REPEAT Rapid Energy Policy Evaluation and Analysis Toolkit

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PRINCETON UNIVERSITY

ZERO LAB

Zero-carbon Energy Systems Research and Optimization Laboratory

Summary Report: The Climate Impact of Congressional Infrastructure and Budget Bills

This version: February 28, 2022

Summary Report: The Climate Impact of Congressional Infrastructure and Budget Bills (February 28, 2022)

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Suggested citation: Jenkins, J.D., Mayfield, E.N., Jones, R., Farbes, J., Patankar, N., Xu, Q., Jacobson, A., Schivley, G., Leslie, E., Pascale, A., Wayner, C., Manocha, A., Bhandarkar, R., and Feng, C. 2022, "Summary Report: The Climate Impacts of Congressional Infrastructure and Budget Bills," REPEAT Project, Princeton, NJ, February 28. doi:10.5281/zenodo.6311986

Access and download data and other resources at **repeatproject.org**

Preface

This report describes the national-scale 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 but remains stalled in the Senate. To track the impacts of Congressional negotiations, we also model the original version of the Build Back Better Act introduced in September 2021 (H.R. 5376, H. Rept. 117-130) .

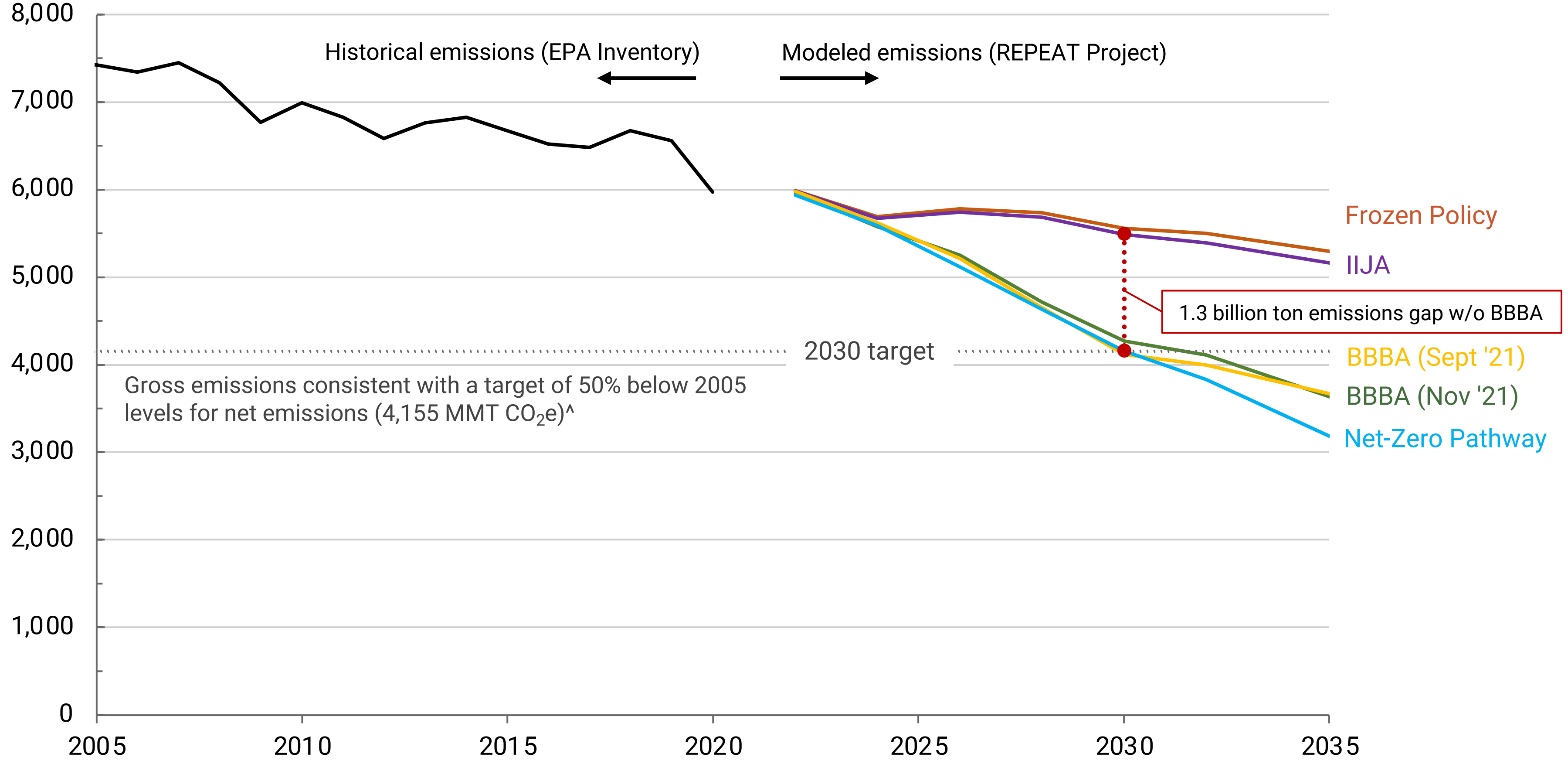
The report also presents two 'benchmark' scenarios: **Frozen Policies**, which captures the impacts of federal policies and regulations as of the start of the 117th Congress and inauguration of President Biden in January 2021; and **Net-Zero Pathway,** a cost-optimized pathway to reduce economy-wide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

This report contains macro-energy system modeling results including impact on carbon dioxide emissions, clean energy and electric vehicle deployment, fossil energy use, and more, along with estimated impacts on U.S. energy expenditures, capital investment in energy supply infrastructure, energy supply-related employment changes and improvements in air pollution and public health.

Executive Summary

Total Gross U.S. Greenhouse Gas Emissions

million metric tons CO_2-equivalent^



Enacting the climate and clean energy investments in **BBBA (Nov '21)** would cut U.S greenhouse gas emissions by **a cumulative 5.2 billion tons CO_2-equivalent** between 2022-2030 and put the United States within easy reach of President Biden's commitment to cut emissions to half of peak levels by 2030.

Without such policies, the recently enacted **IIJA** would leave annual greenhouse gas emissions **1.3 billion tons short of the nation's 2030 climate goals**, a yawning gap unlikely to be bridged by executive action and state policy alone.

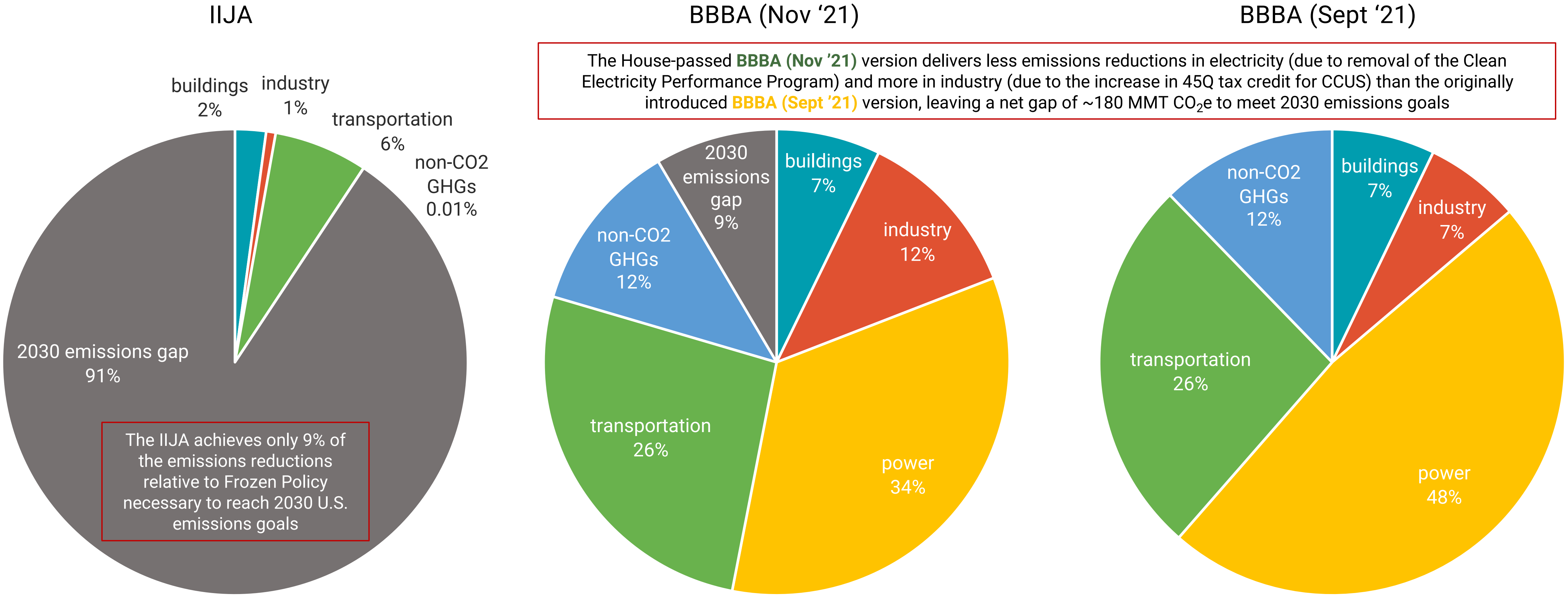
^ - CO_2e calculations use 100 year global warming potential equivalence as per EPA Inventory of Greenhouse Gas Emissions. Gross emissions exclude net changes in land carbon sinks. Target for gross emissions reductions by 2030 assumes 100 MMT CO_2-e increase in net land carbon sinks, bringing net GHG emissions to 50% below 2005 levels. See p. 15 for additional details.

* - 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 MMT to +25 MMT change in CO_2 emissions from transportation.

2030 Contributions to Gross U.S. Greenhouse Gas Emissions Reductions Needed to Reach U.S. Climate Targets

percentage of gross emissions reductions relative to Frozen Policy Benchmark consistent with a target of 50% below 2005 levels for net emissions (-1,405 MMT CO_2e)^

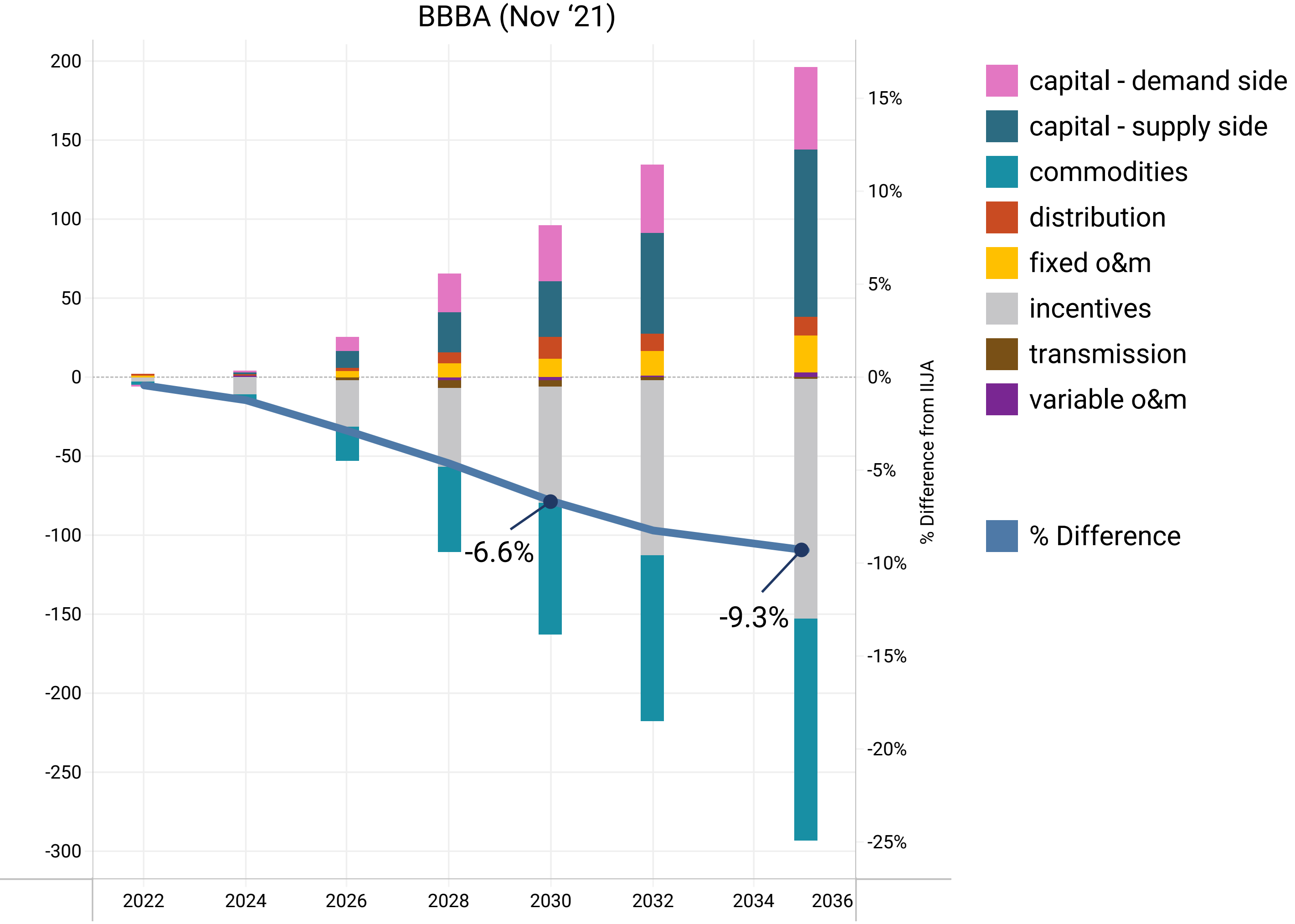
The House-passed **BBBA (Nov '21)** version delivers less emissions reductions in electricity (due to removal of the Clean Electricity Performance Program) and more in industry (due to the increase in 45Q tax credit for CCUS) than the originally introduced **BBBA (Sept '21)** version, leaving a net gap of ~180 MMT CO_2e to meet 2030 emissions goals



^ - CO_2-e calculations use 100 year global warming potential equivalence as per EPA Inventory of Greenhouse Gas Emissions. Gross emissions exclude net changes in land carbon sinks.
Target for gross emissions reductions by 2030 assumes 100 MMT CO_2-e increase in net land carbon sinks, bringing net GHG emissions to 50% below 2005 levels. See p. 15 for additional details.

Change in annual U.S. energy expenditures vs IIJA

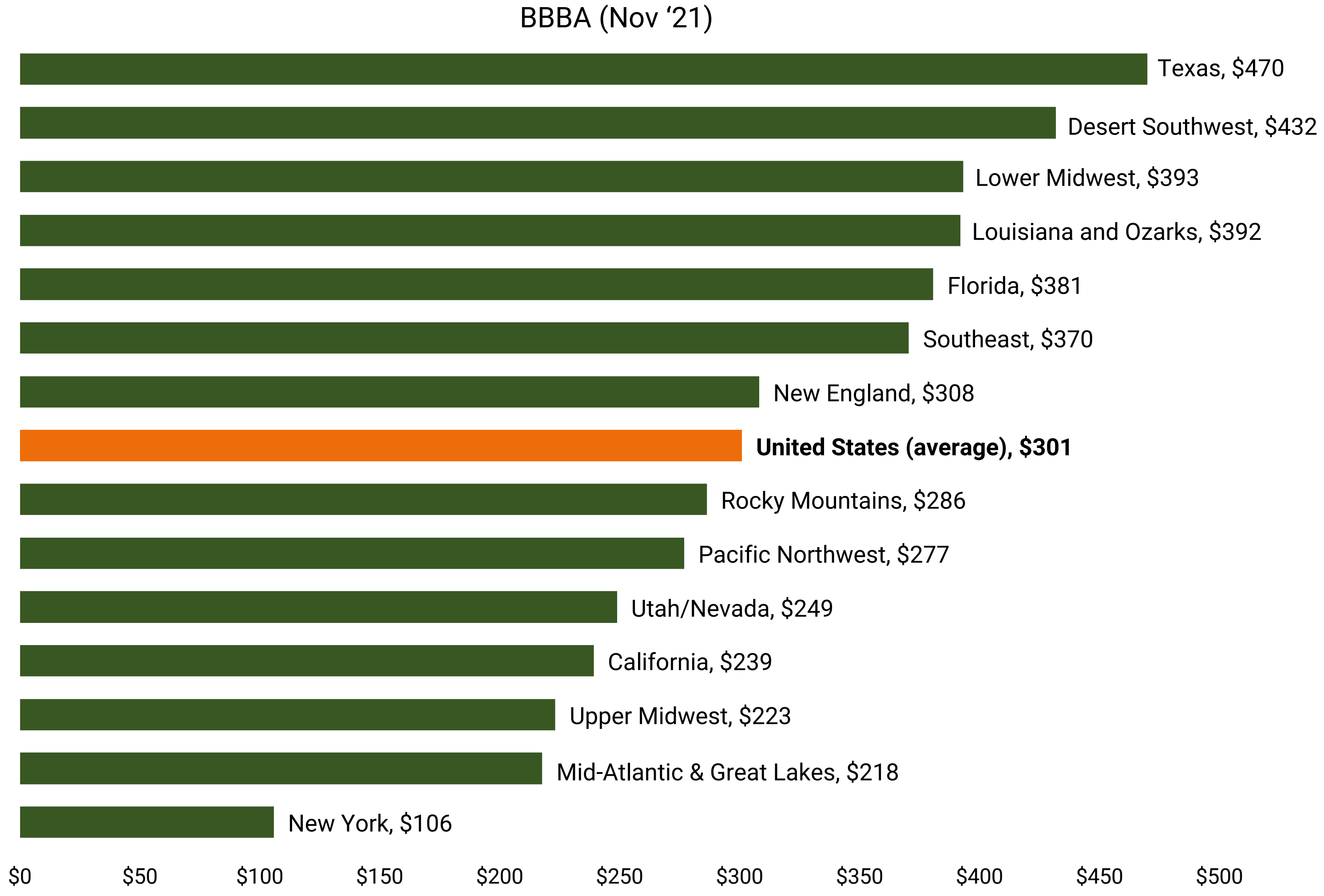
billion 2018 USD



Enactment of BBBA (Nov '21) **lowers annual U.S. energy expenditures by 6.6% in 2030**, an annual savings of **$67 billion dollars** for households, businesses and industry. 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 and heat pumps for individuals and businesses, and finance investments in energy productivity enhancing improvements and carbon capture equipment by U.S. industry.

Reduction in 2030 average household energy costs vs IIJA

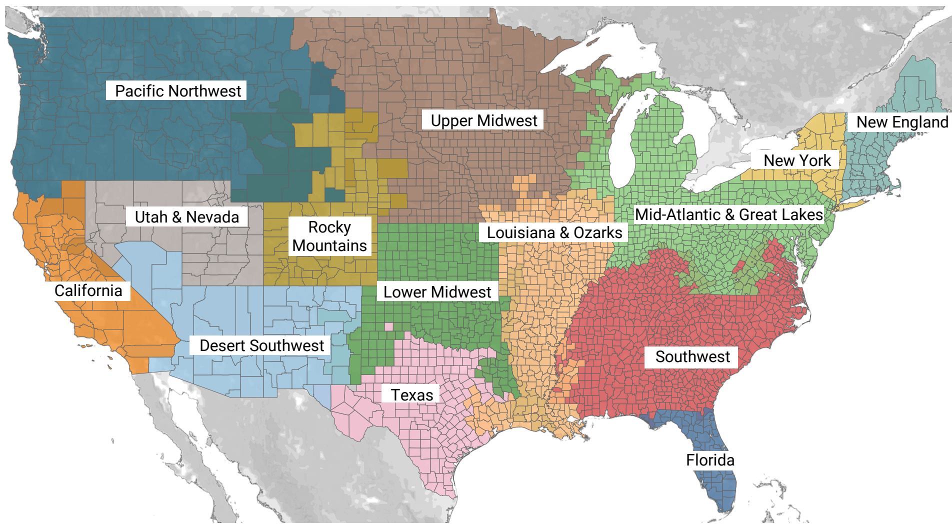
2018 USD per household per year



Enactment of BBBA (Nov '21) would **reduce average household energy costs in 2030 across all regions** of the country, delivering **about $300 per year in savings to the average U.S. household** relative to costs under IIJA alone.

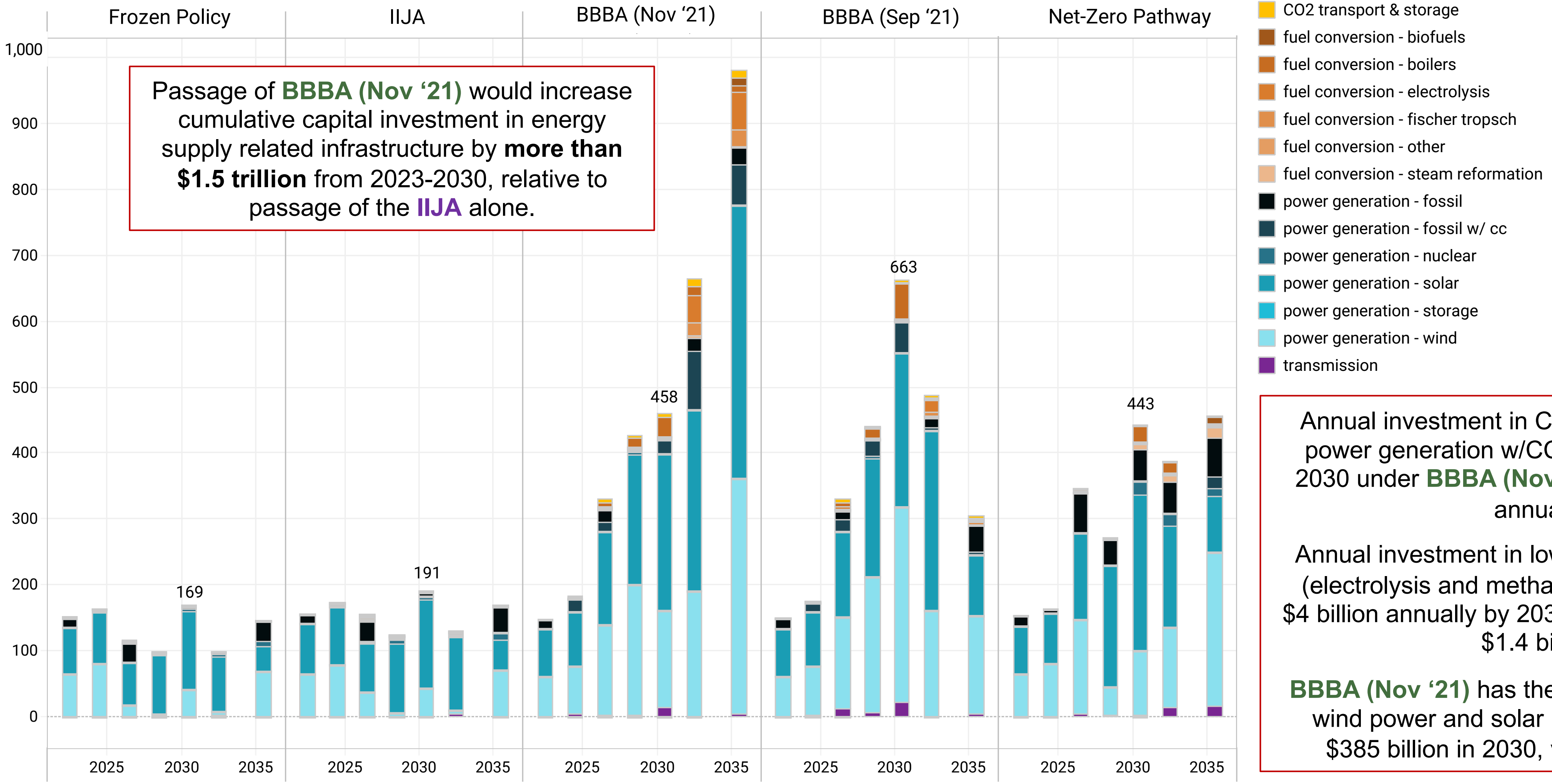
Average household savings across U.S. regions ranges from about $100 to $470 per household per year.

RIO model regions



Annual capital investment in energy supply related infrastructure vs IIJA

Billion 2018 USD per year



Average annual supply-side capital investment, 2023-2030

2018 dollars/year

Frozen Policy: $126 billion

IIJA: $150 billion

BBBA (Nov. ’21): $313 billion

BBB (Sept ‘21): $315 billion

Net-Zero Pathway: $260 billion

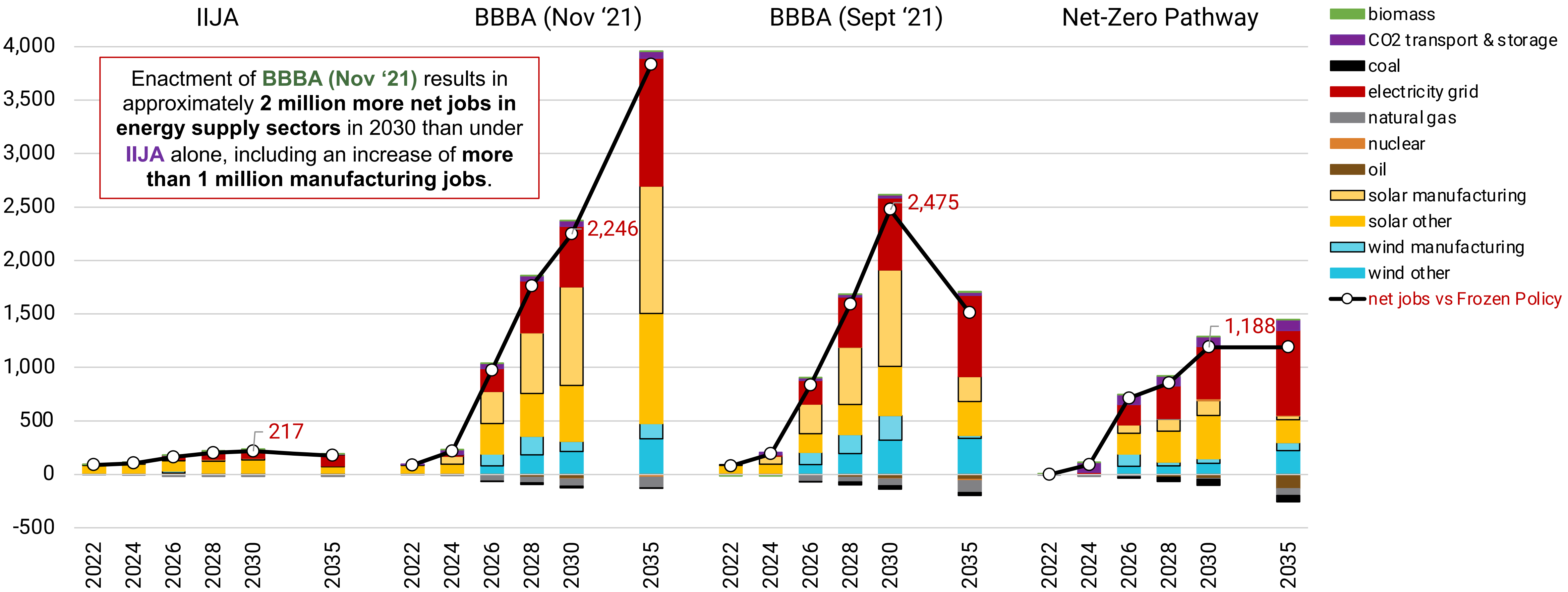
Annual investment in CO_2 transport & storage and fossil power generation w/CC reaches $24 billion annually by 2030 under **BBBA (Nov ‘21)**, up from less than $2 billion annually under **IIJA**.

