COMPARING INFLATION REDUCTION ACT MODELING TO THE ANNUAL ENERGY OUTLOOK

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This research note supplements Energy Innovation Policy & Technology LLC® Inflation Reduction Act modeling originally released on August 1, 2022 and updated analysis on August 23, 2022. See these research notes for further details.

INTRODUCTION

The Inflation Reduction Act (IRA), signed into law in August 2022, is the most significant federal climate and clean energy legislation in United States history. Its provisions span all sectors of the U.S. economy, including transformative tax credits and large-scale investments in domestic manufacturing of clean energy technologies. This historic legislation is poised to slash U.S. greenhouse gas (GHG) emissions 37 to 43 percent below 2005 levels by 2030, based on our previous analysis using the U.S. Energy Policy Simulator (EPS).

Since the IRA's passage, multiple other analyses have reached similar conclusions: the IRA will cut emissions 40 to 42 percent[i] below 2005 levels by 2030.[i,ii,iii] While these analyses differ in terms of approach, scope, and coverage of IRA provisions, they broadly agree on the magnitude of impacts.

The Energy Information Administration's (EIA) Annual Energy Outlook (AEO), released on March 16, 2023, highlights the IRA's impact in its updated projections of U.S. energy use and emissions,[iv] forecasting a significant drop in U.S. emissions compared to its baseline.

[i] Considering the mid-cases of the cited analyses.

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However, the emissions reductions fall short of those in our analysis as well as those of several other groups. While it is not possible to quantify all the factors leading to differences in outcomes, several key observable differences drive significant variation between the AEO and other model estimates of IRA impact.

While both the AEO and our analysis include a range of IRA scenarios, we focus this note on the central (mid-point) scenarios of each. We conclude that while the AEO finds the IRA will reduce 2030 U.S. energy-related carbon dioxide (CO_2) emissions to 31 percent below 2005 levels,[ii] multiple sources conclude it will more significantly reduce emissions, with our analysis finding 41 percent below 2005 levels.

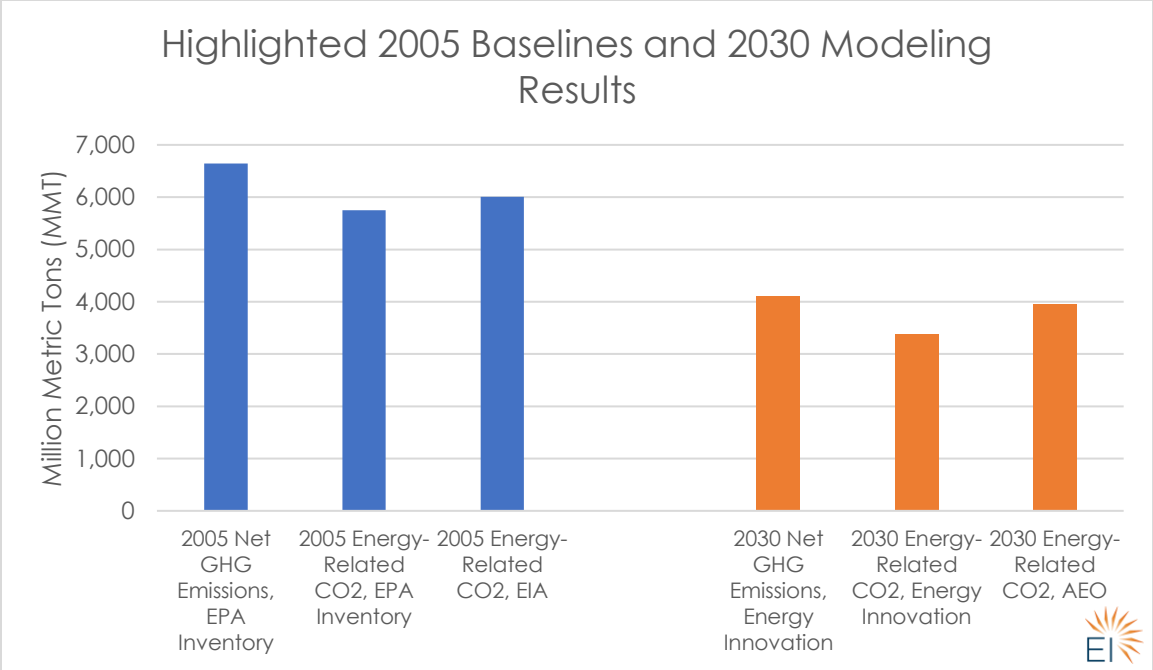
A notable area of disagreement between the new AEO and other models evaluating the IRA is the scale of clean energy deployment in the electricity sector over the next decade. Differences in expectations for how quickly clean energy will be deployed are mostly responsible for discrepancies between the AEO and other modeling, including ours.

