Economic and Health Impacts of a Clean Fuel Standard for New York

June 2022

Scioto Analysis
Economics | Public Policy

Executive Summary

The New York State Climate Action Council has identified a clean fuel standard as a strategy for reducing emissions from the transportation sector and transitioning to zero-emission technologies. A clean fuel standard is a market-based regulatory framework that allows providers of low carbon intensity fuels to claim credits against fuel that is produced below annual threshold levels of carbon intensity. Providers of high carbon intensity fuels must either reduce the carbon intensity of the fuels they produce or buy credits from providers of low carbon intensity fuels. In the United States, clean fuel standards are in place in California and Oregon and have just been adopted in Washington state.

A clean fuel standard supports development of a low carbon fuel industry by providing credits certified by the state to providers of low carbon intensity fuels such as clean electricity, renewable diesel, biodiesel, green hydrogen, ethanol, and biomethane. Benefits gained by selling credits generated by producing low carbon intensity fuels help spur new markets and diversify the range of transportation fuel options available to consumers of fuel, giving consumers access to fuels produced from more secure energy sources than gasoline while not significantly impacting the cost of gasoline itself. If New York's quick start projects for low carbon fuel intensity projects resemble New Mexico's, a clean fuel standard could help create 9,200 jobs worth $2.6 billion in wage income for state residents.

Clean fuel standards have been effective at abating carbon emissions. Best-practice econometric research estimates that California's Low Carbon Fuel Standard cut carbon emissions in its state transportation fuel sector by 10% in its first few years of implementation. We estimate a clean fuel standard that reduces fuel carbon intensity by 20% would reduce carbon emissions in New York by **13-20 million metric tons per year**, which amounts to **$6.6 billion to $10 billion** in annual economic benefits**.**

Clean fuel standards have also been successful at reducing tailpipe emissions of NO_X and PM 2.5, two pollutants that cause respiratory illness and death. We estimate a 20% carbon intensity reduction clean fuel standard would **save 24-43 lives every year** from reduced emission of harmful local pollutants, worth **$550 million to $3.7 billion** in annual economic benefits.

Clean fuel standards also reduce consumption of gasoline and diesel and lessen reliance on oil, causing more stability in transportation fuel prices and improving energy security. We estimate a 20% carbon intensity reduction clean fuel standard would **reduce oil consumption by 8-25 million barrels of oil per year** in the state of New York, worth **$850 million to $5.1 billion** in annual economic benefits.

A reduction in the carbon intensity of transportation fuels would also promote environmental justice in the state. Rural communities would benefit from incentives to produce fuel manufactured from crops. Majority non-white neighborhoods, which suffer disproportionately from exposure to tailpipe emissions, will benefit from reductions in NO_X and PM 2.5 brought on by a clean fuel standard. Other people vulnerable to NO_X and PM 2.5 including children, the elderly, and people who suffer from asthma will also benefit from reductions in emissions.

A clean fuel standard in New York would complement a suite of other state and federal policies like carbon pricing, the Renewable Fuel Standard, and state fiscal and regulatory policy aimed at transitioning the state to a low-carbon energy economy.

All told, we estimate a clean fuel standard would generate **$4-17 billion in net social benefits through 2050** and would generate between **$2.06 and $10.16 in benefits for every dollar of costs** in the form of infrastructure spending. We also find cumulative benefits will likely outweigh cumulative costs in less than ten years of adoption of the policy.

Introduction

This analysis aims to inform policymakers about the economic, energy security, public health, and environmental justice impacts of a clean fuel standard for the state of New York. The first half of this analysis describes the features of a clean fuel standard, then reviews insights from the academic and evaluation literature on the economic, energy security, and health impacts of clean fuel standards already in place. The analysis then discusses how a clean fuel standard interacts with other policies designed to reduce carbon emissions and transition the transportation fuel economy.

This assessment culminates in a presentation of the methodology and results of a cost-benefit analysis of the proposed New York clean fuel standard to reduce carbon intensity of transportation fuels in the state by 20% by 2030, and concludes with a discussion of the equity and environmental justice implications of the proposal.

What is a clean fuel standard?

The draft scoping plan for the New York State Climate Action Council identifies lower carbon renewable fuels as one of its twelve key sector strategies for effectively reducing emissions from the transportation sector and transitioning to zero-emission technologies.[1] The first component of this strategy cited in the report is a “clean fuel standard,” a requirement for those who manufacture and distribute transportation fuels (herein referred to as “providers”) to reduce the carbon intensity of fuels they provide.[2]

A clean fuel standard requires that the average carbon intensity of transportation fuels sold within a given jurisdiction meet a certain energy-related greenhouse gas reduction target, often measured in grams of CO_2 per megajoule, within a certain time period.[3,4] Providers that are able to produce fuels below the carbon intensity target for a given year claim credit that they can either bank to use in future years or sell to providers that have accrued deficits by not meeting the standard. Figure 1 shows an example of the carbon intensity threshold providers

[1] “Draft Scoping Plan,” New York State Climate Action Council, December 30, 2021.
[2] SB S2962B defines "providers" as “includ[ing], but…not…limited to, all refiners, blenders, producers or importers of transportation fuels, or enablers of electricity used as transportation fuel.”
[3] Bracmort, Kelsey, “A Low Carbon Fuel Standard: In Brief,” Report, Congressional Research Service, July 7, 2021.
[4] Lade, Gabriel E., and C-Y. Cynthia Lin Lawell. "The design and economics of low carbon fuel standards." Research in Transportation Economics 52 (2015): 91-99.

of transportation fuel are scored against to generate credits or deficits under California's Low Carbon Fuel Standard. A similar chart is provided for Oregon's Clean Fuels Program in Appendix A.

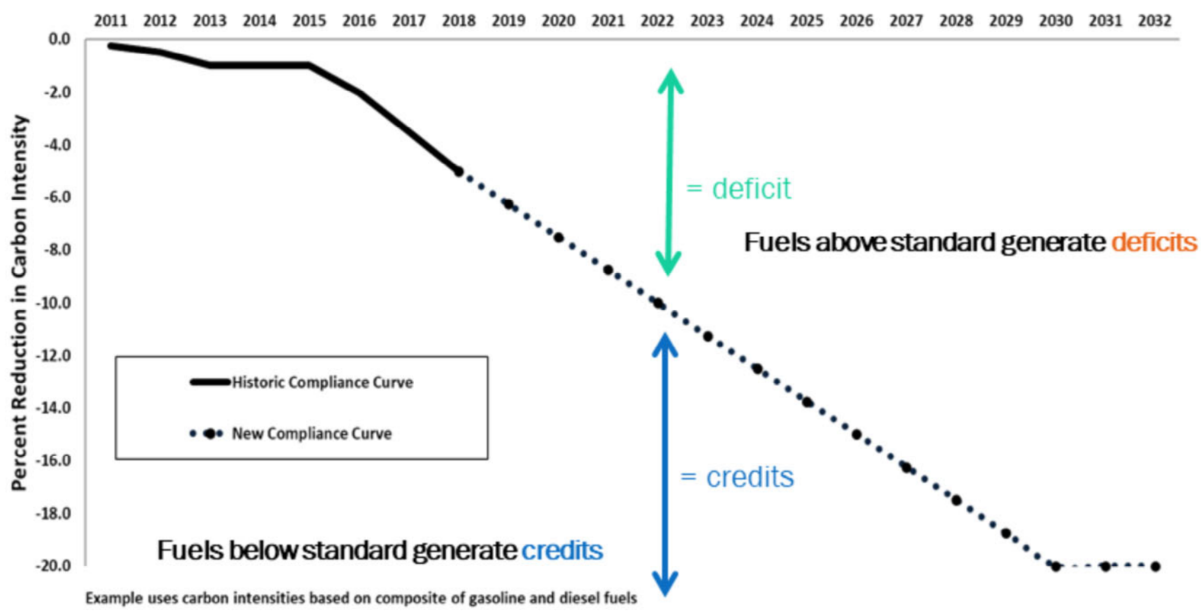

Figure 1: Credits and Deficits under California's Low Carbon Fuel Standard[5]

These transactions encourage production of low carbon intensity fuels and discourage production of high-carbon intensity fuels, with providers incurring deficits for producing transportation fuels that don't meet the standard. Deficits can be offset with credits earned through production of low-carbon intensity fuels or by buying credits from low-carbon fuel providers.

An agency like the California Air Resources Board certifies "pathways" for fuels that estimate the full "well-to-wheels" lifecycle carbon intensity of different combinations of transportation fuel technology, feedstock, production process, and end use in vehicles.[6] Current average certified carbon intensities for a range of transportation fuel technologies are shown in figure 2.

[5] "Low Carbon Fuel Standard Basics with Notes," California Air Resources Board, 2022.
[6] "LCFS Pathway Certified Carbon Intensities," website, California Air Resources Board, 2022.

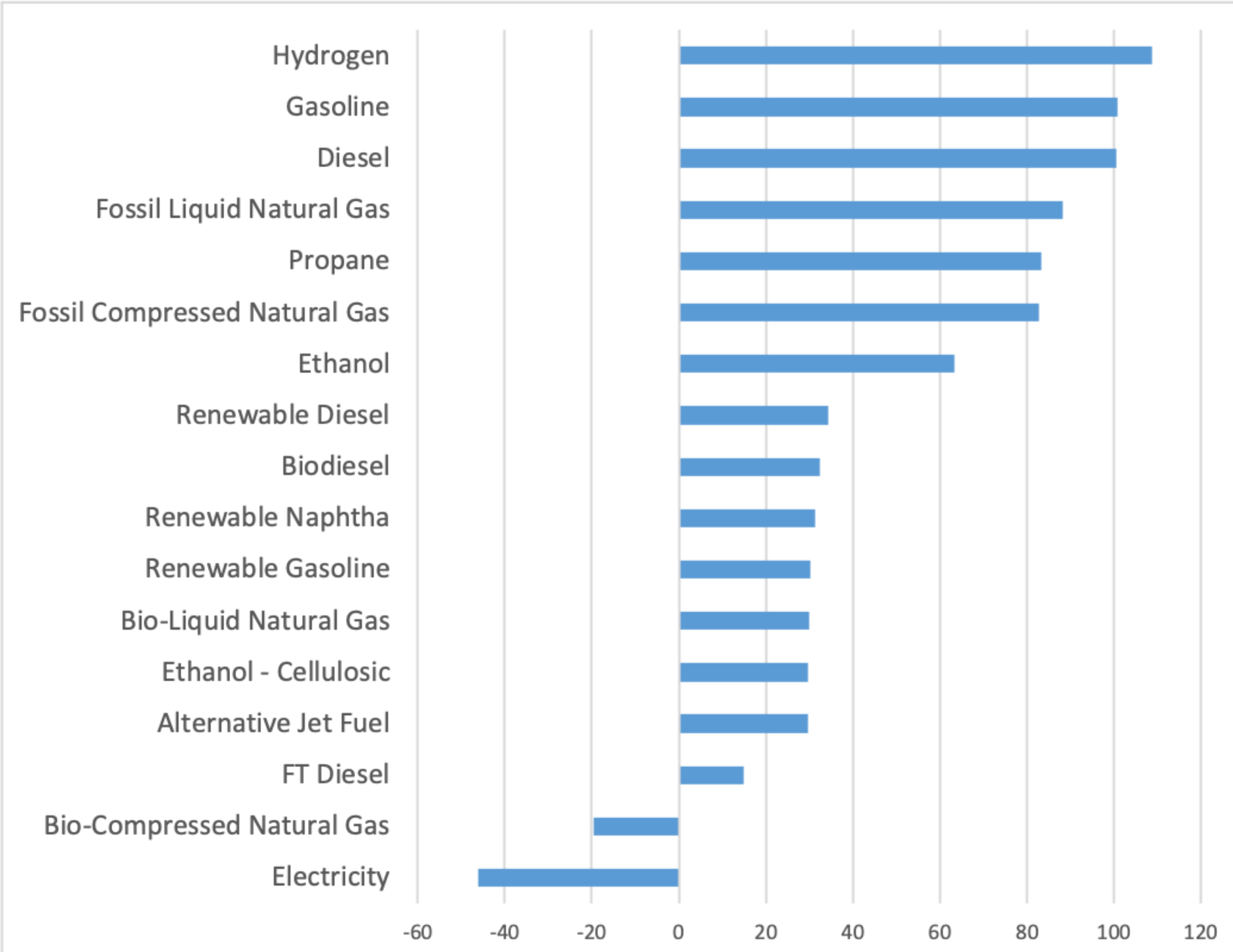

Figure 2: Average energy economy-adjusted carbon intensities for fuels in California (gCO_2e/MJ)[7]

Three U.S. states have adopted a clean fuel standard: California, Oregon, and most recently Washington. Clean fuel standards have been adopted by governments in other countries as well, as can be seen in table 1. Target carbon intensities range from a 6% reduction from 2010 levels by the European Union as a directive to all member states, fully implemented in 2020, to Oregon's 25% reduction from 2015 levels by 2035.

[7] "LCFS Pathway Certified Carbon Intensities," website, California Air Resources Board, 2022.

Jurisdiction	Carbon Intensity (CI) Target	Target Year
California	20% below 2010 CI	2030
Oregon	10% below 2015 CI	2025
	20% below 2015 CI	2030
	25% below 2015 CI	2035
Washington	20% below 2017 CI	2038
British Columbia	20% below 2010 CI	2030
European Union	6% below 2010 CI	2020
Brazil	10% below 2017 CI	2028

Table 1: Current Jurisdictions with Clean Fuel Standards[8,9]

While a program like a carbon tax generally reduces economic activity within a sector by levying a tax on its economic activity, a clean fuel standard reallocates revenue within transportation fuel markets from production of high carbon intensity fuels to production of low carbon intensity fuels. It does this through its credit mechanism, which is based on annual targets for carbon intensity set by the state as directed in statute and/or developed within a designated agency's regulatory process.

The benefit gained by selling clean fuel standard credits gives a reason for firms to increase investments in low carbon intensity fuel production and technology but also to reduce the carbon intensity of existing fuel technology and develop new fuels with lower carbon intensity. Clean fuel standards also have created positive externalities through incentivizing

[8] Kelly, Casey, and Nikita Pavlenko. "Assessing the potential for low-carbon fuel standards as a mode of electric vehicle support." Working Paper 2020-29 (2020).

[9] "Clean Fuel Standard," Reducing Greenhouse Gases, Climate Change, Air & Climate, Website, Department of Ecology, State of Washington.

innovation and new technology development while having less impact on gasoline prices than a carbon tax or cap-and-trade.[10]

California's Low Carbon Fuel Standard is an illustrative model for creating a regulatory framework for carbon intensity accounting. California has successfully ensured compliance by providers of transportation fuels, with the California Air Resources Board reporting in 2019 that 100% of providers in the state have complied with the program by meeting carbon intensity standards or purchasing credits from those who do.[11] Of these providers of transportation fuels, 84% met carbon intensity standards on their own, while the remainder purchased credits from those meeting standards to cover their deficits.

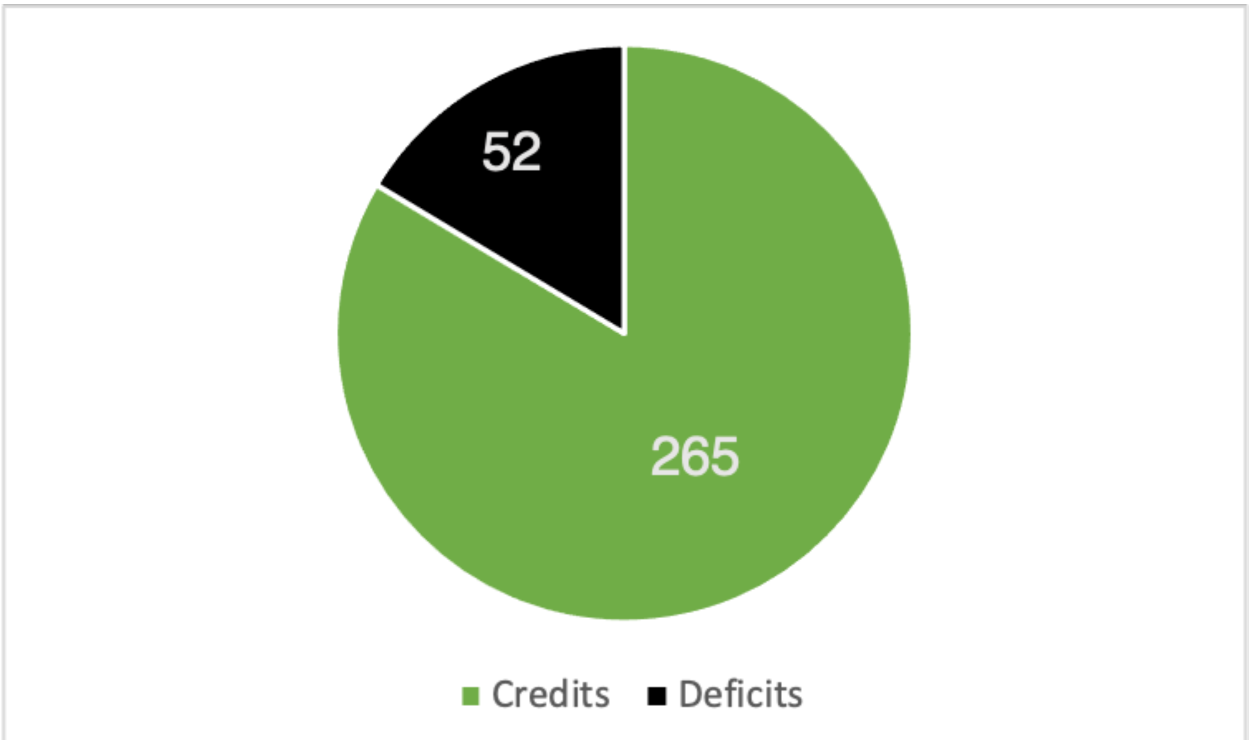

Figure 3: Number of firms in 2018 receiving credits or running deficits under California's Low Carbon Fuel Standard[12]

Economic impacts of a clean fuel standard

Clean fuel standards are designed to decrease the carbon intensity of transportation fuels produced in a given jurisdiction. The mechanism of credits and deficits that a clean fuel

[10] Yeh, Sonia et al, "Tradable Performance Standards in the Transportation Sector," Working Paper 20-18, Resources for the Future, October 2020.
[11] "Cleaner fuels have now replaced more than 3 billion gallons of diesel fuel under the Low Carbon Fuel Standard: 2018 data shows 100 percent compliance with California's clean fuels rule," Press Release number 19-22, California Air Resources Board, May 16, 2019.
[12] Data from "Cleaner fuels Cleaner fuels have now replaced more than 3 billion gallons of diesel fuel under the Low Carbon Fuel Standard," California Air Resources Board.

standard puts in place encourages investment in production of low carbon intensity fuels. This helps **stabilize transportation fuel costs** and **spur innovation and private sector investment in the low carbon fuel industry**.

