Colorado Energy Policy Simulator (EPS) Summary Documentation

Estimating Economy-wide Emissions for Colorado

The Colorado Energy Policy Simulator (EPS) accounts for emissions produced in the following sectors: electricity generation, building energy consumption, industrial energy consumption, industrial process emissions, agriculture process emissions, land use change, and transportation.

Our primary sources are federal data sets from the Environmental Protection Agency (EPA), Energy Information Association (EIA), the National Renewable Energy Lab (NREL), and E3 (Energy and Environmental Economics, Inc.). The table below summarizes our data sources and methodology.

DATA SOURCES

Sector	Subsectors	Source	Methodology	Benchmarking Sources for Comparisons
ELECTRICITY	In-state capacity and generation; out of state imports	For capacity and generation: EIA's Form 923 and EIA's Form 860 For imports/exports: EIA's State Electricity Profiles Table 10.	Added all utility-owned generation and capacity in-state. No scaling needed. Imports and exports are held constant.	Emissions - EPA "State CO2 Emissions from Fossil Fuel Combustion, 1990-2017" & AEO "State CO2 Emissions from Fossil Fuel Combustion"
BUILDING ENERGY USE	All energy use, all building components, residential and commercial buildings	E3's Colorado Pathways results: reference scenario	No scaling needed. E3 reports total energy use by fuel type and demand technology in CO for each year 2017-2050.	Energy Use - EIA's "State Energy Data Systems" 2018 ; CO2 Emissions - AEO "State CO2 Emissions from Fossil Fuel Combustion"
INDUSTRIAL ENERGY USE	All fuel use for industrial sector	EIA's Annual Energy Outlook tables on Industrial Energy Use EIA's "State Energy Data Systems" & E3's Colorado Pathways results: reference scenario	Scaled down by Census Data (County Business Patterns) and BEA output by industrial subsector and state compared to national output by industrial sector. These values are then aligned to E3 data on total industrial consumption by energy resource.	Energy Use - NREL Electrification Futures and EIA's "State Energy Data Systems" Emissions - EPA "State CO2 Emissions from Fossil Fuel Combustion, 1990-2017" & AEO "State CO2 Emissions from Fossil Fuel Combustion"
INDUSTRIAL PROCESS EMISSIONS	Process Emissions	E3's Colorado Pathways results: reference scenario	No scaling needed. E3 reports industrial process emissions.	Emissions – The Center for Climate Strategies' "Colorado Greenhouse Gas Inventory and Forecast"
AGRICULTURE, LAND USE AND FORESTRY		The Nature Conservancy (researcher-provided dataset), U.S. Forest Service Total Forest by State	No scaling needed.	Emissions - EPA "State CO2 Emissions from Fossil Fuel Combustion, 1990-2017" & AEO "State CO2 Emissions from Fossil Fuel Combustion"

TRANSPORTATION	All energy use, vehicle miles	Energy Information Association's Annual Energy Outlook tables on Industrial Energy Use & NREL Electrification Futures Study - Reference Scenario	Scaled down US data, using NREL to find the proportion of national vehicle stock and service demand in CO.	Emissions - EPA "State CO2 Emissions from Fossil Fuel Combustion, 1990-2017" & AEO "State CO2 Emissions from Fossil Fuel Combustion"

Understanding the EPS Reference Scenarios & Projections

The Colorado EPS model includes multiple built-in reference scenarios, in addition to example climate mitigation scenarios, described in a subsequent section of the document. The reference scenarios are:

- **The Business As Usual Scenario (as of Spring 2021):** This Scenario is the model's foundation, capturing projected changes based on economic growth, technology and cost changes, and existing policy commitments. To set this foundation, Energy Innovation and RMI built a forecast of Colorado's economy-wide greenhouse gas emissions through 2050 using publicly available, national models of energy consumption (EIA's Annual Energy Outlook, NREL's Electrification Future Study).
- **Enacted Policy Scenario (as of October 2021):** This scenario shows the impacts of enacted policies over the BAU pathway. This scenario is updated as significant policy changes are enacted, and the date of update is included in the scenario label. Currently, the Enacted Policy Scenario reflects the impact of legislation from the 2021 regular session.
- **Rulemaking Opportunity Scenario (as of October 2021):** This scenario adds the impacts of targets and binding policies that could result from in-progress or upcoming rulemakings to the most current Enacted Policy Scenario. In doing so, it captures a high-end estimate of impact by assuming that policy implementation is maximally effective.[1]
- The **2019 Policy Action Scenario** is based on policy priorities laid out by the Colorado state government to achieve its climate targets. This scenario reflects proposed policies to achieve Colorado's greenhouse gas emissions reduction goals, as part of Colorado's Greenhouse Gas Pollution Reduction Roadmap.[2] Should these policies be implemented, they will become part of a refreshed **Enacted Policies scenario**. This Scenario in the EPS is loosely based on the 2019 Action Scenario modeled by E3 in the Roadmap Report.