Annual investment in low emissions hydrogen production (electrolysis and methane reforming w/CC) increases to $4 billion annually by 2030 under **BBBA (Nov ‘21)**, up from $1.4 billion under **IIJA**.

BBBA (Nov ‘21) has the greatest impact on investment in wind power and solar PV, which more than doubles to $385 billion in 2030, versus $177 billion under **IIJA.**

Net change in energy supply-related employment by energy resource vs Frozen Policy

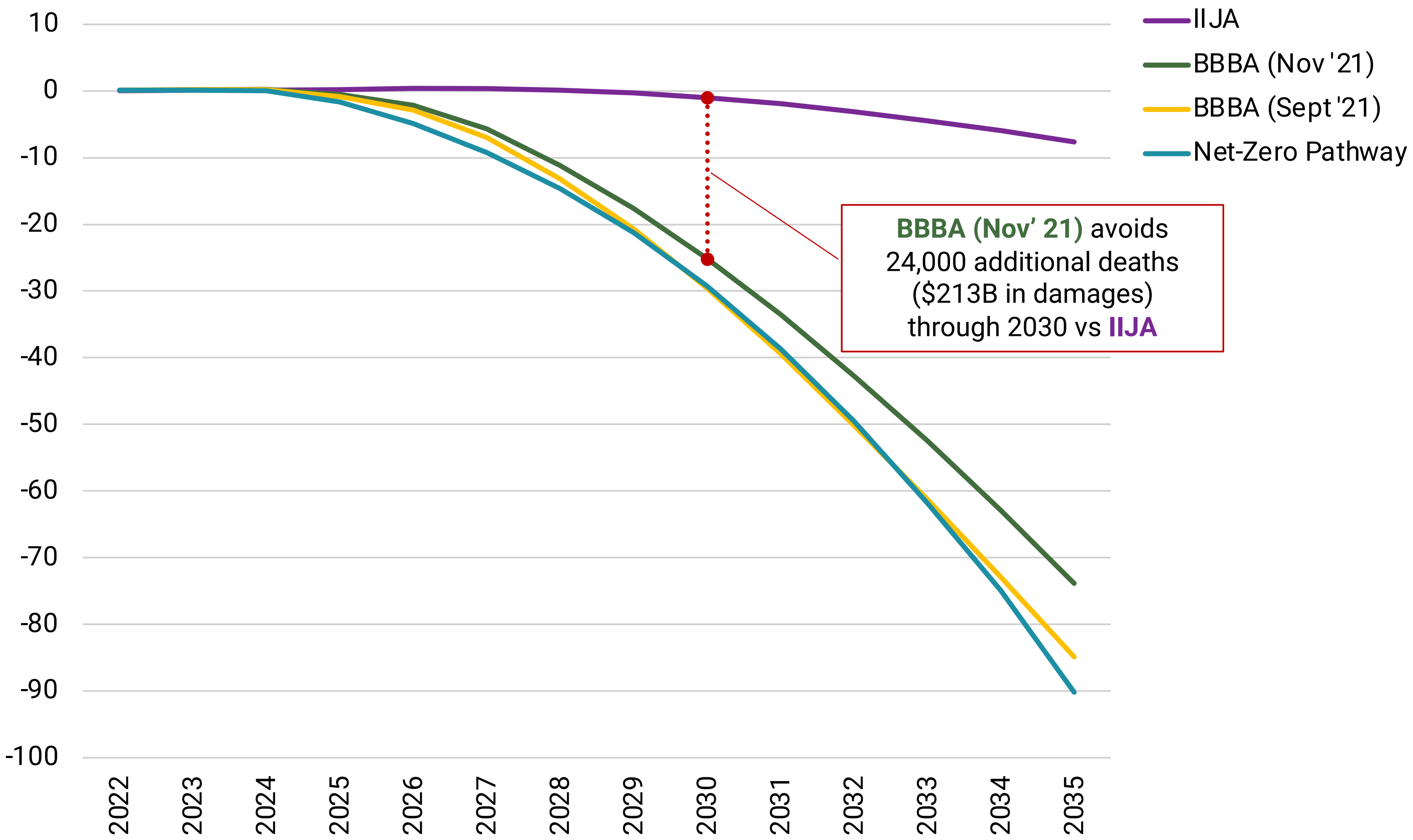
thousand jobs



Note: employment in petroleum fuel refining, distribution, and retailing; hydrogen production, distribution and retailing; and biofuel conversion, distribution, and retailing are excluded from this analysis.

Cumulative change in annual premature deaths from exposure to fine particulate matter from energy activities vs Frozen Policies

thousand premature deaths



Modeled cumulative reduction in premature deaths vs Frozen Policies, 2022-2030 (and avoided damages)

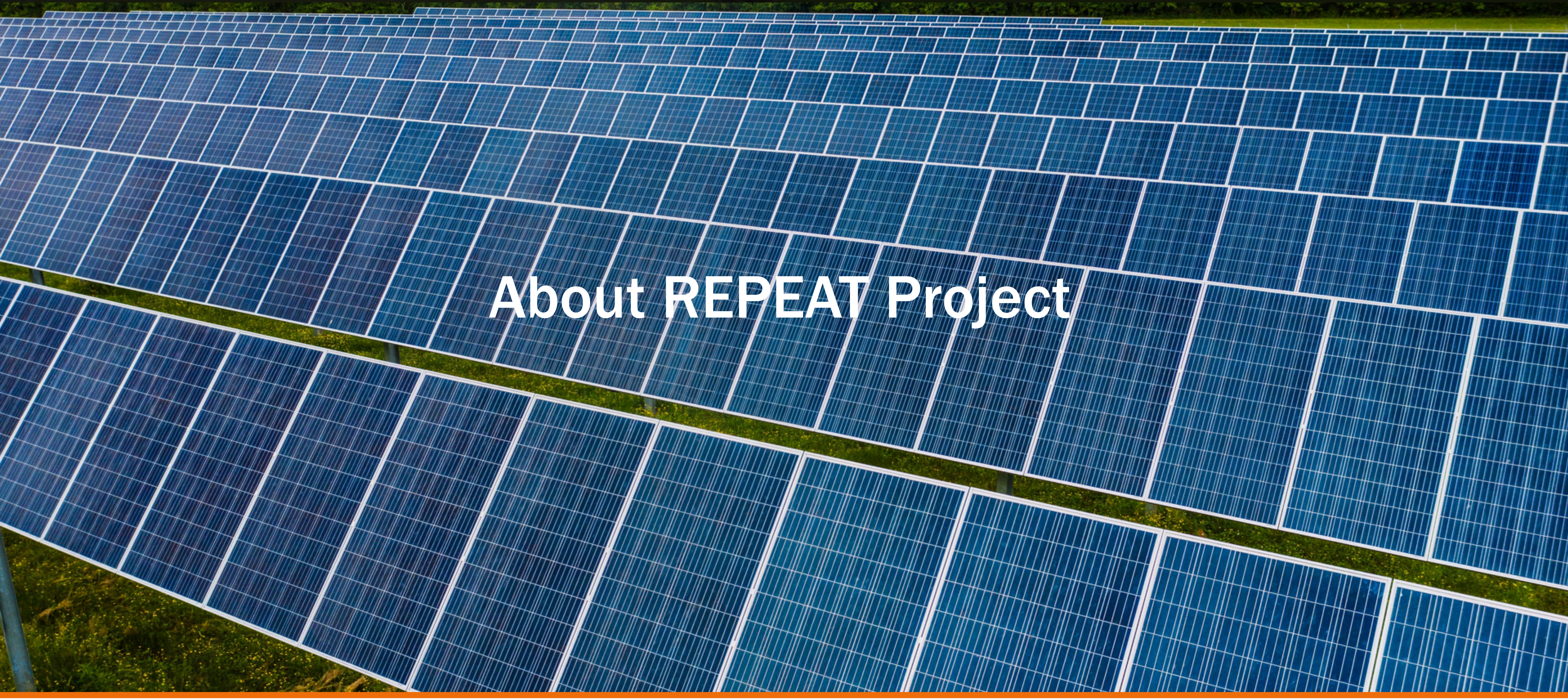
premature deaths (dollars of damages)

IIJA: ~1,000 ($9 billion)

BBBA (Nov. '21): ~25,000 ($222 billion)

BBB (Sept '21): ~30,000 ($261 billion)

Net-Zero Pathway: ~29,000 ($258 billion)



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

Dartmouth College: Prof. Erin Mayfield (co-PI);

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

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

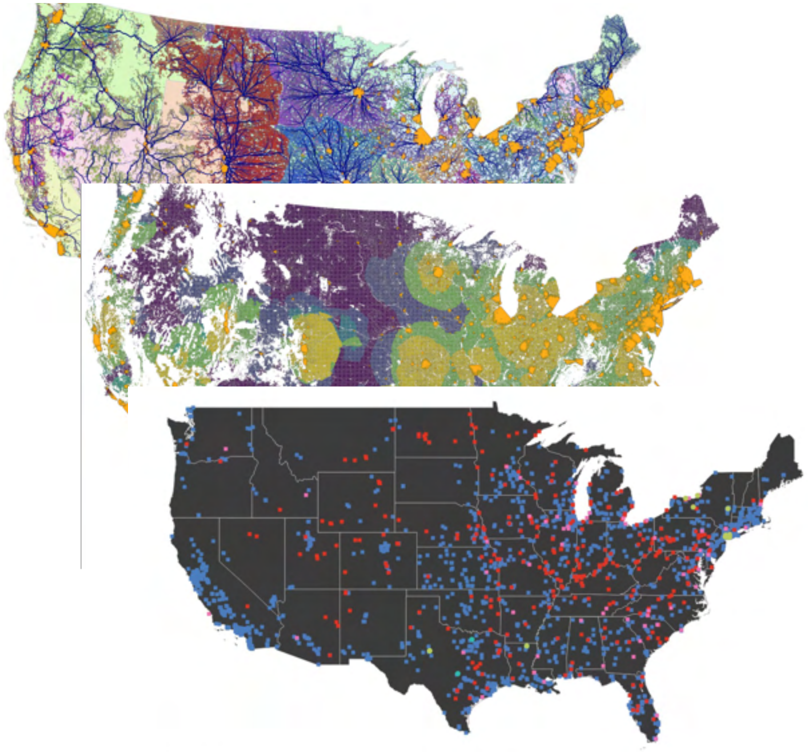
Montara Mountain Energy: Emily Leslie, Andrew Pascale (renewable energy candidate project areas, transmission cost surface)

Website development by Hyperobjekt.

Summary of Methods

Analysis Framework

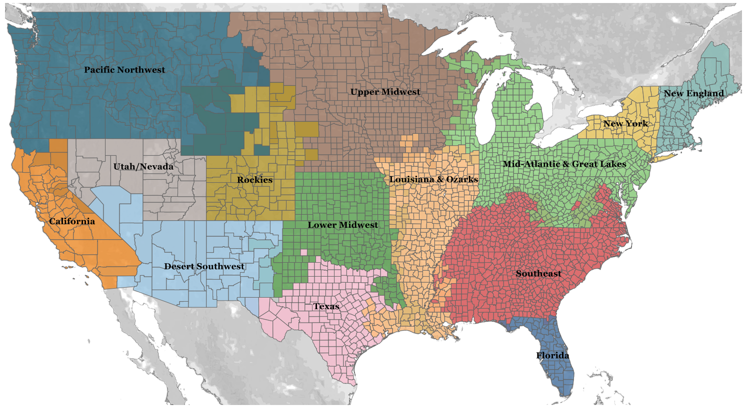
1. Geospatially-resolved inputs



2. Macro-energy systems modeling

EVOLVED ENERGY RESEARCH

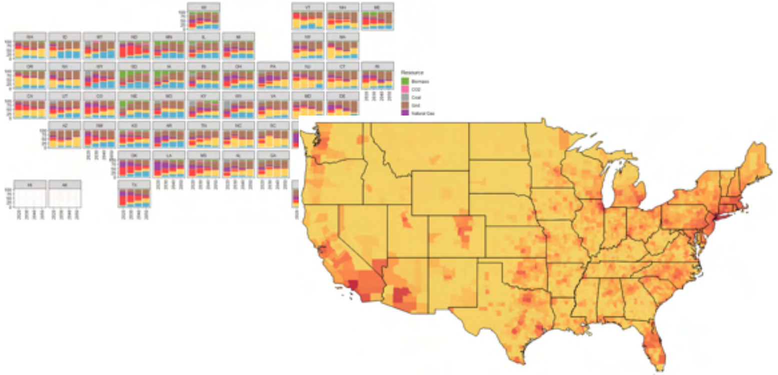
EnergyPATHWAYS
scenario tool
+
RIO
optimization tool



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.

Infrastructure Investment and Jobs Act ('**IIJA**', H.R. 3685) as signed into law on November 15, 2021.

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.

Original Build Back Better Act ('**BBBA Sept '21**', H.R. 5376, H. Rept. 117-130), as introduced and reported to the House Budget Committee on September 25, 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.

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, an important limitation of our analysis of the bill.

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).

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

Agriculture, Title I, Subtitle C:

Section 12004, Rural Energy Savings program
Section 12005, Rural Energy for America program

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

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

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 (implicit)

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

Note: All BBBA scenarios also include 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.

Build Back Better Act (BBBA), Nov. 2021 version, notes

Notes:

Impacts of Title I (Agriculture) and Title VII (Natural Resources) programs on land carbon sinks are not modeled.

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.

Build Back Better Act (BBBA), Sept. 2021 version, modeled policies

Agriculture, Title I, Subtitle C:

Section 12004, Rural Energy Savings program
Section 12005, Rural Energy for America program

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 30204, Environmental justice and climate justice block grants
Section 30411, Clean Electricity Performance Program (CEPP)
Section 30421, Home energy performance-based, whole house rebates and training programs
Section 30422, High-efficiency electric home rebate program
Section 30431, Weatherization assistance
Section 30432, Critical facility modernization
Section 30442, Electric vehicle supply equipment rebate program
Section 30443, Electric vehicle charging equity program
Section 30445, State energy transportation plans
Section 30461, Transmission lines and intertie grants
Section 30481, Federal energy efficiency fund
Section 30482, Energy efficiency and conservation block grants
Section 30483, Low-income solar

Financial Services, Title IV, Subtitle A

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

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

Build Back Better Act (BBBA), Sept. 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, Zero emission facility credit

Section 136107, Extension and modification of credit for carbon oxide sequestration (45Q)

Section 136109, Zero-emission nuclear power production credit (implicit)

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

Note: All BBBA scenarios also include 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.

Build Back Better Act (BBBA), Sept. 2021 version, notes

Notes:

Impacts of Title I (Agriculture) programs on land carbon sinks are not modeled.

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

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 ($30 billion of loan guarantee authority, $700 million 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 ($1 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 ($2 billion) is implicitly supportive of modeled transition.

Section 30462 Grants for facilitating inter-state transmission, Section 30463 technical assistance grants for RTOs/ISOs, and Section 30464 inter-regional and offshore wind transmission planning, modeling and analysis, and Section 30471 and Section 30472 funding for DOE and FERC environmental reviews are all implicitly supportive of the ‘low friction’ deployment environment for transmission in RIO.

Section 110002 Community Climate Incentive Grant Program and Section 110020 Assistance to Federal Buildings programs were not modeled due to an oversight on part of the REPEAT Project team.

Section 136501 Extension of the advanced energy project credit (section 48C clean energy manufacturing investment credit) 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.

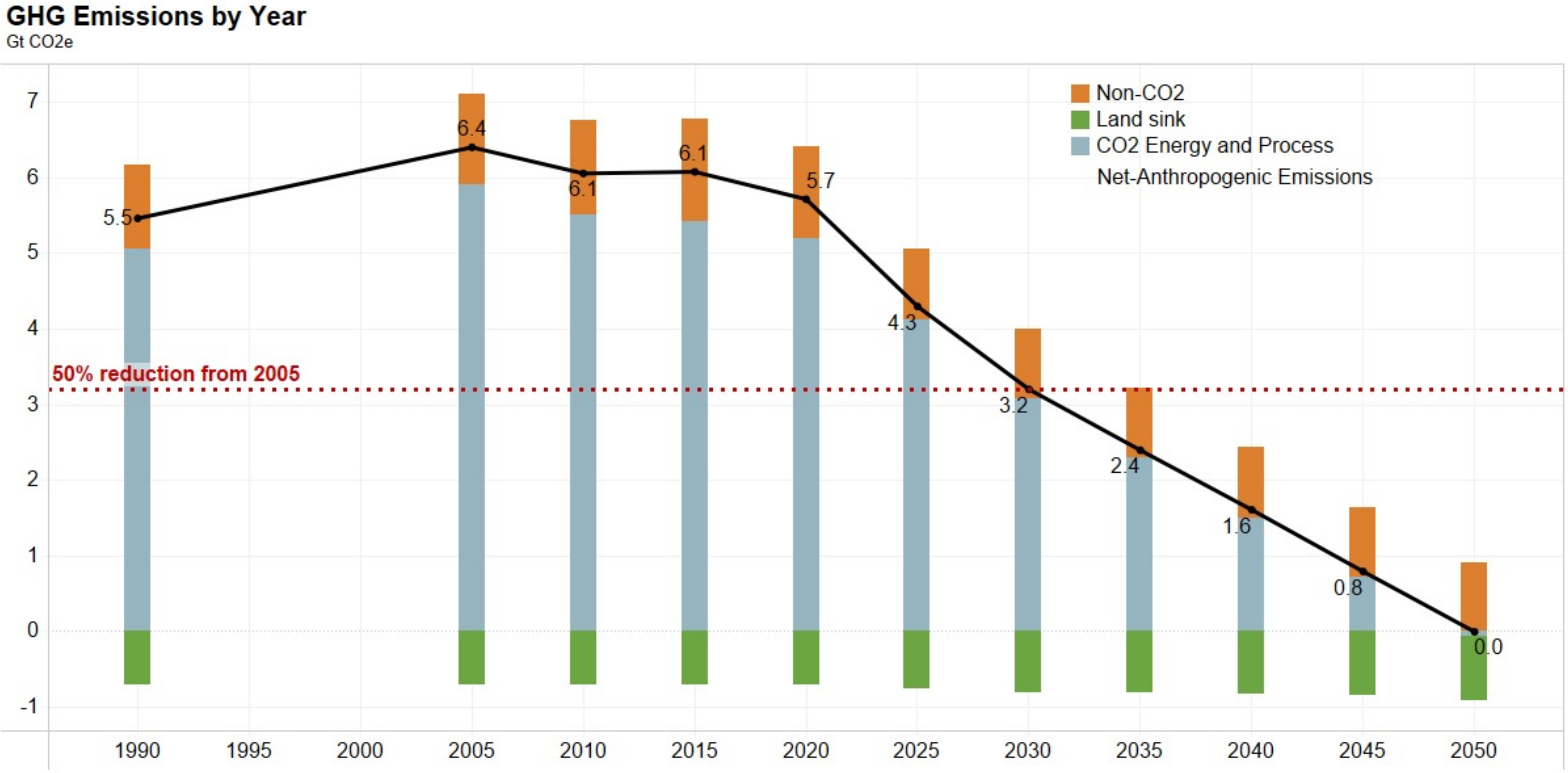
All eligible projects are assumed to qualify for direct pay via domestic content or via waivers due to inadequate supply.

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	1.19	-0.7	5.16
2025	0.93	-0.75	**4.12**
2030	0.93	-0.8	**3.08**
2035	0.92	-0.81	**2.29**
2040	0.93	-0.83	**1.51**
2045	0.91	-0.84	**0.72**
2050	0.91	-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 MMT 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 MMT CO_2e reduction in 2030).
- Land sink assumptions are based on a National Academies study
  - 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 million tCO_2e/y resulting in a total land sink of 850 million tCO_2e/y.
- CO_2 energy and process emissions targets achieve net-anthropogenic GHG targets for 2030 (50% below 2005) and 2050 (net-zero).

Net-Zero Pathway: Emissions targets hit a 50% reduction in 2030 and net-zero in 2050



CO_2 from energy and industry:
48% below 2005 levels by 2030 (2.84 billion tons).

Non-CO_2 GHGs:
-260 million metric tons CO_2-e from 2005 or 2020.

Land carbon sinks:
Increases by ~100 million metric tons CO_2-e from 2005 or 2020. (BAU would decline gradually).

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.

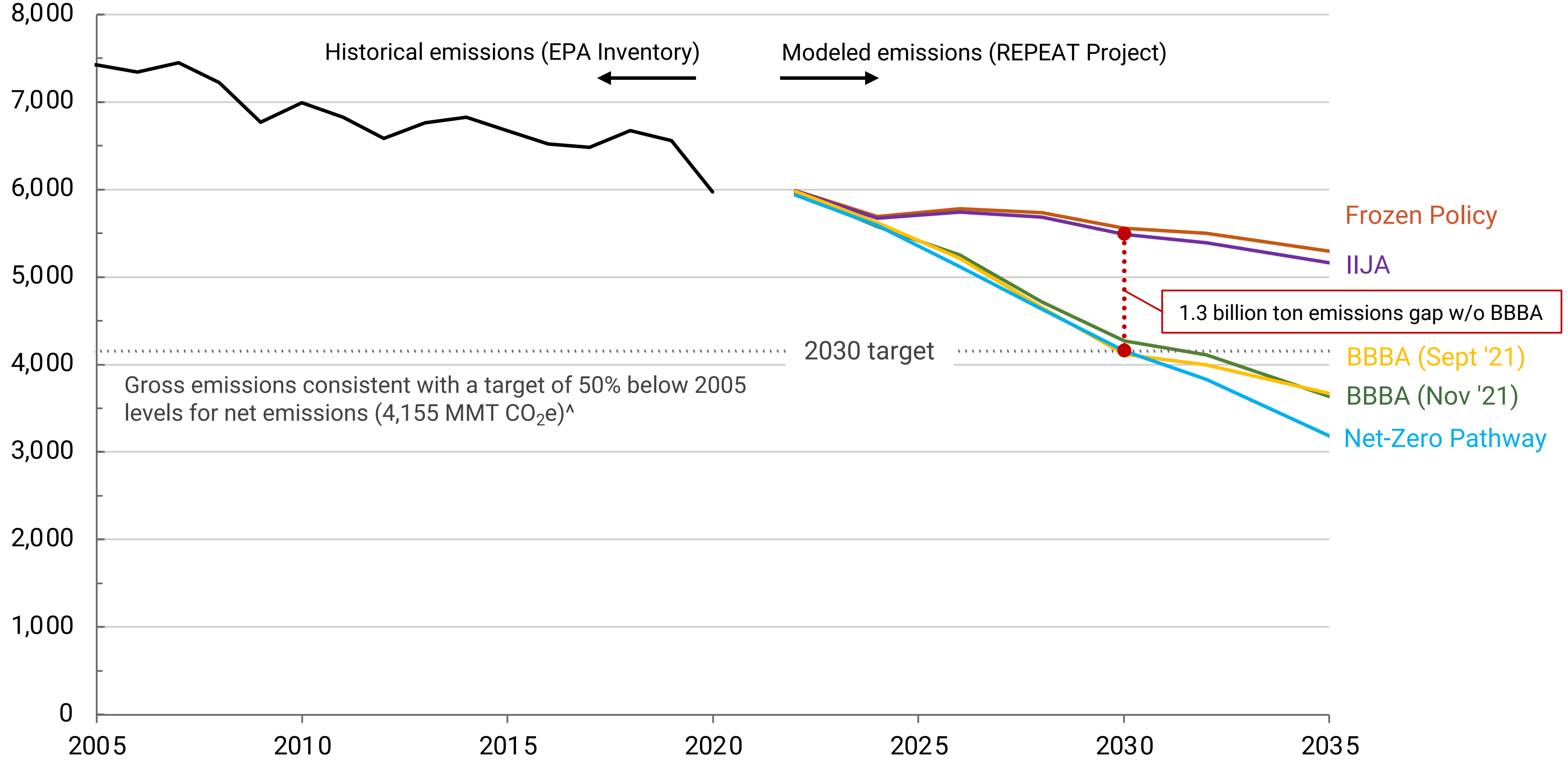
Readers should interpret modeled results accordingly.

Summary of Results

Greenhouse Gas Emissions

Total Gross U.S. Greenhouse Gas Emissions

million metric tons CO_2-equivalent^



Modeled 2030 Gross GHG Emissions

CO_2-equivalent^

Frozen Policy (5,650 MMT): 1.4 billion tons CO_2-e short of 2030 target.

IIJA (5,489 MMT): Only 71 MMT below Frozen Policy (46-86 MMT, including possible changes from transportation mode shifting*). Leaves a ~1.3 billion ton emissions gap that must be closed to reach the nation's 2030 climate commitments.

BBB (Nov '21) (4,274 MMT): Delivers 1.2 billion tons additional reductions vs IIJA by 2030, putting U.S. within close reach of a 50% reduction in GHG emissions from 2005 levels.

BBBA (Sept '21) (4,116 MMT): Tracks 2030 target closely, delivering ~160 MMT more emissions reductions than November House-passed version of BBBA.

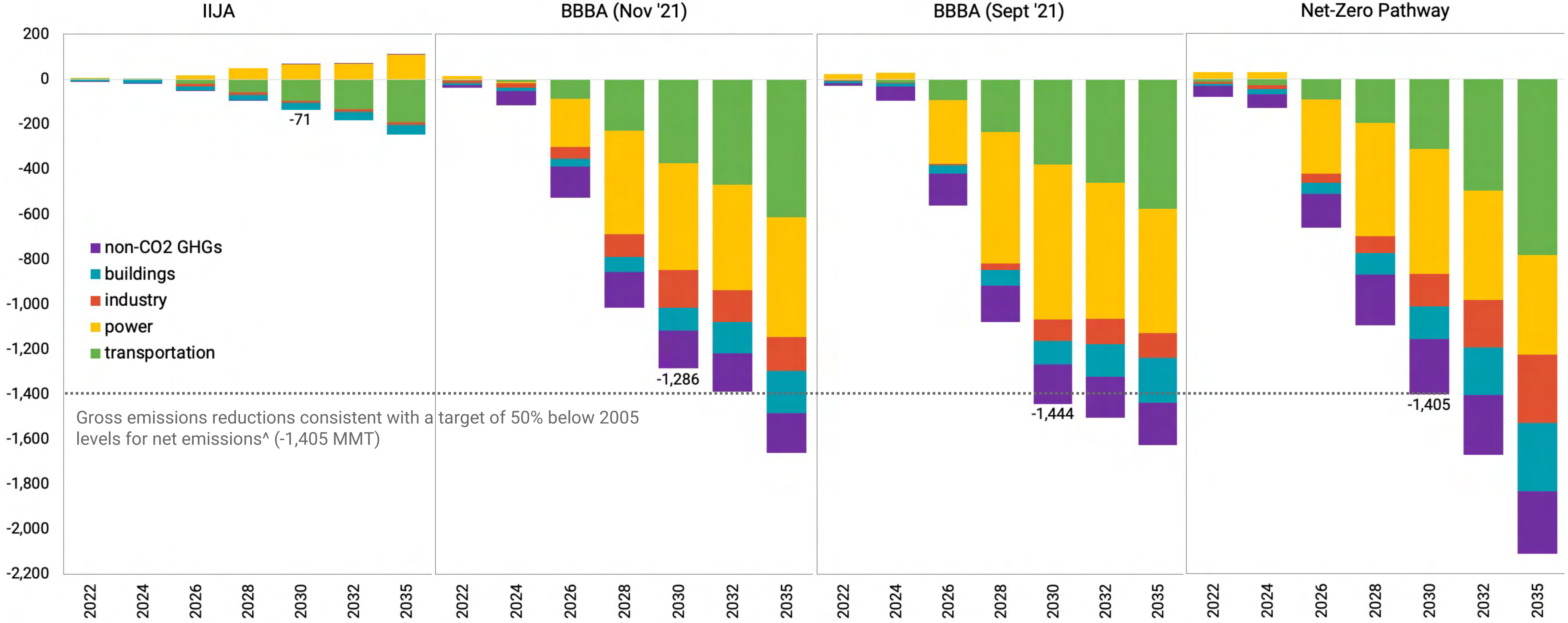
Net-Zero Pathway (4,155 MMT): Consistent with a 50% reduction in net GHGs.^

^ - CO_2e calculations use 100 year global warming potential equivalence as per EPA Inventory of Greenhouse Gas Emissions. Gross emissions exclude net changes in land carbon sinks. Target for gross emissions reductions by 2030 assumes 100 MMT CO_2-e increase in net land carbon sinks, bringing net GHG emissions to 50% below 2005 levels. See p. 15 for additional details.

