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# Establishing a Baseline of Global Climate Facts: Understanding the Scale and Sources of Contributions

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## Introduction

Senator Manchin, Senator Barrasso, and distinguished members of the Committee:

Thank you for the opportunity to provide testimony to the Energy & Natural Resources Committee as part of the Committee's establishment of a baseline of global climate facts to understand the scale and sources of contribution toward global climate trends from energy-related sectors—and to consider where and how progress has been made in addressing climate change.

My name is Richard Newell, and I am President and CEO of Resources for the Future (RFF), an independent nonprofit research institution in Washington, DC. RFF's mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement. The institution, which will mark its 70th anniversary next year, is committed to being the most widely trusted source of research insights and policy solutions leading to a healthy environment and a thriving economy.

Our work on topics such as emissions trading, regulatory design, and measurement of benefits and costs has been used to inform the policy conversation around climate for decades, and we understand the tradeoffs any new policy will face. Today, we focus on two strategic areas: we help decisionmakers to design smart emissions reduction strategies; and we help decisionmakers to confront climate risks and build resilience. While RFF researchers are encouraged to offer their expertise to inform policy decisions, the views expressed here are my own and may differ from those of other RFF experts, its officers, or its directors. RFF does not take positions on specific legislative proposals.

From 2009 to 2011, I served as the Administrator of the Energy Information Administration, or EIA, at the US Department of Energy. In that capacity, I had the opportunity to testify before this Committee, and it is my pleasure to be with you again this morning, to speak about global climate, emissions, and energy trends from a US perspective.

I bring to you the perspective of someone who recognizes the importance of global climate data informed by the latest and most reliable science. I have provided expertise to many of the institutions trusted to collect global energy and climate data, analyze it, and produce the reports and data repositories we rely on both nationally and globally—institutions like the National Academy of Sciences (NAS), the Intergovernmental Panel on Climate Change (IPCC), and the International Energy Forum. I am also a non-industry member of the National Petroleum Council (NPC) and appreciate the changes in energy markets around the world that have taken place over the past decade.

## Global Warming and Greenhouse Gas Emissions

The IPCC and other international scientific bodies tell us clearly that the climate is, unquestionably, changing, and that human activity is the primary driver of this change.[1] Since the Industrial Revolution, as populations and economies have expanded, global energy consumption has grown rapidly,[2] and humans have released increasing amounts of greenhouse gases into the atmosphere.[3] We see the results of higher greenhouse gas concentrations in higher average global temperatures, which in turn have resulted in melting ice caps, sea level rise, and other noticeable impacts.[4] As long as net contributions to the atmosphere remain above zero, greenhouse gas concentrations will continue to rise, and temperatures will continue to increase. The consequences of our actions to date are stark: the average global temperature has already risen by 1°C (nearly 2°F), and some regions, such as Alaska,[5] have had to confront temperature increases more than twice that amount.[6]

## Sources and Trends in US Greenhouse Gas Emissions

The United States is currently the second largest emitter of greenhouse gases, having been surpassed by China in 2005.[7] Yet the United States remains the largest contributor to cumulative historic emissions.[8] Greenhouse gas emissions are pervasive throughout the economy, extending across sectors from power, transport, and industry to buildings and agriculture. For the United States in particular, 83 to 85 percent of greenhouse gas emissions consistently come from the production and use of energy, particularly coal, oil, and natural gas.[9] About 95 percent of these energy-related emissions is from carbon dioxide primarily associated with fuel combustion, and the remaining 5 percent is mostly due to methane releases to the atmosphere.[10]

Overall energy use is driven principally by population and economic growth, moderated by declines in the energy intensity of the economy. While the US economy grew in real terms by 28 percent[11] from 2005 through the end of 2019, energy consumption was essentially flat, due both to improvements in energy efficiency and

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[1] "This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects…are extremely likely to have been the dominant cause of the observed warming since the mid-20th century." (p. 4) https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf

