



An Analysis of Decarbonization Methods in Vermont

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January 2019

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As requested by the Vermont General Assembly in Act 11 (June 2018), this report provides information on policies to reduce greenhouse gas (GHG) emissions in Vermont

Our study aims to inform the policy dialogue, but it is not intended to address the complete universe of policy options.

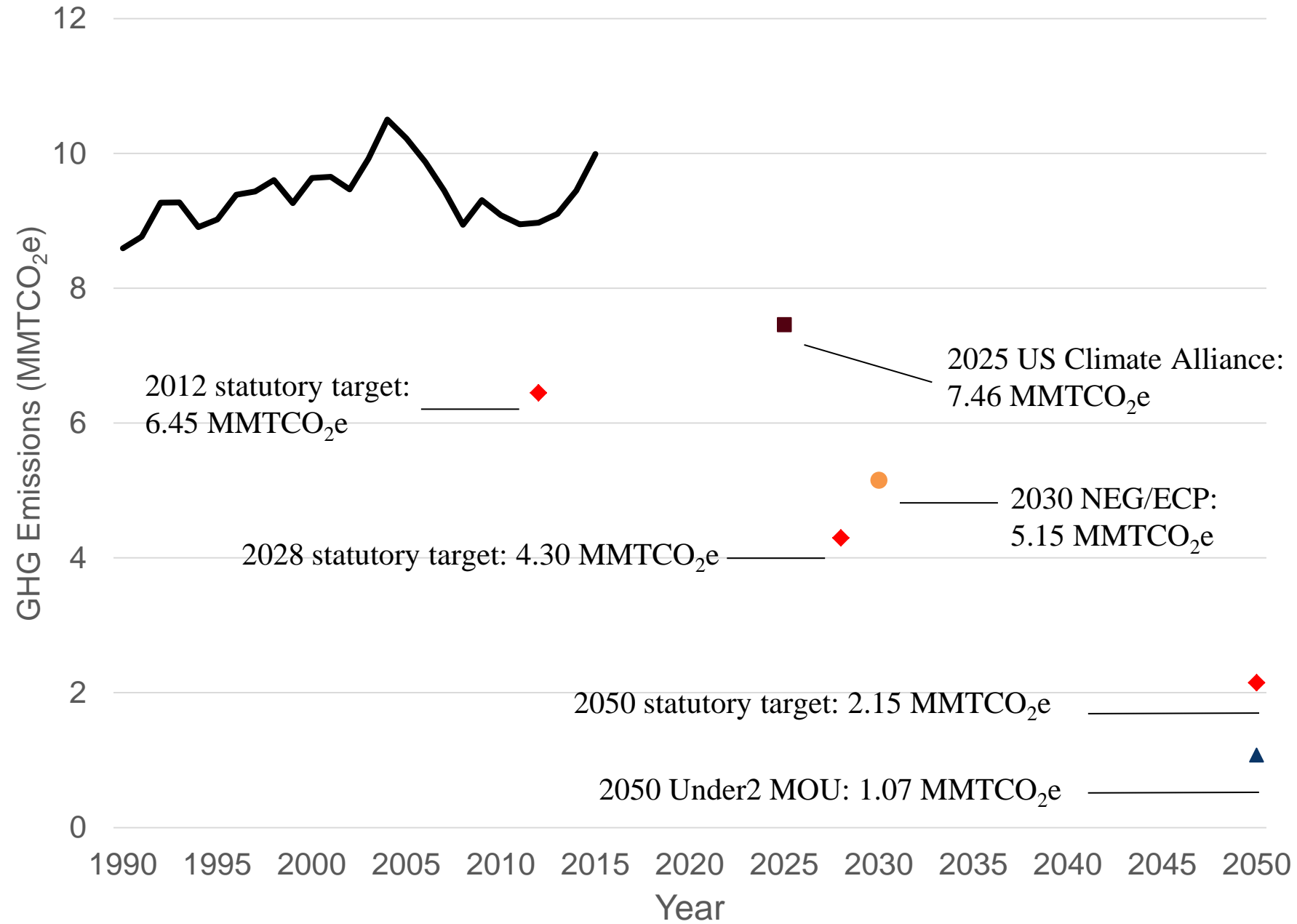
We do not offer specific policy recommendations.