* - 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 MMT to +25 MMT change in CO_2 emissions from transportation.

Annual Change in Gross U.S. Greenhouse Gas Emissions Relative to Frozen Policy Benchmark

million metric tons CO_2-equivalent^

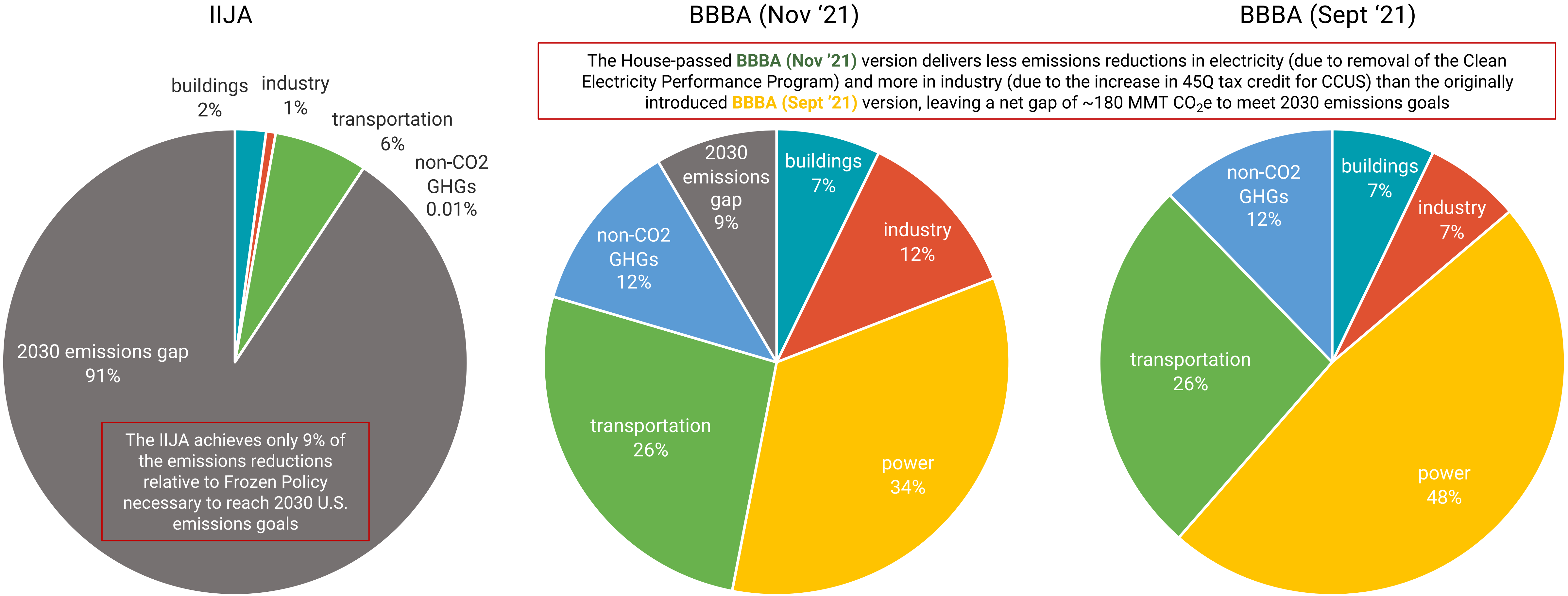


^ - CO_2-e calculations use 100 year global warming potential equivalence as per EPA Inventory of Greenhouse Gas Emissions. Gross emissions exclude net changes in land carbon sinks.
Target for gross emissions reductions by 2030 assumes 100 MMT CO_2-e increase in net land carbon sinks, bringing net GHG emissions to 50% below 2005 levels. See p. 15 for additional details.

2030 Contributions to Gross U.S. Greenhouse Gas Emissions Reductions Needed to Reach U.S. Climate Targets

percentage of gross emissions reductions relative to Frozen Policy Benchmark consistent with a target of 50% below 2005 levels for net emissions (-1,405 MMT CO_2e)^

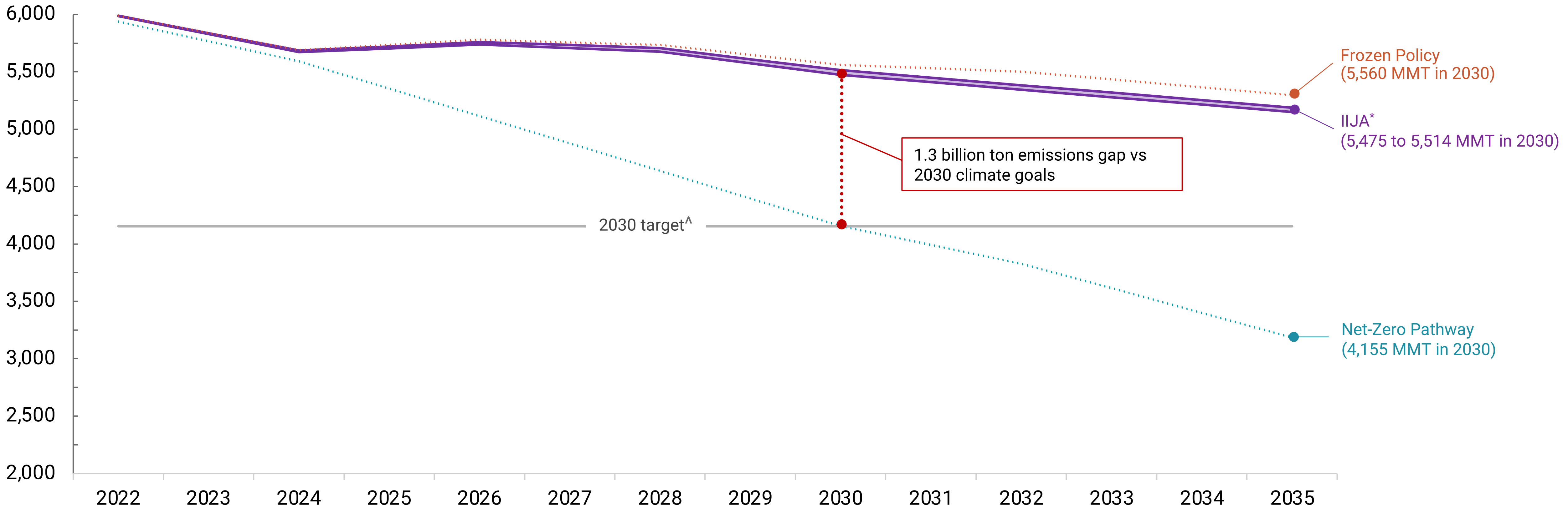
The House-passed **BBBA (Nov '21)** version delivers less emissions reductions in electricity (due to removal of the Clean Electricity Performance Program) and more in industry (due to the increase in 45Q tax credit for CCUS) than the originally introduced **BBBA (Sept '21)** version, leaving a net gap of ~180 MMT CO_2e to meet 2030 emissions goals



^ - CO_2-e calculations use 100 year global warming potential equivalence as per EPA Inventory of Greenhouse Gas Emissions. Gross emissions exclude net changes in land carbon sinks.
Target for gross emissions reductions by 2030 assumes 100 MMT CO_2-e increase in net land carbon sinks, bringing net GHG emissions to 50% below 2005 levels. See p. 15 for additional details.

Total Gross U.S. Greenhouse Gas Emissions Under IIJA
(including range of likely outcomes depending on implementation of surface transportation investments)*

million metric tons CO_2-equivalent^

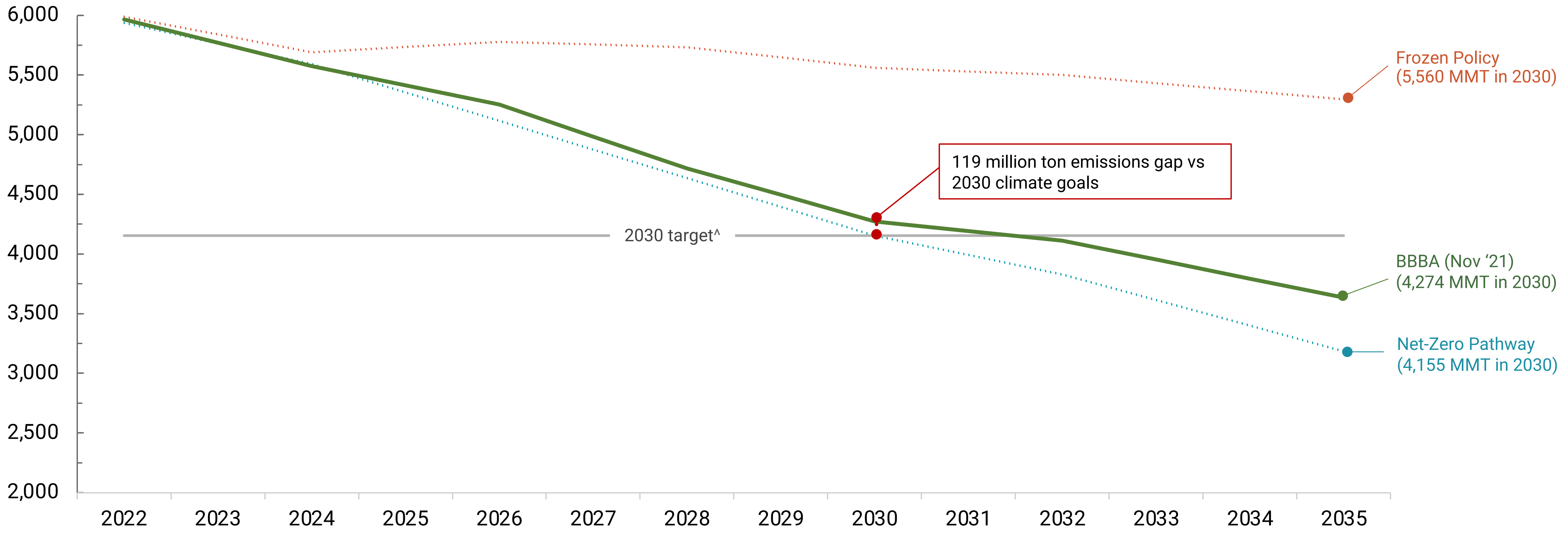


^ - CO_2e calculations use 100 year global warming potential equivalence as per EPA Inventory of Greenhouse Gas Emissions. Gross emissions exclude net changes in land carbon sinks. Target for gross emissions reductions by 2030 assumes 100 MMT CO_2-e increase in net land carbon sinks, bringing net GHG emissions to 50% below 2005 levels. See p. 15 for additional details.

* - REPEAT Project 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 MMT to +25 MMT change in CO_2 emissions from transportation. This range if reflected in modeled impact of IIJA above.

Total Gross U.S. Greenhouse Gas Emissions Under BBBA (Nov '21)

million metric tons CO_2-equivalent^

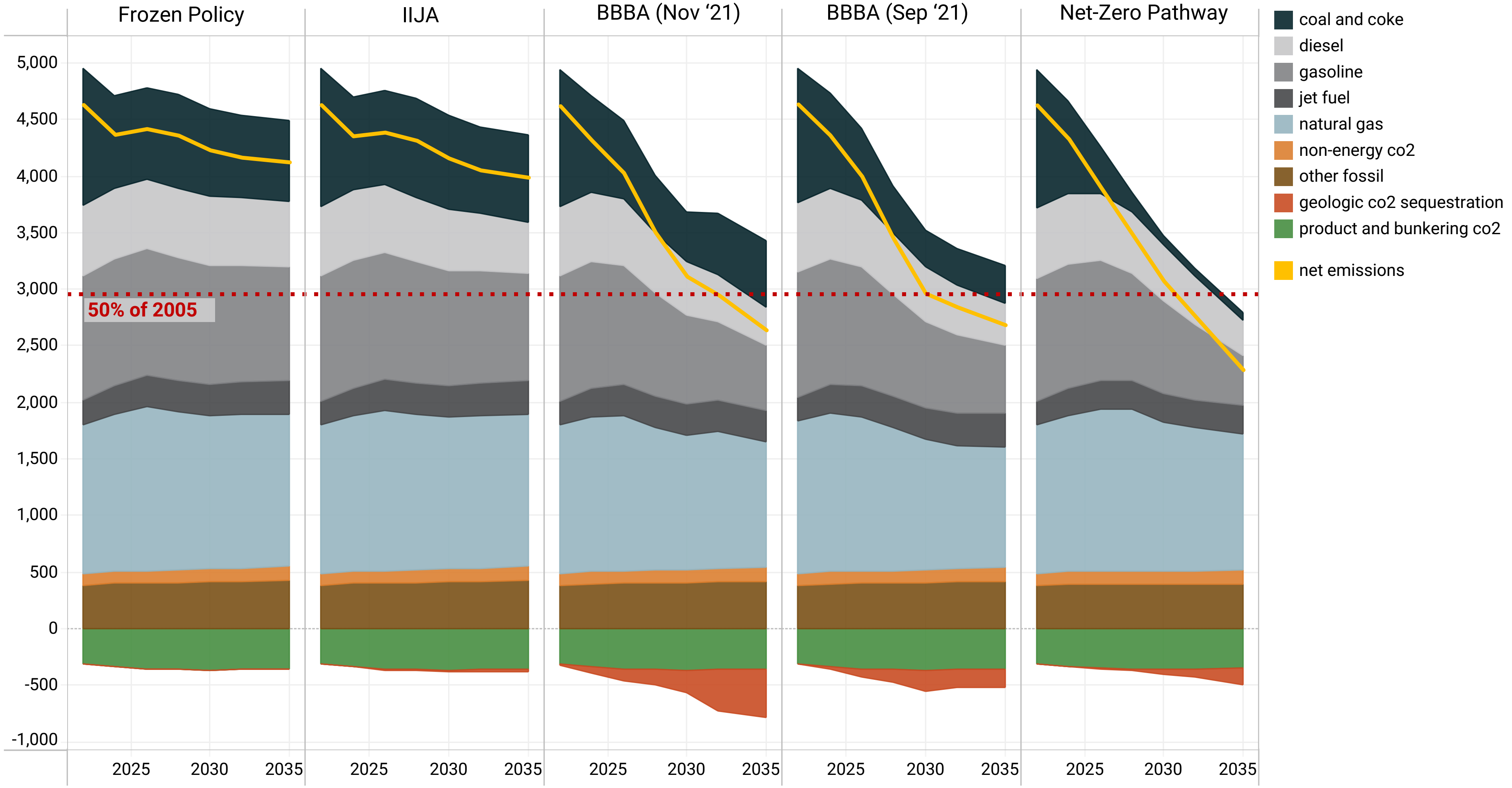


^ - CO_2e calculations use 100 year global warming potential equivalence as per EPA Inventory of Greenhouse Gas Emissions. Gross emissions exclude net changes in land carbon sinks. Target for gross emissions reductions by 2030 assumes 100 MMT CO_2-e increase in net land carbon sinks, bringing net GHG emissions to 50% below 2005 levels. See p. 15 for additional details.

* - REPEAT Project 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 MMT to +25 MMT change in CO_2 emissions from transportation. This range if reflected in modeled impact of IIJA above.

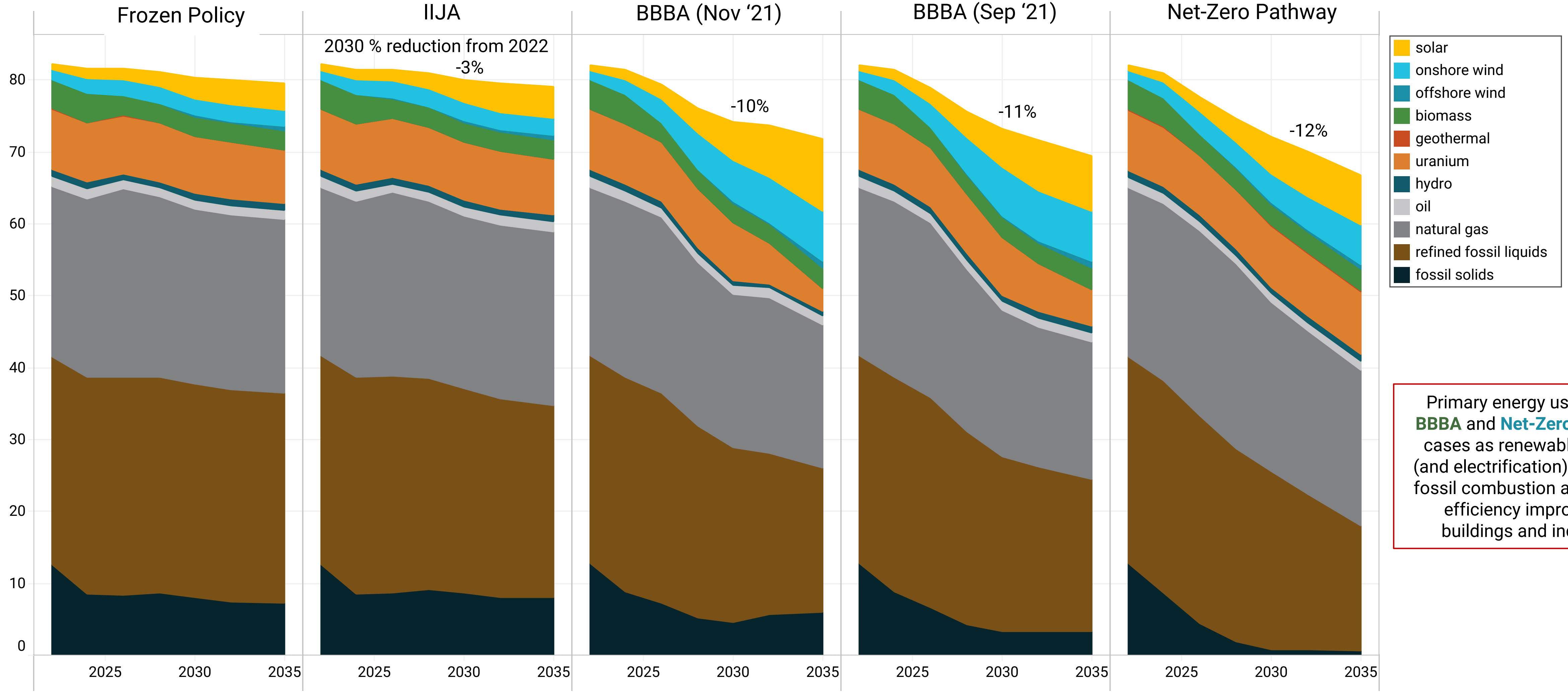
Annual CO_2 Emissions From Energy and Industry

million metric tons



Primary Energy Supply

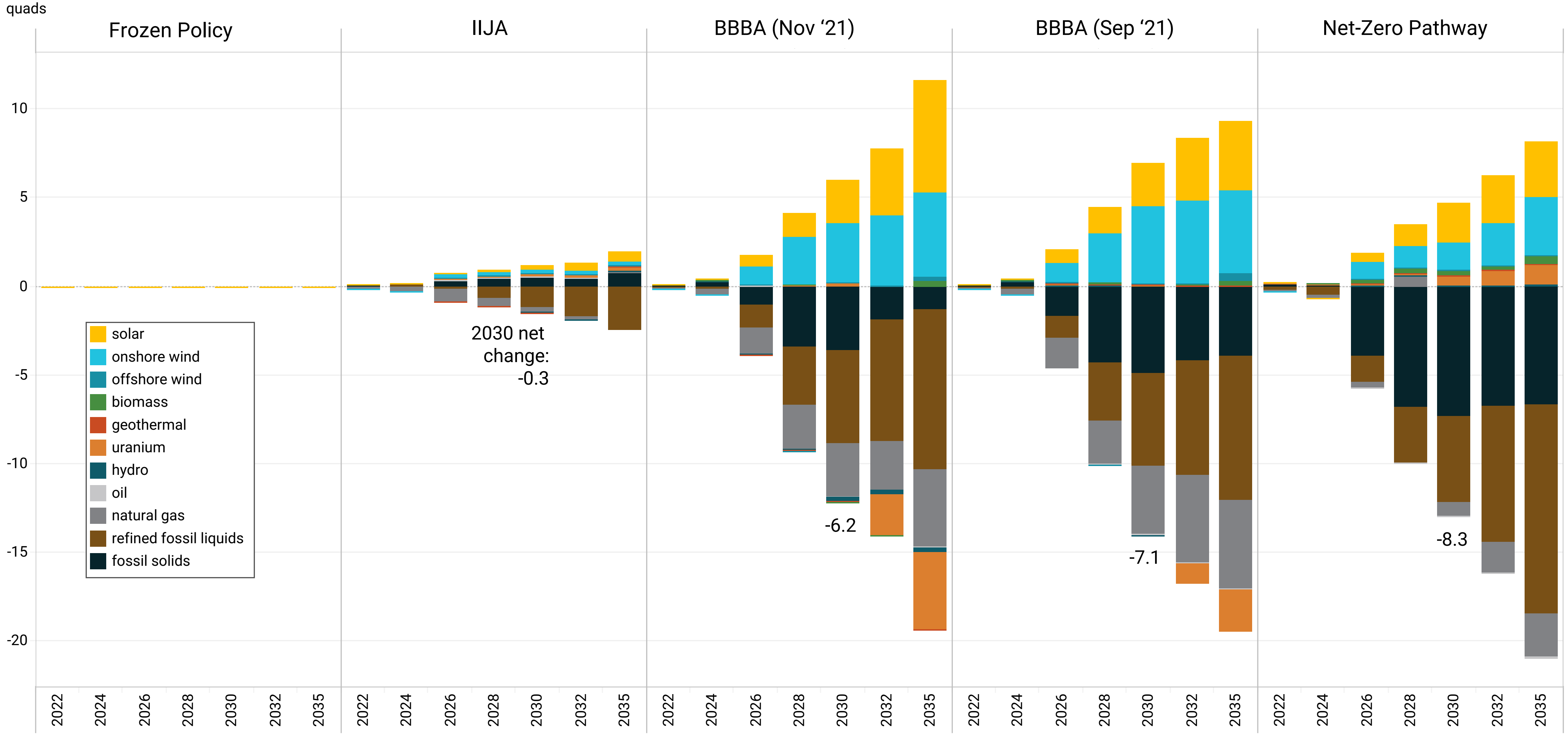
Primary Energy
quads



Primary energy use falls in **BBBA** and **Net-Zero Pathway** cases as renewable energy (and electrification) displaces fossil combustion and energy efficiency improves in buildings and industry.

