Rhodium Group

Energy & Climate

Taking Stock 2024: Technical Appendix

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This document provides additional detail on the methods and data sources used in Rhodium Group's Taking Stock 2024 report. Direct access to all energy and emissions results from our Taking Stock 2024 baselines—including results broken down by gas and sector for all 50 US states through 2035—is available via the ClimateDeck. All historical greenhouse gas (GHG) emissions and removal estimates (1990-2022) come directly from the Environmental Protection Agency (EPA) Greenhouse Gas Inventory. Like the EPA inventory, all gases are reported in carbon dioxide (CO_2)-equivalent emissions based on the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5) 100-year global warming potential (GWP) values. To model potential future emissions and policy scenarios, we use RHG-NEMS, a modified version of the detailed National Energy Modeling System used by the Energy Information Administration (EIA) to produce the Annual Energy Outlook 2023[1] (AEO2023) and maintained by Rhodium Group. We expand on this model to project all six GHGs targeted for reduction under the Kyoto Protocol.

Energy market, technology, and economic assumptions

To construct our national Taking Stock GHG emissions projections range, we revised multiple energy market, technology cost, policy, and behavioral assumptions in RHG-NEMS to be consistent with the most recent research and to reflect the range of market and economic uncertainties. Each year these assumptions are updated to reflect the best

[1] EIA did not release an updated Annal Energy Outlook or an updated version of the National Energy Modeling System this year. We continue to use the version of the model released alongside AEO2023.

available data and information. More granular data for many of these inputs are included on the ClimateDeck.

Unless otherwise stated below, we use EIA's AEO2023 Reference case assumptions in our Taking Stock projections.

Sources of uncertainty

To construct the full range of emission projections in Taking Stock, we looked at three key sources of uncertainty:

- Energy markets: We consider a range of energy market variables that shape emissions outcomes, including natural gas and oil resource availability and prices.
- Technology cost and performance: We estimate ranges for key technology cost and performance variables, including capital and operating costs for clean electricity generators and battery costs for light-duty electric vehicles (EVs).
- Economic growth: We use two different projections of US gross domestic product (GDP) growth in Taking Stock 2024: a baseline growth rate and a high growth rate.
- Demand growth: We use three different projections of electricity demand growth from data center expansion.

RHG-NEMS inputs that are consistent across the emissions outlook

We make several revisions to input assumptions beyond EIA's AEO2023 Reference case that are consistent across our Taking Stock emissions range. The key revisions are described below.

- Announced power plant retirements/additions: We incorporate all announced coal and nuclear power plant retirements through 2035. We account for the Civil Nuclear Credit that was enacted as part of the Infrastructure Investment and Jobs Act (IIJA) as well as state-level policy actions that will allow for continued operation of certain nuclear power plants in those states.
- Electric vehicle uptake: We revise key parameters to reflect recent historical EV sales as well as expectations relating to ongoing EV research and development and industry investment.
- Electric vehicle charging costs: We alter fuel costs for electric vehicles to reflect current charging behavior.
- Automated vehicle deployment: RHG-NEMS does not capture the impact of autonomous transportation technologies for personal vehicle use.

RHG-NEMS inputs that vary to capture energy market uncertainty

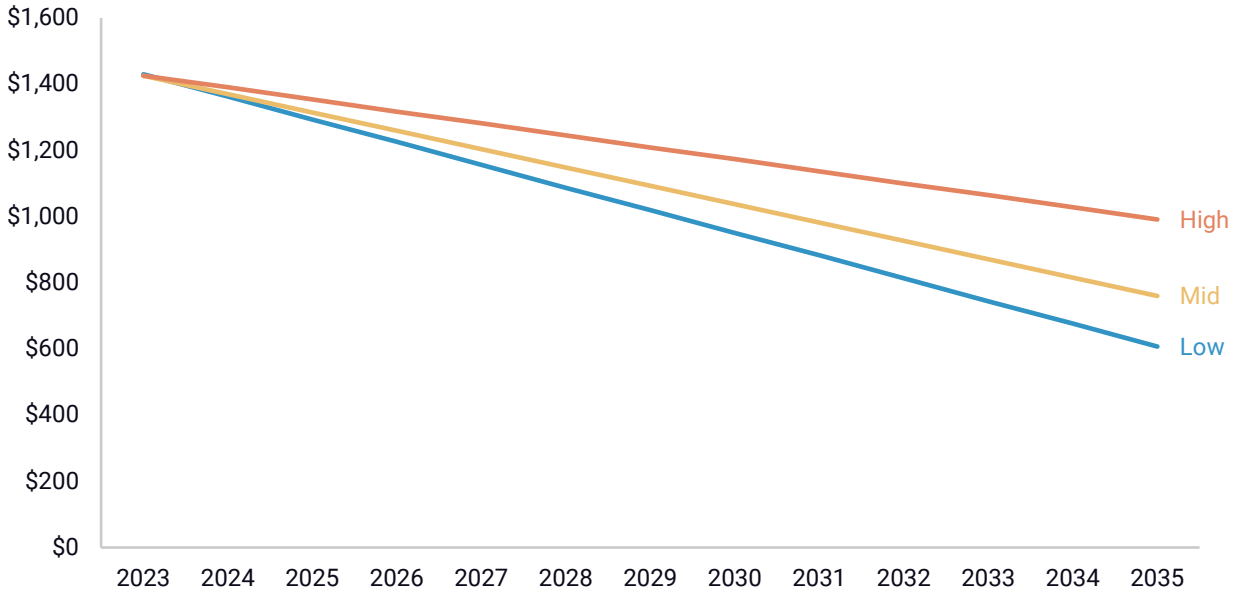
Below are the key assumptions that vary across our estimated emissions range and underlying data sources. For each input, we defined a mid, low, and high case to reflect a

range of potential market and technology cost outcomes. We provide charts for select assumptions. New this year, in the high scenario only we limit the ability of wind and solar to deploy meaningfully beyond historic maximum capacity additions in a single year to represent the supply-side barriers currently facing renewable energy build-out.