It is important to note that the AEO's reported emissions reductions are relative to 2005 energy-related CO_2, not total 2005 GHG emissions. The U.S. Nationally Determined Contribution under the Paris Agreement (its emissions target of 50 to 52 percent below 2005 levels by 2030) is relative to total 2005 GHGs and includes emissions of non-CO_2 pollutants and non-energy related emissions.

To compare modeled IRA impacts in a consistent manner, we report percentage emissions reductions relative to 2005 CO_2 emissions from fossil fuel combustion as reported in the U.S. Environmental Protection Agency's (EPA) Greenhouse Gas Inventory report. The 2005 energy-related CO_2 baseline used by EIA in its own AEO reporting differs from the EPA baseline we use, most notably in its inclusion of international bunker fuels (which are excluded in the EPA accounting methodology).

For context, Figure 1 shows 2005 net GHG emissions and energy-related CO_2 emissions from the EPA GHG Inventory compared to the 2005 energy-related CO_2 baseline EIA used in its reporting, alongside 2030 modeling results from our analysis and the AEO. The 2030 AEO number shown below is adjusted to remove emissions from international bunker fuels to be consistent with EPA's accounting methodology.

[ii] The EIA reported a 33 percent reduction relative to 2005 values in its Reference case. We adjust to report relative to a 2005 from the EPA, as discussed below, which leads to a value of 31 percent.



MODEL SCOPE

As discussed above, the EPS covers the four main greenhouse gases (CO_2, methane, nitrous oxide, and fluorinated gases), whereas the AEO covers only energy-related CO_2. Only 79 percent of the emissions reductions in our IRA analysis were from CO_2, with avoided methane emissions due to the IRA's Methane Fee and reduced natural gas use in the power sector contributing significant reductions.

Even when limiting the comparison to solely CO_2, the EPS covers industrial process emissions, such as byproduct CO_2 produced during cement calcination, in addition to the energy-related emissions from fossil fuel combustion included in the AEO. However, even accounting for this difference still leaves a large discrepancy in modeled emissions reductions, as reflected in the energy-only CO_2 values compared above.[iii]

EPS includes the agriculture and land use sectors, which are excluded from the AEO (though fossil fuel combustion in agricultural equipment is included). The IRA features important agriculture and forestry incentives that contribute nearly 90 million metric tons (MMT) CO_2 sequestration, roughly 10 percent of the total projected GHG emissions reductions in our analysis. These emissions

[iii] The AEO emissions values appear to include some emissions from coking coal, which are classified as non-energy emissions in the EPS. This may contribute to the noted differences.

reductions are not represented in the AEO analysis. These emissions reductions are not represented in the AEO analysis.

To compare findings on an apples-to-apples basis, we limit the discussion below to only energy-related CO_2 emissions.

COMPARISON

Even after accounting for differences in model scope and covered emissions, we find the IRA will reduce emissions more than the AEO projection. Our analysis finds a 41 percent reduction in energy-related CO_2 in 2030 compared to 2005 values, compared to a 31 percent reduction in the AEO. Figure 2 summarizes emissions by sector in both our analysis and the AEO.

To demonstrate the magnitude of the expected emissions reductions from the IRA, Figure 1 also includes our pre-IRA business-as-usual (BAU) scenario, as well as the AEO's "No IRA" scenario. Energy-related CO_2 emissions are 29 percent below 2005 levels in 2030 in our BAU, versus 24 percent below 2005 levels in the AEO "No IRA" scenario.