Primary Energy Relative to Frozen Policy

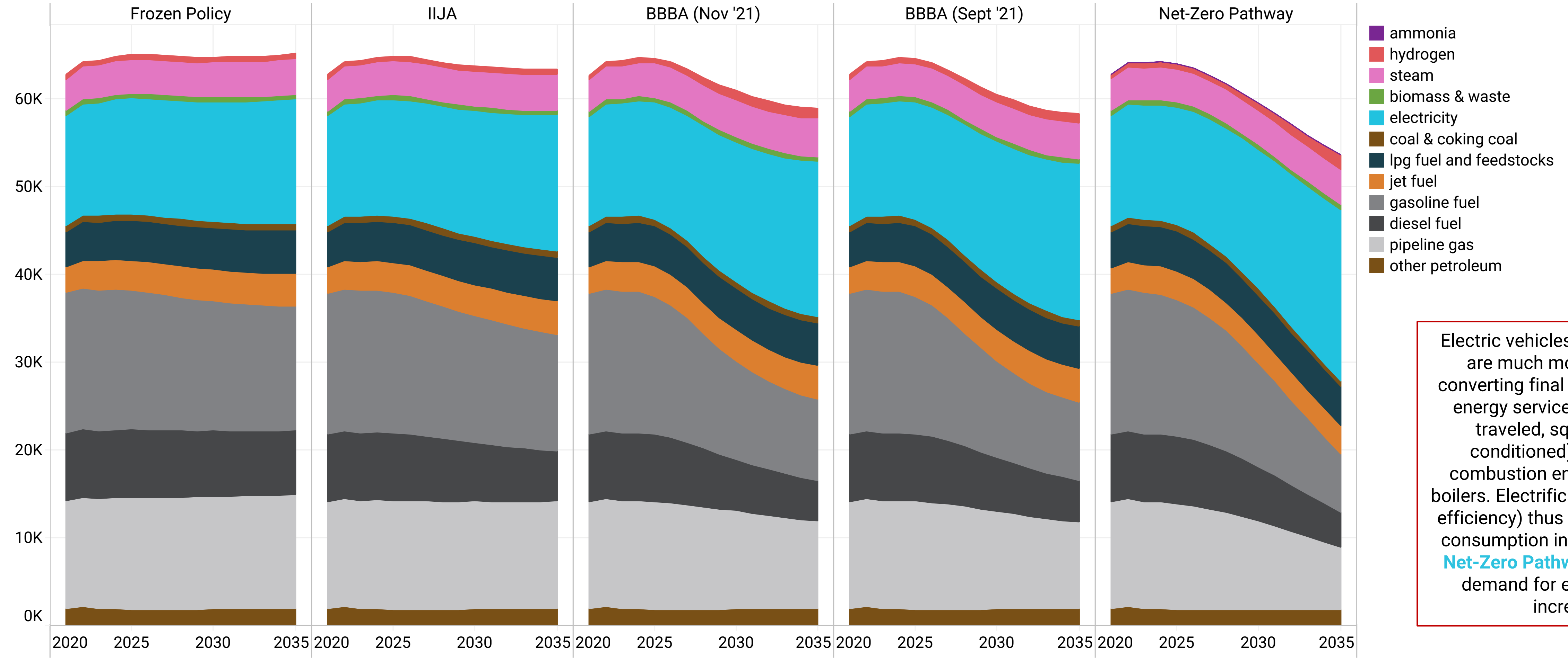
quads



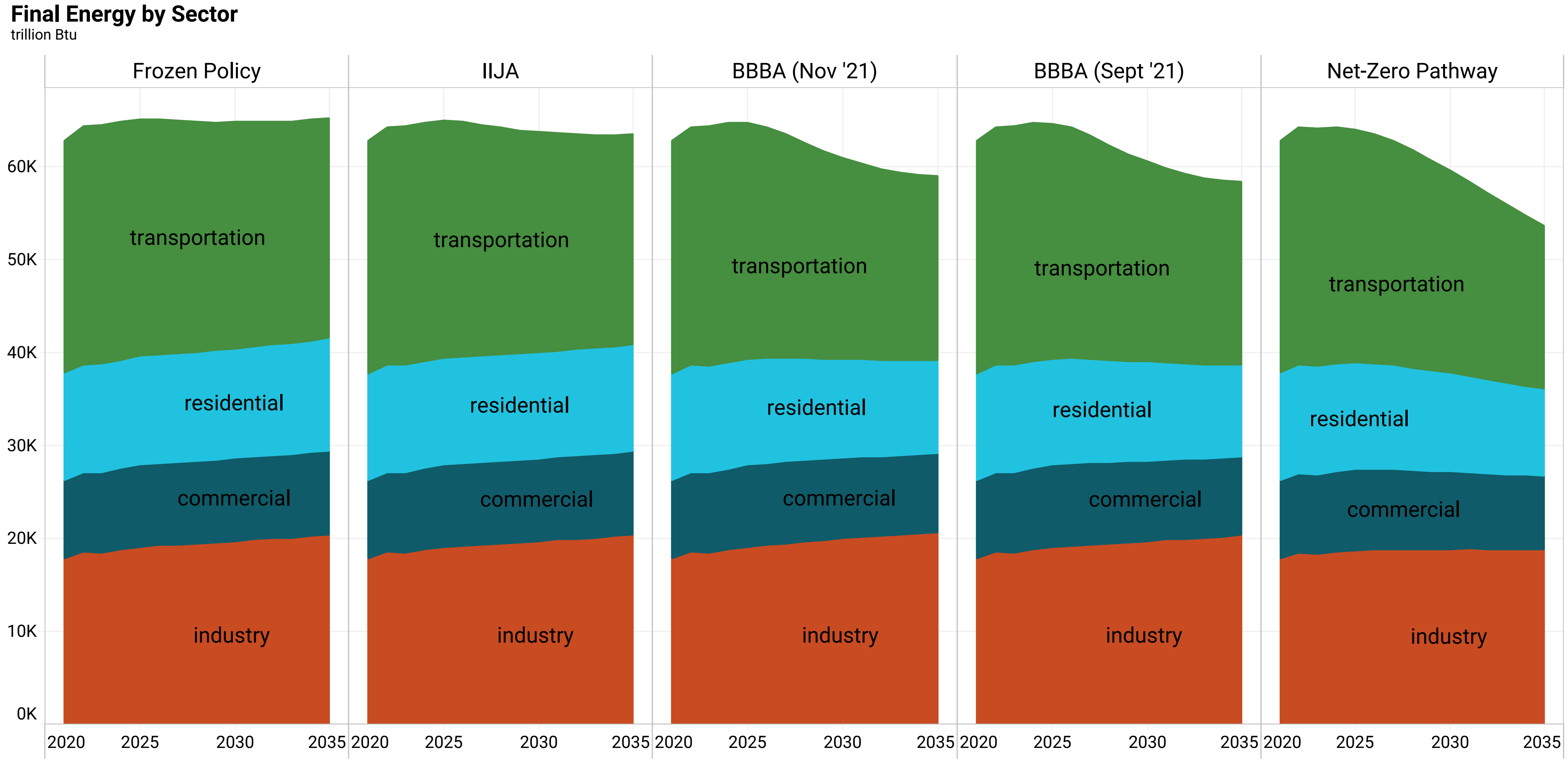
Energy Demand

Final Energy Demand by Energy Carrier

trillion Btu



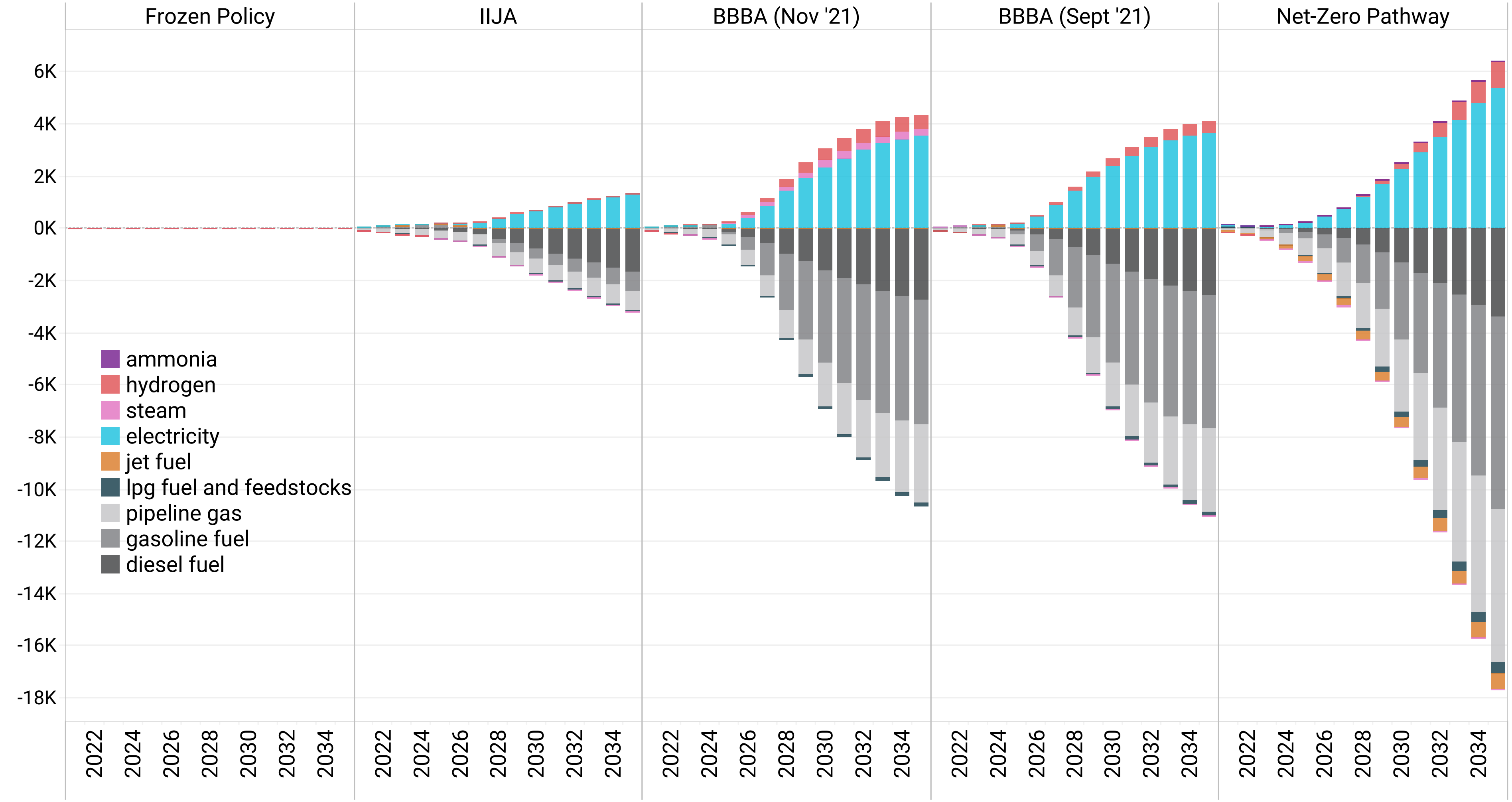
Electric vehicles and heat pumps are much more efficient at converting final energy carriers to energy services (vehicle miles traveled, square footage conditioned) than internal combustion engines and fossil boilers. Electrification (and end-use efficiency) thus lower final energy consumption in **BBBA** cases and **Net-Zero Pathway**, even as total demand for energy services increases.



Electric vehicles and heat pumps are much more efficient at converting final energy carriers to energy services (vehicle miles traveled, square footage conditioned) than internal combustion engines and fossil boilers. Electrification (and end-use efficiency) thus lower final energy consumption in **BBBA** cases and **Net-Zero Pathway**, even as total demand for energy services increases.

Final Energy Demand Relative to Frozen Policy

Difference in TBtu



Modeled Change in 2030 Final Energy Demand Relative to Frozen Policy

quadrillion Btus (quads)

IIJA: -1.0 quads; -2%

BBBA (Nov. '21): -3.8 quads; -6%

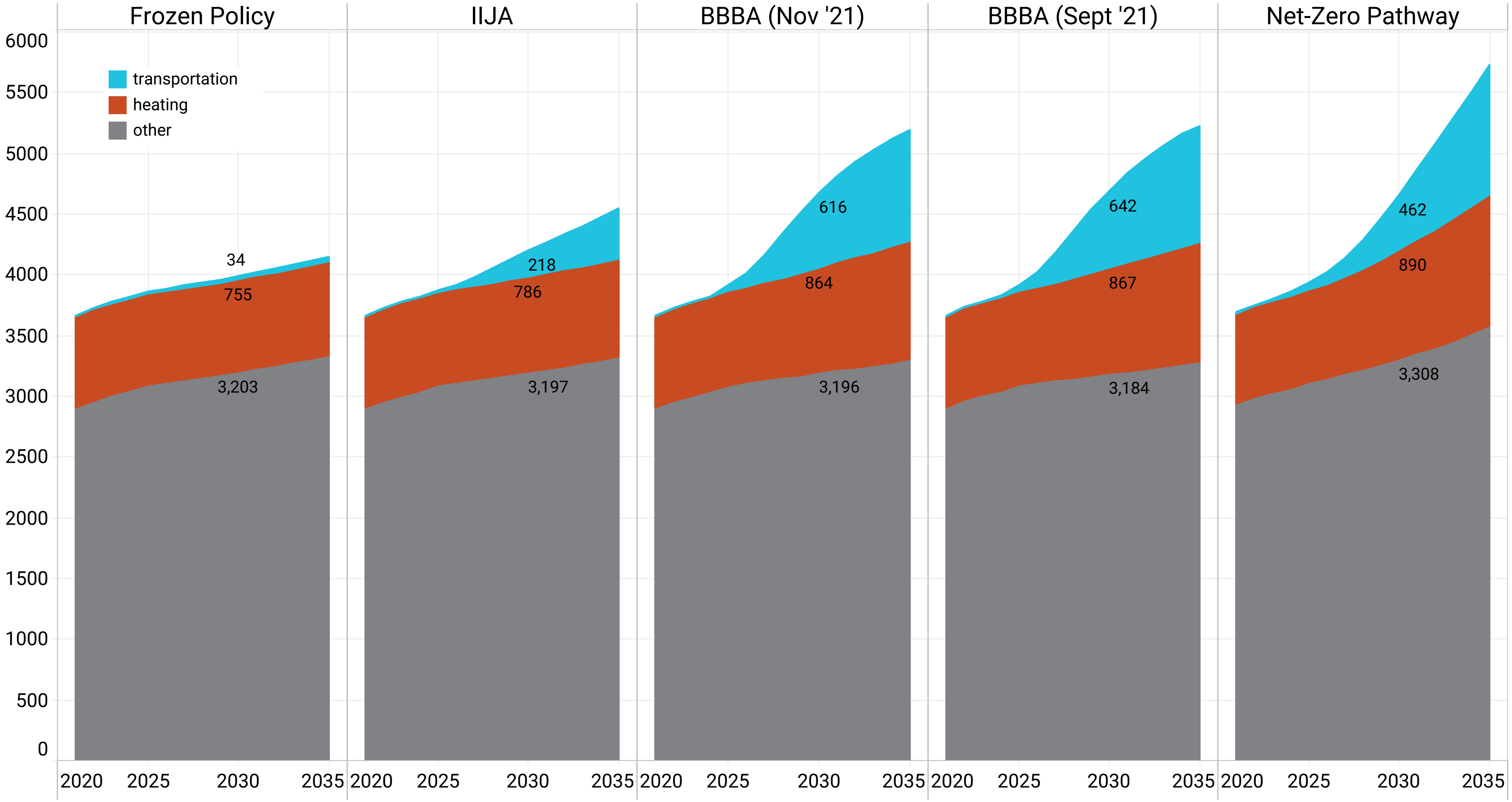
BBB (Sept '21): -4.2 quads; -7%

Net-Zero Pathway: -5.2 quads; -8%

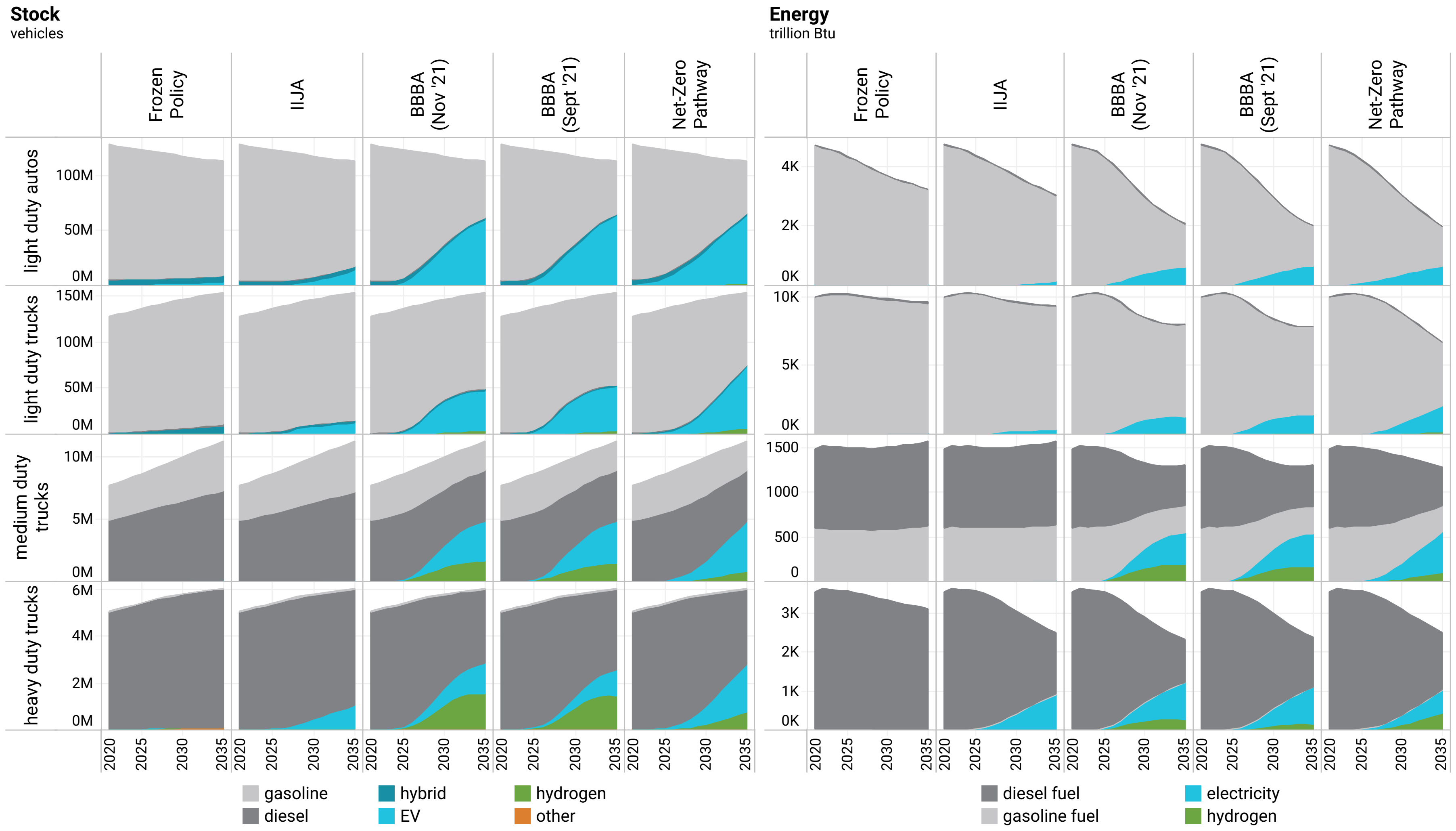
Frozen Policy Final Energy Demand in 2030: 64.8 quads

Annual Electricity Demand

TWh



Transportation



Impact of BBBA (Nov '21) in 2030

Light duty autos: ~100% EV sales reached, ~35 million EVs on road (vs 21% of sales in IIJA).

Light duty trucks/SUVs: ~90% EV sales reached, ~33 million EVs on road (vs 9% of sales in IIJA).

Light duty EV on road share: 26%

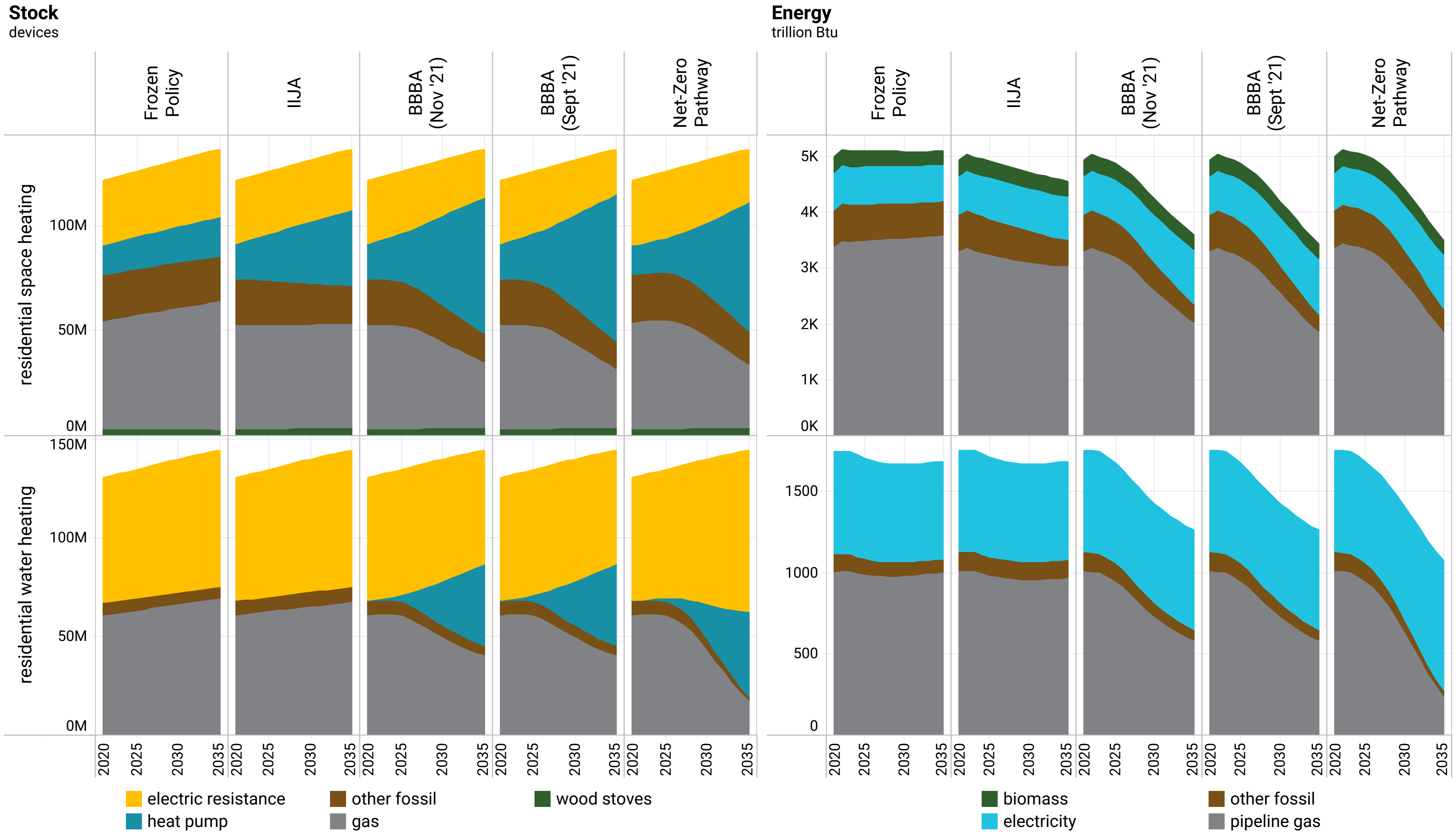
Medium and heavy trucks: ~100% of sales are EV or fuel cell vehicles, ~4.6 million zero emissions trucks on road

Final energy demand: 20% below 2021.

Fossil fuel demand: 33% below 2021.

Notes: Vehicle sales are optimized based on relative cost of ownership and distribution of required payback periods across purchasers. Incentives provided in BBBA are sufficient to make zero-emissions light duty autos and medium and heavy trucks lower cost than internal combustion alternatives, making clean vehicles the 'rational' economic choice for nearly all consumers. **Real purchase decisions may depart from modeled results.**

Residential



Impact of BBBA (Nov '21) in 2030

Space heating: ~72% of new sales are electric heat pumps, nearly saturating demand outside coldest climate zones. ~43 million residences with heat pump space heating (33% of residences vs 22% in IIJA).

Water heating: ~33% of new sales are electric heat pump in 2030. ~23 million residences with heat pump water heating (16% of residences, vs 0% in IIJA).

Final energy demand: 15% below 2021.

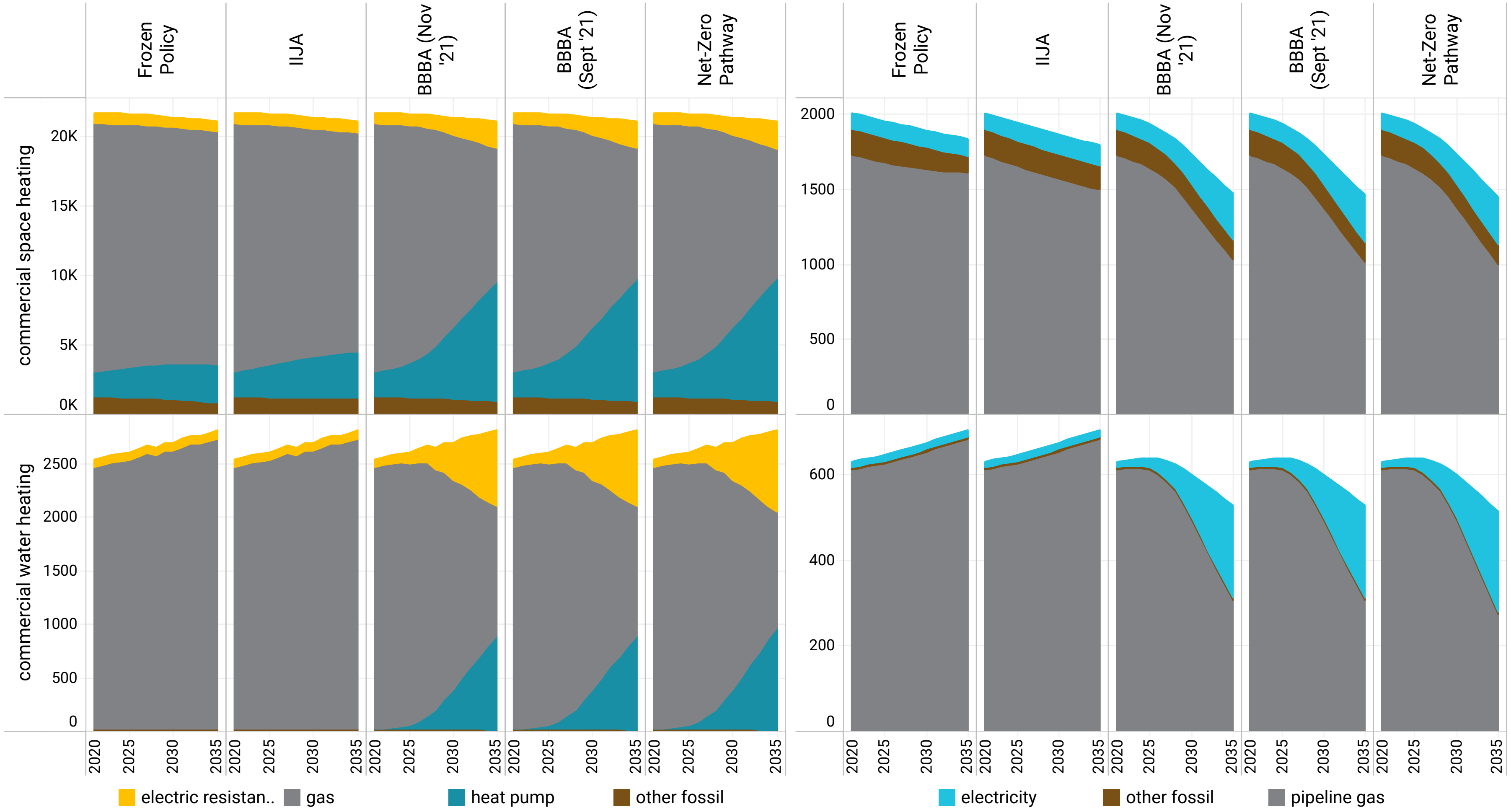
Fossil fuel demand: 23% below 2021.

Notes: Heat pump adoption based on applying available grant and tax credit funding (less 20% for administrative cost, inefficiencies, etc.) to cover incremental costs of the subsector in the Net-Zero Pathway relative to the Frozen Policies scenario until the available funds are exhausted, at which point sales shares remain constant.

Commercial

Stock
TBtu of capacity

Energy
trillion Btu



Impact of BBBA (Nov '21) in 2030

Space heating: ~69% of new sales are electric heat pumps. ~23% of commercial building space heated with heat pumps.

Water heating: ~47% of new sales are electric heat pump. ~14% of commercial building water heated with heat pumps.

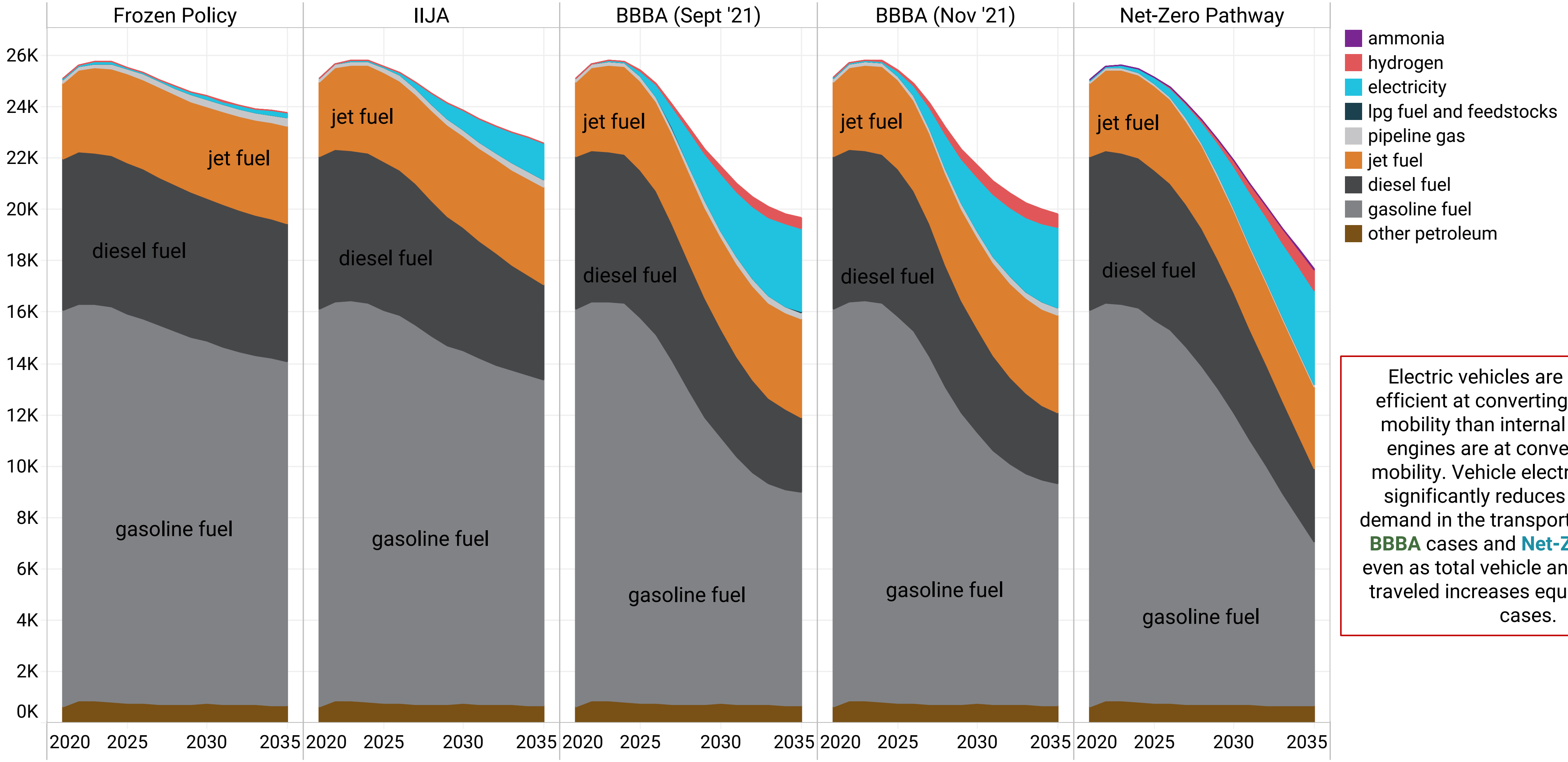
Final energy demand: 12% below 2021.