ELECTRIC GENERATING TECHNOLOGY COSTS: We generally assume capital costs for utility-scale and distributed solar photovoltaic, land-based wind, off-shore wind, and nuclear decline according to NREL's 2024 Annual Technology Baseline's (ATB) technology cost projections. We adjust the costs included in ATB to account for differences between the default technology that NREL assumes for its projections and the comparable technology in RHG-NEMS. Our mid-cost assumptions follow ATB's Moderate Technology Innovation Scenario, while our low- and high-cost assumptions follow the Advanced Scenario and Conservative Scenario, respectively. For utility-scale energy storage, we adopt the costs used in the AEO 2023 Reference case and High and Low Zero-Carbon Technology cost cases as our mid, high, and low costs, respectively.

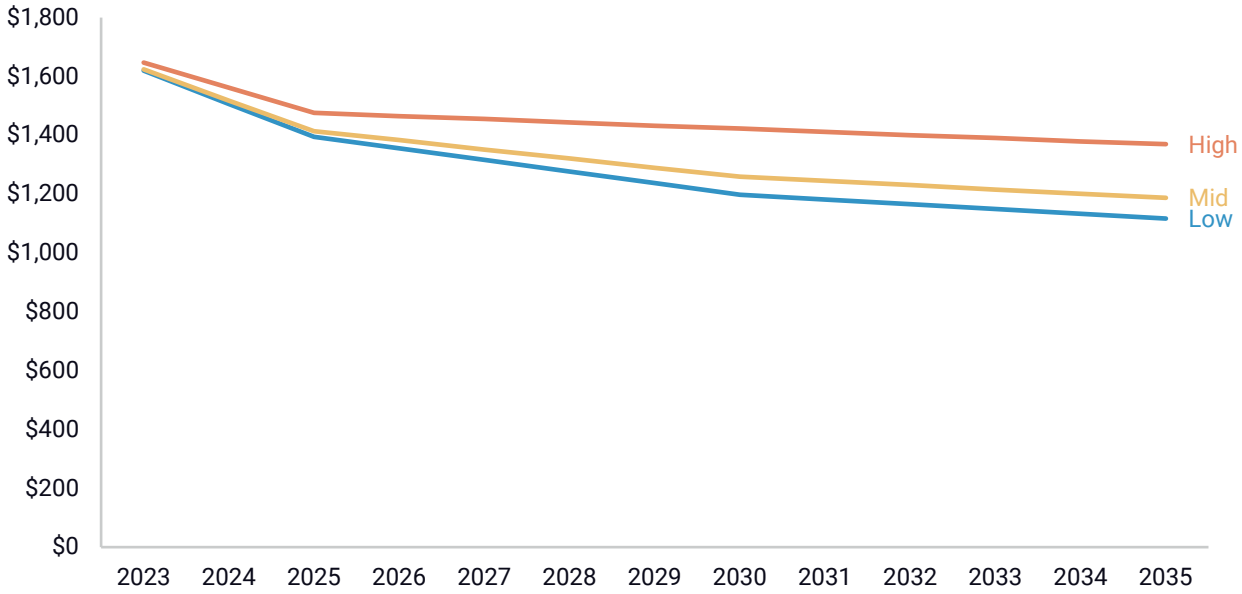
We also change relevant cost and performance parameters for power generating facilities equipped with carbon capture technology, informed by Rhodium analysis and current literature. Of particular note are modified regional transportation and storage costs that are consistent with those used in Rhodium's Industrial Carbon Abatement Platform (see section below) and revisions to costs of new-build natural gas plants with carbon capture. We adapt work from the National Energy Technology Laboratory, which details cost and performance for natural gas-fueled direct supercritical CO_2-fired power plants.

FIGURE 1
Utility-scale solar photovoltaic overnight capital costs
2023 dollars per kilowatt



