

Minnesota Energy Policy Simulator (EPS) Summary Documentation

Estimating Economywide Emissions for Minnesota

The Minnesota 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), and the National Renewable Energy Lab (NREL). We supplemented national data with state-specific estimates of agricultural emissions and emissions associated with land use change. 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. Scaled 2019 import data from EIA by forecasted growth rate from Minnesota's BAU forecast.	Emissions - EPA " State CO2 Emissions from Fossil Fuel Combustion, 1990-2017 " & AEO " State CO2 Emissions from Fossil Fuel Combustion " & MPCA " Minnesota's 'Business-as-usual' Greenhouse Gas Forecast Technical Support Document "
BUILDING ENERGY USE	All energy use, all building components, residential and commercial buildings	NREL Electrification Futures Study - Reference Scenario	No scaling needed. NREL reports total energy use by fuel type and demand technology in MN for each year 2017-2050.	Energy Use - EIA's " State Energy Data Systems " 2018 CO2 Emissions - AEO " State CO2 Emissions from Fossil Fuel Combustion " & Minnesota's GHG Inventory
INDUSTRIAL ENERGY USE	All fuel use for industrial sector	Energy Information Association's Annual Energy Outlook tables on Industrial Energy Use & EIA's " State Energy Data Systems "	Scaled down by Census Data (County Business Patterns) employment by industrial subsector and state compared to national employment by industrial sector	Energy Use - NREL Electrification Futures and SEDS Emissions - EPA " State CO2 Emissions from Fossil Fuel Combustion, 1990-2017 " & AEO " State CO2 Emissions from Fossil Fuel Combustion " & Minnesota's GHG Inventory
INDUSTRIAL PROCESS EMISSIONS	Process Emissions	EPA Global Non-CO2 Greenhouse Gas Emissions	Scaled down US data to state data using a variety of sources, including data from	Emissions - Minnesota's GHG Inventory and E3's Pathways Report

Sector	Subsectors	Source	Methodology	Benchmarking Sources for Comparisons
		Projections & Mitigation Potential: 2015-2050	EPA's FLIGHT tool and EPA's State Inventory Tool Output Dataframe	
AGRICULTURE	Process Emissions	Minnesota's Greenhouse Gas Inventory Data	Note that for agricultural emissions we took an average of emissions for years 2005, 2010, 2015, 2016 and reallocated emissions from "cultivated histosols" to the land use sector	Emissions - Minnesota's GHG Inventory and E3's Pathways Report
LAND USE AND FORESTRY		Minnesota's Greenhouse Gas Inventory Data	Include forestry, land use sector emissions and "cultivated histosols" from the agricultural sector	Emissions - Minnesota's GHG Inventory
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 MN.	Emissions - EPA " State CO2 Emissions from Fossil Fuel Combustion, 1990-2017 " & AEO " State CO2 Emissions from Fossil Fuel Combustion " & Minnesota's GHG Inventory

Understanding the Business-as-Usual and Reference Projections

The Minnesota EPS model includes two baseline scenarios. The first is a **business-as-usual (BAU) scenario**, which represents all policy that is currently enacted in Minnesota. The **Reference scenario** includes planned policy and utility IRPs that are not yet implemented but are in progress. Once these policies are implemented, they will become part of the **BAU scenario**.

Business-as-Usual: Energy Innovation and RMI built a forecast of Minnesota'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) and direct emissions data from Minnesota Pollution Control Agency's Greenhouse Gas Inventory.¹ The BAU Scenario is the model's foundation, capturing projected changes based on economic growth, technology and cost changes, and existing policy commitments.

Reference: The Reference scenario provides an additional baseline reflecting very recently passed or imminently planned policies. Reference policies have been reviewed with in-state partners. In Minnesota, the primary source of additional policies was Xcel's draft Integrated Resource Plan.²

The table below summarizes the policies included in the BAU and Reference scenarios.

¹ <https://www.pca.state.mn.us/air/greenhouse-gas-emissions-data>

² <https://www.xcelenergy.com/staticfiles/xcel-responsive/Company/Rates%20&%20Regulations/The-Resource-Plan-No-Appendices.pdf>

► SUMMARY OF POLICY ASSUMPTIONS

Sector	BAU Scenario	Reference Scenario
Electricity	<ul style="list-style-type: none"> From EIA's Annual Energy Outlook and NREL Includes Minnesota's Renewables Portfolio Standard Assumes all currently planned retirements are completed on time (incl. Sherco 1 by 2025, Sherco 2 by 2022, Sherco 3 by 2034) Assume existing nuclear power plants are retired at the time their current permits expire (Monticello 2030 and Prairie Island 2033/34) 	<ul style="list-style-type: none"> Nuclear power plants extended additional 10 years: Monticello through 2040, Prairie Island through 2043 (Unit 1) and 2044 (Unit 2)³ Retire 2 coal units early: King in 2028, Sherco 3 in 2030 Assume 1500 MW demand response by 2034 above the BAU case 1200 MW wind and 4000 MW of solar added by 2034
Buildings	<ul style="list-style-type: none"> From EIA's Annual Energy Outlook and NREL Assumes some equipment performance improvements over time, based on market data (described here)⁴ 	<ul style="list-style-type: none"> Energy efficiency savings included in Xcel's IRP
On-Road Transportation	<ul style="list-style-type: none"> 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 EVs⁵ 	<ul style="list-style-type: none"> <i>Same as BAU</i>
Industry	<ul style="list-style-type: none"> From EIA's Annual Energy Outlook and NREL Assumes equipment performance improvements over time (described here) Does not include implementation of Kigali Amendment to the Montreal Protocol. 	<ul style="list-style-type: none"> Energy efficiency savings included in Xcel's IRP
Land use/Agriculture	<ul style="list-style-type: none"> Agriculture, biomass, and forestry projections 	<ul style="list-style-type: none"> <i>Same as BAU</i>
Imports/Exports	<ul style="list-style-type: none"> Imported electricity emissions held constant 	<ul style="list-style-type: none"> Imported natural gas and coal electricity emissions decrease by 50% by 2030 Assume no reductions in production, reductions in state consumption increase exports