Fossil fuel demand: 19% below 2021.

Notes: Heat pump adoption based on applying available grant and tax credit funding (less 20% for administrative cost, inefficiencies, etc.) to cover incremental costs of the subsector in the Net-Zero Pathway relative to the Frozen Policies scenario until the available funds are exhausted, at which point sales shares remain constant.

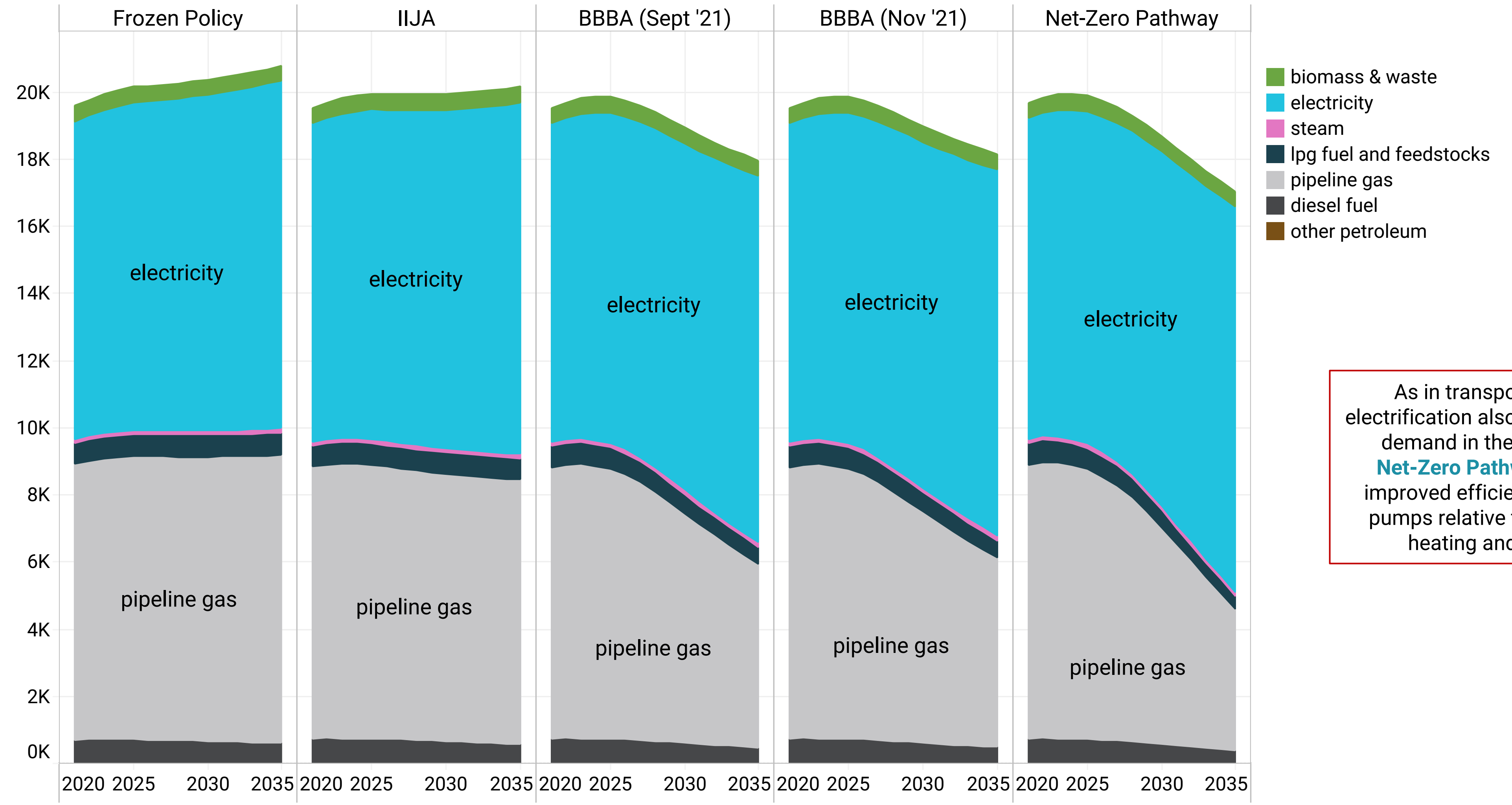
Transportation Final Energy Demand by Energy Carrier

trillion Btu



Electric vehicles are much more efficient at converting electricity to mobility than internal combustion engines are at converting fuel to mobility. Vehicle electrification thus significantly reduces final energy demand in the transportation sector in **BBBA** cases and **Net-Zero Pathway**, even as total vehicle and freight miles traveled increases equally across all cases.

Final Energy Demand in Buildings
trillion Btu

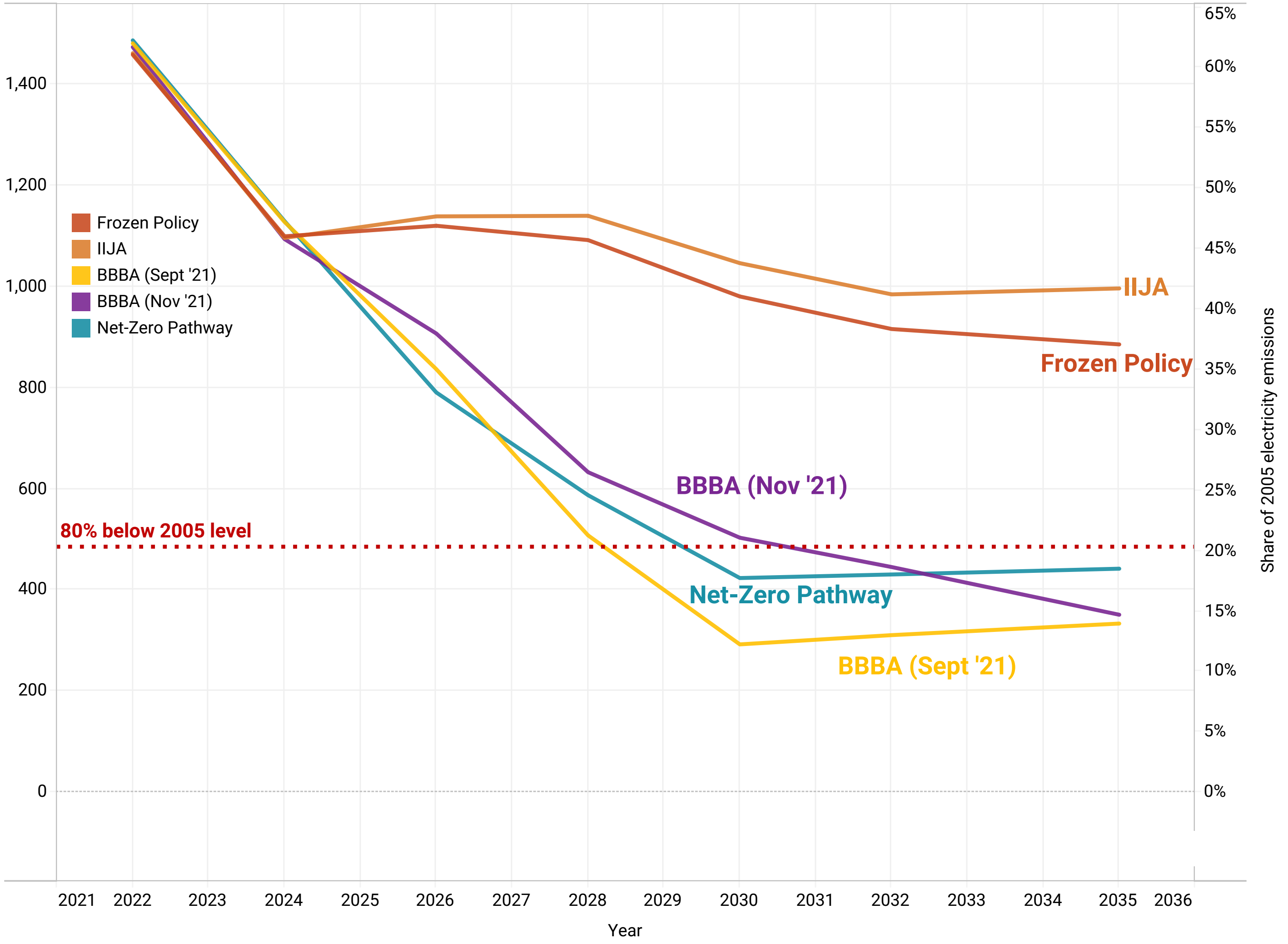


As in transportation, building electrification also reduces final energy demand in the **BBBA** cases and **Net-Zero Pathway**, thanks to the improved efficiency of electric heat pumps relative to electric resistive heating and fossil boilers.

Electricity

Power Sector Annual CO2 Emissions

million metric tons



Modeled 2030 Power Sector CO_2 Emissions

Frozen Policy (980 MMT): 59% below 2005 levels

IIJA (1,046 MMT): 57% below 2005 levels

BBB (Nov '21) (503 MMT): 79% below 2005 levels

BBBA (Sept '21) (293 MMT): 88% below 2005 levels

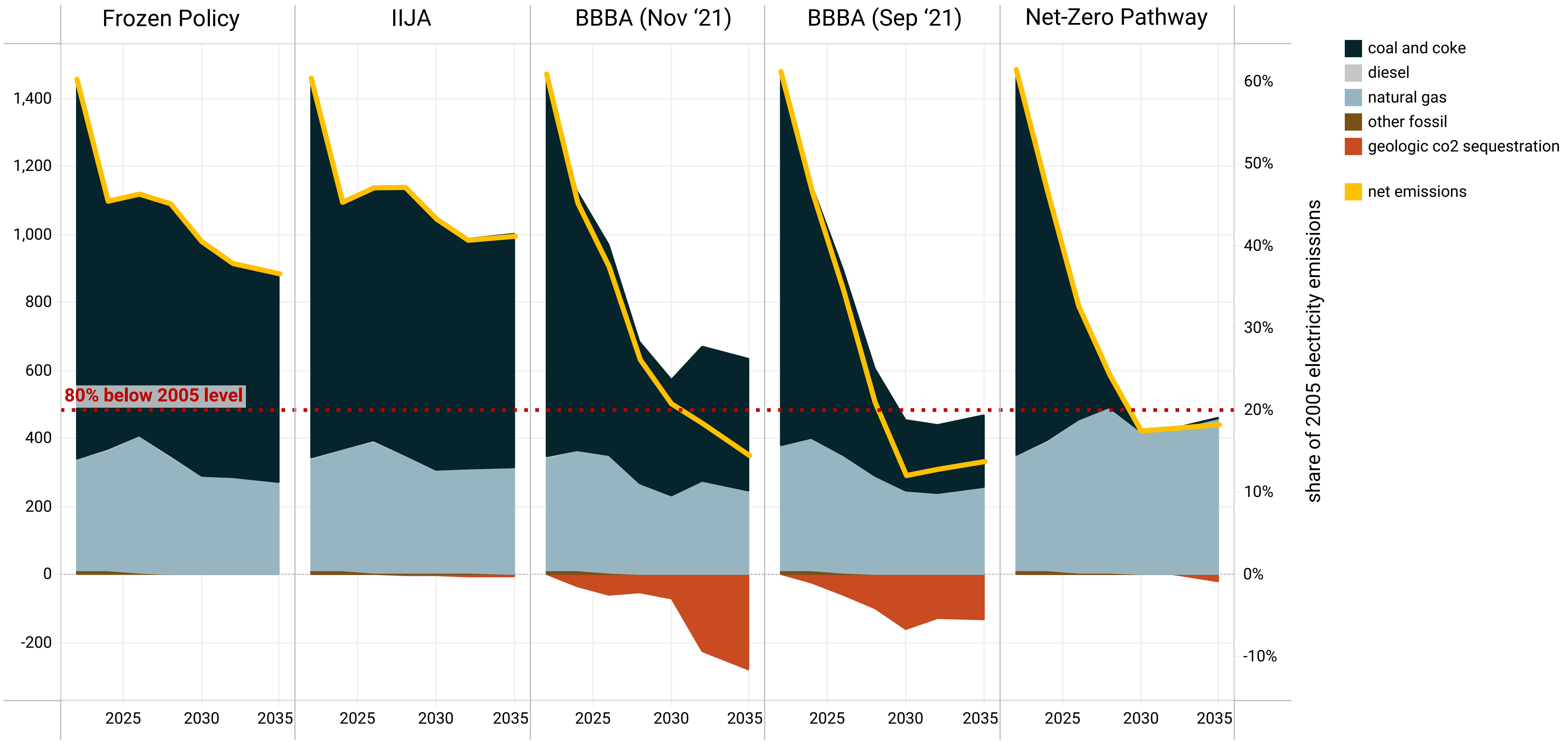
Net-Zero Pathway (424 MMT): 82% below 2005 levels

The House-passed **BBBA (Nov '21)** version results in ~210 MMT CO_2 more emissions from electricity generation in 2030 than the originally introduced **BBBA (Sept '21)** version, due principally to the removal of the Clean Electricity Performance Program.

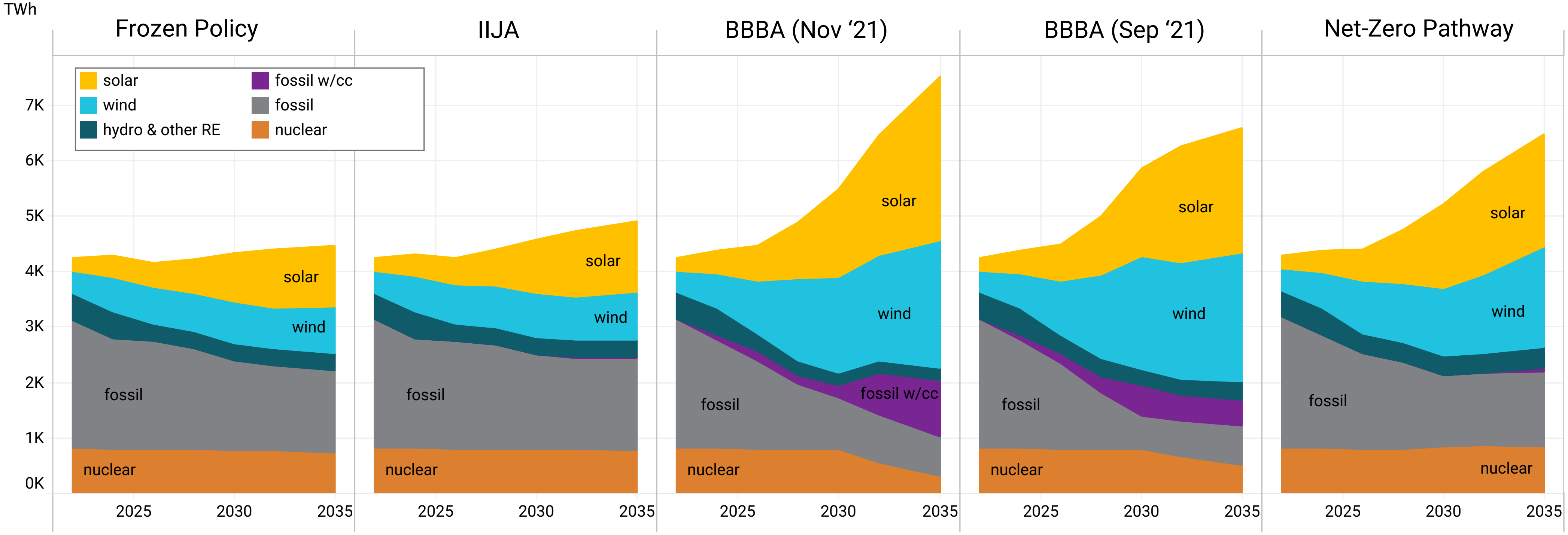
The switch to longer-term, technology neutral tax credits for all clean electricity sources in the Nov '21 version (Sections 136801 and 136802, Clean Electricity Production Credit and Clean Electricity Investment Credit) drives more sustained emissions reductions beyond 2030 than the original Sept '21 version, which saw all tax credits expire after 2031.

Power Sector Annual CO2 Emissions

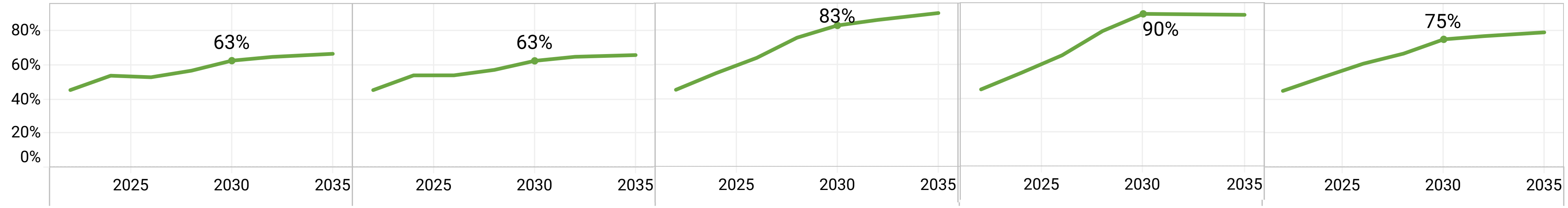
million metric tons



Electricity Generation



Share of Clean Generation



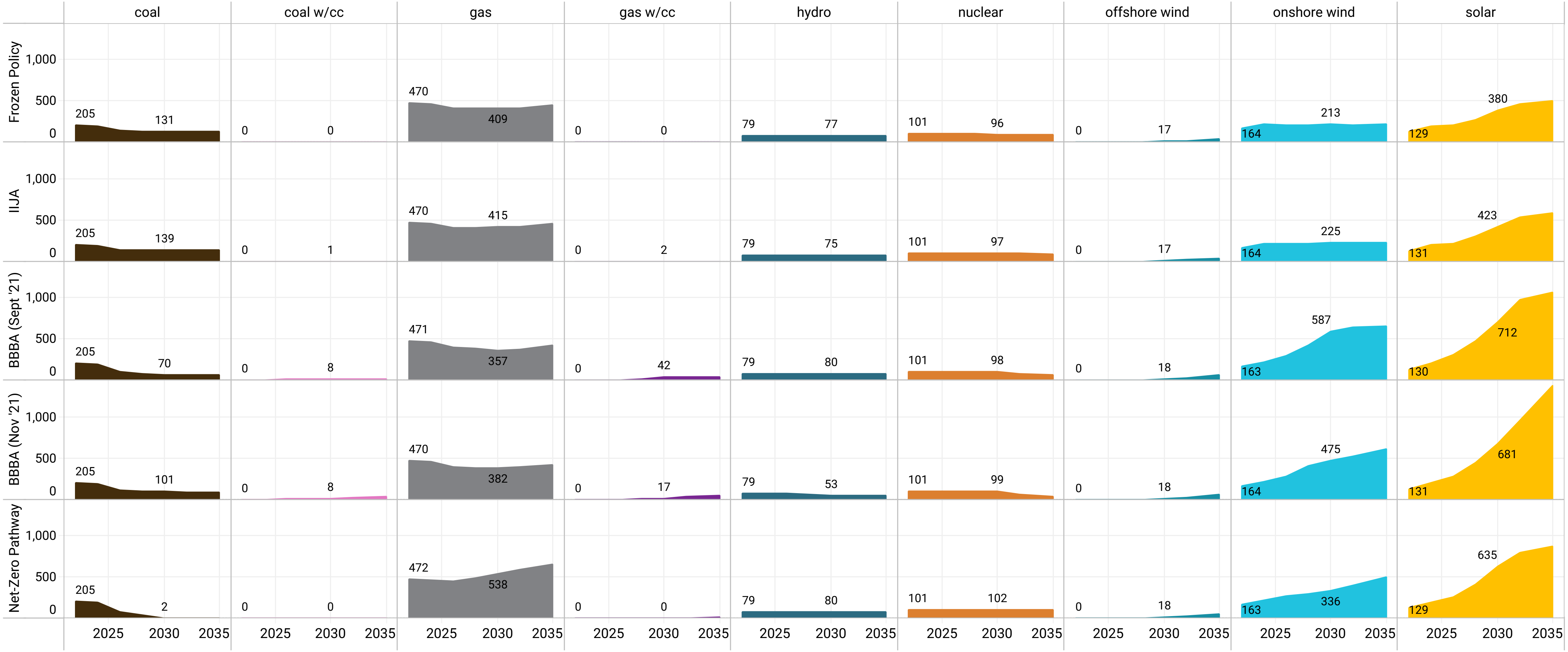
Enactment of **IIJA** alone leaves the trajectory of United States' clean electricity growth largely unchanged.

In contrast, enacting **BBBA (Nov '21)** would spur growth of wind power, solar PV, and fossil power plants w/carbon capture, bringing the share of clean electricity to more than 80% by 2030.

Note that all modeled scenarios meet hour-by-hour electricity demand and regional capacity reserve requirements, ensuring **grid reliability is maintained in all cases**.

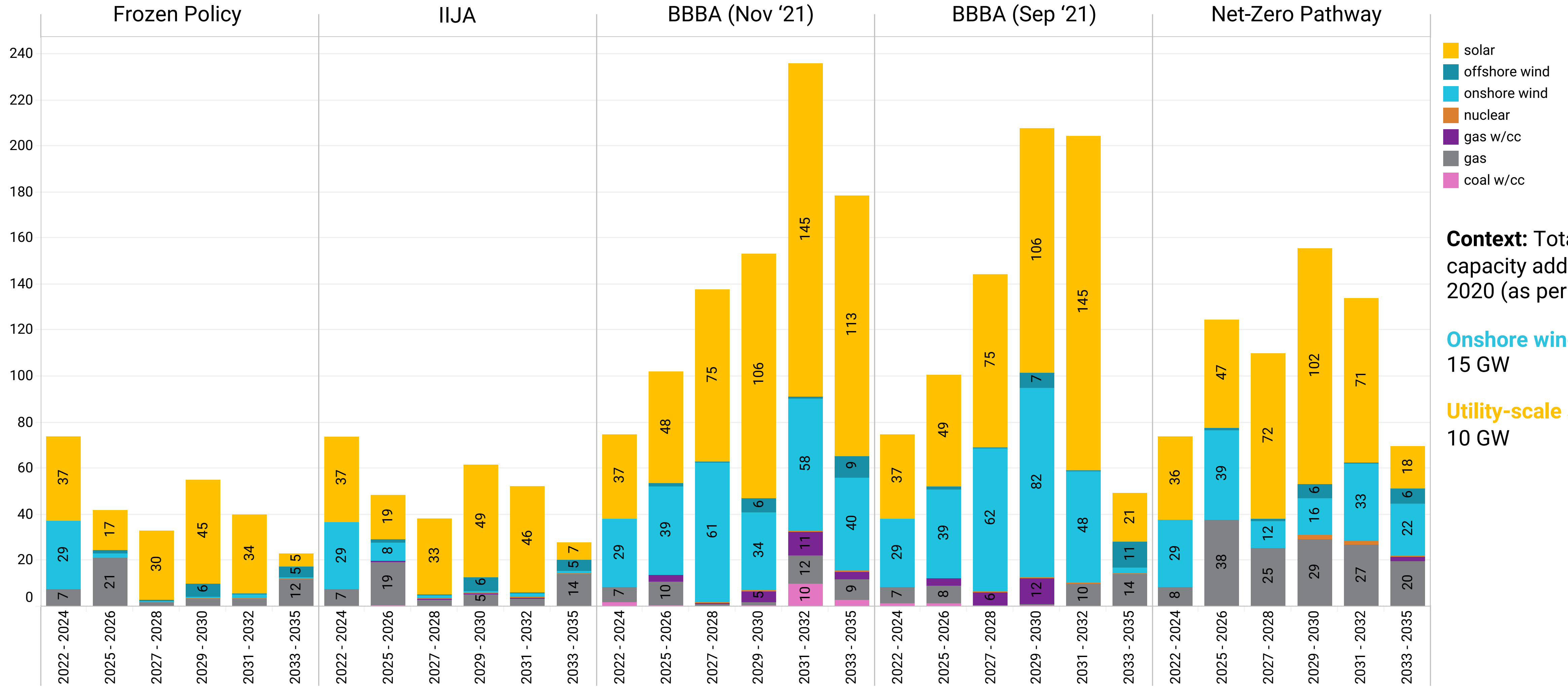
Capacity

GW


coal
coal w/cc
gas
gas w/cc
hydro
nuclear
offshore wind
onshore wind
solar
Frozen Policy
IIJA
BBBA (Sept '21)
BBBA (Nov '21)
Net-Zero Pathway
1,000
500
0
2025
2030
2035
205 131
0 0
470 409
0 0
79 77
101 96
0 17
164 213
129 380
205 139
0 1
470 415
0 2
79 75
101 97
0 17
164 225
131 423
205 70
0 8
471 357
0 42
79 80
101 98
0 18
163 587
130 712
205 101
0 8
470 382
0 17
79 53
101 99
0 18
164 475
131 681
205 2
0 0
472 538
0 0
79 80
101 102
0 18
163 336
129 635

