

Greenhouse Gas Reductions by Policy

U.S. ENERGY POLICY SIMULATOR VERSION 4.0

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Energy Innovation¹ has updated the United States Energy Policy Simulator (EPS), our free and open-source climate and energy policy model available at <https://energypolicy.solutions>.

The new model version 4.0 includes new features such as an entirely rebuilt electricity sector with hourly electricity dispatch, seven new power plant types, electricity storage, estimation of wholesale electricity prices, and more.

This update also incorporates impacts of recent U.S. policy developments, including the Inflation Reduction Act (IRA) and the Infrastructure Investment and Jobs Act (IIJA), which enables users to better understand how U.S. emissions are expected to evolve.

Our updated business-as-usual scenario (BAU) represents our best estimate of energy use and emissions through 2050 given all current policies and expected technology costs. The BAU scenario looks markedly different than previous EPS versions, mainly due to the IRA, the landmark federal law passed in August 2022 to invest in clean energy, clean industrial processes, climate-smart agriculture, and forest management.

Energy Innovation's previously released estimates of IRA impacts through 2030 relied on a prior version of the model. EPS 4.0 incorporates an updated estimate for IRA impacts into its updated BAU, including accounting for new insights such as recent guidance from the U.S. Department of the Treasury on how tax credits will be implemented. The EPS 4.0 BAU includes additional recent policy developments, such as the U.S. Environmental Protection Agency's (EPA) rules for existing oil and gas sources, power plant pollution and vehicles, as well as state-level adoption of Advanced Clean Cars II and Advanced Clean Trucks rules. It also incorporates the latest data from the U.S. Energy Information Administration's Annual Energy Outlook (AEO).

We find that the U.S. is now on track to reduce its greenhouse gas (GHG) emissions to 37 percent below 2005 emissions in 2030. This is a steep drop from the 2021 emissions reduction outlook (17 percent below 2005 levels in 2030), and a marked difference from the emissions trajectory the U.S. was on before the IRA and other recently finalized climate policies (23 percent below 2005 levels in 2030).

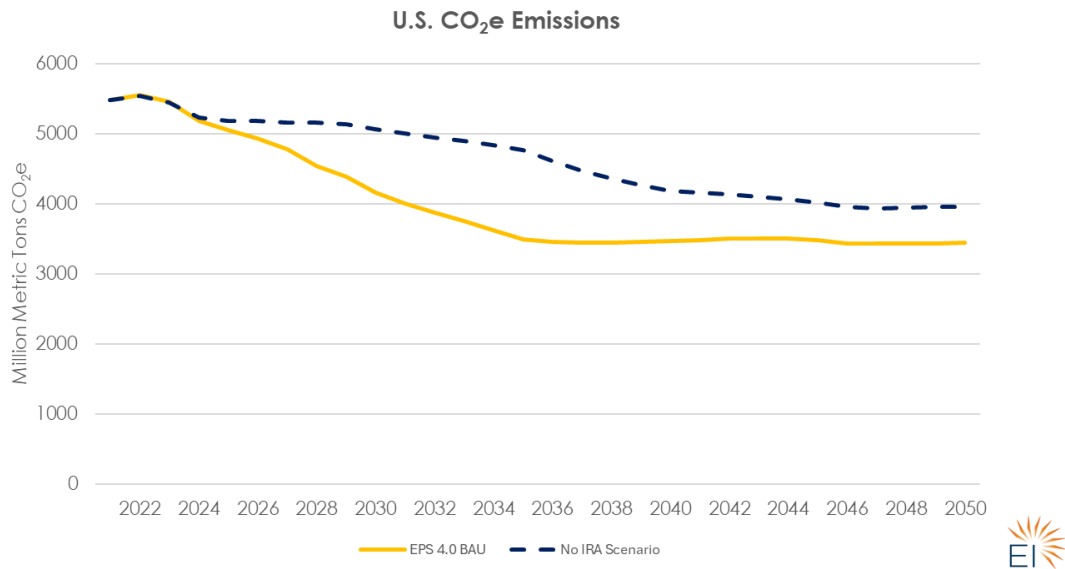
EPS 4.0 projects the U.S. is on track to more than double its pace of emissions reductions this decade compared to the decarbonization rate achieved in the 2010s, thanks primarily to bold federal climate policies adopted over the last few years, as well as to falling costs of clean energy and state, local, and private sector action.