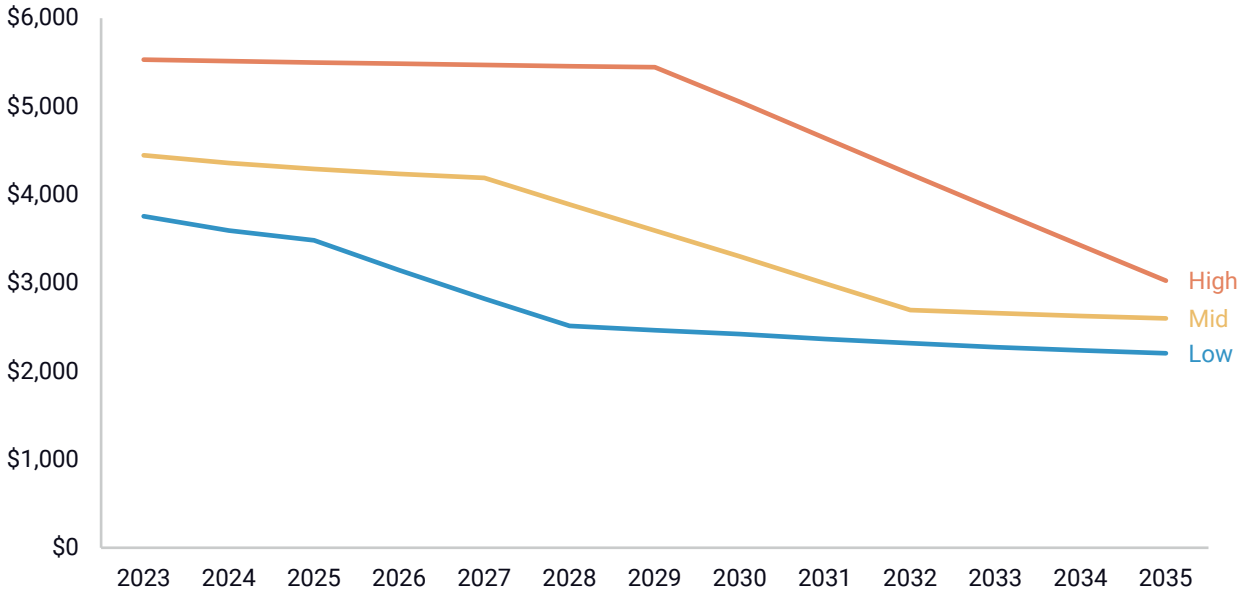
Source: Rhodium Group analysis, NREL

FIGURE 2
Land-based wind overnight capital costs
2023 dollars per kilowatt



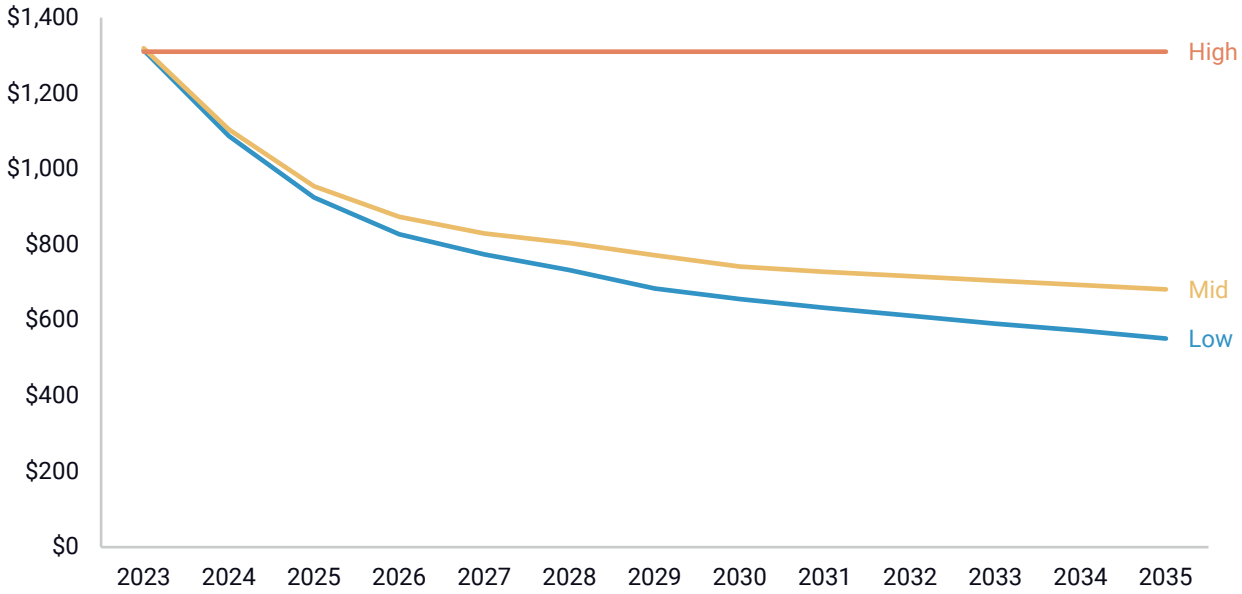
Source: Rhodium Group analysis, NREL

FIGURE 3
Offshore wind overnight capital costs
2023 dollars per kilowatt



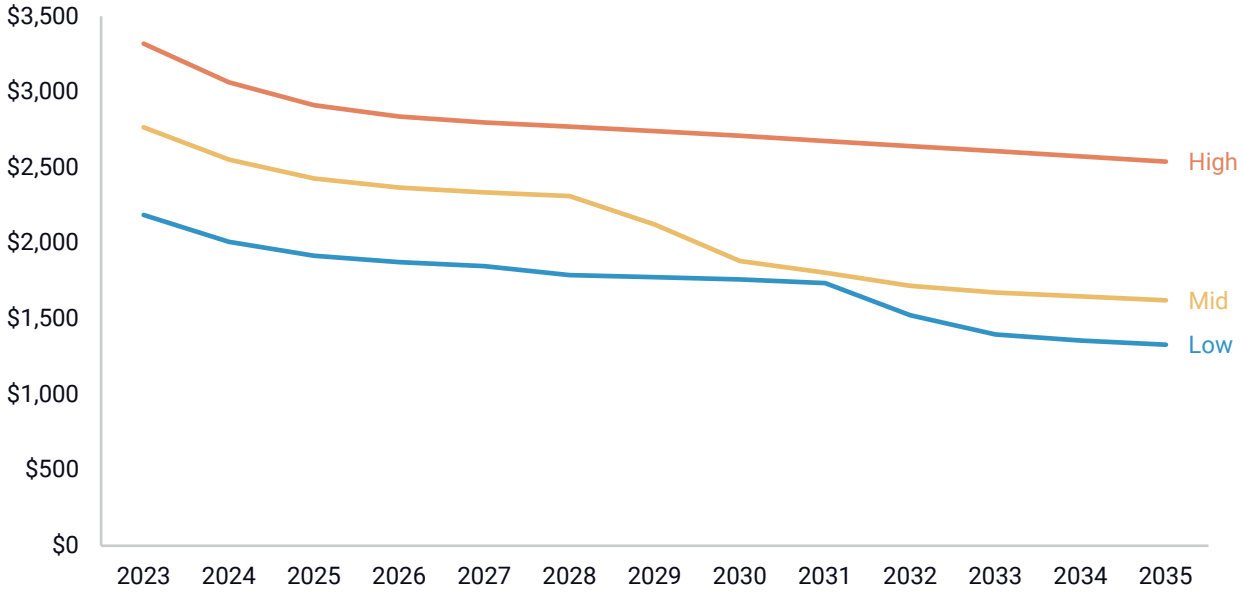
Source: Rhodium Group analysis, NREL

FIGURE 4
Utility scale energy storage overnight capital costs
2023 dollars per kilowatt