Annual Average Capacity Additions

GW



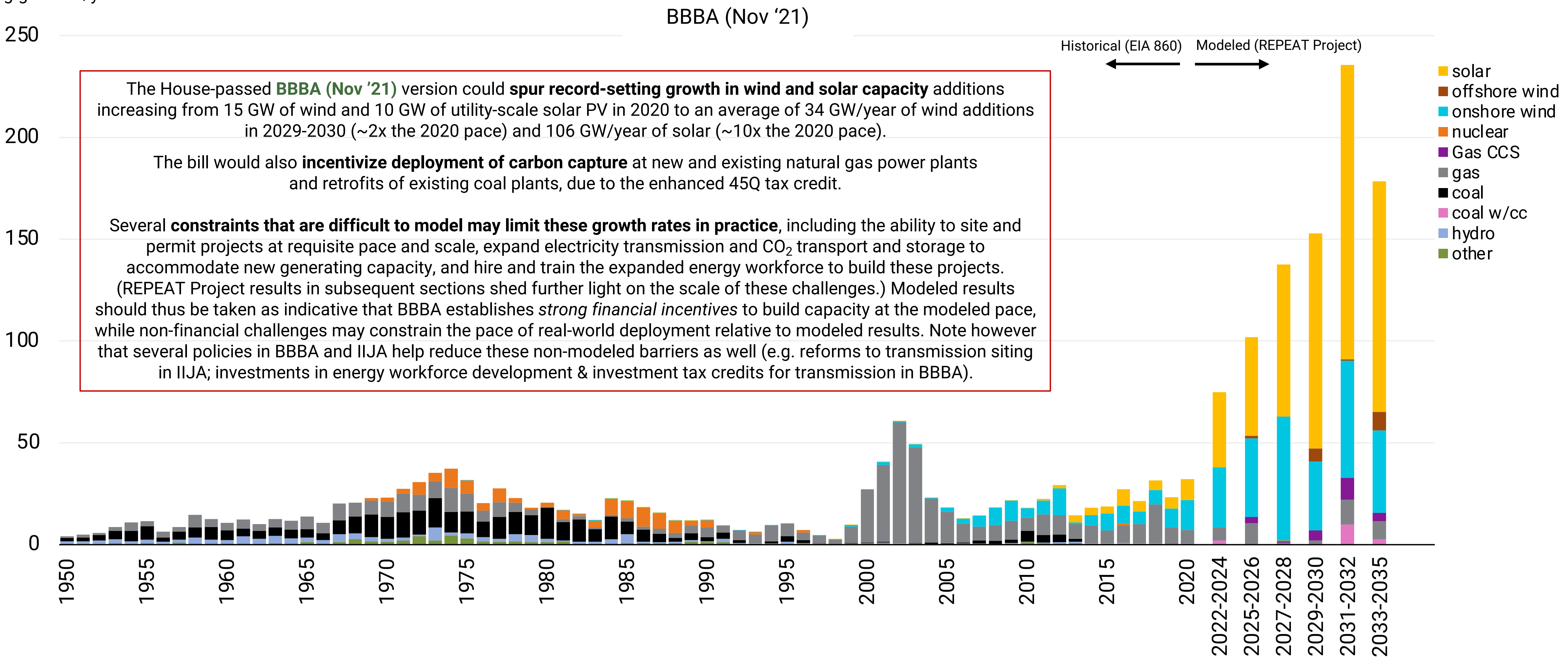
Context: Total annual capacity additions in 2020 (as per EIA):

Onshore wind: 15 GW

Utility-scale solar: 10 GW

Historical Annual Capacity Additions vs. Modeled Annual Average Capacity Additions

gigawatts/year

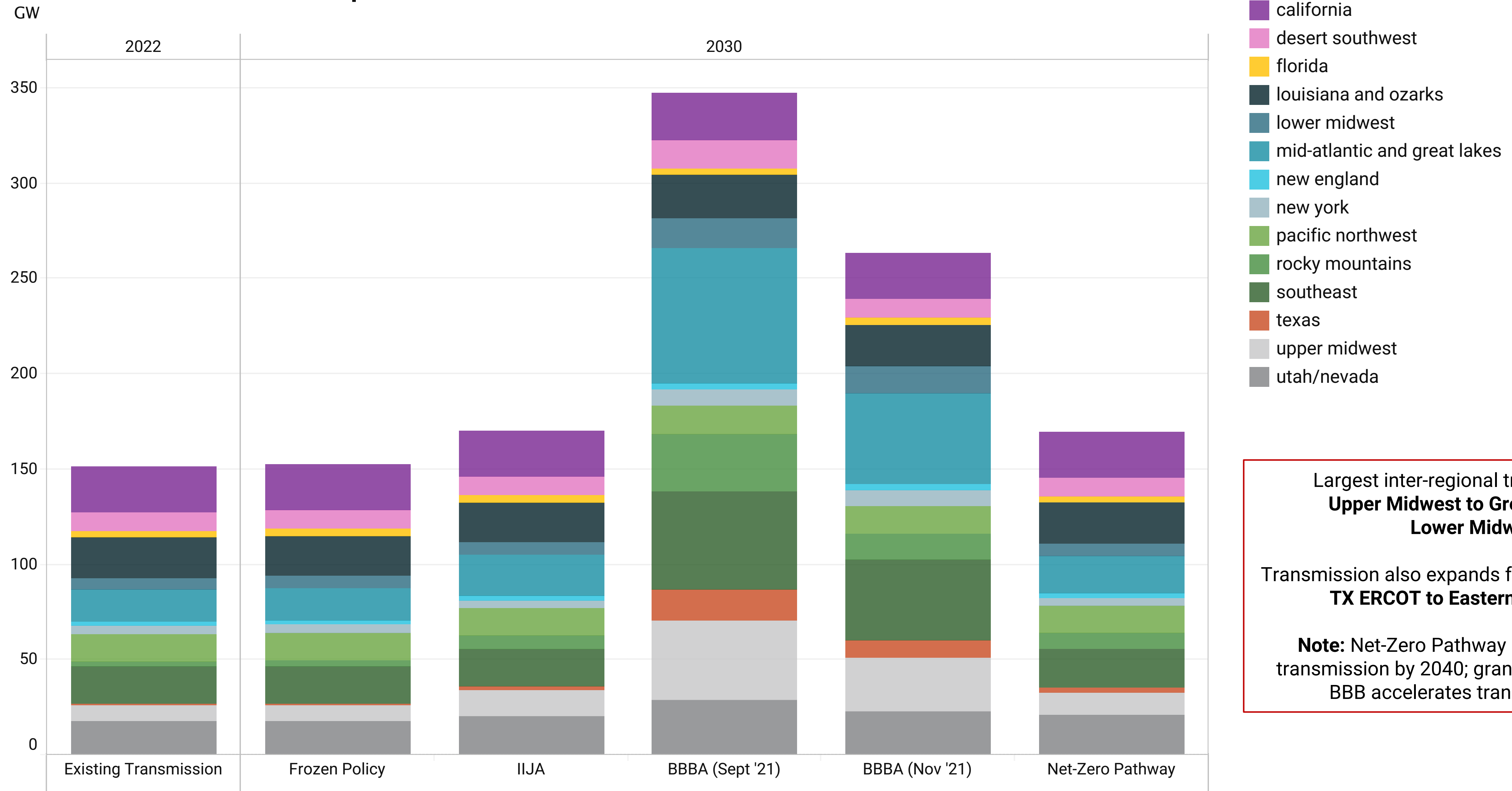


The House-passed **BBBA (Nov '21)** version could **spur record-setting growth in wind and solar capacity** additions increasing from 15 GW of wind and 10 GW of utility-scale solar PV in 2020 to an average of 34 GW/year of wind additions in 2029-2030 (~2x the 2020 pace) and 106 GW/year of solar (~10x the 2020 pace).

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. (REPEAT Project results in subsequent sections shed further light on the scale of these challenges.) Modeled results should thus be taken as indicative that BBBA 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. Note however that several policies in BBBA and IIJA help reduce these non-modeled barriers as well (e.g. reforms to transmission siting in IIJA; investments in energy workforce development & investment tax credits for transmission in BBBA).

Electrical Transmission Expansion

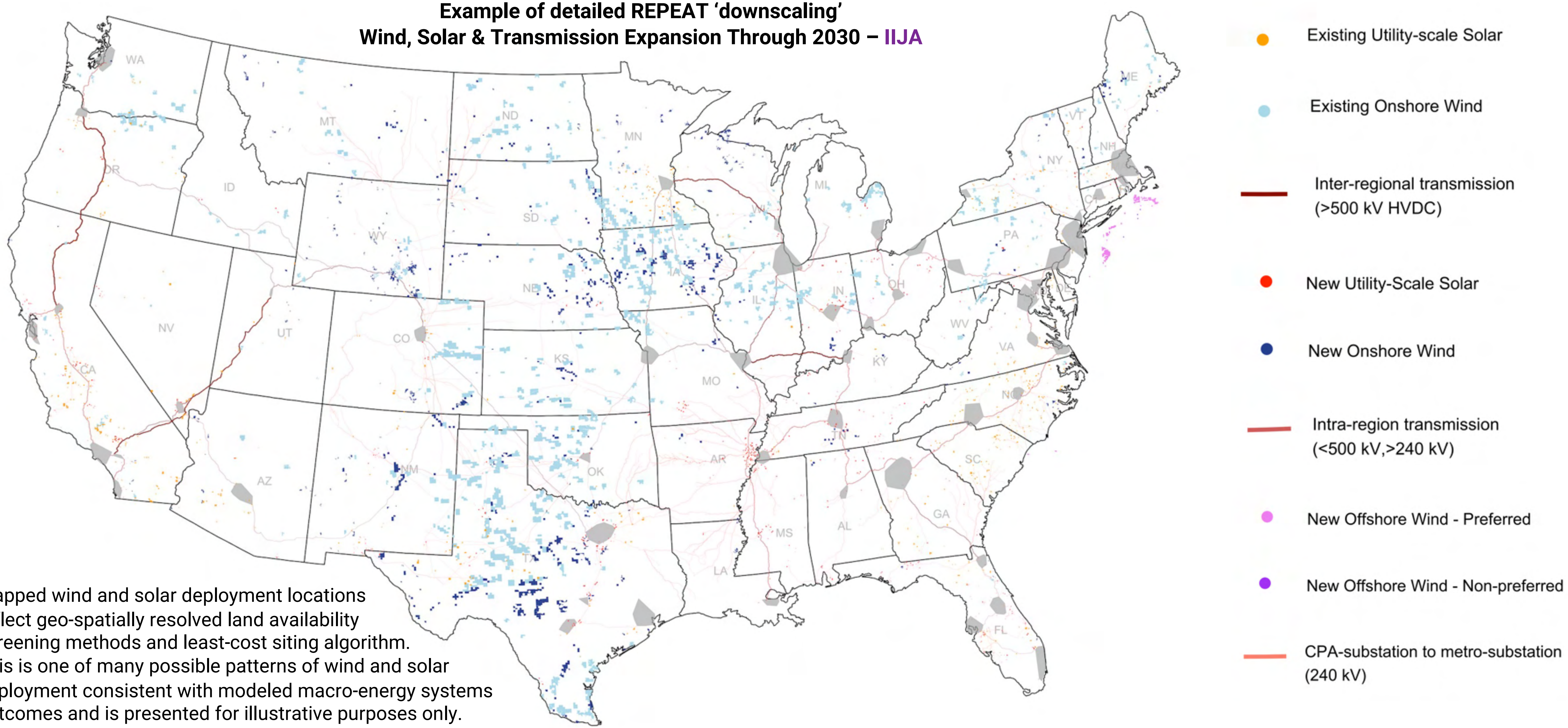


Largest inter-regional transmission build-out is from **Upper Midwest to Great Lakes/Mid-Atlantic** and **Lower Midwest to Southeast.**

Transmission also expands from **UT/NV and AZ to CA** and from **TX ERCOT to Eastern Interconnect** (OK and LA).

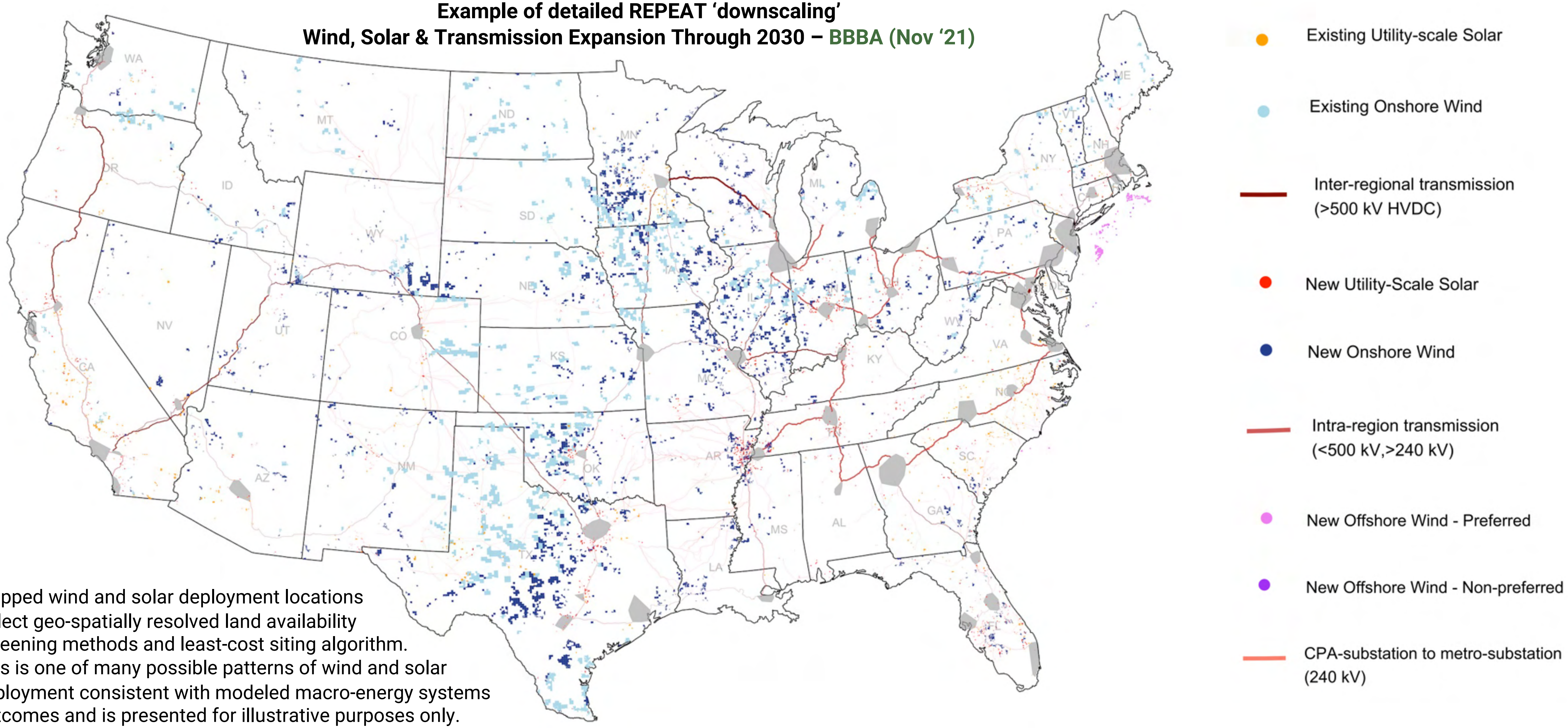
Note: Net-Zero Pathway builds an equivalent amount of transmission by 2040; grant funding and transmission ITC in BBB accelerates transmission build-out to 2030.

Example of detailed REPEAT 'downscaling'
Wind, Solar & Transmission Expansion Through 2030 – IIJA



Mapped wind and solar deployment locations reflect geo-spatially resolved land availability screening methods and least-cost siting algorithm. This is one of many possible patterns of wind and solar deployment consistent with modeled macro-energy systems outcomes and is presented for illustrative purposes only.

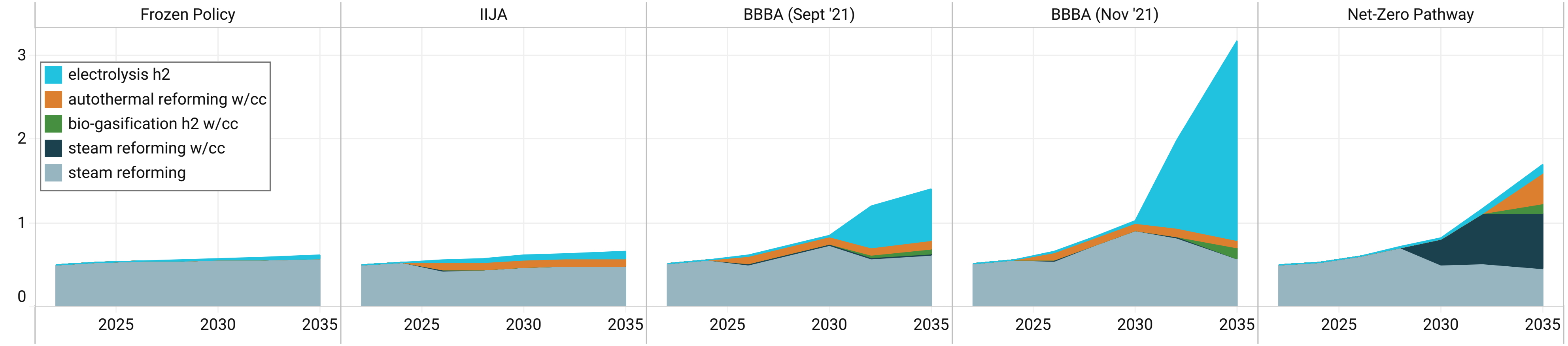
Example of detailed REPEAT 'downscaling'
Wind, Solar & Transmission Expansion Through 2030 – BBBA (Nov '21)



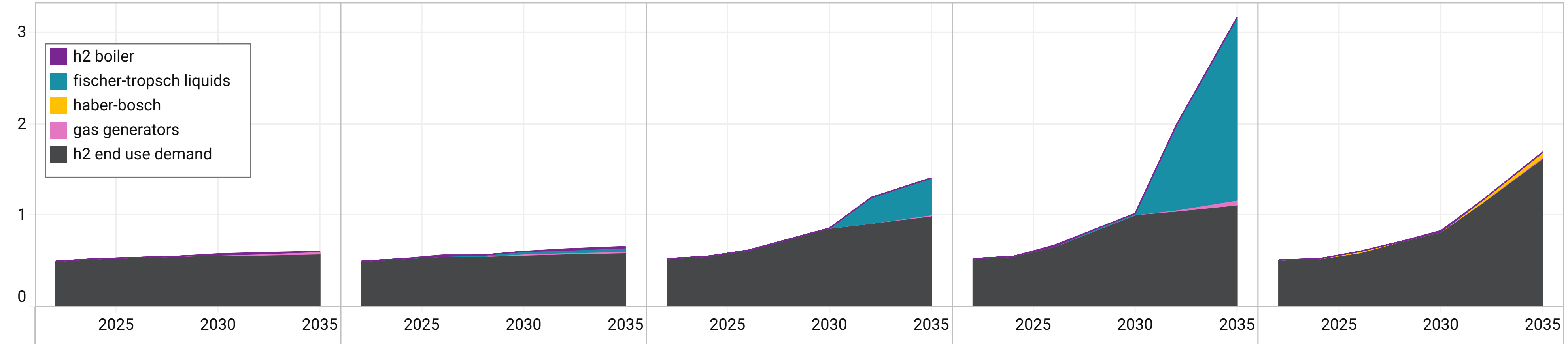
Mapped wind and solar deployment locations reflect geo-spatially resolved land availability screening methods and least-cost siting algorithm. This is one of many possible patterns of wind and solar deployment consistent with modeled macro-energy systems outcomes and is presented for illustrative purposes only.

Hydrogen and CO_2 Capture and Storage

H2 Supply
Quads



H2 Demand
Quads



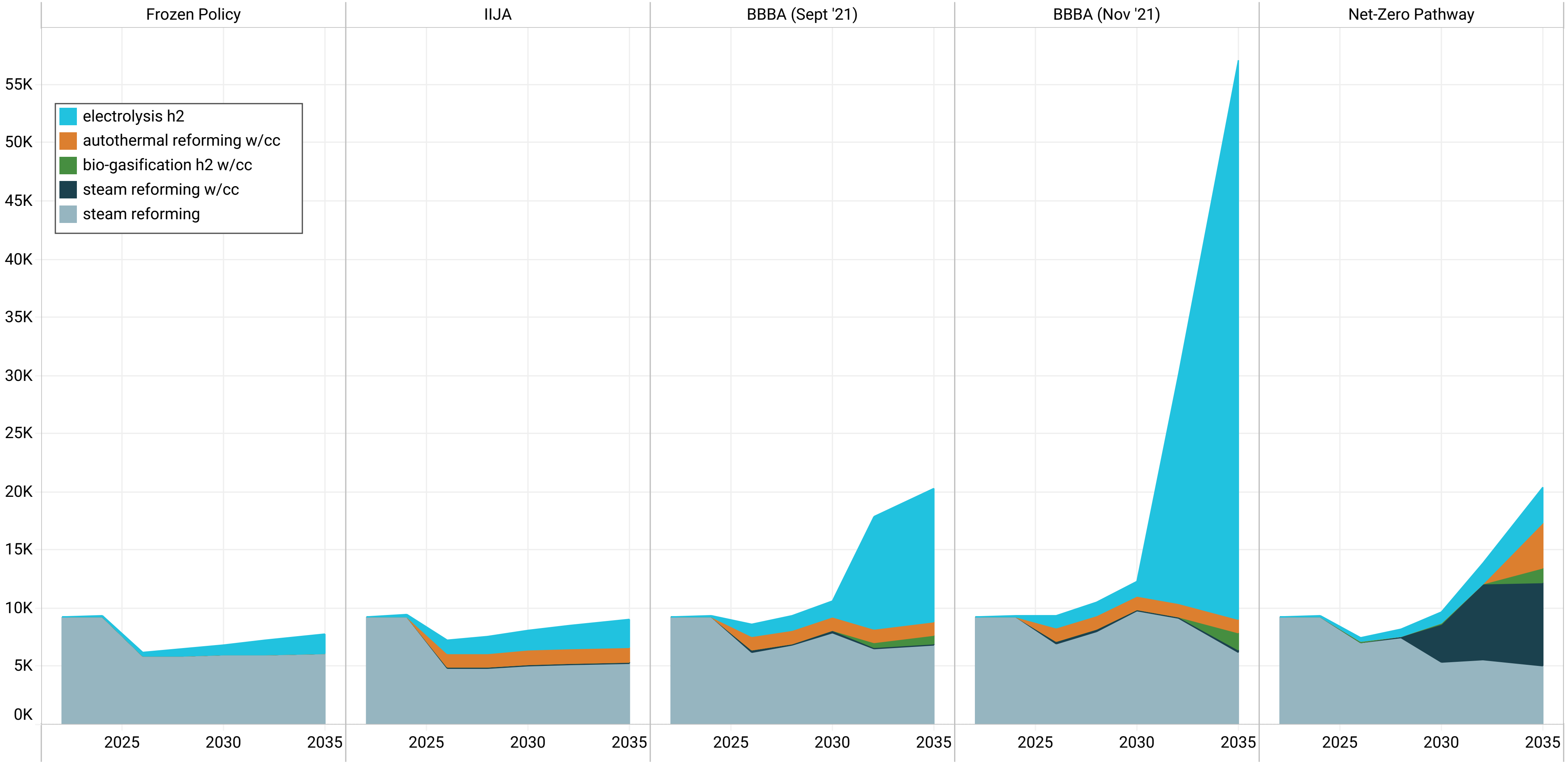
The **IIJA** supports deployment of 'hydrogen hubs,' which are modeled here as a mix of electrolysis, steam methane reforming with carbon capture (CC) and more advanced autothermal reforming of natural gas with CC.

A combination of low marginal cost electricity due to renewable electricity and CCUS tax credits present in **BBBA** and expected declines in electrolyser cost results in a boom in hydrogen production from electrolysis after 2030 in these policy scenarios. Most of the produced hydrogen is converted to liquid fuels via Fischer-Tropsch process to provide sustainable aviation fuels or diesel, something that is not present in the Net-Zero Pathway until the 2040s.

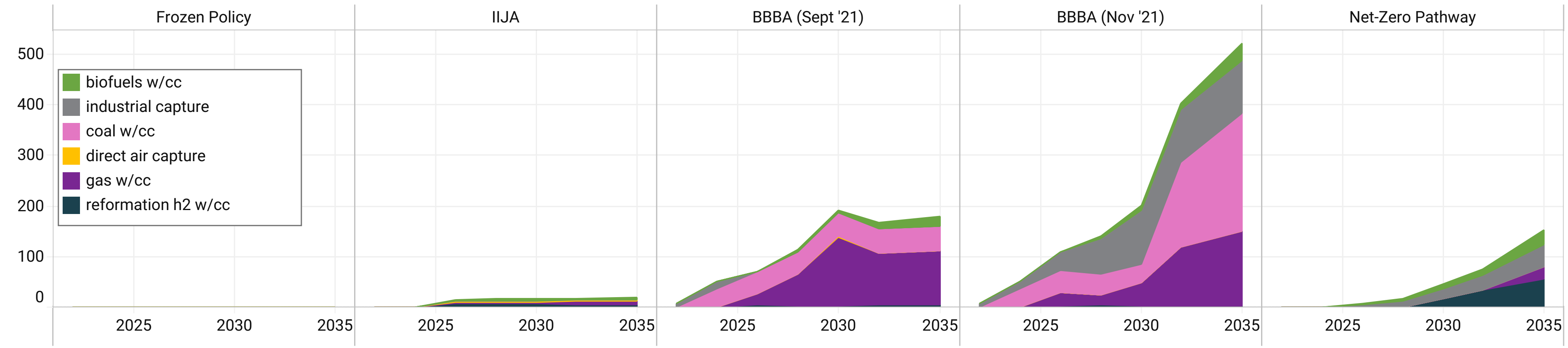
The **Net-Zero Pathway** features significant deployment of steam methane reforming w/CC starting in 2028, which is initially lower cost than electrolysis absent subsidies (given input assumptions; this result is sensitive to the relative cost of natural gas fuel and the pace of electrolyser cost declines). Electrolysis and biomass gasification w/CC feature prominently in this pathway in the late 2030s and 2040s (not depicted here).

H2 production capacity

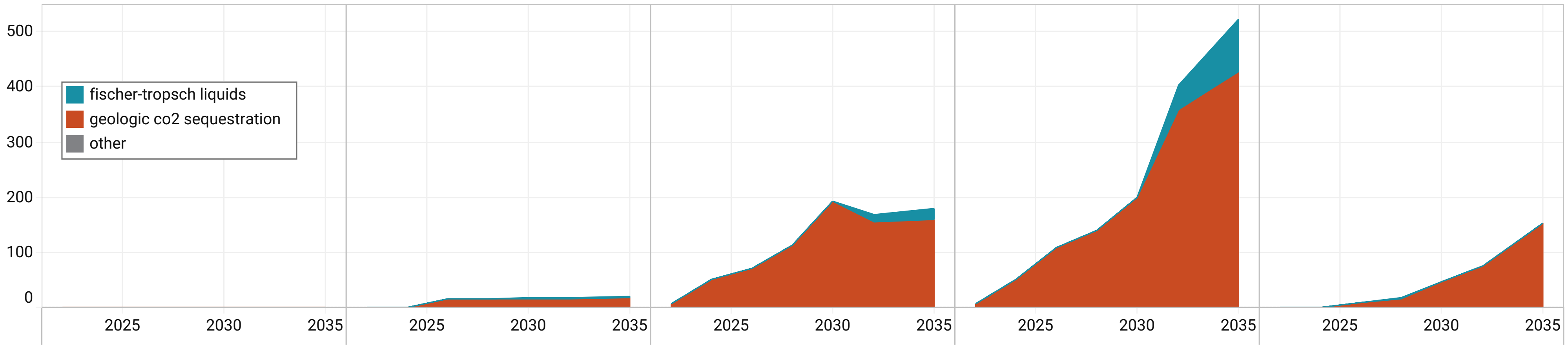
Million tonnes per year



Captured CO2 Sources
million metric tons



CO2 Destination
million metric tons



The **IIJA** supports demonstration of a range of CCS projects, including in power generation, methane reforming for hydrogen production, and direct air capture.

Under the **BBBA (Nov '21)** version, the expansion of the 45Q tax credit to $85/t for power and industry results in a significant increase in CCUS, with an estimated 106 MMT CO_2 captured in industry (across iron & steel, cement, and refineries) and 80 MMT in power (split between coal retrofits and new oxy-combustion natural gas power plants w/CC).