The table below summarizes the policies included in the current reference scenarios.

[1] Some rulemakings are already underway but we do not attempt to reflect progress to date. For example, phase 1 of the GEMM rulemaking in the industrial sector is complete, while phase 2 (slated for 2022) will address overall sectoral targets. Given the regulatory considerations outstanding, the potential industrial sector impacts are represented in the Rulemaking Opportunity scenario and the impact of phase 1 alone is not evaluated in isolation. RMI plans to release updated modeling in 2022 to estimate the impacts of completed rulemakings.

[2] https://energyoffice.colorado.gov/climate-energy/ghg-pollution-reduction-roadmap

SUMMARY OF POLICY ASSUMPTIONS

Sector	Business As Usual Scenario (as of Spring 2021)	Enacted Policy Scenario (as of October 2021)	Rulemaking Opportunity Scenario (as of October 2021)	Colorado 2019 Policy Action Scenario
Electricity	• Assumes all currently planned retirements are completed on time, including planned Xcel retirements consistent with its Integrated Resource Plan	• Assumes all currently planned retirements are completed on time, including planned Xcel retirements consistent with its Integrated Resource Plan and resource usage necessary to achieve sector targets in HB1266	• Same as left-hand cell	• 69% carbon-free electricity standard by 2030, 97% by 2050 • 3.4 GW storage capacity by 2050 • CCS for remaining fossil generation ramps up from 0% in 2040, covering 94% of remaining fossil generation by 2050[3]
Buildings	• From EIA's Annual Energy Outlook and NREL • Assumes some equipment performance improvements over time, based on market data (described here)[4]	Same as left-hand cell plus: • Assumes strong compliance with SB264 (clean heat plan legislation)	• Same as left-hand cell	• 100% of new lights sold are high-efficiency by 2021[5] • 100% of commercial cooking is high efficiency by 2021[6]
On-Road Transportation	• From EIA's Annual Energy Outlook and NREL • Includes 2012 Federal Corporate Average Fuel Economy Standards (CAFE) standards (full text via AEO) • Federal EV subsidies • Economic adoption of EVs[7]	Same as left-hand cell plus: • Assumes moderate boost in EV infrastructure and fleet conversions to reflect heightened investment under SB260	Same as left-hand cell plus: • Assumes rapid and dramatic modeshifting and elevated EV infrastructure investment	• Electric Vehicle Sales Standard: ○ 43% of light-duty vehicle sales by 2030 ○ 5% of heavy-duty vehicle sales by 2030
Industry	• From EIA's Annual Energy Outlook and NREL • Assumes equipment performance	• From EIA's Annual Energy Outlook and NREL • Assumes equipment performance improvements over time (described here)	Same as left-hand cell plus: • Assumes significant methane abatement to meet the oil & gas fugitive emissions targets in HB1266	• 37% reduction in fossil methane leakage by 2030; 58% reduction by 2050

[3] Source: E3 electricity generation data 2019 Action plan electricity model (here): in 2050, E3 projects CCS will cover 5,131 MW of the projected 5,450 MW of natural gas remaining, or ~94% of total fossil generation

[4] Efficiency improvements are derived from NREL electrification futures study Reference Case. Energy Efficiency policies – including those in Colorado -- are not explicitly included in the BAU.

[5] Note: max feasible efficiency in Energy Policy Simulator

[6] Estimated to be equivalent to an 8% efficiency increase in all appliances.