Impact of clean fuel standards on fuel prices

A study released earlier this year by Bates White Economic Consulting analyzed the impact of clean fuel standards on the retail price of gasoline.[13] This study analyzed retail fuel prices associated with California's Low Carbon Fuel Standard, the longest-running clean fuel standard in the United States.

An objective of a clean fuel standard is to decrease the price of low carbon intensity transportation fuels compared to the price of high carbon intensity fuels. Analysts at Bates White found low-carbon fuels in California are often cheaper than high-carbon fuels, with renewable diesel, at one-third the carbon intensity of petroleum diesel, sold at a substantially lower price than petroleum diesel in 10 of the last 12 quarters and remaining price competitive in the other two.[14] High ethanol blend E85 was even lower in cost compared to gasoline, selling at a dollar a gallon less than its higher-carbon intensity gasoline counterpart throughout 2021. Electricity as a transportation fuel has an even more dramatic price differential with gasoline than renewable diesel and E85, with a recent study by Consumer Reports finding that fuel costs for battery electric vehicles were 60 percent lower than the average for vehicles in their class.[15]

Analysts at Bates White found no significant relationship between California's Low Carbon Fuel Standard and state gasoline prices. Using data on retail gasoline prices from 2007 to 2021, their analysis found that 71% of the variation in gasoline prices over the past fifteen years can be explained by changes in crude oil prices and another 19% of the variation can be explained by state taxes and the impact of the state cap-and-trade program. This leaves only 10% of the variation to other factors including anti-smog fuel blend regulations, isolation of the California fuels market, concentration of refining within the state, costs and profit margins for refiners, distributors, and retailers, and potential impacts from policies other than cap-and-trade such as the Low Carbon Fuel Standard.

[13] "Low Carbon Fuels Standards Market Impacts and Evidence for Retail Fuel Price Effects," Report, Bates White Economic Consulting, February 2022.
[14] "Clean Cities Alternative Fuel Price Report," Report, Clean Cities, Energy Efficiency & Renewable Energy, U.S. Department of Energy, July 2021.
[15] Harto, Chris, "Electric Vehicle Ownership Costs: Today's Electric Vehicles Offer Big Savings for Consumers," Report, *Consumer Reports*, October 2020.

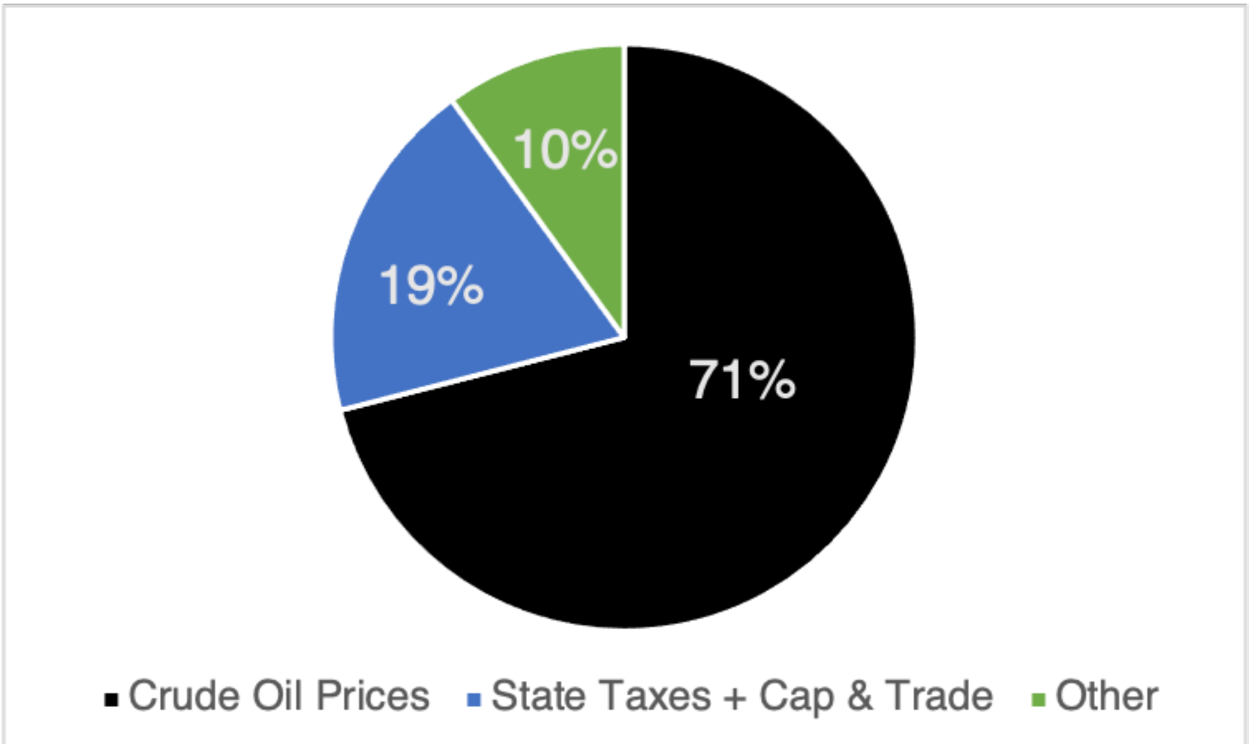

Figure 4: Correlation coefficients for explanatory variables for variation in California state gasoline prices.

Bates White analysts also compared the price of Low Carbon Fuel Standard credits to the price of retail gasoline to assess their relationship. If gas prices went up and down when Low Carbon Fuel Standard credits went up and down, then that could be evidence that gasoline providers were passing the costs of Low Carbon Fuel Standard credits to consumers.

The analysts found no relationship between Low Carbon Fuel Standard credit prices and gasoline prices. The correlation coefficient between the two prices from the beginning of 2013 through the beginning of 2022 was 0.06, which is statistically indistinguishable from zero.

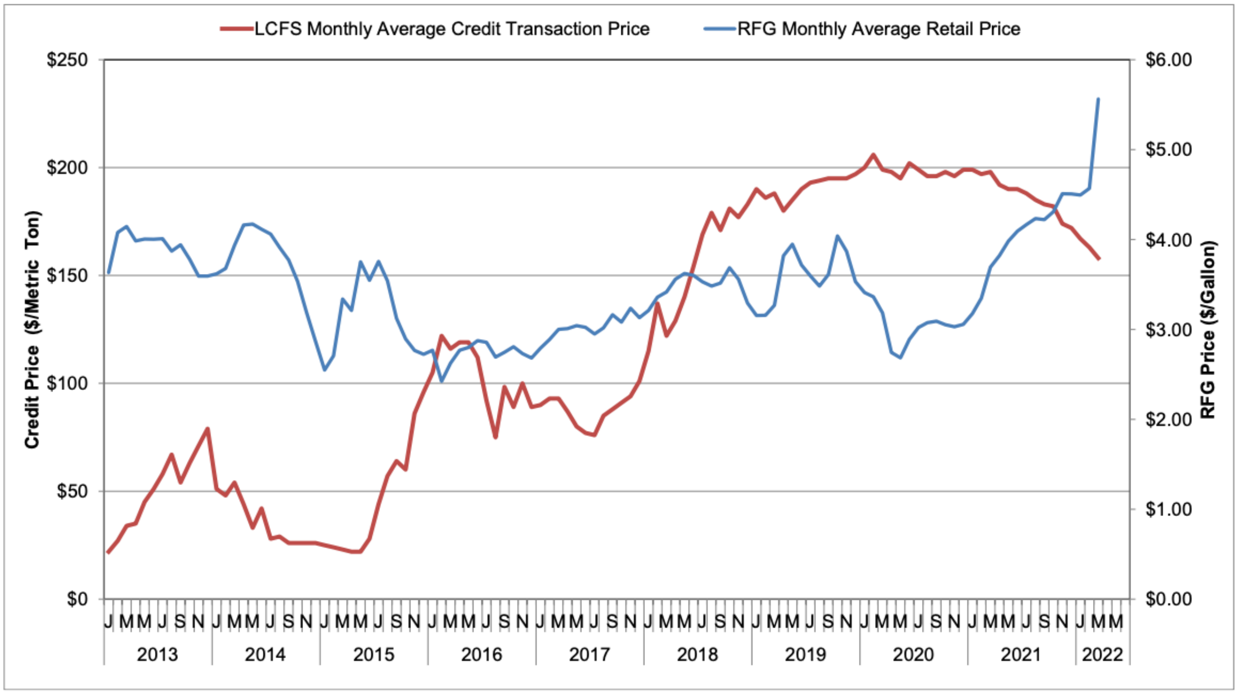

Figure 5: Low Carbon Fuel Standard credit price and retail gasoline price[16]

For comparison, Figure 6 shows retail gasoline prices and West Texas Intermediate crude oil prices as reported by the Energy Information Administration from 2007 to 2022. In California, gasoline prices have had a strong relationship with crude oil prices while they have had no detectable relationship with Low Carbon Fuel Standard credit prices.

[16] "Low Carbon Fuels Standards Market Impacts and Evidence for Retail Fuel Price Effects," Report, Bates White Economic Consulting, April 2022.

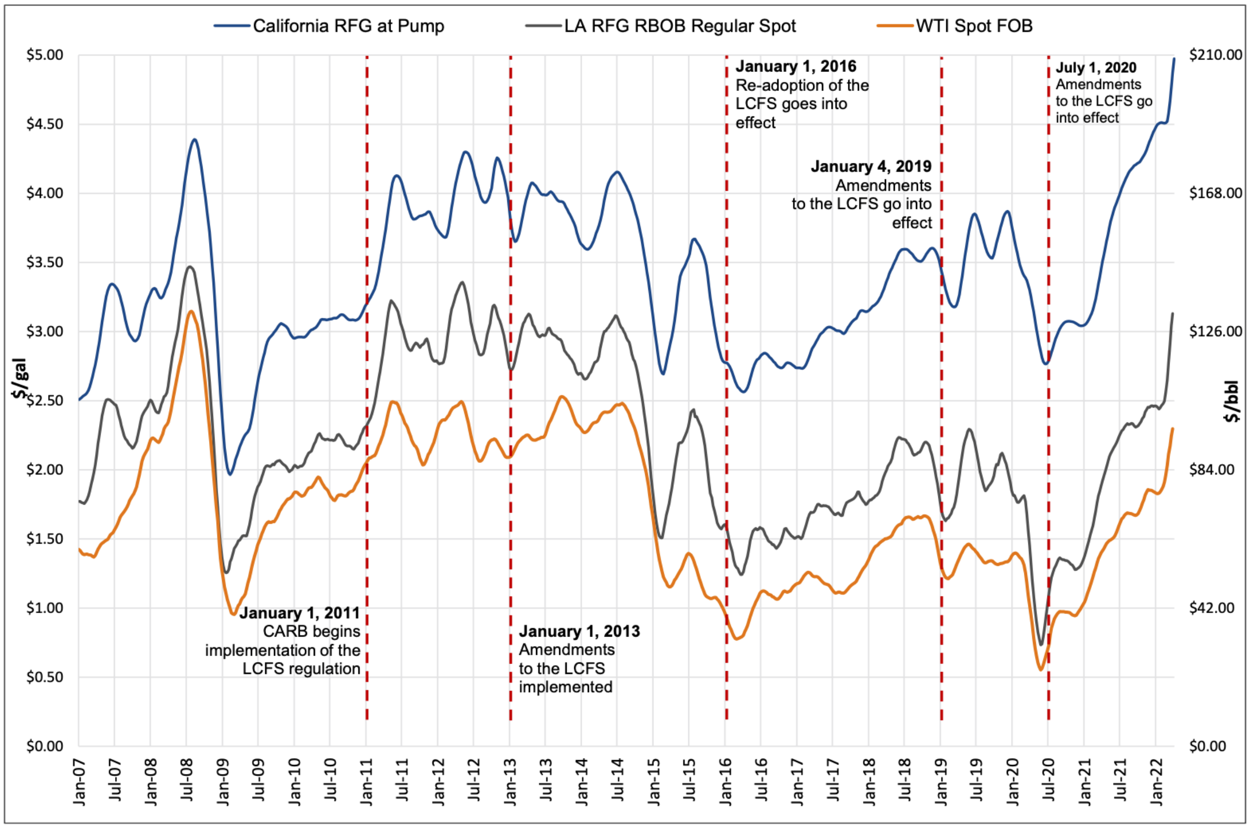

Figure 6: West Texas Intermediate (WTI) crude oil prices and retail reformulated gasoline (RFG) prices[17]

How a clean fuel standard impacts innovation and private sector investment

This section presents the evidence available on how clean fuel standards in the United States and internationally have impacted innovation and private sector investment in production of low carbon intensity fuels.

Increasing diversity of transportation fuel technologies in low-carbon transportation fuel market

One objective of a clean fuel standard is to increase the diversity of options for consumers of transportation fuels. The decade of data from the Low Carbon Fuel Standard provides an example of how this developed in California. In Q1 of 2011, 79% of Low Carbon Fuel Standard credits were generated through ethanol production.[18] By Q2 of 2021, that number had dropped to 22%, with renewable diesel now generating more credits (31%) than

[17] "Low Carbon Fuels Standards Market Impacts and Evidence for Retail Fuel Price Effects," Bates White Economic Consulting.
[18] "Low Carbon Fuels Standards Market Impacts and Evidence for Retail Fuel Price Effects," Bates White.

ethanol. Electricity, biomethane, and biodiesel each also generate a substantial proportion of credits in the state.

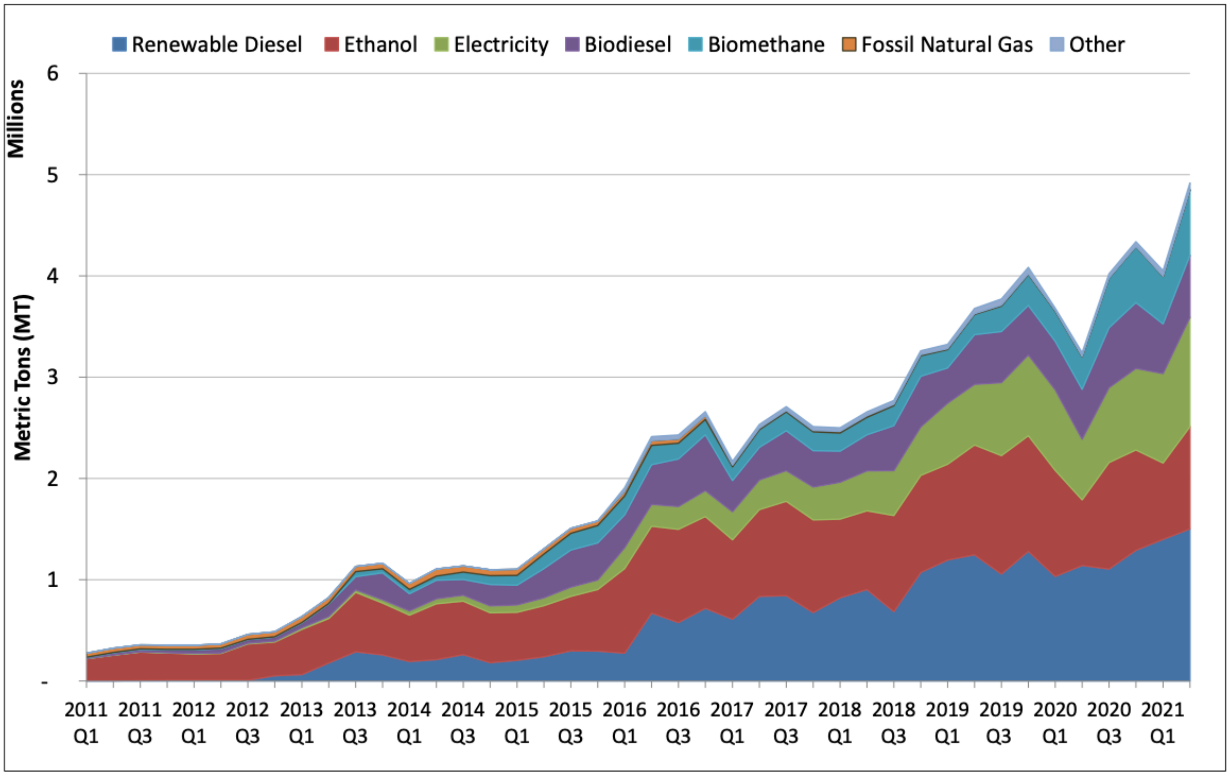

Figure 7: California Low Carbon Fuel Standard credits generated by fuel type[19]

California has seen growth in production of alternative fuels since implementation of its Low Carbon Fuel Standard. The number of gallons of gasoline equivalent of alternative fuels produced in the state more than doubled from 2011 to 2021.[20] This growth was spurred entirely by technologies that each made up no more than 1% of the alternative transportation fuel mix in 2011, with renewable diesel, biodiesel, biomethane, and electricity growing from a combined 2% of alternative transportation fuel produced in 2011 to 63% in 2021. This was driven by large growth in biodiesel and biomethane, which were being produced at 23 and 110 times their 2011 rates in 2021, but even more by renewable diesel and electricity, which were being produced at 520 and 400 times their 2011 levels in 2021. This allowed state alternative fuel production to more than double in the 2010s, even though ethanol production and distribution fell 5% and fossil natural gas production and distribution for transportation fuels fell 94% over the decade.

[19] “Low Carbon Fuels Standards Market Impacts and Evidence for Retail Fuel Price Effects,” Bates White.
[20] “Alternative Fuels Volumes and Credits,” LCFS Data Dashboard, Website, California Air Resources Board, 2022.