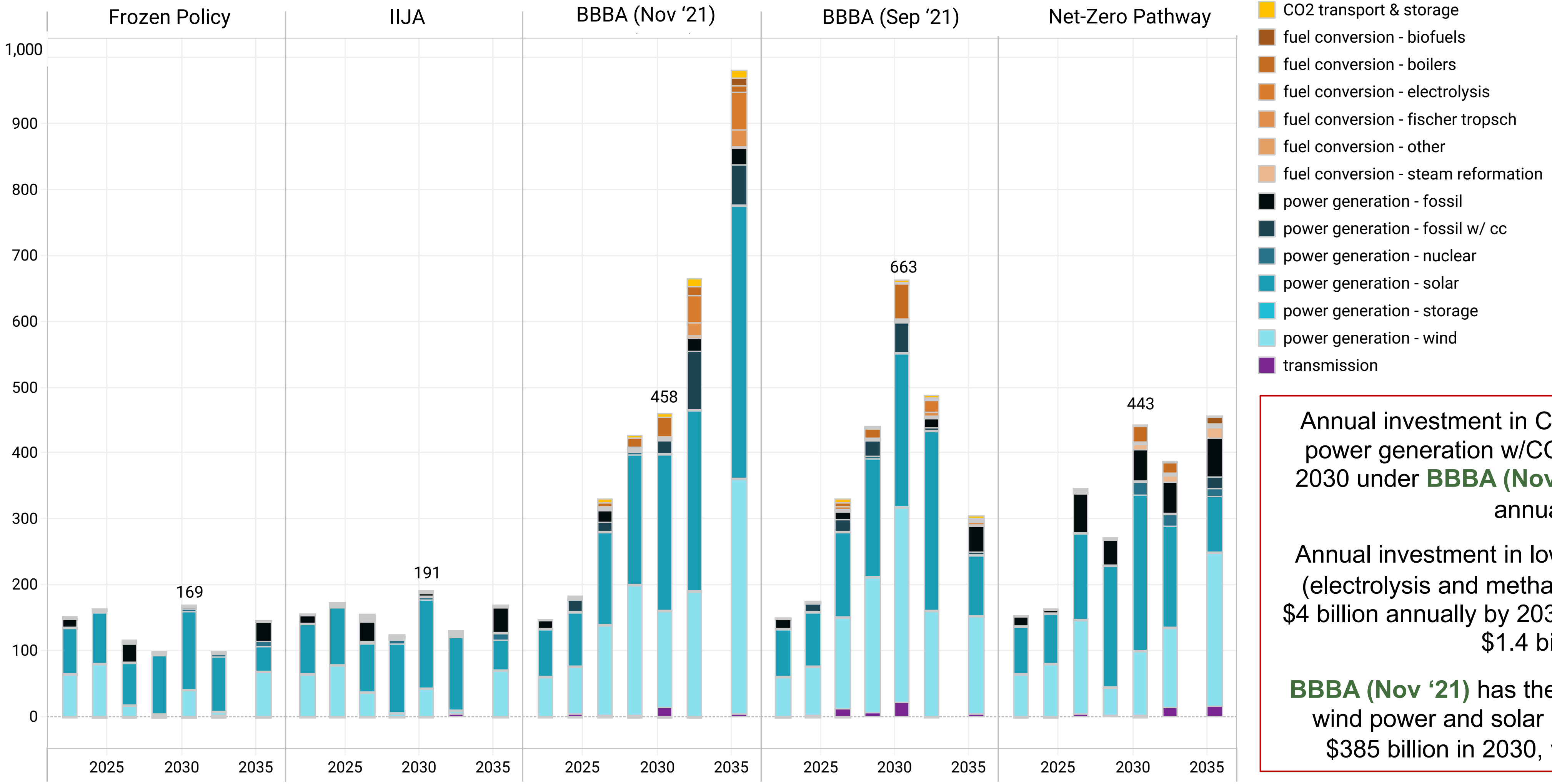
In the **Net-Zero Pathway** CCUS grows more slowly in the 2030s but reaches gigaton scale by 2050, so the policy scenarios successfully pull forward CCUS deployment and can drive technological learning and infrastructure build-out that can make larger-scale CCUS more plausible in the longer-term.

Note that by assumption, we limit the maximum geologic CO_2 storage to 200 MMT in 2030 based on assumed limitations on infrastructure scale-up, a binding limit in both BBBA scenarios.

Capital Investment in Energy Supply Infrastructure

Annual capital investment in energy supply related infrastructure vs IIJA

Billion 2018 USD per year



Average annual supply-side capital investment, 2023-2030

2018 dollars/year

Frozen Policy: $126 billion

IIJA: $150 billion

BBBA (Nov. '21): $313 billion

BBB (Sept '21): $315 billion

Net-Zero Pathway: $260 billion

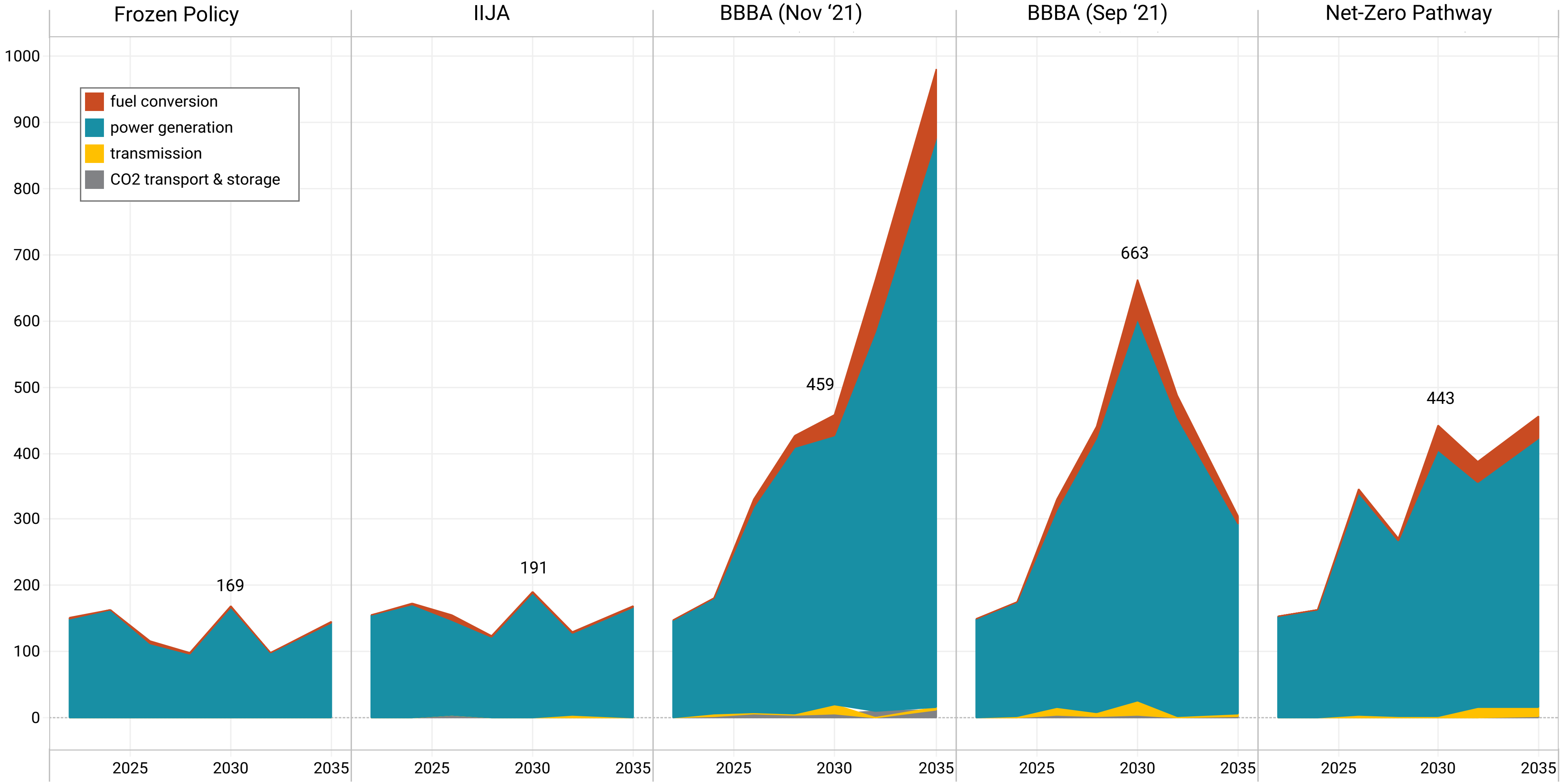
Annual investment in CO_2 transport & storage and fossil power generation w/CC reaches $24 billion annually by 2030 under **BBBA (Nov '21)**, up from less than $2 billion annually under **IIJA**.

Annual investment in low emissions hydrogen production (electrolysis and methane reforming w/CC) increases to $4 billion annually by 2030 under **BBBA (Nov '21)**, up from $1.4 billion under **IIJA**.

BBBA (Nov '21) has the greatest impact on investment in wind power and solar PV, which more than doubles to $385 billion in 2030, versus $177 billion under **IIJA.**

Annual capital investment in energy supply related infrastructure

Billion 2018 USD per year



Average annual supply-side capital investment, 2023-2030
2018 dollars/year

Frozen Policy: $126 billion

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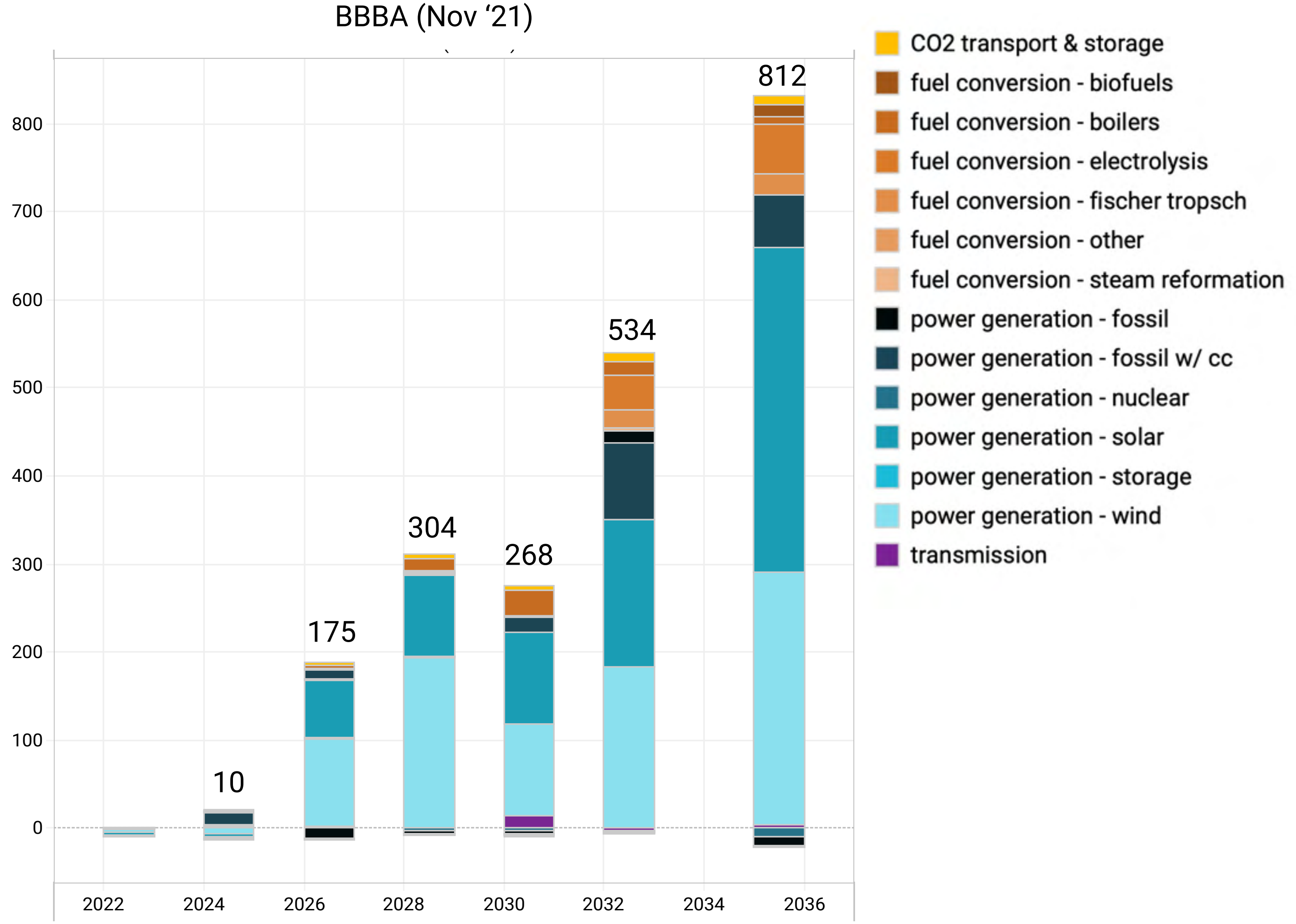
Net-Zero Pathway: $260 billion

The electric power sector receives the bulk of incremental investment in energy supply infrastructure under all pathways.

Annual capital investment in energy supply related infrastructure vs IIJA

Billion 2018 USD per year

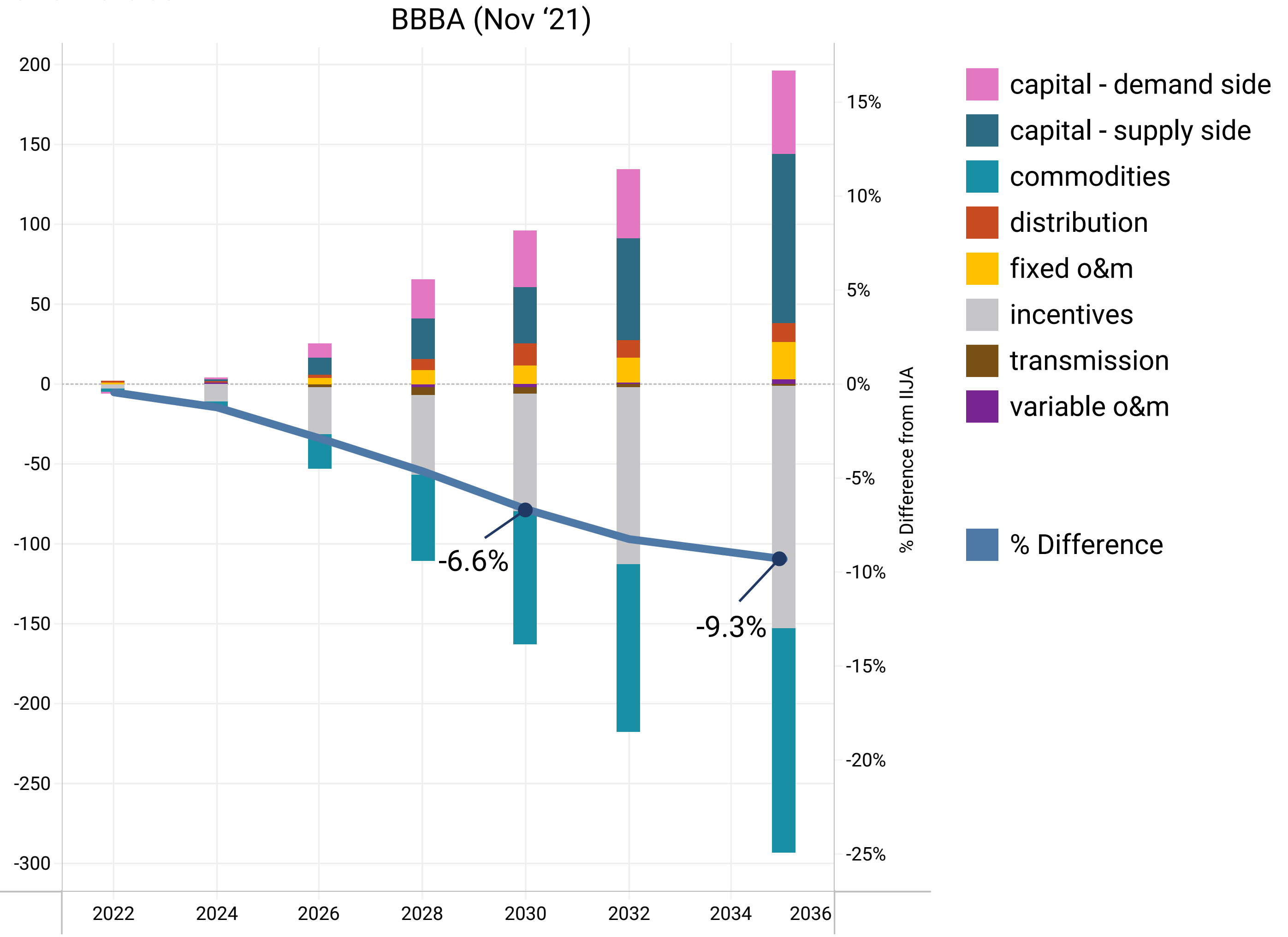


Passage of BBBA (Nov '21) would increase cumulative capital investment in energy supply related infrastructure by **more than $1.5 trillion** from 2023-2030, relative to passage of the IIJA alone.

Energy Expenditures Impacts

Change in annual U.S. energy expenditures vs IIJA

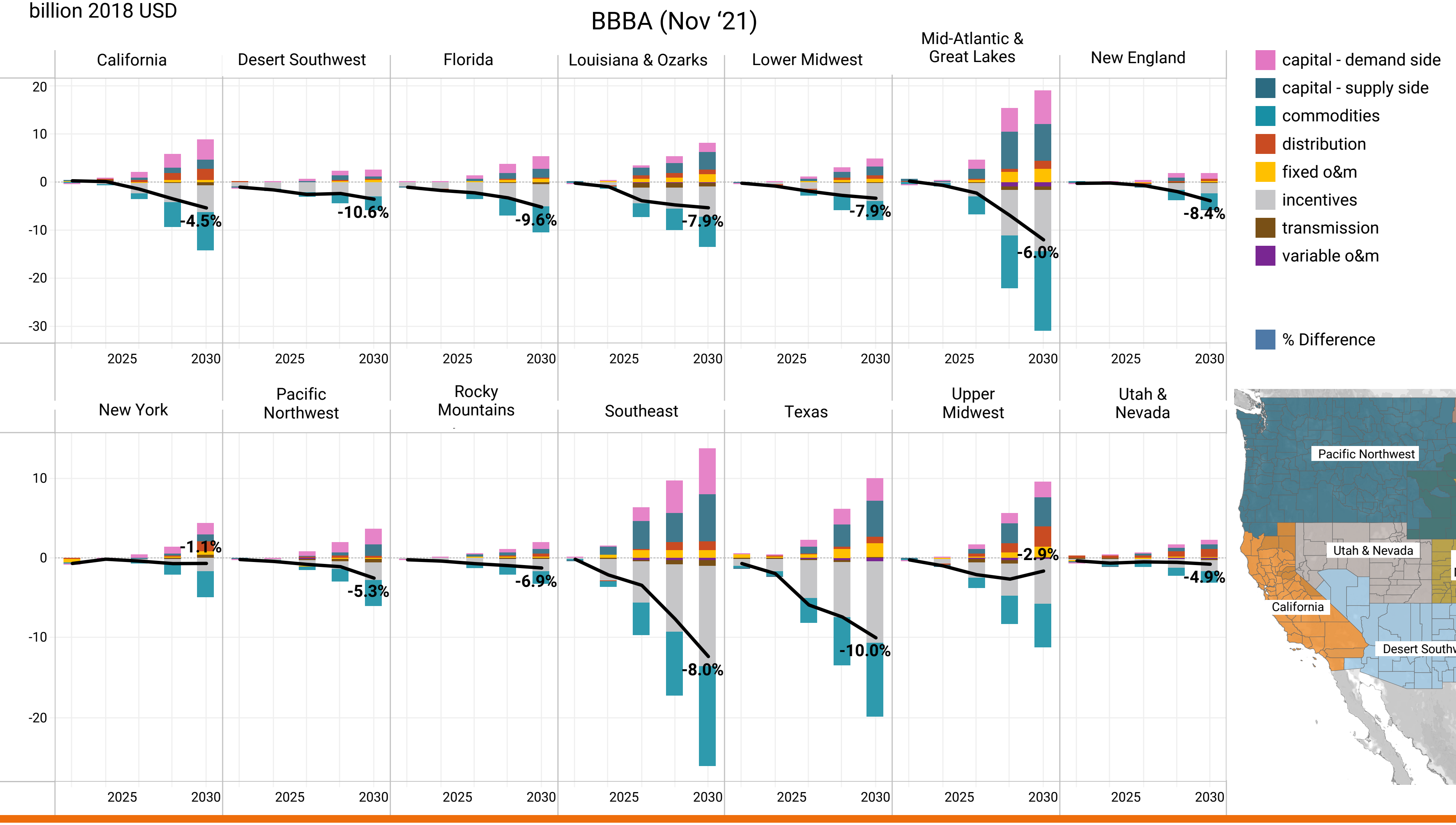
billion 2018 USD



Enactment of BBBA (Nov '21) **lowers annual U.S. energy expenditures by 6.6% in 2030**, an annual savings of **$67 billion dollars** for households, businesses and industry. 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 and heat pumps for individuals and businesses, and finance investments in energy productivity enhancing improvements and carbon capture equipment by U.S. industry.

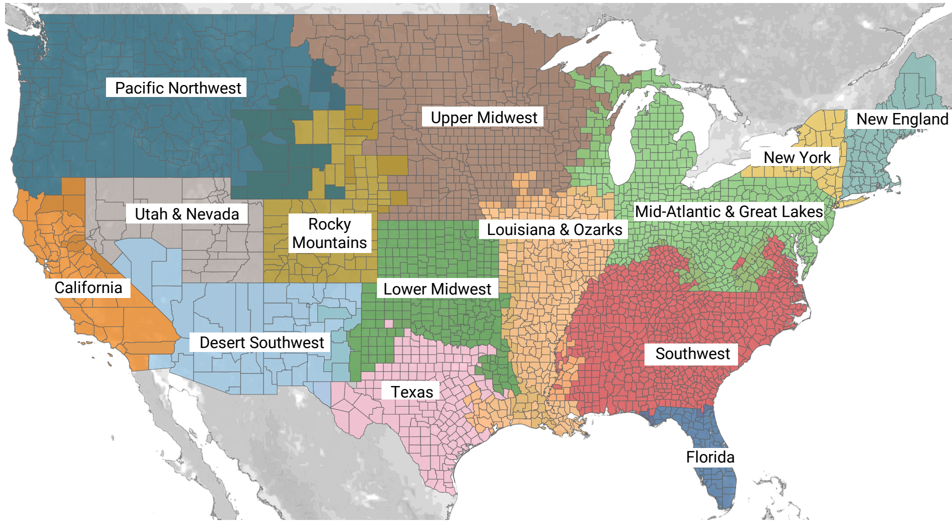
Change in annual regional energy expenditures vs IIJA

billion 2018 USD



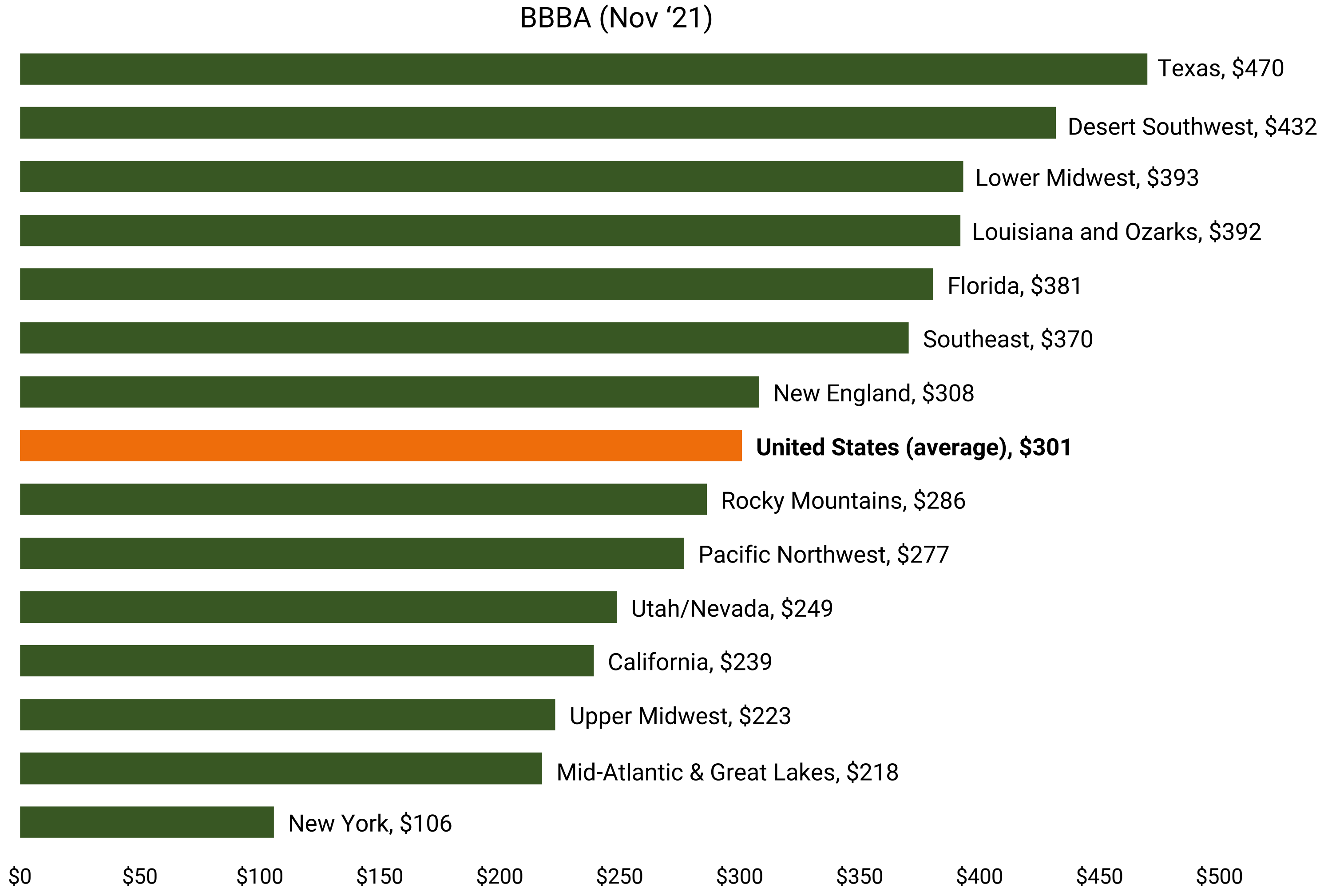
Enactment of **BBBA (Nov '21) lowers annual energy expenditures across all U.S. regions** in 2030.

RIO model regions



Reduction in 2030 average household energy costs vs IIJA

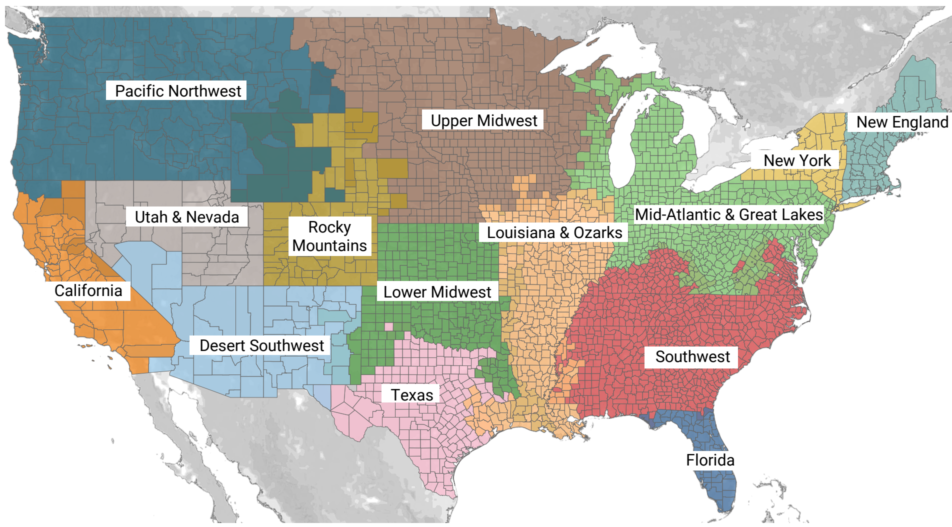
2018 USD per household per year



Enactment of **BBBA (Nov '21)** would **reduce average household energy costs in 2030 across all regions** of the country, delivering **about $300 per year in savings to the average U.S. household** relative to costs under **IIJA** alone**.**

Average household savings across U.S. regions ranges from about $100 to $470 per household per year.