³ Xcel's IRP only extends the Monticello plant by an additional 10 years, but the EPS policy setting design can only extend all retiring nuclear plants or none, so in this scenario, Prairie Island is extended 10 years beyond its license year as well.

⁴ Efficiency improvements are derived from NREL electrification futures study Reference Case. Energy Efficiency policies – including those in Minnesota such as building rebates-- are not explicitly included in the BAU.

⁵ Electric vehicle adoption in the BAU case is based on economic adoption modeled in the EPS, detailed info 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>.

Defining Targets shown in the tool

The EPS model shows two greenhouse gas reduction targets.

Minnesota's targets: Minnesota's Next Generation Energy Act (NEGA) set economy-wide greenhouse gas reduction targets. The act requires the state to reduce greenhouse gas emissions 30% below a 2005 baseline (not shown) and 80% by 2050.

2030 sector GHG target range: Rocky Mountain Institute has done a US-wide analysis to define sector level targets consistent with limiting cumulative US greenhouse gas emissions consistent with a global 1.5°C budget. To inform these targets, RMI reviewed both global 1.5°C guidance⁶ 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- and politically effective paths that reduce emissions more quickly. RMI will provide additional information on the target calculations in a subsequent companion document.

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°C by 2100. This national scenario has been downscaled to Minnesota, 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 national 1.5°C scenario.

Policy Assumptions in the US 1.5 Degree Scenario

Sector	US 1.5 Degree Scenario
Electricity	<ul style="list-style-type: none">• Nuclear power plants extended additional 10 years: Monticello through 2040, Prairie Island through 2043 (Unit 1) and 2044 (Unit 2)⁷• 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 plants⁸• All existing coal retired by 2030
Buildings	<ul style="list-style-type: none">• 100% electric new appliances and buildings by 2030 ("building component electrification")• 15% of existing buildings are retrofit by 2050

⁶ See IPCC [Global Warming of 1.5°C](#) and [UNEP 2019 Emissions Gap](#)

⁷ Xcel's IRP only extends the Monticello plant by an additional 10 years, but the EPS policy setting design can only extend all retiring nuclear plants or none, so in this scenario, Prairie Island is extended 10 years beyond its license year as well.

⁸ Some natural gas peaker plants may be built to help meet peak demand

Sector	US 1.5 Degree Scenario
	<ul style="list-style-type: none"> Efficiency improvement in line with the Xcel IRP with ambition extended to 2050, plus additional efficiency improvements for building heating equipment and appliances
On-Road Transportation	<ul style="list-style-type: none"> 100% electric new light-duty vehicle, motorbike, and bus sales by 2035 100% electric new medium- and heavy-duty 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	<ul style="list-style-type: none"> 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 100% remaining industrial CO2 emissions captured and sequestered through CCS by 2050
Land use/Agriculture	<ul style="list-style-type: none"> 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 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](#) benchmark policies for the US to undertake “ambitious climate actions and targets.”

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 Minnesota. Because it is generic, it applies incrementally to the BAU, not the Reference Scenario.

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

Sector	Accelerated Efficiency, Electrification, & Renewables Scenario
Electricity	<ul style="list-style-type: none">● 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	<ul style="list-style-type: none">● 100% electric new appliances and buildings by 2030 (“building component electrification”)● 50% of existing buildings are retrofit by 2040
On-Road Transportation	<ul style="list-style-type: none">● 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	<ul style="list-style-type: none">● \$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	<ul style="list-style-type: none">● \$100/ton carbon tax applies to non-combustion emissions by 2030

Calculating Policy Impacts

For additional information on Energy Innovation’s Energy Policy Simulator, please view the tutorial [here](#). Detailed model documentation is also available [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.⁹ 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 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.

⁹ <https://energyinnovation.org/2020/07/28/hal-harveys-insights-and-updates-congressional-climate-plan-is-a-bet-your-country-moment/>

The EPS model is available for download online [here](#).¹⁰ And full documentation on methodology and assumptions are available online [here](#).¹¹

Contact

If you have questions about using the EPS, we recommend first watching our video series, available [here](#).¹² For further information on the EPS, contact us at policy@energyinnovation.org. For more information on RMI analysis and our state advocacy support network contact us at [BeyondCarbon](#) Support@rmi.org.

The Minnesota EPS is developed as a partnership between Energy Innovation and Rocky Mountain Institute (RMI), with RMI work supported by Bloomberg Philanthropies.

¹⁰ <https://us.energypolicy.solutions/docs/download.html>

¹¹ <https://us.energypolicy.solutions/docs/index.html>

¹² <https://us.energypolicy.solutions/docs/video-series.html>