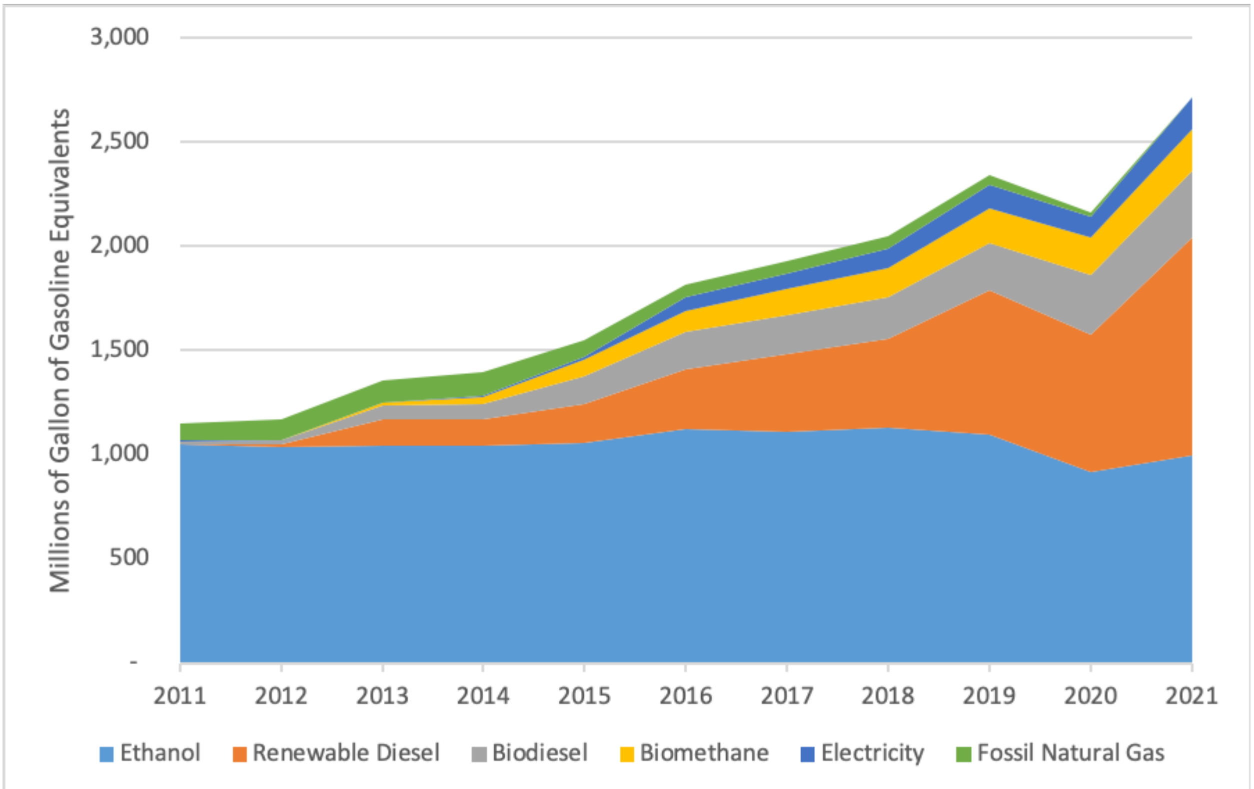

Figure 8: California's low carbon intensity fuel production grew after implementation of Low Carbon Fuel Standard[21]

The first five years of Oregon's Clean Fuel Standard have also been marked by a diversification of production of liquid biofuel. In 2016, 79% of gallons of liquid biofuel was ethanol, with the remaining 21% biodiesel.[22] By 2020, providers were producing 18 million more gallons of biodiesel and another 18 million more gallons of renewable diesel than in 2016. This drove ethanol's proportion of the liquid biofuel market down to 63% and created a market where three different types of liquid biofuels were being produced in quantities of 18 million gallons or more that year.

A clean fuel standard can also provide incentives for providers of low-carbon fuels to further reduce the carbon intensity of fuels produced in the state. In Oregon, average carbon intensity of ethanol and biodiesel fell over the first five years of their Clean Fuels Program.[23]

[21] "Alternative Fuels Volumes and Credits," LCFS Data Dashboard, Website, California Air Resources Board, 2022.
[22] "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.
[23] "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.

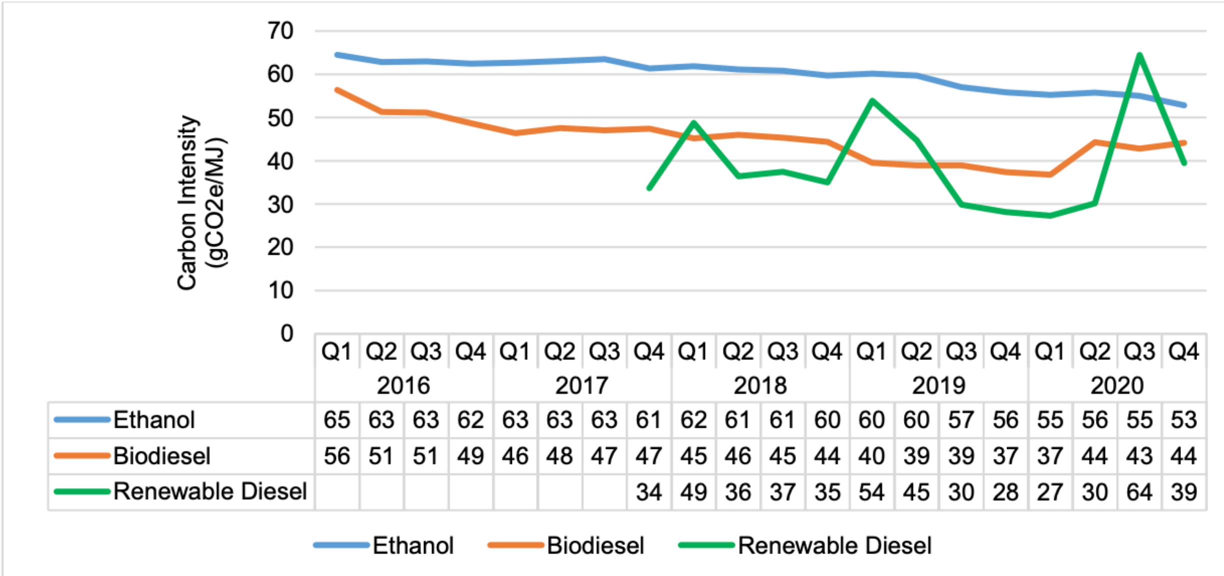

Figure 9: Average carbon intensity of low-carbon transportation fuels in Oregon after implementation of state Clean Fuels Program[24,25]

Analysts from British Columbia's Ministry of Energy, Mines, and Petroleum Resources also expect their provincial Low Carbon Fuel Standard to lead to diversification of the low carbon transportation fuel mix in the province. In a 2019 presentation, Michael Rensing, director of Low Carbon Fuels for British Columbia shared projections that the state's low carbon transportation fuel production mix would change from being a majority ethanol and renewable natural gas in 2017 to mostly fungible fuel and electricity in 2030.[26]

The New York State Climate Action Council's Draft Scoping Plan notes that a clean fuel standard for the state may accelerate expansion of electrification of the state's vehicle fleet.[27] As can be seen in figure 7, electricity has grown from a negligible contributor to decarbonization of California's transportation fuel market a decade ago to a fifth of all Low Carbon Fuel Standard credits generated last year. New York's plentiful supply of low-carbon intensity electricity due to its hydroelectric power resources position the state well to grow its electric vehicle fleet with adoption of a clean fuel standard. It would also send a clear price signal to operators of electric vehicle charging stations to buy low-carbon electricity, helping ensure the growth in adoption of electric vehicle technology is accompanied by a reduction in carbon emissions.

[24] "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.
[25] Tristan Brown, Associate Professor of Sustainable Resources Management at the SUNY College of Environmental Science and Forestry, says renewable diesel may be more volatile in its quarter-to-quarter carbon intensity due to renewable diesel providers temporarily switching to soy or canola oil after the harvest season.
[26] Rensing, Michael, "British Columbia's Low Carbon Fuel Requirements," Presentation, October 4, 2019.
[27] "Transportation Advisory Panel: Recommended Strategies," Appendix A: Advisory Panel Recommendations, New York Climate Action Council, May 3, 2021.

Research firm Cerulogy made projections for how the low-carbon fuel industry would meet a clean fuel standard in New York.[28] These projections start with a low-carbon fuel industry in 2020 mostly dominated by ethanol but with substantial biodiesel and electric vehicle fuel production. By 2030, Cerulogy projects providers will increase electric vehicle fuel production and production of conventional ethanol, renewable diesel, biodiesel, and renewable natural gas.[29]

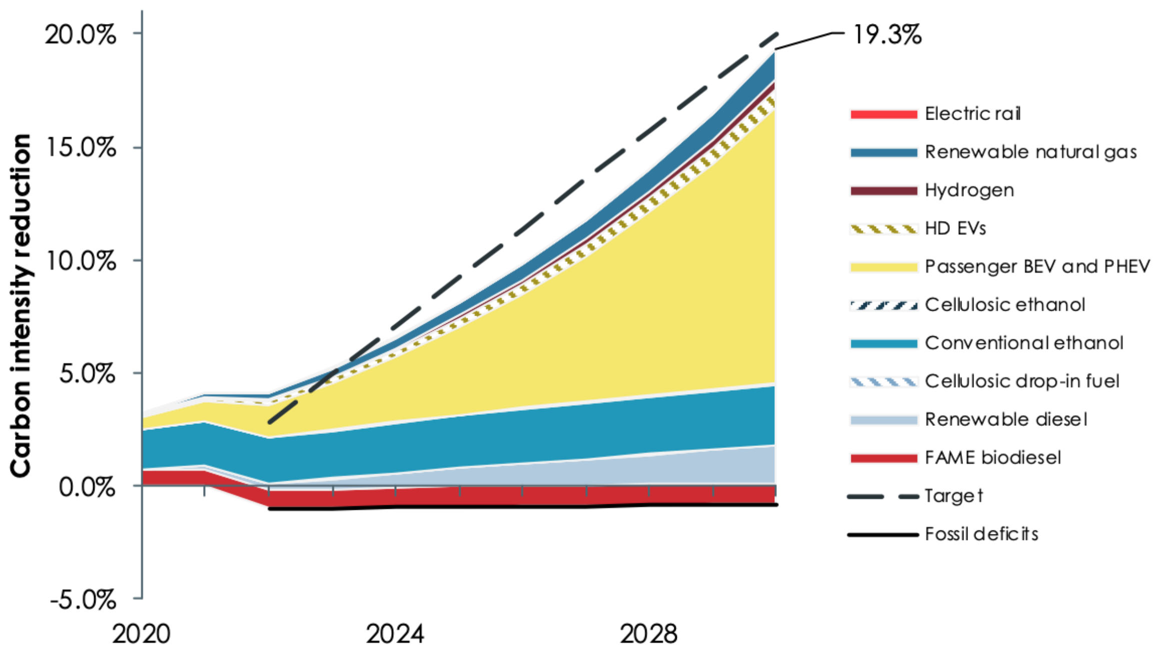

Figure 10: Projection for growth of New York low-carbon transportation fuel industry under state clean fuel standard[30]

An analysis by the International Council on Clean Transportation (ICCT) projected that a national clean fuel standard would spur growth in the electric vehicle market and that the improvement of electric vehicle technology will lead to cheaper electric vehicles relative to the current clean fuel standard.[31] This would allow more room for policymakers to institute an even more ambitious national clean fuel standard target in the future. This has already started to come to fruition as California surpassed a quarter of a million electric vehicle sales that have been awarded clean fuel credits as of last month.[32]

[28] Malins, Chris, "New York's Clean Fuel Future," Report, Cerulogy, March 2020.
[29] Malins, Chris, "New York's Clean Fuel Future," Report, Cerulogy, March 2020.
[30] Malins, Chris, "New York's Clean Fuel Future," Report, Cerulogy, March 2020.
[31] Kelly, Casey, and Nikita Pavlenko. "Assessing the potential for low-carbon fuel standards as a mode of electric vehicle support." Working Paper 2020-29 (2020).
[32] "California Clean Fuel Reward surpasses 250,000 point-of-sale financial incentives for EV buyers," Press Release #22-16, California Air Resources Board, May 9, 2022.

Investment and economic development

One policy objective of a clean fuel standard is to encourage investment and innovation in new industries. The standard does this by awarding providers that produce credits that can be banked until later or sold to firms producing high carbon intensity fuels, a new benefit for firms developing and investing in emerging technologies. This credit market stimulates the development and deployment of these technologies, growing new energy sectors while reducing the carbon intensity of fuels.

Estimates of the impacts of a national clean fuel standard suggest the policy could spur investment in the electric vehicle market. The ICCT analysis estimated that a national clean fuel standard would generate $500 per battery electric vehicle annually from charging.[33] This analysis also says that charging can generate credits cheaper than other low carbon intensity transportation fuels once electric vehicle adoption is widespread, suggesting electrification may grow into a leading low carbon intensity fuel in the future.

Cerulogy's analysis of a proposed clean fuel standard for New York reducing statewide fuel carbon intensity by 20% by 2030 estimated that under a balanced scenario of electric vehicle adoption along with renewable natural gas, ethanol, biodiesel and renewable diesel, $900 million of credits would be sold by electric vehicle deployment and infrastructure.[34] In the three scenarios for transportation fuel industry response to a clean fuel standard put forth in the Cerulogy report, electric vehicle deployment accounts for over half of clean fuel credits generated, with most of those coming from light duty electric vehicles.

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[33] Kelly, Casey, and Nikita Pavlenko. "Assessing the potential for low-carbon fuel standards as a mode of electric vehicle support." Working Paper 2020-29 (2020).
[34] Malins, Chris, "New York's Clean Fuel Future," Report, Cerulogy, March 2020.

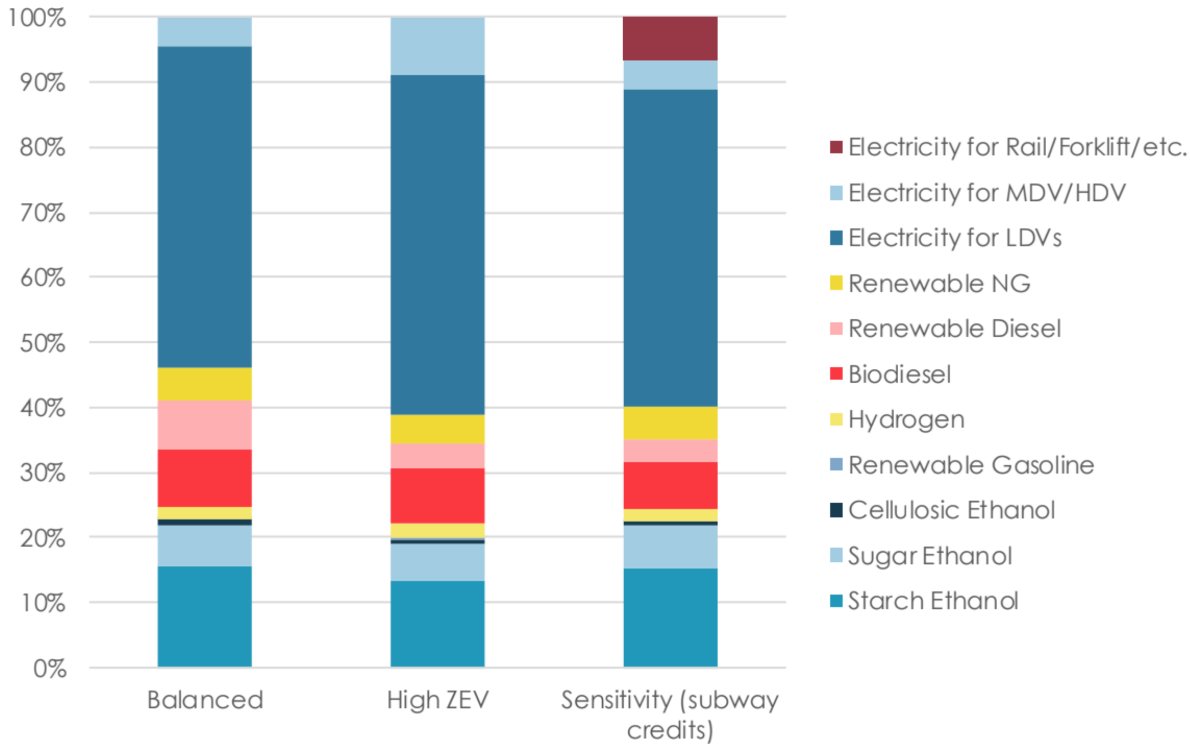

Figure 11: Sources of credit generation for clean fuel standard of 20% carbon intensity reduction by 2030 under different scenarios[35]

Researchers studying proposed clean fuel standards have projected investments in infrastructure and human capital from the standard. The Oregon Department of Environmental Quality contracted with Jack Faucett Associates to study the macroeconomic effects of their state Clean Fuels Program.[36] Analysts at Jack Faucett projected that the Clean Fuels Program would spur investment in infrastructure and jobs in natural gas and electricity. This projection was borne out as the number of electric vehicle charging stations quadrupled in the state from 700 to 2,900 from 2018-2021.

A 2022 study for the New Mexico Environment Department by Adelante Consulting projected that passage of a clean fuel standard in the state would accelerate the development of an array of low-carbon fuel projects that have either been announced or are currently being explored in the state of New Mexico.[37] The report estimates these projects will create 1,641 permanent jobs generating $470 million in wage income and $240 million of direct investment in New Mexico's low-carbon fuel delivery and production infrastructure through 2030.

[35] Malins, Chris, "New York's Clean Fuel Future," Report, Cerulogy, March 2020.
[36] "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.
[37] "New Mexico Clean Fuel Standard Economic Impact Analysis," Report prepared for the New Mexico Environment Department, Adelante Consulting, Inc., January 26, 2022.

New York's personal consumption expenditures on gasoline and other energy goods is over five times the size of New Mexico's.[38] If New York's "quick-start" projects are proportionately larger than the relative amount of New York state spending on gasoline and other energy goods compared to that of New Mexico, then those projects would create nearly 9,200 jobs worth over $2.6 billion and spur over $1.3 billion in investment through 2030.

Energy security

The Russian invasion of Ukraine has drawn attention to the energy security and associated economic ramifications of reliance on petroleum in the U.S. transportation sector. Petroleum-based fuels have an 89% transportation fuels market share in the U.S., a number that rises to above 90% globally.[39,40] The war in Ukraine is the most recent demonstration of how tightly this oil dependence ties U.S. energy security and American geopolitical and economic interests to the decisions of authoritarian governments.

New York has historically been much more reliant on crude oil from authoritarian governments Venezuela than the rest of the country. The EIA's company-level import data for 2019 shows that 20% of the crude and refined products imported by New York-supplying refineries came from those Russia, Saudi Arabia, and Venezuela, with 11% coming from Russia alone.[41] That combined volume equaled 33% of New York's total petroleum demand that year.