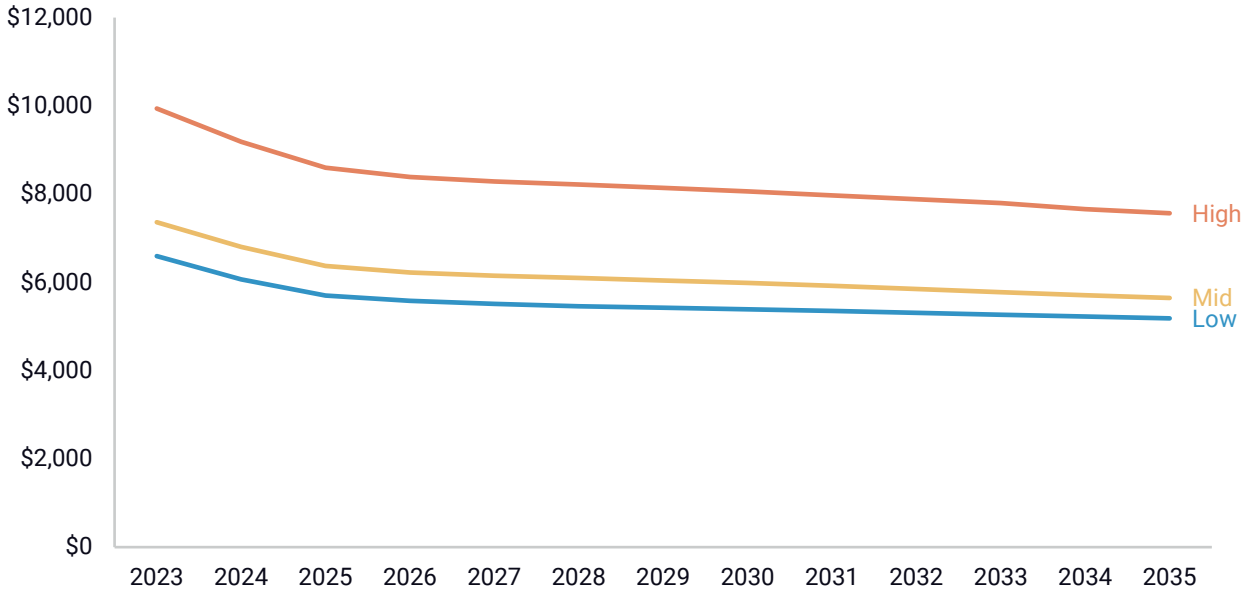
Source: Rhodium Group analysis, NREL

FIGURE 5
Natural gas with CCS overnight capital costs
2023 dollars per kilowatt



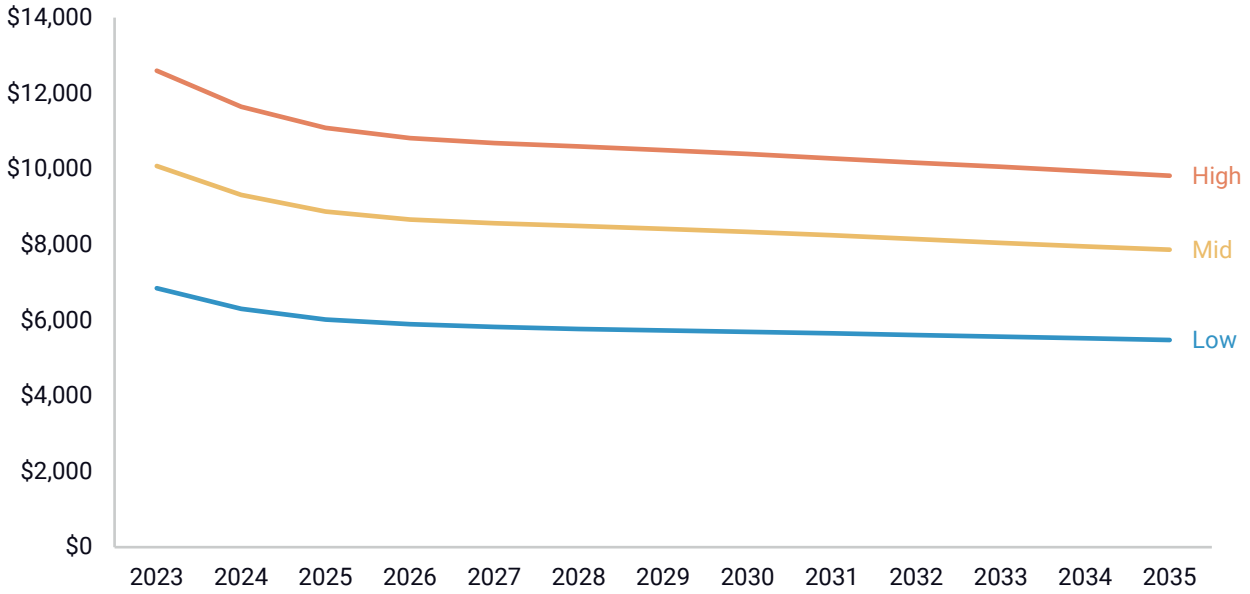
Source: Rhodium Group analysis, NETL

FIGURE 6
Advanced nuclear light water reactor overnight capital costs
2023 dollars per kilowatt



Source: Rhodium Group analysis, NREL

FIGURE 7
Small modular reactor overnight capital costs
2023 dollars per kilowatt

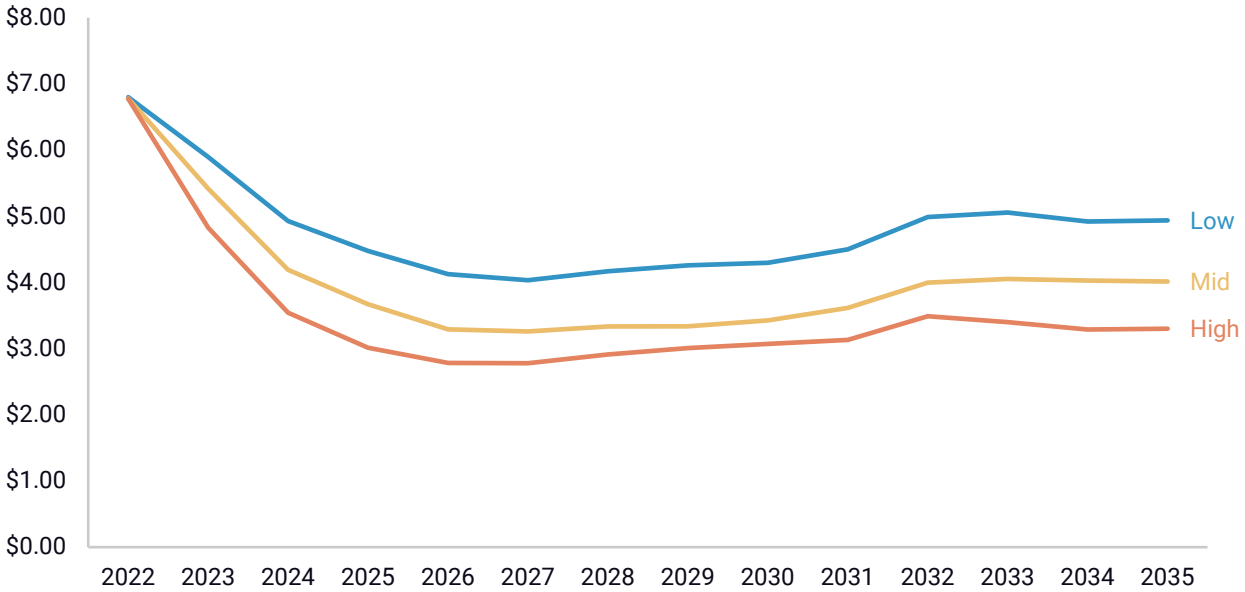


Source: Rhodium Group analysis, NREL

ELECTRIC VEHICLE BATTERY COSTS: We align our light-duty electric vehicle (EV) battery costs with the battery cost assumptions underpinning EPA's Regulatory Impact Analysis of the light-duty vehicle multi-pollutant standards for model year 2027 and later. Our mid-cost case reflects costs derived from Argonne National Laboratory's analysis that uses the latest version of the BatPaC model. Our low- and high-cost cases align with EPA's low and high battery cost sensitivity cases and assume 15% lower and 25% higher costs than the mid-cost case, respectively.

