Virginia Energy Policy Simulator (EPS) Summary Documentation

Estimating Economy-wide Emissions for Virginia

The Virginia 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). 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	NREL Electrification Futures Study - Reference Scenario	No scaling needed. NREL reports total energy use by fuel type and demand technology in VA 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	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 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	EPA Global Non-CO2 Greenhouse Gas Emissions Projections & Mitigation Potential: 2015-2050	Scaled down US data to state data using a variety of sources, including data from EPA's FLIGHT tool and EPA's State Inventory Tool Output Dataframe	Emissions – VA GHG Inventories: "Virginia's Accomplishments Since the 2008 Climate Action Plan Release" and The Center for Climate Strategies' "Virginia Greenhouse Gas Inventory and Forecast"

AGRICULTURE, LAND USE AND FORESTRY		EPA "State Inventory and Projection Tool"		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 VA.	Emissions - EPA "State CO2 Emissions from Fossil Fuel Combustion, 1990-2017" & AEO "State CO2 Emissions from Fossil Fuel Combustion"

Understanding the Business-as-Usual and Virginia Clean Economy Act Projections

The Virginia EPS model includes multiple built-in reference scenarios. The first is a **business-as-usual (BAU) scenario**, which represents all policy that is currently enacted in Virginia. The **Virginia Clean Economy Act scenario** includes planned policy that is not yet implemented but is in progress.

Business-as-Usual: Energy Innovation and RMI built a forecast of Virginia'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). The BAU Scenario is the model's foundation, capturing projected changes based on economic growth, technology and cost changes, and existing policy commitments.

Virginia Clean Economy Act: The VCEA scenario provides an additional baseline reflecting very recently passed or imminently planned policies. This scenario has been reviewed with in-state partners. In Virginia, the source of additional policies was the Virginia Clean Economy Act.[1] In future updates, once these policies are implemented, they will become part of the **BAU scenario**.

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

[1] https://lis.virginia.gov/cgi-bin/legp604.exe?201+sum+HB1526

➤ SUMMARY OF POLICY ASSUMPTIONS

Sector	BAU Scenario	Virginia Clean Economy Act Scenario
Electricity	● Does not include VCEA ● Assumes all currently planned retirements are completed on time	● Weighted average clean electricity standard[2] ● For existing plants owned by Phase I and II utilities, all gas and petroleum plants are retired by 2045, all coal plants retired by 2024, all biomass plants by 2028 ● Mandated electricity capacity construction of offshore wind and battery storage ● Building energy efficiency ● Includes projected RGGI prices through 2031, then grows prices through 2050 to hit emissions reduction targets from VCEA, reaching $325/metric ton in 2050. ● Some natural gas peaking units remain online and dispatch at very low levels to help meet peak demand.
Buildings	● From EIA's Annual Energy Outlook and NREL ● Assumes some equipment performance improvements over time, based on market data (described here)[3]	● Energy efficiency savings included in VCEA
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[4]	● Same as BAU
Industry	● From EIA's Annual Energy Outlook and NREL ● Assumes equipment performance improvements over time (described here) ● Does not include implementation of the Kigali Amendment to the Montreal Protocol.	● Same as BAU
Land use/Agriculture	● Agriculture, biomass, and forestry projections	● Same as BAU

[2] The scenario estimates a weighted average clean electricity standard in every year, based on historical data on generation by utility and electricity demand projections from the model to approximate generation by utility. We subtract out nuclear generation, then calculate the clean generation requirements for Phase I and II utilities according to the VCEA targets. For implementation purposes, we then calculate the total clean electricity requirements in each year by summing the requirements by utility and adding nuclear generation back in (since the model includes nuclear as a qualifying source). We have not addressed any specific carve-outs.

[3] 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.

[4] 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.

Imports/Exports	• Imported electricity emissions held constant	• Changes in fuel demand will be met by changes in imports and exports, not through changes in in-state production. • The total amount of imported electricity will be held constant.

Defining Targets shown in the tool

Greenhouse gas reduction target

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 guidance[5] 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 Virginia, 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°C scenario.

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 in line with VCEA scenario • Offshore wind and storage deployment in line with VCEA scenario
Buildings	• 100% electric new appliances and buildings by 2030 (“building component electrification”) • 30% of existing buildings are retrofit by 2050 • Efficiency improvement in line with VCEA with ambition extended to 2050, plus additional efficiency improvements for building heating equipment and appliances

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

On-Road Transportation	● 100% electric new light-duty vehicle, motorbike, and bus sales by 2035 ● 100% electric new medium- and heavy-duty truck sales by 2045 ● 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 2050 ● 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 ● 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 2050

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 Virginia. Because it is generic, it applies incrementally to the BAU, not the Virginia Clean Economy Act.

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.[6] 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.

The EPS model is available for download online here.[7] Full documentation on methodology and assumptions are available online here.[8]

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

[7] https://us.energypolicy.solutions/docs/download.html

[8] https://us.energypolicy.solutions/docs/index.html

Contact

If you have questions about using the EPS, we recommend first watching our video series, available here.[9] 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 Virginia EPS is developed as a partnership between Energy Innovation and Rocky Mountain Institute (RMI), with RMI work supported by Bloomberg Philanthropies.

[9] https://us.energypolicy.solutions/docs/video-series.html