The national security price of this dependence is clear in the significant ongoing U.S. military and financial investments in protecting oil routes in regions such as the Middle East. Given the potential for clean fuel standards to diversify the transportation fuel supply, researchers from Oak Ridge National Laboratory and the University of Maine have analyzed the impact of a national clean fuel standard, finding that this policy could produce from $5 to $22 per barrel in energy security benefits by increasing consumption of domestically-produced low carbon intensity transportation fuels and lowering demand for foreign crude oil.[42]

A projection of the impacts of a 10% clean fuel standard by 2026 for the state of Washington prepared for the state's Office of Financial Management estimated that a state clean fuel standard would reduce gasoline consumption by 0-10% compared to a baseline scenario of non-adoption and reduce diesel consumption by 16% compared to that baseline scenario.[43] Using Bureau of Transportation Statistics data on gasoline and diesel consumption in Washington State and EIA estimates for BTU per gallon combined with Oak Ridge National Lab estimates for the energy security dollar value per barrel of oil, this estimate implies an

[38] "SAPCE3 Personal consumption expenditures (PCE) by state by type of product," GDP and Personal Income, Regional Data, Bureau of Economic Analysis, October 8, 2021.
[39] "Use of energy explained: Energy use for transportation," Website, Energy Information Administration, May 17, 2021
[40] "International Energy Outlook 2016," U.S. Energy Information Administration, p. 127.
[41] Brown, Tristan, E-mail communication, June 1, 2022.
[42] Leiby, Paul N., and Jonathan Rubin. "Energy security implications of a national low carbon fuel standard." Energy Policy 56 (2013): 29-40.
[43] Pont, Jennifer et al, "A Clean Fuel Standard in Washington State: Revised Analysis with Updated Assumptions," Final Report LCA 8056.98.2014, December 14, 2014, Available Online: https://ofm.wa.gov/sites/default/files/public/legacy/reports/Carbon_Fuel_Standard_evaluation_2014_final.pdf

energy security benefit of $17 million to $75 million per year.[44,45] If the state of New York had similar results, a 10% carbon intensity standard would generate $24-370 million in energy security benefits. If benefits increase linearly, a 20% carbon intensity standard would eventually lead to $48-740 million in energy security benefits per year.

National security vulnerability also creates direct economic effects which are not mitigated by the relative volumes of U.S. domestic oil production. While the United States has reduced oil imports over the past fifteen years, retail gasoline prices have not responded. The correlation coefficient between weekly gasoline prices and oil imports over the past three decades as reported by the Energy Information Administration in the United States is .12, suggesting no relationship between changes in volumes of oil imports and variation in gasoline prices in the United States over the past three decades.[46,47]

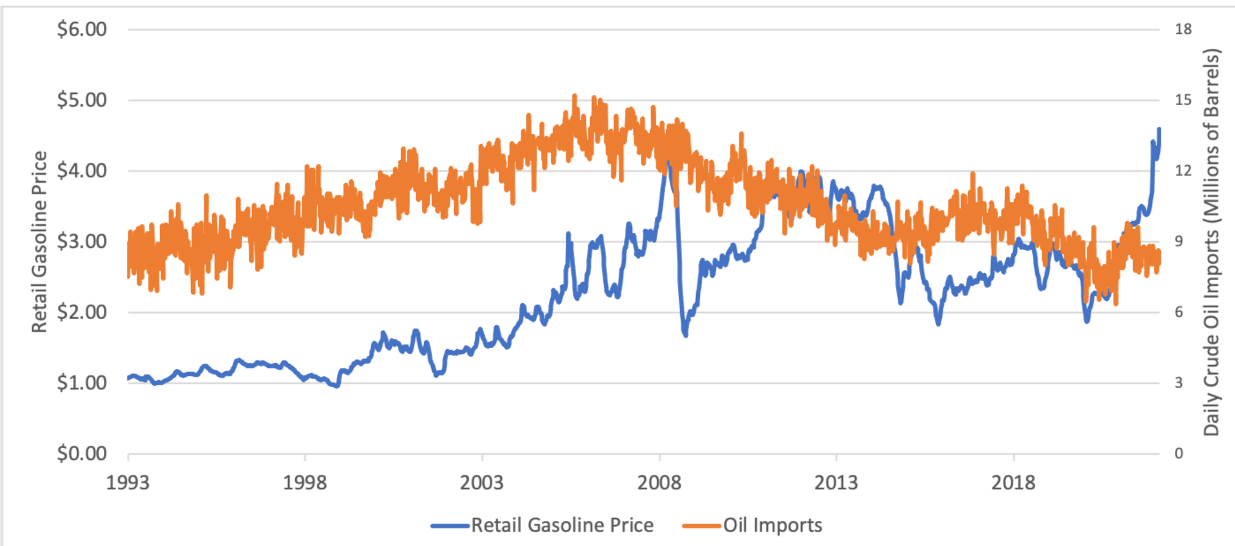

Figure 12: U.S. gas prices and oil imports from 1993 to present[48,49]

Instead, retail gasoline prices are associated much more strongly with petroleum prices. Like relative import volumes, U.S. production has little impact on world petroleum prices. The domestic price of petroleum tracks closely with the world price, as shown in Figure 13. These

[44] "State Transportation Sector Energy Consumption," Bureau of Transportation Statistics, United States Department of Transportation, Available Online: https://www.bts.gov/browse-statistical-products-and-data/state-transportation-statistics/state-transportation-sector
[45] "Units and calculators explained: British thermal units (Btu)," U.S. Energy Information Administration, May 13, 2021, Available Online: https://www.eia.gov/energyexplained/units-and-calculators/british-thermal-units.php
[46] "Weekly U.S. All Grades All Formulations Retail Gasoline Prices," Petroleum & Other Liquids, Website, U.S. Energy Information Administration, May 16, 2022.
[47] "Weekly U.S. Imports of Crude Oil and Petroleum Products," Petroleum & Other Liquids, Website, U.S. Energy Information Administration, May 18, 2022.
[48] "Weekly U.S. All Grades All Formulations Retail Gasoline Prices," Petroleum & Other Liquids, Website, U.S. Energy Information Administration, May 16, 2022.
[49] "Weekly U.S. Imports of Crude Oil and Petroleum Products," Petroleum & Other Liquids, Website, U.S. Energy Information Administration, May 18, 2022.

two correlations allow the actions of dictators and undemocratic governments to directly affect fuel prices, which ripple through the U.S. economy.

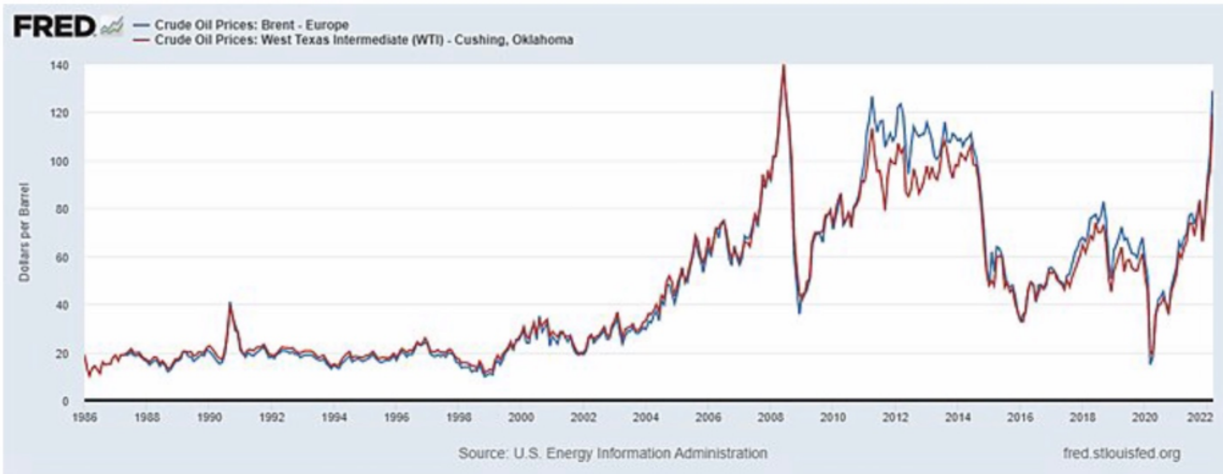

Figure 13: Brent (world) price and West Texas Intermediate (U.S.) price from 1986 to present[50]

Ultimately, long-term energy security will require reducing the dependence of our transportation system on petroleum. Clean fuel standards have diversified fuel options in California and Oregon as shown above in this analysis. Further diversifying the fuel market can create a more secure energy economy. It will also help establish a transportation system where gasoline prices are not a central concern because availability of alternatives will buffer consumers from dramatic fuel price swings and stave off the macroeconomic and externality effects we are experiencing today due to overreliance on petroleum-based transportation fuels.

Electrification is one tool for reducing petroleum reliance. Electricity is generated from a wide variety of U.S. energy sources including natural gas, coal, rivers, solar, wind, nuclear, geothermal reservoirs and more. Electricity prices are insulated from swings in petroleum prices that affect the transportation sector and battery electric vehicles are powered by domestic energy outside of foreign control.

However, the vast majority of vehicles on the road today are powered by liquid fuels and they will likely be so for the next two decades.[51] The U.S. has energy resources that can be deployed to produce liquid or gaseous fuels to decrease dependence on oil and increase national security in these vehicles and in hard-to-electrify transportation subsectors such as aviation.

For on-road vehicles, reducing reliance on gasoline and diesel can provide more price stability for consumers in the transition to more diverse transportation fuels, buffering Americans from the economic effects of world events. One place we can see this is in the difference in price stability between high ethanol blend (E85) and regular gasoline over the past

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[50] "Crude Oil Prices: Brent," FRED Economic Data, St. Louis Federal Reserve Bank.

[51] Dwyer, Michael, "EIA projects global conventional vehicle fleet will peak in 2038," *Today in Energy,* U.S. Energy Information Administration, October 26, 2021.

five years. Over this time period, E85 prices fluctuated within a range half as large as gasoline prices.

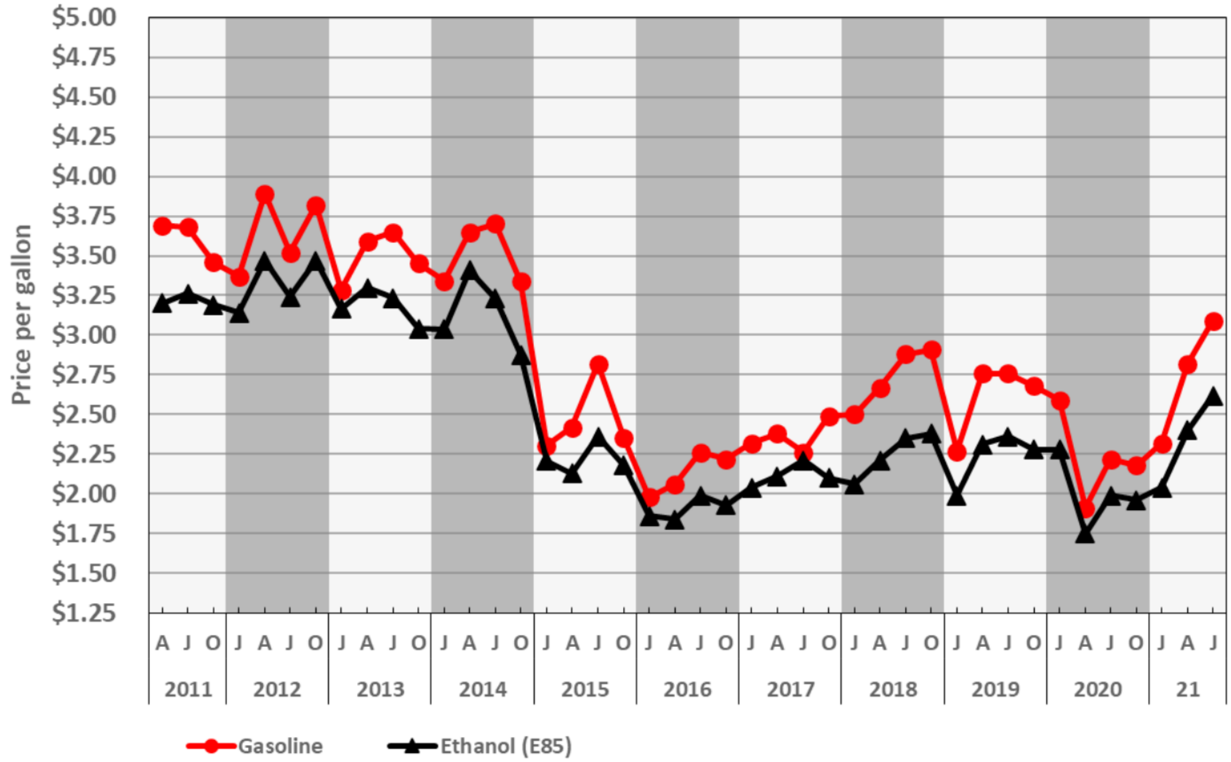

Figure 14: Historical E85 ethanol and gasoline prices[52]

This effect is even clearer in California due to its Low Carbon Fuel Standard. The diversified fuels market insulated drivers of flex-fuel vehicles from the spike in fuel prices after Russia's invasion of Ukraine. From February 2022 to March 2022, California gasoline (E10) prices jumped from $4.90 to $5.78.[53] Over that same time period, E85 prices stayed flat, and they have only increased slightly in the months afterward while the widened price gap has remained.

[52] "Clean Cities Alternative Fuel Price Report," Report, Clean Cities, Energy Efficiency & Renewable Energy, U.S. Department of Energy, July 2021.
[53] "E85 Prices," Website, E85prices.com

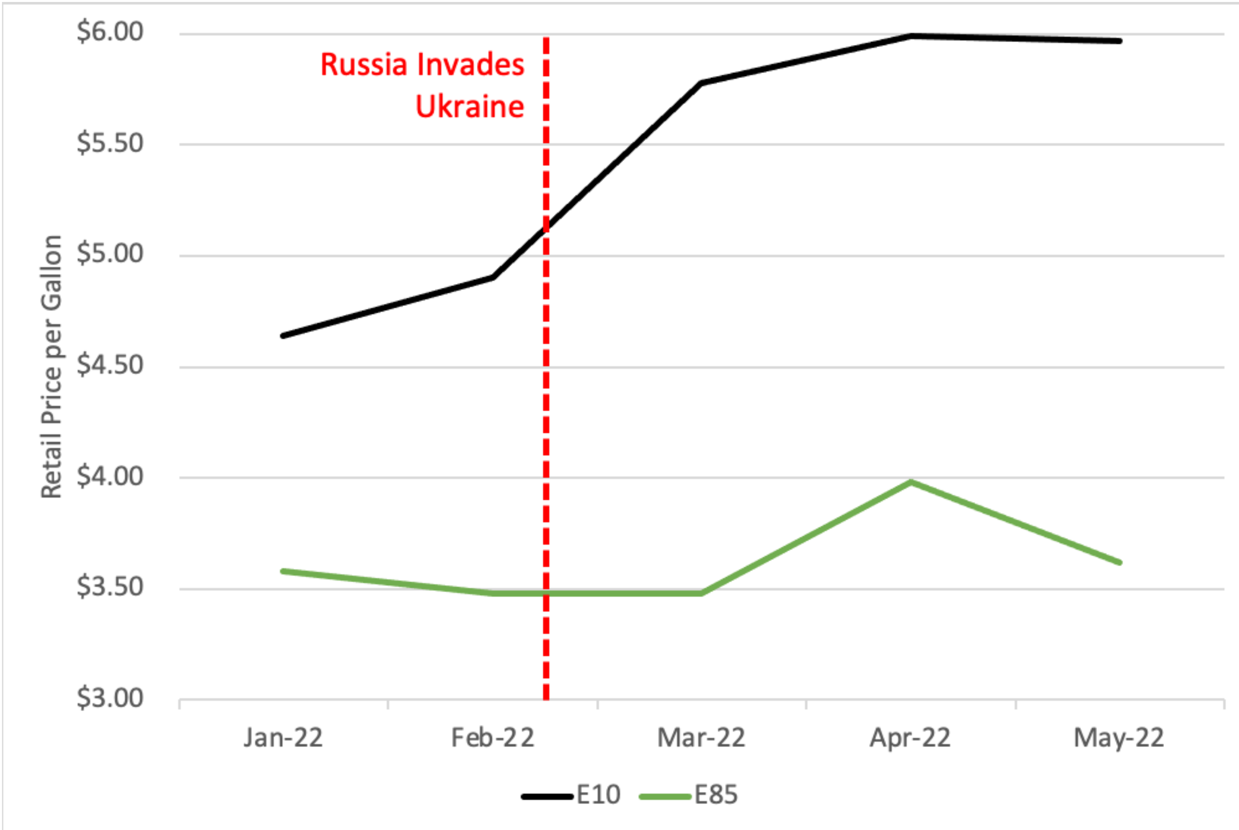

Figure 15: Stability of E10 and E85 prices in 2022 in the state of California[54]

Consumers of E85 would have paid $1.16 more per gallon from March to April of this year if E85 prices had risen the same dollar amount of E10 from January through that period. The California Air Resources Board estimates consumers bought over 62 million gallons of E85 in 2021.[55] If consumers bought E85 at the same rate in 2022 as they did in 2021 (a conservative assumption considering E85 consumption has grown exponentially for the past 15 years), these E85 purchases would constitute total savings for fuel consumers of over $18 million compared to gasoline prices over those three months.

Environmental and public health impacts of a clean fuel standard

How a clean fuel standard impacts greenhouse gas emissions

A central goal of a clean fuel standard is to reduce greenhouse gas emissions in the transportation sector. When transportation fuels are burned, they release carbon into the

[54] "E85 Prices," Website, E85prices.com
[55] "Annual E85 Volumes," Chart, California Air Resources Board, March 24, 2022.

atmosphere, which traps heat on earth and causes average climate temperatures to rise.[56] Rising temperatures then impact agriculture, energy use, health, economic development, biodiversity, and even violent conflict.[57]

To value the climate change impact of public policies, economists have developed a valuation for carbon emissions called the “social cost of carbon.” The social cost of carbon is a dollar estimate of the economic cost of total damages from emitting one ton of carbon dioxide into the atmosphere.[58] Table 2 shows a sampling of social cost of carbon valuations from government and academic sources.

