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Preliminary Report: The Climate and Energy Impacts of the Inflation Reduction Act of 2022

August 2022

Preliminary Report: The Climate and Energy Impacts of the Inflation Reduction Act of 2022

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Preface

This report describes the national-scale energy system and greenhouse gas emissions impacts of the ***Inflation Reduction Act*** (IRA), as released by the Senate Democratic Leadership on July 27, 2022.

The report also reflects prior REPEAT Project analysis of the impacts of the ***Infrastructure Investment and Jobs Act*** (IIJA, H.R. 3684), which was signed into law in November 2021, and the ***Build Back Better Act*** (BBBA, H.R. 5376), which passed the House of Representatives on November 19, 2021. All results for IRA and BBBA include impacts from enactment of the Bipartisan Infrastructure Law (IIJA).

The report also presents two 'benchmark' scenarios: **Frozen Policies**, which captures the impacts of state and federal policies and regulations as of the start of the 117th Congress and inauguration of President Biden in January 2021; and **Net-Zero Pathway,** a cost-optimized pathway to reduce economy-wide U.S. greenhouse gas emissions 50% below 2005 levels by 2030 and net-zero by 2050.

This report contains macro-energy system modeling results including impact on greenhouse gas emissions, a break-down of sectoral reductions, and estimated impacts on U.S. energy expenditures and capital investment in energy supply infrastructure. The report also discusses the impact of variation in future U.S. oil and gas production on U.S. emissions and exports.

Given the preliminary nature of this analysis and significant uncertainty about future outcomes, **all results in this report should be considered approximate** and may be updated or refined by subsequent analysis.

Summary of baseline and background assumptions

For consistency and comparability across published REPEAT Project analysis of the Infrastructure Investment and Jobs Act and House-passed Build Back Better Act, this report uses modeling inputs and assumptions for energy services demand, macroeconomic conditions, and fossil fuel prices based on the U.S Energy Information Administration (EIA) *Annual Energy Outlook 2021* and energy technology costs primarily derived from the National Renewable Energy Laboratory *Annual Technology Baseline 2021* mid-range costs for most technologies. These assumptions will be updated and refreshed for all policy scenarios in subsequent analysis later this year.

The **Frozen Policies** baseline and all other cases include the impacts of state and federal policies and regulations as of January 2021. This includes the Environmental Protection Agency (EPA) final rule for the phasedown of hydrofluorocarbons (HFCs). The baseline does *not* include final EPA tailpipe greenhouse gas emissions standards for passenger cars and light trucks for model years 2023-2026, which were finalized in December 2021.

The **Current Policies** baseline also includes the impact of the Bipartisan Infrastructure Law (the *Infrastructure Investment and Jobs Act* or IIJA), as modeled by REPEAT Project and detailed in our Summary Report from February 2022.

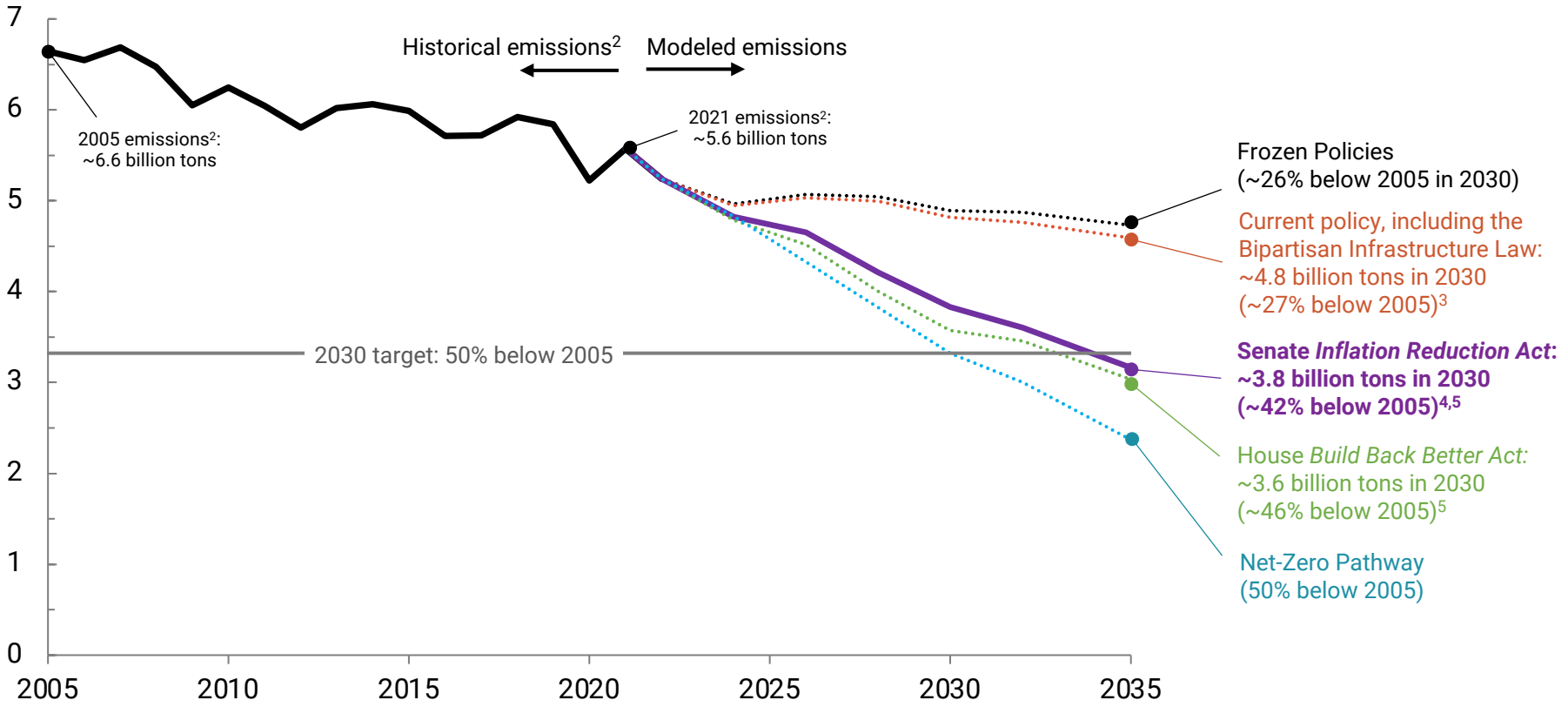
All cases exclude the potential impacts of any proposed rules and regulations, such as the proposed EPA methane rule.

CO_2-equivalent emissions are calculated and reported throughout using IPCC *Fourth Assessment Report* (AR4) 100-year global warming potential (GWP), consistent with the practices of the EPA Inventory of Greenhouse Gas Emissions and Sinks.

Preliminary Findings

Historical and Modeled Net U.S. Greenhouse Gas Emissions (Including Land Carbon Sinks)

billion metric tons CO_2-equivalent (Gt CO_2-e)[1]



The Senate *Inflation Reduction Act* would:

- **cut annual emissions in 2030 by an additional ~1 billion metric tons** below current policy (including the Bipartisan Infrastructure Law)
- **close two-thirds of the remaining emissions gap** between current policy and the nation's 2030 climate target (50% below 2005)
- **get the U.S. to within ~0.5 billion tons of the 2030 climate target**
- **reduce cumulative GHG emissions by about 6.3 billion tons over the next decade** (through 2032).

1 - CO_2-equivalent emissions calculations use IPCC AR4 100 year global warming potential as per EPA Inventory of Greenhouse Gas Emissions and Sinks. **All values should be regarded as approximate given uncertainty in future outcomes.**

2 - Historical data from US EPA Inventory for 2005-2030; 2021 preliminary emissions estimate assumes total net emissions change in proportion to 6.7% year-on-year change in CO2 emissions from energy and industrial processes estimated by Global Carbon Monitor.

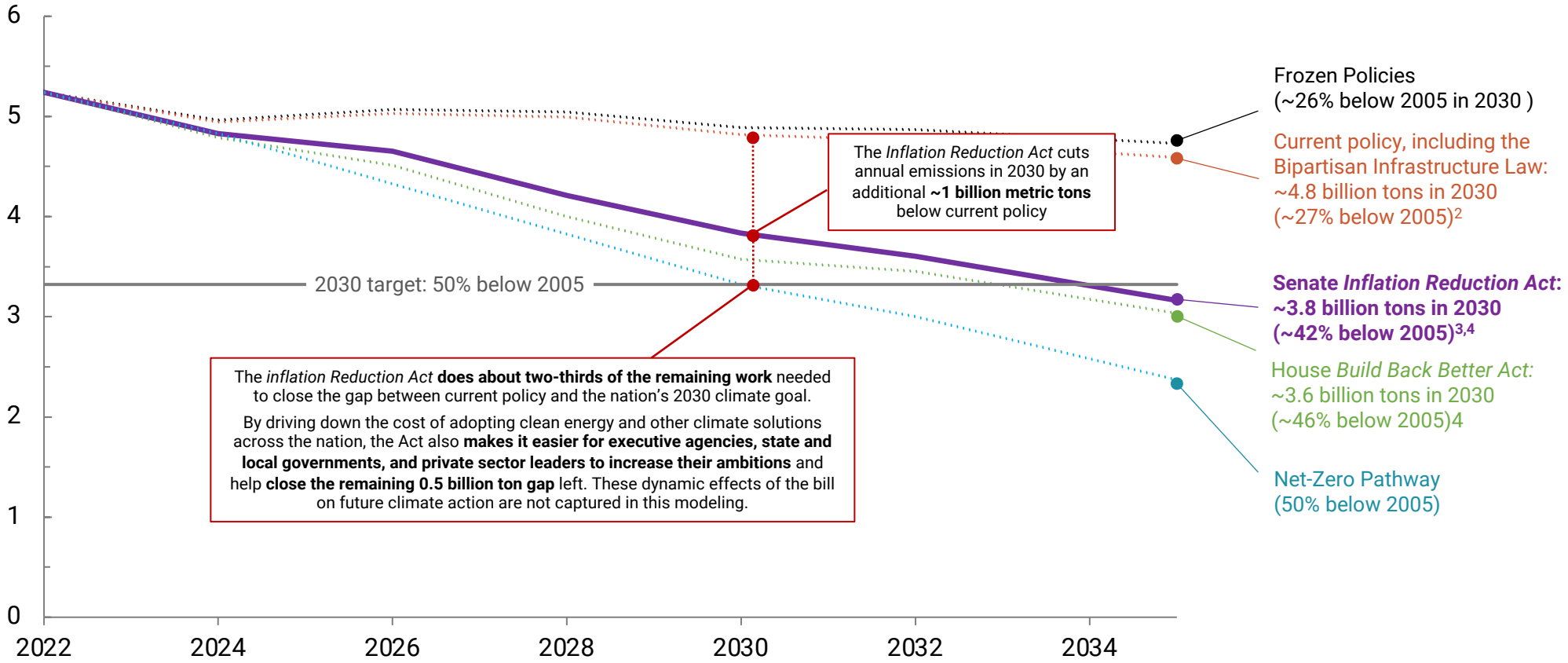
3 - Modeled emissions exclude any changes in passenger and freight miles traveled due to surface transportation, rail, and transit investments in IIJA. According to the Georgetown Climate Center, emissions impact of these changes depend heavily on state implementation of funding from IIJA, which could result in anywhere from -14 Mt to +25 Mt change in CO_2 emissions from transportation in 2030.

4 - Results reflect preliminary modeling based on the July 27, 2022 draft legislation.

5 - Results reflect average of estimated high and low oil & gas production scenarios, which span +/- 20 Mt CO_2-e in 2030 (see p. 14-15). Impact on land carbon sinks based on analysis by Energy Innovation.