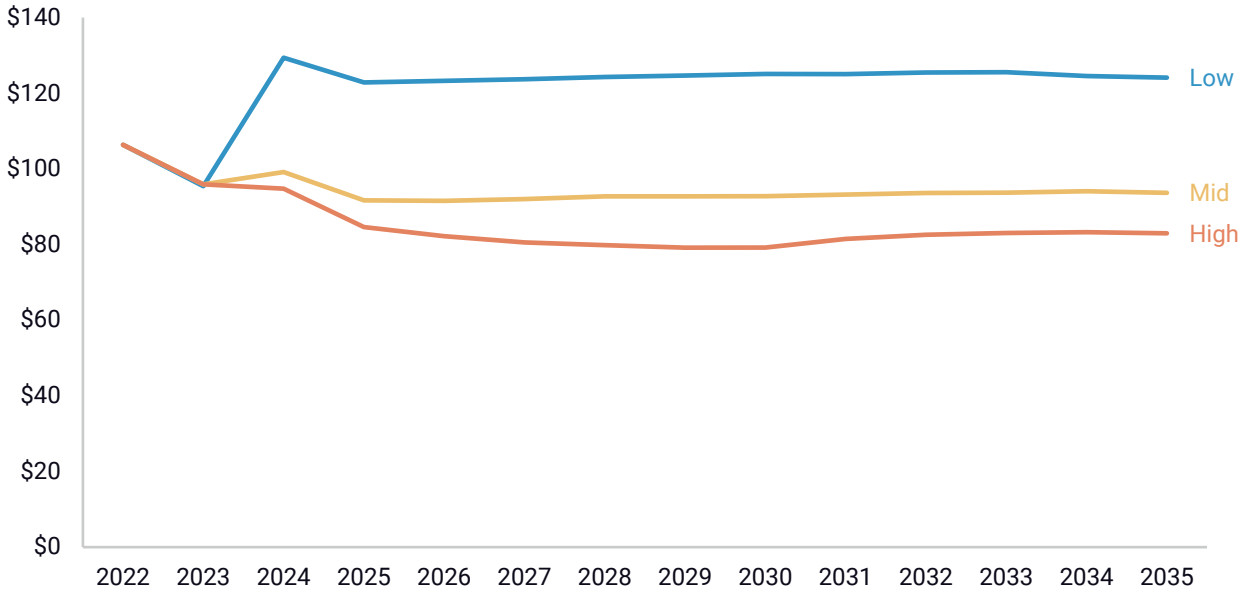
NATURAL GAS AND OIL RESOURCE AND PRICES: For our mid fossil fuel cost case, which we use in our mid emissions scenario, we use the oil and natural gas resource and prices reflected in the AEO2023 reference case. In this case, natural gas averages $3.82/MMBtu from 2023 through 2035 at Henry Hub. On average, the price of Brent crude stays relatively constant from $96/barrel in 2023 to $94/barrel in 2035. In our low fossil cost case, we use the oil and natural gas resource and prices reflected in EIA's high oil and gas supply side case. The resulting average natural gas price is $3.27/MMBtu from 2023 through 2035, and Brent crude reaches $83 per barrel in 2035. In our high fossil cost case, we assume oil and gas supply falls in between EIA's low oil and gas supply side case and the AEO2023 reference case, and we further increase oil prices by about $25. We calibrated this scenario to yield roughly flat oil production at today's levels through 2035 and to lower our high-cost natural gas prices relative to Taking Stock 2023. Natural gas prices in our high-cost case average $4.66/MMBtu from 2023 to 2035, while Brent crude rises to $124/barrel in 2035.

FIGURE 8
Natural gas spot price at Henry Hub
2023 dollars per million Btu



Source: Rhodium Group analysis, EIA

FIGURE 9
Brent crude oil spot price
2023 dollars per barrel



Source: Rhodium Group analysis, EIA

INDUSTRIAL CARBON CAPTURE COSTS: Rhodium has developed the Industrial Carbon Abatement Platform (ICAP) to assess technology deployment and emissions abatement potential in the industrial sector under a variety of scenarios. Using ICAP, we project future carbon capture retrofits at existing industrial facilities under low-, mid-, and high-cost assumptions for CO_2 capture, transportation, and storage. ICAP is integrated with the rest of RHG-NEMS such that industrial facilities see dynamic energy costs and expected revenue from CO_2 sales. We integrate results from our recently updated ICAP model, which included revisions to capture costs as well as integration of electrolytic hydrogen as a decarbonization technology at relevant industrial facilities.