[2] https://www.rff.org/geo/

[3] "Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever." (p. 5)
https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf

[4] "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen."(p. 2) https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf

[5] https://uaf-iarc.org/wp-content/uploads/2019/08/Alaskas-Changing-Environment_2019_WEB.pdf

[6] https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature

[7] https://www.climatewatchdata.org/ghg-emissions?end_year=2017&start_year=1990

[8] https://ourworldindata.org/contributed-most-global-co2

[9] https://www.epa.gov/sites/production/files/2020-04/documents/us-ghg-inventory-2020-main-text.pdf (Table ES-4, p. ES 19-20)

[10] https://www.epa.gov/sites/production/files/2020-04/documents/us-ghg-inventory-2020-main-text.pdf (Table 2-4, p. 2-11)

[11] https://fred.stlouisfed.org/series/GDPC1#0

an increasing share of services in overall economy activity.[12] Emissions depend, in turn, on how these energy needs are met, with about 80 percent of US and global energy needs currently being met by fossil fuels.[13]

How quickly emissions grow or decline, therefore, hinges on population and economic growth, improvements in energy efficiency, and switching from more carbon-intensive fuels, like coal, to lower-carbon fuels, like natural gas, and zero-carbon energy sources, like nuclear and renewable power.[14] In addition, there is increased interest in technologies that can remove carbon dioxide from the atmosphere through natural carbon sinks, direct air capture, or bioenergy with carbon capture and storage (BECCS). These shifts among energy sources are driven in turn by three major forces: energy market conditions, technology innovation, and public policy.

## Trends by Sector

US greenhouse gas emissions peaked around 2005 to 2007, and have declined during most years since then, resulting in 2019 emissions that were 11 to 12 percent below 2005 emissions.[15]

**Power Sector:** The vast majority of the decline in emissions has come from carbon dioxide emissions reductions associated with declining coal-based electric power production, due to a substitution toward increased power generation from natural gas and renewables.[16] Wind and solar have benefitted from cost reductions of about 70 percent and 90 percent respectively since 2009,[17] as well as financial support in the form of tax credits and state-level policies. Natural gas power has benefitted from low natural gas prices due to innovation in techniques for shale gas production. There have also been substantial advances in technologies that can complement intermittent renewables (such as wind and solar) to provide regular, dispatchable power. These include energy storage, advanced nuclear and geothermal systems, natural gas with carbon capture, decarbonized hydrogen,[18] and energy demand-side and grid management made smarter through advances in information technology.[19] RFF researchers are studying the design of state and federal policies that affect the US power sector, such as clean energy standards,[20] carbon pricing[21], and electricity market design and regulation.[22]

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[12] https://www.eia.gov/totalenergy/data/annual/ (Table 1.1)

[13] https://www.eia.gov/totalenergy/data/annual/

[14] While there are supply-chain emissions associated with renewable energy sources, the National Renewable Energy Laboratory (NREL) has found that "life cycle greenhouse gas (GHG) emissions from technologies powered by renewable resources are generally less than from those powered by fossil fuel-based resources. The central tendencies of all renewable technologies are between 400 and 1,000 g $CO_2$eq/kWh lower than their fossil-fueled counterparts without carbon capture and sequestration (CCS)." https://www.nrel.gov/analysis/life-cycle-assessment.html

[15] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

[16] https://www.eia.gov/outlooks/steo/

[17] https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2020/

[18] https://www.rff.org/publications/reports/decarbonizing-hydrogen-us-power-and-industrial-sectors/

[19] https://www.rff.org/advanced-energy-technologies/

[20] https://www.rff.org/topics/carbon-pricing/clean-energy-standards/

[21] https://www.rff.org/publications/explainers/carbon-pricing-201-pricing-carbon-electricity-sector/