Modeled Net U.S. Greenhouse Gas Emissions (Including Land Carbon Sinks)

billion metric tons CO_2-equivalent (Gt CO_2-e)[1]



1 - CO_2-equivalent emissions calculations use IPCC AR4 100 year global warming potential as per EPA Inventory of Greenhouse Gas Emissions and Sinks. **All values should be regarded as approximate given uncertainty in future outcomes.**

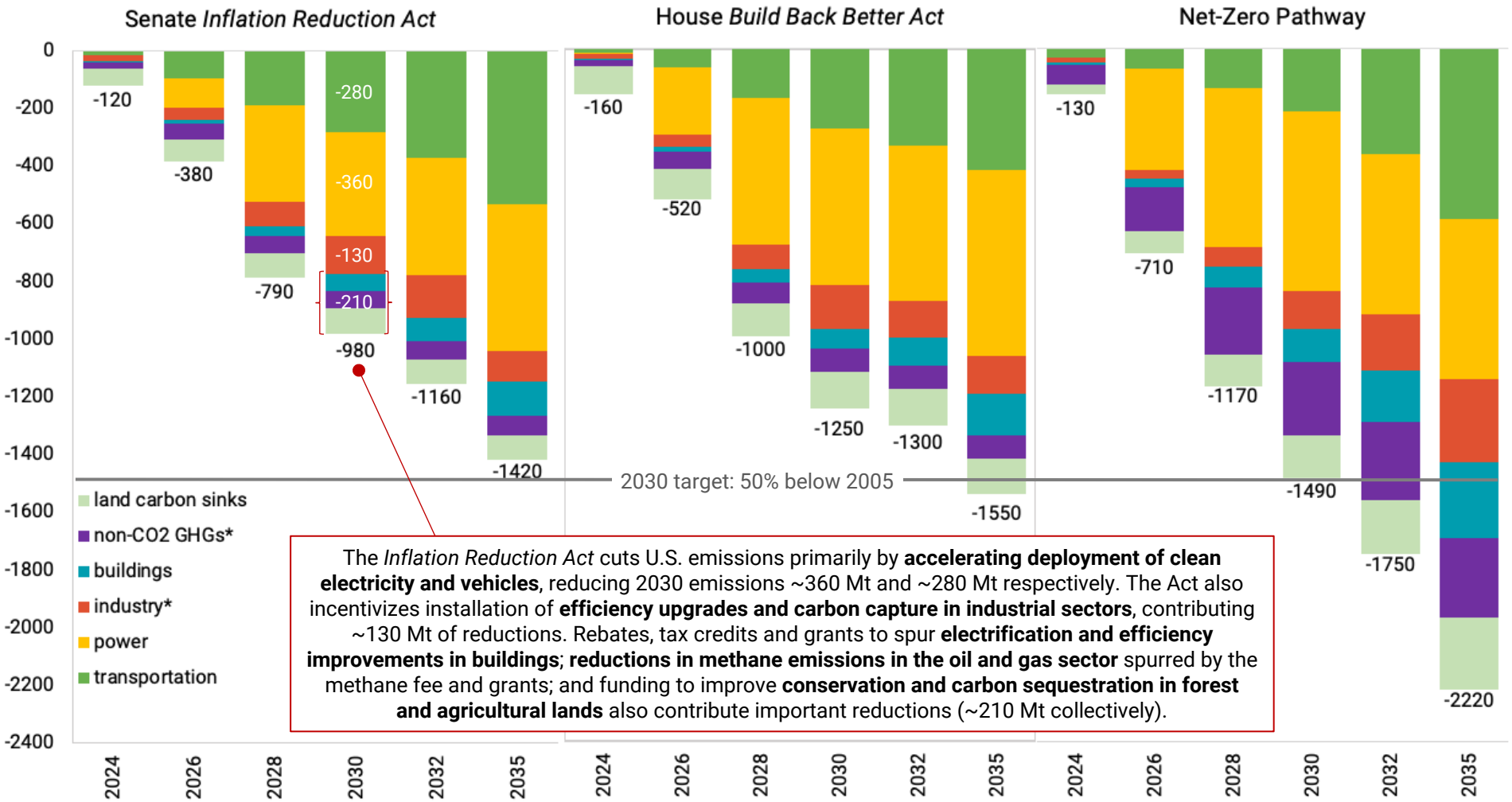
2 - Modeled emissions exclude any changes in passenger and freight miles traveled due to surface transportation, rail, and transit investments in IIJA. According to the Georgetown Climate Center, emissions impact of these changes depend heavily on state implementation of funding from IIJA, which could result in anywhere from -14 to +25 Mt change in CO_2 emissions from transportation in 2030.

3 - Results reflect preliminary modeling based on the July 27, 2022 draft legislation.

4 - Results reflect average of estimated high and low oil & gas production scenarios, which span +/- 20 Mt CO_2-e in 2030 (see p. 14-15). Impact on land carbon sinks based on analysis by Energy Innovation.

Annual Change in Net U.S. Greenhouse Gas Emissions Relative to Current Policy (including Bipartisan Infrastructure Law)

million metric tons CO_2-equivalent (Mt CO_2-e)[1]



The *Inflation Reduction Act* cuts U.S. emissions primarily by **accelerating deployment of clean electricity and vehicles**, reducing 2030 emissions ~360 Mt and ~280 Mt respectively. The Act also incentivizes installation of **efficiency upgrades and carbon capture in industrial sectors**, contributing ~130 Mt of reductions. Rebates, tax credits and grants to spur **electrification and efficiency improvements in buildings**; **reductions in methane emissions in the oil and gas sector** spurred by the methane fee and grants; and funding to improve **conservation and carbon sequestration in forest and agricultural lands** also contribute important reductions (~210 Mt collectively).

Notes:

1 - CO_2-equivalent emissions calculations use IPCC AR4 100 year global warming potential as per EPA Inventory of Greenhouse Gas Emissions and Sinks. **All values should be regarded as approximate given uncertainty in future outcomes.** Results rounded to nearest 10 Mt CO2-e

2 - Modeled emissions exclude any changes in passenger and freight miles traveled due to surface transportation, rail, and transit investments in IIJA. According to the Georgetown Climate Center, emissions impact of these changes depend heavily on state implementation of funding from IIJA, which could result in anywhere from -14 to +25 Mt change in CO_2 emissions from transportation in 2030.

3 - Results reflect preliminary modeling based on the July 27, 2022 draft legislation.

4 - Results reflect average of estimated high and low oil & gas production scenarios, which span +/- 20 Mt CO_2-e in 2030 (see p. 14-15). Impact on land carbon sinks based on analysis by Energy Innovation.

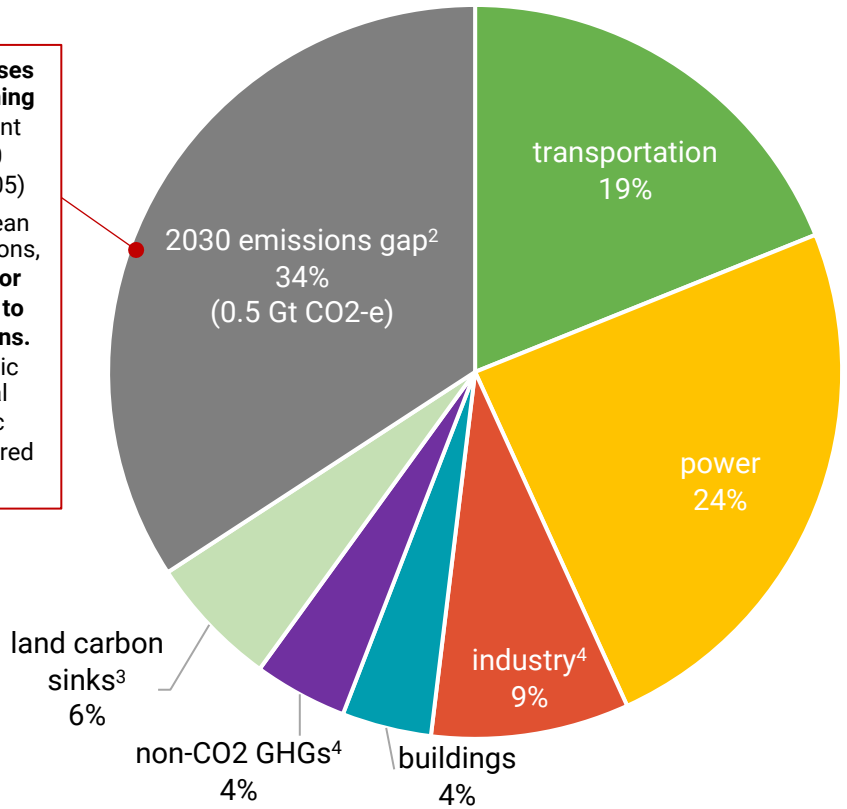
Contributions to Additional Net U.S. Greenhouse Gas Emissions Reductions Below Current Policy Needed to Reach 2030 Climate Target

percentage of net emissions reductions relative to Current Policy (including the Bipartisan Infrastructure Law) to reach 50% below 2005 levels (-1.5 Gt CO_2e)[1]

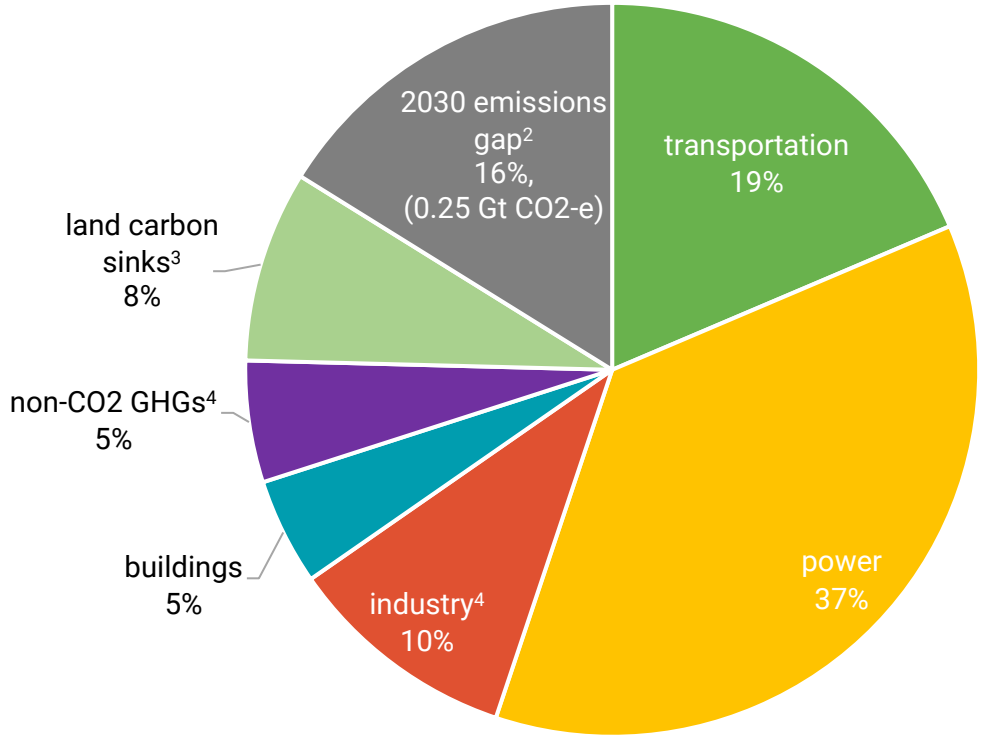
The *Inflation Reduction Act* **closes about two-thirds of the remaining emissions gap** between current policy and the nation's 2030 climate target (50% below 2005)

By driving down the cost of clean energy and other climate solutions, the Act also **makes it easier for states or cities or companies to increase their climate ambitions.** It also reinforces the economic benefits of any future federal regulations. (These dynamic effects of the bill are not captured in this modeling.)

Senate *Inflation Reduction Act*



House *Build Back Better Act*



1 - CO_2-equivalent emissions calculations use IPCC AR4 100 year global warming potential as per EPA Inventory of Greenhouse Gas Emissions and Sinks. **All values should be regarded as approximate given uncertainty in future outcomes.**