RHG-NEMS inputs that vary to capture macroeconomic uncertainty

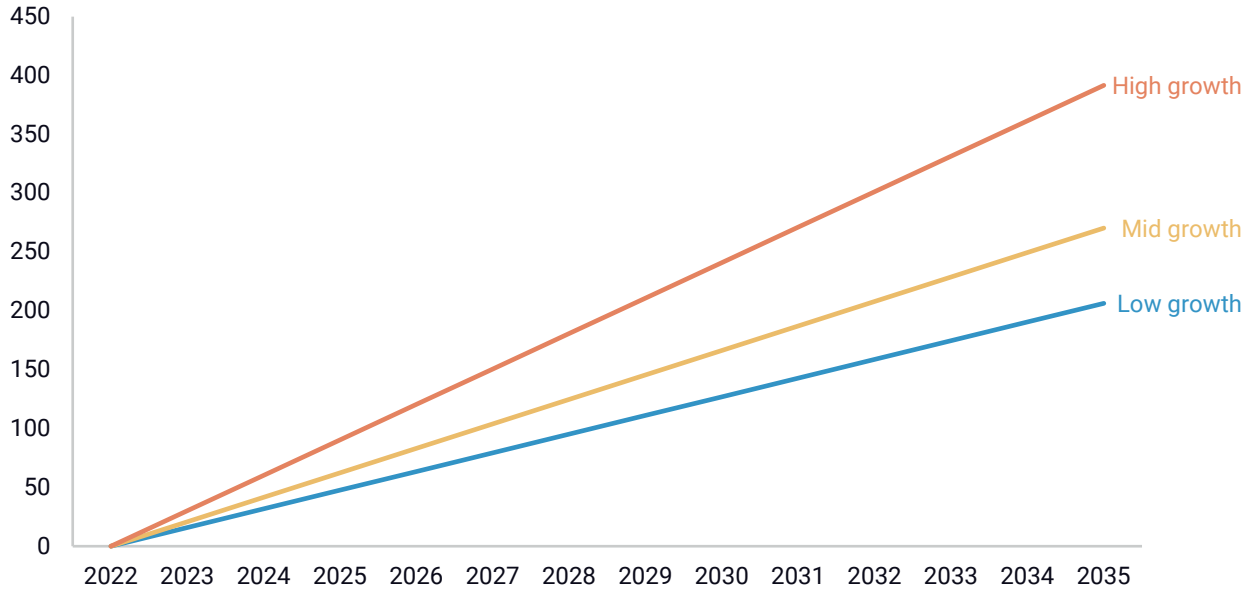
We model a range of future economic growth scenarios to capture the emissions impact of uncertainty in the annual growth rate of the US economy. Our slow economic growth assumptions deliver an average 1.1% real annual rate of growth from 2023 to 2025 and a 2.0% real annual rate of growth from 2026 to 2035. In our baseline economic growth case, GDP grows at an average rate of 1.6% from 2023 to 2025 and 2.3% from 2026 to 2035. These assumptions are aligned with the AEO 2023 Reference and High Economic Growth cases, respectively. In all scenarios, we increase interest rates through 2026 to reflect elevated near-term projected rates from the Congressional Budget Office and others.

RHG-NEMS inputs that vary to capture demand growth uncertainty

New in Taking Stock 2024, we include electricity demand projections based on the recent growth in data centers and battery and EV manufacturing. While previous Taking Stocks

included data center demand, they did not account for the rapid growth in data center demand driven by recent trends such as AI development and increasing demand for cloud computing. We derive low, mid, and high data center demand pathways by synthesizing recent projections from a host of sources including the financial sector, consultancies, and other energy system modelers.

FIGURE 10
Additional projected electricity demand from data centers
Billion kilowatt-hours



Source: GS, Mckinsey, EPRI, BCG, IEA, Citi, Rhodium Group analysis

To project increased electricity demand from new clean manufacturing facilities, we start from the Clean Investment Monitor's analyses of new battery and EV manufacturing facility announcements and apply assumed facility-level electricity demand scaled to production size. Additional demand from manufacturing is small compared to data center demand reaching 9 billion kWh in 2035 and is constant across all three scenarios.

Sensitivity Scenarios

Our mid emissions scenario assumes our mid data center demand growth pathway and no explicit supply-side constraints. To quantify both the combined and isolated impacts of supply-side constraints and data center demand growth, Taking Stock 2024 includes three sensitivity scenarios built off the mid emissions scenario that round out all combinations of these two inputs: data center growth plus supply constraints, no data center growth plus supply constraints, and no data center growth with no supply constraints. Results from these sensitivity scenarios are discussed in the main report, but the associated data is not available on the ClimateDeck.

Federal and state policy assumptions

Our scenarios include emission reductions from all actionable and quantifiable existing federal and state policies as of June 2024. To remain consistent with United Nations (UN) guidelines for reporting the impact of "current measures," we include only policies that have been finalized and adopted. We do not include aspirational goals or economy-wide targets that have not been solidified in specific, actionable policy, nor do we explicitly include specific city-level or corporate commitments.

CO_2 policies

CARBON PRICING: We include the Washington Cap-and-Invest Program, the California Cap-and-Trade Program, and the Regional Greenhouse Gas Initiative (RGGI)[2], which prices electricity sector carbon emissions from 12 states. Carbon pricing policies that have not been finalized with clear, implementable milestones have not been included in our analysis. This includes the New York Cap-and-Invest Program, which was announced by Governor Hochul in January 2023 and directs policymakers to design an economywide Cap-and-Invest Program that establishes a declining cap on greenhouse gas emissions. We do not explicitly include the Oregon Climate Protection Program.

ELECTRIC POWER: EPA finalized a suite of power sector regulations in April 2024. We include EPA standards regulating carbon pollution from existing coal-fired and new gas-fired power plants promulgated under the Clean Air Act sections 111(d) and 111(b), respectively. We also represent EPA's final rule to strengthen and update the Mercury and Air Toxics Standards for Power Plants. We further include EPA's 2023 update to the "Good Neighbor" plan, though the Supreme Court has temporarily blocked the regulations.[3] We layer these new regulations with the Inflation Reduction Act (IRA) and its suite of federal clean energy tax credits, including production and investment tax credits for new clean generation, the zero-emitting nuclear production tax credit, and the tax credit for carbon oxide sequestration (45Q). Our IRA modeling adopts the IRS's recently released guidelines for the technology-neutral tax credits, though they are yet to be finalized. Power sector emissions reductions only hit the IRA's 75% reduction target from 2022 levels in the low emissions scenario. The phase-out is triggered in 2032, but it does not meaningfully affect results within our reporting timeline. We allow for direct pay and transferability of the new clean energy tax credits as detailed in the IRA. We also include the IIJA Civil Nuclear Credit. We include a list of state-level Renewable Portfolio Standards (RPS), Clean Energy Standards (CES), and zero-emission credit programs in Table 1. In light of substantial delays and setbacks experienced by the offshore wind industry in the last year, we do not include state offshore wind mandates in Taking Stock 2024. We incorporate all announced power plant additions and retirements through 2035 as of June 2023 and all announced coal and nuclear retirements as of June 2024.