About Resources For the Future (RFF)

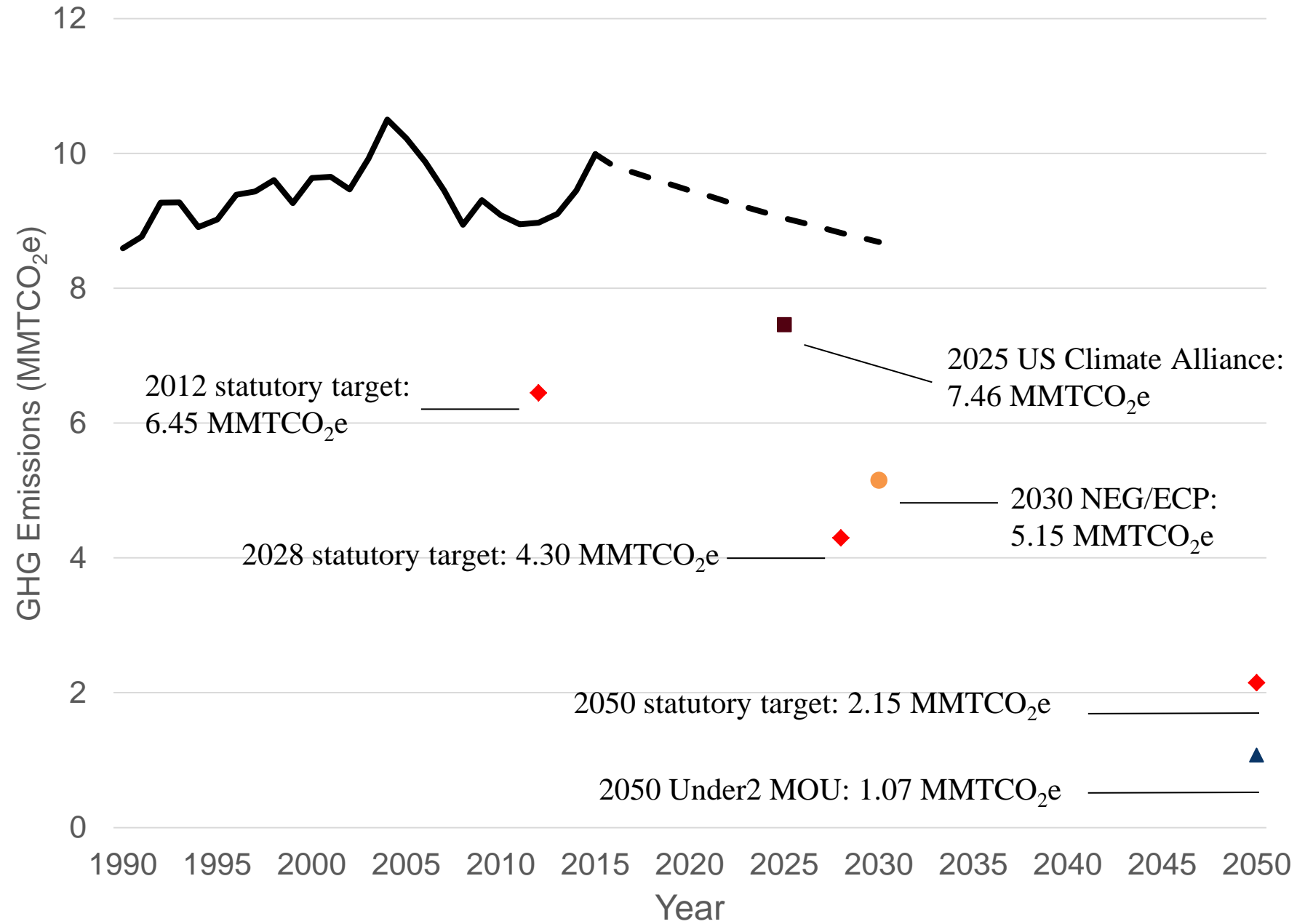


Resources for the Future (RFF) is an independent, nonprofit research institution in Washington, DC. Its mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement. RFF is committed to being the most widely trusted source of research insights and policy solutions leading to a healthy environment and a thriving economy.