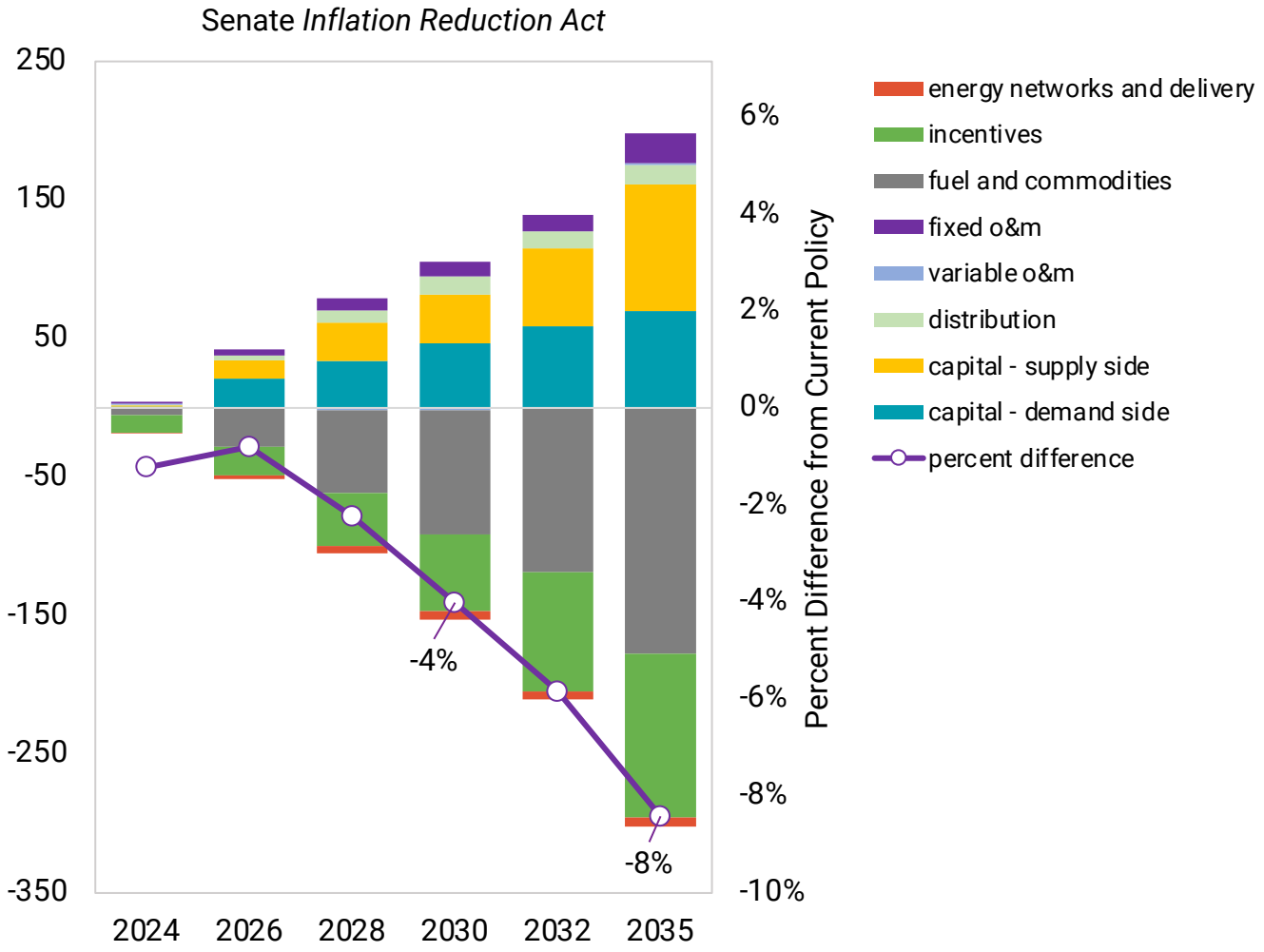
2 - Results reflect preliminary modeling based on the July 27, 2022 draft legislation.

3 - Impact on land carbon sinks based on analysis by Energy Innovation.

4 - Results reflect average of estimated high and low oil & gas production scenarios, which span +/- 20 Mt CO_2-e in 2030 (see p. 14-15).

Change in annual U.S. energy expenditures vs Current Policy (including Bipartisan Infrastructure Law)

billion 2022 USD



Enacting the *Inflation Reduction Act* would **lower annual U.S. energy expenditures by at least 4% in 2030**, a savings of nearly **$50 billion dollars** per year for households, businesses and industry. That translates into **hundreds of dollars in annual energy cost savings for U.S. households**.

Tax credits, rebates, and federal investments in the Act would shift costs from energy bills to the progressive federal tax base, lower the cost of electric and zero emissions vehicles, heat pumps, and efficiency upgrades for individuals and businesses, and finance investments in energy productivity improvements and carbon capture equipment by industry.

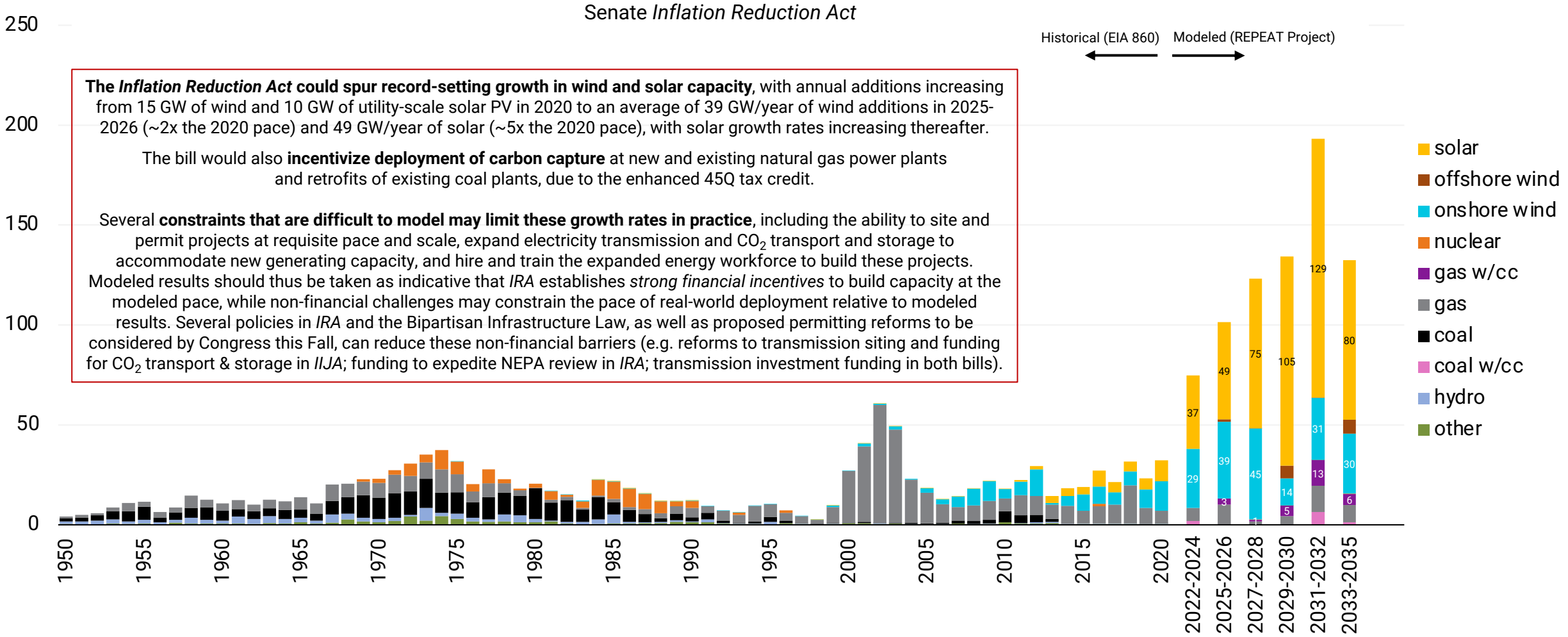
These **savings do not include the additional downward pressure the Act will put on prices for oil and natural gas** by driving lower consumption of these commodities, which will further reduce U.S. energy costs. Price responses to changes in demand are not captured in our energy system modeling.

Using a spreadsheet model of oil and gas elasticities, REPEAT Project estimates that **lower U.S. consumption of petroleum products and natural gas could reduce crude oil prices by approximately 5% and reduce U.S. natural gas prices by ~10-20%** in the medium term (2030-2035).[1]

1 – Based on supply/demand model of an internationally traded product derived from the appendix of Prest, 2022, "Partners, Not Rivals: The Power of Parallel Supply-Side and Demand-Side Climate Policy," Resources for the Future, Report 22-06, April 2022, (see p. 31). Oil price effect reflects 5-year elasticity for supply of 0.6 for US producers, 0.5 for foreign producers, and elasticity of consumption of 0.2. Natural gas price effect reflects 5-year elasticity of supply of 0.3 for US producers, 0.25 for foreign producers and elasticity of consumption of 0.2. Demand shock based on REPEAT Project modeled reductions in 2030 US petroleum product and natural gas consumption and initial global supply and demand from EIA *Short-Term Energy Outlook*. Natural gas price effect is modeled for both a fully integrated global market (7% predicted price effect) and fully isolated US market (23% price effect). Constrained LNG export capacity makes the US gas market partially integrated with global markets, and thus the price effect from a U.S. demand shock should fall between this range, hence the reported estimate of ~10-20%. Estimates should be considered approximate and reflect order of magnitude impacts given uncertainty in assumptions.

Historical Annual Capacity Additions vs. Modeled Annual Average Capacity Additions

gigawatts/year



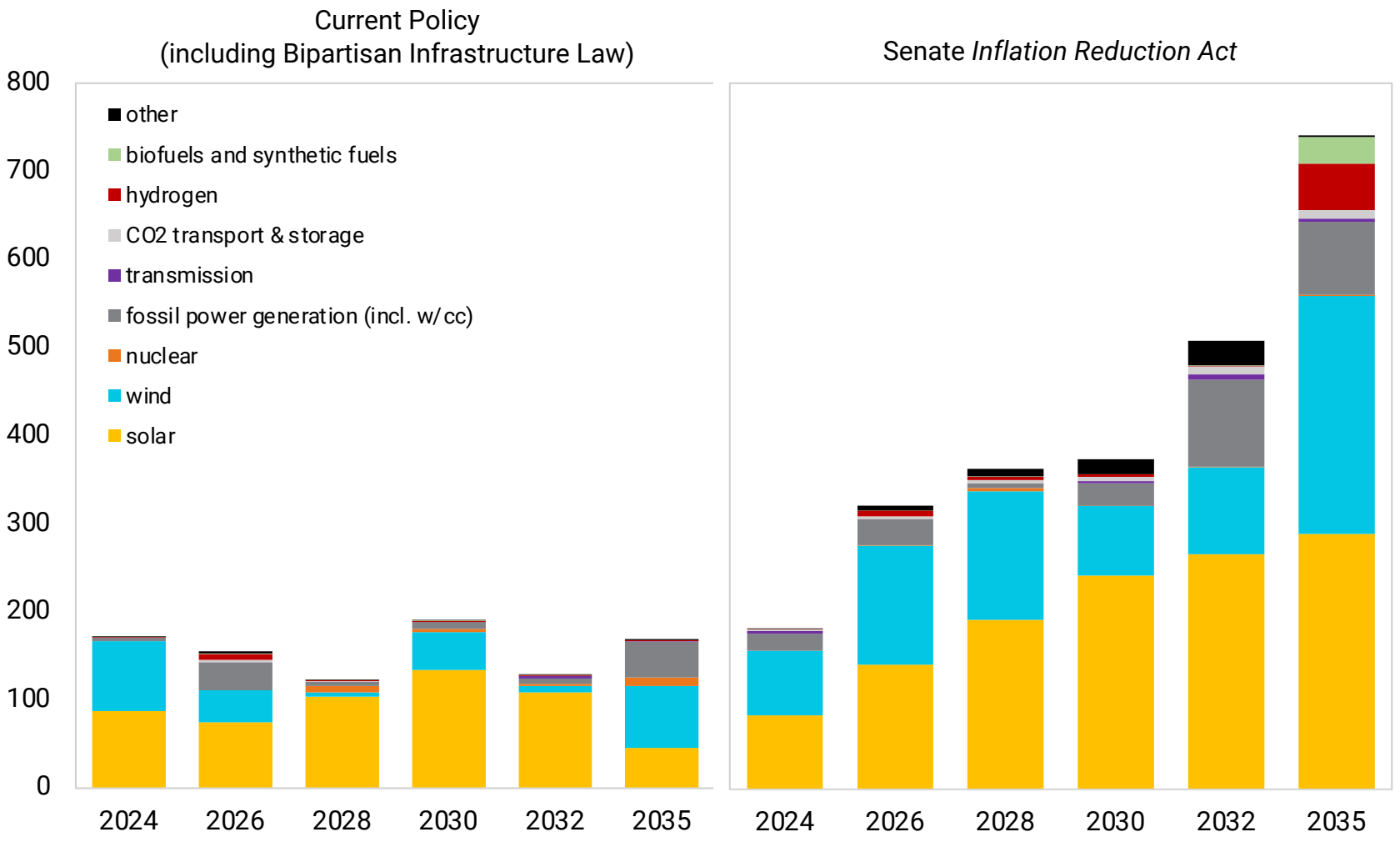
The *Inflation Reduction Act* could spur record-setting growth in wind and solar capacity, with annual additions increasing from 15 GW of wind and 10 GW of utility-scale solar PV in 2020 to an average of 39 GW/year of wind additions in 2025-2026 (~2x the 2020 pace) and 49 GW/year of solar (~5x the 2020 pace), with solar growth rates increasing thereafter.

The bill would also **incentivize deployment of carbon capture** at new and existing natural gas power plants and retrofits of existing coal plants, due to the enhanced 45Q tax credit.

Several **constraints that are difficult to model may limit these growth rates in practice**, including the ability to site and permit projects at requisite pace and scale, expand electricity transmission and CO_2 transport and storage to accommodate new generating capacity, and hire and train the expanded energy workforce to build these projects. Modeled results should thus be taken as indicative that *IRA* establishes *strong financial incentives* to build capacity at the modeled pace, while non-financial challenges may constrain the pace of real-world deployment relative to modeled results. Several policies in *IRA* and the Bipartisan Infrastructure Law, as well as proposed permitting reforms to be considered by Congress this Fall, can reduce these non-financial barriers (e.g. reforms to transmission siting and funding for CO_2 transport & storage in *IIJA*; funding to expedite NEPA review in *IRA*; transmission investment funding in both bills).