Previous Energy Innovation analysis identified a range of projected emissions outcomes due to the IRA. The BAU in EPS 4.0 represents an updated central case accounting for evolving market and macroeconomic trends, which include higher industrial output due to stronger-than-expected economic growth.

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Under the new BAU which accounts for current policies, the greenhouse gas emissions intensity of GDP falls to 140 grams of carbon dioxide equivalent (CO₂e) per \$1 in 2030, compared to 330 g CO₂e per \$1 in 2005.

Figure 1. U.S. CO₂e emission trajectories with and without the IRA

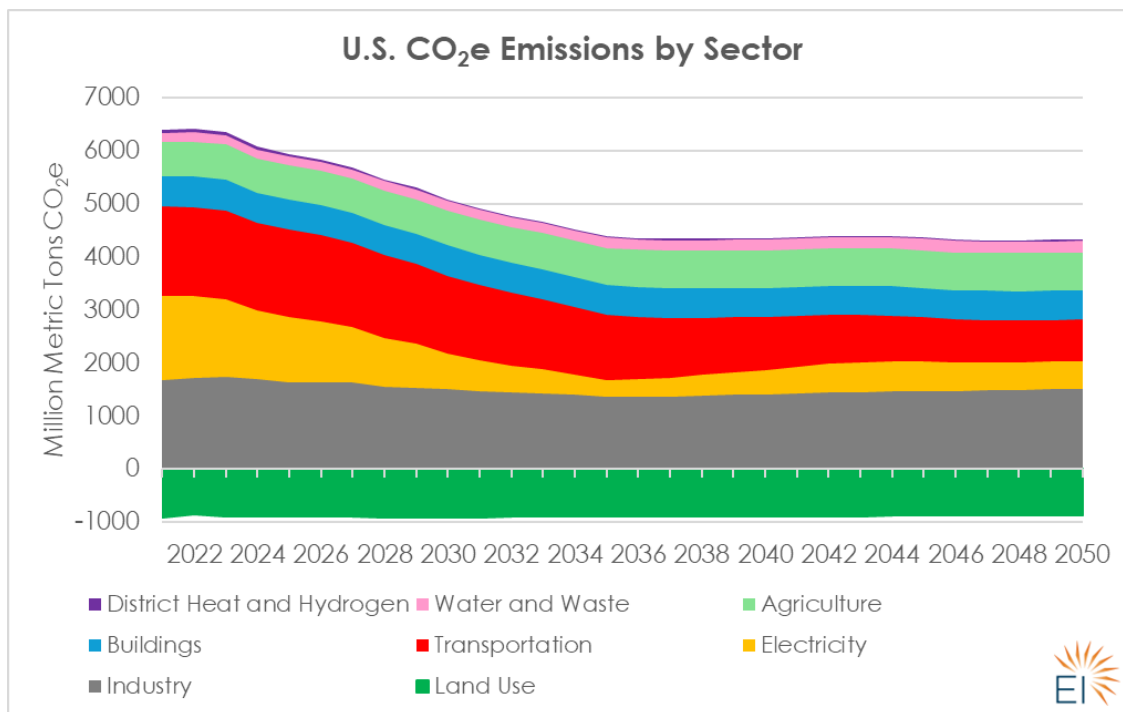


Emissions reductions in the updated BAU scenario are largely led by the electricity sector, where the share of clean electricity grows from today's value of roughly 40 percent to 70 percent in 2030. This rapid growth in clean electricity deployment is due to the IRA's clean electricity tax credits that can cover more than half the cost of wind and solar plants, depending on the project.