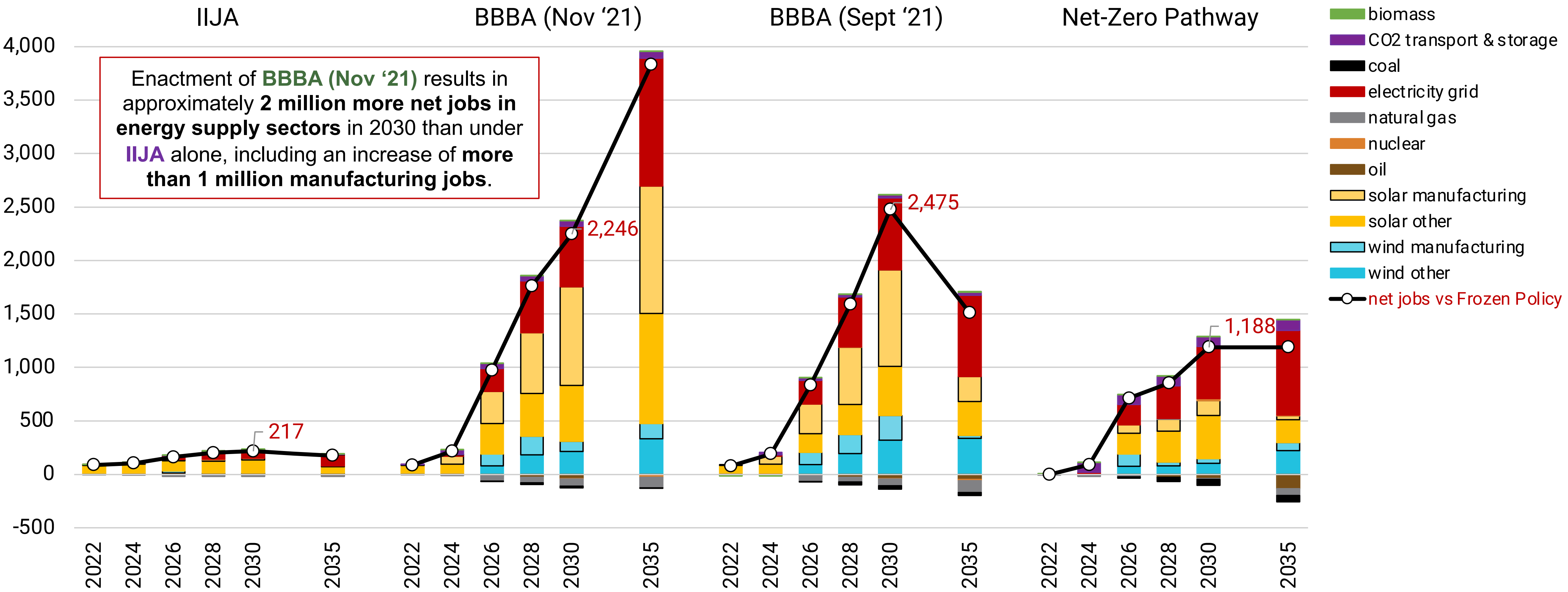
RIO model regions



Employment Impacts

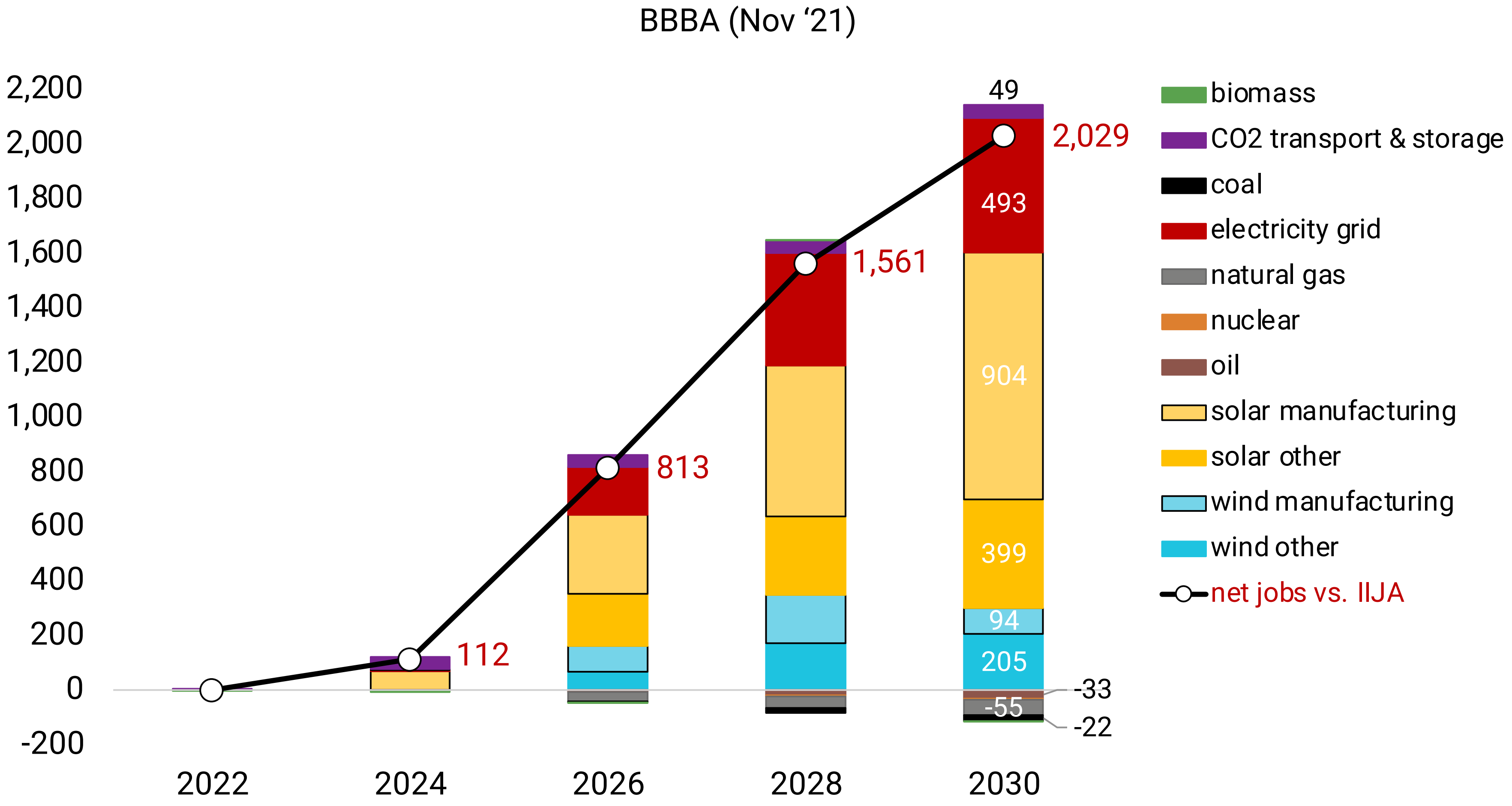
Net change in energy supply-related employment by energy resource vs Frozen Policy

thousand jobs



Note: employment in petroleum fuel refining, distribution, and retailing; hydrogen production, distribution and retailing; and biofuel conversion, distribution, and retailing are excluded from this analysis.

Net change in energy supply-related employment by energy resource vs IIJA
thousand jobs

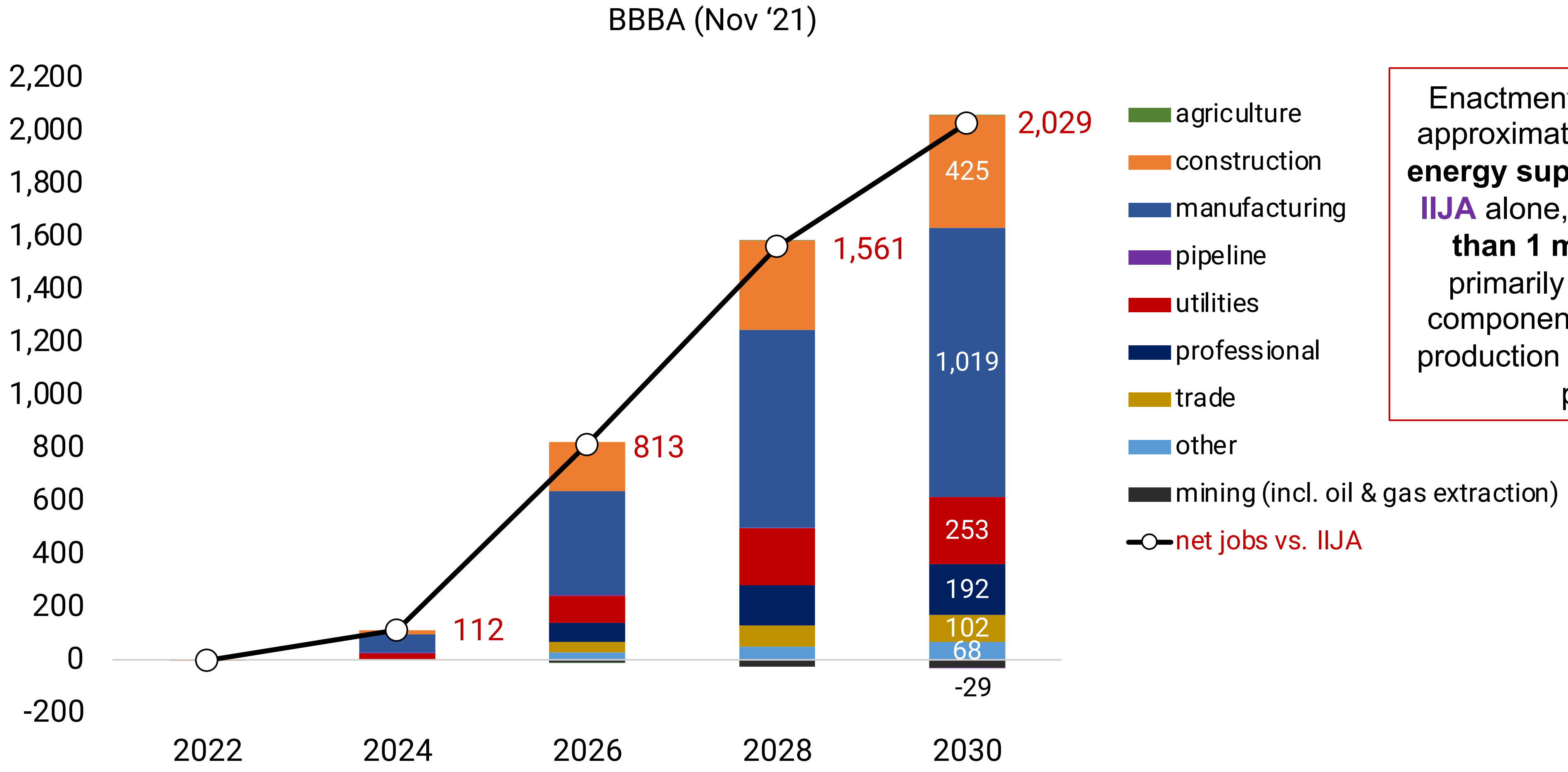


Enactment of **BBBA (Nov '21)** results in approximately **2 million more net jobs in energy supply sectors** in 2030 than under **IIJA** alone, including an increase of 1.3 million jobs in solar, 0.3 million in wind, nearly 0.5 million in electricity grid related jobs, and nearly 49,000 jobs in CO_2 transport and storage. Roughly 110,000 fewer people are employed in fossil related employment sectors.

Note: employment in petroleum fuel refining, distribution, and retailing; hydrogen production, distribution and retailing; and biofuel conversion, distribution, and retailing are excluded from this analysis.

Net change in energy supply-related employment by economic sector vs IIJA

thousand jobs



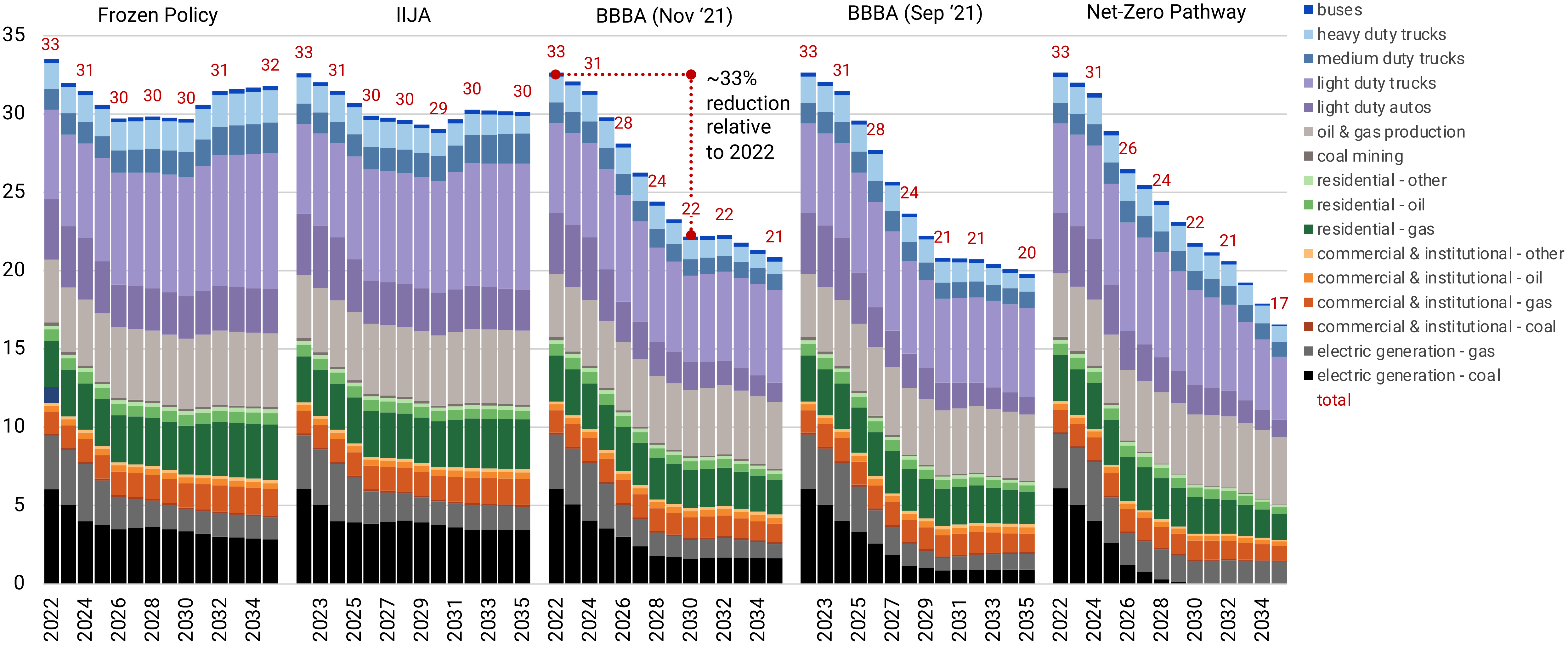
Enactment of BBBA (Nov '21) results in approximately **2 million more net jobs in energy supply sectors** in 2030 than under IIJA alone, including an increase of **more than 1 million manufacturing jobs**, primarily in solar PV and wind turbine component manufacturing, supported by production tax credits and "Buy American" provisions in the Act**.**

Note: employment in petroleum fuel refining, distribution, and retailing; hydrogen production, distribution and retailing; and biofuel conversion, distribution, and retailing are excluded from this analysis.

Air Pollution and Public Health Impacts

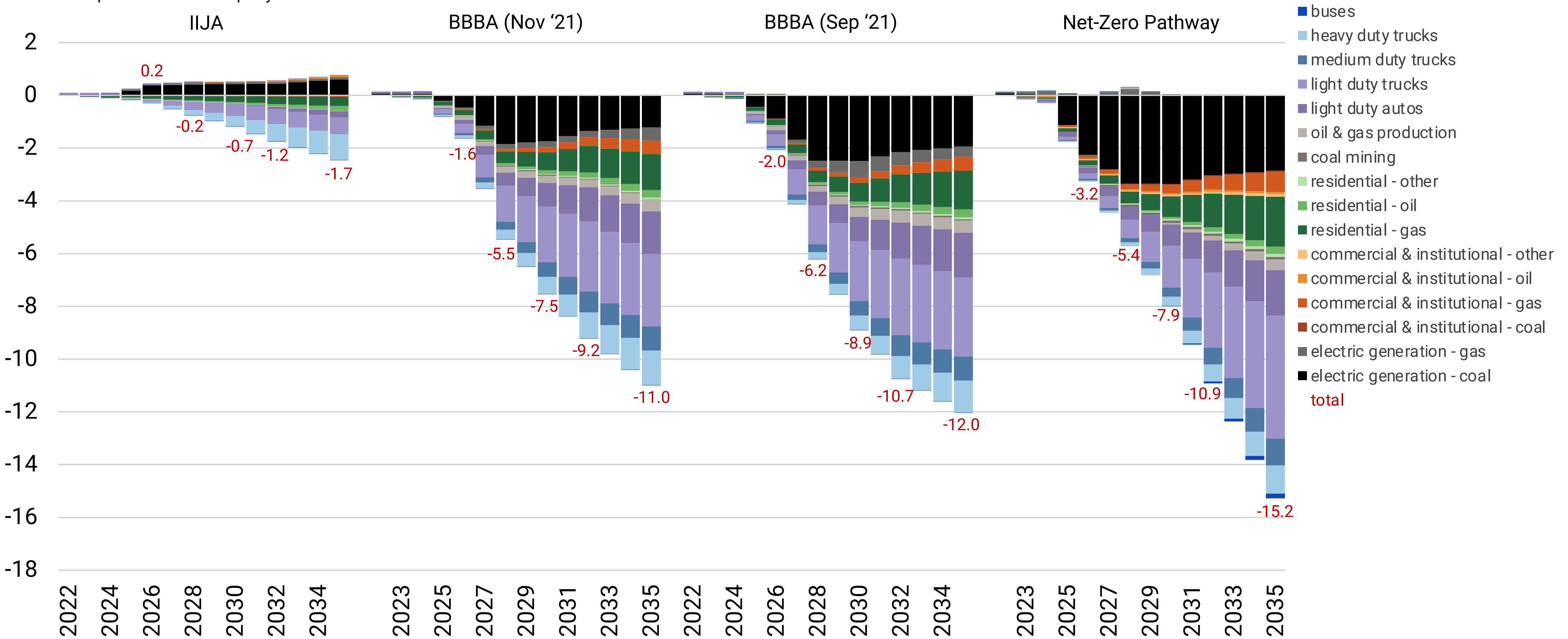
Annual premature deaths from exposure to fine particulate matter from energy activities

thousand premature deaths per year



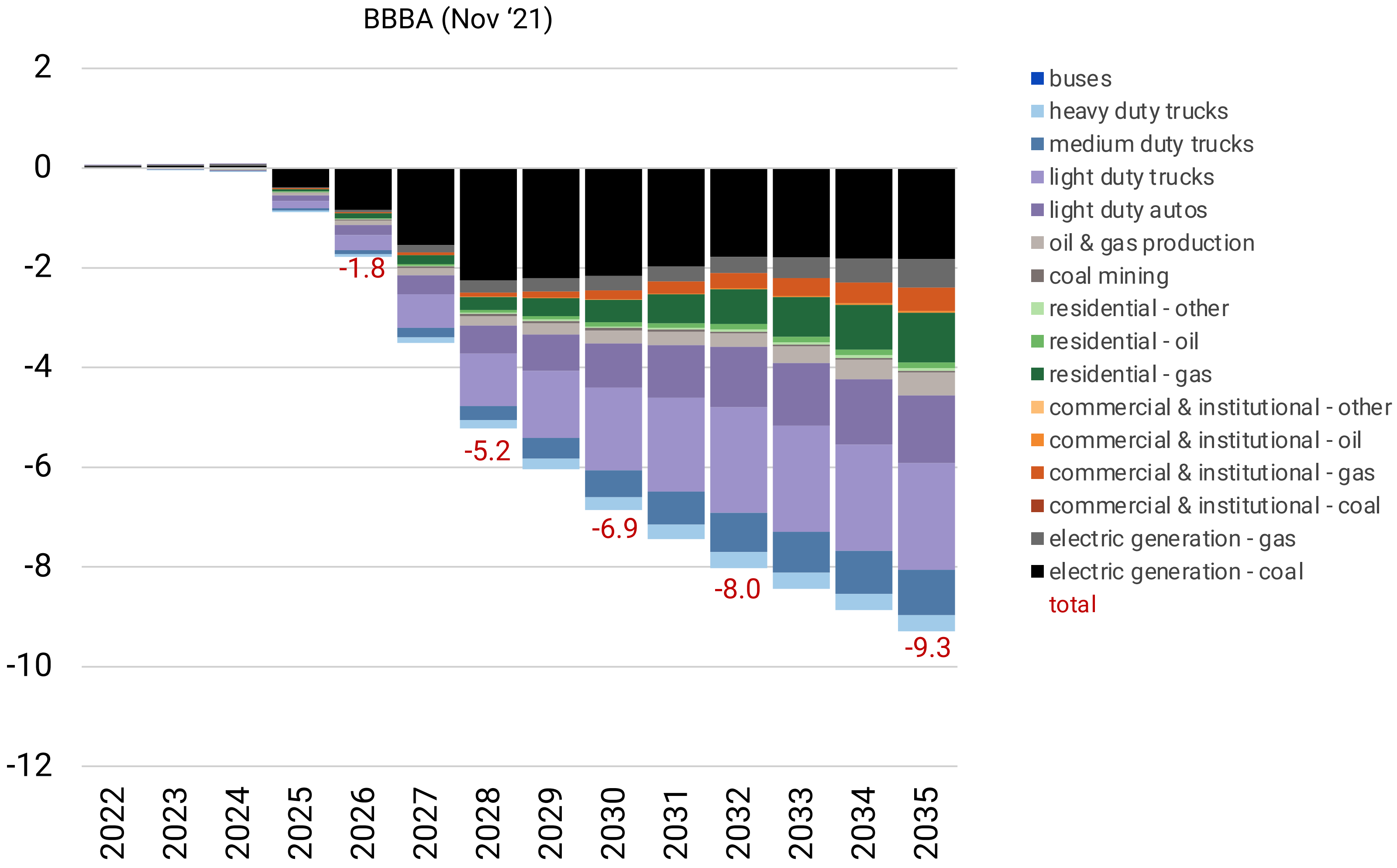
Net change in annual premature deaths from exposure to fine particulate matter from energy activities vs Frozen Policies

thousand premature deaths per year



Net change in annual premature deaths from exposure to fine particulate matter from energy activities vs IIJA

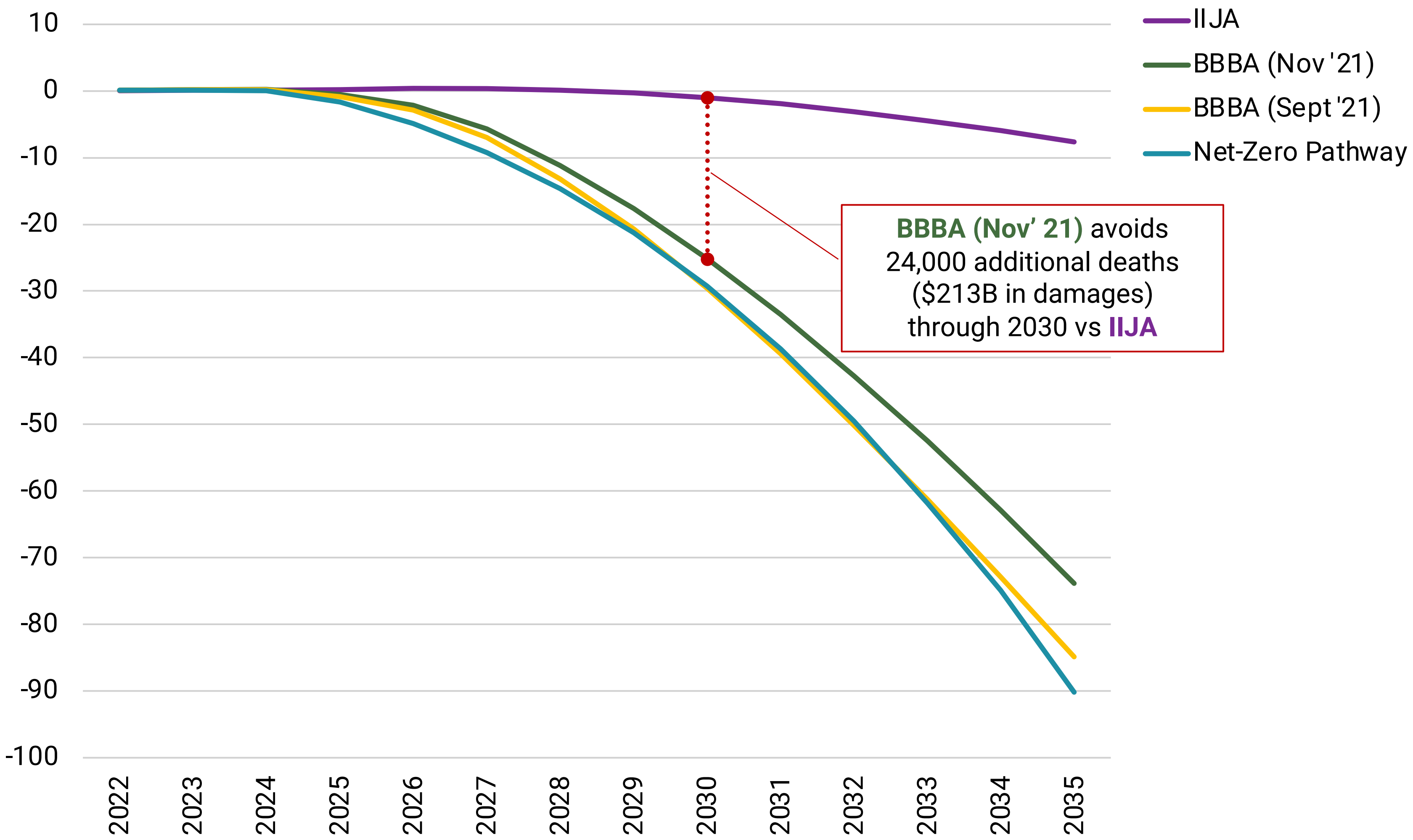
thousand premature deaths per year



Enactment of BBBA (Nov '21) results in approximately **seven thousand less premature deaths annually** in 2030 due to exposure to fine particulate pollution from energy activities than under IIJA alone.

Cumulative change in annual premature deaths from exposure to fine particulate matter from energy activities vs Frozen Policies

thousand premature deaths



Modeled cumulative reduction in premature deaths vs Frozen Policies, 2022-2030 (and avoided damages)

premature deaths (dollars of damages)

IIJA: ~1,000 ($9 billion)

BBBA (Nov. '21): ~25,000 ($222 billion)

BBB (Sept '21): ~30,000 ($261 billion)

Net-Zero Pathway: ~29,000 ($258 billion)

REPEAT Rapid Energy Policy Evaluation and Analysis Toolkit

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