Annual capital investment in energy supply related infrastructure

Billion 2018 USD per year



The *Inflation Reduction Act* would drive nearly $3.5 trillion in cumulative capital investment in new American energy supply infrastructure over the next decade (2023-2032)**.**

That includes more than $20 billion in annual investment in CO_2 transport & storage and fossil power generation w/carbon capture by 2030.

Annual investment in hydrogen production (including electrolysis and methane reforming w/carbon capture) increases to $3 billion annually by 2030, triple levels under current policy, and rises to over $50 billion by 2035.

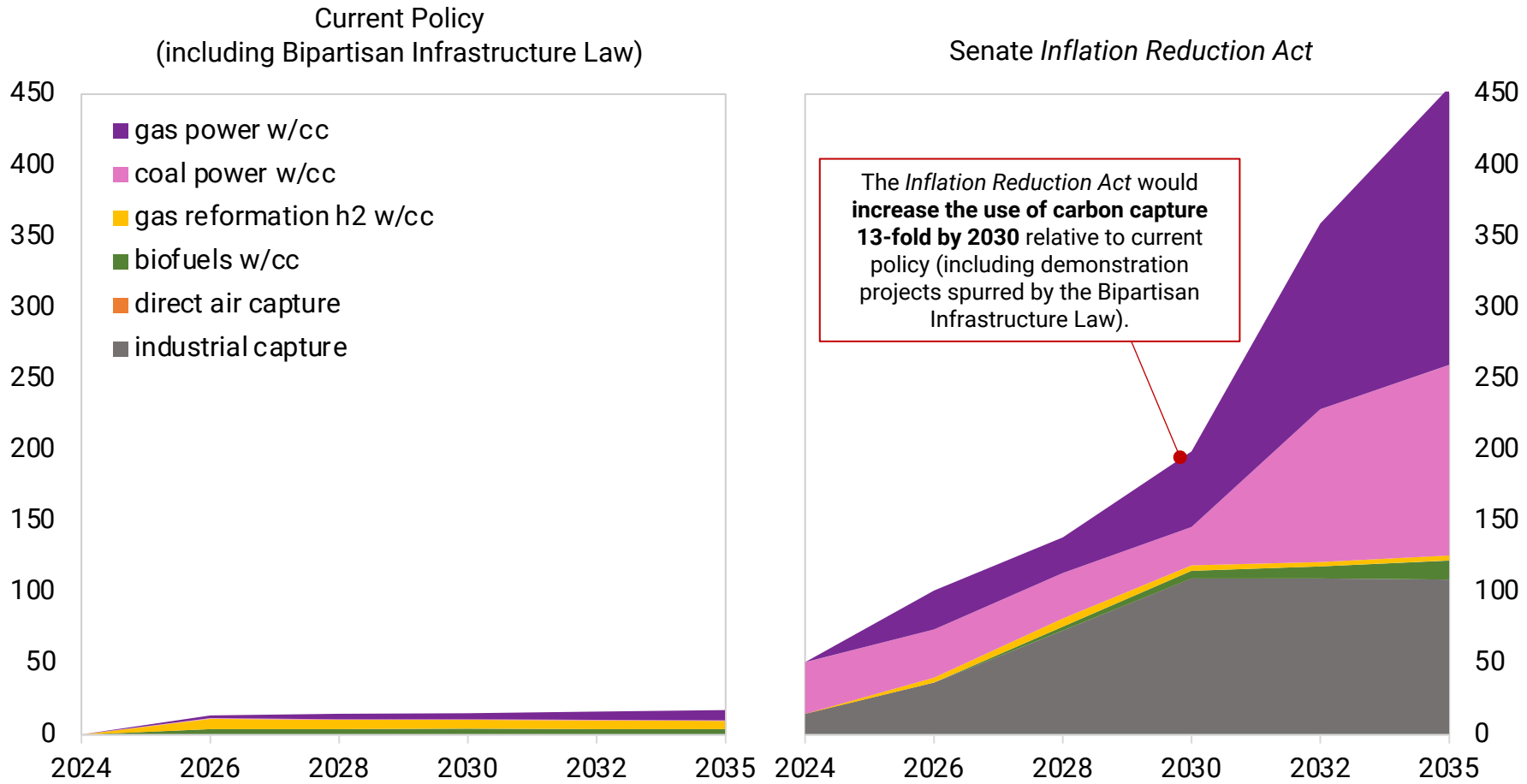
The Act has the greatest impact on investment in wind power and solar PV, which nearly doubles to $321 billion in 2030, versus $177 billion under current policy.

The Act will drive substantial additional investments by households and businesses on the demand side of the energy system, including purchases of more efficient and electric vehicles, appliances, heating systems, and industrial process.

It also provides tens of billions of dollars in grants, tax credits, and loan programs to develop manufacturing and supply chains for clean energy components, batteries, electric vehicles and critical minerals, spurring additional capital investment (and associated jobs) not captured in this report.

Annual carbon dioxide captured for transport and geologic storage

Million tons per year (Mt/y)



Incentives for carbon capture, storage, and use in the *Inflation Reduction Act* would build on demonstration funding in the Bipartisan Infrastructure Law to **make carbon capture a viable economic option** for the most heavily emitting industries, such as steel, cement, and refineries, as well as power generation from coal and natural gas.

The total volume of CO_2 captured for transport and geologic storage across energy and industry could reach **200 million tons per year** by 2030, if sufficient investment in transport networks and storage basins can be deployed.[1]

That includes roughly 110 million tons across industries and 90 million tons in power generation.[2] Modeled results include 6 gigawatts of carbon capture retrofits at existing coal-fired power plants and 18 gigawatts of gas power plants with carbon capture installed by 2030.

1 – Growth in annual CO2 injection capacity in storage basins is likely to constrain the pace of carbon capture deployment. This modeling assume maximum annual CO2 injections increase to 200 Mt CO2/y by 2030 based on expert input and Princeton *Net-Zero America* study.

2 – Industrial CO_2 capture volumes are fixed exogenously based on analysis in Larson et al., 2021, "Capturing the Moment: Carbon Capture in the American Jobs Plan," Rhodium Group, April 2021. Carbon capture in fuels conversion (biofuels, hydrogen, ammonia) and power generation are optimized in RIO modeling, constrained by remaining available annual injection volume limit.

Global and domestic demand for petroleum products and natural gas will be much larger drivers of future U.S. oil and gas production than the changes to public lands provisions in the *Inflation Reduction Act*.

To address this uncertainty, REPEAT Project constructs high and low oil and gas production scenarios that span a wide range of potential future domestic production (the variation in 2030 equals 11-12% of 2021 production levels, see p. 15) and estimates the impact on U.S. emissions for each scenario.

The low oil and gas production scenario assumes that reductions in U.S. petroleum products and natural gas consumption spurred by the Act result in lower domestic fossil fuel production while holding exports of oil and liquefied natural gas (LNG) fixed at the trajectory in the EIA's *Annual Energy Outlook 2022* (*AEO 2022*).

The high oil and gas production scenario assumes declining domestic consumption increases U.S. fossil fuel exports, with domestic production of oil and gas equal to the levels in *AEO2022*.

Despite wide variation in oil and gas production, the difference in 2030 U.S. emissions between high and low oil and gas production scenarios spans only 40 million metric tons per year; that's a plus or minus 2 percent variation around the ~1 billion tons per year of emissions reductions driven by the bill in 2030 (see p. 6).

The *Inflation Reduction Act* does include several notable changes to public lands policy that could affect oil and gas production in federal lands and waters.

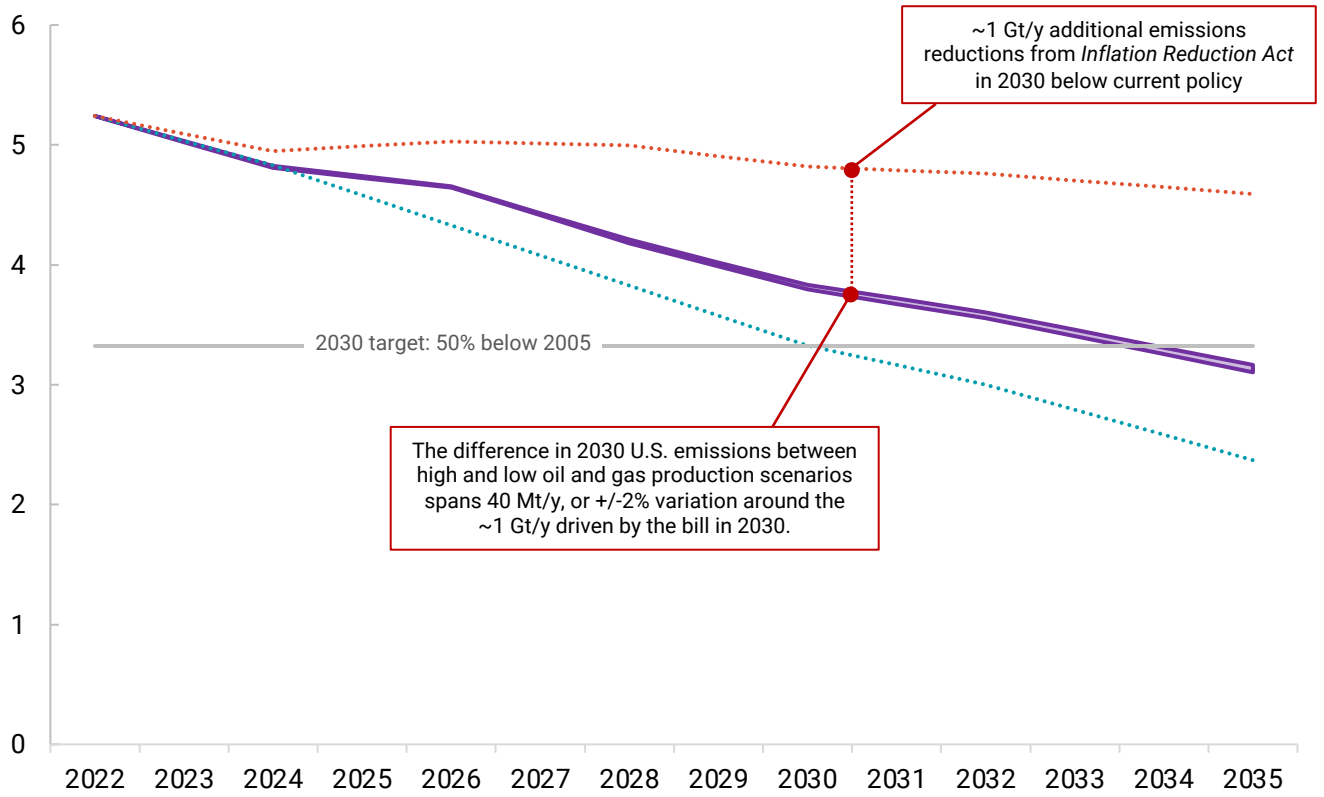
The Act specifically requires sale of four offshore lease areas that were previously withdrawn by court order or executive action. It also implements new rules that tie offshore wind lease offerings to recent offshore oil and gas lease offerings and links renewable energy leasing and right-of-way issuances on public lands to recent onshore oil and gas lease offerings.

The Act simultaneously increases royalties and rental fees for fossil fuel production in federal lands and waters, which may put downward pressure on future production. The Act also establishes a new fee on methane emissions in the oil and gas supply chain and provides $1.55 billion in funding to assist companies in monitoring and reducing methane pollution.

Modeling the specific impact of these countervailing provisions is challenging, but their impact is expected to be much smaller than the variation in production spanned by our high and low oil and gas production scenarios.

Modeled Net U.S. Greenhouse Gas Emissions (Including Land Carbon Sinks) Under High and Low Oil and Gas Production Scenarios[1]

billion metric tons CO_2-equivalent (Gt CO2-e)[1]

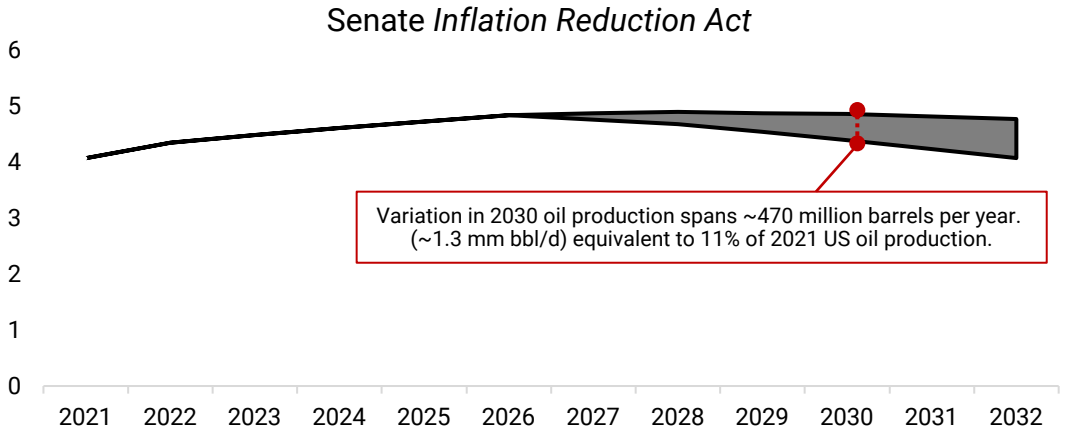


1- See p. 14 for description of high and low oil and gas production scenario assumptions.

