Clean Economy Graphics Data Sources and Documentation

Overview

RMI developed these State Clean Energy Eco to illustrate the economic opportunity of the clean energy transition. The metrics are intended to show the rough magnitude of energy system transformation needed to achieve net zero emissions in 2050, as well as the associated economic, social, and health benefits. State projections to 2050 have several major sources of uncertainty. As a result, these metrics are not intended to represent precise forecasts. To convey the appropriate level of precision, metrics are generally rounded to one significant figure. Also note that the savings from avoided deaths only include conservative estimates of avoided deaths from air pollution and could be larger than shown.

RMI estimated the 2050 metrics using modeling that represents detailed pathways to a net zero carbon US economy at the state level. The Princeton Net Zero America project (NZA) was the primary data source for most metrics, using the higher electrification, higher renewable energy scenario ("E+RE+").[1] Additional data sources included: the state Energy Policy Simulator (EPS) models developed jointly by RMI and Energy Innovation, using the "NDC Pathway" scenarios which reach approximately net zero in 2050; the NREL Cambium national electricity system scenarios, using the 95% clean electricity by 2035 + High Electrification scenario;[2] and state population projections adjusted for housing market disequilibrium developed for the Berrill et al (2021) national study on residential construction and materials emissions.[3]

RMI also estimated the potential federal investment in state clean economies under the Inflation Reduction Act (IRA) by separating provisions in the IRA by funding mechanism, as detailed below. Much of this analysis uses data from the EPS. Click here to access a full methodology file for the IRA downscaling analysis.

- Typically for provisions where the funding mechanism is through tax credits, we found the technology level by 2030 per state that is consistent with a Climate Ambitious level of action (typically by downscaling national values from the NZA "E+RE+" scenario) and used the dollar value of the credit to calculate the total federal investment possible through the provision. We

[1] Princeton University, 2021, *Net Zero America Project*, https://netzeroamerica.princeton.edu/. The raw national data was obtained in full via personal communication with Eric Larson in 2022.
[2] National Renewable Energy Lab, 2021, "Cambium Standard Scenarios," https://www.nrel.gov/analysis/cambium.html, retrieved January 2022. The short scenario label is "Electrification 95 x 35."
[3] Berrill, P. and Hertwich, E.G., 2021, "Material flows and GHG emissions from housing stock evolution in US counties," 2020–60. *Buildings and Cities*, 2(1), pp. 599–617, https://doi.org/10.5334/bc.126. The data can be generated from https://github.com/peterberr/US_county_HSM; RMI obtained intermediate data to facilitate post-processing via personal communication with Peter Berrill in 2021.

factored in constraints such as the domestic manufacturing requirements for the Clean Vehicle Tax Credit (30D) and the levels of tax credit rates based on prevailing wage, apprenticeship, domestic content, and energy community bonuses if applicable.

- Provisions where the funding mechanism is not through a tax credit are typically calculated by downscaling the Congressional Budget Office Score of each provision at the national level provided in the IRA Guidebook.[4,5]
- In cases where the federal government has released formula funding allocations for specific provisions, such as the Home-Energy Performance-Based, Whole-House and the High Efficiency Electric Home Rebate Programs, we use those allocations.[6]

In displaying the graphics, RMI included the current greenhouse gas (GHG) emissions for each state for the four major sectors highlighted in the graphics: Electricity, Industry, Transportation, and Buildings. These emissions are retrieved from the state EPS models for the year 2021. Electricity emissions are for within-state electricity production only. Industry emissions include leakage of fossil methane and fluorinated gases. Note that additional emissions sectors not shown include Agriculture, Waste, and Land Use. As these emissions are modeled based on the downscaled, benchmarked state input data used in the EPS models, and EPS sector conventions are used, they may sometimes differ from state emissions inventories.

[4] Congressional Budget Office, 2022, "Estimated Budgetary Effects of H.R. 5376, the Inflation Reduction Act of 2022," https://www.cbo.gov/publication/58366, retrieved November 2022.
[5] The White House, "Inflation Reduction Act Guidebook," 2022, https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/, retrieved November 2022.
[6] U.S. Department of Energy, 2022, "Biden-Harris Administration Announces State And Tribe Allocations For Home Energy Rebate Program," https://www.energy.gov/articles/biden-harris-administration-announces-state-and-tribe-allocations-home-energy-rebate, retrieved November 2022.

Data Sources and Notes by Metric

The table below summarizes data sources, assumptions, and notes for each metric included in the graphics.