Transportation emissions reductions are the second-most important factor in economy-wide emissions reductions in the updated BAU scenario. We expect emissions from on-road vehicles to fall steadily due to increased uptake of zero-emission vehicles (ZEVs). New tailpipe pollution standards announced by the EPA along with IRA tax credits for light- and heavy-duty ZEVs, federal and state support for charging infrastructure, and domestic battery and vehicle manufacturing together will shift the market toward cleaner transportation.

Given current policies and market dynamics, we forecast ZEVs will compose 53 percent of all 2030 light-duty passenger vehicle sales and 15 percent of all light-duty passenger vehicles on the road in 2030.

Figure 2. Annual emissions by sector in the BAU scenario



Though the IRA also includes important provisions that address other economic sectors, the EPS 4.0 BAU scenario projects more modest emissions changes in the buildings and industry sectors, where industrial emissions decline slightly through 2030 and buildings emissions hold roughly constant.

The EPS uses AEO energy consumption projections directly for these sectors, with minor modifications to reflect additional recent policy developments – in contrast to the electricity and transportation sectors, where the EPS endogenously determines technology choices on a cost-driven basis. Though the AEO does not show the IRA significantly reducing industry and building emissions, its authors note they were unable to incorporate all IRA provisions, and the actual impacts may be greater depending on how the legislation is implemented.

Finally, the updated BAU shows relatively constant emissions in the agriculture and land use sectors. Though the EPS projects the IRA will reduce emissions in 2030, agricultural emissions are expected to continue increasing due to demand for agricultural products.

In addition to the updated BAU, EPS 4.0 also includes an updated NDC scenario that achieves the U.S. Nationally Determined Commitment of reducing emissions 50 to 52 percent below 2005 levels by 2030 and reaches net zero emissions by 2050. This scenario includes a suite of policies that accelerate progress anticipated under the current policy trajectory, including new federal standards and regulations as well as

new state action. These policies target all sectors of the economy, but are especially important in the industry, buildings, and land use sectors. Table 1 outlines emissions reductions in the BAU and NDC scenarios.

Table 1. Emissions Reductions by Scenario (Percent Reduction Below 2005 Emissions)