2 - CO_2.equivalent emissions calculations use IPCC AR4 100 year global warming potential as per EPA Inventory of Greenhouse Gas Emissions and Sinks. U.S. emissions estimates include methane emissions from oil and gas supply chains and natural gas consumption in pipelines and liquefaction at LNG export terminals and exclude overseas consumption related emissions. **All values should be regarded as approximate given uncertainty in future outcomes.**

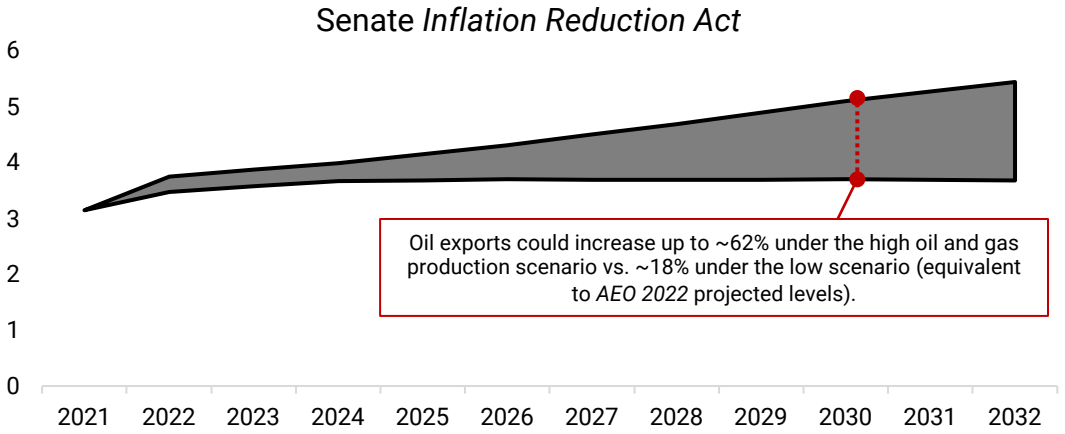
Range of potential U.S. crude oil production[1]

billion barrels per year



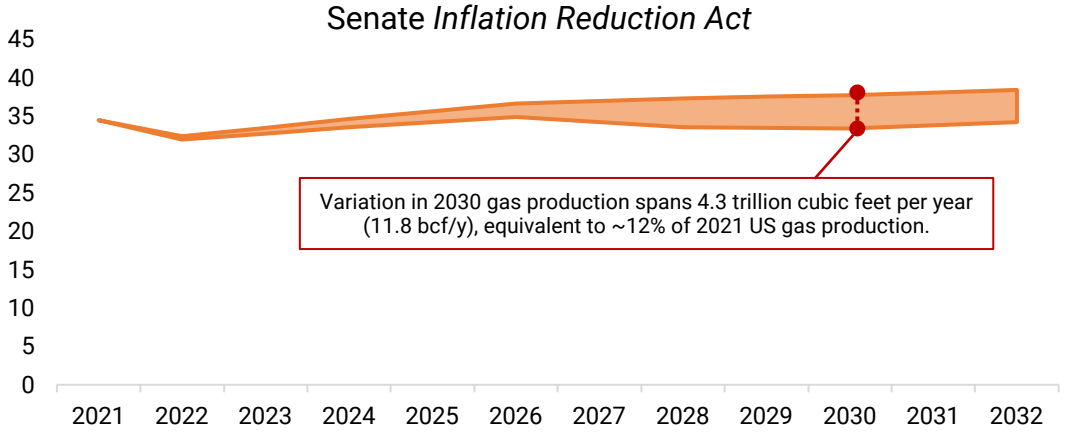
Range of potential U.S. crude oil and petroleum product exports[1]

billion barrels per year



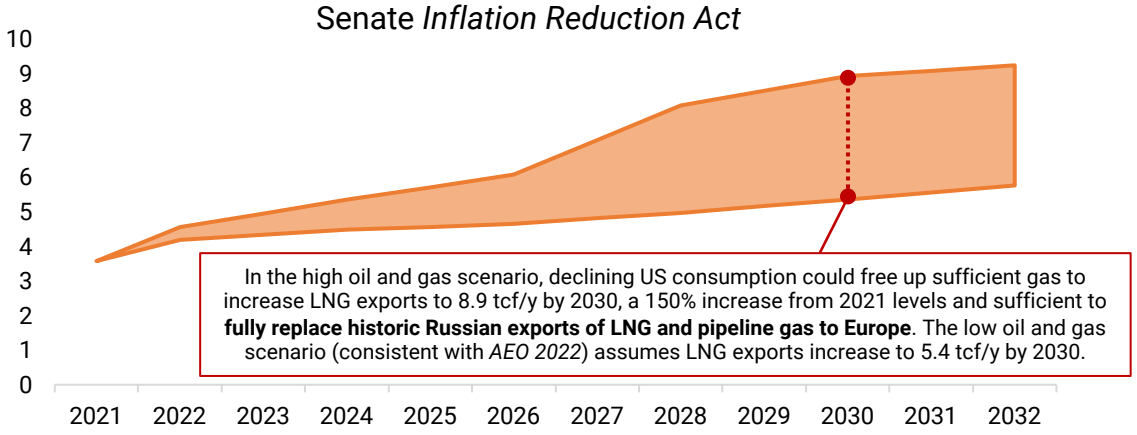
Range of potential U.S. natural gas production[2]

trillion cubic feet per year (tcf/y)



Range of potential U.S. liquefied natural gas (LNG) exports[2]

trillion cubic feet per year (tcf/y)



1 – **Low oil production scenario** assumes modeled changes in refined product consumption first reduce refined product imports. After refined products imports are eliminated, further reductions in refined product consumption result in reductions in domestic crude and crude imports in proportion to *AEO2022* ratio of domestic crude to imported crude. Assumes proportionate cut in refinery output across US refiners (and thus consistent blend in imported vs domestic crudes). US petroleum product exports equal to EIA *AEO2022* Reference scenario.
High oil production scenario assumes US production equal to *AEO2022* Reference scenario, with all reductions in domestic consumption leading to increases in petroleum and crude exports. Imports held constant at *AEO2022* Reference scenario levels.

2 – **Low natural gas production scenario** assumes all modeled declines in domestic consumption translate to lower production and imports, in proportion to *AEO2022* ratio of domestic production to total production and imports. LNG exports are equal to *AEO2022* Reference scenario.
High natural gas production scenario assumes US production equal to *AEO2022* Reference scenario and assumes US natural gas supply available for export as LNG is equal to projected exports from *AEO2022* plus an increase equal to modeled declines in domestic consumption (less consumption during liquefaction). The maximum increase in exports is constrained through 2028 by available LNG export capacity if lesser than domestic supply available for export. Includes scheduled completion of projects under construction: Sabine and Calcasieu in 2022 and Golden Pass terminal completed in 2024. Also includes additional capacity from Plaquemines (completed 2025), and Wildwood and Corpus Christi (2027) as per S&P projections given current contracted capacity for these permitted facilities. After 2028, additional LNG capacity is assumed to be added to export available supply. Note that global demand for US LNG may be insufficient to induce investment in this level of export capacity despite potentially available supply in this scenario.

Impact of additional, non-modeled policies

Beyond the direct emissions reduction impacts of the policies modeled in this report, the *Inflation Reduction Act* contains important policy measures and programs that will build spur innovation and maturation of nascent advanced energy industries, build U.S. clean energy manufacturing and supply chains, improve public health and environmental justice, and drive investment and economic opportunities in communities across the United States.

The Act builds on the demonstration and hubs funding in the Bipartisan Infrastructure Law by **providing early market deployment opportunities over the next decade that will drive innovation and maturation of important nascent clean technologies** that need to be ready for wide-scale deployment in the 2030s and 2040s, including clean hydrogen, carbon capture, zero-carbon liquid fuels, direct air capture, advanced nuclear and geothermal energy, and more. These technologies all have access to robust deployment subsidies (many for the first time)[1] that are likely to have a similar catalytic impact as the production and investment tax credits that cultivated wind and solar energy industries and drove costs down by ~90% for solar and ~70% for wind since 2009.

The Act contains **robust support for the development of American manufacturing of solar, wind, battery and electric vehicle components and assembly as well as critical minerals processing**. The bill ties bonus tax incentives for clean electricity and credits for consumer clean vehicles purchases to domestic content sourcing standards, providing strong demand for U.S. materials and manufacturing.[2] It also provides $2 billion in grants and $30 billion in loans to retool American auto manufacturing to produce clean vehicles and $37 billion in new tax credits to spur investment in America's capacity to produce and assemble wind and solar PV components, batteries and clean vehicles, and process critical minerals.[3] An additional $0.5 billion is also appropriated for the President to use the Defense Production Act to build American supply chains for heat pump and battery manufacturing, critical minerals, and other strategic priorities.[4] Those policies are important to expand supply chains and enable rapid scale-up of these technologies, and they will also create **hundreds of thousands of manufacturing jobs across the country**, giving countless communities a direct, tangible, near-term stake in the clean energy transition.

1 – These include the clean hydrogen PTC (Sec. 13204), 45q tax credit for CCS (Section 13104), and new technology-neutral production and investment tax credits for all carbon-free electricity generation (Sec. 13701 and 13702) and a clean fuel production tax credit (Sec. 13704). The bill also provides $40 billion in expanded loan authority for the DOE Loan Programs Office (LPO) to support investment in nascent clean energy sectors.

2 – A bonus 10% increase in the value of the production tax credit (Sec. 13101 and 13701) and 10 percentage point increase in the investment tax credit (Sec. 13102 and 13702) are available for clean electricity projects that meet domestic content requirements for materials and manufactured components. The consumer clean vehicles tax credit (Section 13401) is also tied to increasing requirements for sourcing of batteries and critical minerals from North America or our trade partners.

3 – See the Domestic Manufacturing Conversion Grants (Sec. 50143), Advanced Vehicle Technology Manufacturing loan program at DOE (Sec. 50142), and the 48C Advanced Energy Project Credit (Sec. 13501) and Advanced Manufacturing Production Credit (Sec. 13502).

4 – Enhanced Use of Defense Production Act of 1950 (Sec. 30001).

Impact of additional, non-modeled policies (continued)

A package of environmental justice provisions in the *Inflation Reduction Act* provide at least $60 billion to reduce harmful pollution in environmentally overburdened communities, ensure more equitable access to renewable energy and energy efficiency and building electrification opportunities, and improve public health and climate resiliency.

A variety of programs will direct funding to **cut pollution in low-income communities and areas burdened by the worst air pollution in the country**. This includes $3 billion for block grants for community-led environmental and climate justice projects and more than $4 billion in funds to reduce air pollution at America's ports, replace dirty heavy duty vehicles like garbage trucks and city buses with zero-emissions vehicles, and improve interior air quality in schools in low-income communities.[1] The bill funds 'fenceline' air pollution monitoring to empower EPA and local air quality agencies to track and reduce pollution burdens on the most vulnerable communities, and it appropriates needed funding for the White House to map and identify environmental justice communities on the frontlines of pollution.[2] The bill reinstates (and adjusts for inflation) the 'polluter pays' Superfund Tax to cover the cost of remediating the worst environmentally contaminated industrial sites, and it invests $1 billion to improve energy and water efficiency, indoor air quality, and climate resiliency of affordable housing and over $3 billion to improve transportation access and affordability.[3]

The *Inflation Reduction Act* also dedicates tens of billions of dollars to **expand equitable access to clean and efficient technologies**. The $27 billion Greenhouse Gas Reduction Fund devotes more than half of this funding to deploy clean energy and pollution-reducing technologies in low-income and disadvantaged communities and to establish 'green banks' to provide financial assistance for clean energy projects benefiting disadvantaged communities.[4] Hundreds of millions in grants and $20 billion in loan authority will help Tribal and Native Hawaiian communities improve climate resilience, access clean electricity, and electrify buildings.[5] Finally, two rebate programs also provide $8.8 billion to ensure access to energy efficiency and building electrification funds for low- and middle-income households that lack tax liability to take advantage of other tax credits.[6]

1 – See the $3 billion Environmental and Climate Justice Block Grants program (Sec. 60201), $3 billion for Grants to Reduce Air Pollution at Ports (Sec. 60102), $1 billion for Clean Heavy-Duty Vehicles (Sec. 60101), $60 million for Diesel Emissions Reductions (Sec. 60104), and $50 million for Funding to Address Air Pollution at Schools (Sec. 60106).

