogen as a decarbonized feedstock and to provide the high-temperature heat needed for industrial production.

The same challenges apply to buildings. If the current slow pace of electrification continues, clean alternatives to natural gas such as synthetic gas will be needed to decarbonize this sector. In agriculture, low-GHG production processes for meat and dairy will need to be developed and scaled along with plant-based alternatives.

Electric power decarbonization will need to continue after 2030 to deliver the full potential from electrification of cars and buildings. To get at the last 20% of emissions reductions, the continued scale-up of renewables will be critical. As the grid becomes dominated by variable generation, clean, dispatchable assets like next-generation natural gas plants, advanced geothermal, advanced nuclear plants and long-duration storage (including hydrogen storage) will be needed to maintain balance on a daily and seasonal basis.

Finally, carbon removal will need to continue to scale to counter any remaining emissions by mid-century. This strategy will also be an important hedge should decarbonization efforts in other sectors fall short of what's needed. Natural solutions will continue to play a

role just as they do today but may hit land and biological limits while a changing climate may make the total carbon sink less reliable. This fact means technological carbon removal, such as bioenergy with carbon capture and storage (BECCS) and DAC with storage (DACS), will need to scale up from near zero today to gigaton scale over 30 years. In a net-zero America, carbon removal is not a free pass to emit, it's the lynchpin to getting to zero after all other efforts deliver the reductions they are going to deliver.

Tackling the green premium

An additional challenge is that most of the technologies needed to cut emissions in the 2030s and beyond are not affordable or commercially available at scale today. The green premium for hydrogen, clean fuels, clean dispatchable generation, DACS and other products and technologies is too high and the supply chains are unestablished. Without innovation and cost reductions through deployment and scale, the US will not have the tools it needs to get the rest of the way to net-zero by mid-century—at least not in an affordable manner.

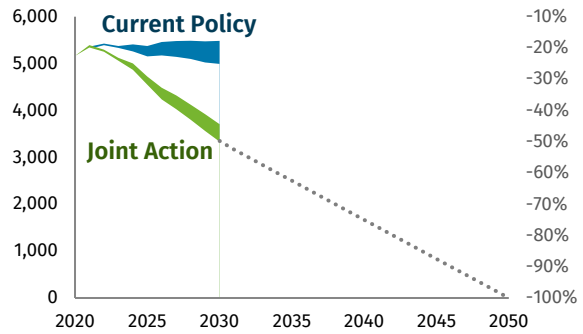
The good news is that all of these emerging clean technologies exist today at research and demonstration scales. The infrastructure and budget packages in Congress contain massive new investments in research and development and commercial deployment for all of these technologies. While they will play a small role in reaching the 2030 target, these investments will be critical to enabling the next wave of climate action later this decade and beyond.

Last, it's not just the emerging clean technologies themselves that are essential to our low-carbon future—the infrastructure that enables them is a monumental lift as well. The systemic build-out of transmission lines and carbon dioxide and hydrogen pipelines are examples of areas where extreme streamlining and coordination will be needed to achieve decarbonization goals within the first half of this century.

We will track the progress of these technologies and assess whether or not they are on track to meet the challenge ahead in a subsequent analysis.

Post-2030: a more moderate pace

FIGURE 6.2
US net GHG emissions trajectory, 2020-2050
Million metric tons of CO_2e (left), change from 2005 (right)



Source: Rhodium Group analysis

Another point of encouraging news is that if the US meets the 2030 target, the pace of emission reductions required to reach net-zero by mid-century is a bit slower than what's needed in the 2020s. The scale of the challenge is still daunting, nothing short of transforming the entire energy system. The US has a long, challenging road ahead (Figure 6.2). Still, if the US is able to achieve 230-240 million tons per year in emission reductions on average through 2030, then maintaining the roughly 165 million ton per year pace needed to get to net-zero in 2050 does not seem impossible, especially if the scale-up of emerging clean technologies is on track.

Time to get to work

The US and the world have little time or room for error to avoid the worst impacts of climate change. This analysis shows that with sustained, deliberate efforts by Congress, federal agencies, and subnational actors, the ambitious 2030 US target is within reach. Now it's time for Congress to pass a robust investment package alongside the infrastructure bill to serve as the foundation of an unprecedented decarbonization policy push. We hope this analysis provides leaders at all levels and corners of the US with the tools needed to get the country on track to tackle the threat of climate change.

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