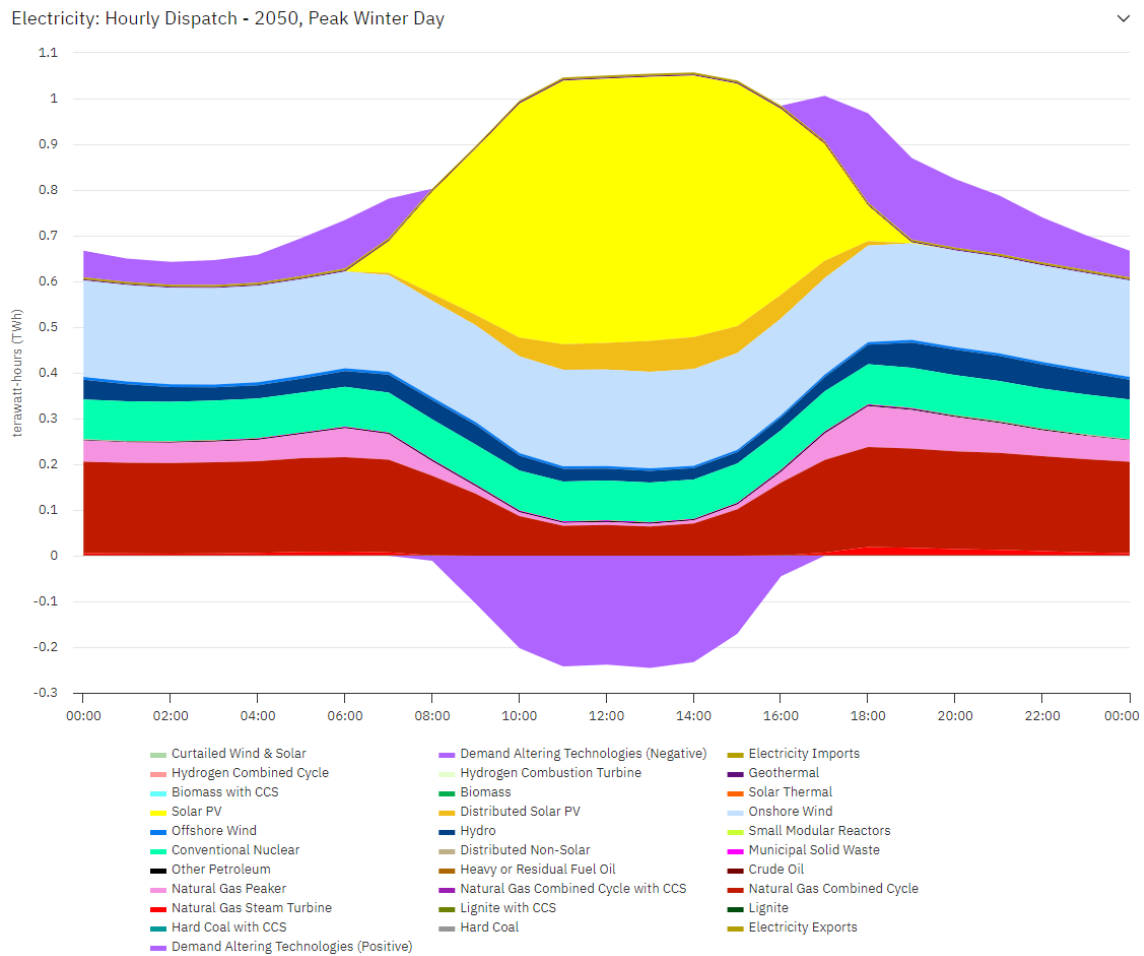
	2030	2035	2040	2050
BAU Scenario	37	47	47	48
NDC Scenario	52	70	82	100

NEW MODEL FEATURES

The EPS version 4.0 features a completely redesigned electricity module. Whereas previous versions of the EPS only captured the electricity sector at annual time resolution with a simplified representation of peak demand, version 4.0 includes hourly electricity demand and dispatch for six representative days of the year, including average seasonal days along with peak winter and summer days.

This more detailed representation allows us to analyze profitability- and reliability-based capacity expansion mechanisms; endogenous cost-driven retirements and retrofits; endogenous deployment, charging, and discharging of electricity storage; and a new bottom-up calculation of electricity rates. Figure 3 exemplifies a new graph available via the web app demonstrating hourly dispatch by plant type for a selected time slice.

Figure 3. Example hourly dispatch graph



These enhancements were necessary to properly represent the impact of the IRA's clean electricity tax credits, and the model is now better positioned to accurately model financial incentives in the electricity sector. Additionally, the EPS now has an improved representation of electricity capacity needs and hourly dispatch.

The electricity sector updates also added seven new power plant types, pushing total represented power plants to 24. These include four different types of plants equipped with carbon capture and sequestration (CCS), two types of hydrogen power plants, and small modular reactors. The model now allows power plants to economically retrofit with CCS, if cost-effective.

Other notable additions made to represent policies included in the IRA are better tracking of ZEV costs and vehicle battery manufacturing incentives, more detailed representation of industrial CCS costs, and new pathways for clean hydrogen

production and enhanced rock weathering.

CONCLUSION

The U.S. energy and emissions landscape has undergone profound changes in the past few years due to federal policies enacted during the Biden Administration, particularly the IRA and IIJA. Against this backdrop, emissions reductions are now projected to more than double, falling to a record low of 37percent below 2005 levels by 2030, led by significant gains in the share of electricity generated by clean sources as well as increased adoption of zero emissions vehicles.

EPS 4.0 captures these changing dynamics and empowers more accurate and fine-grained analysis than ever before. Model users can explore all these changes and can test the potential impact of additional climate and energy policies in our open-source online simulator at <https://energypolicy.solutions>.