2 – See the $281 million Funding to Address Air Pollution (Sec. 60105) and $32.5 million Environmental and Climate Data Collection program for the White House Council on Environmental Quality (Sec. 60401).

3 – See the Reinstatement of Superfund (Sec. 13601), Improving Energy Efficiency or Water Efficiency or Climate Resilience of Affordable Housing (Sec. 30002), and Neighborhood Access and Equity Grant Program (Sec. 60501).

4 – The Greenhouse Gas Reduction Fund (Sec. 60103) dedicates at least $15 billion out of $27 billion in total funding to low-income and disadvantaged communities.

5 – See Tribal Energy Loan Guarantee Program (Sec. 50145), $260m for Tribal Climate Resilience and Native Hawaiian Climate Resilience (Sec. 80001 and 80002), $150m Tribal Electrification Program (Sec, 80003) and $13m Emergency Drought Relief for Tribes (Sec. 80004).

6 – See the $4.3 billion Home Energy Performance-Based Whole-House Rebates Program (Sec. 50121) and $4.5 billion High-Efficiency Electric Home Rebate Program (Sec. 50122).

Impact of additional, non-modeled policies (continued)

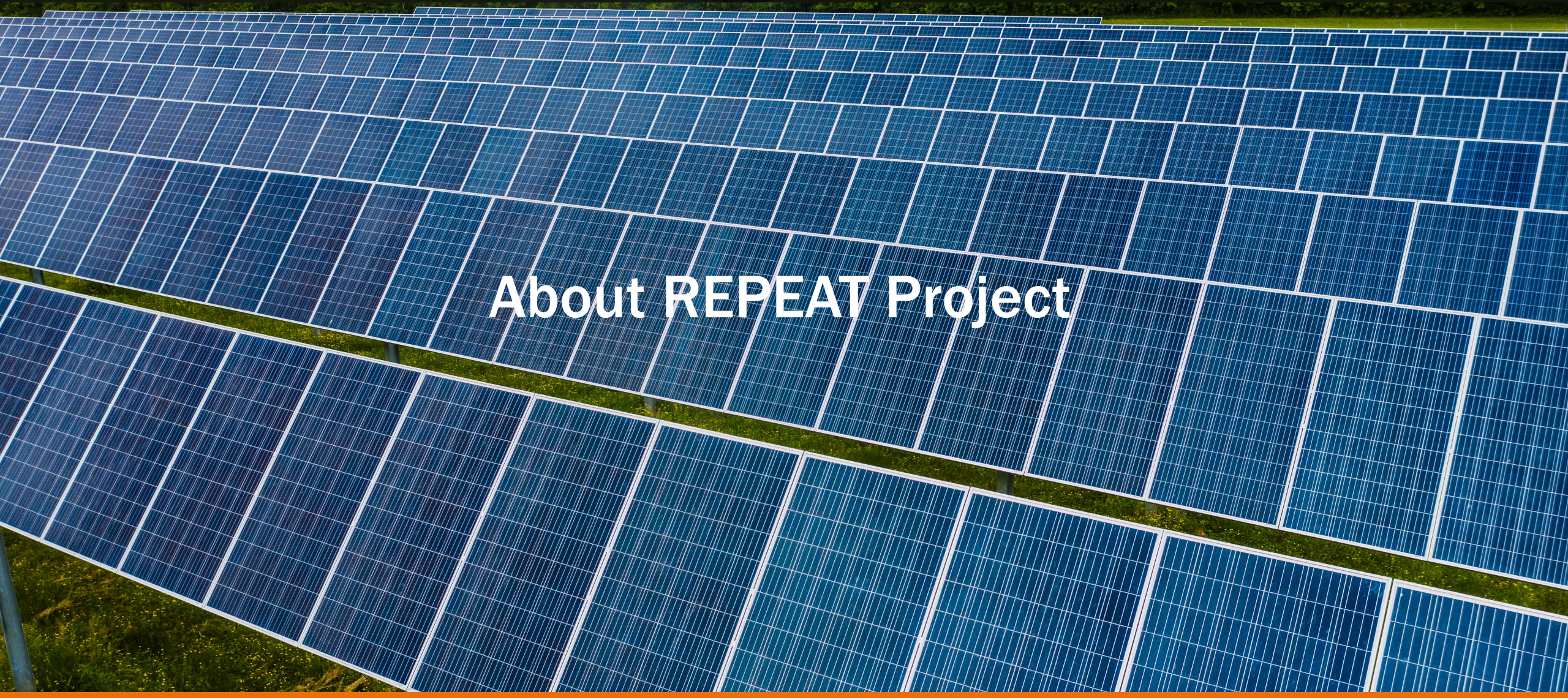
The *Inflation Reduction Act* provides grants, loans, and tax incentives that will drive hundreds of billions of dollars in cumulative investment in American energy communities between now and 2030. Bonus tax credits are available for investments in clean electricity generation sited in traditional 'energy communities' across America, defined as areas with significant historical employment in energy resource, extraction, processing or transportation or where coal plants or mines have closed in recent decades, providing a strong financial incentive to retool and repower existing power plant sites and reinvest in energy producing communities.[1] These tax incentives complement $9.7 billion in financial assistance for rural electric cooperatives to install zero-emissions generation, carbon capture, or grid upgrades and $5 billion in appropriations to create a new energy community reinvestment financing program that will support up to $250 billion in loan guarantees to retool, repower, repurpose, or replace aging energy infrastructure and install carbon capture and other low emissions retrofits at electricity generation and fuels production and refining facilities.[2] The Act also sets aside $4 billion in tax incentives that will spur at least $13 billion in clean energy manufacturing investments in these energy communities.[3]

The impacts of most of these provisions are beyond the scope of this project to model, but they will nevertheless deliver real, salient benefits for diverse communities across the country.

1 – A bonus 10% increase in the value of the production tax credit (Section 13101 and 13701) and 10 percentage point increase in the investment tax credit (Section 13102 and 13702) are available for clean electricity projects installed in 'energy communities.'

2 – See the USDA Assistance for Rural Electric Cooperatives program (Sec. 22004) and new DOE Section 1703 Energy Infrastructure Reinvestment Financing program (Sec. 50144).

3 – The 48C Advanced Energy Project Credit (Sec. 13501) specifically sets aside $4 billion (out of $10 billion in total incentives) for energy communities; the 30% investment tax credit will spur at least $13.3 billion in investment.



About REPEAT Project

A New Toolkit for Evaluating Energy and Climate Policy

The **REPEAT Project** provides regular, timely and independent environmental and economic evaluation of federal energy and climate policies as they're proposed and enacted, offering a detailed look at the United States' evolving energy and climate policy environment and the country's progress on the road to net-zero greenhouse gas emissions.

Approach: employ geospatial planning and analysis tools coupled with detailed macro-energy system optimization models to **rapidly evaluate federal policy and regulatory proposals at politically-relevant spatial resolutions** (e.g., state, county, and finer resolutions). A refinement of methods used in the Princeton *Net-Zero America* study.

Goal: provide independent, timely, and credible information and analysis for broad educational purposes, including as a resource available publicly for stakeholders, decision-makers, and the media.

Funding: funding for the REPEAT Project was provided by a grant from the Hewlett Foundation.

The REPEAT Team

Princeton ZERO Lab: Prof. Jesse D. Jenkins (PI); Dr. Neha Patankar (research scholar); Dr. Qingyu Xu (postdoc); Annie Jacobson (PhD candidate); Undergraduate research assistants: Claire Wayner, Aneesha Manocha, Riti Bhandakar, Cady Feng

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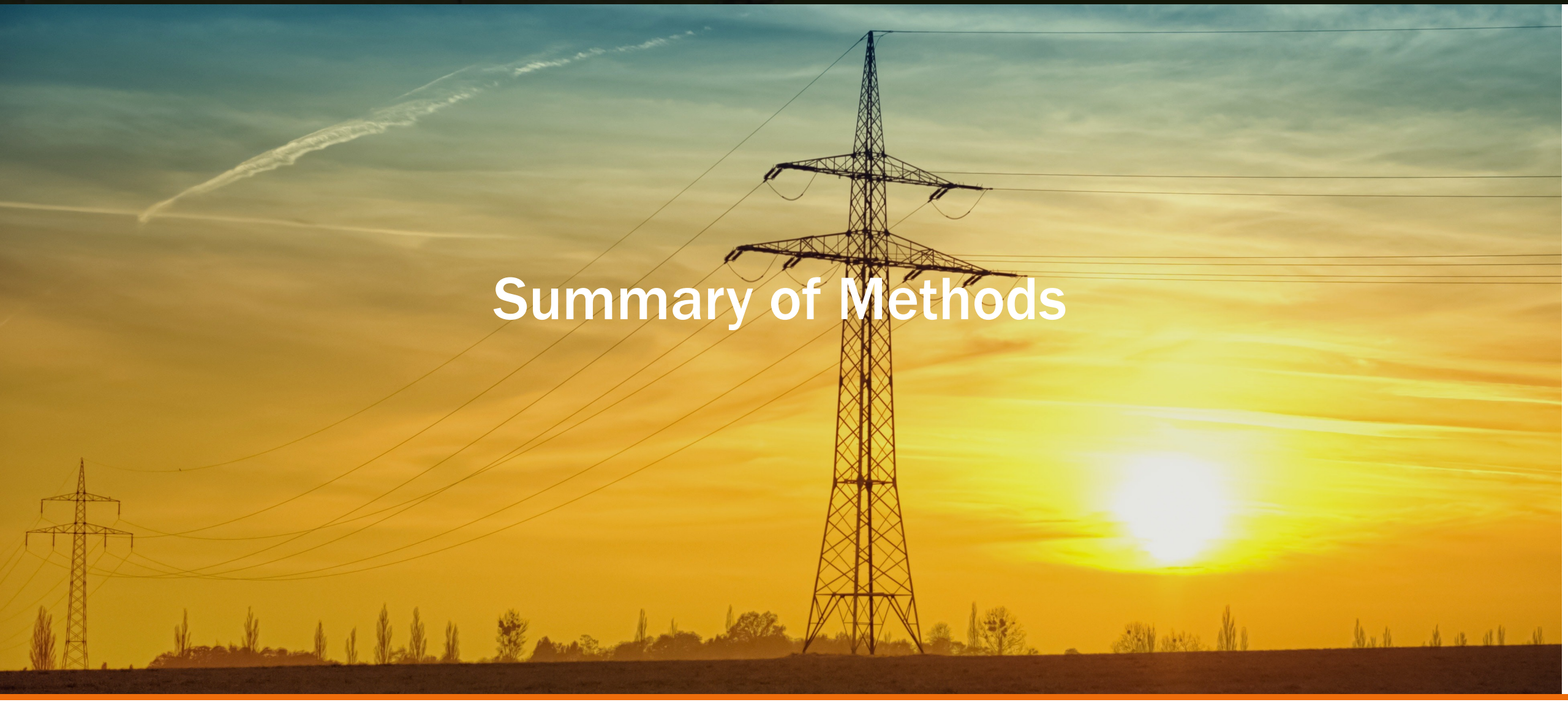
Evolved Energy Research: Ryan Jones, Jamil Farbes (macro-energy systems modeling)

Carbon Impact Consulting: Greg Schivley (scenario inputs, transmission interconnection routing, etc.)

Montara Mountain Energy: Emily Leslie, Andrew Pascale (renewable energy candidate project areas, transmission cost surface)

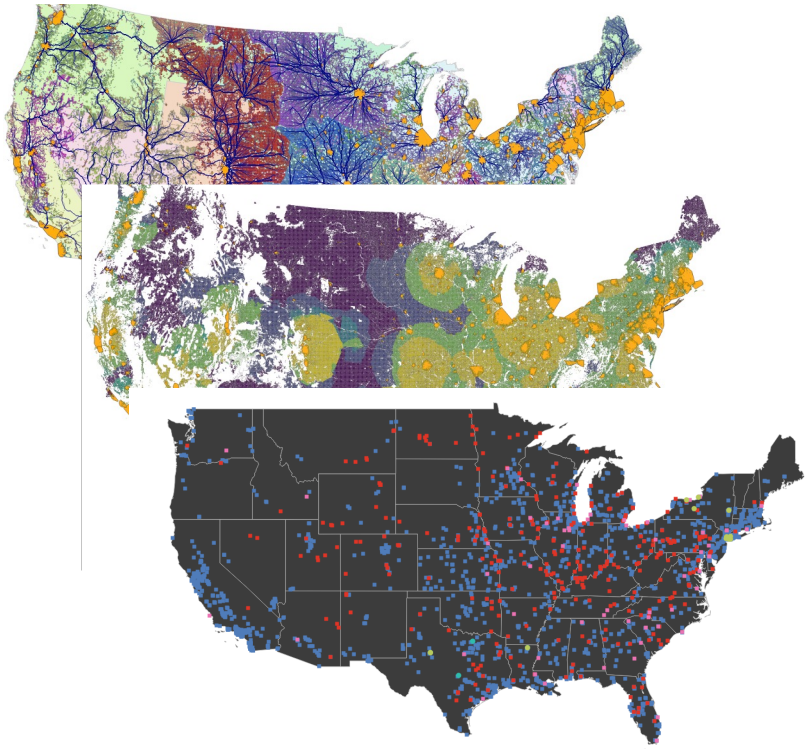
Website development by Hyperobjekt.