Source	Valuation
Trump Administration[59]	$1/metric ton
Biden Administration[60]	$51/metric ton
Wang et al[61]	$54/metric ton
NY Department of Evironmental Conservation[62]	$125/metric ton
Intergovernmental Panel on Climate Change[63]	$135/metric ton
Kikstra et al[64]	$307/metric ton

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56 Hayhoe, K., D.J. Wuebbles, D.R. Easterling, D.W. Fahey, S. Doherty, J. Kossin, W. Sweet, R. Vose & M. Wehner. (2018). Our changing climate. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock & B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, p. 76. doi: 10.7930/NCA4.2018

57 Tol, Richard S J. 2009. "The Economic Effects of Climate Change." Journal of Economic Perspectives, 23 (2): 29-51.

58 Rennert, Kevin, Brian C. Prest, William A. Pizer, Richard G. Newell, David Anthoff, Cora Kingdon, Lisa Rennels, Roger Cook, Adrian E. Raftery, Hana Ševčíková, and Frank Errickson. 2021. “The Social Cost of Carbon: Advances in Long-term Probabilistic Projections of Population, GDP, Emissions, and Discount Rates.” Brookings Papers on Economic Activity, Fall. Forthcoming.

59 “Regulatory Impact Analysis for the Proposed Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units; Revisions to Emission Guideline Implementing Regulations; Revisions to New Source Review Program,” Regulatory Impact Analysis, United States Environmental Protection Agency, August 2018.

60 Clark, Lesley, and Niina H. Farah, “Federal agencies can use social cost of carbon — for now,” Article, CLIMATEWIRE, E&E News, May 27, 2022.

61 Wang, P.; Deng, X.; Zhou, H.; Yu, S. (2019). "Estimates of the social cost of carbon: A review based on meta-analysis". Journal of Cleaner Production. Journal of Cleaner Production 209 (2019) 1494-1507. 209: 1494–1507. doi:10.1016/j.jclepro.2018.11.058. S2CID 158145495.

62 “DEC Announces Finalization of 'Value of Carbon' Guidance to Help Measure Impacts of Greenhouse Gas Emissions,” Press Release, New York Department of Environmental Conservation, December 30, 2020.

63 de Coninck, H.; Revi, A.; Babiker, M.; Bertoldi, P.; et al. (2018). "Chapter 4: Strengthening and Implementing the Global Response" (PDF). Global Warming of 1.5 °C. pp. 313–443.

64 Kikstra, Jarmo S., Paul Waidelich, James Rising, Dmitry Yumashev, Chris Hope, and Chris M. Brierley. "The social cost of carbon dioxide under climate-economy feedbacks and temperature variability." Environmental Research Letters 16, no. 9 (2021): 094037.

Ricke et al[65]	$417/metric ton

Table 2: Social Cost of Carbon Estimates

Researchers have found California's Low Carbon Fuel Standard has been successful at reducing emissions in the transportation sector. Economists from Texas A&M University have used quasi-experimental evaluation methods to estimate that the Low Carbon Fuel Standard reduced annual carbon dioxide emissions in California's transportation sector by 10% in the early years of the program.[66] Their study used three different techniques to estimate the impact of the standard on carbon emissions from transportation fuels and found results around that same point estimate of 10%.

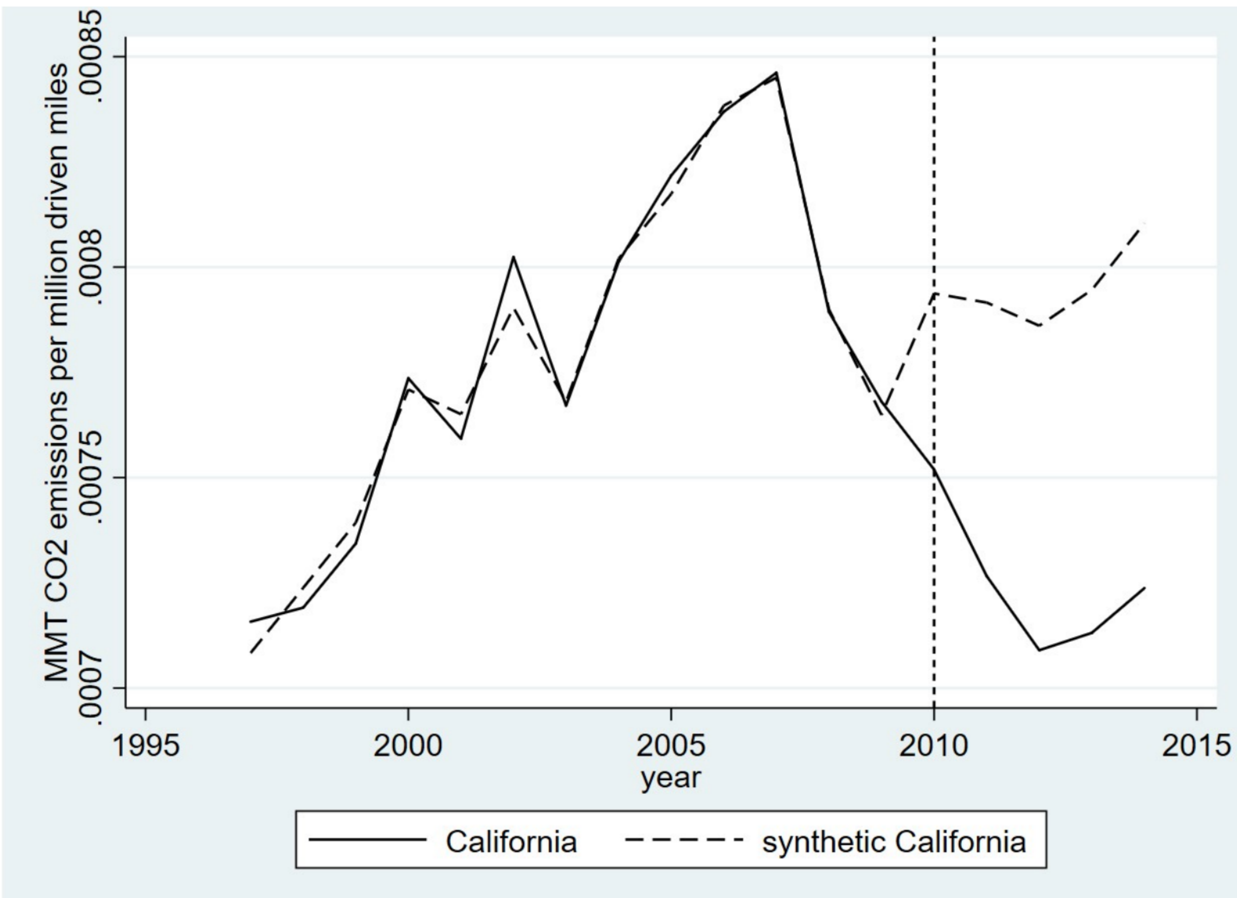

Figure 16: Comparison of carbon emissions in California to synthetic control constructed of similar states to California before and after adoption of their Low Carbon Fuel Standard[67]

[65] Ricke, Katharine, Laurent Drouet, Ken Caldeira, and Massimo Tavoni. "Country-level social cost of carbon." Nature Climate Change 8, no. 10 (2018): 895-900.
[66] Huseynov, Samir, and Marco A. Palma. "Does California's Low Carbon Fuel Standards reduce carbon dioxide emissions?." *PloS one* 13, no. 9 (2018): e0203167.
[67] Samir and Palma, "Does California's Low Carbon Fuel Standards reduce carbon dioxide emissions?"

According to the United States Energy Information Administration, New York's transportation sector was responsible for emitting 79.8 million metric tons of carbon dioxide in 2019, accounting for 47% of total carbon dioxide emissions.[68] If a New York clean fuel standard had the same impact these researchers found California's Low Carbon Fuel Standard did and assuming benefits grow linearly with increased stringency of the standard, the state clean fuel standard could abate 16 million tons of carbon dioxide emissions per year when fully implemented. This would be larger in magnitude than the impact of the state of Vermont completely eliminating carbon emissions from its state economy.

The monetized value of social benefits generated by reducing carbon emissions can be estimated using social cost of carbon estimates from researchers and federal regulatory agencies. Using an estimate of the social cost of carbon at $307 per ton and assuming benefits scale linearly with the strength of the standard, a clean fuel standard requiring 20% reduction in carbon intensity in New York fuels could generate $4.9 billion in social benefits annually on carbon emission reduction grounds alone, with a 90% range of $1.3-13 billion in benefits generated.[69] Even the more conservative $51 per ton put forth by the Biden Administration would put this 16 million-ton reduction at an annual value of $810 million.

The 2022 program review for the Oregon Clean Fuels Program estimates the Oregon program abated over 5.3 million metric tons of carbon dioxide from 2016 to 2020.[70] The evaluation also suggests a slight improvement in greenhouse gas reductions from 2018 to 2020 compared to the reduction in greenhouse gas emissions from 2016 to 2018, potentially driven by improvements in transportation fuel technology over the time period. By 2020, when Oregon had achieved a 5% carbon intensity reduction, the state was abating 1.3 million metric tons, good for $67 million in social benefits using the Biden administration's $51 social cost of carbon.

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[68] "2019 State energy-related carbon dioxide emissions by sector," Energy-Related CO2 Emission Data Tables, U.S. Energy Information Administration, April 13, 2022.

[69] Kikstra, Jarmo S., Paul Waidelich, James Rising, Dmitry Yumashev, Chris Hope, and Chris M. Brierley. "The social cost of carbon dioxide under climate-economy feedbacks and temperature variability." Environmental Research Letters 16, no. 9 (2021): 094037.

[70] "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.

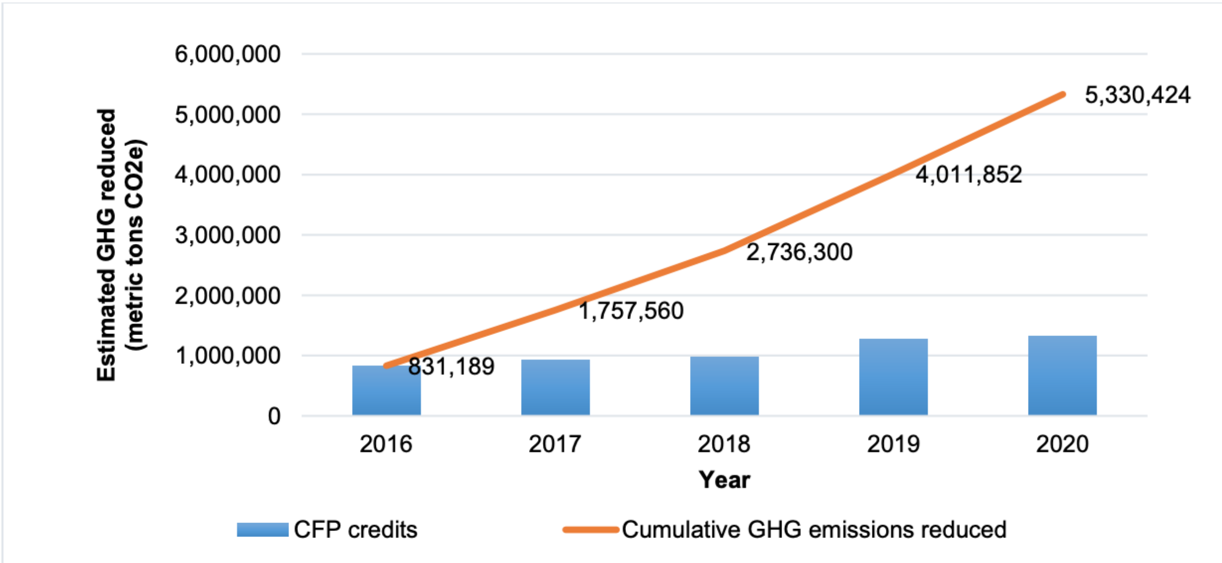

Figure 17: Estimated greenhouse gas reductions for Oregon Clean Fuels Program[71]

Applying the same magnitude of reductions adjusted for the current transportation-related carbon emissions in New York, and assuming a clean fuel standard with a 20% target is four times as effective as a 5% standard, the fully implemented clean fuel standard as proposed in New York Senate Bill S2962B would reduce carbon emissions by 20 million metric tons per year and generate $1 billion in social benefits. This estimate is derived using the more conservative $51 social cost of carbon put forth by the Biden administration. If we use a higher social cost of carbon of $82-831 put forth by Kikstra et al, the total value rises to $1.6-16 billion.[72]

Cerulogy estimates carbon emissions would decrease under a New York clean fuel standard resulting in climate benefits of $1.2-1.3 billion from 2020 to 2023, coming out to an annualized value of $120 million to $130 million–one-seventh that of the relative benefits derived from the California example using a conservative $51 per ton social cost of carbon.[73] Cerulogy estimates lower carbon emission reductions for New York than California had, with Cerulogy's implied annualized reductions in carbon emissions from a clean fuel standard only amounting to 1.4-1.5% of 2019 emissions compared to the 10% reduction California experienced according to Huseynov and Palma.[74]

Estimate	Low	High

[71] "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.

[72] Kikstra, Jarmo S., Paul Waidelich, James Rising, Dmitry Yumashev, Chris Hope, and Chris M. Brierley. "The social cost of carbon dioxide under climate-economy feedbacks and temperature variability." Environmental Research Letters 16, no. 9 (2021): 094037.

[73] Malins, Chris, "New York's Clean Fuel Future," Report, Cerulogy, March 2020.

[74] Huseynov, Samir, and Marco A. Palma. "Does California's Low Carbon Fuel Standards reduce carbon dioxide emissions?." *PloS one* 13, no. 9 (2018): e0203167.

Cerulogy	$120 million	$130 million
Oregon Analogue	$1 billion	$16 billion
California Analogue	$810 million	$13 billion

Table 3: Projected annual economic benefits of carbon emission reductions from a New York 20% carbon intensity reduction clean fuel standard

How a clean fuel standard impacts local air pollution

While carbon abatement is the primary policy objective of a clean fuel standard, clean fuel standards also have the indirect benefit of reducing local air pollutants. These include pollutants released by the burning of gasoline and diesel such as nitric oxide (NO) and nitrogen dioxide (NO_2), together referred to as NO_X as well as fine particulate matter, which is referred to as PM 2.5.

Short-term exposure to NO_X pollution can irritate respiratory disease like asthma and can lead to difficulty breathing and admission to hospital and emergency rooms.[75] Long-term exposure to NO_X can lead to development of asthma and greater susceptibility to respiratory diseases. Short-term exposure to PM 2.5 can lead to irritation of eyes, nose, throat, and lungs and difficulty breathing.[76] Long-term exposure to PM 2.5 can lead to hospital and emergency room admissions, development of disease such as bronchitis, and death.

Depending on the speed of deployment of zero-emission vehicles, Cerulogy projects a 20% carbon intensity reduction clean fuel standard for the state of New York by 2030 would lead to a cumulative reduction of 1,300 to 3,700 metric tons of NO_X and 600 to 800 metric tons of PM 2.5 through 2030.[77] This would lead to aggregate health benefits that would run from $450-510 million in social value. This would come from a 0.5-1% decrease in NO_X emissions from older vehicles and a 3.5-6% decrease in PM 2.5 emissions from all vehicles. Figure 18 shows these projections over the first decade after adoption of a clean fuel standard for New York assuming a "balanced" uptake scenario of low carbon intensity fuel technologies.

75 "Basic Information about NO2," Nitrogen Dioxide (NO2) Pollution, Online, United States Environmental Protection Agency, June 7, 2021.
76 "Fine Particles (PM 2.5) Questions and Answers," Air Quality, Online, New York State Department of Health, February 2018.
77 Malins, Chris, "New York's Clean Fuel Future," Report, Cerulogy, March 2020.

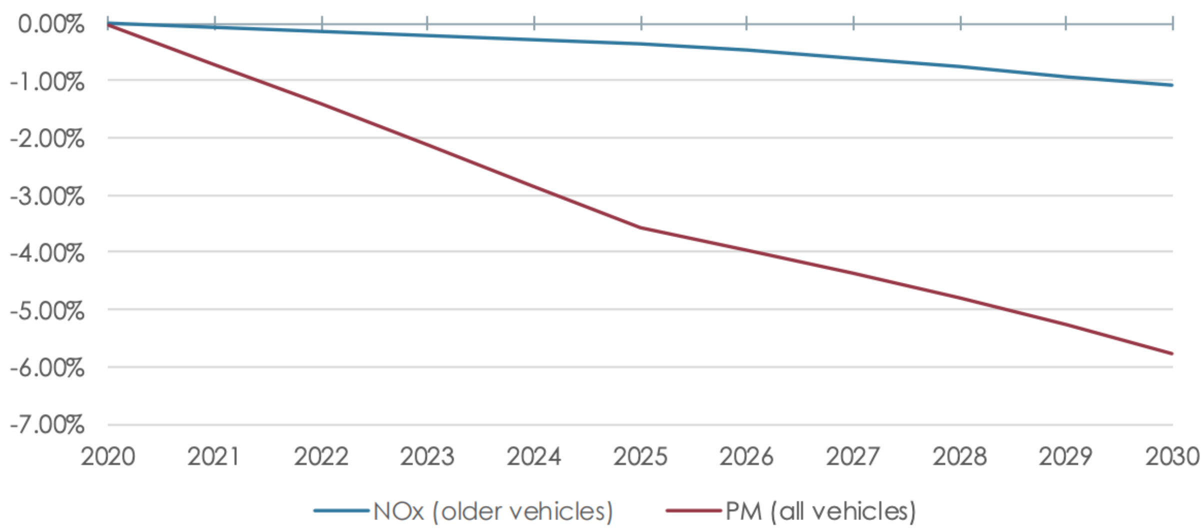

Figure 18: Projected percentage reduction in local emissions from a clean fuel standard[78]

Oregon's Department of Environmental Quality has funded analysis to project the local emissions impact of their state Clean Fuels Program. The Oregon Department of Environmental Quality contracted with the University of California, Davis' Policy Institute for Energy, Environment, and the Economy and Department of Civil and Environmental Engineering to examine how traditional tailpipe air pollutants such as particulate matter, nitrogen oxides, sulfur dioxide, and ozone are reduced along with reductions in lifecycle greenhouse gases from the use of cleaner fuels.