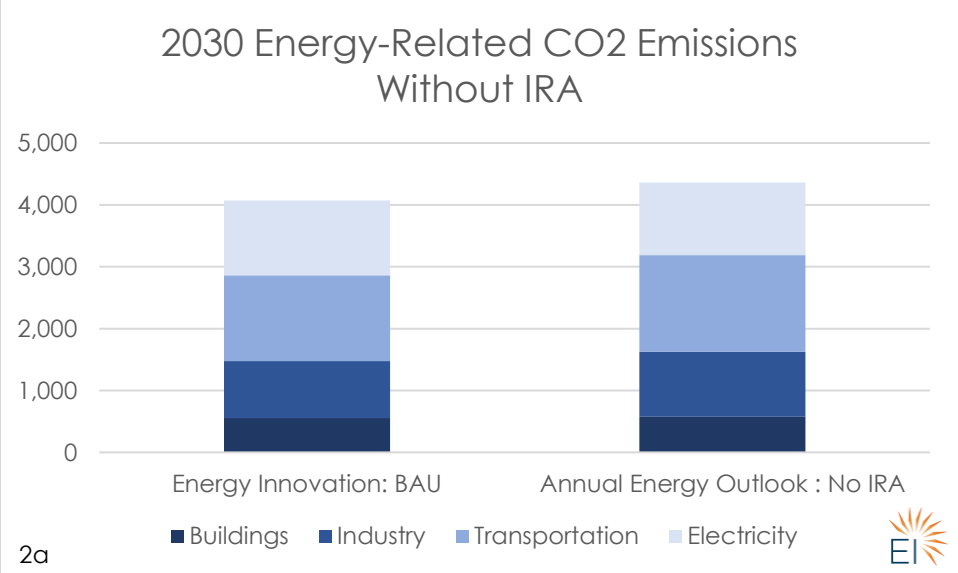


Figure 2a. Energy-related CO_2 emissions by sector in the EPS and the AEO, without IRA

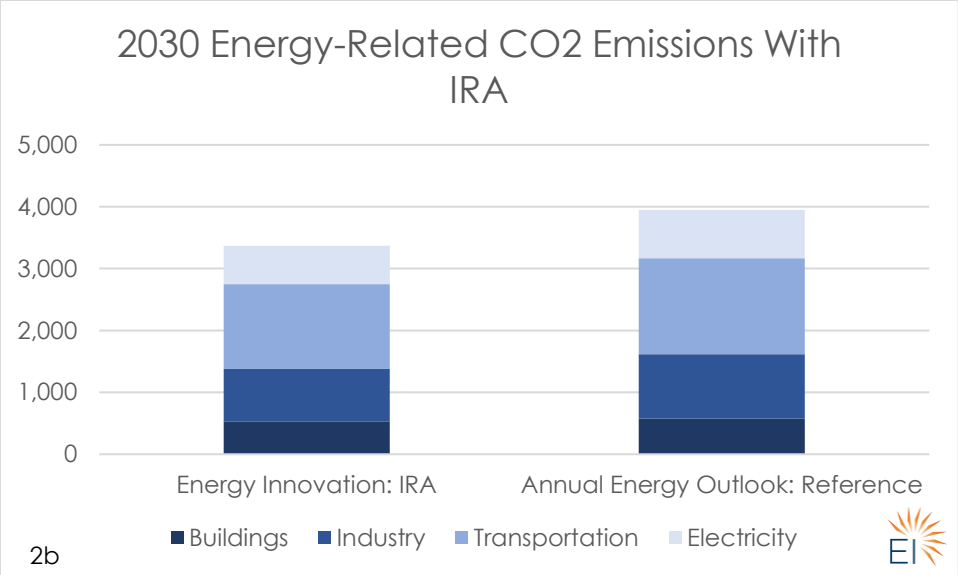


Figure 2b. Energy-related CO_2 emissions by sector in the EPS and the AEO, with IRA

We find lower emissions when compared to the AEO across all demand sectors, as shown above, which can partly be explained by differences in how models implement the IRA. The AEO implements the IRA only through tax credits, which affect the costs of various clean energy technologies.[5] Table 1 summarizes which tax credit provisions are included in each analysis. Several tax credits that are excluded from the AEO are included in the EPS analysis, which contributes to sectoral differences.

Tax Credit	Section	Included in EPS?	Included in AEO Reference Case?
Clean Electricity	13101-13102, 13701-13703	Yes	Yes
Wind and Solar Bonus Credit for Low-Income Communities	13103	Yes	No
Carbon Capture and Storage	13104	Yes	Yes
Nuclear Power	13105	Yes	Yes
Biodiesel and Alternative Fuels	13201	No	Yes
Second Generation Biofuels	13202	No	Yes

Sustainable Aviation Fuels	13203	No	Yes
Clean Hydrogen	13204	Yes	No
Nonbusiness Energy Property Credit	13301	Yes	Yes
Residential Clean Energy Credit	13302	Yes	Yes
Energy Efficient Commercial Buildings	13303	Yes	No
New Energy Efficient Home Credit	13304	Yes	Yes
Clean Vehicles	13401	Yes	Yes
Previously Owned Clean Vehicles	13402	No	No
Commercial Clean Vehicles	13403	Yes	No
Alternative Fuel Refueling Property	13404	No	No
Advanced Energy Project	13501	Yes	No
Advanced Manufacturing Production	13502	Yes	No
Clean Fuel Production	13704	No	Yes

Table 1: Tax credits included in the EPS and AEO analyses

Another important difference is modeling numerous other budget-based government programs included in the legislation, which are absent from the AEO. These include programs such as the Advanced Industrial Facilities program (which we direct entirely toward industrial efficiency improvements), government green procurements programs, the Greenhouse Gas Reduction Fund, and clean fleet investments.