Summary of Methods

Analysis Framework

1. Geospatially-resolved inputs



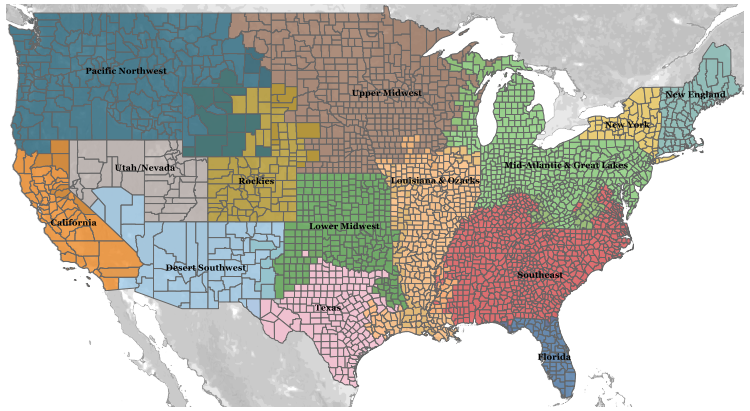
2. Macro-energy systems modeling

EVOLVED ENERGY RESEARCH

EnergyPATHWAYS scenario tool

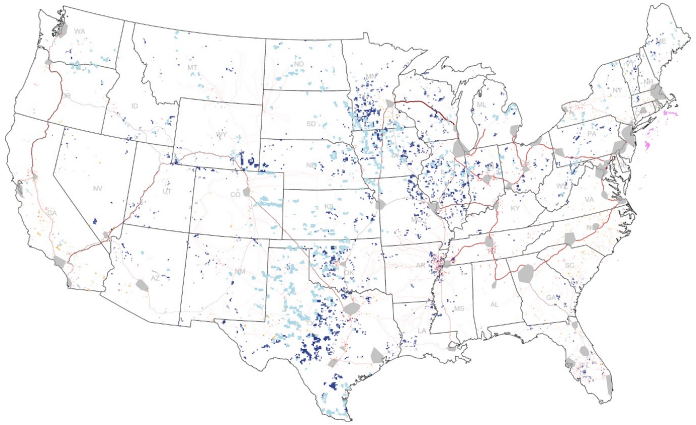
+

RIO optimization tool

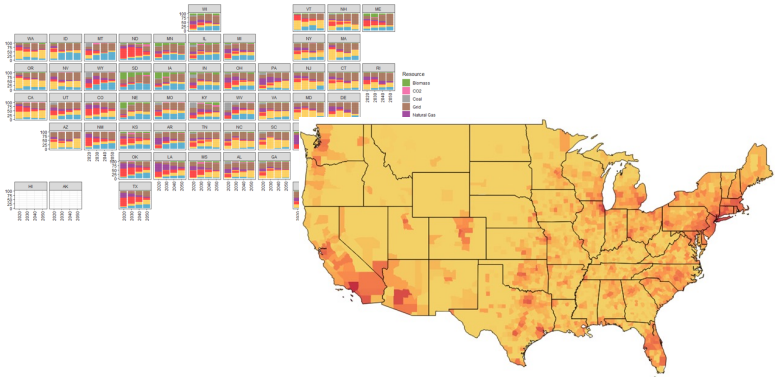


MIT-Princeton **GenX** model may be used for power-sector specific policies in future

3. Geospatially-resolved downscaling & mapping



4. Impact modeling (employment & air pollution)



Scenarios modeled in this report

Frozen Policies Benchmark – no new policies or regulations after January 2021.

Net-Zero Pathway Benchmark – cost-effective pathway to reduce GHG emissions 50% below 2005 levels by 2030 and net-zero by 2050, consistent with President Biden's climate mitigation goals.

Current Policies, including the Bipartisan Infrastructure Law, (Infrastructure Investment and Jobs Act, H.R. 3685) as signed into law on November 15, 2021.

Senate draft Investment Reduction Act ('**IRA July '22**', H.R. 5376 amendment), as released by the Senate Democratic Leadership on July 27, 2022.

House-passed Build Back Better Act ('**BBBA Nov '21**', H.R. 5376), as passed by the U.S. House of Representatives on November 19, 2021.

See **https://bit.ly/REPEAT-Policies** for detailed section-by-section descriptions of climate and clean energy related policies in each legislation and explanation of treatment in REPEAT Project modeling.

Senate *Inflation Reduction Act* (IRA), July 2022 version, modeled policies

Title I, Finance (Part D, Energy Security)

Clean Electricity and Reducing Carbon Emissions

Section 13101, Extension of credit for electricity produced from certain renewable sources (PTC)

Section 13102, Extension and modification of energy credit (ITC)

Section 13103, Increase in energy credit for solar facilities placed in service in connection with low-income communities

Section 13104, Extension and modification of credit for carbon oxide sequestration (45Q)

Section 13105, Zero-emission nuclear power production credit[1]

Clean Fuels

Section 13201, Extension of incentives for biodiesel, renewable diesel and alternative fuels

Section 13202, Extension of second generation biofuels incentives

Section 13203, Sustainable aviation fuel credit

Section 13204, Clean hydrogen PTC

Clean Energy and Efficiency Incentives for Individuals

Section 13301, Extension, increase, and modification of nonbusiness energy property credit (25C)

Section 13302, Residential energy efficient property

Section 13303, Energy efficient commercial buildings deduction

Section 13304, Extension, increase, and modification of new energy efficient home credit (45L)

Clean Vehicles

Section 13401, Clean vehicle credit

Section 13403, Qualified commercial electric vehicles (45W)

Section 13404, Alternative fuel refueling property credit

Investment in Clean Energy Manufacturing and Energy Security

Sections 13501, Extension of the advanced energy project credit[2]

Incentives for Clean Electricity and Transportation

Sections 13701 and 13702, Clean Electricity Production Credit and Clean Electricity Investment Credit (Section 45Y and 48D)

Section 13704, Clean fuel production tax credit

1 -- Due to error in implementation, this provision is not correctly included in these preliminary modeling results; ~11 GW of nuclear retirements occur in the 2029-2030 period, which should be prevented by this provision, potentially resulting in ~30-50 Mt CO_2 higher power sector emissions in reported results. This will be corrected in forthcoming update to this analysis.

2 – Modeled in part, assuming 20% of total credit available supports industrial efficiency improvements).

Senate *Inflation Reduction Act* (IRA), July 2022 version, modeled policies (continued)

Title II, Agriculture:

Section 21001, Additional Agricultural Conservation Investments*
Section 21002, Conservation Technical Assistance*
Section 22002, Rural Energy for America program
Section 23001, National Forest System Restoration and Fuel Reduction Projects*
Section 23002, Non-Federal Land Forest Restoration and Fuels Reduction Projects and Research*
Section 23003, State and Private Forestry Conservation Programs*

Title III, Banking

Section 30002, Improving Energy Efficiency or Water Efficiency or Climate Resilience of Affordable Housing

Title V, Energy and Natural Resources

Section 50121, Home energy performance-based, whole house rebates and training programs
Section 50122, High-efficiency electric home rebate program
Section 50151, Transmission lines and intertie grants
Section 50161, Advanced Industrial Facilities Demonstration Program
Section 50221, National Park and Public Lands Conservation and Resilience*
Section 50222, National Park and Public Lands Conservation and Ecosystem Restoration *

Title VI, Environment and Public Works

Section 60101, Clean heavy duty vehicles program
Section 60103, Greenhouse Gas Reduction Fund
Section 60113, Methane Emissions Reduction Program (estimated impact)
Section 60201, Environmental justice and climate justice block grants
Section 60502, Assistance to Federal Buildings

Title VII, Homeland Security and Government Affairs

Section 70002, U.S. Postal Service clean vehicle fleet and facility maintenance

Title VII, Indian Affairs

Section 80003, Tribal Electrification Program

* -- REPEAT Project lacks modeling capabilities to reflect impacts of grant programs and other incentives on land carbon sinks and carbon sequestration in agriculture and forestry lands. We therefore adopt emissions impact estimates for these programs based on analysis conducted by Energy Innovation.

Senate *Inflation Reduction Act* (IRA), July 2022 version, modeled policies (notes)

Notes:

Section 13401 Clean Vehicle Credit is modeled as follows: for 2022-2024, EV and PHEV sales shares are fixed at levels consistent with BNEF forecasts prior to passage of IRA, e.g. we model no change from incentives in IRA through 2024, assuming sales are constrained by available supply during this period. Sales shares as per BNEF are 8% in 2022, 11% in 2023 and 14% in 2024, with 80% BEV and 20% PHEV, both split 40%/60% across light autos/trucks and SUVs. Over 2025-2032, the effective value of the credit phases in, assuming the sector progressively reorients to meet the requirements with assistance of the advanced manufacturing PTC for batteries and materials, ATVM loan program, domestic manufacturing conversion grants, and support in IIJA for critical minerals and batteries: $5000 in 2025/2026 period (~67%); $6000 in 2027/2028 period (~80%); $7500 in 2029/2032 period (~100%). Note that the 2025-2032 period could also include negotiation of new Free Trade Agreements with critical minerals producing countries to support compliance with the materials sourcing requirements.

Section 13501 Extension of the advanced energy project credit (section 48C clean energy manufacturing investment credit) and Section 13502 Advanced Manufacturing Investment Credit (production tax credit for wind turbine, solar PV and battery component manufacturing and critical materials processing) are implicitly assumed to support growth of domestic supply chain.

Section 13101, 13102, 13701 and 13702 production and investment tax credits

All eligible projects are assumed to qualify for Bonus tax credits (full value) consistent with prevailing wage and apprenticeship requirements through Title I.

Additional bonus tax credits for domestic content through Title I are assumed to cover incremental costs of domestic content when available or to be waived due to inadequate supply, and hence impact on modeled costs is not considered.

Potential impact of Section 22001, Additional Funding for Electric Loans for Renewable Energy ($1b of forgivable loan authority) is assumed to be expended before marginal resource, so does not impact marginal deployment in model (a conservative assumption).

Section 22004 Clean Energy Repowering for Rural Utilities funding ($9.7 billion) is not modeled.

Potential impact of Section 50141 DOE Loan Program Office funding ($40 billion of loan guarantee authority, $3.6 billion for credit subsidy) is assumed to be expended before marginal resource, so does not impact marginal deployment in model (a conservative assumption).

Section 50142 Advanced technology vehicle manufacturing ($3 billion) and Section 50143 Domestic manufacturing conversion grants ($2 billion) assumed to provide support for expanded domestic supply chain to meet domestic content requirements for consumer EV credits.

Section 50144 Energy community reinvestment financing ($5 billion) is implicitly supportive of modeled transition.

Section 50152 Grants for facilitating inter-state transmission, Section 50153 inter-regional and offshore wind transmission planning, modeling and analysis, Section 50301 and Section 50302 funding for DOE and FERC environmental reviews are all implicitly supportive of the 'low friction' deployment environment for transmission in RIO.

Sections 40003, 50303, 60115, 60301, 60402, 60505 provide funding across various agencies for expedited and efficient NEPA review, which may facilitate 'low friction' deployment environment in RIO.

House *Build Back Better Act* (BBBA), Nov. 2021 version, modeled policies

Agriculture, Title I, Subtitle C:

Section 11001, National Forest System Restoration and Fuel Reduction Projects*
Section 11002, Non-Federal Land Forest Restoration and Fuels Reduction Projects and Research*
Section 11003, State and Private Forestry Conservation Programs*
Section 12004, Rural Energy Savings program
Section 12005, Rural Energy for America program
Section 15001, Soil Conservation Assistance*
Section 15002, Additional Agricultural Conservation Investments*
Section 15003, Conservation Technical Assistance*

Energy & Commerce, Title III, Subtitles A, B, D:

Section 30101, Clean heavy duty vehicles program
Section 30103, GHG Reduction Fund
Section 30114, Methane fee (estimated impact)
Section 30202, Environmental justice and climate justice block grants
Section 30411, Home energy performance-based, whole house rebates and training programs
Section 30412, High-efficiency electric home rebate program
Section 30421, Critical facility modernization
Section 30431, Electric vehicle supply equipment rebate program
Section 30451, Transmission lines and intertie grants
Section 30471, Advanced Industrial Facilities Deployment Program

Financial Services, Title IV, Subtitle B

Section 40006, Direct loans and grants for energy or water efficiency or climate resilience of affordable housing

Natural Resources, Title VII, Subtitle B

Section 70103, Tribal Electrification Program

Oversight and Reform, Title VII, Subtitle A

Section 80001, General Services Administration clean vehicle fleet
Section 80003, U.S. Postal Service clean vehicle fleet and facility maintenance
Section 80008, General Services Administration Procurement and Technology

Transportation and Infrastructure, Title XI

Section 110002, Community Climate Incentive Grant Program
Section 110010, Assistance to Federal Buildings

* -- REPEAT Project lacks modeling capabilities to reflect impacts of grant programs and other incentives on land carbon sinks and carbon sequestration in agriculture and forestry lands. We therefore adopt emissions impact estimates for these programs based on analysis conducted by Energy Innovation.