Researchers who conducted the study estimated that achieving Oregon's target of 25% reduction in carbon emissions by 2035 would produce a co-benefit of 12 fewer deaths from reduced particulate matter emissions annually.[79] Using the United States Environmental Protection Agency's recommended value of a statistical life of $7.6 million in 2006 dollars ($10.6 million in 2022 dollars), we can estimate that the risk of death from particulate matter reduction benefit of the Oregon clean fuels program by 2035 will be about $130 million in 2022 dollars.[80,81]

Using these estimates, we can derive a second estimate for what the co-benefit impacts of a clean fuel standard would be for New York. Assuming New York's reductions in NO_X and PM 2.5 reductions would scale proportionally with the size of New York's gasoline consumption compared to Oregon's and that a 20% carbon intensity decrease would be 80% as effective at abating NO_X and PM 2.5 as a 25% carbon intensity decrease, a 25% clean fuel

78 Malins, Chris, "New York's Clean Fuel Future," Report, Cerulogy, March 2020.
79 "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.
80 "Mortality Risk Valuation," Environmental Economics, Website, United States Environmental Protection Agency, March 30, 2022.
81 "CPI Inflation Calculator," Charts and Applications, Data Tools, Website, U.S. Bureau of Labor Statistics.

standard would save 33 lives in New York annually from reduction in particulate matter released at a risk of death reduction value of $350 million per year.[82]

The California Air Resources Board has assessed impacts on local emissions from California's Low Carbon Fuel Standard as well. In 2018, the state of California considered an amendment to its Low Carbon Fuel Standard regulation and the Air Resources Board submitted a detailed evaluation of the policy's local air pollution and public health impacts.[83] In this report, the California Air Resources Board estimated that the Low Carbon Fuel Standard would reduce NO_X emissions by about 1,400 tons a year from 2023 to 2025. As can be seen in figure 19, the Board also estimated the reductions in NO_X and PM 2.5 emissions prevent 4-8 hospitalizations for cardiovascular and respiratory illness, 10-30 emergency room visits for asthma and 20-75 deaths per year depending on the year, with all impacts increasing from 2012 to 2022 then leveling off.

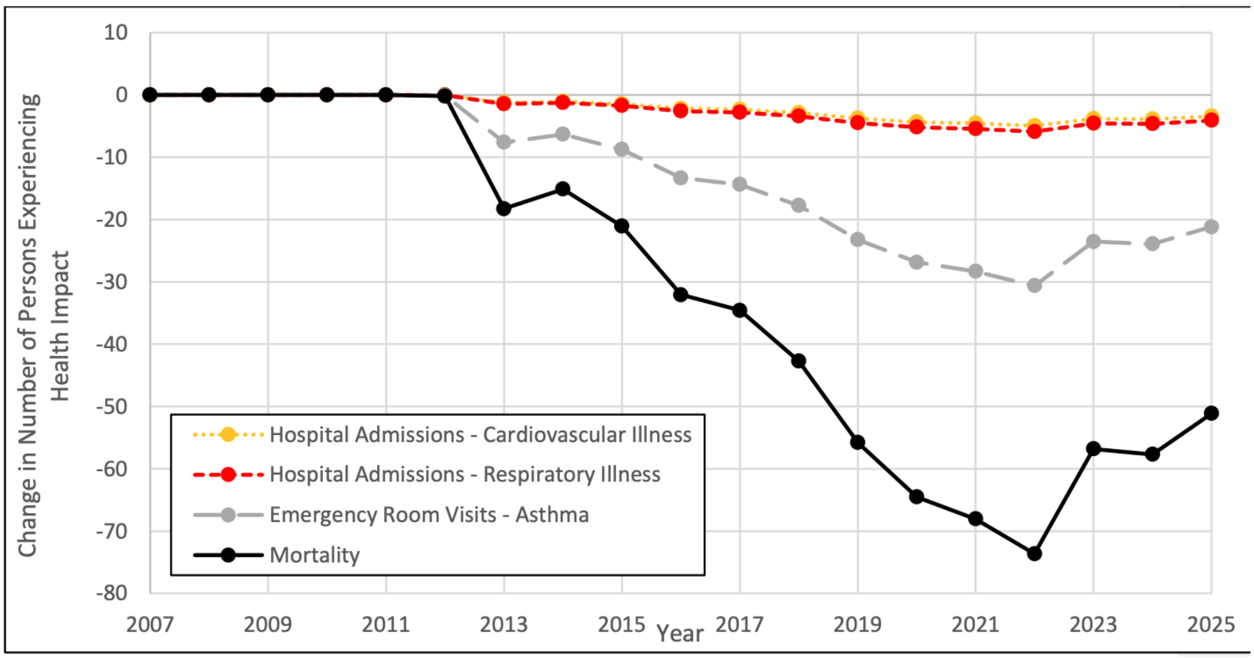

Figure 19: Health impacts associated with California Low Carbon Fuel Standard biomass-based NO_X and PM reductions[84]

Using Washington State Institute of Public Policy valuations of hospitalization and emergency room visits adjusted to 2022 real dollar values along with EPA value of a statistical life estimates, we estimate these reductions in emergency room visits, hospitalizations and deaths are worth $61,000 to $180,000 in avoided emergency room costs per year, $120,000 to

[82] "Table F3: Motor gasoline consumption, price, and expenditure estimates, 2020," U.S. States: State Profiles and Energy Estimates, Website, U.S. Energy Information Administration, 2022.
[83] "Final Supplemental Disclosure Discussion of Oxides of Nitrogen Potentially Caused by the Low Carbon Fuel Standard Regulation," Report, California Air Resources Board, September 17, 2018.
[84] "Final Supplemental Disclosure Discussion of Oxides of Nitrogen Potentially Caused by the Low Carbon Fuel Standard Regulation," Report, California Air Resources Board, September 17, 2018.

$230,000 in avoided hospitalization costs per year, and $210 million to $800 million in risk of death reduction benefits per year in California.[85,86]

These projections for California allow us to develop a third estimate of the co-benefit impacts of a clean fuel standard for New York. Assuming New York's reductions in NO_X and PM 2.5 reductions would scale proportionally with the size of New York's gasoline consumption compared to California and be equally effective, a clean fuel standard for New York would save 16-58 lives in New York annually from reduction in NO_X and particulate matter emissions and would result in between $170 million and $620 million in risk of death reduction and avoided hospitalization and emergency room visit benefits.

Table 4 shows estimates for the annual economic benefits of NO_X and PM 2.5 emission reduction from Cerulogy. It also shows estimates for economic benefits of emission reductions if New York's clean fuel standard has similar results to Oregon's Clean Fuel Program or California's Low Carbon Fuel Standard adjusted for the size of New York's gasoline fuel sales in 2020. Overall, conservative estimates by Cerulogy put the annual economic benefits of NO_X and PM 2.5 emission reduction in the $41-46 million range while reductions that mirror the Oregon analysis would put the benefits in the $350 million range.

Estimate	Low	High
Cerulogy	$41 million	$46 million
Oregon Analogue	$350 million	$350 million
California Analogue	$170 million	$620 million

Table 4: Projected annual economic benefits of NO_X and PM 2.5 reductions from a New York clean fuel standard

How a clean fuel standard interacts with other policies

Carbon pricing

Cap-and-trade and carbon taxation are two favorite policies of economists interested in reducing carbon emissions. Both of these policies work by bringing the private cost of carbon emissions in line with their social cost. A cap-and-trade system fixes the quantity of carbon emitted in a jurisdiction then either auctions emissions allowances directly or allows companies to trade with one another to create a market price for carbon. A carbon tax sets a fixed price

[85] "Benefit-Cost Technical Documentation," Technical Documentation, Washington State Institute for Public Policy, December 2019.
[86] "CPI Inflation Calculator," Charts and Applications, Data Tools, Website, U.S. Bureau of Labor Statistics.

per metric ton of carbon to bring the private cost of emitting carbon in line with the social cost, increasing the cost of emitting carbon and decreasing the quantity of carbon emitted.

Carbon taxes are rare in the United States but have been implemented in a number of other countries, covering 5.6% of global greenhouse gas emissions in 2021.[87] Substantial international carbon taxes have been levied in Japan since 2012, South Africa since 2019, and Ukraine since 2011.

Emissions trading systems like cap-and-trade, which cover 16% of global greenhouse gas emissions, are more common than carbon taxes in the U.S. and abroad. In the United States, state governments have taken the lead on adopting cap-and-trade programs. California's cap-and-trade program is large enough to count itself as the fifth-largest emissions trading system in the world and the multi-state Northeast Regional Greenhouse Gas Initiative is the eighth largest worldwide.

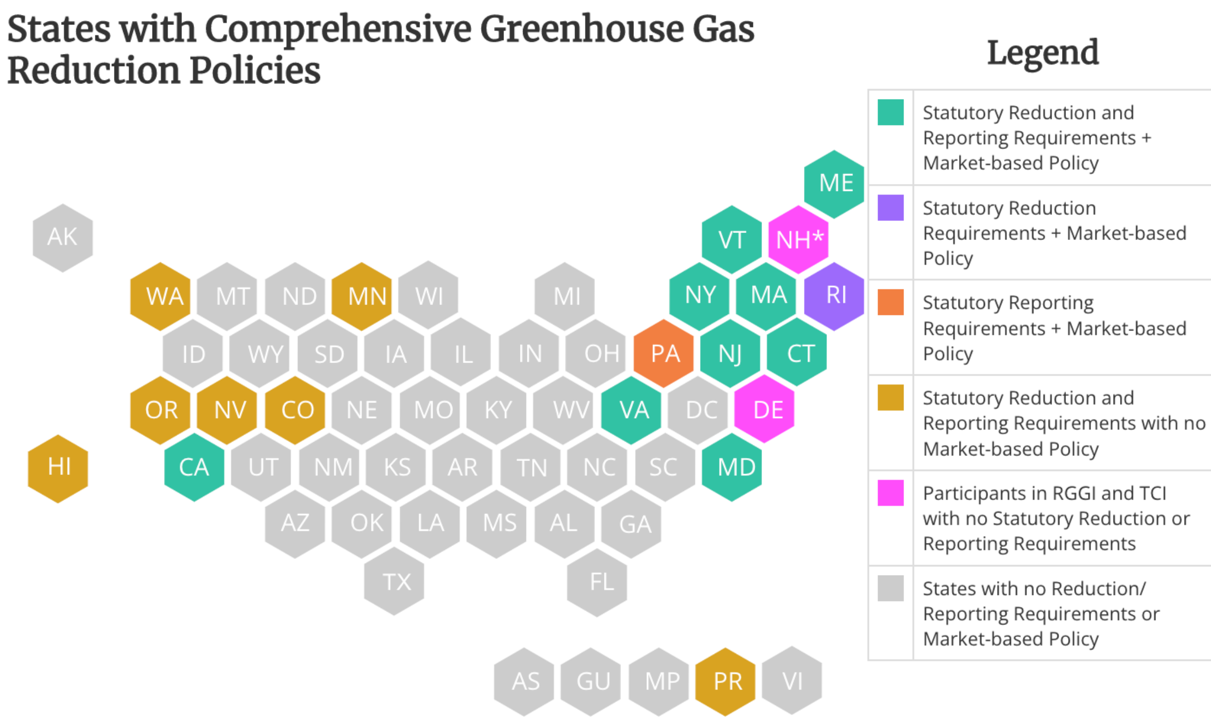

Figure 20: Cap-and-Trade Programs in the United States[88]

New York is part of the Regional Greenhouse Gas Initiative, an emissions market for electric power generation in Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont and Virginia.[89] New York was part of a coalition of northeast states investigating a cap-and-trade program for transportation

[87] "Carbon Pricing Dashboard," Website, The World Bank, 2022.
[88] Shield, Laura, "Greenhouse Gas Emissions Reduction Targets and Market-based Policies," Website, National Conference of State Legislatures, September 22, 2021.
[89] "The Regional Greenhouse Gas Initiative (RGGI): Carbon Dioxide (CO2) Budget Trading Program," Website, Department of Environmental Conservation, New York State.

emissions, but that effort has slowly unwound over the past two years.[90] With nearly half of all carbon emissions in the state of New York coming from the transportation sector, the Regional Greenhouse Gas Initiative as it is today leaves the largest single source of carbon emissions untouched by pricing mechanisms.[91]

In the absence of a cap-and-trade program for transportation, a clean fuel standard can abate carbon emissions while helping develop the low carbon intensity fuel market. Stephen Holland, a leading economist in the study of clean fuel standards, conducted a prominent economic analysis finding that a properly designed clean fuel standard is more efficient than a cap-and-trade program when "regulatory leakage" is a problem, like when environmental damages regulated in one state are experienced by another state not subject to that regulation.[92] With only 22% of global emissions currently facing a carbon price, carbon emissions present a clear case of regulatory leakage.[93]

If New York were to enact a cap-and-trade program for transportation, a clean fuel standard would be a valuable complement in the state's energy transition policy portfolio. While cap-and-trade is a powerful tool for abating carbon, it does not have a clean fuel standard's distinct mechanism of credits, which encourages development of new low-carbon intensity fuel technology by rewarding production of low carbon intensity fuels.

Federal Renewable Fuel Standard

The federal Renewable Fuel Standard mandates that transportation fuel sold in the United States meet goals for minimum volume of renewable fuels.[94] The Renewable Fuel Standard was first adopted as part of the Energy Policy Act of 2005 then was expanded under the Energy Independence and Security Act of 2007. The Energy Independence and Security Act sets volume requirements for each renewable fuel category and the Environmental Protection Agency updates these volume requirements year to year based on statutory guidance and fuel availability. Conventional biofuel, cellulosic biofuel, biomass-based diesel, and other advanced fuels are mandated under the standard.

[90] Brody, Sharon, "Massachusetts pulled out of a regional emissions pact. Here's what that means," radio news, WBUR, November 21, 2021.
[91] "Energy-Related CO2 Emission Data Tables," Website, Environment, U.S. Energy Information Administration, April 13, 2022.
[92] Holland, Stephen P. "Emissions taxes versus intensity standards: Second-best environmental policies with incomplete regulation." Journal of Environmental Economics and management 63, no. 3 (2012): 375-387.
[93] "Carbon Pricing Dashboard," Website, The World Bank, 2022.
[94] "Renewable Fuel Standard," Website, Alternative Fuels Data Center, U.S. Department of Energy: Energy Efficiency & Renewable Energy.

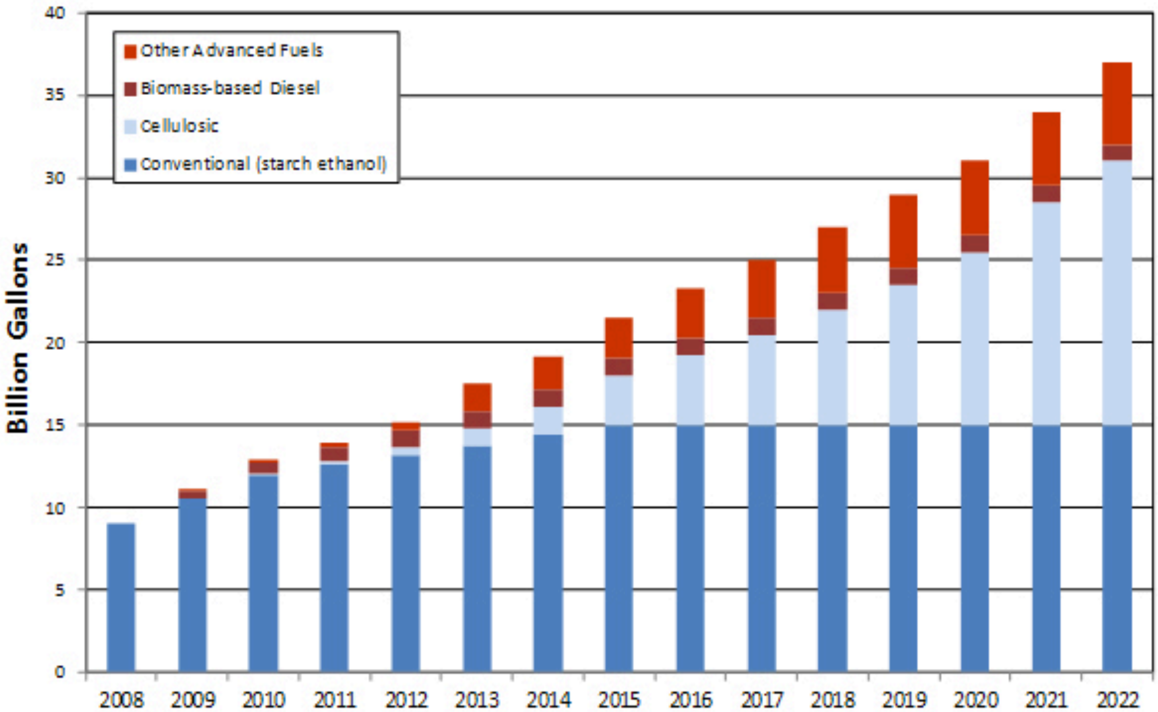

Figure 21: Renewable Fuel Standard mandated volumes by year[95,96]

The Renewable Fuel Standard mandates have increased the amount of biofuel in gasoline and diesel in the United States and developed the first-generation ethanol industry.[97] However, a notable feature of the Renewable Fuel Standard is its focus on specific liquid biofuels to the exclusion of other alternative transportation fuels such as electricity and hydrogen. The technology-neutral approach of a clean fuel standard provided by its performance-based carbon intensity metric provides policy support for introduction of a broader range of low-carbon intensity fuels including electricity, green hydrogen, renewable natural gas, and others to the transportation fuel market.

Economists at the University of Missouri and USDA also find that California's Low Carbon Fuel Standard and the federal Renewable Fuel Standard reinforce one another since compliance costs for one policy are lower in the presence of another.[98] The incentives for production of biofuels created by both programs supplemented by the LCFS's decreasing carbon intensity standard ensure that low-carbon biofuels advance both environmental and economic goals in California.

[95] "Renewable Fuel Standard," Website, Alternative Fuels Data Center, U.S. Department of Energy: Energy Efficiency & Renewable Energy.
[96] Note this chart illustrated mandated volumes, not actual volumes of biofuels in the fuel mix, since noncompliance may result in lower volumes than shown here.
[97] Kesan, Jay P., Hsiao-Shan Yang, and Isabel F. Peres. "An empirical study of the impact of the renewable fuel standard (RFS) on the production of fuel ethanol in the US." Utah L. Rev. (2017): 159.
[98] Whistance, Jarrett, Wyatt Thompson, and Seth Meyer. "Interactions between California's low carbon fuel standard and the national renewable fuel standard." Energy Policy 101 (2017): 447-455.

Researchers at the University of California, Davis estimate that California's Low Carbon Fuel Standard along with the federal Renewable Fuel Standard and tax credits provided an incentive of roughly $1.50-2.00 per gallon for breakthrough biofuel technologies.[99] These researchers note, though, that creating a strong program that provides sufficient incentive for breakthrough technology may require more stringent standards, stronger policy incentives, and financial mechanisms for innovators.

Other Policies

Fuel economy standards, which on the Federal level are governed by the Department of Transportation (miles per gallon) and EPA (carbon emissions per mile), are another tool for reducing emissions, with a goal of reducing the consumption of gasoline and also the carbon emitted when it is burned. The Department of Transportation governs mile per gallon standards and the EPA governs carbon emission per mile standards.