[7] Electric vehicle adoption in the BAU case is based on economic adoption modeled in the EPS, with more details available here: https://us.energypolicy.solutions/docs/transportation-sector-main.html. EPS transportation data, such as vehicle prices, is largely taken from EIA, and the resulting EV adoption curve rates are similar to other studies, including the "Electric Vehicle Outlook 2020": https://about.bnef.com/electric-vehicle-outlook/#toc-viewreport.

	improvements over time (described here) ● Includes implementation of the Kigali Amendment to the Montreal Protocol.	● Includes implementation of the Kigali Amendment to the Montreal Protocol.	● Assumes significant deployment of carbon capture, energy efficiency measures, and electrification technologies to meet industrial emissions targets in HB1266	
Land use/ Agriculture	● Agriculture, biomass, and forestry projections	● Agriculture, biomass, and forestry projections	● Same as left-hand cell	● *Same as BAU*
Imports/ Exports	● Imported electricity emissions held constant	● Imported electricity emissions held constant	● Same as left-hand cell	● *Same as BAU*

Defining Targets shown in the tool

Greenhouse gas reduction target

RMI has conducted a US-wide analysis to define sector level targets consistent with limiting cumulative US greenhouse gas emissions in line with a global 1.5℃ budget. To inform these targets, RMI reviewed both global 1.5℃ guidance[8] and numerous national decarbonization pathways analyses, with a focus on required action by 2030. The sector-level targets have been translated to state-level benchmarks to guide policy evaluation and discussion. Targets by sector are downscaled from national to state levels using 2019 emissions to allow for disparate emissions trends since 2005 across states. Due to the considerable uncertainties in these analyses, the national and state level sector targets are approximate, and should not be considered equivalent to an optimum state-by-state decarbonization assessment. State-level assessments may identify more cost-effective and politically feasible pathways that reduce emissions more quickly.

The tool also includes, as reference, emission targets from the Colorado's Greenhouse Gas Pollution Reduction Roadmap

[8] See IPCC Global Warming of 1.5°C and UNEP Emissions Gap Report 2019

Coal Retirement Schedule (BAU Scenario as of Spring 2021)

Plant Name	Size (MW)	Date Retiring	Source
Comanche 1	325	2022	EIA[9]
Comanche 2	335	2025	EIA
Comanche 3	766	2040	E3
Craig 1	428	2025	EIA
Craig 2	428	2028	EIA
Craig 3	448	2029	EIA
Hayden 1	212	2028	Xcel[10]
Hayden 2	286	2027	Xcel
Martin Drake 6	83	2022	EIA
Martin Drake 7	141	2022	EIA
Pawnee 1	505	2028	E3
Rawhide 1	280	2029	EIA
Ray D Nixon 1	208	2029	EIA

Example Climate Mitigation Scenarios

US 1.5 Degree Scenario

Energy Innovation developed a US 1.5 Degree Scenario, which is designed to put the US, nationally, on an emissions trajectory broadly consistent with limiting global warming to 1.5℃ by 2100. This national scenario has been downscaled to Colorado, adjusting for differences in the state technology mix compared to the national technology mix. This policy scenario is illustrative and is meant to represent one set of policies that could be used to reduce emissions in line with a 1.5℃ scenario.

[9] Table 6.6. Planned U.S. Electric Generating Unit Retirements (source)
[10] Source: Xcel Announces Early Closure of Hayden plants (source)

Policy Assumptions in the US 1.5 Degree Scenario

Sector	US 1.5 Degree Scenario
Electricity	• Clean Electricity Standard of 80% by 2030, 100% by 2035 • Accelerate deployment of storage, transmission, and demand response • No new construction of coal and natural gas plants • Power plant retirements
Buildings	• 100% electric new appliances and buildings by 2030 (“building component electrification”) • 30% of existing buildings are retrofit by 2050 • Efficiency improvement with ambition extended to 2050, plus additional efficiency improvements for building heating equipment and appliances
On-Road Transportation	• 100% electric new light-duty vehicle, motorbike, and bus sales by 2035 • 100% electric new medium- and heavy-tuy truck sales by 2045 • 90% improvement in fuel economy standards for internal combustion engine light-duty vehicles by 2040, as well as a 45% improvement for buses, a 50% improvement for medium- and heavy-duty freight vehicles, a 28% improvement for aircraft, and a 20% improvement for rail and ships • 20% light-duty vehicle miles traveled reduced or shifted from BAU by 2050 • 22% reduction in truck freight transport by 2050
Industry	• 100% achievement of cement clinker substitution by 2030 • 100% achievement of HFC emissions reductions from the Kigali Amendment to the Montreal Protocol • 25% improvement in industrial energy intensity/efficiency by 2050 • 20% by 2030, 100% by 2050 shift from fossil fuels to a mix of electricity and hydrogen, varying by industrial potential for each fuel type, by 2050 • 5% reduction in cement demand and 10% reduction in iron and steel demand from improved material efficiency policies by 2050 • 100% achievement of potential emissions reductions from methane capture and destruction in natural gas and oil, coal mining, water, and waste sectors by 2030 • 100% of hydrogen is produced via electrolysis by 2030 • 50% remaining industrial CO2 emissions captured and sequestered through CCS by 2050
Land use/Agriculture	• 100% achievement of potential additional carbon uptake from afforestation/reforestation measures, improved forest management, cropland measures, and livestock measures (such as requiring anaerobic digesters) by 2030