House *Build Back Better Act* (BBBA), Nov. 2021 version, modeled policies (continued)

Ways and Means, Title XIII, Subtitle G

Renewable Electricity and Reducing Carbon Emissions

Section 136101, Extension of credit for electricity produced from certain renewable sources (PTC)

Section 136102, Extension and modification of energy credit (ITC)

Section 136103, Increase in energy credit for solar facilities placed in service in connection with low-income communities

Section 136104, Elective payment for energy property and electricity produced from certain renewable resources (direct pay)

Section 136105, Investment credit for electric transmission property

Section 136106, Extension and modification of credit for carbon oxide sequestration (45Q)

Section 136108, Zero-emission nuclear power production credit

Renewable Fuels

Section 136201, Extension of excise tax credit relating to alternative fuels (biodiesel credit)

Section 136202, Extension of second generation biofuels incentives

Section 136203, Sustainable aviation fuel credit

Section 136204, Clean hydrogen PTC

Green Energy and Energy Efficiency Incentives for Individuals

Section 136301, Extension, increase, and modification of nonbusiness energy property credit (25C)

Section 136302, Residential energy efficient property

Section 136303, Energy efficient commercial buildings deduction

Section 136304, Extension, increase, and modification of new energy efficient home credit (45L)

Greening the Fleet and Alternative Vehicles

Section 136401, Refundable new qualified plug-in electric drive motor vehicle credit for individuals: light duty vehicles

Section 136403, Qualified commercial electric vehicles (45V)

Section 136405, Alternative fuel refueling property credit

Incentives for Clean Electricity and Transportation

Sections 136801 and 136802, Clean Electricity Production Credit and Clean Electricity Investment Credit (Section 45AA and 45BB)

Section 136803, Increase in clean electricity investment credit for facilities placed in service in connection with low-income communities

Section 136805, Clean fuel production tax credit

Note: BBBA scenario includes modeling of all policies enacted as part of the Infrastructure Investment and Jobs Act of 2021 (IIJA) and thus represent the cumulative impact of passage of IIJA and BBBA.

House *Build Back Better Act* (BBBA), Nov. 2021 version, modeled policies (notes)

Notes:

Potential impact of Section 12003 Additional Funding for Electric Loans for Renewable Energy ($2.88b of forgivable loan authority) is assumed to be expended before marginal resource, so does not impact marginal deployment in model (a conservative assumption).

Section 12007 Clean Energy Repowering for Rural Utilities funding ($9.7 billion) is not modeled.

Section 30116 Climate Pollution Reduction Grants ($5 billion) is assumed to be enabling of the 'low friction' deployment environment in the RIO model.

Section 30444 State energy transportation plan funding is implicit in/supportive of 'low friction' deployment environment for EVs in the RIO model.

Potential impact of Section 30451 DOE Loan Program Office funding ($40 billion of loan guarantee authority, $3.6 billion for credit subsidy) is assumed to be expended before marginal resource, so does not impact marginal deployment in model (a conservative assumption).

Section 30452 Advanced technology manufacturing ($3 billion) and Section 30453 Domestic manufacturing conversion grants ($3.5 billion) assumed to provide support for expanded domestic supply chain to meet domestic content requirements for EV bonus credits in Ways & Means Title.

Section 30454 and 30455 Energy community reinvestment financing ($5.2 billion) is implicitly supportive of modeled transition.

Section 30452 Grants for facilitating inter-state transmission, Section 30453 technical assistance grants for RTOs/ISOs, and Section 30454 inter-regional and offshore wind transmission planning, modeling and analysis, and Section 30461 and Section 30462 funding for DOE and FERC environmental reviews are all implicitly supportive of the 'low friction' deployment environment for transmission in RIO.

Section 136501 Extension of the advanced energy project credit (section 48C clean energy manufacturing investment credit) and Section 136504 Advanced Manufacturing Investment Credit (production tax credit for wind turbine and solar PV component manufacturing) are implicitly assumed to support growth of domestic supply chain.

All eligible projects are assumed to qualify for Bonus tax credits (full value) consistent with prevailing wage and apprenticeship requirements through Title XIII

Additional bonus tax credits for domestic content through Title XIII are assumed to cover incremental costs of domestic content when available or to be waived due to inadequate supply, and hence impact on modeled costs is not considered.

All eligible projects are assumed to qualify for direct pay via domestic content or via waivers due to inadequate supply.

Infrastructure Investment and Jobs Act (IIJA) modeled policies

Division A. Surface Transportation

Section 11115, Congestion mitigation and air quality improvement program
Section 11401, Grants for charging and fueling infrastructure
Section 11403, Carbon reduction program
Apportionment, National Electric Vehicle Formula program

Division D. Energy

Section 40106, Transmission facilitation program
Section 40304, Carbon dioxide transportation infrastructure finance and innovation
Section 40308, Carbon removal (direct air capture 'hubs')
Section 40314, Additional clean hydrogen hubs
Section 40323, Civil nuclear credit program
Section 40333, Maintaining and enhancing hydroelectricity incentives
Section 40342, Clean energy demonstration program on current and former mine land
Section 40502, Energy efficiency revolving loan fund capitalization grant program
Section 40521, Future of industry program and industrial research and assessment centers (small & medium sized manufacturer energy efficiency grants)
Section 40541, Grants for energy efficiency improvements and renewable energy improvements at public school facilities
Section 40542, Energy efficiency materials pilot program
Section 40551, Weatherization assistance program
Section 40552, Energy Efficiency and Conservation Block Grant Program
Section 40554, Assisting Federal Facilities with Energy Conservation Technologies grant program
Section 40601, Orphaned well site plugging, remediation, and restoration
Section 41001, Energy storage demonstration projects
Section 41002, Advanced reactor demonstration project
Section 41004, Carbon capture demonstration and pilot programs
Section 41008, Industrial emissions demonstration programs
Section 41201, Office of Clean Energy Demonstrations

Division G. Other Authorizations

Section 71101, Clean school bus program

Division J. Appropriations

National Electric Vehicle Formula Program
Port Infrastructure Development Program

Notes:

REPEAT Project lacks modeling capabilities to reflect the net effect of surface transportation investments in highways (which tend to increase on-road vehicle and freight miles traveled) and rail and public transit (which tend to reduce on-road vehicle and freight miles traveled). These significant programs are therefore not modeled in this analysis. However according to the Georgetown Climate Center, the emissions impact of these changes depend heavily on state implementation of funding from IIJA, which could result in anywhere from -14 Mt/yr to +25 Mt/y change in CO_2 emissions from transportation in 2030.

We also do not model impacts of the Department of Energy Loan Programs Office, which has significant prior loan authority that was expanded and revised by the IIJA (Section 40401).

Net-Zero Pathway: Non-CO_2 and land sink assumptions drive modeled CO_2 targets

Gt CO_2-e			
Year	Non-CO_2	Total Land sink	CO_2 Energy and Process
1990	1.10	-0.7	5.06
2005	1.19	-0.7	5.92
2010	1.24	-0.7	5.52
2015	1.35	-0.7	5.43
2020	1.35	-0.75	5.16
2025	1.30	-0.80	4.12
2030	1.07	-0.85	3.08
2035	0.89	-0.85	2.29
2040	0.88	-0.85	1.51
2045	0.85	-0.85	0.72
2050	0.83	-0.85	-0.06

- The non-CO_2 trajectory used to determine modeled CO_2 limits in the Net-Zero Pathway Benchmark scenario is based on EPA's 2019 analysis
  - US data from EPA's global non-CO_2 report, **includes all mitigation measures up to $500 per tCO_2e**
  - Through 2030, **a $60 per tCO_2e fee on CH_4 would achieve more than half of the reductions** assumed by this trajectory (~130 Mt CO_2e)
  - The American Innovation and Manufacturing Act passed in December 2020 also requires **phase down of HFCs**, which will result in an additional ~120 Mt CO_2e reduction in 2030).
- Land sink assumptions are based on a National Academies study and analysis by Energy Innovation
  - Through 2030, land sink increases by ~100 million tCO_2e/y (while BAU would gradually decline).
  - By 2050 existing land sink declines to 300 million tCO_2e/y but incremental measures add 550 Mt CO_2-e/y resulting in a total land sink of 850 Mt CO_2-e/y.
- CO_2 energy and process emissions targets achieve net-anthropogenic GHG targets for 2030 (50% below 2005) and 2050 (net-zero).

Vehicle sales methodology overview

The Frozen Policy and Net-Zero sales trajectories are scenario based

- Frozen Policy tracks AEO 2021 vehicle adoption
- Net-Zero assumes an S-curve change in sales patterns that saturate in 2035, consistent with a comprehensive and sustained effort to achieve economy-wide net-zero GHG at low cost

Policy case sales are based on a co-optimization of energy supply and vehicle adoption to show how lowering vehicle costs can impact deployment of key technologies

- The optimization model chooses vehicle adoption based on a distribution of required consumer payback times for investment and implied discount rates. Different shares of the market are parameterized with different discount rates and consumers select vehicles based on cost-effectiveness given purchase/investment costs and discounted operating and fuel costs.
- Vehicle costs are derived using a combination of AEO, ICCT and BNEF data sources, allowing for comparability to AEO reference vehicles while also capturing declining battery and fuel cell cost. Fuel switching and pro-rata shares of charging/fueling station costs are part of the adoption decision in the optimization.
- Vehicle sales were calibrated to 2030 AEO levels of vehicle adoption utilizing a friction factor which accounts for costs not directly captured in the optimization.
- Incentives in the policy cases lower the overall cost of vehicles, including both the capital cost and any associated charging station costs. Fuel costs (such as electricity) are endogenous and can also vary across policy cases. Changes in incentives and fuel costs result in different vehicle investment and ownership costs, which in turn, changes the vehicle sales share mix over time.

Treatment of policy incentives for other demand-side adoption

For demand-side choices other than vehicles (e.g. heating, cooling, building efficiency), sales trajectories are scenario based in all cases.

- Frozen Policy tracks AEO 2021 vehicle adoption
- Net-Zero assumes an S-curve change in sales patterns that saturate in 2035, consistent with a comprehensive and sustained effort to achieve economy-wide net-zero GHG at low cost

For policy cases: we allocate funds from demand-side incentives to specific end-use subsectors and assume these funds "buy our way up the S-curve" of adoption for each technology in Net-Zero pathway.

- We calculate incremental up-front cost of all demand-side subsectors in the Net-Zero scenario vs the Frozen Policy scenario (e.g. commercial ventilation, residential building shells, residential heating, etc.).
- We total all available budgets for incentives for each demand-side subsector (with some judgement applied as to allocation of budgets that apply to multiple sub-sectors; see Policy Worksheet for details).
- We reduce effective budget for all demand-side measures (incl. vehicles) by 20% to reflect administration, implementation costs, programmatic inefficiencies, and funding for inframarginal purchases that would have occurred otherwise (a simplifying assumption reflecting that programs are not perfectly efficient in allocating available funds).
- Then we follow the sales curve for the Net-Zero scenario, using the policy funds to cover incremental costs of the subsector in the Net-Zero scenario relative to the Frozen Policies scenario until the available funds are exhausted.
- After funds are exhausted, sales shares stay fixed at the highest level achieved at that time.

A note on interpretation of modeled results

Optimization modeling used in this work assumes rational economic behavior from all actors. The modeling also has limited 'frictions' on deployment of infrastructure (e.g., power generation or transmission capacity), scale-up of industry supply chains (e.g., wind and solar), or consumer adoption of alternative products (e.g., EVs, heat pumps).

Real world outcomes will contend with various non-cost related challenges that may slow pace of change relative to modeled results.

Modeling results should thus be interpreted as indications of the relative alignment of economic incentives as a result of policy changes. In other words, these results indicate what decisions make good economic sense for consumers and businesses to make. This is likely a necessary condition, but whether or not actors make such decisions in the real world depends on many factors we are unable to model.

Additionally, modeled outcomes reflect a least-cost optimization process. There are likely many alternative outcomes with near-optimal costs (e.g., similar costs within a few percent of these outcomes) which may offer advantages in terms of other important outcomes related to the distribution of costs and benefits associated with energy systems. Various stakeholders may prefer one or more of these alternative portfolios to the outcomes presented herein.

Readers should interpret modeled results accordingly.

REPEAT Rapid Energy Policy Evaluation and Analysis Toolkit

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