VT emissions have been increasing since 2011...

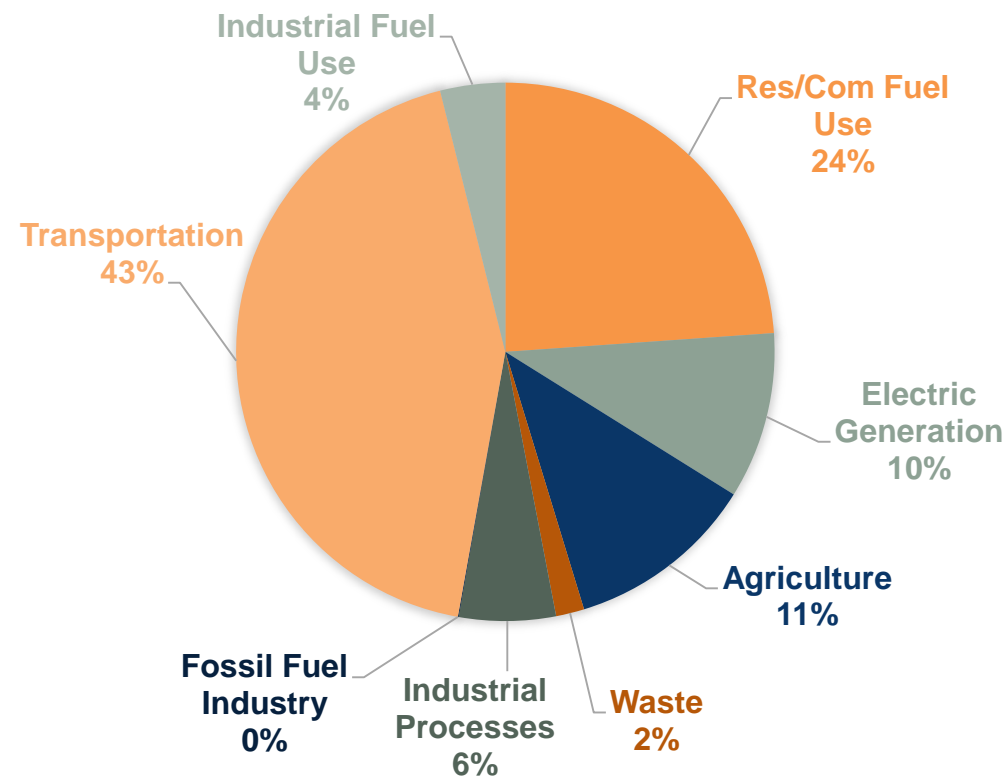


and are not expected to meet any of the state's targets

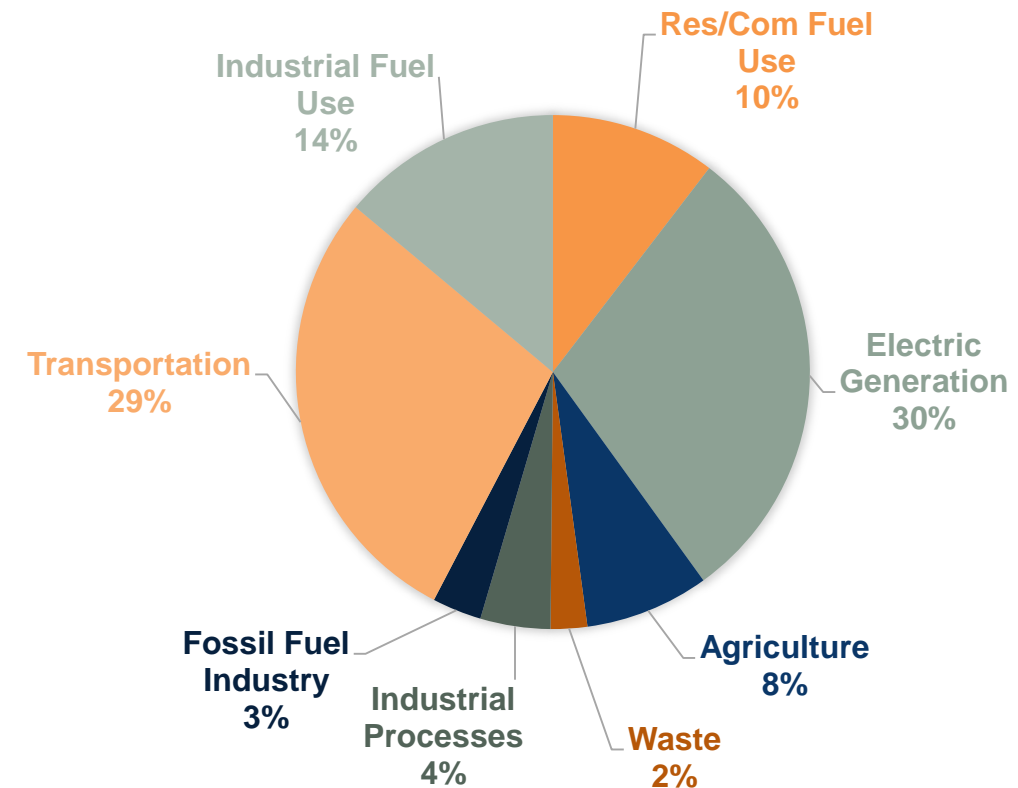


The Vermont context is important

VERMONT GHG EMISSIONS



U.S. GHG EMISSIONS



Transportation and Residential/Commercial Fuel Use for Heating are difficult to decarbonize (because close noncarbon substitutes are very expensive)

Policy Options Considered in this Report

- Carbon Pricing Policies
 - Carbon Tax or Cap-and-Trade Programs
 - A **quantitative** analysis of costs and benefits across a range of policy designs
- Nonpricing Policies
 - Including, but not limited to, electric vehicle (EV) and energy efficiency incentives, weatherization programs, investments in low-carbon agriculture
 - A **qualitative** review of emission reduction potential of Vermont Climate Action Commission (VCAC) recommendations and 100 percent Renewable Energy Standard

Carbon pricing policies vary by

- Price (directly through tax or indirectly through cap-and-trade)
- Sectors Covered
- Revenue Use
- Geographical Scope