Category	Metric	Displayed Units	Data Sources	Assumptions and Notes
Electricity	Grid-Scale Storage	Billion Battery Cells	NREL Cambium	The increase in installed grid-scale battery storage capacity from 2022 to 2050, including all storage durations and combined solar plus storage installations. This is converted from power capacity to battery cells assuming 2 watts per cell, about equivalent to a Li-ion "18650" cell size when designed for a 5 hour duration. (This battery cell type is 18 mm long by 65 mm around, somewhat longer and fatter than a household AA battery.)
Electricity	New Transmission	Miles New Transmission	NZA	The high voltage transmission mileage added from 2020 to 2050 to support solar and wind expansion. The underlying unit is GW-miles: miles are reported assuming a typical line has about 1 GW of power capacity.
Electricity	Solar Capacity	Million New Solar Panels	NZA	The increase in installed rooftop plus utility-scale solar capacity (using NZA "base land use assumptions") from 2020 to 2050. This is converted from power capacity to solar panels assuming 320 watts per panel.
Electricity	Wind Capacity	New Wind Turbines	NZA	The increase in installed land-based plus offshore wind capacity (using NZA "base land use assumptions") from 2020 to 2050. This is converted from power capacity to wind turbines assuming 3 megawatts per turbine.
Industry	Hydrogen Use	Million Gallons Gasoline-Equivalent Clean Hydrogen	NZA	The hydrogen consumed as final energy in transportation and industrial sectors in 2050.
Industry	Industrial fuel switching	Billion kWh Industrial Electrification	NZA	The increase in electricity consumed as final energy in the industrial sector from 2020 to 2050.
Transportation	Electric Cars	Million Electric Cars	NZA	The stock of electric light-duty vehicles (e.g., cars, light trucks, SUVs, and motorcycles) on road in 2050. May include some plug-in hybrid electric vehicles but mostly consists of battery-electric vehicles.
Transportation	EV DC Fast Chargers	Fast Chargers	NZA	The number of public, direct current fast charging plugs for electric vehicles in 2050. Note there may be many individual plugs at a single charging station.
Transportation	Transit Usage	% Increase in Transit Usage	EPS	The percent increase in bus passenger miles traveled in 2050 relative to 2020, assuming 20% mode shift (i.e., avoided and shifted light duty vehicle miles traveled relative to the Business as Usual scenario).
Transportation	Zero Emission Trucks	Zero Emission Trucks	NZA	The stock of electric and hydrogen medium- and heavy-duty trucks on road in 2050.

Category	Metric	Displayed Units	Data Sources	Assumptions and Notes
Buildings	Commercial Electrification	Commercial Buildings Electrified	NZA; CBECS[7]	The approximate increase in buildings with heat pumps from 2020 to 2050. The heat pump stock is converted from heating power capacity units to number of buildings by normalizing the 2020 national heating capacity against the national number of commercial buildings in 2018.
Buildings	New Homes	Million Clean New Homes	Berrill et al (2021); Up for Growth (2022); [8] Census Quickfacts[9]	The projected cumulative number of new homes needed by 2050. New homes are assumed to be built to keep up with gross state population growth assuming 2.3 people per home (national average including secondary and vacant housing units grossed up for the estimated cumulative 2019 housing shortage) plus a natural turnover time for rebuild of 150 years.
Buildings	Residential Electrification	Million New Heat Pumps in Homes	NZA	The increase in installed space plus water heat pump stock from 2020 to 2050.
Human Impact	Avoided Asthma Attacks	Fewer Asthma Attacks per Year	EPS	The asthma attacks avoided in 2050 relative to the EPS Business as Usual scenario due to reduced air pollution.
Human Impact	Avoided Mortality	Fewer Deaths from Air Pollution per Year	NZA	The premature deaths avoided in 2050 relative to the NZA Reference scenario due to reduced air pollution.
Human Impact	Economywide Job Creation	New Clean Economy Jobs	NZA	The additional jobs in all sectors in 2050 relative to the NZA Reference scenario.
Human Impact	IRA Funding	$Billion Potential Federal Investment from IRA	NZA; EPS; additional RMI analysis	The cumulative potential federal investment in each state via the Inflation Reduction Act through 2030 under a "climate ambitious" scenario where consumers and businesses adopt clean technologies at the pace and scale needed to meet national climate targets.
Human Impact	Monetized Avoided Deaths	$Billion per Year Saved from Avoided Deaths	NZA	The monetized benefits of avoided premature deaths avoided in 2050 relative to the NZA Reference scenario due to reduced air pollution. This is equal to the avoided deaths times an assumed Value of Statistical Life of $10 million (converted to 2023$) as used in NZA.

[7] Energy Information Agency, 2022, Commercial Building Energy Consumption Survey 2018, https://www.eia.gov/consumption/commercial/data/2018/bc/html/b1.php, retrieved September 2022.
[8] Up for Growth, 2022, *Housing Underproduction in the US*, https://upforgrowth.org/apply-the-vision/housing-underproduction/, retrieved August 2022.
[9] United States Census Bureau, 2022, "QuickFacts," https://www.census.gov/quickfacts/US, retrieved September 2022.