Fuel economy standards on their own can increase driving by lowering its cost. The lower carbon intensity required by a clean fuel standard may offset or exceed this effect to reduce average carbon emissions in transportation. Fuel economy standards and clean fuel standards further complement one another when low-carbon fuels have favorable attributes that also improve engine performance, another situation where compliance with one standard lowers compliance costs when deployed with another standard.

Currently 45 states and the District of Columbia provide incentives for electric vehicles, either through a utility operating in the state or through state legislation.[100] **Electric vehicle subsidies** reduce the up-front cost of electric vehicles for consumers and make it easier for consumers to consume electricity as a transportation fuel. New York offers a rebate of $2,000 for electric vehicle purchasers, which combined with a federal tax credit can reduce the cost of purchasing an electric vehicle by nearly $10,000.[101] These policies complement a clean fuel standard by reducing the up-front price of a vehicle and allowing consumers of transportation fuel to take advantage of fuel that enjoys incentives from a clean fuel standard. A clean fuel standard also encourages public and private investment in the charging network needed to support electric vehicle adoption. Clean fuel standards also encourage charging electric vehicles with low or zero carbon electricity, helping to decarbonize the grid power sector.

Clean fuels standards can also lead to significant private investment in charging infrastructure by enabling charging operators to claim credits for electric vehicle fuel production. Clean fuel standards like that proposed for New York often require electrification investments by utilities that earn credits from the clean fuel standard program, providing funding for electrification projects.

[99] Morrison, Geoff M., Julie Witcover, Nathan C. Parker, and Lew Fulton. "Three routes forward for biofuels: Incremental, leapfrog, and transitional." Energy Policy 88 (2016): 64-73.
[100] Hartman, Kristy and Laura Shields, "State Policies Promoting Hybrid and Electric Vehicles," Website, National Conference of State Legislatures, April 26, 2022.
[101] "Drive Clean Rebate for Electric Cars," Website, New York State Energy Research & Development, 2022.

Currently 14 states, including New York, have **Zero emission vehicle mandates** that require introduction of zero emission vehicles into the fleet of cars produced in the state.[102] New York also announced a regulation to transition to zero-emission trucks in December.[103]

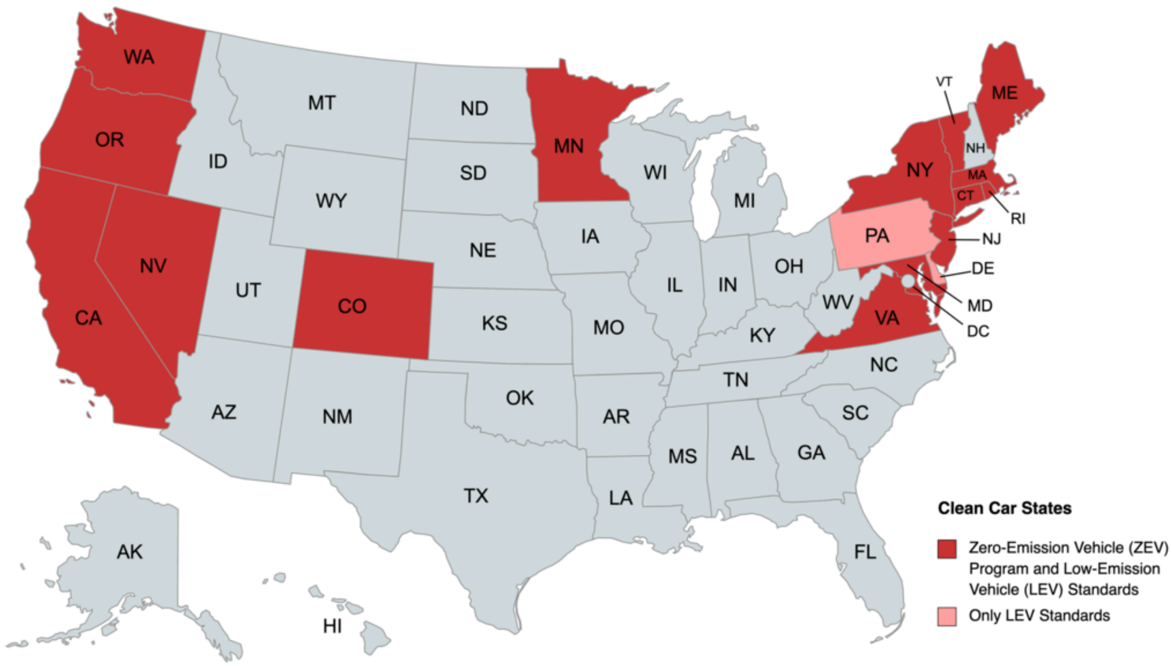

Figure 23: States with Zero-Emission Vehicle Programs[104]

Analysts at the Laurier Centre for Economic Research and Policy Analysis find that a clean fuel standard combined with a zero emission vehicle mandate can be effective at reducing greenhouse gas emissions in the transportation sector.[105] Much like the federal Renewable Fuel Standard, state Zero Emission Vehicle (ZEV) Programs, the Advanced Clean Truck rule in New York, and clean fuel standards go hand in hand, with compliance with one standard lowering the cost for compliance with the other.

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[102] "States that have Adopted California's Vehicle Standards under Section 177 of the Federal Clean Air Act," Website, California Air Resources Board, March 17, 2022.
[103] "Governor Hochul Announces Adoption of Regulation to Transition to Zero-Emission Trucks," Press Release, Governor's Office, State of New York, December 30, 2021.
[104] "Why US states should adopt California's Zero-Emission Vehicle Program," Website, The Climate Group, December 7, 2021.
[105] Rivers, Nicholas, and Randall Wigle. "An evaluation of policy options for reducing greenhouse gas emissions in the transport sector: The cost-effectiveness of regulations versus emissions pricing." Laurier Centre for Economic Research and Policy Analysis Working Papers 107 (2018).

Cost-benefit analysis of a clean fuel standard for New York

New York Senate Bill S2962B proposes a clean fuel standard for the state of New York to reduce carbon intensity of transportation fuels by 20% by 2030. In order to evaluate the proposed legislation from the standpoint of economic efficiency, we conduct a cost-benefit analysis of the social costs and benefits of the policy compared to the baseline of the status quo.

Baseline

All estimates made of the costs and benefits of this policy are measured against a status quo baseline of no adoption of a clean fuel standard for New York through 2050.

Costs

While credits constitute a cost for providers of high carbon intensity transportation fuels, credit purchases also confer an equal benefit to providers of low carbon intensity transportation fuels who sell the credits. These transfer payments amount to a total of zero net cost to society.

A cost that society does accrue due to a clean fuel standard is one-time **infrastructure costs** associated with supporting the distribution and use of alternative fuels. An ex-ante analysis of Washington State's clean fuel standard simulated infrastructure costs associated with scenarios to meet a 10% carbon intensity reduction by 2026.[106] We use the most costly scenario, a scenario where infrastructure costs exceed the "business as usual" scenario by $1.5 billion, in order to derive an upper-end estimate for infrastructure costs for a clean fuel standard for New York. We then adjust this estimate based on the size of New York's fuel industry compared to Washington's and the cost of supporting the more stringent 20% carbon intensity reduction standard in order to estimate the cost of infrastructure for a New York clean fuel standard.

Benefits

To assess the benefits of a clean fuel standard for New York, we estimate the **energy security**, **carbon emission** reduction, and **local emission** reduction benefits associated with its adoption.

To estimate the **energy security** benefit of a clean fuel standard, we use Bureau of Transportation Statistics estimates for gasoline and diesel fuel consumption in New York as a

[106] Pont, Jennifer et al, "A Clean Fuel Standard in Washington State: Revised Analysis with Updated Assumptions," Final Report LCA 8056.98.2014, December 14, 2014, Available Online: https://ofm.wa.gov/sites/default/files/public/legacy/reports/Carbon_Fuel_Standard_evaluation_2014_final.pdf

baseline measure then estimate the reduction in gallons of gasoline and diesel fuel using Washington State's ex ante simulations for reductions in gasoline and diesel consumption with adoption of a 10% carbon intensity reduction clean fuel standard.[107,108] We equate this gasoline and diesel fuel reduction to the number of barrels of oil that would be avoided and multiply that by the monetized energy security benefit per barrel from researchers at Oak Ridge National Laboratory to come up with a 10% carbon intensity reduction energy security benefit.[109] We then scale up this estimate by a factor of 1.5 to 2 to estimate the energy security value of a 20% carbon intensity reduction clean fuel standard.

To estimate the **carbon emission** reduction benefit, we start with total carbon emissions from the transportation sector as reported by the Energy Information Administration.[110] We then use quasi-experimental findings on the impact of a 10% carbon intensity reduction in California to estimate the impact of a 10% reduction in New York and scale up the estimated metric tons of carbon abated to match the proposed 20% carbon intensity reduction.[111] We multiply the total number of metric tons of carbon abated by the Biden Administration's $51 social cost of carbon, to arrive at the carbon emission reduction benefit.

To estimate the value of **local emissions** reductions, we start with the Oregon Department of Environmental Quality's estimate of lives saved from local emissions by the Oregon Clean Fuels Program then estimate how many lives would be saved in New York based on higher levels of gasoline consumption and a lower carbon intensity clean fuel standard.[112,113] We then multiply the estimated saved lives by value of a statistical life estimates from the Environmental Protection Agency and Department of Transportation to estimate the total value of risk of death reduction generated by local emission reductions from a New York clean fuel standard.[114,115]

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[107] "State Transportation Sector Energy Consumption," Bureau of Transportation Studies, United States Department of Transportation, Available Online: https://www.bts.gov/browse-statistical-products-and-data/state-transportation-statistics/state-transportation-sector

[108] Pont, Jennifer et al, "A Clean Fuel Standard in Washington State: Revised Analysis with Updated Assumptions," Final Report LCA 8056.98.2014, December 14, 2014, Available Online: https://ofm.wa.gov/sites/default/files/public/legacy/reports/Carbon_Fuel_Standard_evaluation_2014_final.pdf

[109] Leiby, Paul N., and Jonathan Rubin. "Energy security implications of a national low carbon fuel standard." Energy Policy 56 (2013): 29-40.

[110] "2019 State energy-related carbon dioxide emissions by sector," Energy-Related CO2 Emission Data Tables, U.S. Energy Information Administration, April 13, 2022.

[111] Huseynov, Samir, and Marco A. Palma. "Does California's Low Carbon Fuel Standards reduce carbon dioxide emissions?." PloS one 13, no. 9 (2018): e0203167.

[112] "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.

[113] "Table F3: Motor gasoline consumption, price, and expenditure estimates, 2020," U.S. States: State Profiles and Energy Estimates, Website, U.S. Energy Information Administration, 2022.

[114] "Mortality Risk Valuation," Environmental Economics, Website, United States Environmental Protection Agency, March 30, 2022.

[115] Moran, Molly J. and Carlos Monje, "Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in the U.S. Department of Transportation Analyses – 2016 Adjustment," Memorandum, Office of the Secretary of Transportation, U.S. Department of Transportation, August 8, 2016.

Discounting and key assumptions

We assume infrastructure spending is spread evenly across the years 2023-2030 to allow for linear adoption of technology to meet a 20% carbon intensity reduction by 2030. We assume benefits increase linearly from 2023 until 2030, when they are fully realized, then continue at the same level for years after that. We estimate benefits from 2023 until the midcentury mark of 2050. We discount future year costs and benefits at a rate of 7% to conservatively estimate present bias toward the value of public funds.

A key assumption that undergirds much of the analysis of benefits and costs is that states that have implemented clean fuel standards or that have had ex-ante analysis conducted are generally comparable to New York. We make adjustments for the size of the state's industries to account for some of these differences, but differences in behavioral responses by providers and consumers of transportation fuel may lead to different results than what we find here. We employ conservative assumptions and sensitivity analysis throughout the study to minimize the impact of this assumption on results. We detail additional assumptions in this section of the report as well as in Appendix B: Technical Documentation.

Sensitivity Analysis

We conduct sensitivity analysis for this cost-benefit analysis by running inputs through a Monte Carlo simulation of 10,000 scenarios based on a range of possible outcomes for how idiosyncrasies between New York and comparison states, scale-up differences, ranges of effect sizes in the literature, and ranges in valuation impact cost-benefit estimates. We report benefit estimates at the 5th percentile and cost estimates at the 95th percentile as "low-end" estimates, benefit and cost estimates at the 50th percentile as "median" estimates, and benefit estimates at the 95th percentile and cost estimates at the 5th percentile as "high-end" estimates for net benefits of a clean fuel standard for New York.

We also test a range of discount rates and social cost of carbon estimates and settle on the most conservative estimates within reason. The results of this analysis should be considered a conservative estimate of the net benefit and benefit/cost ratios associated with adoption of a 20% carbon intensity clean fuel standard for New York.

Results

We project the proposed clean fuel standard in New York will reduce annual oil consumption by 8-25 million barrels, will reduce annual carbon emissions by 13-20 million metric tons, and will save 24-43 lives per year from reduced local emissions, at a cost of $1.8-3.8 billion in discounted infrastructure investments made through 2030. This will lead to a total of $4.2-17 billion in net present value of the policy through 2050, generating $2.09 to $10.16 in benefits for every dollar of costs.

Impact	**Low-End Scenario**	**Median Scenario**	**High-End Scenario**
Infrastructure Costs	$3.8 billion	$2.7 billion	$1.8 billion
Energy Security	8 million fewer barrels of oil consumed annually	16 million fewer barrels of oil consumed annually	25 million fewer barrels of oil consumed annually
	$850 million	$2.3 billion	$5.1 billion
Carbon Emissions	13 million metric tons of CO_2 abated annually	16 million metric tons of CO_2 abated annually	20 million metric tons of CO_2 abated annually
	$6.6 billion	$8.1 billion	$10 billion
Local Emissions	24 lives saved annually	32 lives saved annually	43 lives saved annually
	$550 million	$1.9 billion	$3.7 billion
Midcentury Net Present Value	**$4.2 billion**	**$9.6 billion**	**$17 billion**
Benefit-Cost Ratio	**$2.09**	**$4.53**	**$10.16**

Table 5: Cost-benefit analysis results

Figure 24 shows the relative size of discounted costs and benefits in the median benefit and cost simulated estimates. In this scenario, the absolute magnitude of discounted infrastructure costs is larger than the discounted benefits of either energy security or local emissions benefits but smaller than carbon emissions benefits.

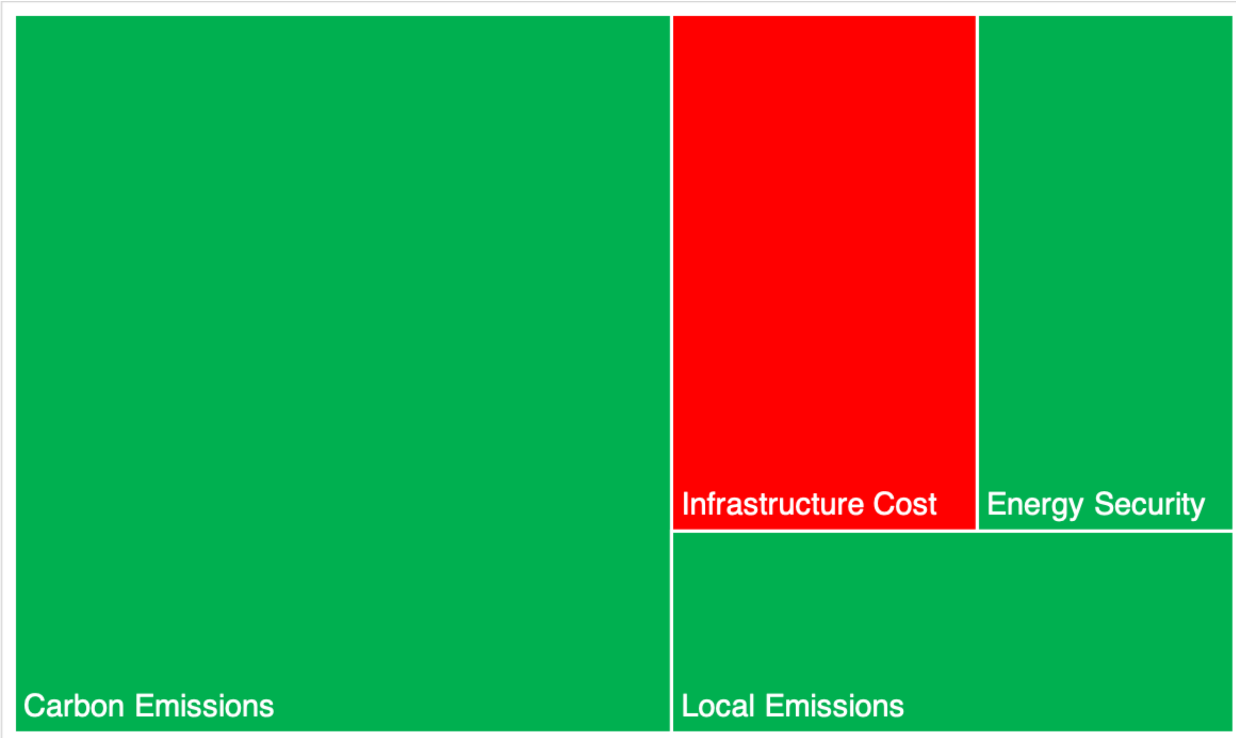

Figure 24: Median simulated cumulative benefit and cost magnitudes for New York clean fuel standard through 2050

With the proposed policy phasing in from 2023 to 2030, infrastructure costs will be accrued earlier while emissions and security benefits will be realized later. This means that costs will outweigh benefits until as early as 2024 and as late as 2033 depending on the simulated scenario. Figure 25 shows the cumulative net benefits of a clean fuel standard from 2023 to 2050 under the median scenario. In this scenario, cumulative benefits first outweigh cumulative costs in 2027.