TRANSPORTATION: In the transportation sector, we include harmonized EPA and National Highway Traffic Safety Administration's CAFE standards for light-duty vehicles through model year 2026. We also include EPA's multi-pollutant emissions standards for model

[2] We include Virginia in RGGI, though the state formally pulled out of RGGI earlier this year after months of legal battles.

[3] Ohio v. EPA, decided June 27, 2024.

years 2027 and later for light-duty and medium-duty vehicles along with EPA's Phase 3 standards for heavy-duty vehicles, both finalized in March 2024. We continue to include IRA tax credits for clean vehicles, clean fuel production, sustainable aviation fuel, and clean hydrogen production. We also include the federal Renewable Fuels Standard requirements through 2022.

At the state level, we include vehicle emission standards and zero-emission vehicle (ZEV) mandates for California and 15 states that follow California's tighter standards (Advanced Clean Cars I) under Section 177 of the Clean Air Act (S177 states). We further include California's Advanced Clean Cars II regulations that require 100% light-duty ZEV sales by 2035. In addition to California, 12 other S177 states have adopted these higher regulations[4] and are also represented. While CA has not yet received the waiver from EPA that's required to formally adopt this policy, we expect that EPA will grant CA this waiver based on its history of doing so. We include the California, Oregon, and Washington low-carbon fuel standards. California's Innovative Clean Transit regulation (requiring 100% zero-emission bus sales by 2040) and Advanced Clean Truck (ACT) regulation (requiring 40%-75% zero-emission truck sales, depending on truck weight class, by 2035) are incorporated. In addition to California, 10 other states have adopted the ACT rule and are also represented. State ZEV commitments with no underlying regulatory policy are not included in our modeling.

INDUSTRY AND BUILDINGS: We include current federal minimum energy conservation standards for appliances and equipment as well as the IRA's tax credits and rebates for residential and commercial energy efficiency and clean energy expenditures. We also include the tax credits for carbon oxide sequestration (45Q), clean hydrogen production, and clean fuel production. Our clean hydrogen production tax credit modeling follows the treasury's guidance released earlier this year, though it is not finalized. State energy efficiency programs are implicitly captured in RHG-NEMS electric demand projections. We also capture the impacts of federal investment in clean hydrogen and direct air capture hubs that were funded as part of the IIJA.

Non-CO_2 policies

METHANE: We include EPA's Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources, finalized in December 2023. We assume emission reductions from EPA's 2016 updated NSPS and emission guidelines for methane from municipal solid waste landfills rules are delayed—with enforcement starting in 2021 rather than 2016—to reflect EPA's recent update to the Obama-era rule. The following state policies are also reflected: oil and gas standards in 10 states and California's landfill methane control measures from 2010 and updated in 2017. All estimates associated with federal and state oil and gas rules are based on modeled estimates from the Clean Air Task Force that align with oil and gas production from each of our scenarios. For landfills, we used emission reduction estimates from EPA and California's Air Resources Board.

[4] Three of the 12 states (CO, DE, and NM) have partially adopted ACC II and cap the EV sales share requirement at 82% by 2032.

HYDROFLUOROCARBONS (HFCS): All our scenarios assume a phasedown in the production and consumption of HFCs in line with EPA's final rule to phase down HFCs, issued September 2021.

OIL AND GAS: Our model reflects the Biden administration's freeze on new liquid natural gas export permitting. This policy was staid by a federal district court earlier this month[5], after we had finalized our modeling.

Federal and state policies included in Taking Stock 2024 baselines

FEDERAL POLICY

Power sector

- Clean electricity tax credits
- Tax credit direct pay provisions and transferability
- Zero-emitting nuclear production tax credit
- USDA assistance for rural electric cooperatives
- Tax credit for carbon oxide sequestration (45Q)
- CCS demonstration and pilot projects
- Civil Nuclear Credit Program
- Cross-State Air Pollution Rules (CSAPR)
- Mercury and Air Toxics Standards (MATS)
- New Source Review (NSR)
- New Source Performance Standards for Greenhouse Gas Emissions From New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units; Emission Guidelines for Greenhouse Gas Emissions From Existing Fossil Fuel-Fired Electric Generating Units; and Repeal of the Affordable Clean Energy Rule

Transportation

- New clean vehicle tax credit
- EV charging infrastructure grants
- Clean fuels tax credit
- Clean hydrogen production tax credit (45V)
- Sustainable aviation fuel credit
- Renewable Fuel Standards (RFS)
- MY2024-2026 Corporate Average Fuel Economy Standards
- Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles
- GHG and fuel consumption standards for heavy-duty vehicles, Phase 2 and Phase 3
- Tier 3 Motor Vehicle Emission and Fuel Standards Program
- International convention for the Prevention of Pollution from Ships (MARPOL) Annex VI

Industry and buildings

- Clean hydrogen production tax credit (45V)
- Clean fuel production tax credit

[5] Louisiana v. Biden, decided July 1, 2024.

- Programmatic efficiency spending in IIJA
- Building efficiency tax credits
- Building electrification and efficiency grants
- Federal investments in clean hydrogen and direct air capture hubs in IIJA

Hydrofluorocarbons (HFCs)

- EPA's final rule to phase down HFCs

Methane

- Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources
- Orphaned mine and well remediation
- Increased onshore and offshore oil and gas royalty rates
- Methane emissions reduction program
- EPA municipal solid waste landfill methane rule

Carbon removal

- Agricultural conservation investments
- Non-federal land forests reforestation projects
- State and private forestry conservation programs
- Tax credit for carbon oxide sequestration (45Q)

STATE POLICY

Power sector
Relevant states

- Renewable portfolio standard (RPS) and clean electricity standard (CES)
  AZ CA CO CT DC DE HI IA IL IN LA MA MD ME MI MN MO MT NC NE NH NJ NM NV NY OH OR PA RI TX VA VT WA WI
- Energy storage mandates
  MA MD MI NV NJ NY OR VA
- Nuclear zero emission credit (ZEC) programs
  IL NJ NY

Transportation
Relevant states

- California light-duty vehicle GHG standards or ZEV mandate (Advanced Clean Cars I regulation)
  CA CO CT ME MD MA MN NJ NM NV NY OR RI VA VT WA
- California Advanced Clean Cars II regulation
  CA CO DC DE MA MD NM NJ NY OR RI VT WA
- Low-Cabon Fuel Standard (LCFS)
  CA OR WA