Different economic assumptions also contribute to differences in emissions outcomes. The BAU (pre-IRA) demand projections in our analysis were sourced from the "Low Economic Growth" scenario rather than the Reference scenario in last year's AEO. We chose the Low Economic Growth

scenario as our baseline because it closely matched the Congressional Budget Office's projections for U.S. Gross Domestic Product as of last summer. However, the 182 MMT CO_2 difference between the 2022 AEO Low Economic Growth and Reference cases in the year 2030 represents less than a third of the difference between our IRA results and the 2023 AEO results.

Differences in underlying model assumptions also contribute to the different emissions projections.[iv] For example, we implemented a detailed methodology for zero-emission vehicle tax credits, accounting for the fraction of vehicle purchases that would qualify given domestic manufacturing and critical minerals requirements. In contrast, the AEO used a more conservative estimate of qualifying vehicle sales from the Congressional Budget Office. As a result, it appears that estimates of the impact of tax credits are likely significantly smaller than in our modeling. The AEO projects that with the IRA, electric vehicles (EVs) will make up 22 percent of passenger light-duty vehicle sales in 2030. This is significantly lower than our original projected sales share of 31 percent, and much lower than our updated estimates from a recent paper with the International Council on Clean Transportation (ICCT) of a minimum of 45 percent. It is even lower than the sales share of 25 percent in our business-as-usual case (which does not reflect the IRA).

Much of the difference in vehicle deployments between the models is likely due to different vehicle cost assumptions, with EV prices in AEO being much higher than those in our modeling, which are derived from ICCT research for projected EV battery cost declines. Figure 3 plots the AEO 2023 battery pack costs on top of a previous ICCT summary for comparison.[6]

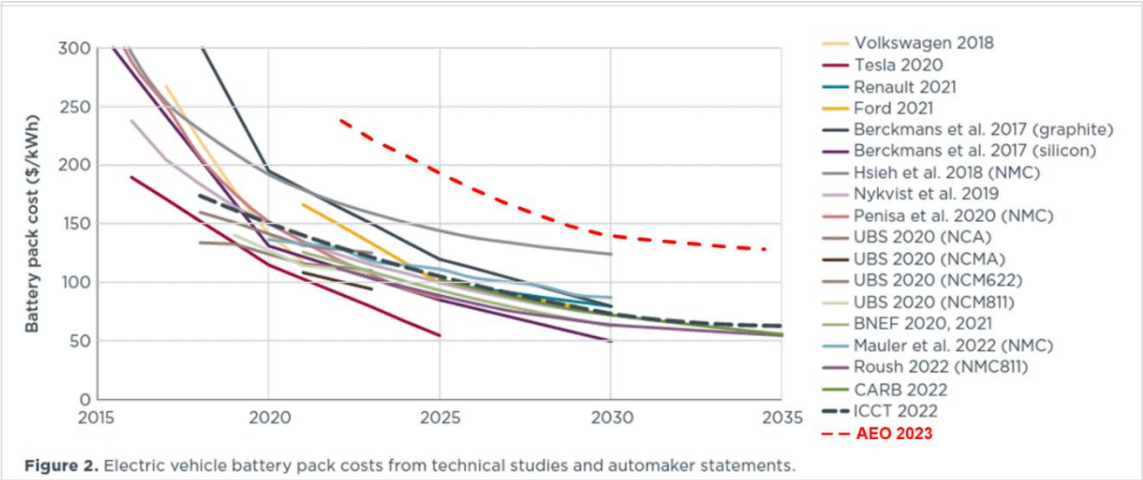


Figure 2. Electric vehicle battery pack costs from technical studies and automaker statements.

Figure 3: Comparison of AEO Battery Pack Prices to Other Studies (modified from ICCT)

[iv] The AEO transportation total is modified in Figure 2 to exclude international shipping and aviation emissions, which are excluded from the accounting of CO_2 emissions under the United Nations convention, and to move "pipeline fuels" from the transportation sector to the industry sector in line with accounting in the EPS.