Accelerated Efficiency, Electrification, & Renewables Scenario

An additional scenario has been included to illustrate an example of a rapid emission reduction scenario in the EPS. This scenario is intended to be a simple combination of EPS policy settings exemplifying some of the decarbonization approaches found to be ready to scale, cost-effective, and critical to near-term action in most recent literature: efficiency at the device and whole systems scale, electrification of buildings and on-road vehicles, and buildout of wind and solar power. It is similar to the UNEP Emissions Gap Report 2019[11] benchmark policies for the US to undertake “ambitious climate actions and targets.”

[11] https://www.unenvironment.org/resources/emissions-gap-report-2019

There is overlap with the US 1.5 Degree Scenario in some of these settings, though these settings may have more ambitious implementation schedules in this scenario. This scenario is designed as a generic US state scenario, and it has not been optimized to be most cost-effective or politically effective for Colorado. Because it is generic, it applies incrementally to the BAU, not the Reference of the GHG Pollution Reduction Roadmap.

Policy Assumptions in the Accelerated Efficiency, Electrification, & Renewables Scenario

Sector	Accelerated Efficiency, Electrification, & Renewables Scenario
Electricity	● 90% clean electricity standard by 2030 and 100% by 2040 ● Accelerate deployment of storage, transmission, and demand response ● $100/ton carbon tax applied to electricity by 2030
Buildings	● 100% electric new appliances and buildings by 2030 (“building component electrification”) ● 50% of existing buildings are retrofit by 2040
On-Road Transportation	● 100% electric new light-duty vehicle and bus sales by 2030 ● 70% electric new truck sales by 2040 ● 30% hydrogen new truck sales by 2040 ● 26% light-duty vehicle miles traveled reduction from BAU by 2040
Industry	● $100/ton carbon tax applied to industry, including process (non-combustion) emissions, by 2030 ● 100% of hydrogen is produced via electrolysis by 2030
Land use/Agriculture	● $100/ton carbon tax applies to non-combustion emissions by 2030

Calculating Policy Impacts

Calculating Impacts of Policies (Emissions, Jobs, Health Impacts)

For additional information on Energy Innovation’s Energy Policy Simulator, please view the tutorial here.

About the EPS

The Energy Policy Simulator is a non-partisan, open-source, and peer-reviewed model. The EPS was developed to evaluate the impacts of climate and energy policies on emissions, costs and savings, and fuel consumption. The EPS model is used by policymakers to select and refine climate legislation. For example, the EPS model was used to assess the impact of climate policies for the U.S. House Select Committee on the Climate Crisis.[12] EPS users input climate policies and the model then analyzes interacting policy impacts to forecast environmental and economic outcomes. The model generates a variety of data outputs including

[12] https://energyinnovation.org/2020/07/28/hal-harveys-insights-and-updates-congressional-climate-plan-is-a-bet-your-country-moment/

greenhouse gas emissions, criteria pollutant emissions, capital and operating cash flow changes, and macroeconomic changes to GDP and jobs. RMI and Energy Innovation are currently developing EPS models for 20 U.S. states.

The EPS model is available for download online here.[13] And full documentation on methodology and assumptions are available online here.[14]

Contact

If you have questions about using the EPS, we recommend first watching our video series, available here.[15] For further information on the EPS, contact us at policy@energyinnovation.org. For more information on Colorado scenario analysis contact us at USAnalysis@rmi.org.

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[13] https://us.energypolicy.solutions/docs/download.html
[14] https://us.energypolicy.solutions/docs/index.html
[15] https://us.energypolicy.solutions/docs/video-series.html