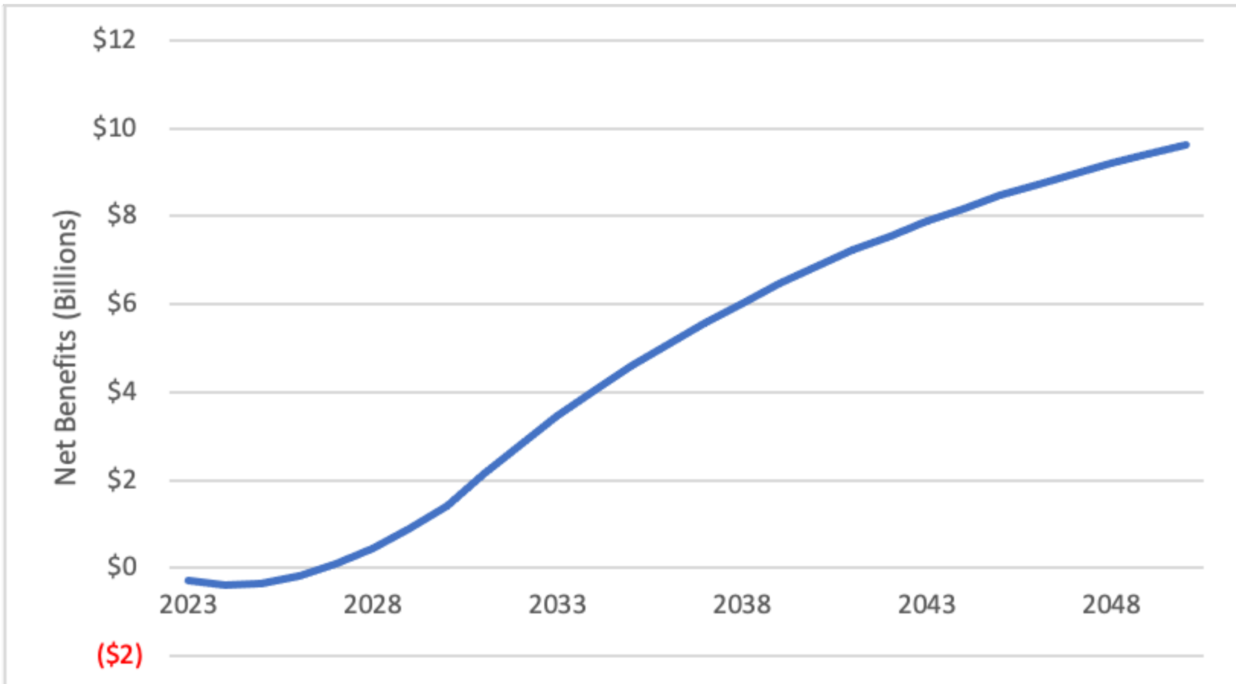

Figure 25: Cumulative net benefits of a New York clean fuel standard from 2023 to 2050, median simulated cumulative benefit and cost magnitudes

Clean fuel standard and environmental justice

Market-based policies to slow climate change are effective at abating carbon, but some worry about the local impacts of these policies on disadvantaged communities. Available evidence shows clean fuel standards have the ability to advance equity and environmental justice concerns by improving health in marginalized communities, reducing risk for children, the elderly, and those with asthma, and providing a source of income in rural agrarian communities.

Health impact on marginalized and disadvantaged communities

A 2014 study of six U.S. cities including New York, New York examined exposure to NO_X and PM 2.5 among people in neighborhoods with certain ethnic groups over- or underrepresented.[116] One of the central findings of the study was that neighborhoods with large Hispanic populations were exposed to higher PM2.5 and significantly higher NO_X concentrations compared with those in neighborhoods with standard or small Hispanic populations. This evidence was mirrored in another study of New York City, which suggested

[116] Jones, Miranda R., Ana V. Diez-Roux, Anjum Hajat, Kiarri N. Kershaw, Marie S. O'Neill, Eliseo Guallar, Wendy S. Post, Joel D. Kaufman, and Ana Navas-Acien. "Race/ethnicity, residential segregation, and exposure to ambient air pollution: the Multi-Ethnic Study of Atherosclerosis (MESA)." American journal of public health 104, no. 11 (2014): 2130-2137.

Latinos, those without a high school degree, and people in poverty were most likely to be exposed to above-average levels of particulate matter in the city.[117]

This evidence suggests a clean fuel standard could have disproportionately large benefits for neighborhoods with large Hispanic or other disadvantaged populations, with residents of these neighborhoods reducing their exposure to NO_X and PM 2.5 emissions and the respiratory illness, emergency room and hospital admission visits, and mortality impacts associated with them. A clean fuel standard can also reduce other health risks in these areas. A model of the health effects of replacing conventional ultra-low sulfur diesel with biodiesel found that communities in New York City could benefit from reduced cancer risk from exposure to toxic air pollution.[118]

Cerulogy's analysis of a clean fuel standard for New York estimates that directing electrification investments toward disadvantaged communities could make $100 million available to help reduce disparities between communities and reduce the impact of historic patterns of discrimination.[119]

Senate Bill S2962B, the current clean fuel standard in the New York State Senate, includes a provision that would require 40% of credit value on electrified transportation programs, projects, and investments to directly benefit disadvantaged communities.[120] California's Low Carbon Fuel Standard has resulted in utilities such as Southern California Edison dedicating charging investments to disadvantaged and low-income communities.[121]

Health impact on age and health subgroups

In addition to geography and socioeconomic status, life stage and health conditions can make people more susceptible to the poor health effects of local emissions. Children, the elderly, and people with asthma are at greater risks for poor health impacts from exposure to NO_X.[122] Figure 28 shows that counties upstate of the Hudson Valley have higher prevalence levels of asthma, suggesting their residents are likely to disproportionately enjoy the health co-benefits of reductions in NO_X emissions brought about by a state clean fuel standard.

[117] Maroko, Andrew R. "Using air dispersion modeling and proximity analysis to assess chronic exposure to fine particulate matter and environmental justice in New York City." Applied Geography 34 (2012): 533-547.
[118] Adkins, Jeffrey et al, "Assessment of Health Benefits from Using Biodiesel as a Transportation Fuel and Residential Heating Oil," Report, Trinity Consultants.
[119] Malins, Chris, "New York's Clean Fuel Future," Report, Cerulogy, March 2020.
[120] "Senate Bill S2962B," New York State Senate, 2021-2022 Legislative Session.
[121] "SCE launches $436M Charge Ready program to install 38,000 EV chargers in Southern California," Blog Post, Green Car Congress, July 13, 2021.
[122] "Basic Information about NO2," Nitrogen Dioxide (NO2) Pollution, Online, United States Environmental Protection Agency, June 7, 2021.

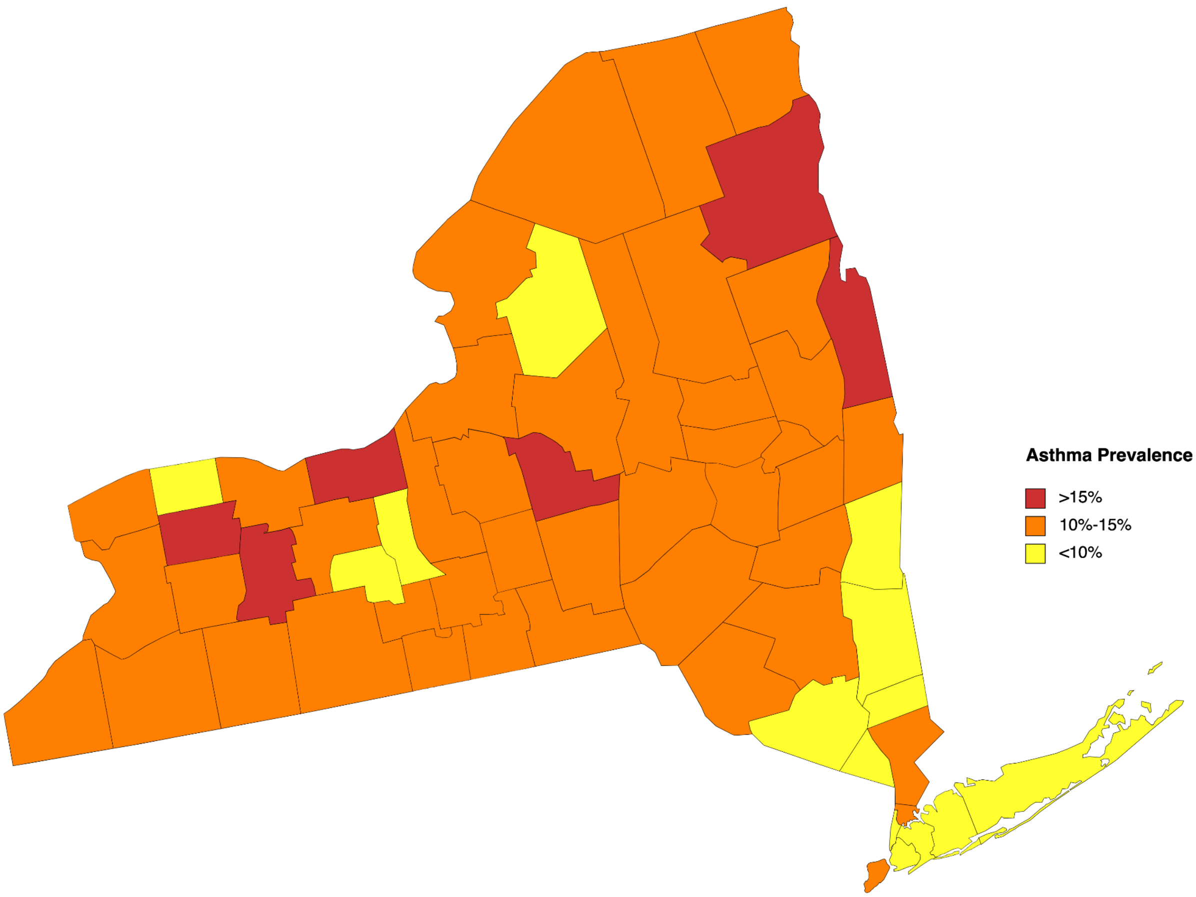

Figure 28: Asthma prevalence by county[123]

[123] "Asthma Dashboard - County Level," Database, Department of Health, New York State, February 2022.

Appendix A: Oregon's Clean Fuels Program Standards

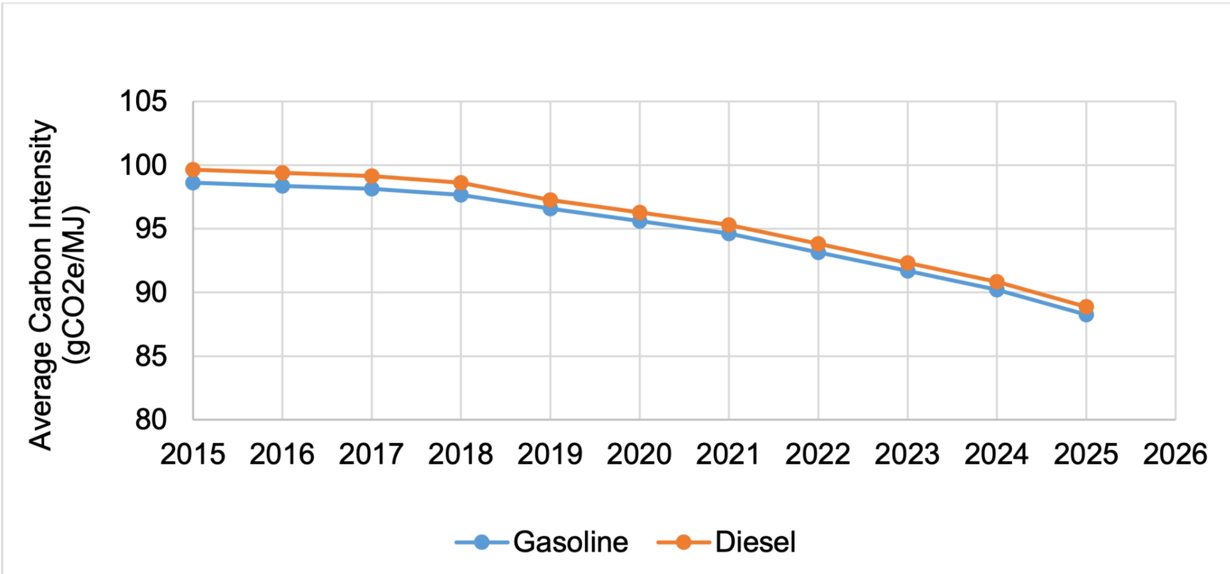

Figure 28: Standards for Oregon's Clean Fuels Program from 2015 to 2025[124]

Appendix B: Cost-Benefit Technical Documentation

The core model for the cost-benefit analysis was run through a Monte Carlo simulation that was then used to generate low-end (5th percentile for each benefit category and 95th percentile for infrastructure costs), median (50th percentile for all cost and benefit categories), and high-end (95th percentile for each benefit category and 5th percentile for infrastructure costs) benefit and cost estimates for the four impact categories. Infrastructure costs were assumed to be equally shared from 2023-2030 then stop accruing after 2030. Energy security and emissions benefits are assumed to increase linearly from zero in 2022 to full simulated levels in 2030, then stay constant after that year. A 7% discount rate is applied to all costs and benefits with 2023 as the first year of the program.

Below are details on constructions of models for the cost and benefit categories.

Infrastructure Costs

Simulations from Washington state estimated that infrastructure costs in the most expensive simulated scenario for a 10% carbon intensity reduction clean fuel standard would

[124] "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.

reach $1.5 billion.[125] Bureau of Transportation Statistics estimates show us that New York's transportation fuel consumption is 80% higher than Washington State's.[126] Factoring in economies of scale, we assumed infrastructure costs for New York must be 125% to 180% of Washington's.

We then adjusted this estimate to project what a 20% carbon intensity reduction clean fuel standard would cost compared to a 10% standard in Washington. Economies of scale should also help reduce the need for higher infrastructure costs, so we assumed infrastructure costs of a 20% carbon intensity reduction clean fuel standard must be 101% to 200% the costs of a 10% carbon intensity reduction clean fuel standard. 10,000 randomly generated multipliers for each of these assumptions were used to generate 10,000 estimates for infrastructure costs for a 20% carbon intensity reduction clean fuel standard for New York.

Energy Security

Washington state simulations estimated gasoline consumption would drop by 0-10% and diesel consumption would drop by 16% through the institution of a 10% carbon intensity clean fuel standard.[127] We use Bureau of Transportation Statistics numbers to estimate New York could reduce diesel consumption by 210 million gallons and gasoline consumption by zero to 550 million gallons (0-10% of total consumption) with an equally effective 10% carbon intensity clean fuel standard.[128]

We use this range of possible gasoline and diesel consumption reduction magnitudes to estimate the range of number of barrels of oil that would not be consumed due to this reduction then multiply this by the $5-22 range of possible per-barrel energy security benefits estimated by researchers at Oak Ridge National Laboratories to estimate total energy security benefit of a 10% carbon intensity clean fuel standard for New York.[129] We then assume a 20% carbon intensity clean fuel standard would be between 150% and 200% as effective as a 10% carbon intensity clean fuel standard at abating oil consumption, with lower levels possible due to troubles with scale-up or less substitution as reduction of diesel and gasoline consumption becomes more expensive. 10,000 randomly generated multipliers for each of these assumptions were used to generate 10,000 estimates for energy security benefits for a 20% carbon intensity clean fuel standard for New York.

[125] Pont, Jennifer et al, "A Clean Fuel Standard in Washington State: Revised Analysis with Updated Assumptions," Final Report LCA 8056.98.2014, December 14, 2014, Available Online: https://ofm.wa.gov/sites/default/files/public/legacy/reports/Carbon_Fuel_Standard_evaluation_2014_final.pdf
[126] "State Transportation Sector Energy Consumption," Bureau of Transportation Statistics, United States Department of Transportation, Available Online: https://www.bts.gov/browse-statistical-products-and-data/state-transportation-statistics/state-transportation-sector
[127] Pont, Jennifer et al, "A Clean Fuel Standard in Washington State: Revised Analysis with Updated Assumptions," Final Report LCA 8056.98.2014, December 14, 2014, Available Online: https://ofm.wa.gov/sites/default/files/public/legacy/reports/Carbon_Fuel_Standard_evaluation_2014_final.pdf
[128] "State Transportation Sector Energy Consumption," Bureau of Transportation Statistics, United States Department of Transportation, Available Online: https://www.bts.gov/browse-statistical-products-and-data/state-transportation-statistics/state-transportation-sector
[129] Leiby, Paul N., and Jonathan Rubin. "Energy security implications of a national low carbon fuel standard." Energy Policy 56 (2013): 29-40.

Carbon Emissions

New York's transportation sector emits a little under 80 million metric tons of carbon annually.[130] Using the low of 9.85% and the high of 13.28% reduction in carbon emissions found in the three quasi-experimental methods used in the Texas A&M study of carbon emissions we estimate the number of metric tons that would be abated by a 10% carbon intensity reduction clean fuel standard for New York.[131] This study was selected over other studies of carbon emission reduction by clean fuel standards due to its strong research design and methodological transparency.

We then assume a 20% carbon intensity clean fuel standard would be between 50% and 100% more effective than a 10% carbon intensity clean fuel standard, with lower levels possible due to troubles with scale-up or less substitution as reduction of diesel and gasoline consumption becomes more expensive. We value carbon abated at $51 per metric ton, the dollar figure used by the Biden Administration and a conservative valuation compared to estimates put forth by the Intergovernmental Panel on Climate Change and leading environmental economists. 10,000 randomly generated multipliers for each of these assumptions were used to generate 10,000 estimates for carbon emission benefits for a 20% carbon intensity clean fuel standard for New York.

We also note that the Texas A&M study bases findings about California on data up to 2014, which is only four years into the implementation of the program. Our assumption that benefits are not realized for seven years is a conservative assumption and if the New York clean fuel standard works as quickly as the California clean fuel standard, benefits will be realized earlier and total net benefits will be higher.

Local Emissions

The Oregon Department of Environmental Quality estimates the state's 25% carbon intensity reduction Clean Fuel Program will reduce deaths from local emissions by 12 per year by the time it is fully implemented in 2035.[132] Since gasoline consumption in New York is 340% as high as in Oregon, we assume the impact of a clean fuel standard on deaths will be 290% to 390% as high in New York as in Oregon. Since New York's clean fuel standard will set a carbon intensity standard at 20% rather than 25%, we assume the standard will be 0-40% less effective in New York than in Oregon.

Since the Environmental Protection Agency's Value of a Statistical Life is $10.6 million and the Department of Transportation's is $11.5 million, we use those as the bound of possible value of a statistical life for purposes of risk of death reduction benefits derived from reductions in local emissions. 10,000 randomly generated multipliers for each of these assumptions were

[130] "2019 State energy-related carbon dioxide emissions by sector," Energy-Related CO2 Emission Data Tables, U.S. Energy Information Administration, April 13, 2022.
[131] Huseynov, Samir, and Marco A. Palma. "Does California's Low Carbon Fuel Standards reduce carbon dioxide emissions?." *PloS one* 13, no. 9 (2018): e0203167.
[132] "Oregon Clean Fuels Program," Program Review, Submitted to the 2022 Oregon Legislature, Oregon Department of Environmental Quality, February 1, 2022.

used to generate 10,000 estimates for local emission benefits for a 20% carbon intensity clean fuel standard for New York.