\$20 carbon price is equivalent to tax of 0.18 cents per gallon on gasoline

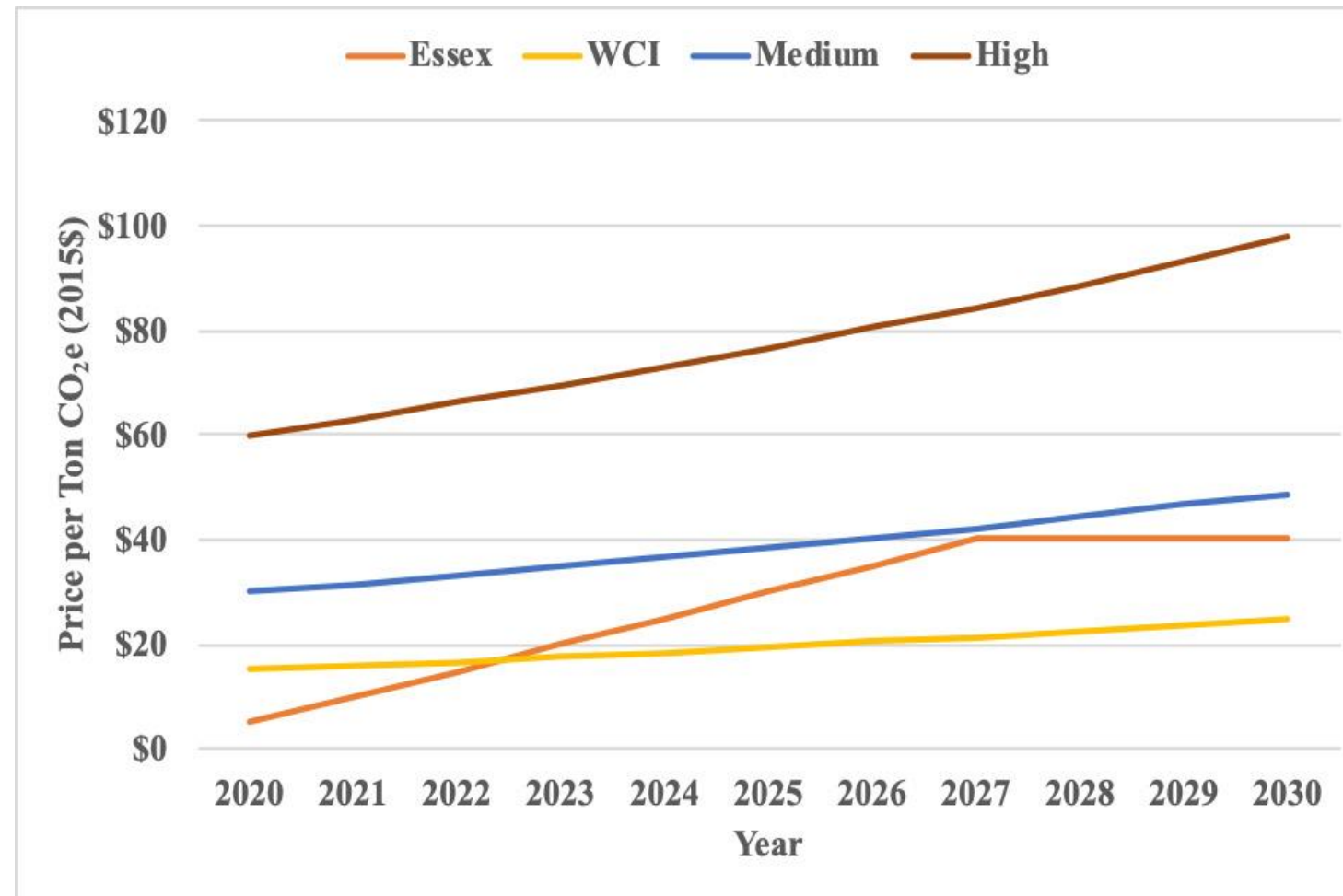
We consider four alternative carbon price paths

ESSEX Price Path:

\$5 per ton in 2020, rising at \$5 each year until the price reaches \$40 and stays constant (in 2015\$).

WCI Price Path:

\$15.22 per ton in 2020, rising at 5 percent (above inflation) annually. This implies \$19.43 in 2025 and \$24.79 in 2030 (in 2015\$).



Medium Price Path:

\$30 per ton in 2020, rising at 5 percent (above inflation) annually. The price reaches \$38.29 in 2025 and \$48.87 in 2030 (in 2015\$).

High Price Path:

\$60 per ton in 2020, rising at 5 percent (above inflation) annually. The price reaches \$76.58 in 2025 and \$97.73 in 2030 (in 2015\$).

We consider three alternative revenue-uses

- **Lump-Sum Rebates:** Net revenue is returned equally through equal per household payments to all Vermont households.
- **Tax Cuts on Wage Income:** Net revenue is used to finance reductions in state taxes on wage income.
- **Electricity Rebates:** Net revenue is used to finance reductions in electricity rates for residential, commercial, and industrial customers.

Note: we do not quantitatively model the use of revenue to invest in nonpricing policies, due to time and budget constraints

We consider three alternative sectoral scopes

- **Economy-Wide (electricity exempt):** transportation, residential, commercial, and industrial sectors
- **Transportation and Heating:** Residential & commercial use of heating fuels, and transportation (transportation emissions include emissions from household purchases of motor vehicle fuels and the transportation sector's purchase of refined petroleum products)
- **Transportation Only:** Transportation carbon dioxide emissions only.

We consider two alternative regional scopes

- **Vermont-only:** Vermont acts on its own to implement additional carbon pricing policies.
- **Regional:** All New England states act together under one unified carbon pricing policy.