- California Advanced Clean Trucks regulation
  CA CO MA MD NJ NM NY OR RI WA VT
- Zero emission bus mandate
  CA

Industry and buildings
Relevant states

- Energy Efficiency Resource Standards (EERS)
  AK AZ CA CO CT DC HI IA IL LA MA MD ME MI MN MO MS NC NH NV NJ NM NY OR PA RI TX UT VA VT WA WI

Methane
Relevant states

- State oil and gas standards
  CA CO MA MD NM NY OH PA UT WY
- Landfill methane regulation (LMR) and SB1383 agricultural methane targets
  CA

Carbon pricing
Relevant states

- Cap and trade program
  CA WA
- Regional Greenhouse Gas Initiative (RGGI)
  CT DE ME MD MA NH NJ NY RI VT VA

Projection and 50-state downscaling methodology

Carbon dioxide emissions

Projected CO_2 emissions from all energy use in RHG-NEMS are inconsistent with EPA's accounting conventions for CO_2 from fossil-fuel combustion in its GHG inventory. To address this inconsistency, we make the following adjustments to RHG-NEMS output to generate a forecast for CO_2 from fossil-fuel combustion:

- **INTERNATIONAL BUNKER FUELS:** Emissions from fuel combustion by ships and airplanes that depart from or arrive in the US from international destinations are not included in EPA's inventory of total US emissions nor are they counted in US climate targets. However, they are included in RHG-NEMS CO_2 output. We subtract these emissions from our projections.

- **INDUSTRIAL NON-ENERGY USE OF FUELS:** Fossil fuels are used as feedstocks in the manufacture of a variety of products such as steel and chemicals. Generally, EPA accounts for CO_2 emissions generated by consumption of these feedstocks in the industrial processes categories of the GHG inventory, not under fossil-fuel

combustion CO_2. We subtract CO_2 emissions from non-energy uses of CO_2 from our fossil-fuel combustion projections and account for non-energy use of fuels and feedstocks elsewhere.

- **TRANSPORTATION NON-ENERGY USE OF FUELS:** A small amount of petroleum fuel used in the transportation sector (largely for lubricants) is not combusted but generates CO_2 emissions through its usage. We subtract this amount from projections of petroleum CO_2 emissions in the transportation sector and account for them elsewhere as non-energy use of fuels.

RHG-NEMS does not provide an Intergovernmental Panel on Climate Change (IPCC) consistent projection output for non-fossil fuel consumption CO_2 emissions from activities such as non-energy use of fuels and industrial processes. We applied the following methods to project non-fossil fuel combustion CO_2 emissions:

- **INVENTORY CATEGORIES WITH EMISSIONS BELOW 25 MILLION METRIC TONS (MMT):** We extrapolate historical trends from EPA's latest GHG inventory in line with EPA's latest GHG projection guidance.

- **INVENTORY CATEGORIES WITH EMISSIONS ABOVE 25 MMT:** We follow EPA's latest guidance, scaling inventory data based on category-appropriate RHG-NEMS output. For example, recent historical CO_2 emissions from natural gas systems are scaled based on the projected change in dry natural gas production available at the play level from RHG-NEMS. This allows for non-combustion CO_2 emissions to change in line with changes in the economic and technology assumptions we make to account for uncertainty in our projections.

Non-CO_2 and land use emissions and removals

All projections of non-CO_2 emissions (i.e., methane, nitrous oxide, hydrofluorocarbons, perfluorocarbon, and sulfur hexafluoride) follow the same general approach as we take in projecting CO_2 emissions from non-fossil fuel combustion sources. Inventory categories with emissions less than 25 mmt CO_2e are extrapolated based on recent historical trends. Inventory categories with emissions more than 25 mmt CO_2e are scaled based on appropriate outputs from RHG- where possible. In some instances, such as agriculture, there are no appropriate outputs from RHG-NEMS to scale emissions. In these instances, we use alternative public projections such as the US Department of Agriculture (USDA)'s long-term projections. Additional modifications are made to reflect the impact of state and federal policies as discussed above.

Historical emissions and removals from land use, land-use change, and forestry (LULUCF) come directly from the 2022 EPA GHG inventory. Projected trends come from the high sequestration scenario from the 2022 Fifth Biennial Report of the United States (the most recent set of federal projections) calibrated to align with EPA's 2022 inventory. For emissions of N2O and CH4 from LULUCF, we assume 2022 emissions from LULUCF remain constant through 2030, following the approach used in the 2022 Biennial Report.

Downscaling national emissions projections to the state level

RHG-NEMS forecasts fuel consumption by sector at various levels of geographical aggregation, which is then downscaled to the state level using state-level activity data. For the power sector, generation-based emissions are taken directly from RHG-NEMS which reports individual plant-level emissions. NEMS builds new fossil-fuel fired plants to meet electricity demand and those plants and their respective emissions are attributed to individual states within an electricity market region based on historical trends. We estimate generation-based power emissions based on the production of electricity within a state, a portion of which may be exported outside the state. We also estimate power sector emissions associated with the consumption of electricity within a state, accounting for the carbon intensity of generation that produced that electricity.

Projections of fuel consumption by other end-use sectors, including industry, buildings (a combination of the residential and commercial sectors), and transportation, are downscaled to the state level from nine census-level regions. In the building sector, we apportion census-level GHG emissions to constituent states using each state's share of historical fuel consumption. In the transportation sector, we use historical demand to allocate fuel consumption by mode in each census region between constituent states. For example, we use the historical share of vehicle miles traveled (VMT) for light-duty vehicle fuel demand, and truck ton-miles for freight fuel demand. For industry, we use EPA's Facility Level Information on Greenhouse Gases Tool (FLIGHT) as weights to apportion census region GHG emissions to constituent states for large industrial facilities, and total value-added as weights to apportion census region fuel consumption for smaller facilities.

For non-fossil fuel combustion CO_2 emissions at the state level, all other GHG emissions, and LULUCF emissions and removals, we use activity data from RHG-NEMS where available. For example, methane emissions from fossil fuel production are downscaled based on production output from RHG-NEMS which is available by fuel basin/play and can be attributed to individual states. In cases where there are no appropriate outputs from RHG-NEMS, we draw on other sources of activity data, including FLIGHT, the EIA, and USDA.

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