[22] https://www.rff.org/publications/explainers/us-electricity-markets-101/

**Transportation Sector:** Transportation sector emissions have fallen less dramatically than in the power sector, declining by roughly 5 percent since 2005, due primarily to enhanced vehicle efficiency.[23] As a result of this comparatively slower decline, the transportation sector surpassed the power sector in 2017 as the largest source of greenhouse gas emissions in the United States. The cost and range of electric vehicles (EVs) has improved considerably over the past decade, and EVs are capturing a rapidly increasing share of new model offerings and purchases. However, certain transportation emission sources, such as aviation, shipping, and long-haul trucking are currently more difficult to electrify, creating opportunities for the widespread deployment of new technologies such as low-emission liquid fuels, hydrogen, or other options. RFF researchers are examining efforts to reduce emissions due to transportation at the federal, regional, and state levels, including fuel economy standards,[24] policies to encourage adoption of electric vehicles,[25] the Transportation Climate Initiative,[26] Zero-Emissions Vehicle programs,[27] and more.

**Industrial Sector:** Emissions from industrial sources such as steel, cement, and petrochemical production have shifted only modestly over the past 15 years, and largely as a function of economic conditions. Industrial processes that require very high temperatures or come with process-related emissions require a distinct set of solutions—possibly carbon capture and storage, decarbonized hydrogen,[28] certain advanced nuclear technologies, direct air capture of carbon,[29] or other as-yet-undiscovered alternatives.[30] In collaboration with other experts around the world, RFF researchers are studying strategies for decarbonizing the industrial sector,[31] including clean energy standards[32] and public procurement programs for more environmentally friendly materials and products.[33]

**Agriculture, Forestry, and Land Use:** Outside of the energy sector, agriculture, forestry, and other land-use emission sources present a distinct group of challenges; they also present an array of opportunities for carbon removal through biomass carbon sequestration in forests, grasslands, and soils.[34] According to the 2018 National Climate Assessment, approximately 22 percent of contiguous US land is in use as cultivated cropland and pastures,[35] and in 2018, agriculture accounted for nearly 10 percent of US greenhouse gas emissions. US land

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[23] https://cfpub.epa.gov/ghgdata/inventoryexplorer/#transportation/allgas/source/all

[24] https://www.rff.org/topics/transportation/cafe-standards-and-fuel-efficiency/

[25] https://www.rff.org/publications/reports/potential-role-and-impact-evs-us-decarbonization-strategies/

[26] See https://www.rff.org/publications/reports/pursuing-multiple-goals-transportation-policy-lessons-integrated-model/ and https://www.rff.org/publications/issue-briefs/managing-investment-revenues-and-costs-transportation-climate-initiative-region/

[27] https://www.rff.org/publications/working-papers/californias-evolving-zero-emission-vehicle-program/

[28] https://www.rff.org/publications/reports/decarbonizing-hydrogen-us-power-and-industrial-sectors/

[29] A recent RFF study, "Benefits of Energy Technology Innovation Part 2: Economy-Wide Direct Air Capture Modeling Results," examines the potential benefits of cost reductions of direct air capture technology: https://www.rff.org/publications/working-papers/benefits-energy-technology-innovation-economy-wide-direct-air-capture/; an RFF Live event explored the potential of this technology for climate mitigation: https://www.rff.org/events/advanced-energy-technologies-series/future-direct-air-capture/

[30] https://www.rff.org/advanced-energy-technologies/

[31] https://www.sciencedirect.com/science/article/pii/S0306261920303603?via%3Dihub

[32] https://www.rff.org/news/press-releases/new-study-clean-energy-standard-can-cut-industrial-emissions/

[33] https://www.rff.org/publications/reports/green-public-procurement-natural-gas-cement-and-steel/

[34] https://media.rff.org/documents/RFF-Bck-LULUCF.pdf

[35] https://nca2018.globalchange.gov/chapter/5/

areas serve as both an emissions source and sink, but on net have acted for many years as a carbon sink, absorbing more $CO_2$ from the atmosphere than they emit.[36] RFF researchers are studying strategies involving land-based carbon sources and sinks, including the potential roles of tree planting[37] and forest bioenergy.[38]

## Technological Inclusivity

Because of the diversity and complexity of the American energy system, reducing emissions will require a broad and inclusive approach to incorporating new technologies.[39] Since we cannot know in advance which technologies will become most competitive in the years ahead, expanding our solution set makes more ambitious and comprehensive strategies more feasible and cost-effective. As we've seen in recent years from innovations across many energy sources, the energy sector is vibrant, and holds enormous potential for innovation.