However, as Figure 2 above demonstrates, the largest difference between the analyses is in the electricity sector. We find 2030 electricity sector CO_2 emissions are 74 percent below 2005 values, compared to 67 percent below in the AEO. As previously mentioned, part of this difference is due to scope of IRA provisions covered. In addition to tax credits for clean electricity sources, our analysis includes government support for rural cooperatives to help retire polluting plants and loan guarantees for clean energy in communities with retiring energy infrastructure, which drive additional coal retirements. Similarly, differences in methodology are likely also significant factors.[v]

Broad consensus exists across several different modeling platforms and organizations that the IRA will spur 70 to 80 percent clean electricity by 2030, resulting in a roughly 75 to 80 percent reduction in electricity sector emissions by 2030, relative to 2005 levels.

Table 2 summarizes several electricity sector indicators from our IRA analysis in addition to several other publicly available analyses from the Rhodium Group (using their modified National Energy Modeling Systems model),[7] the Princeton REPEAT Project (using the Regional Investment and Operation Model),[8] and the National Renewable Energy Laboratory (using the Regional Energy Deployment System [ReEEDS] model).[9] These models employ a range of approaches to estimate IRA impacts – for example, while the EPS is an economy-wide system dynamics model, ReEEDS is a dedicated capacity expansion model wholly focused on the power sector.

Model	2030 % Clean Elec.	Cumulative Wind and Solar Deployment 2023-2030 (GW)	2030 % Reduction in Elec. Emissions (Relative to 2005)	2030 Addl. Emissions Reductions Relative to BAU (MMT)
Energy Innovation	75	728	74	589
Rhodium	76	Not reported	80	660
REPEAT[vi]	76	786	71	360
NREL	74[vii]	580	84	Not reported
EIA AEO	69	382	67	395

Table 1: Electricity sector indicators. Where analyses included multiple scenarios, this table presents the midpoint, or in the case of the EPS analysis, the Moderate Scenario.

[v] Our IRA modeling of electricity sector impacts of the tax credits relied on external modeling using a customized version of the ReEDS capacity expansion model.
[vi] Values taken from forthcoming 2023 report and provided by author.
[vii] Removes CCS to align with other modeling results. Results are approximate.

CONCLUSION

We estimate the IRA could reduce U.S. energy-related CO2 emissions by 41 percent below 2005 levels by 2030, enabling significant progress toward U.S. emissions goals. In particular, the IRA will unleash clean energy deployment in the electricity sector, with tax credits and government incentives set to enable 75 to 81 percent clean electricity by 2030, according to multiple analyses.

While the AEO estimates more modest impacts of a 31 percent reduction in energy-related CO_2 and 69 percent clean electricity, the broader evidence points toward a more transformative role for the IRA. Figure 4 summarizes the 2030 emissions reductions relative to 2005 levels in the AEO and highlights the additional sources of emissions reductions we find in our own analysis.