Key Finding: Carbon pricing-only unlikely to meet US Climate Alliance targets (26-28% below 2005)

Projected GHG emissions in 2025 relative to 2005				
	Carbon Price Policy			
	TCI	WCI	ESSEX	High Price
Carbon Pricing-Only	-12.9%	-13.6%	-14.3%	-19.3%

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TCI: Cap-and-Trade Program on Transportation Emissions Only , \$19.42 in 2025 (in 2015\$)

WCI: Cap-and-Trade Program on Transportation and Heating Emissions, \$19.42 in 2025 (in 2015\$)

ESSEX: Economy-wide Carbon Tax (Electricity Exempt), \$30 in 2025 (in 2015\$)

High Price: Economy-wide Carbon Tax (Electricity Exempt), \$76.58 in 2025 (in 2015\$)

Nonpricing Policies

- Electric Vehicle (EV) incentives
 - Weatherization programs
 - Energy efficiency programs
 - 100 percent Renewable Energy Standard (RES)
-
- Relied on estimates from the Vermont Climate Action Commission (VCAC) – *over 50 individual policy recommendations*

Key Finding: Combined approaches consistent with 2025 US Climate Alliance targets (26-28% below 2005)

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Combined Pricing and Nonpricing approach	-31.6%	-32.5%	-33.7%	-38.0%

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Nonpricing: Implementation of all VCAC recommendations; 100% RES; median estimates of reductions

Measuring costs and benefits of carbon pricing

- Costs
 - Increased prices for fuels and energy-intensive goods
 - Changes in income
 - GDP and employment changes
- Benefits
 - GHG reductions
 - Criteria Air Pollutant Reductions

Key Finding: Economic impact of carbon pricing is small

- The combined climate and health benefits of the carbon pricing policies would exceed the economic costs for every carbon pricing scenario considered in this report.

	2025			
	TCI*	WCI*	ESSEX**	High Price*
Change in Economic Welfare per Household (2015\$)	-\$28	-\$47	-\$71	-\$240
Environmental Benefits per Household (2015\$)	\$56	\$78	\$133	\$317
Percentage Change in State GDP	-0.01%	-0.02%	0.05%	-0.08%
Percentage Change in Total Labor Demand	-0.01%	-0.02%	0.05%	-0.05%
Annual Revenue (Millions 2015\$)	\$75	\$121	\$183	\$434

* Revenues rebated to households. ** Revenues rebated to low-income households and electricity subsidies

Key Finding: Economic impact of carbon pricing is small

- Impacts on state GDP and level of employment would be very small, regardless of policy design

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- A carbon pricing policy would generate significant annual revenue for the state, depending on the carbon price level and the number of sectors covered.

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Key Finding: Economic impacts are not evenly distributed

- Low-income and rural households spend larger fraction of income on energy
- Carbon-intensive industries affected more than other industries

Key Finding: Policies can be designed to offset impacts on low-income and rural households

Economic Welfare Change in 2020 (2015\$ per household)				
	Carbon Price Policy			
	TCI*	WCI*	ESSEX**	High Price*
Quintile 1	\$53	\$96	\$37	\$414
Quintile 2	\$18	\$35	\$24	\$171
Quintile 3	-\$18	-\$38	\$5	-\$132
Quintile 4	-\$22	-\$15	-\$46	-\$82
Quintile 5	-\$122	-\$251	-\$51	-\$1,240
Urban (Chittenden County)	-\$13	-\$12	\$0	-\$122
Rural (Weighted average, all other counties)	-\$20	-\$42	-\$8	-\$191

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Key Finding: Revenue use introduces trade-offs

- According to our modeling analysis, **per household rebates** more than offset the costs of increased energy prices for the average low-income household.
- **Reducing taxes on wage income** would lower the overall cost to Vermont's economy relative to other options considered, but these cuts would not fully offset higher energy prices.
- Devoting revenue to **finance nonpricing policies** would reduce emissions further, but would also impose higher costs on Vermonters, because this would reduce funds that could be used to partially or fully offset the economic impacts on households of carbon pricing.

Caveats

- We do not model policy-induced innovation
- Average household impacts mask potentially large differences in impacts for specific households. No two households are the same and impacts will vary considerably.
- New Hampshire border remains an issue to Vermont-only policies
 - Difficult to predict how many drivers would increase gasoline purchases out of state.
- Further analysis is required to understand the full environmental and economic impacts of nonpricing policies.



Thank You