To harness this potential, economic research has demonstrated that broad, incentive-based policies can be the most effective tool to align the private sector's incentives with society's goals of reducing harmful pollution. For example, an incentive-based approach implemented in the 1990s to reducing the sulfur dioxide emissions that cause acid rain achieved its environmental goals well below the expected costs.[40] Research from Resources for the Future found that harnessing the market by allowing firms flexibility in where, when, and how emissions were reduced saved businesses $250 million per year and reduced public health damages by more than $2 billion in 2002.[41]

## Effects of COVID-19 Pandemic

In 2020, the energy world—like so many other parts of our lives—was turned upside down. The effects of the COVID-19 pandemic and the associated economic disruption led to a reduction in emissions of about 10 percent during 2020.[42,43] As a result, US greenhouse gas emissions currently stand about 21 percent lower than they were in 2005.[44] As the economy recovers, many of these reductions may be short-lived. However, a variety of effects could be sustained for years, if not decades, to come. These include the retirement of some coal-fired power plants, downward revisions to future oil demand, and new pressures from the private sector for companies to reduce their greenhouse gas footprints. Other changes, such as a potential reluctance to return to public transportation, could increase emissions.[45] The direction of our energy system and its associated greenhouse gas emissions will depend on how future market, technological and policy decisions unfold, and there are many indications that we are at an important inflection point.

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[36] https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

[37] https://www.rff.org/publications/issue-briefs/tree-planting-climate-policy/

[38] https://www.rff.org/publications/explainers/forest-bioenergy-101/

[39] https://www.resourcesmag.org/common-resources/technology-inclusive-climate-strategy-open-race-many-winners/

[40] https://www.jstor.org/stable/2647033

[41] https://media.rff.org/archive/files/sharepoint/WorkImages/Download/RFF-DP-15-25.pdf

[42] https://www.eia.gov/outlooks/steo/pdf/steo_full.pdf

[43] https://www.rff.org/geo/

[44] https://rhg.com/research/preliminary-us-emissions-2020/#:~:text=Based%20on%20preliminary%202020%20data,tons%20of%20CO2%2Dequivalent

[45] https://www.iea.org/reports/world-energy-outlook-2020

## Conclusion

Senators, in closing, I would like to emphasize three key observations:

- First, the concentration of greenhouse gases in the atmosphere is increasing rapidly, trapping heat to the planet and causing our climate to change. We know that the use of fossil fuels—coal, oil, and natural gas—is the leading cause, and that the US is a major contributor of these emissions.
- Second, because the energy system is ubiquitous and complex, and is not the only sector relevant to the climate problem, a broad, technologically-inclusive approach to reducing emissions will provide us with the widest set of options to address this challenge.
- And finally, the cost reductions and technological advances in clean energy and other emissions reduction technologies mean that ambitious reductions are now achievable at substantially lower cost.

These observations lead me to conclude that the effectiveness and efficiency of private and public emissions reduction strategies will depend on how well they meet the needs of different economic sectors, incentivize consumers and producers to choose lower-emission options, and spur innovation across a wide range of technologies that can help to decarbonize our economy. We now have a wealth of experience with state, federal, international, and corporate policies and programs, enabling the design of smart emissions reduction strategies, both economy-wide and for specific sectors.

Senators, I thank you again for this opportunity to appear before you and all of the members of the Committee today on this panel. I will now conclude my remarks, and I look forward to taking your questions.