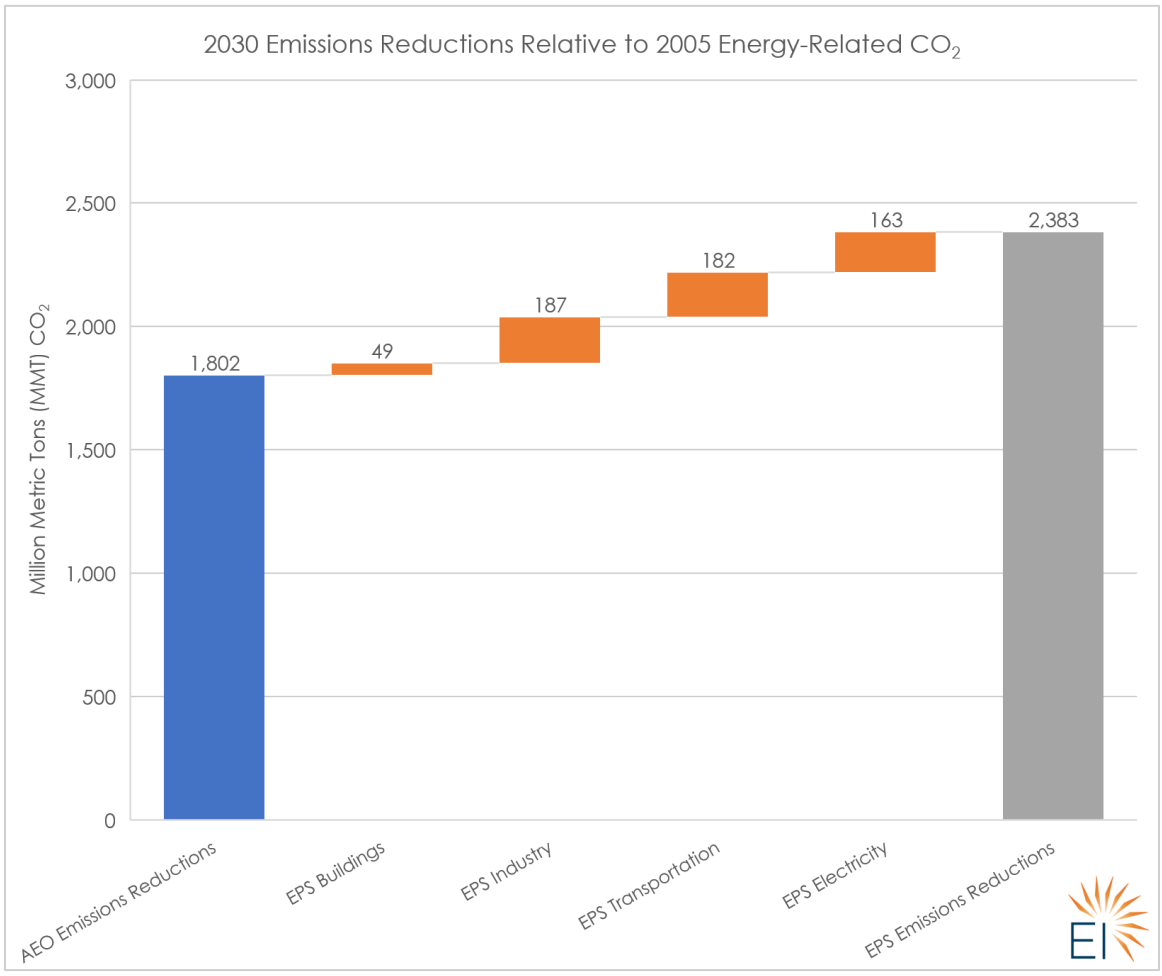


Figure 4: Summary of Energy-Related CO_2 Emissions Reductions Relative to 2005

[i] Megan Mahajan et al., "Updated Inflation Reduction Act Modeling Using the Energy Policy Simulator" (Energy Innovation Policy and Technology LLC, August 2022), https://energyinnovation.org/wp-content/uploads/2022/08/Updated-Inflation-Reduction-Act-Modeling-Using-the-Energy-Policy-Simulator.pdf.

[ii] John Larsen et al., "A Turning Point for US Climate Progress: Assessing the Climate and Clean Energy Provisions in the Inflation Reduction Act" (Rhodium Group, August 12, 2022), https://rhg.com/research/climate-clean-energy-inflation-reduction-act/.

[iii] Jesse D Jenkins et al., "Preliminary Report: The Climate and Energy Impacts of the Inflation Reduction Act of 2022" (Princeton University, August 12, 2022), https://repeatproject.org/docs/REPEAT_IRA_Prelminary_Report_2022-08-12.pdf.

[iv] "Annual Energy Outlook 2023," March 2023, https://www.eia.gov/outlooks/aeo/tables_ref.php.

[5] "Summary of Legislation and Regulations Included in the Annual Energy Outlook 2023" (U.S. Energy Information Administration, March 2023), https://www.eia.gov/outlooks/aeo/assumptions/pdf/Legs_Regs.pdf.

[6] Peter Slowik et al., "Assessment of Light-Duty Electric Vehicle Costs and Consumer Benefits in the United States in the 2022-2035 Time Frame," *International Council on Clean Transportation*, October 2022, https://theicct.org/wp-content/uploads/2022/10/ev-cost-benefits-2035-oct22.pdf.

[7] Larsen et al., "A Turning Point for US Climate Progress: Assessing the Climate and Clean Energy Provisions in the Inflation Reduction Act."

[8] Jenkins et al., "Preliminary Report: The Climate and Energy Impacts of the Inflation Reduction Act of 2022."

[9] Daniel C Steinberg et al., "Evaluating Impacts of the Inflation Reduction Act and Bipartisan Infrastructure Law on the U.S. Power System" (National Renewable Energy Laboratory, March 2023), https://www.nrel.gov/docs/fy23osti/85242.pdf.